The Economic Growth and Energy Consumption:

A Case of Developing Countries

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- Economic growth
- Energy Consumption
- Population growth.


بسم الله الرحمن الرحيم

IN THE NAME OF

ALLAH

THE MOST MERCIFUL AND COMPASSIONATE, THE MOST GRACIOUS AND BENEFICENT.

APPROVAL SHEET

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A Case of Developing Countries

by

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ABSTRACT

This study investigates the direct as well as indirect effect of economic growth on energy consumption, where the later effect is examined by using poverty as a channel variable. We use panel data of 28 developing countries over the period 1970-2013. We employ the methodology of moderated mediation analysis as suggested by Muller et al (2005) and Preacher et al (2007). For estimation purpose, we use Seemingly Unrelated Regression (SUR) method for unbalanced panel data as suggested by Biorn (2004).

Our results show that the direct effect of economic growth on energy consumption is positive and significant, whereas the direct impact of poverty on energy consumption is negative and significant. Further, we observe that the indirect effect of economic growth on energy consumption through the channel of poverty is positive and significant. However, we note that the indirect effect is more profound than the direct effect. Our findings suggest that when people of developing world come out of poverty on account of economic growth, they enhance their demand for energy which ultimately increases energy consumption. Similarly, our study is more useful by exploring channels rather than finding direct relationship of variables.

DECLARATION

I hereby declare that this thesis, neither as a whole nor as a part thereof, has been copied out from any source. It is further declared that I have carried out this research by myself and have completed this thesis on the basis of my personal efforts under the guidance and help of my supervisor. If this thesis as a whole or as part is proven to be copied out or earlier submitted, I shall stand by the consequences. No portion of the work presented in this thesis has been submitted in support of any application for any other degree or qualification in International Islamic University Islamabad or any other University or Institute of Learning.

Lutfullah Khalid

DEDICATION

To My Beloved
Grandfather (Late),
Parents,
Brothers and Sisters.

ACKNOWLEDGEMENT

All praises to Allah Almighty who created the universe and knows whatever is in it, hidden or evident, and who bestowed upon me the intellectual ability and wisdom to search for its secrets. My humblest thanks to Allah, my love to our beloved Prophet, Hazrat Muhammad (S.A.W) from the core of my heart who is the eternal fountain of knowledge and guidance for the whole mankind.

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I am extremely honored to be a part of this department and grateful to all teachers and staff of my department whom I have learnt a lot from regarding my subjects which helped me further to explore new horizon of economic applications.

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Chapter 1

Introduction

As globalization is changing the world, most of the countries are better off and growing their economies rapidly. It has been seen that through economic growth every country has improved their life standards and provide opportunities to their members to share fruits of economic growth. Specifically, economic growth helps the poor in all those countries where there is consistence economic growth. Rapid economic growth is not a dream, it can be achieved by any country but it needs to focus on specific combination of factors required for production. Developing countries have been experienced with curse of poverty, which can only be alleviated through economic growth. From the past few decades it has been observed from different researches that economic growth is the most effective way to pull people out of poverty (Rodrik, 2004).

Indeed high economic growth is the precondition for the alleviation of poverty. The United Nations Millennium Development Goals were the result of the United Nations Millennium Declaration, and are a set of goals set by the member countries that are expected to be met by 2015. The first of the eight goals is the eradication of extreme poverty and hunger. The main target for this goal is that the proportion of people who have an income of less than $1.25 a day by 2015 should be half of what it was in 1990 (World Bank, 2010).

As far as countries achieve economic growth, the first issue for them to solve is poverty reduction. Almost all developing countries have the same hurdle to development, that is, persistent poverty; while, the reduction of poverty is still an important policy goal for all

developing countries. Economic growth appears to be one of the best ways to reduce poverty, (Roemer, 1997).

Countries have adopted different growth drivers to improve the growth rate; today the most important driver is energy. All economies of the world are largely dependent on energy. "Energy is the indispensable for driving all economic activities" (Alam, 2006). We can say that energy consumption enhances economic activities.

Almost all countries have concentrated their attention on energy production, as population increases, the demand for everything increases which enhances industrialization and urbanization in a country thus increasing the demand for energy. In addition, energy is considered as an important driving force for economic growth in many economies of the world (Pokharel, 2006).

Countries that are facing shortage of energy are badly affected from hurdles for rapid economic growth. Indeed energy is playing a crucial role in the way of development today. Economic growth lifts the incomes of many of the world's poor. As income of people raises and electricity coverage expands, many people start energy consumption more than they are used to by buying different electricity assets (Gertler et al., 2013). "At the end of Johannesburg world summit (2002) on sustainable development, all participants affirm that energy must be made a crucial part of all development and poverty alleviation projects and programs" (WEC 1999, WB 2000, UNDP 2000, and DFID 2002).

According to International Energy Agency IEA Report 2010, almost one and a half a billion people of the world have no access to electricity. For reduction of poverty, access to energy is pre condition, not only for reduction of poverty, access to energy contributes enhance economic growth, creates employment opportunities and promotes human development, (Boardman, 2011).

Studies have shown different results in different time periods but always remain ambiguous when they relate economic growth and energy consumption (Fowowe, 2012). It has been noticed that despite rapid economic growth in many countries there remain some socio economic challenges to them, like poverty, unemployment etc. The reason might be that there is not a specific channel through which they can see the better results by taking economic growth and energy consumption.

Keeping in view the literature on economic growth and energy, as economic growth rapidly increases, people tend to move towards energy demand and hence energy consumption increases, but this is not the case for all the world, there remain some factors hidden which are affected first because of economic growth like poverty. When people come out of poverty they increase the demand for energy, (Gertler et al., 2011). As household income of the people increases the consumption of energy of those household also increases, (Howa, 2001). Through energy use economic growth can be achieved rapidly by the way of industrialization which indeed require large portion of energy of a country, (Karekezi, 2006).

The Above discussion has some enigmas to understand about the channels through which economic growth effects energy consumption. The main focus of this study is to find out the

effect of economic growth on energy consumption by taking poverty as intervening variable. The reason behind this is that when people come out of poverty they suddenly increase their demand for everything, so here we find that when economic growth reduces the poverty level then how energy consumption increases.

1.1 Objectives of the study

The objectives of the study are as under:

a. To explore the direct effect of economic growth on energy consumption.
b. To explore the indirect effect of economic growth on energy consumption through the channel of poverty.

1.2 Significance of the study

As the world is becoming a global village, countries have taken great advantages from open trade and open markets. Every country is trying to achieve economic growth as soon as possible by utilizing their resources abundantly. When we talk about world's energy consumption, according to international energy outlook (2013), the energy consumption is likely to grow by 56 percent till 2040, which shows that every country is relying on energy use. Energy is one of the most important factors needed for the betterment of any economy. There is no doubt that energy is the backbone of development process of any country. Not only importance of energy can be seen in industries, rather it plays a crucial role in almost all sectors of the economy.

In 21st century, a lot of people in different parts of the world have no access to electricity because of lack of energy expansion and poverty. So the important question is that whether

people increase their energy consumption when they come out of poverty or not? So in this research we focus on the effect of economic growth on energy consumption through the channel of poverty.

According to our knowledge, there may not be any study that might have examined the impact of economic growth on energy consumption through the channel of poverty.

1.3 Structure of thesis:

This thesis is divided into five chapters; the first chapter comprises of introduction to research problems, different concepts used and case selections. Chapter 2 provides an overview of the literature on the central concepts of our topic. Chapter 3 describes the data and methodology. Chapter 4 provides discussion of results. Chapter 5 consists of conclusion and policy recommendations.

Chapter 2

Review of Literature

The aim of literature review is to identify and describe the relevant theoretical empirical and methodological contributions that have been made on the subject matter of study. This helps in highlighting the existing gaps that prevail in the literature on the subject. Since the aim of this study is to find how economic growth affects energy consumption through the channel of poverty, we describe the relevant studies on economic growth, poverty and energy consumption. This chapter is clustered into three parts, the first part describes about the relationship between economic growth and poverty. The second part elucidates the relationship between economic growth and energy consumption. The last part establishes the research gap, which this study is going to fill.

In last few decades many researchers have examined the relationship between economic growth and energy consumption, with income and employment used as proxy for the former. However, the research findings differ for many reasons. The discrepancy in results is largely because of the use of different techniques, methods, and time periods, besides the different context of the country under scrutiny. It is important to note that most of the future demands for energy use come from developing countries. The reason is that countries with pro-poor growth tend to increase their demand for energy much larger than countries where growth is regressive (see Gertler et al, 2011). It is generally argued that the speed at which households

come out of poverty, affect their asset purchase decisions. Therefore, the mutual relationship between economic growth and energy consumption is influenced by pro-poor economic policies in the countries. In many developing countries, these economic policies are aimed at poverty alleviation.

In the following sub-sections, we review the important studies in the existing literature focusing on economic growth, energy consumption and poverty relationships.

2.1 Studies on Economic Growth and Poverty

Literature on economic growth and poverty has shown that economic growth plays an important role to reduce poverty, especially when it works to boost up employment and also boost up production of a country. Economic growth is considered to be an important instrument for reducing poverty and improving the quality of life in many developing countries. This notion has been consistently supported by many researches like Kakwani (2004), Roemer et al. (1997). Following are some of the significant contributions toward this notion.

Gugerty (1997) finds in his study that persistent poverty from the last few decades has compelled people to think about economic policies and the role of economic growth and development regarding reduction of poverty. He also finds that growth in per capita GDP is an important driver for reduction of poverty. Similarly, Collier and Dollar (2001) in their study for developing countries find that quality of economic policy plays an important role for reduction of poverty, and they suggest that in developing world household and firms can save and invest which can help reducing poverty. Some studies have discussed different factors for reduction of poverty like, Jalilian (2001) stresses the role of financial

development for the reduction of poverty, and also investigates the relationship between economic growth and financial development in developing countries. He finds that indeed financial development plays an important role in reducing poverty.

Agrawal (2003) analyzes the case study of Kazakhstan by analyzing the data of province-level. His research empirically establishes the relationship between poverty and economic growth. His research finds that provinces with higher growth rate achieve faster decline in poverty. He also finds that increase in government expenditure on social sector does contribute significantly to poverty alleviation. This infers that both rapid economic growth and enhance government support for the social sectors are helpful in reduction of poverty. Similarly, some researchers discuss the way out to reduce poverty like, Rodrik (2008) in his study finds that people living in poverty have decreased in many developing countries. He suggests that countries should focus on policies which increase incomes of poor, which could further reduce poverty like investment in education, rural infrastructure and health.

In order to enhance economic growth, trade openness is considered as an important factor. Further, trade openness is also considered as a vital factor for poverty reduction. For instance, Hayashikawa (2008) research evinces from the study of OECD countries that there is positive link between trade openness and economic performance. Undoubtedly, trade improvement is an important source of wealth generation, which may result in sustainable economic growth and reduced poverty. Similarly, Roemer (1997) also suggests that economic growth appears to be one the best way to reduce poverty and also the poor do better in countries that grow quickly even if income distribution deteriorates slightly.

However, it is pertinent to note that growth in one sector of the economy will not automatically translate into benefits for the poor; rather much will depend on the profile of growth in the country which can be included the country's employment, productivity, and nature of economy i.e. whether major share is agrarian or industry, the concentration of poor and the extent of mobility across sectors etc. For employment-intensive growth to translate into poverty reduction it must occur in a "more productive" sector, while "less productive" sectors may require productivity-intensive growth to ensure a decline in headcount poverty (see Hull, 2009).

Within the domain of economic growth, many factors such as excess exports; access to public goods such as health care; electricity; and infrastructure, as well as initial endowments of physical and human capital are found most important for poverty reduction. In some scholars view poverty reduction and high growth rates go in parallel line. In their opinion, when a country is getting higher growth rate and income of the people rises, then people start demanding new things which they have not demanded before, Gertler (2003).

Many researchers have attempted to find the relationship between economic growth and poverty reduction; majority of them have established inverse relationship between these two variables. In their opinion, economic growth alone cannot be translated into poverty reduction, provided if inequality is not taken into account. It has also been demonstrated analytically that the initial levels of economic development and income inequality matter for the reduction of poverty, a surprising result that emerges from the paper is that the higher is the initial level of inequality, the smaller (larger) will be the increase (decrease) in poverty as inequality increases , Kakwani, and Son (2004).

2.2 Studies on Pro-Poor Growth and Energy Consumption

Many researchers like (Gertler, 2013) raise another important issue which depicts that "what happens when people of any country come out of poverty through pro poor growth". Different economists have different views and dimensions about it, some researchers discuss that when people come out of poverty, they suddenly increase their demands for necessities like energy's demand, which is the most important necessity now-a-days; without energy, the life becomes dark and hard. This energy can be found in many forms for mobility and feeding ones' family. Billions of women, men and children are deprived of energy around the world.

Nkomo (2007) finds that access to energy is one of the constraints to alleviate poverty while taking Southern African Development Community (SADC) as a case study. He also finds that a major portion of population in (SADC) countries have lack of access to energy which is the main hurdle in the way to curb poverty. Similarly, many researchers point out that lack of energy affect poor badly like, Kammen (2008) develops a study on energy, poverty and resource use in poor nations, specifically his study focuses on African countries. In his study he concludes that lack of energy, affects poor nations directly and severely. Poor people spend largest part of their income on energy.

The deprivation of energy not only reduces the opportunity to improve one's lives, but also has many facets. These different facets have many social, economic, and psychological implications. Therefore, from many researchers and scholar's discussion and opinion, it can be learned that when people come out poverty, they at first sight demand for energy accessibility for which they increase demand for energy assets, for instance when people

come out of poverty they will try to get electricity for their house. This demand is quite logical and predictable.

However, there is no research available which shows the relationship between economic growth and energy consumption, when poverty is taken as mediation variable. All these variables have been related to each other individually but have not been combined in one model. This research is going to cover this gap. In other words, this research aims to investigate that how or to what extent the demand for energy increases in a country when the people in developing countries move out of poverty trap and move towards pro poor growth[1].

According to the Poor People Energy Outlook (PPEO 2010), one and the half billion people of the world are deprived of electricity at all, three billion people rely on biomass and coal for cooking, it depicts an alarming image of the world that in this 21st century people have no access to energy sources and compelled them to live a tough life. Deprivation of the basic energy keep them away from all the necessities which are needed to keep them healthy, provided them earning opportunities and to lead them towards welfare society.

[1]This term is usually used for primarily national policies to stimulate economic growth for the benefit of poor people (primarily in economic sense of poverty). This can be defined as absolute, where the poor benefits from the overall growth in the economy (Ahlenius, 2006).

The demand for energy starts rising when the developing and under-developing countries move towards development. Indeed as people come out of poverty for better wellbeing,

Demand for assets (energy) rises (Gertler, et al., 2013). Every country tries to achieve pro poor growth for which they focus on different policies to be implemented, specifically in poor countries they always have central issue of achieving pro poor growth which increases the income of the poor (Cord et al., 2003). Pro-Poor Growth is achievable, mainly by increasing the growth rate which resultantly increases employment and real wages that may reduce poverty (Agrawal, 2004).

2.3 Relationship between Economic Growth and Energy Consumption

In most of the researches, the researchers use the same methodology to find the relationship between economic growth and energy consumption. These are co-integration and Granger causality. Causal relationship between economic growth and energy consumption is first time used by Kraft and Kraft (1978) by taking United States as a case study, where causality runs from economic growth to energy consumption. After the seminal work of Kraft and Kraft (1978), many studies adopt the same pattern of finding causality. Similarly, Hwang and Lai (1997) and Adhikari (1997) apply standard Granger test for different countries, and find that energy Ganger causes economic growth.

Similarly, some researchers have just taken electricity (energy form) to find relationship between economic growth and electricity like Gosh (2000) uses annual data for India and finds that if income of people increases the consumption of electricity also increases. Similarly many researchers have examined the relationship between energy consumption and economic growth for more than one country like, Scrimgeour (2000) investigates the

relationship between economic growth and energy consumption for six different countries New Zealand, Australia, Indonesia, India, Philippine and Thailand. The close relationship between economic growth and energy consumption is found in these countries. The study also concludes that energy conservation policies will affect real growth in these countries.

Yang (2000) examines the relationship between economic growth and energy consumption for Taiwan; he uses several forms of energy including coal, oil, natural gas, and electricity. He finds that both energy consumption and economic growth are important for each other. Similarly, Aqeel (2001) has also contribution for Pakistan by finding the casual relationship between economic growth and energy consumption employing techniques of co-integration and Hsiao's version of Granger casualty. According to him, economic growth causes total energy consumption. Karagol (2005) considers the importance of electricity consumption for economic growth. He takes Turkey as a case study for the period of 1950-2000. His study finds that as electricity consumption increases economic growth also increases, which implies that electricity consumption can play a significant role to improve economic growth of Turkey. Similarly, Rufael (2005) investigates the relationship between economic growth and energy consumption for 19 African countries, his study finds that there is a long-run positive relationship between economic growth and energy consumption. Al-Iriani (2006) also shows a unidirectional causality running from economic growth (GDP) to energy consumption.

It has been seen that people in developing countries have lack of access to energy which compels them to live their lives miserable. Many studies have been done on the relationship between accesses to energy and economic growth and development, like, Ailawadi (2006) conducts a study to know the role of energy access for the development of India. He argues

that energy access is considered as a major concern for development because lots of people have lack of access to energy. He argues that alternatives should be introduced which could provide access to energy, like use of local resources, local government and selective market intervention.

Chontanawat (2006) finds the relationship between economic growth and energy consumption for 30 OECD countries and 78 Non-OECD countries. This study finds that the relationship between energy consumption and economic growth has more prevalent role in 30 OECD countries as compared to 78 Non-OECD countries. Similarly, Soytas (2006) also investigates the relationship between economic growth and energy consumption for G-7 countries and concludes that energy is considered to play a major role in enhancing economic growth. Furthermore, Akinlo (2008) investigates the relationship between economic growth and energy consumption, in his study he tries to know the importance of energy consumption for the growth of these countries' economies. He concludes that energy consumption has a significant positive impact on economic growth in these countries. Some researchers use total energy consumption to examine the relationship with economic growth and some use different forms of energy like coal, oil, electricity like, Omotor (2008) examines the relationship between economic growth and energy consumption for Nigeria; he uses coal, electricity and oil consumption. He finds that in Nigeria energy consumption leads to economic growth.

Further, Zahid (2008) sees the relationship between economic growth and energy consumption in five South Asian countries Pakistan, India, Sri Lanka, Bangladesh and Nepal. He uses different types of energy. He confirms the importance of energy consumption for economic growth. For Pakistan he finds that as economic growth increases

energy consumption increases. Pereira et al (2009) evaluate the impact of rural electrification on energy poverty in Brazil, his results reveals that as far as electrification increases in rural areas of Brazil the consumption of energy increases. Kebede et al (2010) investigate the relationship between economic growth and energy consumption for 20 countries of Sub-Sahara Africa. They find that energy plays an important role for the growth of their economies.

Later on Apergis et al (2010) examine the relationship between economic growth and energy consumption for the panel of nine South American countries. They find that there is short-run as well as long-run relationship between economic growth and energy consumption. They conclude that when energy consumption increases economic growth also increases in these countries. Similarly, Shahbaz et al (2011) find the relationship between economic growth and energy consumption for Portugal. For energy consumption they use electricity consumption as a form of energy consumption, they conclude that both energy consumption and economic growth affects each other in Portugal and also increase employment level.

Wang et al (2011) look at the relationship between economic growth and energy consumption for China during the period from 1972 to 2006. The estimation results depict that energy is the most important source to improve economic growth in china. Furthermore, Hossain (2012) works on global energy consumption pattern and GDP, in his study he finds that in developing countries Gross domestic product (GDP) and Energy consumption are increasing exponentially whereas in developed countries these are increasing linearly. Shaari (2013) examines the relationship between economic growth and energy consumption for Malaysia by using co-integration and granger casualty, the results have shown that oil and

coal does not Granger cause economic growth and vice versa. In addition, causality runs from economic growth to energy consumption.

It is pertinent to note that Granger causality is being criticized that it cannot lead to true causality or may mislead when the true relationship involves three or more variables, which is the case in this research. Many researchers have used different methodologies and different data sets for different time periods but there is no unanimous conclusion derived by them. Therefore, in this research we avoid using such tests for causality.

A question may arise that what happen when people come out of poverty and why the people move toward energy or raise their demand for energy. Whether it is a necessity or luxury? Since growth reduces poverty which results in increase in purchasing power of the people. The energy seems to be an important factor which people prefer to have more, and to have 'state of the art' assets of energy appliances so energy consumption indirectly increases with growth. Some studies have been done on economic growth and energy consumption. These studies show a positive long-run co-integrated relationship between real GDP and energy consumption (see for instance, Lee and Chang, 2007).

The studies on the relationship between economic growth and energy consumption are mostly positive, however, the direction does not ascertain that in which direction it moves. In the above discussion it has been shown that economic growth causes increase in energy consumption.

It is a known fact that through energy use/consumption, economic growth can be achieved rapidly by the way of industrialization which indeed require large portion of energy of a country. Karekezi et al (2006) shows that when there is equal distribution of energy services

it will lead to combat inequality in human welfare, which is pivotal to support economic growth and energy policies.

Some researchers have mentioned that as household income of the people increases, the consumption of energy of those household also increases. In the Northeast Census Region 2001 Residential Energy Consumption Survey demonstrates that there is a strong positive correlation between electricity consumption and household income (see Howa, 2001). Indeed expenditures on energy are one of the issues for household income. In Asia and Africa the importance of energy in household expenditure was confirmed in all the countries studied (Bacon, 2005).

Further, Chen (2012) examines the relationship between economic growth and energy consumption for 80 developing countries from 1990 to 2009, he finds that there is a strong relationship between economic growth and energy consumption; he concludes that there is a positive and significant impact of energy consumption on economic growth. Similarly Kalyoncu et al. (2013) see the relationship between economic growth and energy consumption for three countries Georgia, Azerbaijan and Armenia for the period of 1995–2009; they find that when economic growth of these countries improves the level of energy consumption increases.

The relationship between energy consumption and income is widely studied in energy economics, surprisingly, different countries have got different results, it happened because the same relationship has been tested for the same country again and again in different time periods. This issue has been largely explored by different technique, the most renowned is Granger causality test, some have taken single country for his case study some have taken

many countries together to test relationship between energy consumption and economic growth like, Eduardo Rodriguez-Oreggia (2014) works on relationship between energy consumption and income levels by taking Mexico as a case study. He finds that there is an increasing relationship between income levels and energy demand; in energy he has taken electricity and gasoline.

Some studies are conducted to know the relationship between economic growth and energy consumption, but surprisingly the results are different from the rest of the researchers like, Fowowe (2012) finds some interesting results while taking sub-Saharan African countries to know the relationship between economic growth and energy consumption for the period of 1971 to 2004. His study does not find a stable long run relationship between economic growth and energy consumption.

Today's economies of the world cannot be run without modern energy because energy is an important factor of development of any country. The prices of energy also have huge impact on energy consumption. Bastos and Castro (2014) find short-run impacts of price shocks on residential gas utilization in Buenos Aires. They find that a price increase in utility bills received by the consumers causes a prompt and significant decline in gas consumption. According to Carraro (2004) in his special report on "the greening of development", indeed economic development increases the demand for energy, this is true for all countries at all income levels, although as economic progresses, the demand tends to increase more in low-and-middle income countries than in high income ones but energy remains the key ingredient for economic growth and at all stages of development.

2.4 Summary

From the above discussion, we have studied literature thoroughly related to our study. We have studied relationship between economic growth and poverty, case studies as well as cross countries relationship have been studied. In literature we find that some researchers have developed studies in which they have used different indicators of poverty, some have used head count ration and some have used income share held by lowest 20%, many of them have used different other indicators.

So after studying thoroughly all literature of economic growth and poverty we find that both indicators of poverty income share held by lowest 20 % and head count ratio are important to effect economic growth.

Thus it is revealed that most of the studies have been done on the direct relationship or tested directly economic growth and energy consumption but there is no such research which combines economic growth, poverty and energy consumption. Therefore, this research fills the gap by exploring the relationship between economic growth and energy consumption where poverty is taken as a mediation variable. To the utmost knowledge of this research, no work has been done before on this topic, which is the novelty of this research.

Chapter 3

Methodology

This chapter discusses the data used in our study and its sources, further it provides explanation of our econometric model specification and estimation techniques.

3.1 Data

Our data set is based on a panel of 28 developing countries for the period of 1971 to 2013. We use annual data to examine the impact of economic growth on energy consumption through the channel of poverty. The time period and countries have been selected on the basis of data availability, especially data on energy consumption and poverty.

In this study, the dependent variable is energy consumption (EC) kg of oil equivalent, which is obtained from WDI. The data on independent variable economic growth (EG), which is taken as real per capita GDP growth, is obtained from WDI. Poverty is taken as mediation variable, for poverty we use two indicators, head count ratio (HCR) and income share held by lowest 20 % (POV), both indicators of poverty are obtained from WDI. Control variables are Education (EDU), inflation (CPI), trade openness (TOPN) and population growth (POPG).

The tables 3.1 and 3.2 show the summary statistics of variables and correlation respectively

Table 3.1: Summary Statistics

Variable	Obs.	Mean	p50	Std.Dev.	Min	Max
EC	1153	1160.451	620.6992	1766.407	84.07581	13023.89
GDP	1192	2.024	2.455981	4.415555	-17.95155	30.34408
POV (ISL)	221	5.184	4.82	2.340789	.01	10.04
EDU	1106	5.670	5.89	2.588785	.52	10.99
HCR	223	6.537	3.68	7.357289	0	32.16

Table 3.2: Correlation Matrix for Variables

Variables	EC	GDP	POV (ISL)	EDU	HCR
EC	1.0000				
GPD	0.0912	1.0000			
POV	-0.3086	-0.0942	1.0000		
EDU	0.4995	0.0737	-0.5780	1.0000	
HCR	-0.4885	-0.0202	0.2473	-0.6052	1.0000

Table 3.2 shows that economic growth has a positive correlation with energy consumption. The positive correlation between economic growth and energy consumption suggests that the consumption of energy may increase with the increase of economic growth, similarly

economic growth has negative correlation with both indicators of poverty (head count ratio and income share held by lowest 20%) which suggests that as the level of economic growth increases the poverty level decreases. Energy consumption and poverty has also negative correlation which also suggests that as poverty level decreases, consumption of energy may increases. Education has negative correlation with poverty. This also suggests that as the level of education increases, the level of poverty may reduce. Tables of summary statistic and correlation matrix of all variables are given in Appendix: C1 and C2.

3.2 Theoretical foundation of the variables

For our empirical analysis we use in our study the dependent variables, independent variables and control variables (for the robustness of our estimation) in econometric model. The concise explanation and theoretical foundation of our selected variables is given below, however variable's definition and sources is given in the appendix A.

Energy consumption (EC) is our dependent variable, following Hossain (2010), Kourbali (2012), Kalyoncu (2013); we use energy use kg of oil equivalent as energy consumption for all developing countries. Similarly Following Belke and Dreger (2010), Adom (2011), Kourbali (2012), we use Economic Growth (EG) which is taken as real per capita GDP growth; it has been used by many other researchers which are obtained from WDI.

The Mediation variable that we use is Poverty. Measurement of poverty in cross countries is a dilemma, because there have been differences among researchers for comparing poverty in cross countries analysis. Some focus on living standard indicators while others argue for a pre draw line for it, some prefer household surveys. For poverty as there is no single indicator which can satisfy the researcher, so different researchers use different indicators

for different time periods, for us to get a satisfactory results we use two different indicators, the first one is head count ratio (HCR), which is absolute poverty line set at US 2005 $1.25 per day per capita, (purchasing power parities, PPP), following Boardman (2011), Jeanneney and Kpodar (2008) and Nkomo (2007). Along with Head count ratio, we use distribution of income among members of a population which shows the relative amount of poverty in a country. Thus the second indicator for poverty is income share held by lowest 20%, following Dollar and Kraay (2002), Kimani (2011). Both variables are taken from World Bank data.

Education is considered as an important factor of poverty reduction following Rose and Dyer (2008), which is taken as educational attainment for population aged 15 and over, obtained from Barro-Lee.

Further control variables are inflation (INFL) which is taken as annual percentage change in consumer price index, trade openness (TOPN) which is taken as sum of total exports (as a percentage of GDP) and imports (as a percentage of GDP) and population growth (POPG) which is taken as annual growth rate of population.

3.3 Model and Estimation Techniques

In this section, the specification of model and estimation methods are discussed which are being used in our analysis to study the effect of economic growth on energy consumption through the channel of poverty.

3.3.1 Model

As per our study it is considered that economic growth effects energy consumption directly as well as through the channel of poverty, which is our main concern. Exploring the channels through which economic growth effects energy consumption is novelty of this study. Poverty is taken as mediation variable for effecting energy consumption by economic growth. To accomplish this goal we use moderated mediation analysis as used by Muller et al (2005) and Preacher et al (2007). To investigate the direct as well as indirect effect of economic growth on energy consumption we draw Figure 3.3.

Figure 3.3: The relationship between EG and EC through the channel of poverty

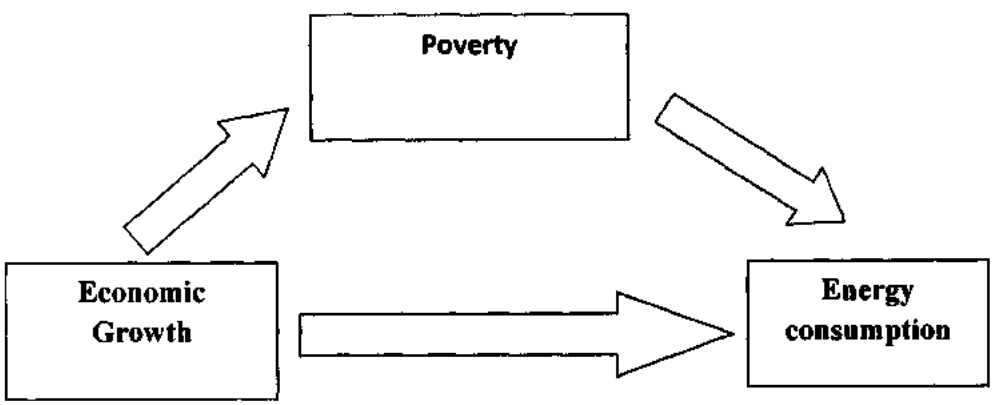

Figure (3.3) shows the direct effect as well as indirect effect of economic growth on energy consumption. Poverty plays the role of mediation variable between economic growth and energy consumption. The chart depicts that when economic growth increases, the level of poverty decreases, as the level of poverty decreases people tend to increase demand for

everything, as energy is considered a necessity today people wish to have energy consumption assets to ease their lives, which ultimately increase energy consumption.

On the basis of our discussion above we specify our econometric model as follow:

$$POVit=\beta_1+\beta_2 (EGit) +\beta_3'Y+\mu_1 \quad (3.4)$$

$$ECit= \alpha_1+\alpha_2 (EGit) +\alpha_3 (POVit) +\alpha_4 (EGit*POVit) +\alpha_5'X + \mu_2 \quad (3.5)$$

Where EC is Energy consumption measured as kilogram of oil equivalent per capita. EG is Economic Growth measured as log difference of real per capita GDP growth. POV is Poverty, measured as income share held by lowest 20%. Poverty is also measured as Head Count Ratio (HCR). EG*POV is an interaction term of Economic Growth and Poverty.

Y is a vector of control variables for Poverty similarly, X is a vector of control variables for energy consumption. In equation (3.4) Poverty is dependent variable and Economic growth is an independent variable. First it checks how economic growth reduces poverty and then in general equation (3.5) the effects of both variables are checked on energy consumption. α_1, β_1 are the intercepts of the regressions. α_2, β_2 are coefficients of variables. U_1, U_2 are the error terms for the equations.

Equations of direct as well as indirect effects are:

$$\frac{\partial EC}{\partial EG} = \alpha 2 \quad (3.6)$$

Direct Effect:

Equation (3.6) shows direct effect of economic growth on energy consumption.

In order to test our hypothesis regarding indirect effects of economic growth on energy consumption, we calculate these effects using equations (3.4) and (3.5) as follows:

Indirect effect using the channel of Poverty

$$\frac{\partial EC}{\partial EG} = \frac{\partial POV}{\partial EG} \text{ X } \frac{\partial EC}{\partial POV} = \beta_2 (\alpha_3 + \alpha_4 EG) \quad (3.7)$$

Equation for indirect effect using the second indicator of poverty that is head count ration (HCR)

$$\frac{\partial EC}{\partial EG} = \frac{\partial HCR}{\partial EG} \text{ X } \frac{\partial EC}{\partial HCR} = \beta_2 (\alpha_3 + \alpha_4 EG) \quad (3.8)$$

In equation (3.7), we use our first poverty indicator which is income share held by lowest 20 %, which is POV and in our second equation (3.8) we use to calculate indirect effect of economic growth (EG) on energy consumption (EC) by taking second indicator of poverty as a mediation variable which is head count ratio (HCR). Equations (3.7) and (3.8) are used to calculate indirect effects of economic growth (EG) on energy consumption (EC) by using poverty as a mediation variable.

3.3.2 Seemingly Unrelated Regression (SUR) Model

The seemingly unrelated regression (SUR) model was introduced by Zellner (1962), which is a generalization of a linear regression model. It comprises of regression equations in which every equation has its dependent variable and all equations can also be estimated separately.

In our case, we also use the SUR method for unbalanced panel data as suggested by Biorn (2004).

In this study, we explore the channel of poverty (POV) through which economic growth (EG) affect energy consumption (EC). In the existing literature, most of the studies have focused on the direct relationship between Energy consumption (EC) and Economic growth (EG) or Economic growth (EG) and Poverty (POV) or their causality. However, some evidence is available where the indirect effect of Economic growth (EG) on energy consumption (EC) have been investigated using the channel of poverty (POV).

Chapter 4

Estimation Results and Discussion

This chapter consists of estimation results, their interpretations and discussion. We divide this chapter into two sections: section one presents the estimation results of our base line and general model. Section two discusses final model.

4.1 Estimation of General and Final model

In the following subsections, we obtain estimates from general and final models.

4.1.1 General model

In Table 4.1.1, model (1) shows the effects of economic growth (EG) on energy consumption (EC). In Table 4.1.1, the poverty equation shows a negative and significant effect of economic growth (EG) on poverty (POV), similarly the energy equation shows the effect of economic growth (EG) on energy consumption (EC) is positive but insignificant.

Similarly the variable education (EDU) has negative and significant effect on poverty (POV). The interaction term EG*POV is negative but insignificant. Further in model (2) the poverty equation shows a positive and insignificant effect of economic growth (EG) on poverty (POV), similarly the energy equation shows that effect of economic growth (EG) on energy consumption (EC) is positive but insignificant.

Table 4.1.1 Effects of Economic Growth on Energy Consumption through the Channel of Poverty (Income share held by lowest 20%)

	Model (1)		Model (2)	
VARIABLES	**POV**	**EC**	**POV**	**EC**
EG	-0.263*** (0.000)	19.824 (0.321)	0.025 (0.304)	20.498 (0.394)
POV				-10.834 (0.584)
EDU	-2.610*** (0.000)		-2.153*** (0.000)	
EG*POV		-2.745 (0.443)		-3.014 (0.476)
TOPN				0.842 (0.586)
POPG				-21.022 (0.606)
INFL				3.862 (0.437)
Observations	176	176	176	176
No. of countries	26	26	26	26

Note: P-value of each coefficient is given in parentheses. ***, **,* depicts significance at 1%, 5%, and 10% levels respectively. Dependent variables are Poverty and Energy Consumption. Poverty has been taken as income share held by lowest 20% and Energy consumption (EC) has been taken as Energy use (kg of oil equivalent per capita).Growth rate is taken as real per capita GDP. Education is taken as Average year of schooling (15 years or above) .EG*POV is an interaction term of Economic Growth and Poverty. INFL represents inflation (CPI). TOPN is trade openness. POPG is annual population growth.

The interaction term EG*POV is negative and insignificant. The control variable education (EDU) is negative and significant at 1 % level. We observe that by including other control variables such as trade openness (TOPN), population growth (POPG) and inflation (INFL), the coefficient of economic growth (EG) in energy consumption (EC) equation of model (2) carries a positive sign but insignificant. Similarly the coefficients of population growth (POPG) and inflation (INFL) carry opposite signs as compared to our expected signs. Further the coefficients of poverty (POV), interaction term of economic growth and poverty (EG*POV) and trade openness (TOPN), though carrying the right signs, are insignificant. However, this situation is improved in our final model as discussed in coming section. As education (EDU) is significant at 1 % level in both models (1) and (2) in Table 4.1.1, we further use it as a control variable for poverty (POV).

Indirect effects of economic growth (EG) on energy consumption (EC) through the channel of poverty (POV) are explained by calculating equation 3.7 of chapter 3. Indirect effects of our general model can be seen in Appendix B, Table: B1

We observe that indirect effects of our general model are all insignificant and negative which are against the study concern. In above general model (4.1.1) we observe that control variables disturb our model and their signs also do not depict a true picture of our study main objectives. Thus in order to reach a specific and significant model we construct model 4.1.2, we re-estimate our econometric model by omitting some control variables to check again the relationship between economic growth (EG) and energy consumption (EC) directly and indirectly, through the channel of poverty (POV).

4.1.2 Final model

In order to carry out the final model we re-estimate econometric models and check the results by omitting control variables in 4.1.1. In Table 4.1.2, model (1) shows the direct as well as conditional effects (through interaction term) of economic growth (EG) on energy consumption (EC).

We observe that the poverty equation shows that the effect of economic growth (EG) on poverty (POV) is negative and significant at 5% level. This result is also consistent with the studies of Agrwal (2003) and Roemer (1997). Similarly, the energy equation shows that the effect of economic growth (EG) on energy consumption (EC) is positive and significant at 1% level, as the existing literature also shows the same results as conducted by Masih (1996) and Mehrara (2007).

Further the interaction term of economic growth and poverty EG*POV is negative and significant, which suggests that as the level of poverty (POV) decreases the effect of economic growth (EG) on energy consumption (EC) increases. Similarly the control variable education (EDU) has a negative and significant effect on poverty (POV), which also suggests that as the level of education increases, the level of poverty (POV) decreases

4.1.2 Effects of Economic Growth on Energy Consumption through the Channel of poverty (income share held by lowest 20%)

	Final Model	
VARIABLES	**POV**	**EC**
EG	-3.648** (0.019)	87.710*** (0.000)
POV		-23.855*** (0.000)
EG*POV		-14.924*** (0.000)
EDU	-110.736*** (0.000)	
OBSERVATIONS	199	199
COUNTRIES	28	28

Note: P-value of each coefficient is given in parentheses. ***, **,* depicts significance at 1%, 5%, and 10% levels respectively. Dependent variables are Poverty and Energy Consumption. Poverty (POV) has been taken as income share held by lowest 20% and Energy consumption (EC) has been taken as Energy use (kg of oil equivalent per capita). Growth rate is taken as real per capita GDP (EG). Education is taken as Average year of schooling (15 years or above). EGP*OV is an interaction term of Economic Growth and Poverty.EDU is education.

To explain the indirect effects of economic growth (EG) on energy consumption (EC), we construct Table 4.1.3.

Table 4.1.3 Indirect Effects of Economic Growth on Energy Consumption. (Final Model), Poverty (Income share held by lowest 20%)

Channels	Levels of EG	Indirect Effects	95% Confidence Interval	
Poverty	Low level EG	92.24233** 0.023	12.54281	171.9419
	Average level EG	220.7529** 0.021	33.38563	408.1202
	High level EG	334.4969** 0.021	51.31241	617.6814

Note. P-value of each coefficient is given in parentheses. ***, **,* depicts significance at 1%, 5%, and 10% levels respectively. Low means 25th percentile, average level is 50th percentile and high level shows 75th percentile levels of EG respectively. Poverty is taken as (income share held by poorest 20%).

In Table 4.1.3, we calculate indirect effects of economic growth (EG) on energy consumption (EC) through the channel of poverty (POV) using equation (3.7) as given in chapter 3. Our results show that the indirect effects of economic growth (EG) on energy consumption (EC) are positive and significant (at 5 % level) for low, average and high levels of economic growth (EG). Further we note that the indirect effects are more profound as compared to direct effects given in Table 4.1.2. These results show that poverty (POV) plays an important role in defining the effect of economic growth (EG) on energy consumption (EC).

4.2 Head Count Ratio (HCR) as an Indicator of Poverty

In our analysis, we use two indicators of poverty: POV and HCR. In section 4.2.1, we use HCR as an indicator of poverty and re-estimate our econometric models.

4.2.1 General Model

Table: B 2 of Appendix (B) shows the direct as well as conditional (through interaction term) effects of economic growth (EG) on energy consumption (EC), whereas the indirect effects are obtained by calculating equations 3.8 of chapter 3. In general model control variables are also shown along with variables of Base-Line model. Similarly we observe that results of our general model are consistent with the previous models of Table (4.1.1), by using the second indicator of poverty that is head count ratio (HCR). We observe that by including control variables such as trade openness (TOPN), population growth (POPG) and inflation (INFL), the coefficients of economic growth (EG) and poverty (POV) in energy consumption (EC) equation of model (2) carry positive signs, and are significant. Similarly the coefficient of inflation (INFL) carries opposite sign as compared to our expected sign. Further the interaction of economic growth and poverty EG*HCR is negative and significant at 1 % level. Similarly the effect of population growth (POPG) on energy consumption (EC) is positive and significant at 10 % level. Further trade openness (TOPN), though carries positive sign, but is insignificant. Thus we neglect trade openness (TOPN) and inflation (INFL), keeping population growth (POPG) as it is found positive and significant at 10 % level with energy consumption (EC), we re-estimate our econometric model and find that including population growth (POPG) only as a control variable, it does affect the whole model. See Appendix B, Table: B2 (general model) and B3 (indirect effects). Thus in order get the specific model, we approach to our final model (4.2.2).

4.2.2 Final model

In Table 4.2.2, model (1) shows the direct as well as conditional effects (through interaction term) of economic growth (EG) on energy consumption (EC).

Table 4.2.2 Effects of Economic Growth on Energy Consumption through the Channel of Poverty, (Final Model) (HCR)

VARIABLES	Final Model	
	HCR	EC
EG	-8.937*** (0.000)	12.380*** (0.000)
HCR		-17.825*** (0.000)
GDP*HCR		-1.239*** (0.000)
EDU	-129.082*** (0.000)	
OBSERVATIONS	199	199
COUNTRIES	28	28

Note. P-value of each coefficient is given in parentheses. ***, **,* depicts significance at 1%, 5%, and 10% levels respectively. Dependent variables are Poverty and Energy Consumption. Poverty has been taken as head count ration (HCR) and Energy consumption has been taken as Energy use (kg of oil equivalent per capita).Growth rate is taken as real per capita GDP. Education is taken as Average year of schooling (15 years or above). EG*HCR is an interaction term of Economic Growth and Poverty.

We observe that the poverty equation shows a negative and significant effect of economic growth (EG) on poverty (HCR), similarly, the energy equation shows a positive and significant effect of economic growth (EG) on Energy equation (EC). The interaction term of economic growth and Poverty which is EG*HCR is also negative and significant at 1%. It suggests that as the poverty (HCR) level decreases the effect of economic growth (EG) on energy consumption (EC) increases.

Education (EDU) is taken as control variable for poverty (HCR) to estimate our models. The effect of education (EDU) on poverty (HCR) is negative and significant at 1 % level. In our final model we observe that all the variables are significant.To explain indirect effects of our final model 4.2.2, we construct Table 4.2.3, which shows the effect of economic growth (EG) on energy consumption (EC) through the channel of poverty (HCR)

4.2.3 Indirect Effects

In Table 4.2.3, we calculate indirect effects of economic growth (EG) on energy consumption (EC) through the channel of poverty (HCR). Our results show that the indirect effect of economic growth (EG) on energy consumption (EC) is positive and significant (at 5 % level) for low, average and high levels of economic growth (EG). Further we note that the indirect effects are more profound as compared to direct effects given in table 4.2.2. These results show that poverty (HCR) plays an important role in defining the effect of economic growth (EG) on energy consumption (EC).

4.2.3 Indirect Effects of Economic Growth on Energy Consumption.

Channels	Levels of EG	Indirect Effects	95% Confidence Interval	
HCR	Low level EG	160.3536*** 0.000	109.1648	211.5425
	Average level EG	186.493*** 0.000	125.2971	247.6889
	High level EG	209.6287*** 0.000	139.4149	279.8426
Note: P-value of each coefficient is given in parentheses. ***, **,* depicts significance at 1%, 5%, and 10% levels respectively. Low means 25th percentile, average level is 50th percentile and high level shows 75th percentile levels of EG respectively				

Thus our results suggest that the countries where poverty (HCR) is low the effect of economic growth (EG) on energy consumption (EC) increases. However the countries with high levels of poverty, the impact of economic growth on energy consumption decreases

4.3 Discussion

After estimation we find that all results are consistent with other chunk of literature. Relationship between economic growth and poverty comes out negative and significant for final models, which means that as growth level increases, poverty decreases. The results are consistent with Roemer (1997) and Rodrik (2004). From the past few decades it has been observed from different researches that economic growth is the most effective way to pull people out of poverty (Rodrik, 2004). Economic growth appears to be one of the best ways to reduce poverty, Roemer (1997).

In order to know the relationship of poverty with energy consumption (EC), economic growth (EG) and education (EDU), we use two different indicators of poverty the first one

is income share held by lowest 20 % (POV) and the second indicator is head count ratio (HCR). Following Rose and Dyer (2008).

Similarly, the Coefficients of our conditional variable education (EDU) are also negative and significant and show negative relationship with poverty (POV, HCR). Further The Coefficients of our variables of interest, Economic growth (EG) are positive and significant in all models. Similarly our second explanatory variable Poverty (POV, HCR) are negative and significant in all models which support our main concern of this study that is to know the role of poverty for the effect of economic growth on energy consumption.

The relationship between Energy consumption (EC) and poverty, with both indicators Head count ratio (HCR) and income share held by lowest 20 % (POV) is negative and significant which are consistent with Gertler et al, 2003, which depicts that as the level of poverty decreases the consumption of energy increases.

The main concern of our study is to find the effect of economic growth on energy consumption through the channel of poverty. The indirect effect of economic growth on energy consumption through the channel of poverty is positive and significant in all model.

Chapter 5

Conclusion and Policy Recommendations

This chapter consists of conclusion and policy recommendations.

5.1 Conclusion

This study aims to explore the direct as well as indirect effects of economic growth on energy consumption through the channel of poverty. In this study we use a panel data set of 28 developing countries; Seemingly Unrelated Regression (SUR) technique proposed by Zellner (1962) has been used, which is used for unbalanced panel data to obtain empirical results as suggested by Biorn (2004), that inquires the indirect linkages between economic growth and energy consumption. Here are two objectives of our research: first to explore direct effect of economic growth on energy consumption. Second to explore the indirect effect of economic growth on energy consumption through the channel of poverty, this study consists of three parts, in our first part we examine the relationship between economic growth and poverty and in second part we examine the relationship between economic growth and energy consumption. And finally in third part we combine both economic growth and poverty variables to see their effect on energy consumption.

Important empirical results of our study are: Economic Growth has significant and negative effect on poverty. This shows that as economic growth of developing countries grows,

poverty declines. Similarly, poverty has significant and negative effect on energy consumption, which means that as poverty level declines people tend to increase energy consumption. Coefficients of all the interaction terms of economic growth and poverty are negative and significant.

As our main concern is to know the indirect effects of economic growth on energy consumption through the channel of poverty ,thus the indirect effects of economic growth on energy consumption are positive and significant which develops a chain of variables and depicts that as far as poverty reduces because of economic growth, energy consumption increases. The overall findings of our study suggest that as people of developing world come out of poverty they enhance their demand for energy which ultimately increases energy consumption.

5.2 Policy Implications

Much of the future increase in the demand for energy will come from low- and middle-income countries (EIA 2010). Our study also shows that as economic growth of developing countries goes up the poverty level reduces and consequently energy consumption increases as people start demanding for energy. As economic growth is found to be the best factor to reduce poverty so the countries where economic growth is regressive should use their resources to boost up growth rates, as many developing countries have improved their growth rates. As the growth rates are improving, countries should also focus on policies which reduce poverty at first sight. Similarly countries which are improving their economies should focus on energy infrastructure. As it has been seen that countries that lack of access to adequate energy services experience poverty and unemployment. There is obviously

negative relationship between energy and poverty. So developing countries which are rapidly improving economic growth should emphasize on energy production because as discussed in our study that people tend to increase energy demand as economic growth increases.

Education has been found one of the important factors for poverty reduction. Our study also proves that as the education level increases the poverty level decreases. Countries should give priority to enhance education level by increasing school enrollment rates, construct new school not only in urban areas but also provide access to people living in rural areas to curb poverty.

Summing up, researchers should also explore channels of different variables, as our study is an example for all researchers. The benefit of exploring channels is to identify some important variables which are mostly ignored by researchers in their researches.

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Appendix A

Table: A1

Variable	Abbreviation	Definition	Source
Energy Consumption	**EC**	Energy Consumption Kg of oil equivalent per capita	WDI, The World Bank
Economic Growth	**EG**	log difference of real per capita GDP growth	WDI, The World Bank
Poverty	**POV**	Income share held by lowest 20%.	WDI, The World Bank
Poverty	**HCR**	Head Count Ratio	WDI, The World Bank
Education	**EDU**	Education Attainment for Population Aged 15 and Over	Barro-Lee.com
Inflation	**INFL**	Annual percentage change in Consumer Price Index	WDI, The World Bank
Population Growth	**POPG**	Population Growth (annual %)	WDI, The World Bank
Trade openness	**TOPN**	Sum of total exports (as a percentage of GDP) and imports (as a percentage of GDP)	WDI, The World Bank

Appendix: B

Table: B1

Indirect Effects of Economic Growth on Energy Consumption, (General model), Poverty (Income share held by lowest 20%)

Channels	Levels of EG	Indirect Effects	95% Confidence Interval	
Poverty	Low level EG	-0.278 0.614	-1.361	0.803
	Average level EG	-0.456 0.423	-1.574	0.660
	High level EG	-0.614 00.384	-1.997	0.768

Note. P-value of each coefficient is given in parentheses. ***, **,* depicts significance at 1%, 5%, and 10% levels. . Low means 25th percentile, average level is 50th percentile and high level shows 75th percentile levels of GDP respectively. Poverty is taken as (income share held by poorest 20%).

Table: B2

Effects of Economic growth on energy consumption through the channel of poverty (HCR)

	Model (1)		Model (2)	
VARIABLES	**HCR**	**EC**	**HCR**	**EC**
GDP	-8.937*** (0.000)	12.380*** (0.000)	0.103 (0.169)	39.457*** (0.000)
HCR		-17.825*** (0.000)		22.964*** (0.000)
EDU	-129.082*** (0.000)		-1.653*** (0.000)	
EGHCR		-1.239*** (0.000)		-4.271*** (0.000)
INFL				9.063** (0.013)
POPG				65.568* (0.059)
TOPN				1.268 (0.313)
OBSERVATIONS	199	199	176	176
COUNTRIES	28	28	26	26

Note. P-value of each coefficient is given in parentheses. ***, **,* depicts significance at 1%, 5%, and 10% levels respectively. Dependent variables are Poverty and Energy Consumption. Poverty has been taken as head count ration (HCR) and Energy consumption has been taken as Energy use (kg of oil equivalent per capita).Growth rate is taken as real per capita EG. Education is taken as Average year of schooling (15 years or above). EG*POV is an interaction term of Economic Growth and Poverty. INFL is inflation, POPG represents population growth and TOPN shows trade openness.

Table: B3

Indirect effects of general model

Channels	Levels of EG	Indirect Effects	95% Confidence Interval	
HCR	Low level EG	2.315 0.186	-1.114	5.745
	Average level EG	1.280 0.202	-.687	3.248
	High level EG	o.364 0.423	-.528	1.258

Note: P-value of each coefficient is given in parentheses. ***, **,* depicts significance at 1%, 5%, and 10% levels. Low means 25th percentile, average level is 50th percentile and high level shows 75th percentile levels of EG respectively

Results of general model which show the effect of economic growth (EG) on energy consumption (EC) through the channel of poverty (POV)

In Tables B4 to B6 we omit control variables from our general model 4.1.1 one by one to check their effectiveness on energy consumption (EC).

B 4: Results of general model while omitting population growth (POPG)

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
pov						
gdp	.0284321	.024164	1.18	0.239	-.0189285	.0757926
edu	-2.111153	.0668535	-31.58	0.000	-2.242184	-1.980123
ec						
gdp	20.61606	24.11518	0.85	0.393	-26.64882	67.88094
pov	-19.15127	19.87366	-0.96	0.335	-58.10293	19.8004
infl	3.436334	4.971864	0.69	0.489	-6.30834	13.18101
topn	1.011695	1.522836	0.66	0.506	-1.973008	3.996399
gdppov	-2.810227	4.238053	-0.66	0.507	-11.11666	5.496203
sigma_u	see e(sigma_u)					
sigma_e	see e(sigma_e)					

Dependent variables: pov ec
Independent variables: gdp edu pov infl topn gdppov

Table B 5: Results of general model while omitting trade openness (TOPN)

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
pov						
gdp	4.199211	6.138543	0.68	0.494	-7.832113	16.23053
edu	-26.46798	15.92619	-1.66	0.097	-57.68274	4.746776
ec						
gdp	41.18245	2.845784	14.47	0.000	35.60482	46.76009
pov	2.303213	3.022115	0.76	0.446	-3.620024	8.22645
infl	9.487236	.8611135	11.02	0.000	7.799485	11.17499
popg	100.6452	7.332489	13.73	0.000	86.27377	115.0166
gdppov	-8.303851	.4741662	-17.51	0.000	-9.2332	-7.374502
sigma_u	see e(sigma_u)					
sigma_e	see e(sigma_e)					

Dependent variables: pov ec
Independent variables: gdp edu pov infl popg gdppov

Table B 6: Results of general model while omitting inflation (INFL)

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
pov						
gdp	.1684202	.0107117	15.72	0.000	.1474256	.1894149
edu	-1.084202	.0299575	-36.19	0.000	-1.142918	-1.025486
ec						
gdp	67.99041	6.583004	10.33	0.000	55.08796	80.89286
pov	-52.89037	5.661686	-9.34	0.000	-63.98707	-41.79367
popg	33.56576	13.33106	2.52	0.012	7.437359	59.69417
topn	1.232944	.3753587	3.28	0.001	.4972541	1.968633
gdppov	-10.09948	1.072413	-9.42	0.000	-12.20137	-7.997589
sigma_u	see e(sigma_u)					
sigma_e	see e(sigma_e)					

Dependent variables: pov ec
Independent variables: gdp edu pov popg topn gdppov

Results of general model which shows the effect of economic growth (EC) on energy consumption (EC) through the channel of poverty (HCR)

Tables B7 to B9 show results of our general model (B2) while omitting control variables one by one

Table B7: Results of general model while omitting inflation (INFL)

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
hcr						
gdp	.2779283	.0250075	11.11	0.000	.2289145	.3269421
edu	.8193157	.0707093	11.59	0.000	.680728	.9579034
ec						
gdp	76.64697	2.663642	28.78	0.000	71.42632	81.86761
hcr	47.76412	1.663168	28.72	0.000	44.50437	51.02387
popg	131.0487	15.63764	8.38	0.000	100.3994	161.6979
topn	-2.435678	.5015246	-4.86	0.000	-3.418648	-1.452708
gdphcr	-6.280333	.3633829	-17.28	0.000	-6.99255	-5.568116
sigma_u	see e(sigma_u)					
sigma_e	see e(sigma_e)					

Dependent variables: hcr ec
Independent variables: gdp edu hcr popg topn gdphcr

Table B8: Results of general model while omitting variable trade openness (TOPN)

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
hcr						
gdp	-.546313	4.799573	-0.11	0.909	-9.953302	8.860676
edu	-5.082428	12.88116	-0.39	0.693	-30.32903	20.16418
ec						
gdp	31.55829	.1986718	158.85	0.000	31.16891	31.94768
hcr	-7.465386	.106229	-70.28	0.000	-7.673591	-7.257181
popg	149.4525	1.023094	146.08	0.000	147.4473	151.4578
infl	5.508824	.1225027	44.97	0.000	5.268723	5.748925
gdphcr	-4.277405	.0225833	-189.41	0.000	-4.321667	-4.233142
sigma_u	see e(sigma_u)					
sigma_e	see e(sigma_e)					

Dependent variables: hcr ec
Independent variables: gdp edu hcr popg infl gdphcr

.

Table B9: Results of general model while omitting variable population growth (POPG)

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
hcr						
gdp	.1610374	.0741362	2.17	0.030	.0157331	.3063417
edu	-2.398816	.1955912	-12.26	0.000	-2.782168	-2.015464
ec						
gdp	36.24088	7.70962	4.70	0.000	21.1303	51.35145
hcr	20.6611	4.132694	5.00	0.000	12.56117	28.76104
topn	3.095817	1.224067	2.53	0.011	.6966889	5.494945
infl	11.3499	3.620387	3.13	0.002	4.254075	18.44573
gdphcr	-3.972837	.9573526	-4.15	0.000	-5.849214	-2.09646
sigma_u	see e(sigma_u)					
sigma_e	see e(sigma_e)					

Dependent variables: hcr ec
Independent variables: gdp edu hcr topn infl gdphcr

Table C1: Summary Statistics

variable	N	mean	p50	sd	min	max
ec	1153	1160.451	620.6992	1766.407	84.07581	13023.89
gdp	1192	2.024797	2.455981	4.415555	-17.95155	30.34408
popg	1202	2.046823	2.126698	.9393312	-1.609576	5.321578
pov	221	5.184706	4.82	2.340789	.01	10.04
topn	1172	77.90432	55.18134	72.84822	6.320343	439.6567
infl	1115	27.48404	8.837937	355.8935	-7.634381	11749.64
edu	1106	5.670533	5.89	2.588785	.52	10.99
hcr	223	6.537164	3.68	7.357289	0	32.16

Table C2: Correlation Matrix

	ec	gdp	popg	pov	topn	infl	edu	hcr
ec	1.0000							
gdp	0.0932	1.0000						
popg	-0.2630	-0.2403	1.0000					
pov	-0.2078	0.0957	-0.0325	1.0000				
topn	0.4618	0.1488	-0.0063	-0.3987	1.0000			
infl	0.0459	-0.1910	0.0118	0.0481	-0.2590	1.0000		
edu	0.3921	0.0794	-0.4594	-0.5350	0.5455	-0.1866	1.0000	
hcr	-0.4892	0.0080	0.3070	0.2408	-0.3054	-0.0321	-0.6152	1.0000