ECONOMIC DETERMINANTS OF ENERGY INTENSITY: A COUNTRY PANEL ANALYSIS

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ABSTRACT

Efforts to lower energy intensity increased initially as a result of rising fuel prices following the first and second oil shocks, which subsequently became serious owing to mounting evidence that fossil fuels are a major cause of climate change and global warming. Energy source is a key problem associated with climate change as oil and gas, and coal constitute major components of fossil fuels. However, the extant literature remains divided on the determinants of energy intensity. For the purpose of filling this gap, this study modeled energy intensity and used panel annual data from 84 countries, (divided to stable and unstable countries for the second research question) from 1980 to 2012. In order to find out the sign and magnitude of the relationships, the current study applied Generalized Method of Moments (GMM). The first research question investigates the relationship between trade and energy intensity in global panel and the effects of exports, imports and export diversification is tested by including them separately in the energy intensity model. FDI, urbanization and industrialization are also included in the model. Results revealed that trade openness significantly and positively affect energy intensity, through increase in the economic activities. Similarly, exports and imports have significant and positive effects on energy intensity. Export diversification positively and significantly affect energy intensity, determining the fact that the more diversity of exports production, results in less energy intensity. Results show that energy prices and urbanization are not statistically significant in all of the estimations. FDI represents highly significant contribution in improving energy efficiency and decrease of energy intensity in all of the models. Increase in industrialization will lead to increase in energy intensity in all of the estimations. Results of the second research question revealed that, FDI in particular has a highly significant contribution towards lowering energy-intensity, as its coefficients were negative and highly significant

at 1 percent in all three groups of countries. However, urbanization had no impact on energy intensity levels in all three groups of countries, while industrialization and trade exacerbated energy intensity in the global panel of countries. Whereas trade showed no relationship with energy intensity among stable and unstable countries, industrialization worsened energy intensity among stable countries. Institutional quality had a highly significant (1 percent) and positive impact on reducing energy intensity in all three groups of countries. The third research question of this study is regarding the direction of relationship between institutional quality and energy intensity in global panel. Prior to Granger causality test, the stationary properties of variables are tested applying Im–Pesaran–Shin (IPS) and Levin–Lin–Chu (LLC) panel unit root tests. Based on the results from these tests, both energy intensity and institutional quality are stationary. Applying GMM estimation, panel VAR model is estimated which is followed by panel VAR Granger causality Wald test. Results of Granger causality test shows that there is unidirectional causality running from institutional quality to energy intensity. The quality of environment is considered as a public good and provision of public goods are affected by the institutional quality.

Keywords: Energy Intensity, Generalized Method of Moments, Institutional Quality, Trade, Granger Causality Test

ABSTRAK

Usaha bagi merendahkan keamatan tenaga telah meningkat berpunca daripada peningkatan harga minyak pada mulanya kemudian diikuti kejutan minyak yang pertama dan yang kedua, disusuli oleh penemuan bukti yang kukuh bahawa bahan api fosil merupakan penyebab utama kepada perubahan iklim dan pemanasan global. Sumber tenaga merupakan masalah utama perubahan iklim kerana minyak dan gas serta arang adalah komponen utama bagi bahan api fosil. Walaupun demikian, literatur yang luas terbahagi pada penentu keamatan tenaga. Oleh hal yang demikian, kajian ini mengikuti model keamatan cahaya dan mengunakan panel data tahunan daripada 84 negara (dibahagikan kepada negara stabil dan tidak stabil untuk persoalan kajian yang kedua) daripada tahun 1980 sehingga 2012. Kajian ini mengaplikasi *Generalize Method of Moment* (GMM) untuk menentukan punca dan magnitud hubugan kajian. Persoalan kajian yang pertama adalah untuk menyiasat hubungan diantara perdagangan dan keamatan tenaga di panel global dan juga kesan eksport, kepelbagaian import dan export diuji dengan cara meletakkan kedua-duanya secara berasingan di dalam model keamatan cahaya. Pelaburan Langsung Asing, urbanisasi dan pengindustrian turut disertakan di dalam model ini. Keputusan menunjukkan bahawa perdagangan terbuka mempunyai kesan yang ketara dan mempengaruhi keamatan tenaga secara positif, melalui peningkatan aktiviti ekonomi. Import dan eksport juga mempunyai kesan yang ketara dan mempengaruhi keamatan tenaga secara positif. Kepelbagaian eksport memberi impak yang positif dan ketara terhadap keamatan tenaga, mengesahkan fakta bahawa pertambahan kepelbagaian produk yang dieksport akan mengurangkan keamatan tenaga. Keputusan menunjukkan harga tenaga dan urbanisasi tidak penting secara statistik dalam kesemua jangkaan. Pelaburan langsung asing (FDI) mewakili penglibatan yang tinggi di dalam memperbaik kecekapan tenaga dan mengurangkan keamatan tenaga di

dalam semua model. Peningkatan pengindustrian akan menyebabkan peningkatan keamatan tenaga di dalam semua jangkaan. Keputusan soalan kajian kedua membuktikan bahawa FDI memberikan sumbangan yang tinggi terhadap penurunan keamatan tenaga, kerana mempunyai pekali yang negatif dan amat penting kerana nilai 1% dalam ketiga-tiga kumpulan negara. Walaubagaimanapun, urbanisasi tiada impak kepada tahap keamatan tenaga di dalam ketiga-tiga kumpulan negara, sehubungan itu pengindustrian dan perdagangan memburukkan lagi keamatan tenaga di panel global kesemua negara. Sebaliknya, perdagangan tiada hubungan dengan keamatan tenaga di negara yang stabil dan tidak stabil, pengindustrian mengeruhkan lagi kadar keamatan tenaga di negara-negara yang stabil. Kualiti berinstitut mempunyai impak yang tinggi dan positif dalam mengurangkan keamatan tenaga pada ketiga-tiga kumpulan negara. Soalan kajian ketiga ialah mengenai arah hubungan di antara kualiti berinstitut dan keamatan tenaga di panel global. Merujuk ujian kasualti Granger, nilai tidak berubah pada pemboleh ubah diuji dengancara mengaplikasi Im–Pesaran–Shin (IPS) dan ujian panel unit root Levin–Lin–Chu (LLC). Berasaskan keputusan daripada kedua ujian tersebut, kedua-dua keamatan tenaga dan kualiti berinstitut tidak berubah. Mengaplikasikan jangkaan GMM, panel model VAR yang telah dijangka diikuti oleh panel VAR kasualti Granger ujian Wald. Keputisan kasualti Granger menunjukkan kasualiti berarah yang satu yang berpunca daripada kualiti berinstitut dan keamatan tenaga. Kualiti persekitaran merupakan kebaikan masyarakat dan peruntukan barangan awam ter Results of Granger causality test shows that there is unidirectional causality running from institutional quality to energy intensity. The quality of environment is considered as a public good and provision of public goods are affected by the institutional quality.

Kata Kunci: Keamatan Tenaga, Generalized Method of Moments, Kualiti Berinstitut, Perdagangan, Ujian Kasualti Granger

DEDICATION

This thesis is dedicated to ***my parents*** and ***my brother*** who supported me financially and emotionally during these years. It is also dedicated to my supervisors ***Professor Rajah Rasiah*** and ***Dr Lim Kian Ping*** who supported me with their incredible knowledge and experience throughout the time of completion of this research. Special thanks to Professor Rajah Rasiah for provision of supervision classes and being a source of inspiration and motivation to me and to the other PhD candidates. I also want to thank the Faculty of Economics and Administration staffs who were always available to provide excellent services to PhD candidates.

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LIST OF SYMBOLS AND ABBREVIATIONS

AFL	:	Affluence
AID	:	Official Development Assistance and Official Aid Inflows As a Share of GDP
AMG	:	Augmented Mean Group
AR	:	Univariate Autoregressive
ARDL	:	Autoregressive Distributed Lag
CCE	:	Common Correlated Effects Estimator Proposed by Pesaran (2006)
CCR	:	Canonical Cointegrating Regression
CO2	:	Carbon Dioxide Emissions
COP21	:	Conference of Parties Held in Paris, 2017
DMAN	:	Changing Technical Characteristics of the Manufacturing Sector
DOLS	:	Dynamic OLS
DK	:	Driscoll–Kraay
DTO	:	Changing Trade Structure
ECM	:	Error Correction Model
ECS	:	Relative Change in Economic Structure
EI	:	Energy Intensity
EIA	:	U.S. Energy Information Administration
EKC	:	The Environmental Kuznets Curve
EP	:	Energy Prices
ES	:	Energy Structure
EU	:	Energy Use

EU27 : European Union including 27 members

EX : Exports

FD : Financial Development (private credit by deposit money banks relative to GDP)

FD* : Other Definitions of Financial Development

FDI : Foreign Direct Investment

FGLS : Feasible Generalized Least Squares

FE : Fixed Effects

FEX : Foreign Innovations from Exports

FFDI : Foreign Innovations from FDI

FIM : Foreign Innovations from Imports

FMOLS : Fully Modified OLS

G : Government Expenditure

GDI : Gross Domestic Investment

GDP : Gross Domestic Product

GEC : Green Energy Consumption

GFCF : gross fixed capital formation

GHGs : Greenhouse Gases

GIPD : Domestic Industrial Output

GIPF : Industrial Output from Foreign Firms

GIPH : Industrial Output of Hong Kong, Taiwan and Macao Owned Firms

GMM : Generalized Method of Moments

HC : Interaction Between Ratio of FDI to GDP and Percentage of The Population Aged 6 and Above with at Least a College Degree

ICRG : International Country Risk Guide

IEA : International Energy Agency

IM : Imports

IMF : International Monetary Fund

IND : Industrialization (Industrial Value Added)

INV : Input in Technological Innovation

Insig. : If The Coefficient of Variable Is Insignificant

IO : Investment Ownership

IS : Industry Scale

K/L : Ratio of Capital Per Labor Which Capture The Scale, Composition and Technique Effects

L : labor force

LIB : Liberalization dummy variable

MAN : Manufacturing Value Added

MG : Mean Group

MNCs : Multinational Companies

NPAM : Nerlove Partial Adjustment Model

NREU : Non-Renewable Energy Use

OECD : Organization for Economic Co-operation and Development

OLS : Ordinary Least Squares

PD : Population Density

PCSE : Panel Corrected Standard Errors

PF : Number of Patents Filed

POP : Population

PPM : Parts per million

PRS : Political Risk Services

PW : Prais–Winsten Estimating Method

P^E/P^T : The Ratio of Purchasing Price Index for Fuels and Power to Price Index for Capital Investment

RE : Random Effects

REU : Renewable Energy Use

R&D : Research and Development

SAARC : South Asian Association for Regional Cooperation

SE : Percentage of Output Represented by State-Owned Enterprise in GDP

SEC : Sub-Sector Dummy Variable

SRD : Indigenous R&D Capital Stock

SSA : Sub-Saharan Africa

STEPLS : Stepwise Least Squares

STIRPAT : Stochastic Impacts by Regression on Population, Affluence and Technology

S.V.A : Service Sector Value Added

TECH : Technology

TI : Ratio of Imports Plus exports to GDP

TO : Trade Openness

UAE : United Arab Emirates

UNFCCC : The United Nations Framework Convention for Climate Change

UN : United Nations

UR : Urbanization

VECM	:	Vector Error Correction Model
Y	:	GDP (Gross Domestic Product)
2SLS	:	Two-Stage Least Squares

CHAPTER 1: INTRODUCTION

1.1 Introduction

Energy is one of the vital inputs for boosting economic growth and is a significant input for economic development. Machinery needs energy to power them. Before the 1970s global oil price shocks, increasing the consumption of energy was highly encouraged in all economies due to the significant relation between consumption of energy and sustainable development. After the occurrence of the oil price shocks and by the rise of climate change and global warming issues, as the main resources of energy are exhaustible, countries started to be more energy efficient. Consequently, policy makers began to devise energy conservation policies especially since the Kyoto protocol. Energy efficiency policies support a safe, reliable, affordable and sustainable energy system for the future. Hence, investigating the determinants of energy intensity as an indicator for energy efficiency is an important research topic.

This chapter provides introduction of this research by defining the main variables of the study and background information regarding energy consumption, energy efficiency and energy intensity. In addition, this chapter discusses about climate change, global warming, CO_2 emissions and the environment in general. The next part is problem statement that explains the problems that this study attempts to address. In addition, research questions of this research are presented in the next section, which is followed by the significance and the scope of this study. The final part is the organization of study that explains the next chapters of this research.

1.2 Background of Study

Energy is a fundamental requirement of human life as people cannot live without it. All types of transportation systems including different types of vehicles, planes and trains, every single light which lets a city to be alive at night, any communication system, every heating or cooling system and the process of production of all goods and services, all significantly depend on existence of energy. Nature provides primary energy for humankind to satisfy their variety of needs and necessity by changing them to secondary types of energy. The accumulation of solar energy into the earth formed the primary energy resources over millions of years. The UN Concepts and Methods in Energy Statistics provides definitions for primary as well as secondary types of energy as follows: “Primary energy should be used to designate those sources that only involve extraction or capture, with or without separation from contiguous material, cleaning or grading, before the energy embodied in that source can be converted into heat or mechanical work” and “Secondary energy should be used to designate energy from all sources of energy that result from transformation of primary sources” (UN, 1982).

Primary energy can be divided into renewable and nonrenewable sources of energy. Nonrenewable sources are categorized as fossil fuels which include crude oil, coal and natural gas. Nonrenewable energy also includes mineral fuels such as natural uranium. Renewable energy sources include wind, solar, biomass, tides and geothermal which can be naturally replenished. The majority part of primary energy consumption is the consumption of crude oil, natural gas and coal which are nonrenewable sources of energy. During the last two centuries, the characteristics and structure of the economy have been substantially related to the discovery and development of fossil fuel energy reserves. These fuels are capable of generating massive energy "surpluses". It means that they have higher net return on energy which is invested for their extraction compared to the net return from renewable energy sources (Cleveland and Peter, 2008). It is predicted that, the world consumption of primary energy will increase at an average growth rate of 1.8 percent annually, during 2005 to 2030 (IEA, 2007).

Data from BP (2014)[1] shows that 86 percent of world total primary energy consumption is the consumption of coal, oil and natural gas which are nonrenewable resources (BP, 2014). In addition energy from fossil fuels accounts for 98 percent of total energy which is used in the global transportation system (De Almeida and Silva, 2009). However, these exhaustible sources of energy are in decline. The production of these resources, especially crude oil is reaching its maximum and after that it will decline (Campbell and Heapes, 2008; Campbell and Laherrère, 1998; Hubbere, 1949). Hence, it is essential to use these resources in ways that are more efficient.

Studying the role of energy in economy was not in the center of researchers' attention until the 1973 oil crisis which showed the importance of energy to the economy. This importance was later confirmed by the second oil shock in 1979. The oil crisis of 1970s (1973-74 and 1978-79) led the oil price to increase and caused the industrialized nations to become aware about the importance of energy. During this period, the major industrial countries of the world faced the shortage of petroleum. The crisis affected economic growth of many nations globally as the oil price increased. Consequently, engineers, scientists, economists and planners began to analyze debate and make conclusion on various issues pertaining to energy pricing, security of supply and alternative fuels. Many governments

[1] British Petroleum Statistical Review of World Energy

and private organizations immediately adopted necessary structural changes in the energy sector to safeguard their respective interests. In addition, these countries started adopting several policies in order to decrease their energy consumption. These nations have become more energy efficient since 1973. Research shows that energy savings started since 1973 resulted in decreasing the demand on the next two decades and without these savings, the total amount of energy consumed in 1998 could be at least 50 percent higher (Cowan and Daim, 2013). The rise in global awareness regarding energy issues, and also international conservation policies, has created new opportunities to study the associations between energy sector and economic performance.

Birol and Keppler (2000) state that while in the IEA countries the oil intensity was constantly increasing during the 1960s, it changed sharply in 1973 and practically has been halved during the next two decades since the second oil shock in the 1979. More specifically in OECD countries, the energy intensity of final energy consumption has decreased by a third between 1973 and 1998. This decline is as a result of improving energy efficiency and decrease in energy intensity in the end-use devices as well as changes in the economy structure such as changes in levels of energy that is required for different sectors in a country (Goldemberg and Prado, 2011).

These policies contributed to a reduction in energy intensity (the ratio of energy consumption to GDP) in the past 40 years. The ratio of energy consumption to GDP has been applied in many studies for the purpose of measuring energy efficiency (Adom and Kwakwa, 2014). In addition, industrialized nations increased their efforts to improve energy efficiency in order to decrease GHGs emissions. As a result, energy efficiency came to center of attentions with increasing the world awareness regarding the problems of climate change and sustainable development.

There have been concerns about global warming since the end of 1980s as a result of increase in consumption of fossil fuels. During the past hundred years the global average temperature showed an unusual increase, which dragged the researchers' attention to the matter of global warming and decrease of GHGs emissions (Shi, 2003). The main goal of the UNFCCC[2] which was adopted by UN at the Rio Earth Summit (1992) was to stabilize the concentrations of GHGs in the atmosphere at a specific level. This specific level can prevent hazardous anthropogenic interference with the climate system (Peet et al., 2010).

As countries became aware of reducing emissions of these gases and also the consumption of energy, at the third Conference of the Parties which was held in Kyoto in 1997 (to come into force in 2005), they agreed to decrease the emissions of their GHGs until 2008-2012 relative to the 1990 levels (UN, 1997). Since this was an obligation that accompanied with the desire of maintaining vigorous and sustainable economic growth, it could only be accomplishable when devised policies are aimed to reduce the ratio of energy consumption and GDP. This made it necessary to improve technical energy efficiency which can be translated as much as possible to corresponding decreases in energy intensities in return (Birol and Keppler, 2000).

This has led to devising new policies to decrease energy consumption in all sectors of the economy, as GHGs emissions mainly originate from consumption of energy. These policies aimed to develop renewable energy sources. In addition, these policies attempted to

[2] Framework Convention of Climate Change

establish energy efficiency policy initiatives to boost a more independent energy mix that was dominated by natural gas and liquid fossil fuels (Bento, 2011). Because of negligence of countries such as US which did not sign the Kyoto protocol, this agreement failed in practice in large. It was expired in 2012, and implementing a new agreement was expected to take in few years (Peet et al., 2010).

In the Copenhagen climate change conference in 2009, countries agreed to help developing nations in using less energy intensive technologies. This agreement achieved as these countries are responsible for contributing around 7 percent of the increase in the world primary energy consumption between the years 2005 and 2030 (Adom and Kwakwa, 2014). In addition, 196 countries of the world attended to the international conference of the parties, COP21, in Paris in December 2015. The objective of this conference was to prevent the world‘s average temperature to rise more than two degrees Celsius during the next hundred years. Paris agreement set uncompromising objectives and requesting all countries to set action plans in order to reduce energy consumption (Elmustapha et al., 2018). Parties are required to reach GHGs emissions global peak ―as soon as possible,” and reduce emissions rapidly afterward (Cosbey, 2017).

IEA (2016) reports that air pollutants resulting from human activities largely resulted from energy consumption and production, mostly the consumption of fossil fuels and biomass products. Almost all nitrogen oxide and sulfur dioxides emissions that travels to the atmosphere are derived from energy, as are some 85 percent of emissions of particulate matters. Some examples of sources of air pollution that are related to energy are as follows: fossil fuelled power plants (especially oil and coal), road transportation (two wheelers, cars and trucks), residential consumption of fossil fuel and bioenergy, industry (combustion and industrial processes), non-road transport (airplanes, trains and ships) and mining activities (IEA, 2016).

Energy demand is dynamic in all dimensions. Innovation of new instruments and changes in social habits are affecting the pattern of energy demand. In addition, when an economy is developing, there is a necessity to produce more goods and services, which requires higher energy demand. Energy consumption trend has been increasing during the time. EIA (2013) predicted a surge in the global energy demand by almost 56 percent over the time period of 2010 to 2040. The majority of these increases will happen in non-OECD countries, as economic growth is associated with consumption of energy (Islam et al., 2013; Khan and Ahmad, 2008).

Data from BP (2014) shows that while the world total primary consumption of energy was 3765.1 million tons of oil equivalent[3] in 1965, this number has reached to 12483.2 in 2012. Figure 1.1 illustrates the trend of world total primary energy consumption. Technological development, population growth and expansion of international trade lead to simultaneous raise in energy consumption globally. The average global energy consumption which was 1454kg of oil equivalent per capita in 1980, increased to 1921 kg of oil equivalent per capita in 2014. There will be an ongoing increase in global consumption of energy which is estimated to be 2 percent annually on average (Shahbaz et al., 2014).

[3] The tonne of oil equivalent (toe) is a unit of energy defined as the amount of energy released by burning one tonne of crude oil.

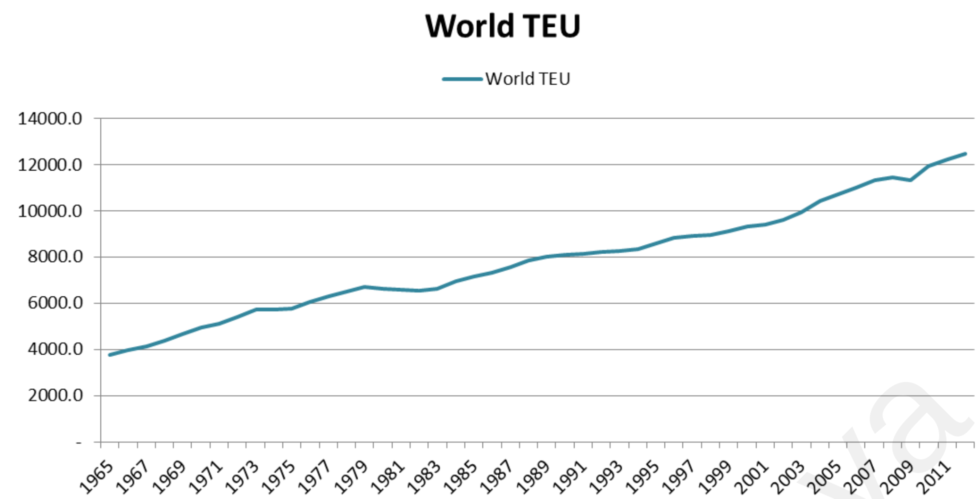

Figure 1.1 World Total Primary Energy Use
Source of Data: BP, 2014

The rapid growth of energy consumption is going to exhaust nonrenewable resources of energy including oil, natural gas and coal without enough time for replacing by other sources. In addition, this leads to increase the GHGs emissions into the atmosphere, as the main part of primary energy consumption is fossil fuels. As the nonrenewable resources are exhausting and the demand for energy has an increasing pattern, the world has especial attentions to decrease the consumption of energy and more specifically fossil fuels.

Despite the increasing trend of energy consumption, energy intensity shows a decreasing trend over the time. Energy intensity can be defined as the relation between energy consumption, measuring in physical units (for example tones oil equivalent (TOE)) and GDP at constant prices (Alcantara and Duarte, 2004). Figure 1-2 illustrates the trend of world energy intensity which is based on the data from World Bank. Energy intensity is an indicator which reflects energy efficiency as well as quality of economic development for an economy. Energy intensity shows the economic structure, fuel mix and the level of technology in a country (Sun, 2002). Energy efficiency can be defined as the quantity of energy which is required to provide useful goods and services at the process level. As a result, energy efficiency is essentially a parameter which relies on the status of technology and method of production. In addition, it critically affects the quantity of energy which is consumed for each unit of production in a country that represents the energy intensity of a particular economy (Birol and Keppler, 2000). Ratios which connect consumption of energy, or its corresponding emissions, to the economic value generated, accommodate the varying progresses on economic development of nations better, in comparison with absolute measures. Policymakers are applying indicators including energy efficiency, intensity, and productivity increasingly in order to solve the interconnected issues of energy security, economic development and environmental sustainability (Bean, 2014).

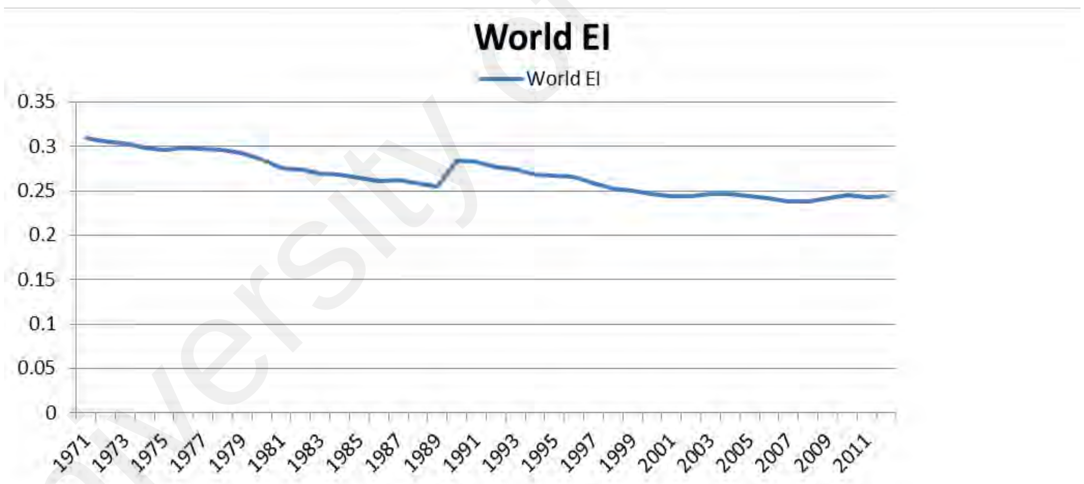

Figure 1.2 World Trend of Energy Intensity
Source of Data: World Bank

While after the 1970s oil price shocks energy intensity decreased in many developed countries (Worrell, 2011), it has risen considerably during the last thirty years in developing countries. For example, African countries represent higher energy intensity, which is mainly because of extractive nature of industries that requires higher levels of energy intensity (Adom and Kwakwa, 2014). As a result, investigating the significant determinants of energy intensity can facilitate devising suitable policies in order to decrease energy intensity in countries that are less energy efficient. Especially focusing on global panel, which represents a decreasing trend, can help to figure out the variables which significantly contribute to the energy intensity reduction.

Globalization resulted in rapid increases ni the amount of merchandise trade between nations during the last twenty years. In 1980 global merchandize trade that is the accumulation of imports and exports of goods was US$ 3.8 trillion and increased to US$ 37 trillion in 2010 (Shahbaz et al., 2014). Cole (2006) states that liberalization of trade, promotes economic growth which stimulates energy consumption. In addition, liberalization of trade boosts capitalization that eventually affects energy consumption. Trade openness will cause the importation of intermediate and capital goods. These imported goods carry the technologies which are incorporated in them. Importing these capital goods together with the enhanced application methods, as a result of competition, provides productivity spillover (Herrerias and Orts, 2011; Hübler, 2011). In addition, trade openness can affect energy intensity through different levels of technology. Higher levels of technology can lead to higher efficiency and as a result lower energy intensity and vice versa.

Based on the significant role of energy in the global economy, such as its role in production process and economic growth and also the significance of energy use regarding the issue of global warming and environment, the objective of this study is to investigate the relation between energy intensity and trade openness as well as studying the effects of imports and exports separately. In addition, this research investigates the effects of export diversification on energy intensity. These investigations also will lead to identify the significant determinants of energy intensity. Moreover, in addition to existing determinants of energy intensity this research examines the role of institutional quality (political risk) in relation to energy intensity. Political risk can be defined as the risk which occurs when a sovereign host government unforeseeably changes –the rules of the game” under which businesses work (Butler and Joaquin, 1998). In addition, the direction of relation between institutional quality and energy intensity is tested in the last analytical chapter of this research.

1.3 Problem Statement

One of the fundamental requirements of modernity is energy. Energy can be defined as the capacity to function and it also is the productive force at the center of all economic, social and environmental changes (Peet et al., 2010). Energy has a significant role in production of almost all goods and services and life of humankind cannot continue without the use of energy. Energy demand is dynamic and growth of an economy highly depends on it.

Modeling energy demand and better understanding about its determinants can lead to devise better energy policies. Studying the determinants of energy intensity (energy consumption per unit of GDP) is an ongoing research topic, which led to introduction of new determinates of this variable in recent years. Understanding energy demand is also essential in order to have better view of global GHGs emissions management. GHGs emitted as result of energy consumption, are the main part of GHGs emissions (Sadorsky, 2010). Emissions of CO_2, which is one of the most important GHGs, have caused the problem of global warming which is believed to be the reason of extreme global climate changes (Chang et al., 2009b).

Population growth and trade developments increased the demand for energy in recent decades (Nasreen and Anwar, 2014). In addition movement of population from rural to urban regions changed the pattern of demand for energy and caused higher levels of energy demand (Mishra et al., 2009). Although world energy consumption shows an increasing trend over time, based on the data from World Bank, world energy intensity shows a decreasing trend.

Energy intensity can decrease because of variables which are independent of energy concerns, such as changes in structure of economy and also as a result of improving energy efficiency. In addition, energy efficiency is affected by the technological changes, production method and also energy prices. The pressure on natural sources of energy will increase within the next years as population is growing over time, income is increasing and demand for energy is growing especially in emerging and developing economies. As a result anthropogenic emissions are expected to increase, unless moving toward more efficient, less energy intensive and cleaner sources of energy (Voigt et al., 2014).

Increasing in international trade will lead to increases the economic activities and as a result energy demand will increase (Cole, 2006; Sadorsky, 2012). In addition trade openness can affect energy intensity through importation of capital goods which can lead to better productivity (Adom and Kwakwa, 2014). As a result, this study attempts to investigate the relation between trade openness and energy intensity which has dragged less attentions compared to energy consumption. This research also investigates the relation between imports and energy intensity and exports and energy intensity in separate models.

Based on traditional models of development for the purpose of achieving sustainable economic growth a shift from dependence on primary exports to diversified manufactured exports is required (Al-Marhubi, 2000). Export diversification can improve production techniques, which benefits other industries through knowledge spillovers (Herzer and Nowak-Lehnmann D, 2006). More specifically, new production techniques and new management or marketing practices, could provide knowledge spillovers which can benefit other industries (de Pineres and Ferrantino, 2018; Herzer and Nowak-Lehnmann D, 2006; Hesse, 2009). As a result, this study aims to investigate the impact of export diversification on energy intensity, to reveal the impacts of knowledge spillover which is resulted from enhancing export diversification on the energy consumed for every unit of production.

Studies on the relation between institutional quality and FDI concluded that institutional quality is a significant determinant of FDI (Busse and Hefeker, 2007; Bénassy-Quéré et al., 2007; Daude and Stein, 2007). Besides FDI can result in technology innovation by the firms and businesses in the host country, which can cause the reduction in energy consumption (Chang, 2015). FDI is identified as an essential source of technological progress from other countries (Adom, 2015a, b; Cole, 2006; Elliott et al., 2013; Herrerias et al., 2016; Herrerias et al., 2013; Hübler and Keller, 2010; Jiang et al., 2014; Mielnik and Goldemberg, 2002; Yan, 2015; Yu, 2012; Zheng et al., 2011).

As a result, for the purpose of having more precise model of energy intensity and devise better energy policies, this research includes the effects of institutional quality (political risk) to take into account the effects of government stability, internal and external conflict, investment profile, socioeconomic conditions, religious tensions, corruption, military in politics, ethnic tensions, law and order, democratic accountability and bureaucracy quality on energy intensity. Meaning that, institutional quality matters in regarding to energy intensity levels. More specifically, any economic policy cannot be suitable for any level of institutional quality. This conclusion can be expanded to policies such as energy policies. The findings of this investigation equip policy makers with the necessary materials to devise appropriate energy policies for countries with different levels of institutional quality. In addition, this research classifies panel of countries based on Fragile States Index provided by the Fund for Peace Organization, into Stable and Unstable groups of countries. Furthermore, this research investigates the direction of relation between energy intensity and institutional quality in the last chapter of this study.

1.4 Research Questions

The central questions of this research are regarding the relation between trade openness, exports, imports and export diversification with energy intensity, the effect of institutional quality on energy intensity and the direction of relation between energy intensity and institutional quality. As a result, the followings are the questions that this study attempts to answer:

1. What is the relationship between trade openness, exports, imports and export diversification with energy intensity?

2. What is the relationship between institutional quality and energy intensity?
3. What is the direction of relationship between institutional quality and energy intensity?

1.5 Aims and Objectives

The purpose of this study is to investigate the relation between trade openness, exports, imports and export diversification with energy intensity in panel group of countries. This study also investigates the relation between institutional quality and energy intensity in stable and unstable group of countries. In addition, the direction of causality between these two variables is tested in the last part of this research. As a result, the objectives of this study are as follows:

1. To investigate the relationship between trade openness, exports, imports and export diversification with energy intensity.

2. To examine the relationship between institutional quality and energy intensity.

4. To examine the direction of relationship between energy intensity and institutional quality.

1.6 Significance of Study

Energy is at the center of every country‘s development. Without energy, communities‘ life goes to the darkness, majority of services including hospitals and schools would be unable to function, and businesses operate under crippling constraints. Energy also provides the suitable conditions for the investments, innovations and new industries that can create employment opportunities and cause growth of economies (WB, 2018). Investigating the determinants of energy intensity is an important research topic as energy is a significant factor of production besides capital and labor. During the past few decades, the world has been facing the issues of global warming and climate change and it is appeared that CO2 emissions is the major contributor to the issue of global warming (Ghosh, 2010). During the time, human activities caused the increase and concentration of GHGs in the atmosphere significantly. The most considerable increase is related to CO2, which is emitted as a result of fossil fuels combustion (Bae et al., 2016).

IEA in a special report regarding energy and air pollution, reports that air pollution is the fourth significant overall risk factor for human health after high blood pressure, smoking and dietary risks worldwide. The latest estimations showed 6.5 million premature deaths because of air pollution per year, which makes the air pollution, world‘s fourth largest risk and threat to human health. Out of this number, coal and oil are responsible for around 3 million of these premature deaths every year. In addition to human health, air pollution causes risks to the economy, the environment and food security (IEA, 2016). Before the 19th century and for the 10,000 years, accumulated CO2 stayed between 260 and 290 ppm, and after that it began to increase rapidly. Currently, accumulated CO2 is more than 385 ppm and it is increasing every year by an average amount of 2 ppm. An 80 percent decrease in global GHGs emissions by the year 2050 is necessary in order to prevent the negative impacts of climate change (Solomon et al., 2007).

Energy intensity, and its changes during the time, plays a leading role in the global warming debates (Baksi and Green, 2007). Improving energy efficiency which is the result of decrease in energy intensity is a critical parameter for policies with the objective of decreasing consumption of energy while maintaining or increasing economic growth (Birol and Keppler, 2000). Appropriate use of energy enables us to solve the problems of economic competitiveness, energy security and environmental sustainability (Baležentis et al., 2011). The findings of this study lead policy makers to devise better energy policies to decrease consumption of energy and improve energy efficiency, as this study estimates the impacts of different determinants of energy intensity on this variable. More specifically, in addition to including energy prices, urbanization, industrialization and FDI in modeling energy intensity, this study has special focus on the role of trade openness, imports, exports and export diversification. Investigating the impacts of these variables on energy intensity will lead to devise suitable trade policies while mitigating climate change and global warming. Moreover, by investigating the relation between a new determinant, which is institutional quality and energy intensity, policy makers will be able to devise specific energy policies for countries with certain levels of institutional quality.

Improving energy intensity will cause:

-Reducing pressure on natural resources of energy

-Reducing dependence on fossil fuels

-Decreasing GHGs emissions which will result in improving air quality and life expectancy of human kind.

-Solving problems of climate change and global warming

-Improving industry competitiveness

-Addressing energy security

-Addressing poverty (Ang et al., 2010).

1.7 Scope of Study

The focus of this research is to investigate the relation between trade openness, exports, imports and export diversification with energy intensity. This study also investigates the role of institutional quality, which is added by this study as one of the determinants of energy intensity. Moreover, the current research investigates causal relation between institutional quality and energy intensity to figure out the direction of relation between these two variables. For the purpose of analysis, the annual data is collected for global panel of 84 countries and the data covers the period 1980 to 2012. The data is analyzed by applying Generalized Method of Moments (GMM) technique, using STATA software. In addition, in order to find the direction of causality between institutional quality and energy intensity, Panel Granger Causality method is applied using STATA software.

1.8 Organization of Study

Following the above introduction, the remaining chapters of this research are as follows:

Chapter 2: Literature Review

In this chapter, the determinants of energy intensity and related theoretical background are explained. Previous literature has been reviewed by dividing them into two categories: individual case studies and multi-case studies. Finally, the gap in the literature is defined. In addition, the tabular format of the literature review and the table of the expected signs of the variables provided. Research hypothesis, aims, and objectives of the study and analytical frameworks of the study are the next parts of this chapter.

Chapter 3: Methodology and Data

This chapter includes the research approach of this study, as well as model development of this research. The dependent and independent variables of this study are defined, and the source and sample of data are explained. In addition, the econometrics methods of the study are introduced, and it is explained how to deal with data concerns.

Chapter 4: Trade and Energy Intensity

This part of study provides the analysis results and discussion of this research, including the findings of investigating the relation between trade openness, exports, imports and export diversification with energy intensity in global panel considering different models for trade openness, exports, imports and export diversification.

Chapter 5: Institutional Quality and Energy

This part of study provides the analysis results and discussion of this research, including the findings of estimating the impact of institutional quality on energy intensity. This chapter also provides the impact of estimating the effect of institutional quality on energy intensity by dividing the panel of countries into two groups of stable and unstable countries.

Chapter 6: Direction of Relation between Institutional Quality and Energy Intensity

This part of study provides the analysis results and discussion of this research, including the findings of testing the causality direction between institutional quality and energy intensity.

Chapter 7: Conclusion

This chapter provides the synthesis of the study which is followed by implications for theory and policy. In addition, this chapter discusses the future directions for further research.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Fossil sources of energy are human‘s main energy resources and they are the major input for production process of different products. This is the nature‘s gift to us which has been shaped over the years, but is being used up rapidly. Fossil fuels are depleting significantly and as a result becoming increasingly costly. Hence we need to find new sources of energy and new solutions. Countries attempt to make their energy consumption stable while they have sustainable economic growth, but the issues of climate change and global warming have made the situation complicated (Saboori and Sulaiman, 2013) as they need to reduce their CO2 emissions by more efficient consumption of energy resources.

Recently, scholars have raised their attention to empirical studies related to the energy efficiency. The determinants of consumption of energy and also energy intensity (which is used as the measurement for energy efficiency), have been studied previously. The current chapter aims to review the past studies regarding the determinants of energy consumption, and energy intensity, by explaining the factors which affect these variables and providing some theoretical backgrounds for the determinants of them in the first part. More detailed revisions are provided for variables of export diversification and institutional quality. The literature is divided into two categories, individual case studies and multi-case studies in the second part of this chapter. In addition, the tabular format of the literature review and the table of the expected signs of variables in relation to energy intensity provided. The gap in the literature is identified after reviewing previous works. Research hypotheses, aims and objectives of the study and analytical frameworks of the study which are followed by the theoretical description about the relation between variables are the next parts of this chapter. The chapter summary is the final part of this chapter.

2.2 Determinants of Energy Consumption and Energy Intensity

The past literature revealed some of the determinants of energy consumption and energy intensity. The following sections review the theoretical backgrounds about these variables including energy prices, trade, financial development indicators, urbanization, industrialization and economic growth.

2.2.1 Energy Prices

Energy prices have usually been a significant independent factor that affects energy intensity in previous studies (Huang et al., 2017). In the 1970's, during the two oil price shocks, both the substitutions between energy and other inputs such as capital, labor and materials, and also the substitutions inside energy factors such as interfuel substitution among fuel sources happened. As a result researchers became aware of the effect of energy prices in determining energy demand behavior, which led to inclusion of energy prices in energy demand model (Kim, 1989). In addition, both energy intensity and energy efficiency depend on energy prices through different channels (Birol and Keppler, 2000).

Increase in energy prices, results in higher energy bills, which will cause the reduction in consumption of energy. This has been confirmed by the study of Atalla and Bean (2017) who found that in long-term energy prices are associated with improvements in aggregate energy productivity. When the market is competitive, higher prices of energy lead to the application of technologies which are capital and labor intensive rather than being energy intensive. This will cause changes in the marginal productivities of the factors of production. As a result, the marginal productivity of labor and capital falls, but the marginal productivity of energy rises. Conversely, lower energy prices lead to the application of more energy intensive and less labor and capital-intensive technologies. As a result, the marginal productivity of energy will decrease but the marginal productivity of capital and labor will increase. Therefore, higher energy prices will cause the application of less energy intensive technologies, but lower prices will cause the application of higher energy intensive technologies. As a result, energy intensity will decrease when prices of energy increase (Adom, 2015a).

Edmonson (1975) explicitly included the energy prices effect, which led the energy prices to become an important factor in determination of energy use. Including variable of price of energy in the energy demand model will result in the provision of new ways in evaluating government policies and also the energy sector technological innovations (Nasreen and Anwar, 2014). Cornillie and Fankhauser (2004) found a significant relation between price of energy and energy intensity in transition countries. When energy prices are higher, it will not only result in the adoption of the more energy efficient technologies among the available ones, but also increases R&D practices for new energy efficient technologies.

Hang and Tu (2007) in their study about the effects of energy prices on energy intensity in China discovered that increasing prices of energy is an effective policy instrument for improving efficiency in consumption of energy. Following their finding, many other studies approved their results. For instance, Yan (2015) and Wu (2012) found that energy prices decrease energy intensity in China considering any time period which has been confirmed by the study of Guo et al. (2019) who found electricity price as a contributing factor in energy intensity reduction in China. They suggested energy prices marketization for energy efficiency improvements in China. These results are inconsistent with the results of Mulder et al. (2014) who applied data of 23 service sectors in 18 OECD nations during 1980 to 2005. They found minimum impacts of energy prices in explaining the fluctuations of energy intensity; hence led to doubts on the efficiency of the price policy instrument in improving energy efficiency. Barkhordari and Fattahi (2017) also concluded that increasing electricity prices was not a successful policy for decreasing electricity consumption intensity in Iranian industries.

Policy makers have several instruments in order to influence the relative prices of energy. These instruments include taxes that are the most important ones and can be on energy or on energy intensive goods. Other instruments include subsidies that can be on alternative processes or products, which are more energy efficient. In addition, trading plans in which majority of energy consumers can only trade a certain number emission permits for energy related pollutants, are another instruments. There are clear evidences from 49 nations that electricity prices have a significant impact on electricity consumption intensity. The two oil shocks also showed that the oil price has significant effects on oil consumption. During these shocks, the relative price of oil almost doubled every time (Birol and Keppler, 2000).

Using instruments such as energy subsidies in order to encourage industrialization and diversification, decreasing inflation and avoid price volatility, and distribution of resource income to the population (Fattouh and El-Katiri, 2013) is very popular in developing and more specifically energy rich countries (Moshiri, 2015). However, energy subsidies can cause significant socioeconomic costs. Energy subsidies can increase the growth of energy consumption together with energy intensity and as a result, energy efficiency will decrease. In addition energy subsidies increase social spending by government, which will result in more inequality and thus making energy prices reform unavoidable (Lipton, 2013). The price reform should be comprehensive in order to support industries during the transition and to prevent the high economic and social costs of increasing unemployment and decreasing production (Moshiri, 2015).

In conclusion, energy prices variable is one of the determinants of energy intensity. Theoretically, higher levels of energy prices will decrease energy consumption when the elasticity of price is not zero, which is confirmed by many empirical works as well. Another effect which is caused because of a rise in energy prices is that the costs of production increases and producers may react to it by improving energy efficiency. Hence, in the condition that the energy market is functioning efficiently, it is expected that higher prices of energy results in reducing energy intensity via more efficient consumption of energy. Hence, the coefficient of energy prices is expected to be negative (Otsuka and Goto, 2017). Karimu et al. (2017) states that the negative relation between price of energy and energy intensity can be as a result of factor substitution or an inefficient consumption of energy. When energy prices grow, firms start substituting labor and capital for energy, which will lead to decreasing energy intensity. In addition, firms may not consume energy efficiently (i.e. as a result of information asymmetries) but as energy prices grow they become more motivated to improve efficiency and reduce the consumption of energy.

2.2.2 Trade

It is substantially important to investigate the relation of energy demand and trade, as trade is a vital element of economic growth. Intensifying international trade is associated with more economic activity and raises the energy consumption (Sadorsky, 2012). Trade liberalization boosts economic growth, which increases the demand for energy. Trade liberalization can affect the trade flow between developing and developed nations. The trade theory of Heckscher–Ohlin states that in the –free trade" condition, developing nations would produce the goods that abundant factors of production including natural resources and labor are used in the process of their production. Developed nations on the other hand would produce the goods that human capital and manufactured capital intensive activities are the main parts of their production processes (Shahbaz et al., 2014). In addition, trade liberalization, enhances capitalization, which results in affecting consumption of energy. In order to study the effect of trade on consumption of energy the country‘s economic condition and also the magnitude of relation of economic growth and trade should be considered (Cole, 2006). In addition, trade openness can cause the import of intermediate and capital goods, which carry the technologies that is embedded in them. Importing the above mentioned goods incorporate with the enhanced application methods which is the result of competition, will cause productivity spillovers (Herrerias and Orts, 2011; Hübler, 2011). Trade openness also contributed in decreasing trend of energy intensity in countries like China (Hübler, 2009).

A significant requirement for trade openness is the shipment of goods which are manufactured in one country to the other country for consumption or more processing. In addition, production of goods is impossible without consumption of energy effectively.

Trade openness can affect energy consumption via technique effect, scale effect, and composite effect. Trade openness leads to more economic activities, and as a result stimulates production domestically and raises economic growth. The increase in production changes energy consumption. This effect is called scale effect which is caused by trade openness (Shahbaz et al., 2013a; Shahbaz et al., 2013b).

Trade openness has two different effects: “the pull effect” and “the push effect”. The pull effect means that more trade openness increases the chances of the host country for emulating and learning from outsiders. If the inhabitants of a country meet and interact with foreign counterparts, they can find an opportunity to acquire technical knowledge that can contribute to the stock of general knowledge in their country. These occasions might never emerge if the country chooses to be economically isolated (Adom, 2015a; Grossman and Helpman, 1991). However, the push effect, discusses that a well-integrated economy results in a competitive environment that affects the energy efficient technologies adoption for local firms and helps them adapting to the extreme international market competition, as the monopolistic tendency often leads to the adoption of inefficient technologies (Holmes and Schmitz Jr, 2001).

Theoretically exports can affect energy consumption through different ways. More exports require more inputs for production including labor, capital and energy to produce the export products. When export products are prepared, they must be loaded and transported to airports, seaports or other stations to travel abroad. The equipment and machinery which used in production, processing and transportation of exports need energy and this increase the demand for energy (Sadorsky, 2012).

Trade openness empowers developing countries through the importation of higher level of technologies from developed countries. The application of modern technology decreases energy intensity. The implementation of advance technologies results in economic consequences which generally called as technique effect and results in decrease in energy consumption and also higher level of output production (Arrow, 1962). Wang and Han (2017) concluded that foreign R&D spillovers as a result of importation significantly improve energy efficiency.

Demand for energy can be affected by imported goods in two different ways. First, for importation of goods there is a necessity for a well function network of transportation, in order to transfer goods around the country. As transportation system needs energy, increasing imports, will result in more consumption of energy. Second the demand for energy can be affected by the composition of importation. If the importation includes energy intensive goods the demand for energy will increase (Sadorsky, 2012).

Cole (2006) states that the effect of trade on energy intensity is a ―country specific” characteristic which is either positive or negative and highly depends on if the country is net exporter or importer of energy intensive goods. Shen (2007) found that trade openness improves energy efficiency by saving energy through importation of goods and this saved energy is higher than the amount of energy which is consumed by exports. In addition, the author concludes that changes in the composition of trade such as importation of more energy intensive products, contribute to the decline in positive role of trade.

2.2.3 Foreign Direct Investment (FDI)

Foreign direct investment (FDI) is mostly recognized as a vital requirement for economic development. Since 1980, FDI flows have been raising about 6 percent per year, which is faster than increase in the global economic growth and trade (Ju and Wei, 2010). More precisely, while the net inflows of FDI increased by 19 percent, global trade of goods and services rose by only 8 percent over the 1996–2006 time period (Buchanan et al., 2012).

Attentions to the relation of financial development indicators (including FDI) and energy consumption are very recent, comparing to the other determinants of energy consumption such as energy prices. Generally, financial development is defined as decisions of a country to permit and promote the increase in FDI, increase in banking activities and increase in stock market activities. These all can eventually increase economic growth, which can change the demand for energy. Financial development can enhance financial system of a country through improving its economic efficiency.

In addition, these indicators have relation with energy intensity (Aller et al., 2018). The work of researchers such as Mielnik and Goldemberg (2002) who found an association between FDI and energy intensity in group of 20 developing nations confirms this. They concluded that, as FDI increases, energy intensity clearly declines and explained their findings by the argument that overseas investors aiming to maximize their profit will bring their higher level of technology when investing in developing economies. Consequently, the output of the host country increases with lower consumption of energy. However, Antweiler et al. (2001) found a different conclusion stating that although the domestic production of the host country can be affected by FDI; FDI does not affect the energy intensity of that country. Sadorsky (2010) states that financial development can cause variety of changes including decreasing ―financial risk” and ―borrowing costs”, improving transparency between borrowers and lenders, access to more financial capital and investment flows and availability of the most recent energy efficient products and advanced technologies, which all would have impacts on the energy consumption.

The higher rate of FDI flow to a country, would lead to stimulating energy consumption because of the increase in development of industrialization, manufacturing and transportation sectors while energy is necessary for the manufacturing (Foon Tang, 2009). Studies showed that FDI would stimulate economic growth in the host country via accumulation of capital, productivity efficiency, technology diffusion and by introducing new practices and procedures (Bende-Nabende et al., 2003; Borensztein et al., 1998; Richard, 1982). While FDI can deteriorate the environment, it can decrease energy consumption. FDI can lead to positive externalities but it can also lead to negative externalities (Sbia et al., 2014).

FDI can increase economic activity, which can lead to more energy use. On the other hand, FDI causes technology innovation in local firms and businesses, which results in decrease in consumption of energy (Alfaro et al., 2004, 2006; Bailliu, 2000; Chang, 2015; Hermes and Lensink, 2003). FDI indirectly improves economic growth via the direct technology diffusion which augments the knowledge stocks in the host country through training of labor, new management methods, organizational arrangements and foreign R&D spillovers (Wang and Han, 2017; Alguacil et al., 2011; Blalock and Gertler, 2008; De Mello, 1999).

Bu et al. (2019) also confirmed that firms receiving FDI have lower energy intensity compared to their other counterparts.

Increase in FDI can cause the increase in energy efficiency (Eskeland and Harrison, 2003; Fisher-Vanden et al., 2004; Mielnik and Goldemberg, 2002). The impact of FDI on energy consumption can be different across countries as the environment of economy, structure of economy, the development status, and prices of energy is different in each one (Cole, 2006). FDI can be realized as an incentive for the application of energy saving technologies that causes the decrease in consumption of energy (Hübler, 2009). FDI is identified as a significant source of technological enhancement from other economies (Huang et al., 2017). If newly relocated foreign companies carry higher levels of technology compared to their domestic counterparts, labor turnover and vertical linkage effects will lead to transferring technological knowledge, managerial procedures and international marketing skills (Saggi, 2002).

FDI significantly affects the economic development of a nation as it has impacts on economic growth and attracts foreign investments and higher levels of technology and skills to the host countries. The FDI flow to a country depends on various macroeconomic indicators, governmental policies and the strategies of MNCs in long-term (Nasir and Hassan, 2011). While FDI can be a significant source of higher level of technology from abroad it can also bring old/mature level of technology into a country especially in the case of developing nations. This can be explained using the Product Cycle Theory of Vernon (1966) arguing that when a multinational corporation initiates the manufacturing and selling of a product which is called product's early life-cycle, it is sold as a finished product first in its original country that the product is invented and other developed markets and finally in developing markets. As competitors start entering the market and as the extensive entry into developing markets become beneficial, FDI activities in developing countries will start. In order to compete in the market, multinational firms have to reduce their product costs using lower labor wages in developing countries (Tan, 2002). This cycle results in sending old/mature production methods to developing markets which might not carry the most energy efficient technologies embedded in them as Chan (2016) argues that there are differences between parent companies and their affiliates. Majority of production lines which are transferred to developing countries belong to mature products which are manufactured by obsolete technologies.

2.2.4 Urbanization

Urbanization is another determinant of energy demand. Economic and social modernization leads to more urbanization. Movement of labor force from an agricultural based to industrial and service based economy is one dimension of urbanization and the structural alteration of rural areas to urban areas is another dimension (Poumanyvong and Kaneko, 2010). Urbanization involves concentration of population that participates in economic activities as a result increases consumption of energy (Jones, 1991; Solarin and Shahbaz, 2013).

Mishra et al. (2009) states that urbanization provides easier access to electricity and those who already had their access to electricity in rural areas tend to use more electricity in urban areas by increasing application of available devices and buying new home appliances. Data from World Bank reveals that while there were only 39 percent of the world population living in urban areas in 1980, this number changed to 52 percent in 2012 (WorldBank, 2016). Bazoglu et al. (2008) predicted that the developing nations will become a host for the 95 percent of the urban population growth globally over the upcoming 40 years.

Air pollution is an urban problem as the majority concentration of population, economic activities and demand for energy is in growing cities of the world. Air pollution movements are not limited to the borders of the cities: the sources are widespread. Although some pollutants distribute only locally, others travel large distances in the atmosphere and create regional and global issues. Energy sector which is an engine for social and economic activities is a major source of air pollution, as a result of human activities especially combustion of fossil fuels. This sector should be the priority of policy makers when they are devising policies in order to decrease air pollution in the world, applying suitable technologies.

Literature shows that Jones (1991) is the first who studied the relation of energy intensity and urbanization and approved the effects of this variable on variations in energy intensity but generally, there is not enough research on the effects of this variable on energy intensity. It is not easy to predict the effects of urbanization on energy intensity, because urbanization results in more concentration of consumption and production which increases economic activity (Jones, 1991; Pariakh and Shukla, 1995; Sadorsky, 2013; York, 2007). On the other hand, urbanization causes the economies of scale which results in increasing energy efficiency (Sadorsky, 2013). More specifically researchers state that urban density and urbanization cause the more efficient utilization of public infrastructure such as public transportation and other utilities which cause decrease in consumption of energy and emissions (Chen et al., 2008; Liddle, 2004).

Shahbaz and Lean (2012) conclude that the rise in urban population increases the demand for energy through more application of home appliances by households. As a result, it can be claimed that urbanization has direct and significant association with increase in energy consumption. Elliot and Sun (2017) found that higher urbanization increases energy intensity for electricity and coal through construction channel and also the transportation and industrial upgrading channels.

2.2.5 Industrialization

Prior to the 1970s‘ two global oil price shocks, based on the strong association between energy consumption and sustainable development, economies were encouraged to increase their consumption of energy. However, the occurrence of these two shocks together with the events that unfolded later on, such as increase in urbanization, population, industrialization, and the issue of global warming created the need to pursue energy conservation and energy efficiency policies more seriously (Adom and Kwakwa, 2014). Consequently, soon after the 1970s world oil price shocks, energy economists began to find out the ways to investigate the impacts of structural shift in industrial production on total industrial energy consumption to have a better realization regarding the mechanisms of change in industrial energy demand (Ang and Zhang, 2000).

Energy intensity variations can be as a result of the technological progress or sectorial composition. The composition effect can be affected by various stages of economic development such as shifts in the economic structure by moving from an energy intensive subsector to a high technology subsector (Huang et al., 2017). Economic development leads to moving from agriculture to industry which causes the energy intensive products to be applied increasingly. The consumption of energy is low at the beginning of economic development, as economy is more agricultural based. As economy initiates moving towards industry, the consumption of energy grows which is called positive composite effect (Arrow, 1962).

The term industrialization can be defined as a rise in industrial activities and majority of researchers believe that industrialization causes higher level of energy demand as higher value added manufacturing consumes higher level of energy compared to traditional agriculture manufacturing. For instance, industries such as primary metals, petroleum refining, paper products and chemicals are more energy intensive than textile industries or agriculture (Jones, 1991; Samouilidis and Mitropoulos, 1984). Industrialization by the establishment of new equipment and techniques for the purpose of producing existing and newly invented products, increases industrial activities which cause the higher level of energy consumption compared to traditional agriculture or manufacturing. As a result, it is possible to conclude that industrialization has a positive relation with energy intensity (Sadorsky, 2013).

Belloumi and Alshehry (2016) and Guang et al. (2019) showed that industrialization and urbanization have positive and significant impacts on energy intensity. Elliott et al. (2017) concluded that while the increase in industrial value added increases energy intensity in Chinese provinces, the magnitude is lower than the expectations. It can be as a result of the cleaner production using higher level of technology. Adom, P. K., & Amuakwa-Mensah (2016) concluded that intense industrialization and FDI lower energy productivity in low income countries.

2.3 Institutional Quality

2.3.1 Defining Institutional Quality

The economic development literature has been changed since the late 1990s, by concentrating on the domestic institutional quality as a significant factor of cross-country differences in economic growth and per capita income (Acemoglu et al., 2005; IMF, 2003). More specifically, civil and property rights which are efficiently protected, expanded economic and political freedom and lower corruption have been found to cause more prosperity (Bénassy-Quéré et al., 2007).

North (1990) described institutions as the “rule of the game” in a society. This definition means that the institutional framework includes all types of humanly formulated constraints which model human interactions, such as economic exchange. Some of the institutions are formal such as constitutions, laws, and others are informal such as conventions and customs. Institutions are designed to decrease the uncertainty in interactions and exchanges, and to define a behavioral norm. As a result, institutions equip societies with a “predictable framework” for interaction (Ali et al., 2010).

Social rule system theory which is consistent with the new institutionalism current of thought emphasis that “specific institutions and their organizational instantiations are deeply embedded in cultural, social, and political environments and that particular structures and practices are often reflections of and responses to rules, laws, conventions, paradigms built into the wider environment” (Powell and Colyvas, 2007). Meaning that specific policy that is working for a country is not necessarily good for another one.

Although the industrialized nations seem to have reached to the majority of their potentials in “good governance”, the developing nations still have a long way to go since institutions are still undeveloped in these countries (Olson, 1996). The essential process of state formation describes most of the cross-country differences in institutional quality and economic and social outcomes nowadays (Charron et al., 2012). Baumol et al. (2007) states that “our own thinking on the subject of economic growth has been strongly influenced by the institutionalist school of economic growth”. New institutionalists such as Willianson (1975), Olson (1996), Olson et al. (2000), Rutherford (2001), North (2005), and Acemoglu et al. (2005), discuss that institutions are vital for the efficient performance of market based economies.

The effects of trade openness in stimulating economic growth, further enhanced by accompanying with supportive policies like improving institutional governance covering influence of law and order, quality of bureaucracy, lower levels of corruption, and public officials accountability (Chang et al., 2009a). If countries are specialized in extractive, natural-resource sectors the country would be prevented from the technological progress that eventually cause long-run growth. In this situation, the underlying imperfection is an institutional weakness that supports natural-resource depletion for fast gains appropriated by specific groups in society (Sachs et al., 1995; Sachs and Warner, 1999).

2.3.2 Flow of Capital and Lucas Paradox

International capital flows have experienced a series of cycles or ―waves”. Capital flows diminished in the late 2001, increased over the mid-2000s, declined significantly throughout the global financial crisis (2008-2009), and finally rebounded in 2010 (Forbes and Warnock, 2012). History shows that, flows of capital to emerging markets have mostly included FDI (Byrne and Fiess, 2016). According to UNCTAD (2009), FDI inflows rose by a factor of almost 10 globally from $208 billion in 1990 to a historic record of $1,979 billion in 2007. Despite the available lower wage labor in developing nations however, FDI mostly was between wealthy nations. The poorer and slower growing economies attracted only 2 percent of all FDI (Buchanan et al., 2012).

Neoclassical theory states that, the flow of capital is expected to be from rich economies to poor economies. Considering similar technologies and production of similar goods, this theory states that new investment and as a result international net inflows of capital should happen more in poor countries which have low stocks of capital per capita and as a result more marginal product of capital (Reinhardt et al., 2013). Hence, assuming free flow of capital, new investments would take place only in the poor economies, and this would continue until the return to investments would be equal in all the countries. However, comparing India and the United States in 1988, Lucas (1990) concluded that, if we assume that neoclassical theory is correct, the marginal product of capital in India should be almost 58 times higher than the United States. Considering these differences, all capital should flow from the United States to India. Practically, such a flow cannot be observed. Lucas doubted the validity of the assumptions that gave rise to these differences in the marginal product of capital and asked what assumptions can replace these. Lucas considers this as the main question for economic development (Alfaro et al., 2008).

Studies regarding the Lucas paradox showed that relaxing one (or more) assumption of the basic neoclassical theory leads to explaining the capital flows from rich to poor nations in a better way (Reinhardt et al., 2013). Differences in the risk of sovereign default (Reinhart and Rogoff, 2004), human capital (Lucas, 1990), capacity to use technology (Eichengreen, 2004), and quality of institutions (Alfaro et al., 2008) can be related to the direction of cross-border flows of capital.

Byrne and Fiess (2016) state that the national determinants of aggregate capital flows can be categorized into the following categories: human capital (Lucas, 1990), financial openness (Chinn and Ito, 2008) and institutional characteristics (North, 1994). North (1994) states that institutions have a significant role in flows of capital since economic returns from investments in emerging markets depend highly on the institutional quality. The significance of institutions for capital flows is studied in an empirical framework by Alfaro et al. (2008) during 1970 to 2000. They found that lower quality of institutions is the main justification for Lucas Paradox. Weak institutions will lead to many economic issues in developing nations such as lower levels of investments, slower growth of productivity, lower income per capita and overall slower growth of output. Good institutions on the other hand will lead to efficient factor allocation, enabling investments in activities with higher return and decreasing uncertainties and frictions (Jude and Levieuge, 2017).

2.3.3 Institutional Quality and FDI

Literature shows that technology diffusion has an essential role in the economic development process. In comparison with the traditional growth theory, which left the technological changes as an unexplained residual, recently the growth theories include the level of domestic technology compared to the other countries in modeling the economic growth (Borensztein et al., 1998). It has been discussed that FDI can improve technological change through knowledge spillover effects and new capital goods (the technological diffusion process) (Hermes and Lensink, 2003).

Profitable investment significantly affects the economic development. Availability of foreign investments provides the chances that otherwise would be impossible. However, it has been confirmed that all kinds of capital inflows are not equally favorable, based on the experience with open capital accounts in developing and emerging countries recently. Portfolio investments and short-term credits would reverse suddenly in case the economic environment or the investors perception changes, which increases the probability of financial and economic crises. Hence, it is recommended that those countries should first attract FDI and be cautious in accepting other financial sources (Prasad et al., 2005). There are several empirical studies that approved the availability of positive associations between FDI and economic growth. FDI is a vital factor for global economic growth which encourages countries to provide suitable environment to attract more FDI inflow (Adhikary, 2010; Azam, 2010; Thangamani et al., 2010).

The trend towards globalization highlighted the importance of FDI. Understanding the factors which determine the MNCs‘ locations is becoming more significant for devising efficient policies in order to attract investments (Daude and Stein, 2007). Recently, reports have emphasized on the significance of a suitable institutional environment in obtaining the most possible benefits from FDI. For example, the flows of FDI to Russia stayed lower than $3 billion, which is much less than China‘s monthly FDI flows. The flawed Russian institutional infrastructure resulted in less investment and economic growth (Buchanan et al., 2012).

Some researchers have concentrated on how the institutional features of the host country affect the flow of FDI. One of the main factors to be focused is the significance of political factors in determining FDI flows (Stevens, 1969; Levis, 1979; Root and Ahmed, 1979; Schneider and Frey, 1985; Wei, 1997). Daude and Stein (2007) found that there are two channels that poor quality of institutions can discourage the flow of FDI. They stated that poor institutions would behave similar to a tax and as a result can be considered as a ―cost” to FDI. Lower quality of institutions would also raise the uncertainty which affects all kinds of investments, including FDI. There are also several empirical studies confirming that inefficient institutions discourage foreign investment (Asiedu, 2006; Asiedu and Villamil, 2000; Aw and Tang, 2010; Campos et al., 1999; Gastanaga et al., 1998).

The recent literature has involved three developments: (1) the significance of institutions in providing incentives to attract investments and achieving the higher economic growth has been emphasized following the study of North (1990); (2) transition and developing countries have become more interested in institutional reforms as an instrument for attracting higher shares of FDI flows, as a result of considerable growth of FDI flows during the 1990s; (3) finally, foreign investors are become increasingly interested in institutional quality in the process of decision making for future investments (Bevan et al., 2004).

The OLI paradigm (Dunning, 1980; Dunning, 1993) is defined based on ―ownership, location and internalization advantage-based framework" in order to discuss ―why, where and how" MNCs would choose for investments in other countries. Thomas L. Friedman in ―Golden Arches Theory of Conflict Prevention" which was published on December 1996, state that "No two countries that both have a McDonald's have ever fought a war against each other." According to Friedman, the justification is that when countries reach to a certain level of economic development which is necessary for having a McDonald's branch, the residents of those countries will end fighting wars for fear of the resultant economic and personal losses. McDonald's, as an international retailer, demonstrate not only a standard quality of living, but also, as James Cantalupo president and CEO of McDonald's International states "a symbol of something, an economic maturity and [openness] to foreign investments" (Li, 2008).

Political stability and risks in the host country usually affects the investment decisions (Dunning, 1993; Imad, 2002). Political risks represent the political activities that disrupt selling or results in damage to properties or harm to staffs. These activities include riots, operational restrictions and property acquisition by government (Daniels et al., 2002). Generally, political risk factors have negative effects on the decisions of MNCs‘ for investments (Dunning, 1993; Dupasquier and Osakwe, 2006; Hailu, 2010). FDI will positively affect economic growth while a certain threshold of institutional quality is provided. FDI-led growth can be beneficial once the institutional reforms precede FDI attraction policies (Jude and Levieuge, 2017).

Many studies examined the association between democratic rights and FDI. Harms and Ursprung (2002), Jensen (2003), and Busse (2004) applied different estimation techniques and considered different time periods to conclude that it is more possible that MNCs‘ be attracted to the locations with democracy. Li (2008) found that FDI flows and military conflicts have an inverse relation. Harms (2002a) and Biswas (2002) found a direct relation of FDI and composites of ICRG indices.

Suitable level of institutional quality can increase capital accumulation by deriving complementarities between foreign and domestic investments. Conversely, an underdeveloped institutional system would interrupt productive activities and will result in preventing the utilization of knowledge spillovers by the firms in the host country. Hence, countries that attract equal levels of FDI, will achieve different growth levels which depend on their quality of institutions (Jude and Levieuge, 2017). It can be concluded that as institutional quality significantly affects the investment decisions of multinational corporations and hence is a determinant of FDI flow (shown by several previous studies in this section) and as FDI itself is a determinant of energy intensity (discussed in section 2.2.3 of this chapter), the level of energy intensity can be related to the quality of institutions which is one of the research questions of this study.

Asiedu (2006) studied the determinants of FDI in Africa. They utilized a group of 22 economies in Sub-Saharan Africa during 1984 to 2000. Findings indicated that, availability of natural resources, large local markets, low inflation, good infrastructure, an efficient legal system and a good environment for investment attract FDI. On the other hand, corruption and political instability behave like a barrier to attract FDI.

Busse and Hefeker (2007) examined the relation between political risk, institutions, and FDI inflows. Considering a dataset of 83 developing economies during 1984 to 2003, the authors investigated the indicators that affect the decisions of MNCs. Their findings indicated that internal and external conflict, government stability, ethnic tensions, corruption, democratic accountability of government, law and order and bureaucracy quality are the main determinants in attracting MNCs.

Bénassy-Quéré et al. (2007) revisited the effect of quality of institutions on bilateral FDI for OECD nations, during 1985 to 2000. An institutional profile dataset was used for the purpose of finding out the significant institutions. Using the Fraser database, the effect of institutions in the source country and institutional distance was examined. They found that institutions have significant effects regardless of income per capita. More specifically the findings showed that the significant determinants of inward FDI are corruption, bureaucracy, information, banking sector and legal institutions. Lower employment protection and capital concentration showed to decrease the flow of FDI. In general, better institutions increase FDI inflow but this is not always true about outward FDI. Finally, they showed that institutional distance reduces bilateral FDI. These findings are promising as the efforts to improve the institutional quality to make them converge towards the source countries' quality of institutions, can help developing countries attracting more FDI.

Daude and Stein (2007) used bilateral FDI stocks to examine the significance of a variety of institutional variables in determining the FDI destinations. Their dataset contained FDI from 34 source countries which majority of them were developed, to 152 destination countries for the period 1982 to 2002. They found that while higher quality of institutions have significant and positive effects on FDI, some institutional determinants have more significant role compared to the others. More specifically, their findings showed that the unpredictable laws and regulations, government instability and lack of commitment and excessive regulatory burden have the most significant role in determination of FDI.

Buckley et al. (2010) investigated the determinants of outward direct investment (ODI) of China. They examined whether the special explanations such as institutional factors, special ownership advantages and capital market imperfections is necessary to be included in the general theory of the multinational firms. The hypotheses were tested using official Chinese ODI data which was collected for the years from 1984 to 2001. Results suggested that Chinese ODI has a relation with the host country‘s level of political risk. The market size and the availability of natural resources in the host country, the cultural similarity with the host country, and geographical proximity found to determine the ODI of China.

Ali et al. (2010) studied the institutions and FDI‘s relation utilizing a panel of 107 nations during 1981 to 2005. They found that institutions are significant determinant of FDI. More specifically they found that the most significant institutional characteristics are connected to the rule of law, propriety rights and the expropriation risk. They also examined the effect of institutions on FDI at the sectoral level. Results showed that institutions do not determine FDI in the primary sectors but they determine FDI in manufacturing and especially in services.

Mohamed and Sidiropoulos (2010) examined the significant determinants of FDI in MENA countries. They run the estimation on the determinants of FDI in the group of 36 countries and the time period ranging from 1975 to 2006. Out of 36 countries in the sample, 12 were MENA countries and the rest of 24 countries were the major destination of FDI in their respective regions in developing countries. By applying a panel data estimation method, the research investigated if the determinants of FDI are similar to the other FDI developing host countries. The findings revealed that the main determinants of FDI inflow in MENA nations are the host country's size of economy, the government size, natural resource endowments and the institutional factors.

Buchanan et al. (2012) using a dataset of 164 nations from 1996 to 2006 studied the impacts of institutional quality on the levels and volatility of FDI. Their findings suggested that good institutional quality attracts FDI. On the other hand, lower institutional quality can have negative and significant impact on both FDI and economic growth. It can be concluded that if institutional variables determine FDI volatility and if the volatility in FDI is associated with changes in economic growth, then the common policy instrument of increasing FDI inflow by offering the suitable macroeconomic environment can be effective while there is enough emphasis on institutional reforms.

Jadhav (2012) studied the impacts of political, economic and institutional determinants of FDI inflow to Russia, Brazil, India, South Africa and China (BRICS). The research used panel data of a decade from 2000 to 2009. The author applied panel unit root test and multiple regressions and included the effects economic and political determinants of FDI. Findings indicated the more significant effects of economic determinants compared to institutional and political determinants in these countries.

Esew and Yaroson (2014) investigated the impact of institutional quality on FDI flows into Nigeria for the period of 1980 to 2011. Finding indicated that political stability and corruption are significant determinants of FDI inflows to Nigeria. Other significant determinants include human capital and trade openness.

Nondo et al. (2016) studied the impact of institutional quality on FDI inflows to 45 SSA nations during 1996 to 2007. Their finding indicated that there isn‘t any significant relationship between quality of institutions and FDI inflows to SSA countries which is as a result of lower score of SSA countries on different dimensions of institutional quality. In addition they found strong evidences showing that a host country‘s natural resources significantly affect FDI inflows.

Peres et al. (2018) examined the impact of quality of institutions on FDI for developed and developing nations. The quality of institutions was measured by the sum of corruption and rule of law. Findings indicated that while the impact of institutional quality on FDI is significant and positive in developed countries its impact is not significant for developing nations as a result of the weak structure of institutions. Results revealed the importance of governance indicators in attracting FDI inflows.

Paul and Jadhav (2019) investigated the significant factors in attracting FDI to emerging markets. Their results indicated that the quality of infrastructure, trade costs measuring by tariffs and non-tariffs barriers, quality of institutions measuring by effective rule of law, political stability, regulatory quality and corruption control are significant determinants for attracting FDI to emerging markets.

2.3.4 Institutional Quality and the Environment

Economists believe that institutional quality is a significant factor for countries' economic growth and development in long-term. There is a new discussion emerging in the body of literature within the new institutional economics which addresses local and international environmental issues and is called the ―institutional ecological economics" (Gani and Scrimgeour, 2014). Some researchers contributed to this area of research including Bromley (1992), Schlager and Ostrom (1992), Dietz et al. (2003), Paavola and Adger (2005), Ostrom (2009) and Paavola (2007).

Pollution control has been in the center of policymakers' attention globally during the past thirty to forty years and the main reason behind the success of these policies is the institutional quality in a country (Goel et al., 2013). Paavola (2007) states that the best definition for environmental governance is: ―establishment, affirmation, or change of institutions" in order to settle environmental disputes. Wu (2017) concludes that government institutions should consider effective pollution control policies and impose environmental rules and regulations for the public goods such as better air quality for their people. As the institutional quality improves, the EKC for CO2 emissions shift downward

(Ibrahim and Law, 2014). Barrett and Graddy (2000) found that an increase in civil and political freedoms declines certain types of pollution.

Reviewing the past literature, there have been some attentions to the nexus between corruption and pollution. Damania et al. (2003) state that by considering the reduction in environmental policy strictness in corrupted countries, corruption may play an important role in policy determination. Sahli and Rejeb (2015) concluded that "institutional weaknesses" such as corruption affect the country‘s productivity. They also affect the government's ability to control the environmental quality. The impacts of corruption on the environment were also showed by Wilson and Damania (2005), Desai (1998) and Cole (2007) studies.

Wilson and Damania (2005) analyzed the political competition and environmental outcomes‘ relation. They suggested that although political competition can lead to policy enhancements, it cannot put an end to corruption at government‘s different levels. Desai (1998) stated that widespread official corruption is a major culprit in environmental destruction in many industrializing countries. Cole (2007) found that, corruption has a direct and positive impact on CO_2 and SO_2 emission per capita. In addition, corruption indirectly affects both pollutants through its negative relation with income per capita. The total effect of corruption on emissions is negative for all countries except the highest income nations.

Huynh and Hoang (2018) found that initially, FDI inflows increase air pollutions in Asian countries, and the improvements in institutional quality leads to reducing this effect until the institutional quality reaches to a certain threshold and beyond this point, FDI decreases air pollution. The study of Tamazian and Rao (2010) showed that financial development enhances the quality of environment by decreasing CO2 emissions in countries with better institutions and vice versa.

2.4 Export Diversification

Export diversification can be defined as the process which results in producing a growing range of economic outputs. This definition means diversifying markets for exports or diversifying of the sources of income more than the boundaries of domestic economic activities (Zhang, 2003). The structural models of economic development state that for the purpose of achieving sustainable economic growth, countries should consider the diversification in their exports which means moving from primary to manufactured products (Chenery, 1979; Syrquin, 1988). Increases in diversification are associated with lower volatility and higher growth. For instance, it is the case of low income countries since 1995 which was also associated with better institutions (Papageorgiou and Spatafora, 2012). Many commodity dependent countries or the countries with limited basket of exports often undergo export instability as a result of unstable and inelastic global demand for products. Export diversification is a policy that can be devised to attenuate these types of risks (Hesse, 2009).

There are generally two different explanations, about the benefits of export diversification for economic growth. The first explanation is the –portfolio effect” that gets its name from the finance literature. Portfolio effects states that in order to avoid volatility in exports earnings the higher degree of diversification should be considered. Lower volatility in exports is associated with lower variance in GDP growth. Second, there is the “dynamic effect” of export diversification. Growth in long-run horizon is associated with learning to produce a wide range of products. This viewpoint considers growth as an outcome of adding new products to the production and export baskets. In countries with limited indigenous sources of productivity growth, majority of their productivity enhancements come from the investment process itself, as new capital goods embody productivity changes and the opening up of new sectors that have higher factor productivity than existing sectors (Agosin, 2007).

The significance of production specialization and trade has been emphasized on the productivity theory of Adam Smith and arguments that consider trade as an engine of growth. The fundamental argument is based on the static benefits of trade, which is emerged from production specialization based on the comparative advantage, and the dynamic benefits from trade emerging from a labor division and the utilization of economies of scale (Aditya and Acharyya, 2013). However, the structuralist theories raise doubts on the theoretical proposition that emphasizes on specialization to enhance growth. Those developing countries that export primary goods faced failure in their trade during the 1950s and the decade after that. It can be concluded that changes in the exports composition by moving from primary products to manufactured products or “vertical diversification” is necessary in achieving sustainable growth (Agosin, 2007; Chenery, 1979; Syrquin, 1988). Gozgor and Can (2016) state that export diversification lead to a significant effect on CO_2 emissions. This occurs when new products are added to the exports basket which leads to a raise in CO_2 emissions. Burton et al. (2002) stated that adapting to climate change is the major target of the UNFCCC in two different but connected ways. The first one which is called "mitigation" defined as prevention from hazardous interference with the climate system by stabilizing the concentration of GHGs in the atmosphere. The second one which is called ―adaptation" defined as reducing the vulnerability to climate change. Both dimensions are related to the policy of increasing economic diversification in the developing economies, but in different ways (Zhang, 2003).

2.5 Individual Case Studies on Determinants of Energy Intensity and Energy Consumption

Foon Tang (2009) examined the model for consumption of electricity in Malaysia. The author used cointegration and Granger causality test during the period started from 1970 to 2005. For the purpose of testing cointegration, the study applied bounds testing procedure. The research studied the potential long-run association and autoregressive distributed lag model applied to estimate the coefficients in short-run and long-run horizons. For the purpose of finding the direction of causality between consumption of electricity and its determinants, the Granger causality test was used. Results revealed new evidences including the cointegration among consumption of electricity, FDI, income and population in the country. In addition, the findings indicated that the impact of FDI and population growth is positive in relation to electricity consumption in Malaysia. Moreover, the results from Granger causality showed that electricity consumption, FDI and income have bilateral causality. The estimated electricity consumption model of Malaysia showed that Malaysia is a country that depends on consumption of energy; as a result energy conservation policies can lead to inverse effects on current and future economic development of this country.

Bento (2011) studied the association between energy consumption (primary), economic growth and FDI applying cointegration test on the dataset covering the period 1980 to 2007 by using Stock-Watson DOLS, Engle and Granger technique, the bounds approach of testing to cointegration and ECM. Finding of this research revealed that a linear long-run cointegration relation exists among the variables. Income represented a positive and large impact on consumption of energy while findings revealed a small and negative impact of FDI on consumption of energy. Studying the short-run relations, the estimation and inference in the ARDL also showed this link. The author concludes that the promotion of suitable structural policies for the purpose of attracting FDI can enforce energy conservation without decreasing economic growth.

Zaman et al. (2012) identified the determinants of electricity consumption in Pakistan. More specifically, they studied the impacts of FDI, economic growth and the growth of population over the period from 1975 to 2010. They applied bounds approach for cointegration for short-run and long-run estimates. For the purpose of finding the direction of causality among consumption of electricity and the determinants of this variable, they applied dynamic short-run causality test, by using Wald-F statistics. Their findings showed cointegration between determinants of electricity consumption. The effects of income, FDI and population growth found to be positive in relation to consumption of electricity in this country. However, the magnitude of these effects on consumption of electricity varies across different variables. It can be concluded that the sources of rise in electricity consumption in Pakistan are population growth, income and FDI. Short-run dynamic causality test revealed a unidirectional causality running from population growth to consumption of electricity in Pakistan.

Shahbaz and Lean (2012) examined the association between economic growth, industrialization, financial development, urbanization and energy consumption in Tunisia during 1971 to 2008. In their study ARDL bounds testing approach to cointegration and Granger causality test were used. Findings showed that the long-run association exists between economic growth, consumption of energy, industrialization, financial development and urbanization. Financial development showed long-run bidirectional causality with energy consumption and industrialization. Industrialization also found to have long-run bidirectional causality with energy consumption. This has led the authors to conclude that suitable financial environment in order to attract investors, improve the stock market and increase the efficiency in economic activities could be applied in this country. However, boosting urbanization and industrialization cannot be ignored for the development targets (Shahbaz and Lean, 2012).

Despite an ongoing body of literature on the availability of long-run relation between consumption of energy and economic growth, Islam et al. (2013) found that there is no constant view on the direction of causality between these two variables. While, experiencing economic growth by a country will cause more energy consumption and population growth also increases consumption of energy, financial development can cause enhancement in energy efficiency which will lead to reducing energy consumption. Economic growth and consumption of energy in Malaysia have been increasing simultaneously during the past years. Malaysia has three public policies including economic growth, population growth and financial development and policy makers aim to realize the dynamic associations between these variables. Considering these policies, the study investigated the availability of long-run associations between consumption of energy, aggregate production, population and financial development of Malaysia, and tested the causal relation applying the VECM. Findings suggested that in the short-run and the long-run horizon, economic growth affects consumption of energy and financial development, but the population and energy consumption‘s relation only exists in the long-run.

Sbia et al. (2014) studied the association between FDI, clean energy (natural gas consumption per capita), economic growth, trade openness and CO_2 emissions for the UAE during 1975Q1 to 2011Q4. Structural breaks were accounted in this study and ARDL, bounds testing approach to cointegration developed by Pesaran et al. (2001), applied in order to investigate the availability of long-run associations between variables. In addition, they applied the VECM Granger causality test to study the causal relation among the variables. Availability of cointegration between the variables has been confirmed by the results of their study and as a result the VECM can be developed. Results indicated that FDI, trade openness and CO_2 emissions reduce energy consumption. Moreover, it has been confirmed that economic growth and clean energy have positive effects on the consumption of energy.

FDI improves energy efficiency, which shows the FDI and consumption of energy‘s negative relation. To raise the motivation of UAE in order to attract FDI flows with no effects on consumption of energy these findings can be applied. Green energy increases energy consumption in a lower rate in comparison with the application of traditional technologies and products. In this study the findings showed trade openness and consumption of energy‘s negative relation and trade openness found to decrease energy consumption by adopting more energy efficient technologies. High volume of UAE‘s trade allows the adoption of innovative technologies to decrease the consumption of energy.

Adom and Kwakwa (2014) studied the impacts of changing trade structure and changing technical characteristics in manufacturing sector on energy intensity in Ghana. They also investigated the effects of urbanization and FDI on energy intensity in this country. They applied the share of FDI in GDP as an indicator in order to consider the –technique effect” on the energy intensity. Testing the unit root and cointegration, the results from their analysis supported the existence of cointegration. The authors concluded that the reasons behind improvement in energy efficiency are the changing technical characteristics in manufacturing sector after the reform and changing production mix in favor of more energy efficient products. However, the consumption of energy as a result of exports that surpassed the energy which is saved via importation of capital goods after the reform in 1983, decreased energy efficiency. Urbanization growth significantly increased energy intensity. In conclusion, the impacts of diffusion of technology through trade were more significant compared to the technological diffusion through FDI on energy intensity.

Komal and Abbas (2015) investigated the associations between energy consumption, economic growth and financial development for Pakistan during 1972 to 2012 by application of system GMM. They aimed to study the impacts of financial development on energy consumption through channel of economic growth. In addition, they considered price of energy and urbanization in their model. While results showed significant and positive impacts of urbanization and economic growth on consumption of energy, the impacts of energy prices on consumption of energy is negative and significant. The findings also indicated that financial development has positive and significant impacts on consumption of energy via the channel of economic growth.

They concluded that the government should have programs to guarantee efficient usage of existing energy sources together with enhancing the capacity of existing energy production plants in order to tackle with energy scarcity issues. In addition, investments in renewable sources of energy can facilitate the availability of lower cost energy for all economic activities, in which financial institutions can collaborate with government. Increase in price of energy have unfavorable economic effects since the cost of production will increase which can lead to losing the competitive advantage of manufacturing products in foreign markets. Accessing to affordable renewable sources of energy can solve this issue which is required for achieving sustainable economic growth in Pakistan.

Adom (2015a) studied the determinants of energy intensity using the FMOLS and canonical cointegration regressions in Nigeria. The author selected these methods, as they are capable of dealing with the second-order bias issues effectively, which is mainly a characteristic for time series data. The asymmetric effects of FDI, crude oil price, industry structure and trade openness confirm the availability of structural effects in the parameters. The price of crude oil, trade openness and FDI impacts found to be negative but get stronger after 1989, resulting in lower energy intensity compared to the period before 1989. The value added of industry has positive and significant impact which becomes weaker after 1989.

Adom (2015b) in his study aimed to examine the different phenomena that have caused the energy intensity to be reduced in South Africa. The existence of structural effects is tested in the parameters of the model. Findings revealed that the deindustrialization which started since 1980s and also trade structure changes favoring higher imports are the significant reasons behind the decrease in energy intensity. In addition, the current composition of industry has caused technological transfer through FDI and this has led to the decrease in energy intensity, in South Africa.

There have been energy prices reforms in Iran which targeted energy consumption patterns in industries. Barkhordari and Fattahi (2017) studied different aspects of potential effects, and explored the short-run and long-run relationships between energy prices, energy intensity, and technological improvements in industries of Iran. Applying ARDL approach and the data for the period of 1986 to 2015, their findings revealed that a long-run relationship between energy prices and energy intensity exists. In addition, technological changes are found to have significant impacts on energy intensity.

Russia has been very energy intensive but its energy intensity has decreased significantly since 1998. Rudenko and Raschetova (2018) investigated how different determinants have affected the reduction in energy intensity of Russia. The cointegration methodology is applied to test the long-run relationship between the variables affecting energy intensity. Findings indicated that energy prices and the share of non-carbohydrate energy significantly affect energy intensity and are negatively correlated to variations in energy intensity.

2.6 Multi-Case Studies on Determinants of Energy Intensity and Energy Consumption

Mielnik and Goldemberg (2002) using a dataset of 20 developing nations found strong evidences to support the decrease in the energy intensity because of increase in FDI. The authors explained that FDI brought with itself modern technologies which were used in these countries. These modern technologies are more energy efficient compared to the older technologies and this has led to reduction in consumption of energy which is used for production of each unit of products in these developing countries.

Cole (2006) applied the model developed by Antweiler et al. (2001). The study empirically modeled the impacts of trade liberalization on consumption of energy. Findings showed that energy consumption per capita is dealing with scale effect that offsets the negative technique effect, revealing that technological and regulations enhancements are not growing as fast as GNP. Regarding the trade-induced composition effect, results revealed that energy intensive industries are affected by contradictory forces as suggested by the factor endowment and the pollution haven hypotheses. Finding also showed that trade liberalization increases per capita consumption of energy in the group of countries that were studied.

Mishra et al. (2009) used Granger causality test and studied long-run associations between GDP, urbanization and energy use considering a group of Pacific Island countries. The reason behind selecting Pacific Island countries is that they are ―small economies" highly dependent on energy for their economic activities and growth. These countries are sensitive to global warming and environmental issues so the association between energy use and GDP is vital for their development plans. They applied panel version of DOLS for estimating the long-run structural coefficients. The findings showed that, for the entire panel of data there is bidirectional Granger causality between energy use and GDP in the long-run and the variables have a positive effects on each other. It can be concluded that this group of countries should invest more in energy infrastructures and should consider regulatory reforms of energy infrastructure to continue promoting alternative energy. Energy conservation policies will also decrease unnecessary wastes. These policies attempt to achieve both goals of decreasing the impacts of energy consumption on the environment, while sustaining the economic growth.

Financial development is usually considered as one of the significant elements that affects economic growth in emerging economies. Hence, it is possible to conclude that financial development affects consumption of energy. Sadorsky (2010) used GMM method to investigate the effects of financial development on energy use in panel of emerging economies. The author considered variety of measurements to define financial development. Considering the dataset of 22 emerging economies during 1990 to 2006, the findings of the research revealed that financial development has a positive and significant association with energy use if financial development is defined by stock market variables.

Hübler and Keller (2010) studied the FDI inflows and energy intensity‘s relation in developing nations. In the first step, the authors applied OLS estimation method, to test the findings in the literature suggesting that FDI inflow decreases energy intensity. Their finding showed spurious results which was only to initiate further research. In their regressions they utilized annual data of 60 developing countries for duration covering from 1975 to 2004. The study also included other potential determinants of energy intensity, and checked robustness of the estimations using the relevant tests. The findings did not prove that FDI inflows can reduce energy intensity in developing economies. On the other hand, there were evidences to support that foreign development aid can reduce energy efficiency.

Ozturk et al. (2010) using a data of 51 economies considered the variables of energy consumption and economic growth during 1971 to 2005 in their model. The countries were categorized based on their income level to three different categories. First, the energy consumption and economic growth‘s relation was studied applying Pedroni (1999) panel cointegration technique. Second, panel Granger causality test was employed to examine the direction of Granger causality between the economic growth and energy use. In the last stage, employing Pedroni (2001) technique, the magnitude of relation between these variables was tested. The findings indicated that variables of energy use and GDP are cointegrated in all the income levels. The results of panel causality test revealed that there is a long-run causality running from GDP to energy use in low income economies and there is bidirectional causality between energy use and GDP for middle income economies. The estimated cointegration factor is not close to one, which means that energy use and economic growth‘s relation is not strong for these three income groups (Ozturk et al., 2010; Pedroni, 1999, 2001).

The association between urbanization, consumption of energy and carbon emissions has been widely examined recently but there are not enough considerations about the dissimilarities in development stages or income levels between economies. Majority of the past studies have the assumption of homogenous impact of urbanization for all countries. Poumanyvong and Kaneko (2010) stated that this assumption raises doubts as countries of different levels of income have many characteristic differences. As a result, their study investigated the effects of urbanization on consumption of energy and carbon emission empirically considering different development levels. Applying the STIRPAT model and using data of 99 nations during 1975 to 2005, and also pooled OLS, FE, PW and first differenced estimation methods, their findings suggested that the effects of urbanization on consumption of energy varies for different development levels. The findings also revealed that while urbanization reduces consumption of energy in the low income economies, it results in more energy consumption in the middle and high income economies. The impacts of urbanization on emission found to be positive across all income levels, but it is more significant in the middle income nations.

Sadorsky (2011a) examined the impacts of financial development on consumption of energy in panel of 9 European countries. Various definitions of financial development are employed such as bank and stock market-related variables. The system GMM estimation method applied in this study. Their empirical findings showed a positive and significant association between financial development and energy use when financial development variable is defined by banking indices. Considering the stock market indices, the stock market turnover is the only variable which positively and significantly affected energy use.

Zheng et al. (2011) examined the effects of exports on industrial energy intensity to find out if higher level of exports can cause reduction in energy intensity. Panel model estimation with data of 20 industrial sub-sectors of China for the period over 1999 to 2007 suggested that in general, higher level of exports deteriorates energy intensity of the industrial sector. As characteristics of sub-sectors and also the roles which different factors across sub-sectors played are different in each one, it is not possible to devise a general policy of exports that would be suitable for all sub-sectors in decreasing energy intensity.

Sadorsky (2011b) raised a question that how does increases in trade affect consumption of energy? The author brought this question based on the significant increases in trade, GDP and consumption of energy during the past 30 years, which happened in many of economies worldwide. For the purpose of answering this question, his study applied panel cointegration estimation method to investigate the effect of trade on consumption of energy in a panel of 8 Middle Eastern nations from 1980 to 2007. The author applied OLS, DOLS and FMOLS techniques for the purpose of estimation. All the variables showed almost the similar results across the three approaches considering sign, statistical significance and magnitude of impact. Results indicated that there is a unidirectional Granger causality running from exports to consumption of energy, and bidirectional Granger causality exists between imports and consumption of energy. Long-run elasticities that estimated using FMOLS technique indicated that there is direct relation between per capita exports and per capita imports and per capita energy consumption. These results have a significant role in devising trade related suitable policies.

Çoban and Topcu (2013) studied the financial development and energy use‘s relation for EU countries during 1990 to 2011 applying system GMM model. Their results did not show any significant relation for the EU27 countries. However the old members‘ results showed strong evidences supporting the significant impact of financial development on energy use. Enhanced financial system will lead to a raise in energy use and it is similar for financial development defined in banking sector or stock market. Evidences found for the new members showed that the effect of financial development on energy use depends on the definition of how financial development. Although using banking indices, the effect of financial development represents an inverted U-shaped illustration, findings did not support the existence of a relation when it is defined by stock market indices.

Sadorsky (2013) used heterogeneous panel regression technique, MG and CCE estimators to estimate the effect of urbanization, industrialization and income on energy intensity for a panel of 76 developing economies. The study found that in the long-term, a rise in income decreases energy intensity. Long-term industrialization elasticities are in the range from 0.07 to 0.12. Mixed results found for the effects of urbanization on energy intensity.

Wong et al. (2013) examined the short-run and long-run elasticities of different types of energy consumption and energy R&D to changes in income and oil prices in 20 OECD countries during 1980 to 2010 applying the NPAM. The authors used first differenced GMM where the lagged first differences of the variables are considered as valid instruments. They found that income elasticity for consumption of coal is negative but income elasticity for consumption of oil and gas is positive. This can be concluded that economic growth has a significant impact in stimulating the consumption of clean energy by moving from coal consumption to oil and gas consumption. Applying time dummies into the model, they showed that climate mitigation policies are capable of encouraging the consumption of clean energy. The dynamic relation between consumption of energy and energy R&D revealed that consumption of fossil fuels stimulates fossil fuel R&D which leads to increase in fossil fuel consumption. Renewable energy R&D which has more significant impact in economic growth decreases consumption of fossil fuels and as a result, R&D in fossil fuels.

Lee (2013) studied the relation between FDI, energy use, clean energy, carbon emissions and economic growth utilizing a panel dataset of G20 countries. Results revealed that FDI stimulates the economic growth while decreasing energy intensity by the application of less energy intensive equipment. FDI decreases carbon emissions. In addition, the adoption of clean energy similarly stimulates economic growth.

Elliott et al. (2013) studied the relation between the energy intensity of the largest cities in China and foreign firms‘ locations applying a panel data of 206 prefecture-level cities for the period from 2005 to 2008. Their findings revealed that FDI flows and energy intensity‘s relation is negative and significant. This relation was varied based on the geographic location which is the sign of differences in the potential of each region to attract and benefit from environmental spillovers. The lower magnitude economic impact of FDI can be explained by the tendency of foreign firms to invest in energy intensive industries.

Herrerias et al. (2013) investigated if openness (to FDI and import) and investment ownership are significant determinants of diffusion of energy efficient technologies in China. In comparison with the past studies, their study attempted to use a panel dataset at provincial level that takes into account the heterogeneity in regional level. The unequal regional growth led to differences in the demand for energy resources across the large China‘s territory. The analysis was categorized by types of energy resources: petroleum, coal and electricity. The author estimated the models using panel corrected standard errors which is developed by Beck and Katz (1995) for the period from 1985 to 2008. The findings confirmed that both foreign and non-state investments have a significant role in decreasing energy intensity across Chinese regions. However, the results did not confirm a positive contribution of state investments. In addition, their findings revealed that energy intensity in each region significantly differs from the other regions, as a result confirmed the significance of the regional differences when analyzing consumption of energy in China.

Salim and Shafiei (2014) examined the effects of urbanization on renewable and nonrenewable consumption of energy in OECD countries, using ―STIRPAT (Stochastic Impacts by Regression on Population, Affluence, and Technology)" model for the period from 1980 to 2011. They applied CCE Estimator (proposed by Pesaran (2006)) to estimate the coefficients. They found that factors such as demographic indicators including total population, population density and urbanization are the significant factors, especially in determining nonrenewable energy consumption. In addition, results showed that while total population and urbanization's relation with nonrenewable energy consumption is positive, population density has a negative relation with nonrenewable energy consumption. Considering the demographic factors, total population shows a significant effect on consumption of renewable energies. The outcome of the Granger causality test showed that in the short-run horizon there is unidirectional causality running from nonrenewable energy consumption to population density. However, results did not show any causality between urbanization and nonrenewable energy consumption. Similarly, causality did not exist between renewable energy consumption and all the demographic factors in the study.

Nasreen and Anwar (2014) examined the trade openness, economic growth and energy use's causal relation for the group of 15 Asian nations. The study used the panel dataset from 1980 to 2011. They used panel cointegration and causality techniques to study the long-run and causal relations among variables. They used FMOLS (proposed by Pedroni (2000) and Pedroni (2001) and DOLS (proposed by Kao and Chiang (2000)) for the purpose of estimating the associated long-run cointegration parameters. Their results showed the availability of cointegration between variables. The authors also found that economic growth and trade openness has positive relation with consumption of energy. Bidirectional Granger causality found on economic growth-energy use and also trade openness-energy use relationship.

Fei et al. (2014) examined the long and short-run associations between electricity consumption (fossil fuel powered), energy prices, economic growth and technological innovation for net energy exporting countries, during the period of 1974 to 2011. The authors selected four countries of Ecuador, Canada, Norway and South Africa to investigate the relation between these variables. Their findings of the ARDL approach and the Granger causality test suggested that the economic growth have positive effects on the changes in electricity consumption in both the short and the long-run. Ecuador and Norway showed the causality running from electricity consumption to economic growth. The degree of dependence on energy exports found to be a significant factor to explain the causality between the electricity and growth. Considering that technological innovation is not a significant determinant of electricity generation, the authors suggested that these net energy exporting countries should replace fossil fuel with more efficient sources for the process of electricity generation.

Omri and Kahouli (2014) examined energy use, FDI and economic growth‘s relation applying a dynamic panel estimation method (GMM) in simultaneous equation for a group of 65 nations. Their study considers the time period of 1990 to 2011. Three income groups were finalized; high, middle, and low income. Empirically, they draw on the growth theory and augment the classical growth model that includes capital stock, labor force, and inflation, with FDI and energy. Their findings showed mixed results regarding the consumption of energy, economic growth and FDI's relation.

Mohammadi and Parvaresh (2014) studied energy use and GDP's long-run and short-run relation considering a group of 14 nations which all were oil exporting during the period from 1980 to 2007. Testing for the panel unit root by including common cross-sectional factors revealed that both variables are stationary. As a result, long-run and short-run relations explored applying panel estimation methods, namely, dynamic FE and MG estimators. Their findings based on the MG estimator with CCE indicated a stable relation among energy use and GDP; bidirectional causality in short and long-run; and the robustness of the long-run causalities to including extra variables. More specifically, for the purpose of avoiding the issue of variable omission bias, the authors considered urbanization, CO_2 emissions, and exports to estimate the results of tri-variate ECM. The results of short-run causality were weaker compared to the long-run.

Shahbaz et al. (2014) investigated trade openness and consumption of energy's relation using a dataset of 91 countries which were grouped based on their level of income. Their study covered the duration of 1980 to 2010 adopting panel cointegration to investigate the long-run relation between the variables. More specifically, they used pooled mean group (PMG) as their estimation technique. Results showed the availability of cointegration between trade openness and consumption of energy. The trade openness and energy consumption‘s relation found to be inverted U-shaped for high income countries while it represented a U-shaped relation in low and middle income nations. The nonhomogeneous and homogenous causality tests revealed the existence of bidirectional causality between energy consumption and trade openness.

Alam et al. (2015) studied energy consumption, economic growth, and energy prices, FDI and various financial development indicators‘ relation in the group of SAARC nations for duration from 1975 to 2011. The result of the panel cointegration analysis indicated that these three variables are cointegrated and there is a long-run association between them. The study applied panel data techniques including FE, pooled OLS and RE methods, to test the validity of the ―energy-growth nexus via financial development” in this group of countries. Specification tests showed that FE model is preferable. The result of FE model showed that there is a significant relation between consumption of energy, economic growth, FDI and financial development indicators. However the magnitude of financial development indicators‘ effects on increasing energy use is larger, in comparison with per capita GDP and FDI.

Yan (2015) empirically investigated the effects of urbanization on aggregate and disaggregated energy intensities using a panel data of 30 provinces in China for the duration from 2000 to 2012 and application of panel estimation methods. The findings indicated that urbanization significantly and positively affects aggregate energy, coal and electricity intensity.

Adom and Amuakwa-Mensah (2016) in their study examined the conditional effects of FDI and industrialization on energy productivity utilizing a panel dataset including 13 East African nations during 1980 to 2011. The starting point findings revealed that the well-integrated economy and the higher income are in favor of energy productivity, but FDI inflows and higher industrialization are not supporting energy productivity in this group of countries. These results remained robust even after excluding the high income group and control for income group impacts. The effect of income in promoting energy productivity in low income group was more significant than middle income group. Only in low income countries, higher industrialization and FDI inflows significantly reduce energy productivity and only in middle income countries, trade openness significantly improves energy productivity. Results indicated that FDI inflows and income, higher industrialization and FDI inflows, and higher industrialization and globalization are “complementary forces” in promoting energy productivity in East African countries, but this is more obvious for the middle income countries compared to the low income countries.

Herrerias et al. (2016) examined the role of foreign and indigenous innovation on energy intensity in 30 Chinese regions. They controlled their estimations by including energy prices and the composition effect. The results suggested that both foreign and domestic innovation activities significantly improved energy efficiency in Chinese regions. In addition, Rafiq et al. (2016) utilized three second generation heterogeneous linear panel models and nonlinear panel estimation methods which allow for cross-sectional dependence. The findings indicated that population density and affluence affect emissions and energy intensity positively while renewable energy does not have a significant role in these emerging economies, but nonrenewable energy raises energy intensity.

Atalla and Bean (2017) investigated the drivers of energy productivity in 39 nations for the period of 1995 to 2009. Their findings showed that increase in sectoral energy productivity is a primary contributor to the improvements in energy productivity. Moving from industry to services had less significant impacts in the improvements of energy productivity. Countries which represented similar economic and demographic characteristics showed the same levels of energy productivity and rates of improvements. Former communist countries undergoing economic liberalization showed the highest rate of improvements, although these countries are still less energy productive compared to developed countries. Higher per capita income and energy prices found to be associated with more energy productivity, while a higher share of industry output is associated with less energy productivity. More specifically higher energy prices and level of income are associated with sectoral energy productivity improvements.

Elliott et al. (2017) investigated the direct and indirect effects of urbanization on energy intensity in China applying data of 30 provinces during 1995 to 2012. Using MG technique of estimation showed that while the direct impact of urbanization on energy intensity is positive, the indirect impact from different channels of construction, industrial upgrading, transportation and changing lifestyles is negative. The construction channel is the most significant indirect channel. The transportation and industrial upgrading channels are also significant but only under specific conditions.

Chen et al. (2019) investigated the effect of foreign and indigenous innovations on China‘s industrial energy intensity in 34 industrial sectors for the period of 2000 to 2010 applying linear and nonlinear analysis methodologies. The linear analysis findings indicated that indigenous innovation lowers the industrial energy intensity during the selected period. The foreign innovations, through FDI and imports, are found to benefiting the decrease in industrial energy intensity; on the other hand, exports increase the industrial energy intensity.

2.7 Expected Signs of Variables

The followings are the table of summary of the determination studies and the table of expected signs of variables of the current research, based on the past studies. The summary of the determinants of the energy consumption and energy intensity only considers determination studies and previous works are arranged chronologically.

Table 2.1 Summary of Determination Studies

NO	Author	Year	Sample Size	Country/ Group	Sample Period	Methodology	Variables	Functional Form	Findings
1	Mielnik & Goldemberg	2002	20	Developing Countries	1987 - 1998	Regression	EI, FDI (FDI/GDI)	No Log	FDI(-)
2	Cole	2006	32	Developed and Developing Countries	1975 - 1995	FE	EU, Y, Y2,TI, K/L, (K/L)2	Log	Y(-), Y^2(+) TI(+), K/L(+), $(K/L)^2$(+)
3	Mishra et al.	2009	9	Caledonia, Fiji, French Polynesia, Samoa, Kiribati, New Papua New Guinea, Solomon Islands, Vanuatu, Tonga	1980 - 2005	DOLS	EU,Y, UR	Log	Y(+),UR(+)
4	Foon Tang	2009	1	Malaysia	1970 - 2005	ARDL, VECM	EU,Y, FDI, POP	Log	Y(+), FDI(+), POP(+)
5	HÜBLER & Keller	2010	60	Developing Countries	1975 - 2004	FE, 2SLS	EI, FDI, Y, IM, AID, GFCF	EI & Y (Log)	IM (Insig.), AID (-), FDI(Insig.), GFCF(+), Y(+,-)

NO	Author	Year	Sample Size	Country/ Group	Sample Period	Methodology	Variables	Functional Form	Empirical Findings
6	Poumanyvong & Kaneko	2010	99	Low (23), Middle (43) and High Income (33) Groups	1975 - 2005	Pooled OLS, FE, PW, FD	EU,Y, POP, IND, S.V.A, UR	Log	OLS:Y(+), POP(+), IND(+), S.V.A(-), UR(+) FE: Y(+), POP(+), IND(-), S.V.A(+), UR(-) PW: Y(+), POP(+), IND(+), S.V.A(+), UR(-) FD: Y(+), POP(+), IND(+), S.V.A(+), UR(+)
7	Sadorsky	2010	22	Emerging Countries	1990 - 2006	Dynamic Panel GMM	EU,Y, EP, FDI	Log (Except FDI)	Y(+),EP(+), FDI(+)
8	Ozturk et al.	2010	51	Low, Lower Middle and Upper Middle Income	1971 - 2005	FMOLS DOLS	EU,Y	Log	Y(+)

NO	Author	Year	Sample Size	Country/ Group	Sample Period	Methodology	Variables	Functional Form	Empirical Findings
9	Bento	2011	1	Portugal	1980 - 2007	DOLS	EU,Y, FDI	Log	Y(+), FDI(-)
10	Sadorsky	2011a	9	Central and Eastern European frontier economies Croatia, Bulgaria, Estonia, Lithuania, Kazakhstan, Romania, Slovenia, Ukraine, Serbia	1996 - 2006	Dynamic Panel GMM	EU,Y, EP, FD	Log	Y(+) EP(-), FD(+) (Some FD* were sig. in other functions.)
11	Sadorsky	2011b	8	Middle Eastern Countries	1980 - 2007	OLS, DOLS, FMOLS	EU,Y, EP, EX, IM	Log	OLS, DOLS & FMOLS: Y(+) (Insig. in OLS), EP(-) EX(+) OLS &FMOLS Y(+),EP(+), IM(+) DOLS: Y(+) EP(-), IM(+)

NO	Author	Year	Sample Size	Country/ Group	Sample Period	Methodology	Variables	Functional Form	Empirical Findings
12	Zheng et al.	2011	20	China's Industrial Subsectors	1999 - 2007	FGLS, PCSE, Panel Threshold	EI, Ex, FDI, INV, ECS, SEC	No Log	Ex(+), FDI(+,-), INV(-,+), ECS(Insig.)
13	Shahbaz & Lean	2012	1	Tunisia	1971-2008	ARDL, UECM	EU,Y, FD, IND, UR	Log	Y(+), FD(+) IND(+), UR(+)
14	Zaman et al.	2012	1	Pakistan	1975 - 2010	ARDL, VECM	EU,Y, FDI, POP	Log	Y(+), FDI(+) POP(+)
15	Herrerias et al.	2013	28	Chinese Regions	1985 - 2008	Time Series Cross-Sectional Model	EI, IM, IND, EP, IO	No Log	IM(-), FDI(-), IND(Insig.), EP(-), IO(-)
16	Çoban & Topcu	2013	27	EU27	1990 - 2011	Dynamic Panel GMM	EU,Y, EP, FDI	Log (Except FDI)	Y(+), EP(-), FDI(+)
17	Islam et al.	2013	1	Malaysia	1971 - 2009	ARDL, VECM	EU,Y, POP, FD	Log	Y(+), FD(+), POP(+)

NO	Author	Year	Sample Size	Country/ Group	Sample Period	Methodology	Variables	Functional Form	Empirical Findings
18	Wong et al.	2013	20	OECD Countries	1980 - 2010	Dynamic Panel GMM	EU,Y, EP	Log	Y(+), EP(-)
19	Sadorsky	2013	76	Developing Countries	1980 - 2010	Pooled OLS FE FE Instrumental Variable FE First Difference	EI, UR, IND, Y	Log	UR(+), IND(+), Y(-)
20	Eilliott et al.	2013	206	Chinese Cities	2005 - 2008	FE, 2SLS	Log	EI, FDI,Y, Y^2, GIPd, GIPh, GIPf	FDI(-), Y(+), Y2(Insig.), GIPd(+), GIPh(Insig.), GIPf(Insig.)
21	Adom & Kwakwa	2014	1	Ghana	1975 - 2011	FMOLS Canonical Cointegration Dynamic OLS	EI,MAN, TO,FDI, UR, DMAN, DTO	Log-Lin	MAN(+), TO(-), FDI(+), UR(+), DMAN(-) and (+) in Dynamic OLS, DTO(+)

NO	Author	Year	Sample Size	Country/ Group	Sample Period	Methodology	Variables	Functional Form	Empirical Findings
22	Nasreen & Anwar	2014	15	Pakistan, India, Bangladesh Sri Lanka, Philippines, Thailad Indonesia, China, Malaysia, Japan, Jordan,Iran, Korea Dem., Nepal, Vietnam	1980 - 2011	FMOLS, DOLS	EU,Y, TO, EP	No Log	FMOLS & DOLS: Y(+), TO(+) EP(-)
23	Salim & Shafiei	2014	29	OECD Countries	1980 - 2011	CCE Estimator	EU,Y, PD, POP, IND, UR, S.V.A	Log	Y(+), PD(-) POP(+), IND(+), UR(+), S.V.A(+)
24	Fei et al.	2014	4	Net Energy Exporting Countries: Ecuador, Canada, South Africa, Norway	1974 - 2011	ARDL, VECM	EU,Y, EP, PF	Log	Ecuador, Canada & South Africa: Y(+), EP(-), PF(-) Norway: Y(+), EP(+), PF(-)
25	Sbia et al.	2014	1	UAE	1975 - 2011	ARDL, VECM	EU,Y, GEC, FDI, TO, CO2	Log	Y(+), TO(-), GEC(+), FDI(-), CO2(-)

NO	Author	Year	Sample Size	Country/ Group	Sample Period	Methodology	Variables	Functional Form	Empirical Findings
26	Mohammadi & Parvaresh	2014	14	Oil Exporting Countries	1980 - 2007	CCE, Dynamic FE, Pooled & MG	EU,Y	Log	Y(+)
27	Omri & Kahouli	2014	65	High, Middle and Low Income	1990 - 2011	Dynamic Panel GMM	EU,Y, FDI, GFCF, L, POP, FD	No Log	Y(+), FDI(+), L(+), GFCF(+), POP(+), FD(+)
28	Shahbaz et al.	2014	91	High, Middle and Low Income	1980 - 2010	Pooled Mean Group (PMG)	EU,TO	Log	High Income: Inverted-U Shaped Middle and Low Income: U Shaped
29	Komal & Abbas	2015	1	Pakistan	1972 - 2012	GMM	EU,Y, EP, UR	Log	Y(+), EP(-) UR(+)
30	Philip Kofi Adom	2015	1	Nigeria	1971 - 2011	FMOLS	EI, EP, FDI, IND, TO	EI, EP (Log), FDI, IND, TO (No Log)	EP (-), FDI (-), IND (+), TO (-)

NO	Author	Year	Sample Size	Country/ Group	Sample Period	Methodology	Variables	Functional Form	Empirical Findings
31	Alam et al.	2015	5	Bangladesh, India, Nepal, Pakistan, Sri Lanka	1975 - 2011	Pooled OLS, FE, RE	EU,Y, EP, FDI, FD	Log	Pooled OLS & RE: Y(+), EP(+), FDI(+), FD(+) Pooled FE: Y(-), EP(-), FDI(+), FD(-)
32	Chang	2015	53	High Income & Non-High Income	1999 - 2008	FE	EU,Y, EP, FD, FDI	Log	Y(+), EP(+), FD(+) Y(+), EP(-), FDI(+)
33	Philip Kofi Adom	2015	All South Africa	South Africa	1970 - 2011	FMOLS	EI, IND, TO, FDI, EP	EI, EP (Log)	IND(+), TO(-), FDI(+), EP(-)

NO	Author	Year	Sample Size	Country/ Group	Sample Period	Methodology	Variables	Functional Form	Empirical Findings
34	Yan	2015	30	Provinces of China	2000 - 2012	Driscoll–Kraay Regression Model	EI, UR, K/L, P^E/P^T, IND, EX, SE, FDI*HC	EI, UR, K/L, P^E/P^T (Log)	UR(+), K/L(-), PE/PT(-), IND(+), EX(+), SE(Insig.), FDI*HC(-)
35	Adom & Amuakwa-Mensah	2016	13	East African Countries	1980 - 2011	Conditional Model	EI, Y, FDI, TO, EP, IND	EI, EP, Y (Log)	Y(-), FDI(+) TO(-), EP(Insig.), IND(+)
36	Herrerias et al.	2016	30	Regions in China	2006 - 2010	PCSE	EI, FDI, IM, PF, EP	Log	FDI(-), IM(-), PF(-), EP(Insig.)
37	Rafiq et al.	2016	22	Emerging Economies	1980 - 2010	MG, CCE, AMG	EI, POP, AFL, REU, NREU, UR	Log	POP(+), AFL(-), REU(Insig.) NREU(+), UR(+)
38	Atalla & Bean	2017	39	Main Developed and Emerging Economies	1995 - 2009	Pedroni co-Integration Test FMOLS ECM	EI EP, Y, FD*	Log	EP (-) Y(-) FD*(-)

NO	Author	Year	Sample Size	Country/ Group	Sample Period	Methodology	Variables	Functional Form	Empirical Findings
39	Elliot & Sun	2017	30	Provinces in China	1995 - 2012	Pooled OLS, FE, MG, Augmented MG	EI, Coal EI, Electricity EI, Y, IND, UR	Log	UR(+),Y(-) IND(+)
40	Barkhordari & Fattahi	2017	1	Iran	1986 - 2015	ARDL	EI, EP, TECH	Log	Electricity: EP(+ (short run) & - (long run)), TECH(+) Natural Gas: EP(+ (short run) & - (long run)), TECH(+)
41	Rudenko & Raschetova	2018	1	Russia	1992 - 2015	FMOLS, DOLS, CCR	EI, EP, FDI, S.V.A	Log	EP (-), FDI (-), S.V.A (+)
42	Chen et al.	2019	34	Industrial Sectors of China	2000 - 2010	FE, RE, FGLS, DK	EI, SRD, EP, FFDI, FEX, FIM, IS	Log	SRD(-), EP(-), FFDI(-), FEX(Insig.), FIM(Insig.), IS(+)

Source: Author's own literature review

Table 2.2 Energy Intensity: Expected Sing of Independent Variables

Variables	Symbol	Expected Sign
Energy Intensity (D.V.)	EI	
Energy Prices (I.V.)	EP	Negative
Foreign Direct Investment (FDI) (I.V.)	FDI	Positive/Negative
Trade Openness (I.V.)	Trade	Positive/ Negative
Exports (I.V.)	EX	Positive/Subject of Study
Imports (I.V.)	IM	Positive/Negative /Subject of Study
Export Diversification (I.V)	EXDIV	Subject of Study
Urbanization (I.V.)	UR	Positive/Negative
Industrialization	IND	Positive
Political Risk (I.V.)	PR	Subject of Study

Source: Author‘s own review

2.8 Research Gap

This study investigates the relation between trade openness, exports and imports with energy intensity as energy intensity dragged less attention in comparison to energy consumption in the literature. In addition, by breaking trade openness to exports and imports it is possible to see the effects of these variables on energy intensity separately. Moreover, the effects of export diversification on energy intensity are studied, which has barely been in past investigations. In the second research question of this research, the institutional quality and energy intensity‘s relation is investigated. Institutional quality is a new determinant of energy intensity we introduce in this study. In this analytical chapter, countries are divided to stable and unstable using Fragile States Index. In the third research question, the direction of relation between institutional quality and energy intensity, which is established by this study, is tested.

2.9 Research Hypotheses

H_{RQ1-1} = There is a relationship between trade openness and energy intensity

(The coefficient of trade openness in energy intensity model ≠ 0)

H_{RQ1-2} = There is a relationship between exports and energy intensity

(The coefficient of exports in energy intensity model ≠ 0)

H_{RQ1-3} = There is a relationship between imports and energy intensity

(The coefficient of imports in energy intensity model ≠ 0)

H_{RQ1-4}= There is a relationship between export diversification and energy intensity

(The coefficient of export diversification in energy intensity model ≠ 0)

H_{RQ2} = There is a relationship between institutional quality and energy intensity

(The coefficient of institutional quality in energy intensity model ≠ 0)

H_{RQ3} = Institutional quality does Granger cause energy intensity

2.10 Analytical Framework

The followings are the analytical frameworks for research questions of this research which are followed by theoretical explanations regarding the variables‘ relation and some examples of empirical studies. Figure 3 illustrates the analytical framework for research question 1 and Figure 4 illustrates analytical framework for research question 2.

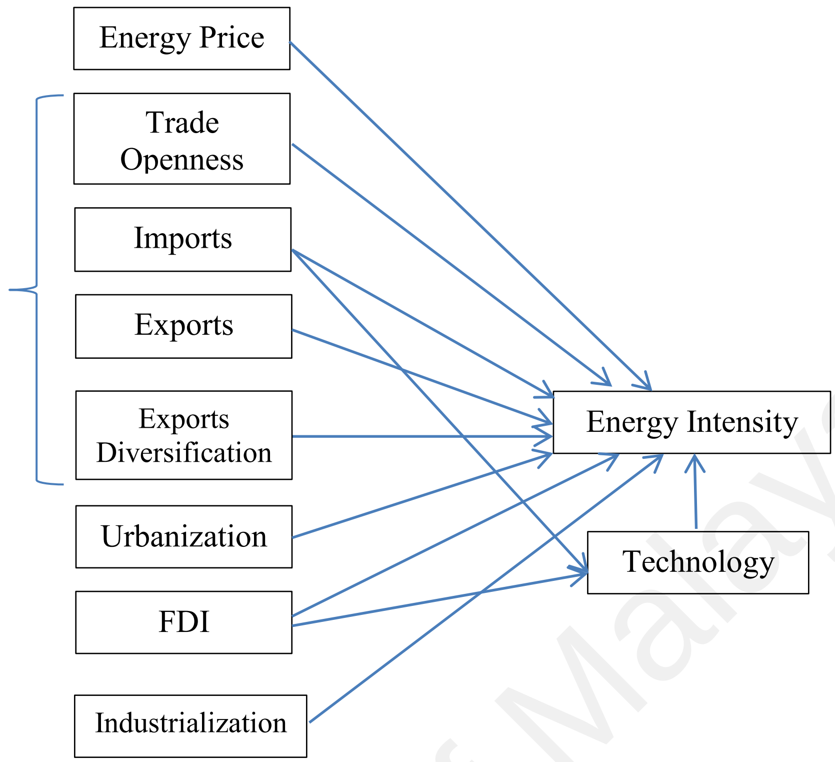

Figure 2.1 Analytical Framework for Research Question 1
Source: Formulated by Author

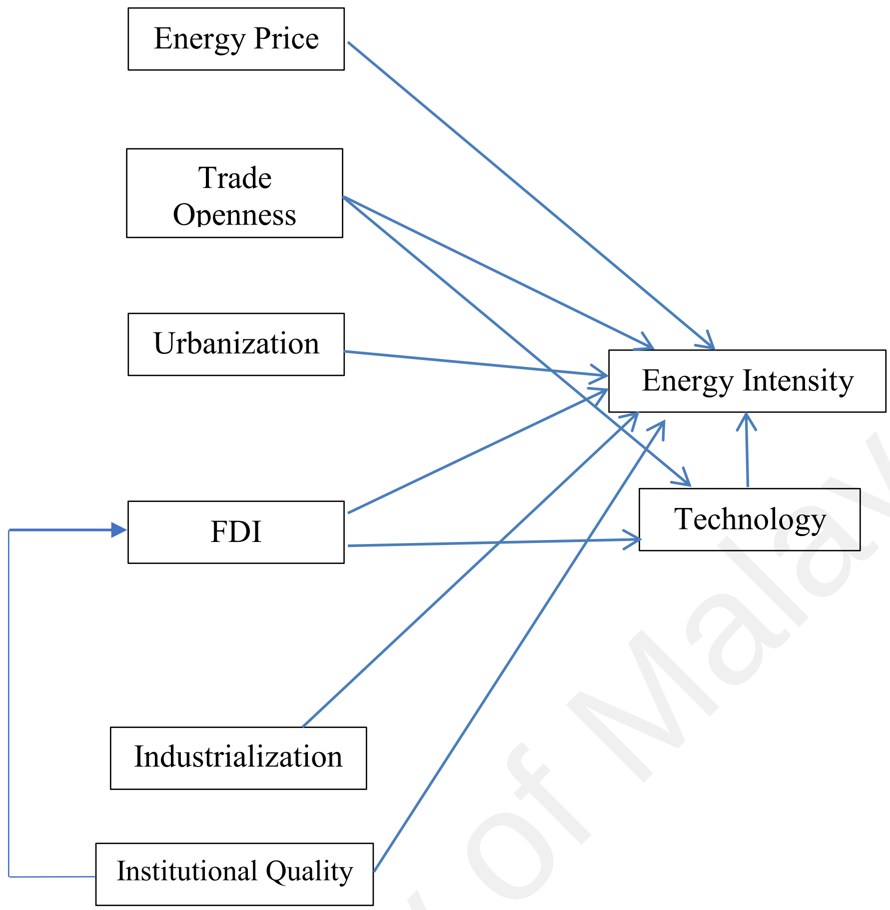

Figure 2.2 Analytical Framework for Research Question 2
Source: Formulated by Author

Energy prices variable in the analytical frameworks for the first and second research questions is one of the determinants of energy intensity. Theoretically higher energy prices will decrease energy consumption, which is confirmed by many empirical works as well such as Alam et al. (2015), Çoban and Topcu (2013), Fei et al. (2014), Komal and Abbas (2015) and Wong et al. (2013). Researchers concluded that increase in energy prices could be considered as an effective policy instrument for increasing energy efficiency (Hang and Tu, 2007) as an increase in the energy prices results in the application of the more energy efficient technologies among the available ones. In addition, it also increases research activities for new energy efficient technologies (Birol and Keppler, 2000).

Trade openness variable in both analytical frameworks for first and second research questions theoretically has relation with energy intensity. Theoretically, increase in international trade can increase energy use. Empirical studies such as Hübler (2009) and Nasreen and Anwar (2014) show the same findings. Trade openness can also cause the decrease in energy consumption. This can happen by the channel of improving productivity through higher technology which is embodied in imported goods. The empirical work of Siba et al. (2014) shows this. Hence, it is possible to conclude that trade openness have both positive and negative impact on energy intensity. Trade and FDI have attracted the most attention in energy research among the various channels that technology spillover can happen (Mielnik and Goldemberg, 2002; Rafiq et al., 2016; Saggi, 2002).

For the first research question of this study exports and imports are modeled separately, which are illustrated by the analytical framework for this research question. Separating the effects of imports and exports on energy intensity which dragged less attentions compared to energy consumption is the contribution of this research question. Theoretically exports can increase the consumption of energy through consuming more energy for production of goods for exports. The research of Sadorsky (2011b) shows the same effect of exports on energy consumption. A rise in consumption of energy can also result in increase in energy intensity. Theoretically import is a determinant of energy intensity. Imported goods need well transportation system to move around the country which increase the consumption of energy. The effect of this variable is also highly depending on whether the imported goods are energy intensive or they have higher levels of technology which can cause more energy efficiency and lower energy intensity, the work of Sadorsky (2011b) has empirical findings on this theory. As a result, imports can affect energy intensity directly through increase of energy consumption and indirectly through the channel of technology. These direct and indirect effects are illustrated by different lines in analytical framework of research question 1. In addition, the impact of export diversification on energy intensity is investigated in this research question. Export products diversification, can affect CO2 emissions significantly and as a result it is essentially significant to investigate the effect of this variable on energy intensity and figure out that if a country diversifies its export production what will be the effects of these changes on energy use efficiency of that country.

Urbanization is another determinant of energy intensity. The urbanization and energy intensity‘s relation is either positive or negative. Urbanization increases economic activities together with the higher consumption and production which can lead to higher levels of energy intensity. On the other hand, urbanization results in economies of scale and increases the energy efficiency which leads to decrease of energy intensity. The works of Jones (1991), Komal and Abbas (2015), Mishra et al. (2009), Poumanyvong and Kaneko (2010), Sadorsky (2013), Salim and Shafiei (2014) and Shahbaz and Lean (2012) have empirical findings on this relation. Theoretically the impact of FDI on energy intensity can be through two different channels. FDI can increase economic activities which can cause increase in consumption of energy. On the other hand, FDI can affect energy intensity through the channel of technology. FDI can result in technology innovation by the firms in the host country, which can help to decrease energy consumption. The research of Adom and Kwakwa (2014), Alam et al. (2015), Bento (2011), Chang (2015), Çoban and Topcu (2013), Foon Tang (2009), Omri and Kahouli (2014), Sadorsky (2010), Ting et al. (2011) and Zaman et al. (2012) have empirical findings on this relation. Industrialization is another determinant of energy intensity which theoretically affects this variable. Industrialization increase energy consumption through increase in industrial activities which can lead to higher levels of energy intensity. The research of Jones (1991), Poumanyvong and Kaneko (2010), Sadorsky (2013), Salim and Shafiei (2014) and Shahbaz and Lean (2012) confirm this relation.

The institutional quality and energy intensity's relation is the subject of second research question of this study which is tested in second analytical chapter of this research. Institutional quality is a new determinant of energy intensity introduced by this study and is the contribution of this research. There is also a relation between institutional quality and FDI. Theoretically institutional quality is determinant of FDI, meaning that better quality of institutions can attract more FDI. The research of Busse and Hefeker (2007), Bénassy-Quéré et al. (2007), Daude and Stein (2007) confirm this theory. There are many reasons why institutional quality is important in attraction of FDI. One is connected to the growth literature: good governance infrastructure may attract foreign investments by raising productivity outlook. The other reason is that low institutional quality can impose extra costs to FDI, such as corruption (Wei, 2000). The final reason is that, as a result of high sunk costs, FDI is sensitive to any types of uncertainties, such as uncertainty because of policy reversals, lower government efficiency, grafts or weak enforcement of property rights and of the overall legal system (Bénassy-Quéré et al., 2007). The Framework also illustrates that decreasing energy intensity cause decrease in CO_2 emissions which can help to solve the problem of global warming and climate change.

2.11 Chapter Summary

This chapter reviews the past literature on energy consumption and energy intensity and more specifically, focuses on determinants of these two variables. Based on the literature, the variables of energy prices, trade, FDI, urbanization and industrialization found as the determinants of energy intensity. Each variable is defined and their relation with energy intensity is explained based on related theories. The available literature is divided into two categories; individual case studies and multi-case studies and each study is explained briefly. In addition, this chapter provides theoretical background on institutional quality which includes defining institutional quality, discussion about flow of capital and Lucas Paradox, the relation between institutional quality and FDI and institutional quality and environment. Moreover, a theoretical background on export diversification is provided in this chapter. By reviewing previous literature, the gap in literature is identified and hypotheses of the study are developed which are followed by the objectives of the study. The variables‘ relations are illustrated by analytical framework and these relations are explained theoretically in the next part.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter includes the research approach of this study, as well as model development for this research. The dependent and independent variables of this study are defined with special focus on institutional quality variable, export diversification index and the Fragile States Index (FSI). Components of institutional quality are defined and their weights which used in measuring institutional quality are represented. The export diversification variable and its methodology also presented. The Fragile states index which is used for the purpose of categorizing countries defined and it is also explained how countries grouped based on this index. In addition, the sources and sample of data are explained and the econometrics methods of the study are introduced. More specifically, this section of the chapter provides wide explanations regarding Generalized Method of Moments (GMM) and Granger causality test. Finally, it is explained how to deal with data concerns including multicollinearity, heteroscedasticity, autocorrelation, endogeneity, omitted variable bias, reverse causality and measurements error.

3.2 Research Approach

This research is a quantitative study; hence, for the purpose of collecting the data for analyzing the research objectives, the secondary annual data collected from different data sources. The sample included panel of 84 countries of the world which are selected based on availability of the data. By applying Generalized Method of Moments (GMM) using STATA software, the first two objectives of this research are achieved. For the third research question, the Granger causality test has been applied, again by using STATA software. This research provides useful energy and environmental policy implications for policy makers for the purpose of reducing consumption of energy and enhancing energy efficiency. Application of these policies helps to tackle with the issues of global warming and climate change.

3.3 Model Development

The empirical model of this research is dynamic panel model of energy intensity. This model called dynamic as lag of dependent variable, which in this study is energy intensity is considered as a right hand side variable and as a predictor of energy intensity. Energy intensity (EI) basically depends upon energy prices (EP), trade openness (TRADE), urbanization (UR), foreign direct investment (FDI), and industrialization (IND). In equations 2 and 3 the effects of exports and imports on energy intensity is separated. As a result, in equation 2 variable EX represents exports and in equation 3, variable IM represents imports. Equation 4 includes export diversification variable and EXDIV represents this variable in this equation. Equations 1, 2, 3 and 4 are used for analyzing the first research question of this study. Equation 5 includes the effects of institutional quality (political risk) to the model. Equation 5 is used for analyzing the second research question. As a result, in this equation PR represents institutional quality.

$$\boldsymbol{EI_{it} = \alpha EI_{it-1} + \beta_1 EP_{it} + \beta_2 TRADE_{it} + \beta_3 UR_{it} + \beta_4 FDI_{it} + \beta_5 IND_{it} + \varepsilon_{it}} \quad \textbf{Eq. 3.1}$$

$$\boldsymbol{EI_{it} = \alpha EI_{it-1} + \beta_1 EP_{it} + \beta_2 EX_{it} + \beta_3 UR_{it} + \beta_4 FDI_{it} + \beta_5 IND_{it} + \varepsilon_{it}} \quad \textbf{Eq. 3.2}$$

$$\boldsymbol{EI_{it} = \alpha EI_{it-1} + \beta_1 EP_{it} + \beta_2 IM_{it} + \beta_3 UR_{it} + \beta_4 FDI_{it} + \beta_5 IND_{it} + \varepsilon_{it}} \quad \textbf{Eq. 3.3}$$

$$\boldsymbol{EI_{it} = \alpha EI_{it-1} + \beta_1 EP_{it} + \beta_2 EXDIV_{it} + \beta_3 UR_{it} + \beta_4 FDI_{it} + \beta_5 IND_{it} + \varepsilon_{it}} \quad \textbf{Eq. 3.4}$$

$$\boldsymbol{EI_{it} = \alpha EI_{it-1} + \beta_1 EP_{it} + \beta_2 TRADE_{it} + \beta_3 UR_{it} + \beta_4 FDI_{it} + \beta_5 IND_{it} + \beta_6 PR_{it} + \varepsilon_{it}} \quad \textbf{Eq. 3.5}$$

In these equations countries represented using the subscript i ($i = 1, \ldots, 84$) and the subscript t represents the time period($t = 1980, \ldots, 2012$).

3.4 Variables and Measurements

3.4.1 Dependent Variable

In this research, the dependent variable is **energy intensity**, which is measured by the ratio of energy use in kilo tone of oil equivalent to GDP at constant 2005 US dollars.

3.4.2 Independent Variables

The independent variables are:

Energy prices: measured by the ratio of annual nominal prices of Brent crude oil to consumer price index (CPI, 2010=100) of each country.

FDI: measured by net inflows as a percentage of GDP.

Trade Openness: measured as sum of exports and imports of goods and services as a percentage of GDP.

Exports: measured as exports of goods and services as a percentage of GDP.

Imports: measured as imports of goods and services as a percentage of GDP.

Urbanization: measured by percentage of the population living in the urban areas.

Industrialization: measured by industrial value added as percentage of GDP.

Institutional quality (political risk): The variable is an important subject of this research, which is measured by ICRG index.

Export diversification: The data on this index are obtained from the database of the IMF which is formulated, calculated and provided by IMF staff.

More information and explanation regarding institutional quality variable and export diversification index provided in following sections. **Fragile States Index** is used for classification of countries in the second research question of this study which is explained more in another section. All the variables transferred to their natural logarithm. Transferring data to natural logarithm makes the interpretation of results comparatively easier (Komal and Abbas, 2015).

Table 3.1 Definitions of Variables of This Study

VARIABLE	DEFINITION
ENERGY INTENSITY (D.V)	Energy use in kilo tone of oil equivalent to GDP at constant 2005 US dollar
ENERGY PRICES	Annual nominal prices of Brent crude oil to consumer price index (CPI, 2010=100) of each country
FDI	Net inflows as a percentage of GDP
TRADE OPENNESS	Sum of exports and imports of goods and services as a percentage of GDP
EXPORTS	Exports of goods and services as a percentage of GDP
IMPORTS	Imports of goods and services as a percentage of GDP
URBANIZATION	Percentage of the population living in the urban areas
INDUSTRIALIZATION	Industrial value added as percentage of GDP
INSTITUTIONAL QUALITY	International Country Risk Guide (ICRG) index
FRAGILE STATES INDEX	The Fund for Peace Index (Stable < 60, Unstable>60)

Source: Prepared by author

3.4.2.1 Institutional Quality (Political Risk)

The data for Political risk is collected from the ICRG which is prepared by the PRS Group. The ICRG composite scores represent a range which starts from zero and continues up to 100 and are divided into categories from ―Very Low Risk" (points from 80 to 100) to ―Very High Risk" (points from zero to 49.9). The political risk index includes 12 weighted components to cover both social and political aspects (PRS, 2012). The following table (Table 3.2) represents the political risk variables and their weights. The main justification for use of composite socio-political indices is that disaggregate indices might include measurement errors. As a result the application of an individual index with little variation, results in estimation issues (Kolstad and Villanger, 2008).

Table 3.2 Political Risk Components and Weights

COMPONENT	**POINTS**
GOVERNMENT STABILITY	12
SOCIOECONOMIC CONDITIONS	12
INVESTMENT PROFILE	12
INTERNAL CONFLICT	12
EXTERNAL CONFLICT	12
CORRUPTION	6
MILITARY IN POLITICS	6
RELIGIOUS TENSIONS	6
LAW AND ORDER	6
ETHNIC TENSIONS	6
DEMOCRATIC ACCOUNTABILITY	6
BUREAUCRACY QUALITY	4
TOTAL	100

Source: ICRG

3.4.2.1.1 Government Stability – 12 Points

Government stability is assessing the capability of government to accomplish its programs, and to assess if it‘s able to stay in office. Reaching to high level of political stability is critical for providing a suitable environment for economic growth. Political stability determines if a country is profitable and is having lower risks to be chosen for the investment destination. It is very important to assure investors that government policies will not change anytime soon. Investors need to trust that the government operates efficiently, and should be encouraged to take risks (Aftab et al., 2002). Foreign and domestic investments would be discouraged by the possibility of political revolution which leads to a new regime to come to power. This situation may cause imposing penalizing taxes or expropriate capital assets by the new regime (Soubbotina and Sheram, 2000). As a result, political instability will discourage domestic and foreign investors for investing in the host country, which leads to preventing rapid economic growth and worsening poverty.

3.4.2.1.2 Socioeconomic Conditions – 12 Points

Socioeconomic condition assesses the socioeconomic pressures in a society that can restrict government actions or increase social dissatisfaction. Poverty and unemployment can increase socioeconomic pressure and social dissatisfaction. Previous investigations confirmed the negative correlation between income per capita and political risk, meaning that the extent of political risk is lower for the richer countries (Harms, 2002b). In addition, youth unemployment has been found to have direct affect in increasing the risk of political instability (Azeng and Yogo, 2013).

3.4.2.1.3 Investment Profile – 12 Points

This component evaluates the factors that affect the risks to investments which are not considered by the other economic, political and financial risks components such as contract viability (expropriation), profits repatriation or payment delays (Busse and Hefeker, 2007).

3.4.2.1.4 Internal Conflict – 12 Points

This component measures political violence and its effects on governance in a country. Internal conflict emphasizes on conflicts‘ mechanisms which are endogenous to the country‘s communities and affects the motivations of the actors who are outside the conflict. Based on this definition, outside actors and motivations can be considered as opportunities that locals can manipulate (Wig and Tollefsen, 2016).

3.4.2.1.5 External Conflict – 12 Points

This component assesses the risks from foreign actions to the incumbent government that could be non-violent or violent external pressures. External explanations emphasize the strategic motivations of external actors for attacking a location. External actors may focus on collaborators of the opposing side (Fjelde and Hultman, 2014), terrorize a population into supporting the attackers (Lyall, 2009), attain strategic control of a specific location (Zhukov, 2013), or to access valuable resources such as diamonds (Buhaug and Rød, 2006).

3.4.2.1.6 Corruption – 6 Points

Corruption component evaluates the corruption of the political system that can reduce foreign investments as it will affect the economic and financial environment negatively. In addition, it decreases the efficiency of government and businesses by filling the power positions based on patronage and not capabilities. The most popular types of corruption that businesses are facing are ―financial corruption” including requests for payments and bribes.

3.4.2.1.7 Military in Politics – 6 Points

This component assesses the effects of the military in politics. This component considers the possibility of internal or external conflicts or threats of conflict occurring by the intervention of the military, causing an unfavorable investment environment (Khoury et al., 2015).

3.4.2.1.8 Religious Tensions – 6 Points

This component assesses the religious tensions which are occurring when a specific religious group dominates the society or governance. In such a condition, that specific group may aim to replace civil law by religious law or they may ignore other religions in the political and social processes.

3.4.2.1.9 Law and Order – 6 Points

Law and order evaluates the willingness of citizens in accepting “established institutions” to create and enforce laws and to judge quarrels (Law et al., 2015). This component also assesses two subcomponents of Law and Order. The subcomponent of Law assesses the “strength and impartiality of the legal system”, and the subcomponent of order is the measurement of the “popular observance of the law” (Perera and Lee, 2013).

3.4.2.1.10 Ethnic Tensions – 6 Points

Ethnic tension assesses the level of tensions between ethnic groups as a result of racial, nationality or language differences. Studies showed that the greater ethnic fragmentation, the most unequal income distribution is. Ethnic fragmentation through income distribution affects the quality of institutions (Alonso and Garcimartín, 2013).

3.4.2.1.11 Democratic Accountability – 6 Points

The component of democratic accountability evaluates how responsive is a government to its people. Based on this definition the less responsive the government is, the more possible it is that the government will fall which can be peaceful in democratic societies, and might include violent actions in non-democratic societies.

3.4.2.1.12 Bureaucracy Quality – 4 Points

This component assesses the ―institutional strength and quality of the bureaucracy" that may behave as a shock absorber for the purpose of decreasing revisions in policies if a government changes. Reforms in the field of bureaucracy quality will cause an increase in benefits of FDI, even for countries with lower institutional quality (Jude and Levieuge, 2015).

3.4.2.2 The Export Diversification Index

This study obtained the data for the export diversification from the IMF‘s database. This dataset has been collected by the staffs of the IMF, and it includes the indices of diversification for different trading partners and different products. The product diversification index which is called the Theil index is a measurement of the export diversification for a country. The higher values of the Theil index reflect a lower diversification in exports.

3.4.2.3 The Fragile States Index (FSI)

The FSI which is provided by the Fund for Peace is based on the twelve primary political, economic and social indicators. The social indicators include “demographic pressures, refugees and IDPs (Internally Displaced Persons), group grievance and human flight and brain drain”. The economic Indicators of this index include “uneven economic development and poverty and economic decline”. The political and military indicators include “state legitimacy, public services, human rights and rule of law, security apparatus, factionalized elites and external intervention”. Each indicator is between the scale of 0 to 10, which 0 is the most stable and 10 is the least stable. As a result, the index changes from 0 to 120. The Fragile States Index categorizes countries to different categories as following table (Table 3.3). This study divided the panel of countries into two groups, countries with scores below 60 including stable, more stable, very stable, sustainable and very sustainable and countries above 60 including warning, elevated warning, high warning, alert, high alert and very high alert. In this research the first group is named stable countries and the second group named unstable countries.

Table 3.3 Fragile States Index Country Categorization

CATEGORY	FSI SCORE
VERY HIGH ALERT	110-120
HIGH ALERT	100-110
ALERT	90-100
HIGH WARNING	80-90
ELEVATED WARNING	70-80
WARNING	60-70
STABLE	50-60
MORE STABLE	40-50
VERY STABLE	30-40
SUSTAINABLE	20-30
VERY SUSTAINABLE	0-20

Source: The Fund for Peace

3.5 Data Sample

This study involved secondary data analysis. The annual macro-level panel data is collected for the period from 1980 to 2012. The panel of data includes 84 countries. The selection of these countries is purely based on availability of data for the chosen duration. The following table (Table 3.4) represents the 84 countries of the study. In order to categorize countries into stable and unstable groups for the second research question of this study, this study applied fragile states index and stable countries are starred in this table. The rest of countries are unstable countries.

Table 3.4 List of Countries

ALBANIA	GERMANY*	JAPAN*
UNITED ARAB EMIRATES*	Denmark*	Korea, Rep.*
ARGENTINA*	Dominican Republic	Sri Lanka
AUSTRALIA*	Algeria	Luxembourg*
AUSTRIA*	Ecuador	Morocco
BELGIUM*	Egypt, Arab Rep.	Mexico
BULGARIA*	Spain*	Malta*
BAHRAIN	Finland*	Malaysia
BOLIVIA	France*	Nigeria
BRAZIL	Gabon	Nicaragua
BRUNEI DARUSSALAM	United Kingdom*	Netherlands*
BOTSWANA	Ghana	Norway*
CANADA*	Greece*	New Zealand*
SWITZERLAND*	Guatemala	Oman*
CHILE*	Hong Kong SAR, China	Pakistan
CHINA	Honduras	Panama*
COTE D'IVOIRE	Indonesia	Peru
CAMEROON	India	Philippines
CONGO, REP.	Ireland*	Portugal*

Source: Author

Table 3.4 List of Countries (Continued)

Colombia	Iraq	Paraguay
Costa Rica*	Iceland*	Romania*
Cuba	Italy*	Saudi Arabia
Senegal	Trinidad and Tobago*	Venezuela, RB
Singapore*	Tunisia	Vietnam
El Salvador	Turkey	South Africa
Sweden*	Uruguay*	Congo, Dem. Rep.
Thailand	United States*	Zambia

Source: Author

3.6 Source of Data

The current research uses the annual data for all variables. The sources of data are as follows:

- World Bank for consumer price index (CPI), energy use, FDI, GDP, Brent crude oil price, industrialization, urbanization and exports, imports and trade data www.data.worldbank.org,
- British Petroleum www.bp.com,
- The Political Risk Group (ICRG) for political risk (institutional quality),
- Fragile States Index from the Fund for Peace organization www.fsi.fundforpeace.org
- International Monetary Fund (IMF), for export diversification index www.imf.org

3.7 Methods of Research

For the purpose of studying the relation between trade openness, exports, imports and export diversification and energy intensity and investigating the institutional quality and energy intensity‘s relation, this research applies Dynamic Panel Generalized Method of Moments (GMM). Countries have different nature and structure; as a result it is necessary to assume countries as not being homogenous. Therefore, to solve this problem and have more accurate estimation, panel methods have been applied. Panel data have some advantages in comparison with time series and cross-sectional data. While either time or individual is only considered by time series and cross-sectional data, panel data combines both dimensions which provides ―more informative data, more variability, less collinearity among variables, more degree of freedom and more efficiency” (Gujarati, 1995). In addition, panel data has the strength to analyze and evaluate policies and programs. ―One can better assess the impact of economic, political, institutional and social policies and programs because the same cross-sectional units are observed in each time-period” (Papke and Wooldridge, 2008).

For the purpose of estimating the coefficients of determinants of energy intensity, this research applies GMM. The application of estimation techniques that include instrumental variables can result in achieving consistent and unbiased estimations of parameters. While instrumental variables are correlated with independent variables in the model they are not correlated with the error terms. The correlation between independent variables and error terms can be removed by instruments. As a result the obtained estimations are consistent and reliable (Komal and Abbas, 2015). Formulating GMM is credited to Hansen (1982) who represented that every instrumental variable estimator, in linear or nonlinear models, with cross-section, time series or panel data which previously were suggested, can be considered as a GMM estimator. GMM as a result is sometimes considered as a unifying framework for inference in econometrics (Söderbom, 2009).

Arellano and Bond (1991) and Arellano (1993) proposed GMM which is both single and system equations. It has advantages compared to other estimators because it is a robust estimator that does not need information regarding the distribution of error terms (Komal and Abbas, 2015). GMM is the estimation technique for panel data which is mostly applied in dynamic models including lag of the dependent variable. Using instrumental variables, this technique overcomes the endogeneity issue of regressors (Omri and Kahouli, 2014).

Arellano–Bond technique initiates the estimation by transforming all the regressors, msotly via differencing, and applies the GMM which is named the difference GMM (Roodman, 2006). Difference GMM has some drawbacks, since it acts weakly if the time series are persistent, as the lagged variables that are used as weak instruments for the subsequent first difference still has correlation with the disturbances. As a result, to overcome this issue Arellano and Bover (1995) and Blundell and Bond (1998) proposed an estimator which is named system GMM. Roodman (2006) states that the Arellano–Bover/Blundell–Bond estimator augment Arellano–Bond by considering an extra assumption that the first differences of the instrumental variables do not have correlation with the FE. This leads to introducing more instruments and significantly enhances the efficiency. It constructs a system including two equations, the original equation and the transformed one which is called system GMM. Therefore, by using system GMM the estimates are not biased anymore by any omitted variables and there is no issue of endogeneity. In addition, by taking first differences the issue of the country specific effects is also resolved.

Both system and difference GMM are general estimators which are suitable for panels with the small T and large N, which means limited time periods and several individuals; linear relations; a dynamic left-hand-side variable, the independent variables that are not purely exogenous, meaning that they have correlation with the past and possibly the current realizations of the errors; fixed effects; and heteroscedasticity and autocorrelation within individuals (Roodman, 2006). For the datasets with the limited time series compared to the number of individuals, it is assumed that the data are stationary and as a result it is not necessary to perform a unit root test. Using instrumental variables are valid including owns lagged. When the model is included the lag of dependent variables, there is no need for fixed effects and random effects estimators and GMM is the most accurate one (Pedroni, 2008).

Essentially, Stata provides three different tests: AR (1) and AR (2) tests and Sargan test. The Sargan test has a null hypothesis of ―the instruments as a group are exogenous". As a result, the higher p-value of the Sargan statistic is preferred. If the estimation is robust, Stata reports the Hansen J statistic instead of the Sargan with the similar null hypothesis (Mileva, 2007). Instrumental variables methods are strong, but in case a rejection of the null hypothesis of the Sargan–Hansen test is experienced, the researcher should doubt the validity of the estimate (Baum, 2007).

For the third research question of this research panel Granger causality test has been applied to identify the institutional quality and energy intensity‘s causal relation. Prior to test the Granger causality, the possibility of a unit root must be checked, to understand the stationary properties of the variables. It is necessary for the series to be covariance stationary in Granger causality (Foresti, 2006). Al-Iriani (2006) states that based on literature, panel unit root tests are stronger than time series unit root tests. This is as a result of having more dimensions both the individual and time (Baltagi, 2008).

Initially, the panel unit root test was applied by Abuaf and Jorion (1990) to the real exchange rates and the number of works that used this technique has significantly risen after this research. The study of Hadri (2000), Levin et al. (2002) and Im et al. (2003) revealed that the time series unit root tests such as the ADF are not capable of including cross-sectional information embedded in the data (Guloglu and İvrendi, 2010). Based on the literature, Levin–Lin–Chu (LLC) test and Im–Pesaran–Shin (IPS) are the most favorable panel unit tests.

LLC and IPS tests are based on the ADF principles. While, homogeneity is one of the main assumptions of the LLC test for all panel individuals, the IPS is more inclusive and accepts the heterogeneity of individuals. As a result, it is defined as a ―heterogeneous panel unit root test”. For ADF tests it is especially rational to consider heterogeneity in selecting the lag length when a similar lag length is not suitable. It is more sensible to allow for slope heterogeneity when cross-country data are utilized. In this condition heterogeneity is the result of economic conditions‘ differences and level of development in countries. Hence, it is approved that this test has more strength than the other tests such as LLC (Al-Iriani, 2006).

The main reason behind application of panel unit root tests is to include the extra information embedded in panel data and enhance the test power (Ozturk et al., 2010). As a result, one of the most popular unit root tests, developed by Im, Pesaran and Shin (Im et al., 2003), is applied in this research. If the assumption of the unit root test is that there is a similar unit root process across the individuals the null hypothesis of the test is that “there exist unit root” which means that the variables are not stationary, and the alternative hypothesis is that “no unit root exists in the series” meaning that the variables are stationary, but if the assumption of the unit root test is that across the cross-sections there are individual unit root processes, the null hypothesis is that “there is a unit root”, while the alternative hypothesis is that “some cross-sections do not have a unit root” (Pao and Tsai, 2011). To show the robustness of the results, this research also performed the LLC unit root test.

Cointegration test which is proposed in 1980s states that a linear combination of non-stationary underlying time series might be stationary. As a result, before using panel cointegration methods, it is necessary to check if all variables are integrated of order one in levels (Ozturk et al., 2010). Based on the findings of the unit root tests which are presented in chapter 7 of this research, both variables are stationary and there is no need to perform the cointegration analysis.

The Granger causality test aims to investigate the amount of the present values that can be explained by the past values (Granger, 1969). More specifically, ―a time series x is a cause of y if it is useful in forecasting y”. Variable X Granger causes variable Y, if the current value of Y (yt) depends on the past values of X (x_{t-1}, x_{t-2}, ... , x_0), hence the past values of X helps to forecast Y (Konya, 2004). ―Granger cause” does not mean ‗is the effect of‘ or ‗the result of‘, it assesses priority and information content (Jones, 2014). It should be remembered that this is causality for a period ahead. Dufour and Renault (1998) generalized it to causality to h periods ahead, where h is a positive integer and can be infinite (Konya, 2008).

The Granger causality‘s mathematical formulation is based on linear regression modeling of stochastic processes (Granger, 1969). The null hypothesis of the test is ―A does not cause B”. It is essential to check the stationary status of variables using unit root test prior to test for Granger causality. If the variables show non-stationary features, the difference of variables should be utilized for the Granger causality estimations (Zhang, 2014). The Mathematical statement of the Granger causality test is as follows:

$$\Delta X_t = \alpha + \sum_{i=1}^{k} \beta_i \, \Delta X_{t-i} + \sum_{i=1}^{k} \chi_i \, \Delta Y_{t-i} + \varepsilon_{1t} \quad \textbf{Eq. 3.6}$$

$$\Delta Y_t = \delta + \sum_{i=1}^{k} \phi_i \, \Delta Y_{t-i} + \sum_{i=1}^{k} \gamma_i \, \Delta X_{t-i} + \varepsilon_{2t} \quad \textbf{Eq. 3.7}$$

The introduction of VAR in panel data (Holtz-Eakin et al., 1988), led the panel VAR models to be applied in multiple applications in different areas. Granger causality test can be captured from the VAR model. Panel vector autoregression models (Panel VAR) estimation fit a panel multivariate regression for each dependent variable on the lags of itself and lags of all other dependent variables (if any) and all exogenous variables. The estimation is by GMM (Abrigo and Love, 2015). K-variate homogeneous panel VAR of order p with panel-specific fixed effects which is represented by the following system of linear equations is considered:

$$\boldsymbol{Y_{it}} = \boldsymbol{Y_{it-1}A_1} + \boldsymbol{Y_{it-2}A_2} + \cdots + \boldsymbol{Y_{it-p+1}A_{p-1}} + \boldsymbol{Y_{it-p}A_p} + \boldsymbol{X_{it}B} + \boldsymbol{u_i} + \boldsymbol{e_{it}} \qquad \textbf{Eq. 3.8}$$

Where Y_{it} represents a $(1xk)$ vector of dependent variables; X_{it} represents a $(1xl)$ vector of exogenous covariates; u_i and e_{it} are $(1xk)$ vectors of dependent variable specific panel fixed effects and idiosyncratic errors, respectively. The (kxk) matrices $A_1, A_2, \dots, A_{p-1}, A_p$ and the (lxk) matrix B are parameters for the estimation (Abrigo and Love, 2015).

The VAR model which is proposed by Sims (1980) is a generalization of the AR model. The VAR model is a valid framework that is extensively applied in the economics studies. This model provides a systematic method to obtain rich dynamics in the panel data. In addition, the statistical toolkit that comes with VAR is easy to utilize and it is also easy to interpret the results (Stock and Watson, 2001).

3.8 Dealing with Data Concerns

This study used panel data, because they are more accurate in econometric estimation than cross-sectional data and time series data separately. Panel data provides more degrees of freedom and variability than cross-sectional data which ignores the time dimension or time series data which neglects the individuality of the entity. As a result, panel data have a greater potential for capturing the complexity of economic issues in comparison with a single cross-section or time series data set. In addition, panel data includes the heterogeneity among individuals such as culture, policies, regulations and others (Baltagi, 2008). Panel data also face some challenges including the data collection issues as well as methodological issues such as endogeneity and heterogeneity issues (Hsiao, 2007). The following parts explain how this study deals with the problems of multicollinearity, heteroscedasticity, autocorrelation, and endogeneity.

3.8.1 Multicollinearity

In order to detect the multicollinearity issue this study provides the correlation matrix between independent variables. Based on the correlation matrix, if the correlation between two of the variables is more than 0.8, it means that these two variables are overlapping to a large extend, therefore, it is necessary to drop one of them. Another way to detect multicollinearity, is based on VIF (Variance Inflation Factor) indicator. The higher the VIF value, the more likely is there a multicollinearity issue. If the variable has a VIF value more than 10, that means the variable has a serious collinear issue and must be dropped. It is also important to look at the mean VIF. Once the mean VIF is less than 10, there is no multicollinearity issue in the regression (Gujarati, 2009).

3.8.2 Heteroscedasticity

There are issues happening in the presence of intra-group correlation or ―clustering". If the within groups correlation of error terms in the regression occurs while the error terms are not correlated across groups, then the instrumental variable estimation contains the heteroscedasticity issue: the estimations of the instrumental variables' coefficients are consistent, but their standard errors and the usual forms of the diagnostic tests are not

(Baum et al., 2003). In this study, standard errors are robust, using the option of ―robust" when applying GMM.

3.8.3 Autocorrelation

Autocorrelation occurs when the error terms of a regression u_{t+1}, u_{t+2}, u_{t+3},… are correlated with each other. Application of dynamic panel GMM can take care of the issue of autocorrelation. In addition, Arellano-Bond test for autocorrelation including AR (1) and AR (2) is applied for the purpose of investigating the autocorrelation among the error terms. The test was originally developed for dynamic panel data models, in which there is AR(1) present in the differenced errors by construction, the presence of significant AR(2) is a diagnostic test of the validity of the instruments, complementary to the standard Sargan–Hansen test of overidentifying restrictions (Baum and Schaffer, 2013).

3.8.4 Endogeneity

For the purpose of addressing the endogeneity issue, instrumental variables and GMM has become a standard practice nowadays (Baltagi, 2015). Dynamic panel data estimation is applied when the current value of the dependent variable depends on its own past values. The dynamic panel data method was developed with the belief that the instrumental variable methods cannot fully explore the information in the dynamic panel data. GMM is dynamic panel data estimation developed by Arellano and Bond (1991) which is proved to be more efficient. The endogenous variables can be instrumented by their own past values. Roodman (2006) developed Arellano and Bond estimator by allowing additional features such as IV-style and GMM-style for instruments. As a result, application of GMM can well take care of endogeneity problem. As this method employs a set of instrumental variables, it is able to resolve the endogeneity issue of regressors.

There are three main sources of endogeneity:

(1) Omitted variables

(2) Reverse causality, or ―simultaneity,"

(3) Measurement error

All endogeneity sources-omitted variables, simultaneity, and measurement error, will bias the coefficient on the affected RHS variable, and potentially any other variables that are correlated with the endogenous variable. This is why it is essentially important to determine if a model is suffering from one of these endogeneity problems (Dranove, 2012).

3.8.4.1 Omitted variable bias

Missing information of some variables is very common in many datasets. If the variable with missing values is an important part of the model, omitting the variable from the analysis results in the possibility of significant omitted variables bias (Abrevaya and Donald, 2017). Omitted variables can cause endogeneity. In this case, the endogeneity complaint is a complaint that you left a variable (or two) out of your model. So there are good reasons for adding control variables, even if estimating with instrumental variables (Murray, 2006). As a result, panel data analysis especially the application of instrumental techniques such as GMM and adding control variables to the model can be a remedy for the problem of omitted variable bias.

3.8.4.2 Reverse causality

Reverse causality (simultaneity) is one of the reasons behind endogeneity. Reverse causality means an independent variable is potential caused by the dependent variable (Antonakis et al., 2014). The best way to solve the endogeneity issue is through instrumental variables methods (Shepherd, 2008).

3.8.4.3 Measurement error

If the measurement error occurred in the exogenous variables of a linear regression model, the correct values of the regression parameter are not obtained (Bekker et al., 1984).

3.9 Chapter Summary

This chapter of study includes the research approach, as well as model development of this research. Five different models of energy intensity were developed in order to answer the research questions of this study. These models include trade openness, exports, imports, export diversification and institutional quality variables separately. The dependent and independent variables of this study are defined in this chapter and it is explained how these variables are measured in this research. The sources and sample of data are also explained. The variable of institutional quality is defined in details by explaining the components of this variable and their corresponding weights. In addition, export diversification and its measurement explained in this chapter. Moreover, the Fragile States Index, which is used for categorizing countries for second research question of this study also defined in details. This chapter also covers the econometrics method of the study, which are Dynamic Panel

GMM and Panel Granger causality test and it is discussed how to deal with data concerns including multicollinearity, heteroscedasticity, autocorrelation, and endogeneity.

CHAPTER 4: TRADE AND ENERGY INTENSITY

4.1 Introduction

As the amount of CO_2 emissions increase in the atmosphere, countries face several environmental and economic issues. As a result, for the purpose of achieving sustainable economic development, countries are moving towards low-carbon economies, which cause the policy makers to devise energy conservations policies. Despite the increasing concerns on GHGs emissions and climate change, the wide use of fossil fuels has been one of the most considerable drivers of economic growth. In addition, rapid population growth and trade development have raised the demand for energy in the recent decades. Energy consumption, international trade and economic production tend to move together globally. As a result, it is essentially important to investigate more regarding the relation between these variables.

This chapter includes the results and discussions of the first research question of this study. This part of research answers the question about trade and energy intensity's relation in global panel. In the first part, trade openness is included in the energy intensity model and all the coefficients of model estimated. In the following parts, the effects of exports and imports are tested by including them separately in the model and the model also estimated by including export diversification. The results of this chapter also show the significant determinants of energy intensity by including other variables that affect energy intensity in the model. This also determines which variables contributed to the decreasing trend of global energy intensity. This part of study also represents descriptive statistics, correlation matrix and also tests to identify multicollinearity issue of the panel data. After estimating each model, diagnostic checks also tested, to confirm the validity of the model. The final part is a discussion regarding the results and findings of this chapter.

4.2 Descriptive Statistics

This section describes the nature of the key variables of this chapter by providing the descriptive statistics of variables which is represented in table 4.1. The next table (Table 4.2) represents the descriptive statistics of variables in natural logarithm form. The tables include mean, standard deviation, minimum, maximum and the number of observations for each variable.

Table 4.1 Descriptive Statistics

VARIABLE	MEAN	STD. DEV.	MIN	MAX	OBSERVATIONS
EI	.3562125	.2891035	.0546969	2.763229	2766
EP	1.05e+10	2.50e+11	.1226517	9.22e+12	2492
EX	39.3989	30.64246	.0053768	230.269	2692
IM	39.06155	27.84263	0	224.431	2692
TRADE	78.90528	57.51404	0	449.9926	2682
EXDIV	3.042691	1.21146	1.137947	6.41065	2499
UR	62.64745	20.78114	8.534	100	2772
FDI	3.310401	9.802844	.0000261	430.6407	2440
IND	33.98831	11.55624	6.467179	84.82413	2372

Source: Author

Table 4.2 Descriptive Statistics in Logarithm Form

VARIABLE	MEAN	STD. DEV.	MIN	MAX	OBSERVATIONS
LNEI	-1.295397	.7135895	-2.905949	1.0164	2766
LNEP	.085896	2.950092	-2.098407	29.8524	2492
LNEX	3.445223	.7163414	-5.225669	5.439248	2692
LNIM	3.476961	.6500031	-4.159045	5.413568	2682
LNTRADE	4.178977	.6041061	1.843774	6.109231	2681
LNEXDIV	1.034411	.3984415	.1292257	1.857961	2499
LNUR	4.063721	.4230944	2.144058	4.60517	2772
LNFDI	.3318068	1.552511	-10.55358	6.065274	2440
LNIND	3.470722	.3355217	1.86674	4.44058	2372

Source: Author

4.3 Correlation Matrix

The following tables (Table 4.3 to 4.6) show the correlation matrix of the variables for the model including trade openness, imports, exports and the export diversification. As the correlation matrices represent, the highest correlation for the models including trade openness, exports, imports and export diversification is 0.6635, 0.6627, 0.6627 and 0.6724 which is between logarithm of urbanization and logarithm of energy intensity. The highest correlations are still below 0.8 which confirms that there is no correlation issue.

Table 4.3 Correlation Matrix for the Model Including Trade Openness

	LNEI	LNEP	LNTRADE	LNUR	LNFDI	LNIND
LNEI	1.0000					
LNEP	0.2060	1.0000				
LNTRADE	-0.1858	-0.2809	1.0000			
LNUR	-0.6635	-0.1673	0.2014	1.0000		
LNFDI	-0.0939	-0.2343	0.5348	0.1402	1.0000	
LNIND	0.1824	-0.0084	0.1033	-0.0468	-0.0263	1.0000

Source: Author

Table 4.4 Correlation Matrix for the Model Including Exports

	LNEI	LNEP	LNEX	LNUR	LNFDI	LNIND
LNEI	1.0000					
LNEP	0.1507	1.0000				
LNEX	-0.2124	-0.2842	1.0000			
LNUR	-0.6627	-0.1225	0.2315	1.0000		
LNFDI	-0.0977	-0.2146	0.5182	0.1414	1.0000	
LNIND	0.1720	0.0092	0.2006	-0.0406	-0.0297	1.0000

Source: Author

Table 4.5 Correlation Matrix for the Model Including Imports

	LNEI	LNEP	LNIM	LNUR	LNFDI	LNIND
LNEI	1.0000					
LNEP	0.1507	1.0000				
LNIM	-0.1613	-0.2998	1.0000			
LNUR	-0.6627	-0.1225	0.1683	1.0000		
LNFDI	-0.0977	-0.2146	0.5208	0.1414	1.0000	
LNIND	0.1720	0.0092	-0.0196	-0.0406	-0.0297	1.0000

Source: Author

Table 4.6 Correlation Matrix for the Model Including Export Diversification

	LNEI	LNEP	LNEXDIV	LNUR	LNFDI	LNIND
LNEI	1.0000					
LNEP	0.1717	1.0000				
LNEXDIV	0.4580	0.1445	1.0000			
LNUR	-0.6724	-0.1501	-0.3481	1.0000		
LNFDI	-0.0771	-0.2073	0.0477	0.1321	1.0000	
LNIND	0.1475	0.0224	0.2440	-0.0066	-0.0091	1.0000

Source: Author

4.4 Multicollinearity Issue

The following tables (Table 4.7 to 4.10) show the Variance Inflation Factor (VIF) of the variables of the study. The mean VIF is 1.23, 1.20, 1.25 and 1.13 for the models including trade openness, imports and exports and export diversification respectively, which is greatly less than 10, meaning that there is no multicollinearity issue.

Table 4.7 Mean Variance Inflation Factor for the Model Including Trade Openness

VARIABLE	VIF
LNUR	1.06
LNTRADE	1.51
LNFDI	1.43
LNIND	1.02
LNEP	1.11
MEAN VIF	1.23

Source: Author

Table 4.8 Mean Variance Inflation Factor for the Model Including Imports

VARIABLE	VIF
LNUR	1.04
LNIM	1.46
LNFDI	1.38
LNIND	1.00
LNEP	1.11
MEAN VIF	1.20

Source: Author

Table 4.9 Mean Variance Inflation Factor for the Model Including Export

VARIABLE	VIF
LNUR	1.07
LNEX	1.59
LNFDI	1.41
LNIND	1.08
LNEP	1.10
MEAN VIF	1.25

Source: Author

Table 4.10 Variance Inflation Factor for the Model Including Export Diversification

VARIABLE	VIF
LNUR	1.18
LNEXDIV	1.25
LNFDI	1.07
LNIND	1.07
LNEP	1.08
MEAN VIF	1.13

Source: Author

4.5 Relationship between Trade Openness and Energy Intensity

The following table (Table 4.11) represents the estimation results of the relation between trade openness and energy intensity in global panel of countries using two-step system GMM. In estimating the effect of trade openness on energy intensity the effects of other determinants of energy intensity also estimated. The model included energy intensity as dependent variable and energy prices, trade openness, urbanization, FDI and industrialization as independent variables. Using Dynamic Panel GMM the lag of dependent variable is also included as a RHS variable in the model.

Table 4.11 Relationship between Trade Openness and Energy Intensity

NUMBER OF OBSERVATIONS = 1804						
NUMBER OF GROUPS = 79						
NUMBER OF INSTRUMENTS = 25						
LNEI	**Coef.**	**Corrected Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
L1. LNEI	.9972155	.0030533	326.60	0.000	.9912312	1.0032
LNEP	.0006273	.0009812	0.64	0.523	-.0012959	.0025504
LNTRADE	.0078077	.0037112	2.10	0.035	.0005338	.0150816
LNUR	-.0007336	.0043888	-0.17	0.867	-.0093356	.0078683
LNFDI	-.0039428	.0012139	-3.25	0.001	-.0063221	-.0015635
LNIND	.0173642	.0083864	2.07	0.038	.0009271	.0338012
CONS	-.0977061	.0365506	-2.67	0.008	-.1693439	-.0260683

Source: Author

4.5.1 Diagnostic Checks

The following sections show the diagnostic checks for the analysis result of this chapter. In the first part, autocorrelation is tested and in the second part test of overidentifying restrictions is performed.

4.5.1.1 Arellano-Bond Test

STATA performs two Arellano-Bond autocorrelation tests of AR1 and AR2 after running GMM analysis. The results of autocorrelation tests which are represented in Table 4.12 reveal the existence of first order serial correlation (as the p-value < 0.05). This result is correct and also consistent with theory of GMM. The null hypothesis for the second order serial correlation failed to reject (as the p-value > 0.05), which is again consistent with GMM.

Table 4.12 Arellano-Bond Test for Autocorrelation

ARELLANO-BOND TEST FOR AR(1) IN FIRST DIFFERENCES	Z = -3.68	PR > Z = 0.000
ARELLANO-BOND TEST FOR AR(2) IN FIRST DIFFERENCES	Z = 1.14	PR > Z = 0.255

(H_0: no autocorrelation) Source: Author

4.5.1.2 Hansen Test

The null hypothesis of the Hansen overidentifying restrictions test is that the instruments are valid instruments meaning that they are not correlated with the error terms, and those instruments which are excluded from the estimated equation, are accurately excluded. As a result, if H_0 is confirmed, instruments pass the test and are valid. The Hansen test result confirms the failure in rejecting the null hypothesis (as the p-value > 0.05) (Table 4.13). This reveals that the overidentifying restrictions are valid.

Table 4.13 Hansen Test of Overidentifying Restrictions

HANSEN TEST OF OVERIDENTIFYING RESTRICTIONS	CHI2 = 16.71	PROB > CHI2 = 0.543

(H_0= instruments are valid) Source: Author

4.6 Relationship between Exports and Energy Intensity

The following table (Table 4.14) represents the estimation results of exports and energy intensity‘s relation using two-step system GMM. The model also includes energy prices, urbanization, FDI and industrialization together with the lag of energy intensity as independent variables since the estimation the model is dynamic.

Table 4.14 Relationship between Exports and Energy Intensity

NUMBER OF OBSERVATIONS	=	1800				
NUMBER OF GROUPS	=	79				
NUMBER OF INSTRUMENTS	=	25				
LNEI	**Coef.**	**Corrected Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
L1. LNEI	.9978834	.0032271	309.22	0.000	.9915583	1.004208
LNEP	.0006009	.0006	1.00	0.317	-.0005751	.001777
LNEX	.006735	.0035413	1.90	0.057	-.0002057	.0136758
LNUR	-.000208	.0047191	-0.04	0.965	-.0094573	.0090413
LNFDI	-.0035774	.0013198	-2.71	0.007	-.0061643	-.0009906
LNIND	.0158673	.0083759	1.89	0.058	-.0005491	.0322838
CONS	-.0846975	.0351629	-2.41	0.016	-.1536155	-.0157795

Source: Author

4.6.1 Diagnostic Checks

The Arellano-Bond tests for autocorrelation (AR1 and AR2) and Hansen Test of Overidentifying Restrictions‘ results represented in the following parts for the purpose of diagnostic checks.

4.6.1.1 Arellano-Bond Test

As the results for the Arellano-Bond tests for autocorrelation show, since p-value < 0.05 for AR (1), the first order serial correlation is confirmed and for the AR (2) since the p-value > 0.05 the second order serial correlation is not confirmed (Table 4.15) which both are in line with the theory of GMM.

Table 4.15 Arellano-Bond Test for Autocorrelation

ARELLANO-BOND TEST FOR AR (1) IN FIRST DIFFERENCES	Z = -3.67	PR > Z = 0.000
ARELLANO-BOND TEST FOR AR (2) IN FIRST DIFFERENCES	Z = 1.14	PR > z = 0.255

(H_0: no autocorrelation) Source: Author

4.6.1.2 Hansen Test

The test result failed to reject the null hypothesis (the p-value > 0.05) which reveals that the overidentifying restrictions are valid and instruments are not correlated with the error terms (Table 4.16). As a result, there is no uncertainty on the quality of estimations.

Table 4.16 Hansen Test of Overidentifying Restrictions

HANSEN TEST OF OVERIDENTIFYING RESTRICTIONS	CHI2 = 18.84	PROB > CHI2 = 0.402

(H_0= instruments are valid) Source: Author

4.7 Relationship between Imports and Energy Intensity

The following table (Table 4.17) represents the estimation results of imports and energy intensity's relation using two-step system GMM. The model includes energy prices, imports, urbanization, FDI and industrialization. Using dynamic estimation method, the model also includes the lag of dependent variable as a RHS variable.

Table 4.17 Relationship between Imports and Energy Intensity

NUMBER OF OBSERVATIONS	= 1800					
NUMBER OF GROUPS	= 79					
NUMBER OF INSTRUMENTS	= 25					
LNEI	**Coef.**	**Corrected Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
L1. LNEI	.9970999	.0031677	314.77	0.000	.9908914	1.003308
LNEP	.0006523	.0005448	1.20	0.231	-.0004155	.00172
LNIM	.0065433	.0035831	1.83	0.068	-.0004795	.013566
LNUR	-.0003164	.0044459	-0.07	0.943	-.0090302	.0083974
LNFDI	-.0034931	.0012076	-2.89	0.004	-.00586	-.0011262
LNIND	.0174855	.0090033	1.94	0.052	-.0001607	.0351316
CONS	-.0903823	.0373449	-2.42	0.016	-.163577	-.0171876

Source: Author

4.7.1 Diagnostic Checks

The following sections show the diagnostic checks of the analysis result for imports and energy intensity‘s relation. In the first part, autocorrelation is tested using Arellano-Bond AR1 and AR2 tests and in the second part, test of overidentifying restrictions is performed.

4.7.1.1 Arellano-Bond Test

The result of AR (1) test confirms the existence of the first order serial correlation (as the p-value < 0.05). This result is consistent with theory of GMM. The null hypothesis of the second order serial correlation is failed to be rejected (as the p-value > 0.05), which is also consistent with GMM theory (Table 4.18).

Table 4.18 Arellano-Bond Test for Autocorrelation

ARELLANO-BOND TEST FOR AR (1) IN FIRST DIFFERENCES	Z = -3.67	PR > Z = 0.000
ARELLANO-BOND TEST FOR AR (2) IN FIRST DIFFERENCES	Z = 1.14	PR > Z = 0.253

(H0: no autocorrelation) Source: Author

4.7.1.2 Hansen Test

As the result of Hansen test of overidentifying restrictions shows, the p-value is greater than 0.05 which fails to reject the null hypothesis. This reveals that the overidentifying restrictions are valid meaning that instruments are selected correctly (Table 4.19).

Table 4.19 Hansen Test of Overidentifying Restrictions

HANSEN TEST OF OVERIDENTIFYING RESTRICTIONS	CHI2 = 16.41	PROB > CHI2 = 0.564

(H_0= instruments are valid) Source: Author

4.8 Relationship between Export Diversification and Energy Intensity

The following table (Table 4.20) represents the estimation results of export diversification and energy intensity‘s relation using two-step system GMM. The model also includes energy prices, urbanization, FDI and industrialization. Using a dynamic estimation model, the lag of dependent variable also included as an independent variable in the model.

Table 4.20 Relationship between Export Diversification and Energy Intensity

NUMBER OF OBSERVATION			=	**1632**		
NUMBER OF GROUPS			=	**75**		
NUMBER OF INSTRUMENTS			=	**25**		
LNEI	**Coef.**	**Corrected Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
L1. LNEI	.9903998	.0032183	307.74	0.000	.9840921	.9967075
LNEP	.0002908	.0003069	0.95	0.343	-.0003107	.0008922
LNEXDIV	.0203943	.0051324	3.97	0.000	.010335	.0304536
LNUR	-.0063886	.0059096	-1.08	0.280	-.0179712	.0051939
LNFDI	-.0022717	.0010815	-2.10	0.036	-.0043914	-.000152
LNIND	.0149542	.0074945	2.00	0.046	.0002654	.0296431
CONS	-.0624941	.0344822	-1.81	0.070	.0002654	.0050898

Source: Author

4.8.1 Diagnostic Checks

The following sections show the diagnostic checks for the analysis result. In the first part, autocorrelation is tested using Arellano-Bond AR(1) and AR(2) tests, and in the second part test of overidentifying restrictions are performed to confirm the validity of instruments.

4.8.1.1 Arellano-Bond Test

The results of Arellano-Bond AR (1) and AR (2) tests confirms first order serial correlation (since p-value < 0.05) and the absence of second order serial correlation (p-value > 0.05) respectively which are consistent and in line with GMM theory (Table 4.21).

Table 4.21 Arellano-Bond Test for Autocorrelation

ARELLANO-BOND TEST FOR AR (1) IN FIRST DIFFERENCES	Z = -3.41	PR > Z = 0.001
ARELLANO-BOND TEST FOR AR (2) IN FIRST DIFFERENCES	Z = 1.25	PR > z = 0.211

(H0: no autocorrelation) Source: Author

4.8.1.2 Hansen Test

The Hansen overidentifying restrictions test result failed to reject the null hypothesis (as the p-value > 0.05). This reveals that the overidentifying restrictions are valid and instruments are able pass the test (Table 4.22).

Table 4.22 Hansen Test of Overidentifying Restrictions

HANSEN TEST OF OVERIDENTIFYING RESTRICTIONS	CHI2 = 16.41	PROB > CHI2 = 0.268

(H_0= instruments are valid) Source: Author

4.9 Discussion

This section provides discussions and interpretations of the findings for the first analytical chapter, including estimation results of the energy intensity model including trade openness, exports, imports and finally export diversification using dynamic panel GMM on global panel of 84 countries. In estimating the effects of trade openness, imports, exports and export diversification, on energy intensity the effects of other determinants of energy intensity including FDI, industrialization, urbanization and energy prices are also estimated.

The reason for estimating the coefficients of these variables is that, this study attempts to model energy intensity with the most significant determinants of this variable. Hence the model and estimations will be more accurate.

The model included energy intensity as dependent variable and energy prices, trade openness/imports/exports/export diversification, urbanization, FDI and industrialization as independent variables. Using Dynamic Panel GMM, the lag of dependent variable is also considered in the model as an independent variable. The estimated coefficients on the lagged energy intensity variable in all four estimations are positive, highly persistent, and statistically significant at the 1 percent level, revealing that energy intensity in one year is influenced significantly by energy intensity in the year before.

While it is expected that the estimated coefficient of energy prices to be negative and significant, results show that this coefficient is not statistically significant in all of the estimations. This is inconsistent with the findings of Hang and Tu (2007), Wu (2012), Yan (2015) Atalla and Bean (2017), and Guo et al. (2019) who found that increasing energy prices is an effective policy tool for increasing energy use efficiency. On the other hand, results are in line with findings of Mulder et al. (2014) and Barkhordari and Fattahi (2017), who found a minor role for energy prices in explaining variations in energy intensity, as a result raising doubts on the usefulness of the price instruments for reducing energy intensity. The estimation result of energy prices variable in this chapter reveals that for this group of countries within the selected time period energy prices do not significantly affect energy intensity. Hence, changes in energy prices do not contribute to energy use efficiency and cannot be considered as a policy tool to lower energy intensity.

Urbanization which causes more concentration of consumption and production shows an insignificant coefficient in all of the estimations models including exports, imports, trade openness and export diversification. These findings indicate that for this specific group of countries during this specific time period, however, other variables are more significant in determining energy intensity compared to urbanization which is inconsistent with findings of Shahbaz and Lean (2012) Elliot and Sun (2017) who found a significant role for urbanization in increasing energy consumption and higher energy intensity.

FDI represents highly significant contribution in improving energy efficiency and decrease of energy intensity in all the models including exports, imports, trade openness and export diversification. The estimation results show a negative and highly significant coefficient for this variable at 1 percent level for the models including trade openness, imports and exports. For the model including export diversification this coefficient is negative and significant at 5 percent level. A 1 percent increase in FDI in the model including trade openness will lead to decrease of 0.0039 percent energy intensity. A 1 percent increase in FDI will lead to decrease of 0.0035 percent energy intensity in the model including exports and 0.0034 percent for the model including imports. In the model including export diversification, energy intensity will decrease 0.0022 percent with every 1 percent increase in FDI. Results indicate that for this group of countries during the selected time period, FDI significantly lowered energy intensity hence the higher level of FDI led to higher energy efficiency. While FDI increases economic activities, which will lead to more energy use, it causes use of modern technologies in the host country and stimulates technology innovation of host country‘s firms which can result in reduction in energy consumption and hence improves energy efficiency. In addition, FDI brings new management methods, organizational arrangements and foreign R&D spillovers to the host country which can lead to lower energy consumption and energy intensity. The analysis results of this chapter confirm this which is consistent with the findings of studies such as Mielnik and Goldemberg (2002), Eskeland and Harrison (2003), Fisher-Vanden et al. (2004), Bento (2011) and Sbia et al. (2014).

Estimation results revealed that 1 percent increase in industrialization will lead to 0.0173 percent, 0.0158 percent, 0.0174 percent and 0.0149 percent increase in energy intensity in the models including trade openness, exports, imports and export diversification respectively. These estimated coefficients are significant at 5 percent level. This indicates that for this group of countries within the selected time period industrialization increased industrial energy intensive activities which has led to consumption of more energy and caused the increase in energy intensity. Industrialization results in more energy consumption as higher value added manufacturing such as primary metals, petroleum refining, paper products and chemicals consumes higher level of energy compared to traditional agriculture manufacturing such as textile industries. This result is in line with the findings of Shahbaz and Lean (2012), Sadorsky (2013), Salim and Shafiei (2014) Belloumi and Alshehry (2016) and Guang et al. (2019).

The coefficient of trade openness appeared to be significant at 5 percent level. This coefficient is positive and for every 1 percent expansion in trade openness, energy intensity increases by value of 0.0078 percent. In this group of countries and during the selected time period one of the channels that trade openness can affect energy intensity is stronger than the other which is the channel of increase in energy consumption. The estimation result of the coefficient for trade openness indicates that increase in trade openness caused increase in the economic activities including production of products for the purpose of exportations and also shipments of exportations and importations. As a result demand for energy increased. It can also be concluded that imported goods and also the manufacturing activities to produce exportations were energy intensive. The other channel looks to work weaker, the channel of improving productivity through higher technology which is embodied in imported goods. This result is consistent with findings of Nasreen and Anwar, (2014) who found a positive relationship between trade openness and energy use and inconsistent with the findings of Shen (2007) who showed that trade openness improves energy efficiency.

The coefficient of exports is significant at 5 percent level. This coefficient is positive and for every 1 percent increase in exports, energy intensity increases by value of 0.0067 percent. Theoretically more exports require more factors of production such as energy to produce the exports and the exports products need to be transported which requires energy as well. As a result, exports increase the demand for energy which will cause the increase in energy intensity. It can also be concluded that the manufacturing activities to produce exportations were energy intensive activities for this group of countries and within the selected time period. This result is consistent with the finding of Sadorsky (2011b) who found positive impact of exports on energy consumption.

The coefficient of imports is significant at 10 percent level. This coefficient is positive and for every 1 percent increase in imports, energy intensity increases by value of 0.0065 percent. This is consistent with the finding of Sadorsky (2011b) who found positive impact of imports on energy consumption. Importing goods needs well transportation network, in order to move goods to different destinations in the country and transportation system needs energy. As a result, increasing imports will increase the demand for energy. In addition, the composition of imports can affect the demand for energy in two different ways. If the goods are energy intensive products such as automobiles, dishwashers and air conditioners, the demand for energy will increase and if there imported goods have higher level of technology which will lead to higher efficiency, the consumption of energy and as a result energy intensity will decrease. In the case of this result, it is possible to say that the imported goods were more energy intensive compared to the technologies embodied in them.

The estimated coefficient of export diversification is highly significant at 1 percent level. This coefficient is positive and results revealed that for every 1 percent increase in export diversification index, energy intensity increases by the value of 0.0203 percent. The higher the export diversification (Theil index), the lower export product diversification is. The estimation shows that increase in export diversification index leads to increase in energy intensity. This result can be interpreted as lower diversity of export products, causes the increase in energy intensity. Commodity dependent countries which represent a narrow export basket often suffer from export instability as a result of inelastic and unstable global demand. As the developing countries exporting primary commodities including their primary resources such as crude oil and natural gas, and these types of commodities are energy intensive to be extracted, these countries represent higher level of energy intensity.

4.10 Chapter Summary

This chapter provides the analysis, results and discussions of the first analytical chapter of this study which is regarding the trade and energy intensity's relation in global panel by including trade openness in the energy intensity model and in the following parts the effects of exports and imports is tested by including them separately in the models. Finally, the effect of export diversification is investigated in relation to energy intensity. The model is estimated using dynamic panel GMM and as a result the lag of dependent variable is also used as an independent variable. The other variables in energy intensity model include energy prices, industrialization, urbanization and FDI.

The analysis results revealed that the coefficient of trade openness is significant and positive which shows that increase in trade openness caused increase in the economic activities and as a result demand for energy for every unit of production increased. The coefficient of exports appeared to be significant and positive, meaning that exports increased the demand for energy which caused the increase in energy consumption. It is also concluded that for this group of countries during the selected time period exports-related activities has been energy intensive.

The coefficient of imports is significant and positive. It means that importation of goods increased consumption of energy in order to move goods around the country. In addition, the composition of imported products has been energy intensive which affected the demand for energy. The coefficient of export diversification is positive and significant, determining the fact that the more diversity of exports production results in less energy intensity.

CHAPTER 5: INSTITUTIONAL QUALITY AND ENERGY INTENSITY

5.1 Introduction

The development of modern ways of energy generation caused increase in the combustion of fossil fuels including coal and oil. Energy consumption and climate change are closely related and policy makers try to devise suitable policies in order to improve energy efficiency and mitigate global warming and climate change issues. Previous literature attempted to find out the determinants of energy intensity and found some of these determinants such as energy prices, trade, industrialization, urbanization and FDI. The focus of the current chapter is to examine the institutional quality and energy intensity‘s relation, as this relation is not investigated by the previous works.

This chapter includes the analysis results and discussions of the second research question of this study. This part of the current research answers the question regarding the institutional quality and energy intensity‘s relation in global panel of countries and two subgroups; stable and unstable countries and begins with the descriptive statistics and explanation about how this study tackled with issues of correlation and multicollinearity. The analysis result is provided by the application of Generalized Method of Moments (GMM) followed by diagnostic checks which tested for the results of this chapter. In the final part, the discussion regarding the results of this research question is provided.

5.2 Descriptive Statistics

The following table (Table 5.1) shows the descriptive statistics for variables of this chapter. The next table (Table 5.2) represents the descriptive statistics of variables in natural logarithm form. These tables include mean, standard deviation, minimum, maximum and the number of observations for each variable.

Table 5.1 Descriptive Statistics

VARIABLE	MEAN	STD. DEV.	MIN	MAX	OBSERVATIONS
EI	.3562125	.2891035	.0546969	2.763229	2766
EP	1.05e+10	2.50e+11	.1226517	9.22e+12	2492
TRADE	78.90528	57.51404	0	449.9926	2682
UR	62.64745	20.78114	8.534	100	2772
FDI	3.310401	9.802844	.0000261	430.6407	2440
IND	33.98831	11.55624	6.467179	84.82413	2372
PR	67.10826	15.21954	13	97	2420

Source: Author

Table 5.2 Descriptive Statistics in Logarithm Form

VARIABLE	MEAN	STD. DEV.	MIN	MAX	OBSERVATIONS
LNEI	-1.295397	.7135895	-2.905949	1.0164	2766
LNEP	.085896	2.950092	-2.098407	29.8524	2492
LNTRADE	4.178977	.6041061	1.843774	6.109231	2681
LNUR	4.063721	.4230944	2.144058	4.60517	2772
LNFDI	.3318068	1.552511	-10.55358	6.065274	2440
LNIND	3.470722	.3355217	1.86674	4.44058	2372
LNPR	4.176312	.2571351	2.564949	4.574711	2420

Source: Author

5.3 Correlation Matrix

The following table (Table 5.3) shows the correlation matrix of the variables. The highest correlation is 0.6596 between logarithm of urbanization and the logarithm of energy intensity. Even the highest correlation is still below 0.8 which confirms that there is no correlation issue in the data.

Table 5.3 Correlation Matrix

	LNEI	LNEP	LNTRADE	LNUR	LNFDI	LNIND	LNPR
LNEI	1.0000						
LNEP	0.2027	1.0000					
LNTRADE	-0.1759	-0.2389	1.0000				
LNUR	-0.6596	-0.1332	0.1843	1.0000			
LNFDI	-0.0905	-0.2015	0.5363	0.1257	1.0000		
LNIND	0.2269	0.0264	0.0693	-0.0907	-0.0331	1.0000	
LNPR	-0.6186	-0.3391	0.2916	0.5418	0.2758	0.0104	1.0000

Source: Author

5.4 Multicollinearity Issue

The following table (Table 5.4) shows the Variance Inflation Factor (VIF) for the variables of the study. The mean VIF is 1.38 which is greatly less than 10, meaning that there is no multicollinearity issue.

Table 5.4 Mean Variance Inflation Factor

VARIABLE	VIF
LNUR	1.45
LNTRADE	1.49
LNFDI	1.45
LNIND	1.03
LNEP	1.17
LNPR	1.67
MEAN VIF	1.38

Source: Author

5.5 Relationship between Energy Intensity and Institutional Quality

The following sections represent the estimation results and related diagnostic checks including Arellano-Bond tests of AR(1) and AR(2) and also Hansen test of overidentifying restrictions for the institutional quality and energy intensity‘s relation using two-step system GMM in global panel, panel of stable countries and unstable countries. Countries are categorized based on Fragile States Index (FSI). The models also include industrialization, urbanization, FDI, energy prices and trade openness. The lag of depended variables is also included as an independent variable since the model is dynamic.

5.5.1 Global Panel

The following table (Table 5.5) represents the estimation results of the institutional quality and energy intensity‘s relation using two-step system GMM in global panel which includes all 84 for countries of this study.

Table 5.5 Relationship between Institutional Quality and Energy Intensity in Global Panel

NUMBER OF OBS	**=**	**1687**				
NUMBER OF GROUPS	**=**	**79**				
NUMBER OF INSTRUMENTS	**=**	**29**				
LNEI	**Coef.**	**Corrected Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
L1. LNEI	.992808	.002604	381.27	0.000	.9877044	.9979117
LNEP	-.0005387	.0006434	-0.84	0.402	-.0017998	.0007225
LNTRADE	.0064613	.0033549	3..1	0.054	-.0001143	.0130369
LNUR	.0036341	.0066562	0.55	0.585	-.0094117	.01668
LNFDI	-.0040682	.0012837	-3.17	0.002	-.0065841	-.0015522
LNIND	.0183331	.0068769	2.67	0.008	.0048547	.0318115
LNPR	-.0227074	.0098117	-2.31	0.021	-.041938	-.0034769
CONS	-.0236721	.0472068	-0.50	0.616	-.1161958	.0688516

Source: Author

5.5.2 Diagnostic Checks

The following sections show the diagnostic checks of the analysis result for the institutional quality and energy intensity‘s relation in Global Panel. In the first part, autocorrelation is tested using AR (1) and AR (2), and in the second part result of Hansen test of overidentifying restrictions is represented.

5.5.2.1 Arellano-Bond Test

Results of Arellano-Bond tests of AR(1) and AR(2) (Table 5.6) show the existence of the first order serial correlation (as the p-value < 0.05) for AR (1), which is correct and in line with GMM theory. The null hypothesis of the second order serial correlation is failed to reject, since p-value > 0.05, which is also consistent with GMM theory.

Table 5.6 Arellano-Bond Test for Autocorrelation

ARELLANO-BOND TEST FOR AR (1) IN FIRST DIFFERENCES	Z = -4.76	PR > Z = 0.000
ARELLANO-BOND TEST FOR AR (2) IN FIRST DIFFERENCES	Z = 0.83	PR > z = 0.408

(H0: no autocorrelation) Source: Author

5.5.2.2 Hansen Test

The test result (Table 5.7) failed to reject the null hypothesis as the p-value is greater than 0.05. This test identifies the validity of instrumental variables. Results indicate that the overidentifying restrictions are valid, which means that instruments are not correlated with the error terms and correctly selected.

Table 5.7 Hansen Test of Overidentifying Restrictions

HANSEN TEST OF OVERIDENTIFYING RESTRICTIONS	CHI2 = 17.70	PROB > CHI2 = 0.668

(H_0= instruments are valid) Source: Author

5.5.3 Stable Countries

The following table represents the estimation results of the institutional quality and energy intensity‘s relation using two-step system GMM in panel of stable countries. Stable countries are countries with scores below 60 based on Fragile States Index. The model is dynamic; hence lag of dependent variable also included as an independent variable in the model. Other independent variables include industrialization, urbanization, trade openness, energy prices and FDI.

Table 5.8 Relationship between Institutional Quality and Energy Intensity in Stable Countries

NUMBER OF OBS	**=**	**683**				
NUMBER OF GROUPS	**=**	**35**				
NUMBER OF INSTRUMENTS	**=**	**29**				
LNEI	**Coef.**	**Corrected Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
L1. LNEI	.9916133	.0065051	152.44	0.000	.9788637	1.004363
LNEP	-.0044044	.0018944	-2.32	0.020	-.0081174	-.0006914
LNTRADE	.0056844	.0042648	1.33	0.183	-.0026744	.0140433
LNUR	-.0082241	.0067711	-1.21	0.225	-.0214953	.0050471
LNFDI	-.0046308	.0019285	-2.40	0.016	-.0084107	-.000851
LNIND	.0237309	.0159745	1.49	0.137	-.0075786	.0550403
LNPR	-.0558354	.031163	-1.79	0.073	-.1169138	.005243
CONS	.1519256	.1363394	1.11	0.265	-.1152947	.4191459

Source: Author

5.5.4 Diagnostic Checks

The following parts show the diagnostic tests for the analysis result of the institutional quality and energy intensity‘s relation in stable countries (FSI score below 60). In the first part, autocorrelation is tested using Arellano-Bond test for autocorrelation (AR (1) and AR (2)) and in the second part Hansen test of overidentifying restrictions is performed.

5.5.4.1 Arellano-Bond Test

Results of Arellano-Bond tests of AR(1) and AR(2) (Table 5.9) confirms the presence of first order serial correlation (as p-value < 0.05 for AR (1) test) which is correct and consistent with GMM theory. Result of AR (2) test shows that the null hypothesis for the second order serial correlation is failed to reject since the p-value > 0.05, which is also in line with theory of GMM.

Table 5.9 Arellano-Bond Test for Autocorrelation

ARELLANO-BOND TEST FOR AR (1) IN FIRST DIFFERENCES	Z = -2.65	PR > Z = 0.008
ARELLANO-BOND TEST FOR AR (2) IN FIRST DIFFERENCES	Z = 0.65	PR > z = 0.519

(H0: no autocorrelation) Source: Author

5.5.4.2 Hansen Test

As the p-value of Hansen test of overidentifying restrictions is greater than 0.05, it is failed to reject the null hypothesis which indicates that the overidentifying restrictions are valid. As the result shows, instruments selected correctly for this estimation (Table 5.10).

Table 5.10 Hansen Test of Overidentifying Restrictions

HANSEN TEST OF OVERIDENTIFYING RESTRICTIONS	CHI2 = 25.18	PROB > CHI2 = 0.239

(H_0= instruments are valid) Source: Author

5.5.5 Unstable Countries

The following table (Table 5.11) represents the estimation results for the institutional quality and energy intensity‘s relation for unstable countries using two-step system GMM. Unstable countries are those countries with scores above 60 based on Fragile States Index. The model also include lag of dependent variable as the model is dynamic, industrialization, urbanization, energy prices, trade openness and FDI.

Table 5.11 Relationship between Institutional Quality and Energy Intensity in Unstable Countries

NUMBER OF OBS = 1023						
NUMBER OF GROUPS = 45						
NUMBER OF INSTRUMENTS = 29						
LNEI	**Coef.**	**Corrected Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
L1. LNEI	.9909347	.0045846	216.14	0.000	.981949	.9999204
LNEP	-.0004629	.0007759	-0.60	0.551	-.0019836	.0010579
LNTRADE	.0065116	.0043284	1.50	0.132	-.0019719	.0149951
LNUR	.0051043	.009675	0.53	0.598	-.0138585	.024067
LNFDI	-.0036537	.0014246	-2.56	0.010	-.0064459	-.0008616
LNIND	.0081965	.0086762	0.94	0.345	-.0088086	.0252016
LNPR	-.0263942	.0155192	-1.70	0.089	-.0568113	.004023
CONS	.0194442	.0660641	0.29	0.769	-.110039	.1489274

Source: Author

5.5.6 Diagnostic Checks

The following parts show the diagnostic checks of the analysis result of the institutional quality and energy intensity‘s relation in unstable countries (FSI score above 60). In the first part, autocorrelation is tested using Arellano-Bond tests of AR(1) and AR(2) and in the second part Hansen test of overidentifying restrictions is performed.

5.5.6.1 Arellano-Bond Test

Results of Arellano-Bond tests of AR(1) and AR(2) (Table 5.12) confirm the first order serial correlation since the p-value < 0.05, which is correct and consistent with theory of GMM. For the second order serial correlation the null hypothesis is failed to reject as p-value > 0.05, which is also in line with GMM theory.

Table 5.12 Arellano-Bond Test for Autocorrelation

ARELLANO-BOND TEST FOR AR (1) IN FIRST DIFFERENCES	Z = -4.35	PR > Z = 0.000
ARELLANO-BOND TEST FOR AR (2) IN FIRST DIFFERENCES	Z = 0.59	PR > z = 0.552

(H0: no autocorrelation) Source: Author

5.5.6.2 Hansen Test

The result of Hansen test of overidentifying restrictions (Table 5.13) failed to reject the null hypothesis as the p-value > 0.05. This reveals that the overidentifying restrictions are valid and instruments are selected correctly.

Table 5.13 Hansen Test of Overidentifying Restriction

HANSEN TEST OF OVERIDENTIFYING RESTRICTIONS	CHI2 = 22.93	PROB > CHI2 = 0.348

(H0= instruments are valid) Source: Author

5.6 Discussion

The following section includes discussions and interpretations of the results for the second research question of this study including discussions regarding the results of the institutional quality and energy intensity‘s relation in global panel, panel of stable and unstable countries. Countries are categorized based on FSI score and energy intensity model is estimated using dynamic panel GMM. In estimating the effect of institutional quality on energy intensity the effects of other determinants of energy intensity also considered in the model. The model included energy intensity as dependent variable and energy prices, trade openness, urbanization, FDI, industrialization and political risk as independent variables. Using Dynamic Panel GMM the lag of dependent variable is also considered in the right hand side of the model.

The estimated of coefficient for the lagged energy intensity variable in global panel of countries, shows a positive sign and is highly persistent. It is also statistically significant at the 1 percent level, revealing that energy intensity in one year is significantly affected by energy intensity in the past year. The same result was obtained from estimation of stable and unstable countries‘ model. It can be concluded that energy intensity depends on its own lag in all models regardless of degree of stability (FSI score).

Estimation of coefficient for energy prices variable shows an insignificant coefficient for global and unstable panel of countries. For the stable group of countries, the estimation of coefficient for energy prices variable shows a negative sign and it is statistically significant at 5 percent level. This is in line with a downward sloping demand for energy equation where energy prices are approximated by oil prices. For every 1 percent increase in energy prices in stable countries, energy intensity decreases by value of 0.0044 percent. This indicates that energy prices can be effective policy tool to decrease energy intensity only in stable countries, which means states' vulnerability is a determining factor in effectiveness of energy prices policies to improve energy efficiency.

Urbanization which causes more concentration of consumption and production shows an insignificant coefficient meaning that for global panel, panel of stable and unstable countries during this specific time period, however, other variables are more significant in determining energy intensity compared to urbanization. In conclusion, results indicate that urbanization does not determine energy intensity. These findings are inconsistent with the works of Jones (1991), Mishra et al. (2009), Poumanyvong and Kaneko (2010), Shahbaz and Lean (2012), Sadorsky (2013), Salim and Shafiei (2014), Komal and Abbas (2015) and Elliot and Sun (2017) who found urbanization to significantly affect the energy demand.

The coefficient of trade openness in global panel is significant at 10 percent level. This coefficient is positive and for every 1 percent increase in trade openness, energy intensity increases by value of 0.0064 percent. This result is in line with findings of Hübler (2009) and Nasreen and Anwar (2014). The estimation result of the coefficient of trade openness shows that increase in trade openness caused increase in the economic activities and as a result demand for energy increased. In the case of stable and unstable countries this coefficient is insignificant. It can be concluded that trade openness does not significantly affect energy intensity.

The estimated coefficient of institutional quality is negative and significant at 5 percent level for global panel of countries. A 1 percent increase in institutional quality will lead to 0.0227 percent decrease in energy intensity. Higher level of institutional quality means less political risk. As a result, it is possible to conclude that for countries with lower levels of political risks the level of energy intensity decreases. Higher level of institutional quality can also cause the attraction of FDI into countries. Previous studies confirm that, institutional quality is a significant determinant of FDI inflows (Busse and Hefeker, 2007; Bénassy-Quéré et al., 2007; Daude and Stein, 2007; Esew and Yaroson, 2014; Peres et al., 2018; Paul and Jadhav, 2019).

Alterations in political institutions or government policies can affect MNCs' investment behavior, because the risk premium which is included in any investment project and also the location decisions is affected by political risk (Busse and Hefeker, 2007). Besides FDI can stimulate technology innovation in the host country and cause the reduction of energy consumption (Chang, 2015). Moreover higher level of FDI can stimulate the improvement of institutions by government (Selowsky and Martin, 1997).

For panel of stable countries, the estimated coefficient of institutional quality is negative and significant at 10 percent level. A 1 percent increase in institutional quality will lead to 0.0558 percent decrease in energy intensity. For panel of unstable countries, the estimated coefficient of institutional quality is negative and significant at 10 percent level. A 1 percent increase in institutional quality will lead to 0.0263 percent decrease in energy intensity. Although the coefficient of institutional quality is significant at 10 percent level for both stable and unstable countries, the magnitude of this coefficient is higher for stable countries. It can be concluded that the quality of institutions has larger impact in lowering energy intensity and improving energy efficiency in stable countries rather than unstable countries. Hence, stability can be a determining factor in effectiveness of institutional quality in lowering energy intensity for this group of countries and within the selected time period.

FDI showed a highly significant contribution in improving energy efficiency and decrease of energy intensity. The estimation result shows a negative and highly significant coefficient for this variable at 1 percent level for global panel of countries. A 1 percent increase in FDI will lead to decrease of 0.0040 percent energy intensity. This result is consistent with finding of Bento (2011), Eskeland and Harrison (2003), Fisher-Vanden et al. (2004), Mielnik and Goldemberg (2002) and Sbia et al. (2014). FDI can cause the application of modern technologies and will lead to technology innovations by firms in the host country which can result in decrease in consumption of energy. The estimation result shows a negative and significant coefficient for this variable at 5 percent level for stable countries. A 1 percent increase in FDI will result in decrease of 0.0046 percent energy intensity. The estimation result shows a negative and significant coefficient for this variable at 5 percent level for unstable countries. A 1 percent increase in FDI will lead to decrease of 0.0036 percent energy intensity. Results indicate that stable countries benefit more from FDI compared to unstable countries, as the magnitude of FDI coefficient is higher in the energy intensity model estimated using stable countries' data.

Results of estimations showed that a 1 percent increase in industrialization will lead to 0.0183 percent increase in energy intensity in global panel of countries. This estimated coefficient is highly significant at 1 percent level. This coefficient shows that increase in industrial activities led to consumption of more energy which caused the increase in energy intensity. This result is in line with the findings of (Sadorsky, 2013; Salim and Shafiei, 2014; Shahbaz and Lean, 2012). The estimated coefficient of industrialization is insignificant even at 10 percent level for both stable and unstable group of countries.

5.7 Chapter Summary

This chapter provides the results and discussions of the second research question of this study which is the institutional quality and energy intensity's relation in global panel and two subgroups of stable and unstable countries which are categorized based on FSI. This part of study also represents descriptive statistics and correlation matrix of the panel data. The model is estimated using dynamic panel GMM. Lag of dependent variable is also included as an independent variable in the model, since the model is dynamic. The other independent variables include industrialization, urbanization, trade openness, energy prices and FDI. Diagnostic checks also tested for the results of this chapter including Arellano-Bond tests of AR(1) and AR(2) and Hansen test of overidentifying restrictions.

Results showed that in global panel the estimated coefficient of institutional quality is negative and significant. As higher levels of institutional quality mean less political risk, it is possible to conclude that for countries with lower levels of risks, the level of energy intensity decreases. Higher levels of institutional quality can also cause the attraction of FDI into countries which can bring higher level of technology with more efficient use of energy. The coefficient of institutional quality is negative and significant for stable and unstable countries.

CHAPTER 6: DIRECTION OF RELATIONSHIP BETWEEN INSTITUTIONAL QUALITY AND ENERGY INTENSITY

6.1 Introduction

Energy is one of the essential factors which is required for growth and development of an economy. The economic growth and competitiveness of an economy highly depends on the existence of efficient and environmental friendly resources of energy. Economic growth is a favorable target for all countries; however, it has negative effects as well, including increasing consumption of energy and destroying environmental conditions that can be an obstacle for sustainable development. First, the high energy consumption causes the GHGs emissions to increase. As a result, global warming has become one of the most serious environmental problems and must be urgently solved. Second, the higher energy consumption has also derived the rise in the price of energy, which deteriorates the energy poverty problem globally despite the recent temporary trends of a cheap oil market (Papada and Kaliampakos, 2016). As a result, countries not only should aim for higher levels of growth, but also need to take energy conservation policies into account. Enhancing the knowledge of policymakers regarding the determinants of energy demand, will help them to devise better energy policies.

Previous studies found some of the determinants of energy intensity and researchers also investigated the direction of relation between these variables and energy consumption/intensity. This study found institutional quality as one of the determinants of energy intensity that has significant effects on this variable. As a result, it is crucial to know the direction of relation between these variables, using Granger causality test which is the main purpose of this part of the study. This chapter includes the results and discussions of the third research question of this study. This part of study, answers the question regarding the direction of relation between institutional quality and energy intensity in global panel. In the first part, the results of different unit root tests are provided which is followed by the estimation of panel VAR model and the result of Granger causality test. The final part of this chapter is a discussion regarding the findings of this research question, which is followed by the summary of the chapter.

6.2 Panel Unit Root Test

The application of Granger causality test in the area of energy economics is very popular in investigating the direction of causality between energy consumption and income. This investigation started with the research of Kraft and Kraft (1978) who used U.S. data from 1947 to 1974 to discover that income leads energy consumption. During the 1970s, the unprecedented rise in oil price which considerably increased the energy cost in the oil-importing countries caused the researchers to pay more attentions to the direction of relation between these two variables.

In this regard, researchers were confounded with the reported causal relations. There are several reasons behind it. Previous studies have used time series datasets. In addition, the short time series of datasets made many of them to be flawed. Other studies applied OLS with no attention to the properties of series such as being stationary. Finally, Granger and

Newbold (1974) stated that not taking stationarity properties of variables into consideration can result in spurious findings regarding the relations between variables.

The majority of previous causality test results in the area of energy economics have been based on individual countries and the application of time series data. However, different countries showed different results. In addition, different time periods for the same country can result in different outcomes. More information is embedded in panel datasets in comparison with either time series data or cross-sectional data. Moreover, the weaknesses in individual unit root tests and traditional cointegration tests, make it necessary to use the combination of information from time series and cross-sectional data. Hence this study applies the heterogeneous panel unit root tests to prevent more debates and put the issue to rest.

In Granger causality test, it is essential to identify the stationary properties of the variables prior to the test. The relevant variables should be stationary to run Granger causality test. The following table shows the result of panel unit root test, Im–Pesaran–Shin (IPS) for logarithm of energy intensity and logarithm of institutional quality. The null hypothesis for the IPS test is that ―All panels contain unit roots” and the alternative hypothesis is that ―Some panels are stationary”. Based on the results, as the both P-Values are zero (less than 5 percent), the null hypothesizes for both tests are rejected. As a result, the variables lnEI and LnPR in their level form are statistically significant under the IPS test. Therefore, it is possible to conclude that each variable is stationary and I(0) or integrated of order zero. To show the robustness of results, Levin–Lin–Chu (LLC) unit root test also performed for these two variables. The null hypothesis for LLC panel unit root test is that ―Panels contain unit roots" and the alternative hypothesis is that ―Panels are stationary". The results of LLC unit root test also show that both LnEI and LnPR are stationary at their level. For both IPS and LLC test the time trend and panel mean are included.

Table 6.1 Panel Unit Root Test (IPS)

PANEL UNIT ROOT TEST (IPS) AT LEVEL	STATISTIC	P-VALUE	ORDER OF INTEGRATION
LNEI (Time Trend and Panel Mean Included)	-5.6188	0.0000	I(0)
LNPR (Time Trend and Panel Mean Included)	-15.9206	0.0000	I(0)

Source: Author

Table 6.2 Panel Unit Root Test (LLC)

PANEL UNIT ROOT TEST (LLC) AT LEVEL	STATISTIC	P-VALUE	ORDER OF INTEGRATION
LNEI (Time Trend and Panel Mean Included)	-9.3583	0.0000	I(0)
LNPR (Time Trend and Panel Mean Included)	-16.5584	0.0000	I(0)

Source: Author

6.3 Granger Causality Test

As Granger (1969) defined, the ‗Granger Causality Test' is a statistical hypothesis of causality to test whether one factor causes another based on prediction. The null hypothesis is ‗A does not Granger cause B' and the alternative hypothesis is ‗A Granger causes B'. Granger (1988) proposed a Granger causality test to investigate the long-term causality relation between variables that can be captured from the VAR (Vector Auto Regression) model.

In order to apply Granger causality test in this study, a VAR model in levels is used. The following table shows different summary measures to help in panel VAR model selection process. Ng and Perron (2001) proposed a modified information criteria, MAIC (Modified Akaike‘s criterion function (Akaike, 1974)) and MBIC (Modified Schwarz‘s criterion (Schwarz, 1978)). In their research, they compared the values of the proportionality factor of AIC and MAIC on the one hand, and BIC and MBIC on the other hand. Briefly, they highlight the great usefulness of MAIC compared to the rest of criteria. Based on the results from the following table, the third lag has the minimum MAIC. As a result, the selection of the three lag periods is needed to proceed to the estimation of panel VAR model.

Table 6.3 Optimal Lag Length Selection for Panel VAR Estimation

LAG	CD	J	J-P-VALUE	MBIC	MAIC	MQIC
1	0.9995662	60.20804	2.07e-08	-32.94822	36.20804	11.02312
2	0.9995798	41.98141	1.37e-06	-20.12276	25.98141	9.191464
3	0.9949724	21.8963	.0002102	-9.155783	13.8963	5.50133

Source: Author

The results of the GMM estimation of the panel VAR model using the optimal lag are reported in the following table.

Table 6.4 GMM Estimation of Panel VAR Model

		Coef.	Std.Err	z	P>|z|	[95% Conf. Interval]	
LnEI	**LnEI**						
	L1.	.9523242	.0636632	14.96	0.000	.8275467	1.077102
	L2.	.1028502	.0745158	1.38	0.168	-.0431982	.2488985
	L3.	-.0329415	.0397748	-0.83	0.408	-.1108986	.0450157
	LnPR						
	L1.	-.0062071	.0028239	-2.20	0.028	-.0117418	-.0006725
	L2.	.0007583	.0021873	0.35	0.729	-.0035288	.0050454
	L3.	-.0014019	.0015516	-0.90	0.366	-.004443	.0016391

		Coef.	Std.Err	z	P>|z|	[95% Conf. Interval]	
LnPR	**LnEI**						
	L1.	.0654529	.5091779	0.13	0.898	-.9325175	1.063423
	L2.	.8966683	.6421554	1.40	0.163	-.3619331	2.15527
	L3.	-1.230771	.8511434	-1.45	0.148	-2.898981	.4374399
	LnPR						
	L1.	.543452	.0496019	10.96	0.000	.4462341	.6406698
	L2.	-.0087099	.022042	-0.40	0.693	-.0519114	.0344916
	L3.	.0207914	.0174851	1.19	0.234	-.0134787	.0550616

Source: Author

The following table shows the result of Granger causality test. The null hypothesis is that ‗Excluded variable does not Granger-cause equation variable' and the alternative hypothesis is ‗Excluded variable Granger-causes equation variable'. The first row of results shows the results of testing the causality running from logarithm of institutional quality to logarithm of energy intensity. Based on the results, there is unidirectional causality running from institutional quality to energy intensity. As the p-value is 0.015 which is less than 5 percent the null hypothesis is rejected, and the alternative hypothesis is accepted, which shows that logarithm of institutional quality Granger causes logarithm of energy intensity.

The second row of results shows the results of testing the causality running from logarithm of energy intensity to logarithm of institutional quality. Based on the results, there is no causal relation from logarithm of energy intensity to logarithm of institutional quality. As the p-value is 0.227 which is greater than 5 percent the null hypothesis is accepted, which shows that logarithm of energy intensity does not Granger cause logarithm of institutional quality.

Table 6.5 Panel VAR Granger Causality Wald Test

EQUATION	EXCLUDED	CHI2	DF	PROB> CHI2
LNEI	LnPR	10.409	3	0.015
LNPR	LnEI	4.340	3	0.227

Source: Author

6.4 Discussion

This study found institutional quality as a determinant of energy intensity which is a new variable and has not been studied before. An energy intensity model including institutional quality as an independent variable is estimated in the previous chapter. The model is also included industrialization, urbanization, trade openness, energy prices and FDI as other determinants of energy intensity. Result indicated that higher institutional quality can significantly lower energy intensity; hence, the significance of this variable is confirmed. To further investigate the role of institutional quality in lowering energy intensity, the current chapter attempts to find out the direction of relationship between institutional quality and energy intensity.

This chapter established Granger causality test to investigate the direction of causality between these two variables. As an initial step, the stationarity properties of both invitational quality and energy intensity are tested using two tests of IPS and LLC. Both tests confirmed that institutional quality and energy intensity are stationary at their level. Results from Panel VAR Granger causality test showed that there is unidirectional causality running from institutional quality to energy intensity. The explanation of this causal relation is related to provision of environmental quality as a public good. Environmental quality is defined as a public good which is required to be consumed equally by everyone (Siebert and Siebert, 1981). De Mesquita (2005) in his book ―The logic of political survival" states that, institutional arrangements form the selection of leaders and their motivations for providing public goods as well. Theoretically, leaders hold themselves in office by increasing taxes and using a share of government revenue on providing public and private goods. The author developed the selectorate theory (2003) that addresses the allocation problem regarding a bundle of mixed goods and discusses that as the size of the coalition that rulers must build to remain in power rises, the provision of public goods by coalition grows. In addition, some institutions discourage providing public goods that is beneficial for all in society. These institutions benefit leaders' welfare compared to other institutions that encourage the provision of public goods (De Mesquita et al., 2002).

In addition Estevadeordal et al. (2004) state ―Widespread instability, impunity for breaches of the rules, and systematic corruption, are expressions of low institutional quality. This line of reasoning affirms the importance of the institutional realm as a critical dimension in considering regional (and global) public goods, since the quality of institutions determines the attributes of national policies and actions, as well as the extent of governability problems that give rise to negative externalities." As environmental quality is considered as a public good and provision of public goods are affected by the quality of institutions, it can be concluded that policies such as decreasing the consumption of energy which can cause better environmental quality are also affected by institutional quality.

6.5 Chapter Summary

This chapter provides the results and discussions of the third research question of this study which is the direction of relation between institutional quality and energy intensity in global panel of countries. Results from previous chapter confirmed the significance of institutional quality in energy intensity improvements. Hence the current chapter aimed to find out the direction of relationship between these two variables.

Prior to Granger causality test, the stationary properties of variables should be tested. To test the stationarity of the variables, Im–Pesaran–Shin (IPS) and Levin–Lin–Chu (LLC) panel unit root tests are performed. Based on the results from IPS and LLC tests, both logarithm of energy intensity and logarithm of institutional quality are stationary. Applying GMM estimation, panel VAR model is estimated which is followed by panel VAR Granger causality Wald test. Results of Granger causality test shows that there is unidirectional causality running from institutional quality to energy intensity. The quality of environment is considered as a public good and provision of public goods are affected by the institutional quality. It can be concluded that policies such as decreasing the consumption of energy, which can cause better environmental quality, are also affected by institutional quality.

CHAPTER 7: CONCLUSION

7.1 Introduction

A secure energy supply is essential for human life and the sustainability of all economies. Continuous consumption of fossil fuels caused variety of challenges for the world including fossil fuel depletion, global warming and climate changes, geopolitical and military conflicts and continued and considerable surge in fuel prices. The two major oil crises of 1970s approved that economic functions and growth are highly depend on consumption of energy. In addition to the experience of the 1970s, there have been other shocks of oil prices since the 1970s, especially the oil prices decline of 1986 and the rise of oil prices in 2000 as well as the oil prices increases as a result of the 1990-91 Gulf war and the 2003 war in Iraq. Increases in energy resources‘ prices caused recessions, excessive inflation, reduction of productivity and lower economic growth.

As a country produces higher levels of output, the need for energy will increase. There are debates regarding the direction of the relation between energy consumption and economic growth, but there is no debate and doubt about the importance of energy for economic activities. Emissions of GHGs and more specifically CO2, are the most significant reason behind global warming. To settle the issue of global warming many nations have joined the Kyoto Protocol and agreed to reduce their emission levels. As a result, countries try to decrease CO2 emissions while retaining stable economic growth. The energy savings in agricultural, industrial, services and housing sectors is necessary, as it leads to decreasing energy bills, costs and prices of production of goods and services and GHGs emissions. In addition, energy conservation policies will lead to better allocation of resources through shifting the labor and capital from energy sector to more efficient sectors.

To assess the role of energy, and the efficiency of its consumption, energy intensity variable has been introduced. Energy intensity, and its changes over the time, has a significant role in the global warming debates. It has been confirmed that anthropogenically induced climate change is mainly an energy issue. The main source of CO_2 emissions is the combustion of fossil fuels. As a result, the type of energy resources and the way that these resources have been consumed are significantly important in the climate change debates. More specifically, future of GHGs emissions depends not only on future growth of population and economic activities, but also on changes in energy intensity and the degree to which future energy sources are carbon-free. As a result, countries try to decrease their energy intensity, with the shift to renewables and other low emission fuels.

Rapid growth of population and technological and trade development have raised energy consumption in the recent decades. Trade openness empowers developing economies to import higher levels of technologies from developed economies. The adoption of advanced technologies decreases energy intensity and increases production. Hence, it is essential to investigate the role of trade and its effects on energy intensity which is one of the purposes of the current study.

In addition to investigating the impacts of trade on energy intensity, this study investigated the role of institutional quality and its effects on energy intensity which was ignored in the past studies and finally the causal relation between these two variables are studied. This chapter offers an overall overview of the study which is followed by implication of theory and overall evaluation on the policy implications of the study. It also discusses the contribution of the study to professional practices.

7.2 Synthesis of the Study

The focus of this study is on identifying the significant determinants of energy intensity. By modeling energy intensity, the role of trade openness is studied as the first research question. In addition, the specific roles of exports and imports are modeled separately, which forms the other part of the first research question. Moreover, the impact of export diversification has been investigated in this analytical chapter. Export diversification data are collected from the database of IMF. The dataset has recently been provided by IMF staffs. The variables of energy prices, urbanization, FDI and industrialization are also included in modeling energy intensity based on reviewing the findings of the past studies. Lag of energy intensity has also been considered as a RHS variable since the model is dynamic.

For the second research question, a new variable added as one of the determinants of energy intensity, considering other variables including energy prices, urbanization, FDI, trade openness and industrialization in the model. This variable is institutional quality which is theoretically a determinant of FDI as well. The current research used the data collected from the ICRG database provided by the PRS Group for the variable of institutional quality in order to analyze the second question of this research.

This study uses annual panel data of 84 countries of the world from 1980 to 2012. These countries are categorized to stable and unstable countries based on their Fragile States

Index scores for the purpose of analyzing the second research question. In order to answer the first and second research questions, Dynamic Panel GMM has been applied and diagnostic checks are tested. More specifically, the Arellano-Bond Tests of AR(1) and AR(2) for autocorrelation for the first order serial correlation and the second order serial correlation is checked based on the GMM theory. In addition, Hansen Test of Overidentifying Restrictions is performed to test the validity of the instruments.

For the third research question, the direction of relation between institutional quality and energy intensity is investigated by the application of Panel Granger causality test. Prior to the application of Granger causality test; the stationary properties of variables are tested using IPS and LLC panel unit root tests. Both the energy intensity variable and the institutional quality variable found to be stationary. Applying GMM estimation, panel VAR model is estimated which is followed by panel VAR Granger causality Wald test.

The analysis results for the first research question of this study revealed that the coefficient of trade openness is significant and positive. The estimation result of the coefficient of trade openness shows that increase in trade openness caused increase in economic activities and as a result the demand for energy increased. The coefficient of exports found to be significant and positive, meaning that exports increased the demand for energy which caused the increase in energy intensity. The coefficient of imports found to be significant and positive. It means that importation of goods increased consumption of energy in order to move goods around the country. In addition, the composition of imported goods affected the demand for energy, meaning that the imported goods are energy intensive products. In addition, findings revealed that lower diversity of export products, will lead to the increase in energy intensity.

The analysis results for the second research question of this study revealed that in global panel, the estimated coefficient of institutional quality is negative and significant. As higher levels of institutional quality mean less political risk, it is possible to conclude that for those countries with lower levels of risks the level of energy intensity decreases. Higher levels of institutional quality can also cause the attraction of FDI into countries. This will lead to attracting higher levels of technology with more efficient use of energy into the host countries. In addition, institutional quality determines the characteristics of national policies and actions, and also the extent of governability issues that give rise to negative externalities. As a result, better institutional quality will lead to more contribution of national policies to improve environmental quality and decrease of energy intensity. The coefficient of institutional quality found to be negative and significant for stable and unstable countries. Different variables found to be significant in global panel, panel of stable and unstable countries.

Results from analyzing the third research question of study using Granger causality test revealed that there is unidirectional causality running from institutional quality to energy intensity. Provision of public goods such as environmental quality, are affected by the quality of institutions. This study concludes that policies such as decreasing the consumption of energy which can cause decrease in energy intensity and provide better environmental quality are also affected by institutional quality.

7.3 Contribution of Study

This study investigates the trade openness and energy intensity's relation and separates the effects of exports and imports on energy intensity. In order to have more accurate energy intensity model, other determinants of energy intensity have also been found from past studies, these variables include industrialization, urbanization, energy prices and FDI. Although there have been studies on the effects of trade openness, exports and imports on energy consumption there has been less attention on energy intensity so far, especially, comparing the effects of trade openness, exports and imports on energy intensity, considering the same groups of countries. In addition, this study investigates the effects of export diversification on energy intensity in global panel of countries which was ignored in the past energy intensity studies.

This study also adds institutional quality (political risk) as a new determinant of energy intensity, and investigates this variable and energy intensity's relation in global panel, panel of stable countries and panel of unstable countries, categorized based on Fragile States Index scores which is another contribution of this study. Again, in modeling energy intensity, other determinants of this variable which were found by past studies have been included. Finally, this study investigates the direction of relation between institutional quality and energy intensity using panel Granger causality test, which is another contribution from the last research question of this study.

7.4 Implication for Theory

The majority of available literature focused on the trade openness and energy consumption‘s relation. Energy intensity which is energy consumption per unit of GDP can provide better definition in comparison with energy consumption. Using energy intensity as dependent variable, it is possible to see how efficient countries are in relation to imports, exports and trade openness. Separating the effects of exports and imports helps to provide better realization of trade compared to considering trade openness as the only indicator of trade. This study also investigates the effects of export diversification on energy intensity in global panel of countries which was ignored in the past energy intensity studies.

Past studies did not consider institutions and their quality as determinant of energy consumption or energy intensity. It means that the role of institutional quality was ignored in relation to energy consumption, energy intensity and energy literature in general. However, the findings of this study suggest that institutional quality is a significant determinant of energy intensity, meaning that the quality of institutions can affect the efficiency of energy use in a country. In addition, testing the direction of causality between institutional quality and energy intensity further confirmed the role of this new variable in changing the efficiency of energy use. Moreover, looking at the stability of countries using Fragile States Index and categorizing them based on this index, revealed some of the differences in effectiveness and/or magnitude of different variables‘ impacts in lowering/increasing energy intensity.

7.5 Implications for Policy

Considering the imports and energy intensity's relation, results revealed that imports caused the increase in energy intensity in addition to exports and trade openness. The world policy should target the importation of less energy intensive goods, which will cause higher levels of energy efficiency and less CO_2 emissions. This also can help to solve the problem of global warming and climate change. In addition, lower diversity of export products, will lead to the increase in energy intensity. Commodity dependent countries which represent a narrow export basket often suffer from instability in exports arising from inelastic and unstable global demand. As a result, countries should consider diversifying their export productions to decrease their energy intensity. Moreover, renewable energy resources are the solution to the growing energy challenges. Renewable energy resources such as solar, biomass, wind and wave and tidal energy, are abundant, inexhaustible and environmentally friendly.

The inclusion of institutional quality in energy intensity model in this study suggests that institutional quality is a significant determinant in devising energy related policies. Results revealed that countries with lower levels of risk and higher levels of institutional quality represent lower level of energy intensity. It means that those countries that aim to reduce their level of energy intensity should improve their institutional quality and lower their political risks.

The policy of improving institutional quality for decreasing energy intensity can cause the attraction of more FDI into the host country as better level of institutional quality is associated with more attraction of FDI. This policy can decrease energy intensity through higher level of technology which can lead to more efficient use of energy resources. In addition, better institutional quality will affect the selection of leaders and their decision on investments on public goods, such as air quality, which will eventually affect the countries‘ energy policies.

Improving institutional quality can be achieved through different policies explained in the following table (Table 7.1).

Table 7.1 Policies to Improve Institutional Quality

Improving Government Stability
The more government accomplishes its declared plans, programs and policies the more stable it will be which can improve the institutional quality and lowers the political risk. Political stability is an essential factor in creating suitable environment for economic growth. Political stability determines whether a country is profitable and represents lower risks to invest in. Governments with more stability can attract more domestic and foreign investments, which will create the opportunities to import higher level of technologies that consume energy sources more efficiently.
Less Internal Conflict
The less involvement of government in any internal conflicts can decrease the political risk and enhance the institutional quality. This will eventually lead to attracting more FDI to the host country that will bring the higher level of technology with more efficient use of energy. In addition, better institutional quality, will lead to better energy and environmental policies of selected leaders.

Less External Conflict
The less involvement of government in any external conflict with foreign actions, ranging from non-violent external pressure to violent external pressure, will lead to better institutional quality and less political risks. The enhanced institutional quality will lead to better energy and environmental policies devising from selected leaders and also attraction of more FDI to the host country. This will lead to attraction of higher level of technologies with more efficient use of energy.
Improving Socioeconomic Condition
Socioeconomic condition can be improved by decreasing poverty and unemployment. Poverty and unemployment can increase socioeconomic pressure and social dissatisfaction. Increasing per capita income and decreasing unemployment can prevent social dissatisfaction and as result decrease political risk. Less political risk is associated with attraction of more FDI which will bring more energy efficient technologies to the host country. In addition, less political risk which means better institutional quality will result in devising better energy and environmental policies by selected leaders.
Decreasing the Risk to Investment
Decreasing the risk to investment such as contract viability (expropriation), profits repatriation or payment delays, leads to less political risk and improves the condition to attract more foreign investments. FDI will cause the importation of higher levels of technology with more efficient use of energy.
Less Corruption
Corruption is a risk to foreign investments. As a result, the lower the corruption the

	more FDI will be invested in the host country. For the purpose of decreasing corruption, policy makers should devise some policies to decrease the demands for special payments and bribes related to imports and exports licenses, exchange controls, tax assessments, police protection, or loans. By decreasing corruption and attracting more FDI to the country the higher level of technology can be transferred to the country and consumption of energy will decrease for every unit of production.
	Decreasing the Influence of Military in Politics
	As military is not elected by people, its intervention in politics will decrease democratic accountability. The less participation of military in politics will result in lower level of political risk and better environment to attract foreign investments which can eventually lead to importation of more efficient technologies.
	Lower Levels of Religious Tensions
	Lowering religious tensions will lead to less political risks and provides better environment for foreign investments. This can be done by preventing from domination of society or governance by a specific religious group. In addition, other religions should be included in political and social processes and civil law should not be replaced by religious law.
	Strong and Impartial Legal System
	Enhancing the degree to which citizens are willing to accept established institutions to make and implement laws and to adjudicate disputes and improving the strength and impartiality of the legal system.
	Less Tensions Among Ethnic Groups
	Decreasing ethnic tensions will result in less political risk and better institutional quality. As a result, better environment will be provided for foreign investments.

Attracting more FDI can lead to importation of higher level of technology which will cause more efficient use of energy. In addition, better institutional quality will eventually lead to devising better energy and environmental policies by selected leaders.
Governments Being More Responsive to their People
The less responsive it is, the more likely it is that the government will fall, peacefully in a democratic society, but possibly violently in a non-democratic one, which will increase the political risk of the country and will result in decreasing in attraction of FDI into the country.
Improving The Quality of Bureaucracy
Better quality of the bureaucracy will act as a shock absorber which reduces policy revisions if governments change and will lead to better institutional quality and less political risk. This condition will lead to gradual increase of FDI benefits, even for countries situated far below the threshold value of institutional quality.

Source: Author

Categorizing countries using Fragile States Index also revealed that energy prices can be effective policy tools to improve energy efficiency only in stable countries, meaning that vulnerability of states is a determining factor in effectiveness of energy prices policies to lower energy intensity. In addition, stable countries receive more benefits from FDI compared to unstable countries, as the magnitude of FDI coefficient is higher in the energy intensity model estimated for stable countries. Moreover, the quality of institutions has more impacts in lowering energy intensity and improving energy efficiency in stable countries rather than unstable countries. Hence, stability found to be a determining factor in effectiveness of institutional quality in lowering energy intensity for this group of countries.

7.6 Future Direction

The focus of this study is on identifying the determinants of energy intensity by modeling energy intensity against its independent variables including FDI, energy prices, trade (exports, imports and export diversification), urbanization, industrialization and adding institutional quality as a new determinant. The future studies can reach to a more accurate estimation of energy intensity model by including more independent variables that describe the variations in energy intensity in a more precise way. In addition, the confirmation of availability of a significant relation between energy intensity and institutional quality by the current study provides a basis for further research regarding the relation between these two variables. Moreover, considering larger datasets including longer period of time and more countries will definitely provide better estimations.

7.7 Chapter Summary

This chapter starts by synthesis of the study which concludes the whole study including research questions and objectives and also the findings. This part is followed by contribution of this research. Implication of theory and overall evaluation on the policy implications of the study are the next parts of this chapter. This chapter concludes that in order to decrease energy intensity, a country should consider institutional quality as a significant contributor in devising the energy policies, meaning that improving government stability, having less internal and external conflict, improving socioeconomic condition, decreasing the risk to investment, having less corruption, decreasing the influence of military in politics, having lower levels of religious tensions, stronger and impartial legal system, decreasing tensions among ethnic groups, governments being more responsive to their people and improving the quality of bureaucracy can help to reduce energy intensity. This is because improving institutional quality will lead to attracting more FDI into the host country and will cause the importation of higher levels of technologies which consume energy in more efficient ways. In addition, institutional arrangements shape the selection of leaders as well as their incentives to provide public goods. The quality of institutions determines the attributes of national policies and actions, as well as the extent of governability problems that give rise to negative externalities. As a result, better institutional quality will lead to more contribution of national policies to improve environmental quality and decrease of energy intensity. In addition, the study found that importation of less energy intensive goods will lead to higher levels of energy efficiency. Moreover the findings showed that lower diversity of export products, will lead to the increase in energy intensity.

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