T.C.

İSTANBUL ÜNİVERSİTESİ

SOSYAL BİLİMLER ENSTİTÜSÜ

İNGİLİZCE İKTİSAT ANABİLİM DALI

YÜKSEK LİSANS TEZİ

TOTAL FACTOR PRODUCTIVITY, ENERGY INTENSITY AND INCLUSIVE GROWTH: A COMPARISON BETWEEN TURKEY AND ASIAN COUNTRIES

SABİRE KÖSE

2504140001

TEZ DANIŞMANI:

DR. ÖĞR. ÜYESİ TÜRKAN TURAN

İSTANBUL 2019

T.C.
İSTANBUL ÜNİVERSİTESİ
SOSYAL BİLİMLER ENSTİTÜSÜ

YÜKSEK LİSANS
TEZ ONAYI

ÖĞRENCİNİN;

Adı ve Soyadı	:	SABİRE KÖSE	**Numarası**	:	2504140001
Anabilim Dalı / Anasanat Dalı / Programı	:	İNGİLİZCE-İKTİSAT	**Danışmanı**	:	DR. ÖĞR. ÜYESİ TÜRKAN TURAN
Tez Savunma Tarihi	:	11.06.2019	**Saati**	:	10.00
Tez Başlığı	:	TOTAL FACTOR PRODUCTIVITY, ENERGY INTENSITY AND INCLUSIVE GROWTH: A COMPARISON BETWEEN TURKEY AND THE ASIAN COUNTRIES.			

TEZ SAVUNMA SINAVI, İÜ Lisansüstü Eğitim-Öğretim Yönetmeliği'nin **36. Maddesi** uyarınca yapılmış, sorulan sorulara alınan cevaplar sonunda adayın tezinin **KABULÜNE** OYBİRLİĞİ / ~~OYÇOKLUĞUYLA~~ karar verilmiştir.

JÜRİ ÜYESİ	İMZA	KANAATİ (KABUL / ~~RED~~ / ~~DÜZELTME~~)
1- PROF. DR. FERİDE GÖNEL	[signature]	Kabul
2- DR. ÖĞR. ÜYESİ TÜRKAN TURAN	[signature]	Kabul
3- DR. ÖĞR. ÜYESİ GÖKHAN ÖVENÇ	[signature]	Kabul

YEDEK JÜRİ ÜYESİ	İMZA	KANAATİ (KABUL / RED / DÜZELTME)
1- DR. ÖĞR. ÜYESİ TUNA DİNÇ		
2- DR. ÖĞR. ÜYESİ BİLLUR ENGİN BALLIN		

ABSTRACT

TOTAL FACTOR PRODUCTIVITY, ENERGY INTENSITY AND INCLUSIVE GROWTH: A COMPARISON BETWEEN TURKEY AND ASIAN COUNTRIES

SABIRE KOSE

Inclusive growth has become a popular subject for more than a decade. Inclusive growth is a new concept and it is about the relative position of certain social groups especially the disadvantaged ones within the economic growth process. It does not only involve these social groups' benefitting from the economic growth but also their inclusion by way of improving their role in the production process. A more equal income distribution is expected to arise with growing inclusion.

This study aims at exploring the factors that would contribute to inclusive growth. Human capital (HC) seems to be major factor because it certainly raises the total factor productivity (TFP). Accumulation of human capital can be accelerated by either securing equality of equal opportunities for everyone in education, or reducing negative externalities. Equality of opportunity in education renders accumulation of the skills that are crucial in increasing productivity in all sectors of the economy. Reducing negative production externalities leads to better health conditions and to longer expected life span, an integral part of human capital.

Energy sector plays a key role in achieving inclusive growth. It acts upon economic growth in two ways. A lower energy intensity (EI) and a higher energy efficiency contributes to growth by raising TFP. On the other hand a higher energy intensity is one of the main causes in the formation of negative production externalities. The study examines the impact of energy sector and human capital in attaining inclusive growth.

A case study of comparison between Turkey and six Asian countries which are China, India, Kazakhstan, Kyrgyzstan, South Korea and Thailand is present within the thesis between 1990-2014. Augmented Dickey & Fuller test, Johansen cointegration test, and vector error correction model were employed, and panel data of Asian countries were transformed to time series by weighted average via their current GDPs. The same results are obtained for Turkey and Asia that is; HC and TFP, HC and negative externalities, EI and TFP are in relation in the long run. So the findings support TFP, energy and inclusiveness nexus expressed above.

Keywords: Inclusive Growth, Total Factor Productivity, Energy Intensity, Human Capital, Negative Externality, Equal Opportunities

ÖZ

TOPLAM FAKTÖR VERİMLİLİĞİ, ENERJİ YOĞUNLUĞU VE KAPSAYICI BÜYÜME:TÜRKİYE VE ASYA ÜLKELERİ ARASINDA KARŞILAŞTIRMA

SABİRE KÖSE

Kapsayıcı büyüme on yıldan fazladır popüler bir konu haline gelmiştir. Kapsayıcı büyüme yeni bir kavramdır ve belli toplumsal kesimlerin özellikle de dezavantajlı olanların iktisadi büyüme süreci içindeki göreli durumlarıyla ilgilidir. Sadece bu toplumsal kesimlerin iktisadi büyümeden faydalanmalarını değil, iktisadi süreçteki rollerini artırarak büyümeye katılımlarını da içerir. Artan kapsayıcılıkla daha adil gelir dağılımının vuku bulması beklenir.

Bu çalışma kapsayıcı büyümeye katkı sağlayacak etkenleri incelemeyi hedefler. Beşeri sermaye en önemli faktör gibi gözükmektedir çünkü toplam faktör verimliliğini (TFV) mutlaka arttırır. Beşeri sermaye birikimi hem eğitimde herkes için fırsat eşitliğini sağlayarak hem de negatif dışsallığı azaltarak hızlandırılabilir. Eğitimde fırsat eşitliği, ekonomideki tüm sektörlerde verimliliğin artması için kritik olan becerilerin birikimini sağlar. Negatif üretim dışsallığını azaltmak, beşeri sermayenin ayrılmaz bir parçası olan sağlık şartlarının iyileşmesi ve beklenen ömür süresinin uzaması sonucunu doğurur.

Enerji sektörü kapsayıcı büyümenin başarılmasında anahtar rol oynar. İktisadi büyümeyi iki türlü etkiler. Daha düşük enerji yoğunluğu ve yüksek enerji verimliliği TFV' yi artırarak büyümeye katkı sağlar. Diğer yandan yüksek enerji yoğunluğu negatif üretim dışsallığının oluşmasında en önemli nedenlerden biridir. Bu çalışma enerji sektörü ve beşeri sermayenin, kapsayıcı büyümenin başarılmasındaki etkisini inceler.

Bu tez dahilinde Türkiye ile Çin, Hindistan, Kazakistan, Kırgızistan, Güney Kore ve Tayland olmak üzere altı Asya ülkesini kıyaslayan bir vaka çalışması mevcuttur ve 1990-2014 arasını kapsar. Augmented Dickey & Fuller birim kök testi, Johansen eşbütünleşme testi ve vektör hata düzeltme modeli uygulanmış olup Asya ülkelerine ait panel veri, bu ülkelerin cari GSYİH verileri kullanılanılarak ağırlıklandırılmış ve zaman serisine dönüştürülmüştür. Hem Türkiye hem de Asya ülkeleri için aynı bulgulara varılmıştır. Şöyle ki; beşeri sermaye ve TFV, beşeri sermaye ve negatif dışsallık, enerji yoğunluğu ve TFV uzun dönemde birbiriyle ilişkilidir. Yani bulgular yukarıda ifade edilen TFV, enerji ve kapsayıcılık ilişkisini destekler niteliktedir.

Anahtar Kelimeler: Kapsayıcı Büyüme, Toplam Faktör Verimliliği, Enerji Yoğunluğu, Beşeri Sermaye, Negatif Dışsallık, Fırsat Eşitliği

FOREWORD

The productivity, one of the most important subjects in economics, was my starting point for this study. On the other hand, subject of energy is pretty popular although its demanded types, methods of acquisition, access and usage are constantly changing. I have always found issues about energy interesting. Starting to write a thesis on inclusive growth and discovering the effect of energy related issues on economic growth, especially on inclusive growth, have been important for me. Because these concepts find their real meaning when they influence the quality of people's lives and living standards. I am grateful to dear Dr. Türkan Turan who never stints either her academic experience or her moral and material supports, and my tenderhearted parents and entire family who always encourage me to study during this long and toilsome period.

Sabire KÖSE

İstanbul 2019

CONTENT

PART ONE

CONCEPT OF INCLUSIVE GROWTH

PART TWO

TOTAL FACTOR PRODUCTIVITY, ENERGY INTENSITY AND INCLUSIVE GROWTH

PART THREE

TOTAL FACTOR PRODUCTIVITY, ENERGY INTENSITY AND INCLUSIVE GROWTH: A COMPARISON BETWEEN THE ASIAN COUNTRIES AND TURKEY

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

ADB : Asian Development Bank

ADF Test : Augmented Dickey and Fuller Test

ASEAN : Association of Southeast Asian Nations

CH4 : Methane Gas

CO2 : Carbon Dioxide

ECT : Error Correction Term

EI : Energy Intensity

FDI : Foreign Direct Investment

GDP : Gross Domestic Product

GHG : Green-House Gasses

GW : Gigawatt

HC : Human Capital

HFC : Hydrofluorocarbon

HRV : Hausmann R, Rodrik D, Velasco A

IAEA : International Atomic Energy Agency

IBRD : International Bank for Reconstruction and Development

ICT : Information and Communication Technology

IEA : International Energy Agency

IG : Inclusive Growth

IPC : International Poverty Center

IPC-IG : International Poverty Center on Inclusive Growth

IT : Information Technologies

LP : Labour Productivity

MB : Marginal Benefit

MC : Marginal Cost

MDG : Millennium Development Goals

MEB : Marginal External Benefit

MEC : Marginal External Cost

MFP : Multi Factor Productivity

MPB : Marginal Private Benefit

MSB : Marginal Social Benefit

MSC : Marginal Social Cost

N2O : Nitrous Oxide

OECD : Organization for Economic Co-Operation and Development

PFC : Perfluorocarbon

PPPs : Purchasing Power Parity

PRIS : Power Reactor Information System

R & D : Research and Development

SDG 7 : Seventh Article of Sustainable Development Goals

SDG : Sustainable Development Goals

SE4ALL : Sustainable Energy for All

SEAP : Sustainable Energy Access Planning

SF6 : Sulphur Hexafluoride

TFP : Total Factor Productivity

TFPG : Total Factor Productivity Growth

TWh : Terawatt hour

UN : United Nations

UNDP : United Nation Development Programme

UNESCO : United Nations Educational, Scientific and Cultural Organization

USA : United State of America

USD : United State Dollar

VEC : Vector Error Correction

VECM : Vector Error Correction Model

WB : World Bank

WW II : Second World War

INTRODUCTION

The subject of economic development has gained importance after World War II. All the countries wanted to build up and ameliorate their economic conditions in the post-war era. After two big wars the countries were economically, socially and politically in poor condition.

The commonly shared view about how to mend the economies was that an absolute increase in national output and total wealth may lead to higher social welfare, as it influences the welfare of different income groups in the society. This prevalent view was called *trickle-down* theory. Rapid growth in East and Middle East Asia after 1980s showed that strong economic performance may have been helpful for an absolute increase in wealth and a reduction in poverty but it was not enough for lowering the gap between the poor and the non-poor within societies. That’s why development and growth models focusing on reducing poverty and income inequality have gained importance. Afterwards, these models constituted a body of research that was named as *pro-poor growth*. Two approaches within pro-growth became prominent; one aiming at an absolute reduction in poverty, and the other aiming at a higher amelioration in welfare of the poor relative to the non-poor. Practises based on these models did not yield desired outcomes as far as the distribution and the equality were concerned. Because inequality was never just income inequality; non-income dimension of inequality was in question as well. So multidimensional inequality and criteria for multidimensional living standard should have been considered. Higher economic growth was imperative, but what kind of economic growth? The economic growth should have been broad-based, requiring higher levels of participation by various groups. Economic growth being broad-based brings along sustainability. Such a sustainable, broad-based growth can be referred to as *inclusive* growth.

Inclusive growth (IG) has been discussed by academia in the last decade. International organizations such as the World Bank (WB) and the United Nations (UN) has made use of the concept extensively, but it was the international development agencies that has given priority to IG within their agenda. These agencies are associated with IG at the present time. Although they follow different methods and measurements, all these institutions share a common perception about IG. This perception principally involves the participation of different social groups in the economic process without any type of discrimination. It also involves a more equitable distribution of benefits from economic growth among these social groups. Consequently, the process of contribution to and benefiting from economic growth on an equal basis has become short definition of inclusive growth.

Within the neoclassical economics, any increase in output without a rise in the quantity of inputs is referred to as total factor productivity growth (TFPG). TFPG is generally is linked with technological progress. However, it has been shown that the slowdown in productivity since the mid-1990s and the beginning of 2000s was not caused by slower growth in technology. On the contrary, there was a rapid growth in the rate of technological progress during the period. Since more qualified and skilled human resources were required to use the state of the art technology, human capital (HC) became at least as important as technological development. That's why investment in human capital was imperative for raising TFPG. Existing widespread inequality of opportunities had led to a slower accumulation of HC, which in turn led to slower total factor productivity growth.

Although human capital accumulation is a major trigger of TFPG, there is another trigger, energy, which is also a major factor. Energy, as a high cost input, affects the economy from both production and consumption sides. On the production side, he cost of acquiring energy can be divided into two categories as financial cost and external cost. Financial cost arises during processes of purchasing, producing and operating the energy. Purchasing costs a lot because of scarce energy resources, whereas production and operation costs are due to infrastructure investments. External costs arise from negative production externalities such as gas emissions to the atmosphere and other sorts' pollution. Resulting pollution and global warming lowers the labor productivity and the quality of inputs that are obtained from natural resources.

On the consumption side, growing national outputs and populations all over the world, particularly in emerging market economies (EMEs), has led to steady increases in energy demand. Growing energy demand and higher cost of getting the energy has raised the energy intensity (EI). Energy intensity is usually defined as the share of expenditure on energy within the gross domestic product (GDP). Considering higher costs of energy provision and rapidly growing energy demand, energy should be used efficiently, forcing the countries devoting a greater part of their resources for investing on energy. More efficient use of energy will result in a lower EI, with possible gains as far as the inclusiveness is concerned.

The United Nations declared sustainable development goals in 2015 and its seventh goal (SDG 7) was 'clean and affordable energy for all.' Afterwards, sustainable energy for all (SE4ALL) initiative was started. SE4ALL initiative is targeting fair access to clean and low-cost energy by different income groups, and by regions with different development levels. There are three pillars of SE4ALL; i) ensuring universal access to modern energy services,

ii) doubling the share of renewable energy as an alternative to fossil fuels in the global energy mix, and iii) doubling the global rate of improvement in energy efficiency. In the light of these pillars access to clean and affordable energy fosters fairness between firms, from production perspective, whereas it improves HC through better conditions for health, education, heating, lighting and cooking. Moreover, decreasing negative production externalities affects positively both firms and individuals. It affects the firms positively by reducing costs and improving input quality. It influences the individuals positively by increasing labor productivity and by rendering higher HC levels. Hence clean and affordable energy provision or sustainable energy lead to better economic performance and make the economic growth inclusive.

There is also interaction between the positive effects of sustainable energy and TFP and this interaction brings about improvement in every sector of the economy. Potential benefits that would come from investment in sustainable energy are as follows: i) lower energy intensity, ii) transition to high technology opportunities and its spill-over across the sectors, iii) higher energy efficiency, iv) better health and environment conditions, v) provision of affordable and clean energy. These benefits in turn will contribute to TFP growth. On the other hand, increases in TFP leads to energy efficiency. The mutual interaction between TFP and EI, further, gives way to a faster accumulation of HC and efficiency gains in many aspects.

As mentioned above, there are various components of inclusive growth. However, its main idea is broad participation of all economic agents in the economic process. Based on this idea, we introduce the concept of inclusive growth and its association with energy and TFP in Chapter II. We investigate the interaction between energy intensity and TFP and its effects on IG in Chapter III. In the following chapter, we present a case study which compares Turkey with six Asian countries by using Johnasen cointegration and the vector error correction model (VECM). We complete our study by summarizing our findings and discussing the policy suggestions in Chapter V.

PART ONE

CONCEPT OF INCLUSIVE GROWTH

1.1. What Is Inclusive Growth?

1.1.1. Background

The world economies which suffered from World War II (WW II) took priority for economic growth rather than equality in income distribution during post WW II era. Because they thought that improvements in economic performance lead to overall increases in welfare in the society. In the light of the theory that was called 'trickle-down', policy makers applied tax reduction to promote investment and production. Trickle-down theory originated from List's works and Rostow's stages of growth theory and it asserted that expansion in investment and production would raise the standard of living in the society as a whole. [1] Policymakers designed and implemented incentive schemes in accordance with the outcomes of the trickle down approach. However, these incentives schemes did not always yield the desirable results. The 1950s and '60s witnessed not only overall increases in real income and standard of living but also sharpening income inequalities, coupled with soaring poverty rates.

Many developing countries tried to deal with the social problems arising from increasing inequalities and poverty during 1970s because of inadequate policies. So, more convenient incentive schemes were needed for not only better economic performance but also a fairer income distribution. Consequently, a new approach, *pro-poor growth*, was proposed. The idea that economic growth and fair distribution can and should occur together marked an era on development thinking, and pro-poor growth replaced 'trickle down' theory.

Pro-poor growth is basically economic growth that gives priority to the alleviation of the problems of poverty and inequality. Some economists perceived the pro-poor approach as a form of poverty reduction. An absolute decrease in poverty rate without considering the economic situation of the poor relative to the wealthier was enough for the supporters of this view. In short, reducing the number of extremely poor individuals was sufficient rather than lowering the degree of inequality[2]. This was referred to as *absolute* definition of pro-poor growth.

---

[1] LIST and ROSTOW ….

[2] Rafael Ranieri & Raquel Almeida Ramos, **Inclusıve Growth: Building Up A Concept**, International Policy Centre for Inclusive Growth (IPC-IG), 2013, pp.5

The second view about pro-poor growth focused on improving the income distribution. According to the advocates of this view, raising the share of poor in national income, or lowering the income gap between the poor and the non-poor was needed. This was referred to as *relative* definition of pro-poor growth.

There are some strong examples that support the relative pro-poor approach. For instance, the poverty rate in China decreased by approximately three times whereas income inequality increased remarkably between the early 1980s and mid-2000s[3]. The researchers whose work most frequently cited in this branch of analysis were Grosse et al, White & Anderson, Weeks, and Zepeda. These scholars found the 'trickle down' approach fizzled out and they reached a consensus on fair distribution of income. For them, pro-poor growth is required lower income inequality, even though they handle the subject in different dimensions. But there is controversy about the choice of the set of policies that should be implemented[4]. For example, they argued about the applicability of the growth policies focused on social dimensions and the policies focused on poverty and inequality reduction.

Although the pro-poor approach was dominant during 1980s, it fell out of favor during the early 2000s. The reason for why the pro-poor approach lost its influence was the fact that pro-poor growth was successful in reducing poverty and income inequality but it was ineffective in removing disparities among different social groups caused by unequal opportunities. Because the only problem is not distribution of income, there is non-income dimensions of inequality among societies. At this point redistribution of the increase in total wealth which is arising from economic growth is not a long term solution. Because enhancing the level of well-being of the poor by social policies in the areas such as education & health, nourishment & sheltering and etc. or by pro-poor policies for fair distribution of income through absolute growth does not create added value in the economy, and it constitutes a cost factor for policy makers. This is not sustainable.

So the term called as multidimensionality (income and non-income dimensions of inequality among societies) showed that there must be a more comprehensive concept than pro-poor growth. A new definition of sustainable, rapid and *broad-based* growth across all economic agencies in the society appeared. Thus a new concept which is described as '*inclusive growth*' took the place of pro-poor growth.

---

3 Rafael Ranieri & Raquel Almeida Ramos, op. cit, pp.6

4 Ibid, pp.4-6

1.1.2. Definition And Measurement Of Inclusive Growth

Necessity for income and non-income dimension policies for reducing inequality broaden the thinking of growth. Social policies which doesn't create economic utility constitute as financial burden and this bring about to come short of reducing income inequality. Therefore governments / policymakers need to produce different approaches about socioeconomic issues. An economic growth which is achieved by wide participation of various groups and economic agents in the societies, following that fair distribution of the increase in total wealth and social equality in income and non-income dimensions render this growth process to define as broad-based growth. There, inclusive growth is being broad-based of an economic growth.

Socioeconomic problems which are obstacles against IG such as poverty, income and non-income inequalities, discrimination among various groups in the societies from political and economic aspects, absence or deficiency of participation etc. have been investigated by many investigators and international development institutions like Asian Development Bank (ADB), United Nations Development Programme (UNDP), World Bank (WB) and Organization of Economic Cooperation and Development (OECD). These institutions develop regional and global strategies about social welfare and equality, and they study on inclusive growth. There is an overall thinking among the institutes about inclusive growth. As a roof definition; inclusive growth is achieved by participation of different groups in the societies to the economic process without discrimination among religious, ethnic, regional groups or genders, and benefitting from economic growth equitably for reduction of inequality. So contribution to and benefitting from economic growth equally by every economic and social agencies is a short definition of inclusive growth. And that's the point that distinguishes inclusive growth from pro-poor growth.

The institutions have different approaches within this general framework. ADB focuses on reduction of discrimination during *process* of growth and for *outcomes* of economic growth for a broad-based growth. Therefore disadvantage-reducing is occurred. UNDP approach the IG in a similar but more comprehensive way than ADB. Economic growth targeting low and declining inequality, economic and political participation, and fair benefit-sharing is considered as inclusive growth. There is a unit within UNDP whose name was transformed from International Poverty Center (IPC) to International Policy Center on Inclusive Growth (IPC-IG). WB and OECD also handle the subject in similar perspective. For them *pace and pattern* of economic growth are both considerable for inclusive growth. Pace of growth is essential for rapid growth and poverty reduction whereas pattern is very important from the aspects of participation and division. Increase in productivity and opportunities of employment lead to sustainable growth and reduction of poverty through labor. Because most of the poor are from labor or proletariat. In this context pattern of growth is determinant for inclusive growth.

As mentioned above ADB approaches inclusive growth by the separation of the economic process as process & outcome. For ADB dividing society as advantaged and disadvantaged rather than poor and non-poor is more sufficient. Because as total wealth increase poverty falls but disparity and inequality increase among not only the poor but also several disadvantaged groups. So including different groups of societies in the economic growth is a necessity. Thus multidimensional inequality falls and benefit-sharing becomes fairer. Broad-based and non-discriminatory participation of economic agents to the process contributes to sustainability as well since it strengthens the role of labor. That is why investment in human capital is a requirement for broad-based growth strategy.

Broad participation of different social groups to the economic process is the first essential trademark of IG and this separates IG off from pro-poor growth. Moreover from the point of outcome, according to pro-poor growth only poor is considered to be better off whereas it is paid attention to benefitting of all groups but especially disadvantaged ones from economic well-being in IG approach. So the second trademark of IG which distinguish it from pro-poor growth is an outcome-focused economic growth which reduces regional, ethnic, or gender disadvantages. Thus, in terms of process and outcome, inclusive growth could be termed as non-discriminatory and "disadvantage-reducing" growth[5].

A non-discriminatory and "disadvantage-reducing" growth model satisfies that integrity between macro and micro aspects in the economy is achieved. Because such a non-discriminant and broad-based economic process leads to increase in employment (quantity of labor) and higher labor productivity (quality of labor) and improvement in labor intensive areas. Not surprisingly, this reflects positively to volume, scope, permanence, and sustainability of growth.

So according to process & outcome approach, we can specify the requirements to count an economic growth as inclusive growth [6]:

- Positive growth on per capita income

---

[5] Stephan Klasen, **Measuring and Monitoring Inclusive Growth: Multiple Definitions, Open Questions, and Some Constructive Proposals**, ADB Sustainable Development Working Paper Series, No. 12, ISSN 2071-9450, 2010, pp.2
[6] Ibid, pp.10

- Growth rate of primary income of (predefined) disadvantaged groups at least as high as per capita income growth, and ability for participation of these groups to the *process* at least proportionately
- Improvement in well-being, especially in non-income dimensions, that is higher than average of disadvantaged groups

These characteristics require that civil society, public and private institutions, policy makers should set courses and develop projects for inclusive growth. But for this, disadvantaged groups in the society should be defined, and poverty profile of these groups (for both income and non-income dimensions) should be built up. Because economic growth is inclusive if it satisfies improvement in income and non-income dimensions higher than the average condition of disadvantaged groups, so the average is needed to know. Further comparing the groups from the aspects of income growth and expansion in non-income dimension of well-being over time is helpful for tracking strategies, projects. Naturally, micro data is required for this difficult work.

Yet another institution is UNDP which works on inclusive growth but there isn't a categorical definition which belongs to them. They call the situation as "Million Dollar Question" (UNDP, 2008)[7]. A working paper of IPC-IG as compilation of different views about IG by Rafael Ranieri and Raquel Almeida Ramos exists, Inclusive Growth: Building up a Concept. Ranieri and Ramos call the situation as fairly exploratory period for IG. According to them before a consensus about IG there are some questions that are needed to answer: *'At the forefront of the endeavor is clarifying what inclusiveness means. Is it equity? Empowerment? Opportunities? Participation? Satisfaction? A combination of these? Or something else? Greater clarity about this is essential to making sense of the relationship between inclusiveness and growth to define inclusive growth.'* [8].

World Bank have the idea about IG that the *pace* and *pattern* of economic growth must be considered together. Because increase in wealth and poverty reduction depends on pace of absolute growth rate, further broad participation of sectors and economic agents to the pattern of growth which focuses on productive employment and equal opportunity is needed for sustainability. So policy makers should regard macro and micro policy decisions together.

---

[7] M. H. Suryanarayana and Indira Gandhi, **What is Inclusive Growth? An Alternative Perspective**, IPC-IG One pager, 2013, no:205

[8] Rafael Ranieri and Raquel Almeida Ramos, **After All, What is Inclusive Growth?**, IPC-IG One pager, 2013, no:188

Macroeconomic stability policies which is related to interest, inflation and unemployment, and microeconomic policies like investing in; education, health, infrastructure for R&D activities, transportation, communication, technology and etc. are vital for pace and pattern of economic growth.

Two measurement method are prominent in the paper of WB (Ianchovichina and Lundstrom, 2009) . First one is a framework which is developed by Ricardo Hausmann, Dani Rodrik, and Andrés Velasco. It is named as 'growth diagnostics' or 'HRV approach' as WB interpretation. According to this approach it is needed to be determined which one of the numerous distortions have urgency in an economy. Targeting the distortion associated with the biggest multiplier is seemed to be a solution but according to the HRV approach, it may not lead to a welfare improvement, because of the possibility of large second best effects[9]. There are three motivations in this method[10].

- Higher levels of living standards which is achieved by the increasing economic growth rates are the most direct route to obtain improvements in social and human indicators. That's why, especially in developing economies, reform strategies for economic growth must be aimed by policy makers.
- Growth strategies differ from country to country according to domestic opportunities and constraints since the requirement of considerable information which is about domestic specifications near general principles for operational policies,.
- Executive and political restrictions bring about that policy makers should focus on aiming the most binding constraints. So growth strategies require a sense of priorities.

The method is the equation of growth of consumption and growth of capital. Any constraint during consumption or capital accumulation can be the subject to distortion. Then, in the general sense, these two are equated to the share of difference between return on capital and world interest rate. Taxes (the tax rate on capital, actual or expected, formal or informal) have negative multiplier effect on return on capital, and return on capital depends on total factor productivity, availability of complementary factors of production and externality. Total factor

[9] Elena Ianchovichina and Susanna Lundstrom, **Inclusive Growth Analytics: Framework and Application**, Policy Research Working Paper No. 4851, **The World Bank Economic Policy and Debt Department Economic Policy Division**, 2009, pp. 5

[10] Ricardo Hausmann, Dani Rodrik, and Andrés Velasco, **Growth Diagnostics**, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.446.2212&rep=rep1&type=pdf, revised in 2005, pp. 1-2

productivity and availability of complementary factors of production affect positively the return on capital whereas it is affected negatively by externality. The equation is as below:

$$\frac{\dot{c_t}}{c_t} = \frac{\dot{k_t}}{k_t} = \sigma\,(\,r\,(1-\tau) - \rho), \quad r = r\,(\alpha, \theta, x\,)$$

Where c is consumption, k is capital, r is return on capital, τ is tax rate, ρ is world interest rate, σ is elasticity of intertemporal elasticity in consumption, α is indicator of total factor productivity, θ is index of externality, x is availability of complementary factors of production (such as infrastructure or human capital).

HRV approach is only one from many approaches and it is appropriate for low income developing countries with slow growth and low investment or slowly growing sectors[11]. But in the case of high growth but stagnating poverty reduction, the framework isn't enough on its own. The second measurement in the paper (Ianchovichina and Lundstrom, 2009) is a combined method of HRV framework with various techniques which is carried out to time-series, firm and household survey data, and cross-country benchmark comparisons to answer questions about trends, constraints to, and sources of sustainable, broad-based growth[12]. According to the method, income of any individual (poor, non-poor or from any other group of society) who participates to production process is defined approximately as:

$$y_i \equiv w_1 E_1 \omega_{i1} + \cdots + w_j E_j \omega_{ij} \tag{1}$$

where y_i is income of individual i, w_j is price and E_j is endowment of factor j in each country, and ω_{ij} is the share of the j^{th} factor owned by individual i. Then the both sides are divided by total income, and the sample space is degraded to one group of society to obtain the share of income which is received by the group:

$$\psi_P \;\equiv\; \lambda_1 \omega_{P1} + \cdots + \;\lambda_j \omega_{Pj} \tag{2}$$

So ψ_P-the income share of the group is approximately the sum of the products of λ_j-the share of factor j in total income and ω_{Pj}-the share of factor j owned by the group.

The thinking of *pace* and *pattern* of growth is also valid for OECD, just as WB. A rapid pace of growth for poverty reduction through improvement of current economic performance (absolute definition of pro-poor growth), and pattern of growth targeting equality of opportunity

[11] Ianchovichina and Lundstrom, **op. cit**, pp. 6
[12] Ibid

for productive employment are essential for sustained and broad-based growth. So it can be said that components which are needed for IG are economic growth leading improvement in welfare and its fairly distribution, and social prosperity which is arising from expansion of non-income dimensions like education, schooling achievements; health, improvements in survival rates improvements in nutritional status; access to transport, communications, and household services (e.g., clean water, electricity, refuse removal), personal security, work-life balance, environmental quality of life, and social connections. These are summarized as living standard or well-being, and according to OECD raising living standards is ultimate objective for policy making. At this point OECD comes up with three questions; *which growth* (expansion on income or non-income dimension-multidimensionality), *whose growth* (fair distribution), and *which policy* (for IG).

Measuring IG by income and non-income separation in the context of living standard must address the questions above. Computing income based living standard to measure IG econometrically is easier than non-income dimension living standards. Consumption or income data is used to determine the level of individual or any group in the society. Then an adjustment can be done by inequality data through average consumption or income. Second issue is non-income based well-being. There are a lot of non-income dimensions attached with well-being. Since it is impossible to count on all of them, it is important to decide which one is selected in computation of living standard. By this context three stipulations below are important[13]:

- Factors, which matter most of people, must be chosen like health, nutrition etc.
- There must be testable empirical links between establishable policy and the selected non-income dimension living standards.
- There must be reliable, comparable and timely data.

So living standard is a function of income/consumption and non-income dimensions. The problematic part is valuation of non-income dimensions. A broadly used method ‘equivalent income’ which is a hypothetical income is an appropriate method. It would make an individual indifferent between her/his current situation in terms of the various non-income dimensions and a benchmark (usually the most observed outcome) situation. So it is a context of comparing living standards of individuals.

[13] Romina Boarini, Fabrice Murtin and Paul Schreyer, **Inclusive Growth: The Oecd Measurement Framework**, OECD Statistics Working Paper 2015, http://www.oecd-ilibrary.org/economics/inclusive-growth_5jrqppxjqhg4-en, June 2015, pp.10

Defining a benchmark, and looking at the distance between current situation and benchmark are two steps of equivalent income approach. Monetization of non-monetary utilities is required in this approach. That's why relative performance in non-income dimensions are valued through shadow price by one of the four major methodologies[14]:

- Stated Preference: Methodology based on individuals' willingness to pay or their acceptance of loss for non-income dimensions.
- Revealed Preference: A hedonic pricing method to calculate the compensatory income for a given amenity or occupation-related risk. It is broadly used for environmental and residential studies.
- Subjective Well-Being: Again this is also a hedonic perspective. Maximizing satisfaction or avoiding pain is the criterion of well-being. Mathematically it is computed as dividing the coefficients of non-income variables to the coefficient of income variable by each. From that point a compensatory differential is computed as coefficient of components of equivalent income.
- Finally, it is possible to obtain shadow prices by modelling benefit comparison of a representative factor among time. This model-based approach avoids reliance on regression techniques but requires choices of the functional form of individuals' utility functions.

According to OECD, most preferable one is subjective well-being. In this methodology, the variables of income and non-income dimensions which are determined are showed in a function, *Life Satisfaction.* Let the job dimension and health are determined as non-income dimension whereas real household disposable income is determined as income dimension. First we need to compute real household disposable income:

$$\bar{y}_j^t = \frac{1}{N}\sum_{k=1}^{N} y_{i,j}^t$$

Where N is number of different groups in the society, $y_{i,j}^t$ is the real disposable income of group *i* in country *j* at time *t.* If life expectancy and unemployment rate are used for health and job dimension as representatives respectively, the function takes the form as:

$$LS_j^t = a_j + b^t + \alpha \, log \, \bar{y}_j^t + \beta^T \, T_j^t + \beta^U \, U_j^t + \varepsilon_j^t$$

[14] Ibid, pp.14

where j = 1, 2,…, n is number of sample space (country, groups of society or etc.) and t = 1, 2,…, m is time period and pooled regression is carried out. LS_j^t is the life satisfaction, $\bar{y}_j^t$ is average real disposable income of household, T_j^t is life expectancy, U_j^t is unemployment and ε_j^t is residual in sample j and at time t. a_j represent country-specific fixed effects that have role as 'shifters' to take into account differences in the relationship between life satisfaction and its determinants among countries. b^t are fixed effects for each years to hold common trends between explanatory variables. α, β^T and β^U are the coefficients of income, life expectancy, and unemployment respectively. Their regression estimates '$\hat{\alpha}$, $\widehat{\beta^T}$, $\widehat{\beta^U}$' are the elasticities of life satisfaction for income, unemployment and life expectancy respectively. They represent the effect of one unit change in explanatory variables on the life satisfaction.

Second step for equivalent income is to associate the estimates each other. One member of sample space is determined as benchmark for LS, $\bar{y}$, U and T. Then compensating differential (or monetary value) is derived from the difference of LS function and its benchmark. So compensating differential of; an additional year of life expectancy or percentage point of less unemployment are computed as:

$$\delta_{j,t}^k = \bar{y}_j^t \left[1 - e^{-\frac{\widehat{\beta^k}}{\hat{\alpha}}}\right] \quad \text{and} \quad k = T, U$$

Compensating differential $(\delta_{j,t}^k)$, as a share of individual income, is country invariant because $\hat{\alpha}$, $\widehat{\beta^T}$, $\widehat{\beta^U}$ are the estimations or trend values of the coefficients among countries which means they are common average values for countries. After, compensating differentials are employed to compute equivalent income:

$$y_{i,j}^{*t} = y_{i,j}^t - \hat{\delta}^T\left(T^* - T_j^t\right) - \hat{\delta}^U U_j^t$$

where $y_{i,j}^{*t}$ is equivalent income, $y_{i,j}^t$ is the real disposable income of group i in country j at time t, $\hat{\delta}^T$ and $\hat{\delta}^U$ are compensating differentials of additional year of life expectancy and percentage point of less unemployment respectively, T^* is benchmark for life expectancy and T_j^t is life expectancy in country j at time t so their difference is deviation from benchmark, U_j^t is deviation from benchmark on its own because the benchmark for unemployment is zero unemployment. So equivalent income is the difference between the real disposable income and deviations of non-income dimensions from their benchmark (which is the sample where longevity is the most for life expectancy and absence of unemployment for job dimension in this example).

Measurement of *multi-dimensional living standards* (MDLS) which are based on equivalent income is possible now. The measurement is made up of product of average equivalent income and an inequality adjustment '$I_{i,j}^{t}$' which is approximately relative difference between average income and the income of the particular household group:

$$I_{i,j}^{t} \equiv 1 - \frac{y_{i,j}^{t}}{\bar{y}_{j}^{t}}, \quad \bar{y}_{i,j}^{*t} = \frac{1}{N}\sum_{k=1}^{N} y_{i,j}^{*t}, \quad MDLS_{i,j}^{t} = \bar{y}_{i,j}^{*t}\,(1 - I_{i,j}^{t})$$

So the methodologies[15] fundamentally try to make definition of living standard for an individual or a group of society through income and non-income dimensions. These definitions are sometimes made through income level, sometimes through consumption.

As a result, IG is a kind of economic growth which reflects proportionately to every group in the society as increase in welfare and living standards, and decrease in inequality. Such an economic growth doesn't occur by itself, policy makers are responsible inclusive growth by integrated macroeconomic and microeconomic policies.

1.2. Energy And Inclusive Growth

Energy, as a very important factor in production process, is essential for better economic performance. Near that it is the highest cost of input in the social, financial and environmental context. According to several studies, energy intensity (the share of energy consumption in GDP) is higher in the developing countries relative to advanced economies due to their worse performance in the areas such as efficiency in the economy, the development of services sector, the level of improvement in technology and production methods, level of development. On the other hand the increasing demand for energy via industrial improvement, rapid population growth and urbanization are other important factors that raise the energy intensity. So provision of energy demand and capacity increasing are vital in emerging countries. Otherwise excess in energy demand is occurred, industrial sector experience a scarcity of resource, production slower, and the competitiveness of the economy in both domestic and foreign markets decrease.

Another way to provide energy demand is import. But this makes economies with high energy demand external dependent in energy[16]. In this case foreign trade is inversely affected and the import-intensive growth model naturally find place in the economy. Due to the high

[15] The equations above are obtained from Boarini et al. which is told about at footnote '14'.
[16] Pablo Bustelo, **Energy Security with a High External Dependence: The Strategies of Japan and South Korea**, MPRA, 2008, pp.2

cost of energy, the negative effect raise and economy worsens. The foreign dependence in energy supply not only have economic effects but also it may lead to shaping of politics of the country out of national will. So the subject of energy is very important that it may even affect the independence of a country.

The sustainable and native energy gain importance for powerful economy, sustainable growth and full independence at that point. So the topics of energy efficiency, renewable energy and negative externality of supply and usage of energy are very important. Energy efficiency is significant for efficient use of present resources and it decrease the societal, environmental and financial cost. Because waste of energy cause to wasting the money, and running into danger of our health and natural life through pollution and other environmental problems. That’s why energy conservation and efficient use of energy are needed to be worked on and policies on these areas should be produced. Some of policy suggestions are as follows:

- Financial and non-financial encouragements for entrepreneurs like subsidies, logistic and bureaucratic ease and supports, deduction and allowance of taxes,
- Investment in R&D for new technologies,
- Coordinated, cooperated and common projects of public and private sectors,
- Encouraging the private sector to invest in renewable energy and its related technologies,
- Diversifying energy sources and suppliers.

The fossil fuels are not producible, countries have or not. In this case the countries that do not have enough natural resources are disadvantaged, and local possibilities on energy supply should be considered, and alternative sources for energy provision should be on the agenda of policy makers to avoid foreign dependence in energy. Here the renewable energy is very important from different aspects. Near its role to increase energy efficiency, renewable energy is crucial since it is producible. But there is also a conflict about it. Renewables are dependent to seasonal, geographical or climatic factors. For example the solar energy is limited effective in the regions where number of sunny days is low, or wind power is narrow in the low pressure areas, or hydropower is scanty or absent in the low altitude, more even and arid regions. Another good alternative is the nuclear energy because it is a high-yield energy source. Its usage is not enough yet, because of its high cost investment and some possible environmental risks. But still nuclear energy production is growing.

Other topics as important as energy supply are access to energy; technological, infrastructural and financial adequate for energy supply; possession of and capability to operate natural resources. These are topics that are gathering energy and inclusiveness. Actually we can say that access to energy contains the others because economic growth is directly related to energy access. A developed country, which has natural resources, has the possibilities to operate it by appropriate technology and to access to high quality energy with low cost. Even if not enough natural resources, they may produce and supply energy by using alternative energy sources. The financial and technological basis are determinant in both situations. Additionally developed countries/regions are advantaged about minimization of the negative externality and energy intensity, and these lead to dispersion in provision of energy among countries/regions.

Presence of natural resources does not make a country advantaged by itself. The infrastructure to produce and industry to use are needed. It is valid for firms as well. Especially in emerging economies, firms demand more energy, as we mentioned above. So an unfair condition in provision of low cost and high quality energy among firms lead to unfair competition and inequality. Cheap and clear energy for all is needed for reliable and sustainable growth. So sustainable energy is one of the most important subjects for economies which are aiming inclusive growth, and indigenousness in energy supply appears as an important subject.

In this context the subject of energy is counted in sustainable development goals (SDGs) which are transformed from millennium development goals (MDGs) in September of 2015 by UN with the recognition, coherence and cooperation of most of the countries. SDGs are 17 social, economic and environmental development goals which are aiming equal, fair and sustainable economic development all around the world, particularly in under-developed regions. Each goal is a subject to study by itself and they have their own logos as it is shown in the figure 1.1. The aimed maturity is fifteen years. It is expected to be cooperated with governments, private sectors and civil society because these are really extensive development areas.

Figure 1.1: The 17 goals of SDGs

Source: https://www.un.org/sustainabledevelopment/sustainable-development-goals/

Although many developmental areas is included in SDGs, we are interested in the goal of energy access with respect to our subject. The seventh goal “affordable and clean energy” actually is targeting fair access to clean and low cost energy by different income groups, and by regions with different developmental levels. So supply/provision of energy should be sustainable. Transition to sustainable energy requires both national and international policies and strategies which involve energy efficiency regulations, accurate pricing of energy (including carbon pricing), supporting to drive clean energy investments, building up underpinning infrastructure, and R&D of future technologies. Again these are very comprehensive areas to work so coherence and cooperation in local and abroad is important. According to IEA, a proper transition to sustainable energy need to three domains as below:

1

POLICY OBJECTIVES

- Increased energy efficiency
- Exploring cost effective energy efficiency potential

POLICY CHOICES

- Standards, regulations and better consumer information which are encourging behavioural shifts
- Incentives for improved energy efficiency and energy conservation

2

POLICY OBJECTIVES

- Encouraging lower-carbon products and gradual decrease in current high-carbon assets

POLICY CHOICES

- Carbon pricing and decreasing subsidies on products that fossil fuel is used in its production
- Standards and other regulations, subsidies, government investment for any possible gap arising from the article just above

3

POLICY OBJECTIVES

- Development & cost reduction of long-term decarbonisation technologies
- Adaptation of infrastructure to low-carbon energy options

POLICY CHOICES

- Investment in technology RD&D
- Public spending on high cost strategic infrastructure

The first one is like urgent action plan, things to do to lower the cost at first step unless doing investment. In other words, it is considering the negative cost opportunities. Second domain is the optimisation of the cost through pricing, subsidies and investment. Third is both short and long term investments which are targeting long term returns such as reducing energy intensity, reducing carbon emission and pollution, increasing energy efficiency, decreasing nominal cost and external cost.

‘Sustainable Energy for All (SE4ALL)’ initiative of UN is important in the context of sustainable energy. SE4ALL is associated with the seventh goal of SDGs and it is also known as SDG 7. On the other hand UN carry out the Post 2015 Goals Framework or Post 2015 Development Goals Framework within achieving SDGs. This framework is shaped around the concepts of inclusion and equality while SDGs is interested in an absolute development. There are eleven goals from different areas to achieve equality and inclusion near absolute improvement. These goals are propounded in Bellagio, Italy so they are named as “Bellagio Goals”. They are shown in figure 1.2.

Figure 1.2: Post 2015 Goals (Proposed Bellagio Goals)

Source: Nicole Bates-Eamer, Barry Carin, Min Ha Lee and Wonhyuk Lim, with Mukesh Kapila; **Post-2015 Development Agenda: Goals, Targets and Indicators-Special Report**, The Centre for International Governance Innovation | Korea Development Institute, pp. 4

Moreover Asian Development Bank (ADB) has a program which is called as Sustainable Energy Access Planning (SEAP). It contains the developing countries of Asia and the Pacific region. This program is targeting to investigate the issues and to find out solutions, for producing policies about problems such as: energy security, the interlinked issue of energy generation and climate change, and widespread energy poverty, with hundreds of millions having no access to electricity and billions more having no access to modern fuels for cooking or heating[17]. ADB is also one of the partners of UN in initiative. ADB refers to SE4ALL and SDGs in their workings.

1.2.1. Sustainable Energy For All (SE4ALL)

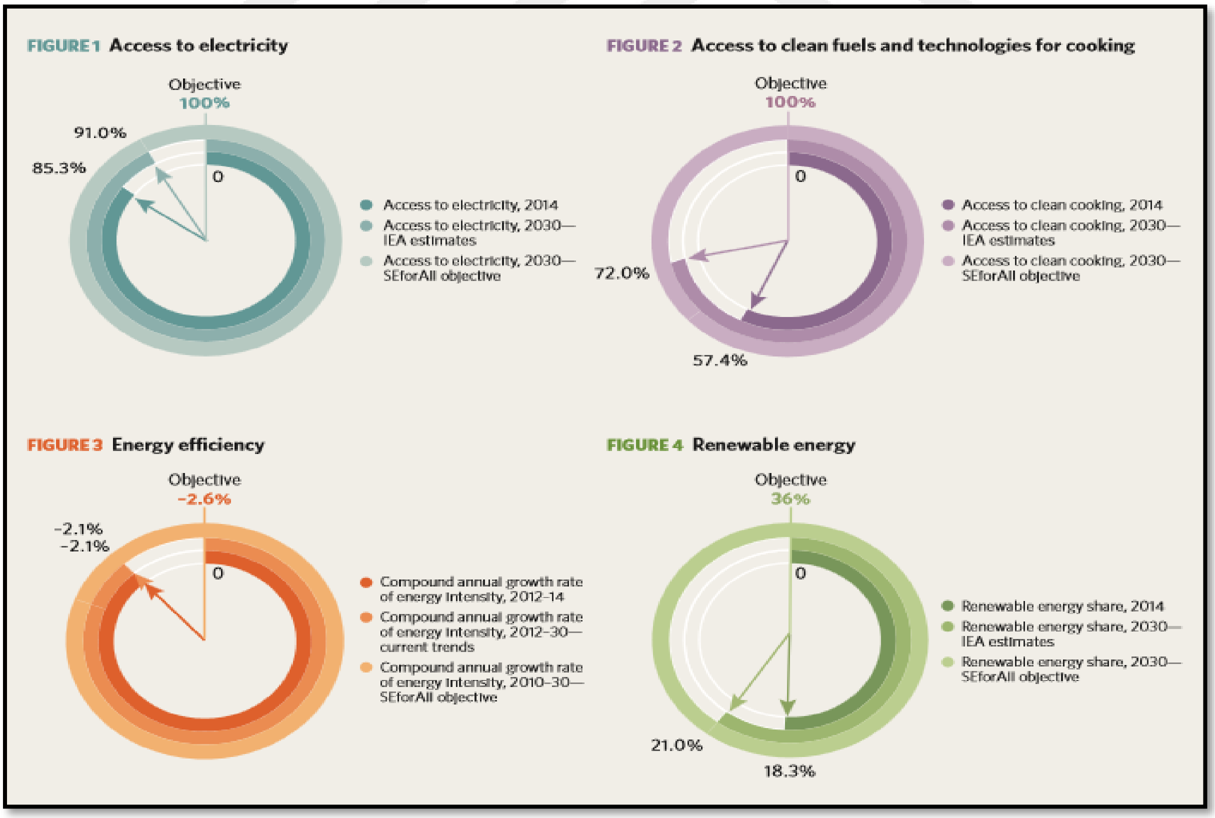
Energy enables! This slogan of SE4ALL beautifully explains the situation. As a goal of SDGs, access to high quality and low cost energy is not a luxury, it is a necessary. That’s why sustainable energy is vital for proper, sustainable and inclusive growth progress. So SE4ALL initiative aims three main goals for sustainable energy until 2030:

[17]Ram M. Shrestha & Jiwan S. Acharya, **Sustainable Energy Access Planning A Framework**, Asian Development Bank, 2015, pp.vii (foreword)

- Ensuring universal access to modern energy services
- Doubling the share of renewable energy in the global energy mix
- Doubling the global rate of improvement in energy efficiency

As it is seen in the articles above sustainable energy concept have three main objectives that are renewable energy, energy efficiency and access to modern energy services. According to the annual report "Global Tracking Framework" of WB and IEA about sustainable energy, the pace of progress on sustainable energy were below than expected to meet the global objectives by 2030 during 2012 -2014. Energy efficiency had the closest growth rate to the objective among the three pillars at that period while the backmost one was renewable energy. As it is shown in figure 1.3 the current paces of changes are well below of the SE4ALL objects and IEA estimates, except energy intensity. The estimation of IEA about energy intensity is satisfied, and 2.1% decrease in energy intensity is achieved. Access to electricity is 85.3% all around the world while access to clean fuels and technologies for cooking is 57.4%, and share of renewable energy is 18.3% between 2012 and 2014.

Figure 1.3: The Percentages of Achieving the Three Pillar Goals

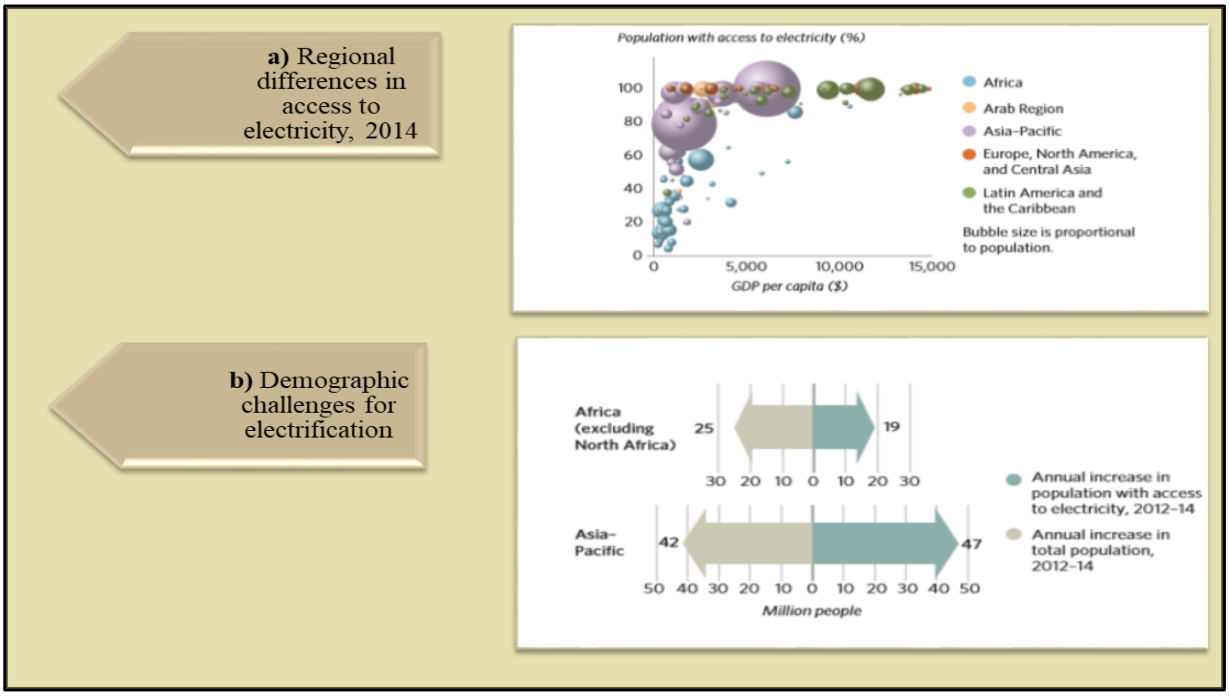


Source: IBRD, WB, IEA, "**Sustainable Energy For All, Global Tracking Framework Progress Toward Sustainable Energy 2017, Summary**", 2017, pp. 1

The first one of the pillar goals of sustainable energy is ‘ensuring universal access to modern energy services’. Dispersion between urban and rural may come to mind first, as a fundamental problem. But it’s not really like that. According to the common report ‘*Sustainable Energy For All, Global Tracking Framework Progress Toward Sustainable Energy 2017, Summary*’ which belongs to WB and IEA, progress in rural electrification has improved faster than urban since 1990, and the gap between urban and rural populations decreased from 35% to 20% in the period of 1990 and 2014. The question is whether there is a parallel growth of population to the improvement in access to electricity. The figure 1.4 shows the relationship between population and electrification. There is positive relation between population with access to electricity and per capita income but it is obviously seen in panel A/section *a*[18]that there is a dispersion in access to electrification between regions. The amounts of population with access to electricity, which are on the same income level, vary relative to regions. The percentage of access to electrification is pretty high in developed and developing regions whereas it is lower in underdeveloped regions. Especially Africa and Asia Pacific differ from other regions and we can deduce about it from section *b* of panel A. Since these regions are not developed enough, it increasing demand is not compensated.

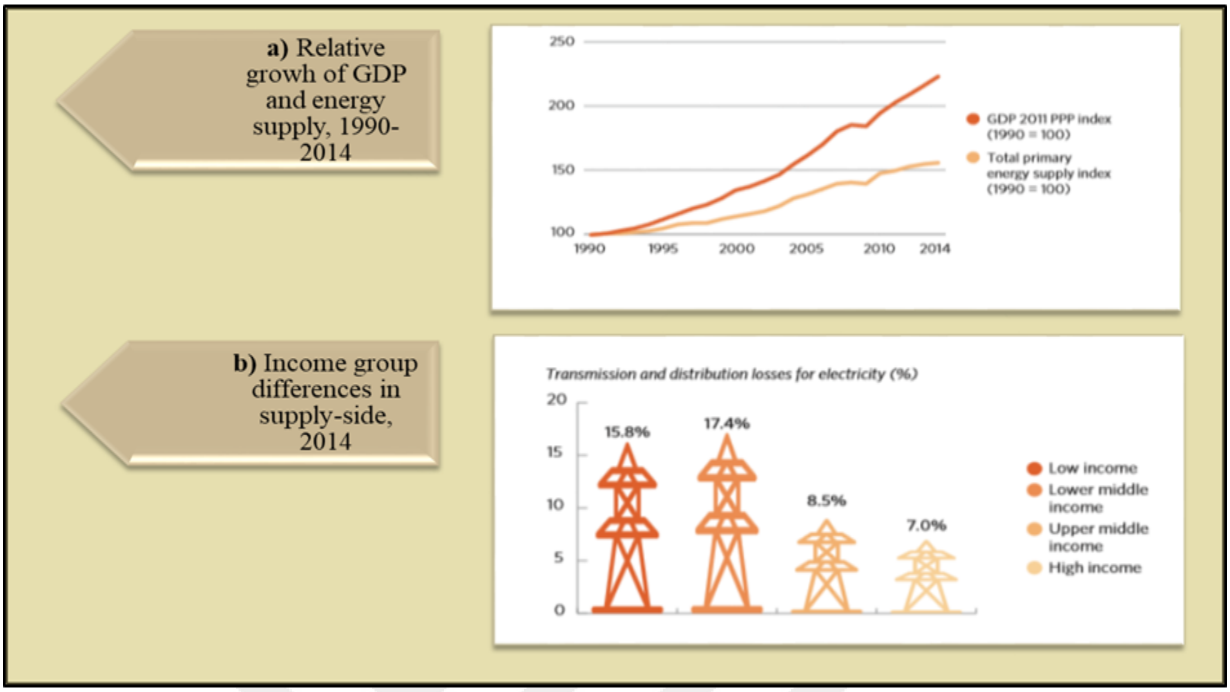
Figure 1.4: Some Details About The Pillar Goals

Panel A: Electrification

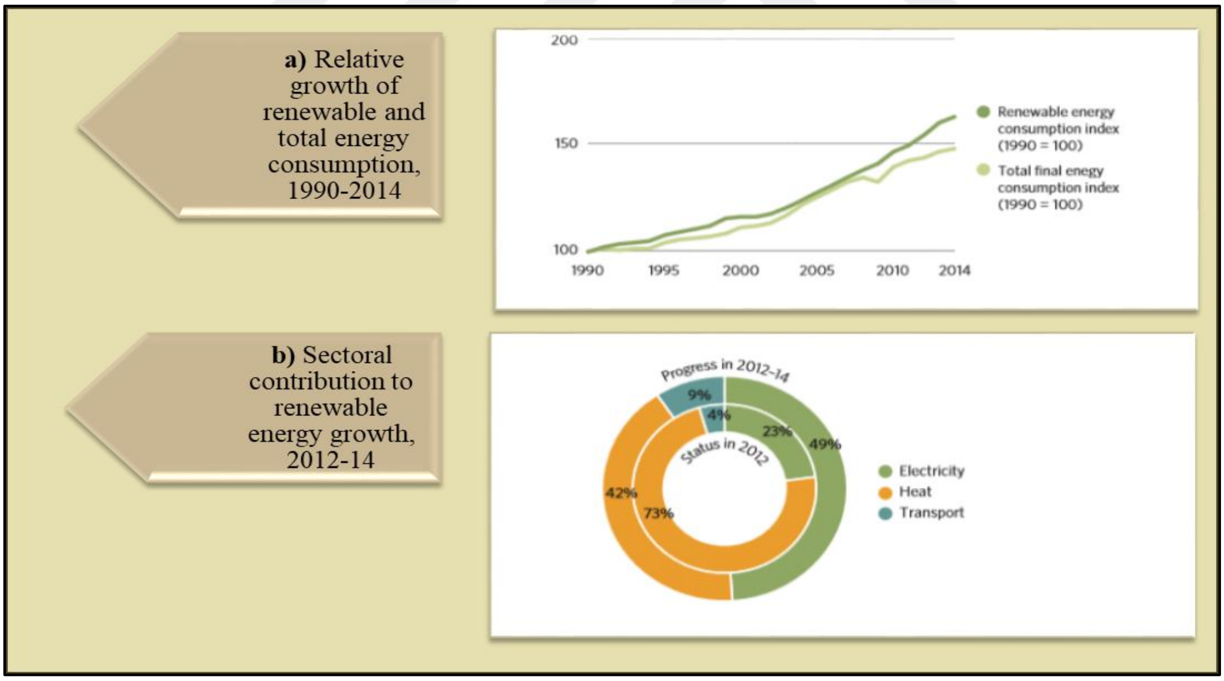


[18] The size of the bubbles means the population density which is able to access to electric in that income level.

Panel B: Energy Intensity



Panel C: Renewable Energy



Source: IBRD/WB and IEA, "**Sustainable Energy For All, Global Tracking Framework Progress Toward Sustainable Energy 2017, Summary**", 2017

Energy intensity is a sufficient indicator for energy efficiency which is another pillar goal of sustainable energy. Reducing energy intensity have also positive impacts on the economy from different aspects. Lower energy intensity lowers the cost to access to energy because of less energy spent, decreasing pollution, improving the competitiveness of industry, and making energy more affordable for households. It is shown in panel B/section *a* that the gap between energy supply and GDP growth raise so if energy intensity is decreased this positively affects economy. Nonetheless there is some challenges in reducing energy intensity like transmission and distribution losses for energy. In section *b* of panel B this situation is shown by percentage of transmission and distribution losses for electricity. This challenges are relative to the income level (or level of development since this is an indicator for development) of the regions. Transmission and distribution losses are 7% in high income countries while it is approximately 16% in low income countries. There is something strange that low income countries have lower losses of transmission and distribution than lower mid-income countries and this can be investigated whether the difference of 1.5% is significant or negligible.

Renewable energy from the pillar goals of sustainable energy does not satiably perform. The section *a* of panel C shows the slow increase in renewable energy. Usage of fossil fuels rather than renewable energy in industry, transportation, and in cooking & heating is the main source of this. But in recent decade, generating electricity from renewable for provision of increasing energy demand gained importance, and it is increasing. To the section *b* of panel C, contribution of electricity to renewable energy is raised from 23% to 49% between 2012 and 2014 which means an increase more than 100%.

So even if a sum of achievements are present, there is so much to do. The goals for sustainable energy – lower energy intensity, higher usage of renewable energy, access to energy are vital to be achieved. Because energy is one of the essential elements of both production and consumption, and access to affordable and clean energy for all is a key factor for sustainable, inclusive growth.

1.2.2. Post 2015 Development Goals Framework

Post 2015 Development Goals Framework is a parallel initiative to SDGs, they are co-ordinated and coherent, and it is determined several goals for sustainable and comprehensive development. The goals are called as Bellagio Goals and they are as follow[19]:

1. Inclusive growth for dignified livelihoods and adequate standards of living

[19] Nicole Bates-Eamer, Barry Carin, Min Ha Lee And Wonhyuk Lim, With Mukesh Kapila, **Post-2015 Development Agenda: Goals, Targets And Indicators- Special Report**, The Centre For International Governance Innovation (CIGI)/ Korea Development Institute (KDI), 2012, pp. 1

2. Sufficient food and water for active living
3. Appropriate education and skills for productive participation in society
4. Good health for the best possible physical and mental well-being
5. Security for ensuring freedom from violence
6. Gender equality, enabling men and women to participate and benefit equally in society
7. Building resilient communities and nations for reduced disaster risk from natural and technological hazards (establishing stability)
8. Improving infrastructure for access to essential information, services and opportunities
9. Empowering people to realize their civil and political rights
10. Sustainable management of the biosphere, enabling people and the planet to thrive together
11. Global governance and equitable rules for realizing human potential

To be achieved of these goals, infrastructure from several aspects are necessary, and energy is indispensable for the stages of infrastructure and after. So continuous access to clean and cheap energy is associated with these development goals and indirectly post 2015 goals framework contains (or have to contain) the subject of sustainable energy. Energy has been actually one of the effective elements of countries' development progresses since industrial revolution. But it couldn't find its rightful place in the development theories and it had been little bit neglected. But energy started to be an important targeting in development strategies of countries, and energy policies started to be essential part of development policies especially by 2000s. Local possibilities and native policies should be prominent about energy. Because any country which is external dependent on energy cannot access to affordable energy, even if it can, at least, it is not sustainable. The necessary for national action takes place in the Post 2015 Goals Agenda as well.

According to the Post 2015 Goals Agenda, transition to sustainable energy creates opportunities for development path as follows[20]:

- A shift to sustainable energy will force the countries to invest in infrastructure to meet current and future energy needs, and it will allow them to substitute older

[20] OECD and Post-2015 Reflections, **Enabling Investment in Sustainable Energy Infrastructure,** Element 4, Paper 2, pp. 3

technologies with new ones to avoid pollution, and it will put them into more efficient approaches in their new-build energy infrastructure.

- Increasing energy production by renewable energy and increasing energy efficiency can reduce dependence on fossil fuels especially for energy-importing countries. By this way external dependence in energy can be lowered. This also increases energy security of countries, and makes countries more robust against volatility of energy prices.
- The renewable energy sector provide new opportunities for the economies in the context of employment and economic growth.
- Environmental improvement will be one of the positive impacts as well. Pollution will be reduced while social and economic benefit is increased, so renewable energy leads to positive externality in particular in urban areas.
- Facilitating cost-effective access to energy in rural and remote areas is occurred by decentralization in energy provision.

1.2.3. Sustainable Energy Access Planning (SEAP)

"*Clearly, sustainable energy access planning (SEAP) is a multidimensional process, which requires a comprehensive analytical framework. This study is an attempt to develop such a framework for SEAP in order to systematically determine cost-effective and cleaner (environmentally sound and climate-friendly) energy resources and technology options for providing sustainable access to modern energy services and their associated investment requirements.*"[21]

The statement above which is quotation from the report of ADB, Sustainable Energy Access Planning A Framework, shows that the SEAP is a compatible and coordinated project with the SDGs and SE4ALL. Two main objectives of the plan are i) identifying cost-effective and sustainable resource, and technology options to satisfy the access to basic energy services, and ii) considering about the affordability of cleaner energy options to energy-poor households. However targets of the program is expressed by some propositions in the report. According to report, SEAP analyses:

- Social inclusiveness in energy access which means fairly access to cleaner energy in cooking, heating and lightening by different income groups

[21] Ram M. Shrestha Jiwan S. Acharya, **Sustainable Energy Access Planning A Framework**, Asian Development Bank (ADB), 2015, pp. 3

- To consider what is the acceptable minimum energy requirement by energy-poor, and what is the energy demand of non-poor,
- To evaluate the financial implications of even low cost options for clean energy to test the affordability
- To consider the sustainability, reliability and acceptability of cleaner energy services at both local and international level. Because quality is as important as affordability,
- To investigate; the investment requirements for clean energy, benefits of energy access programs in terms of improvements in social well-being and environmental quality, greenhouse gas mitigation, and reduction in energy inequality.

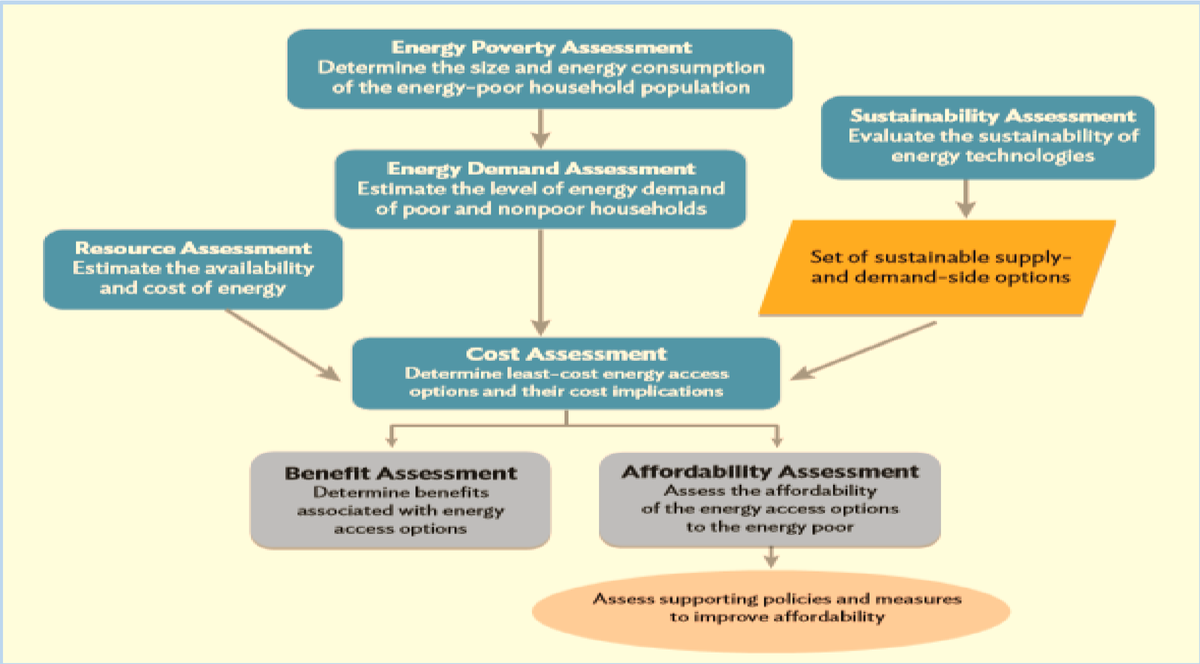
There are seven assessments of SEAP as it can be also deduced from the articles above, and it is figured as below. Figure 1.5 shows the seven assessments of SEAP which are; energy poverty assessment, demand assessment, resource assessment, cost assessment, benefit assessment, sustainability and technology assessment, affordability assessment. If we illustrate them briefly; to see the current situation and to act accordingly, the energy poverty assessment is important for beginning. We can think about it as a feasibility before acting and this is a requirement for determination of investments. Another necessity to determine an investment is demand condition. Because demand factor will affect how much investment in and supply of clean energy is required. Provision, use and distribution of resources are essential for investment, so resource assessment is crucial for production cleaner energy. Affordability and acceptable minimum level of basic energy services for the poor and energy-poor household is very important. So the investments and production should be cost effective and cost assessment is a useful determinant for achieving sustainable energy access.

Figure 1.5: Assessments of SEAP

Source: Ram M. Shrestha, Jiwan S. Acharya, **Sustainable Energy Access Planning A Framework**, Asian Development Bank (ADB), 2015, pp. 5

There are benefits such as time savings, better productivity, health and educational opportunities; improved environmental quality, energy security, energy equality, greenhouse gas (GHG) reduction, reduction in energy inequality. So benefit assessment analyses the improvements in these areas. Identifying a set of appropriate sustainable energy technology and resource options are necessity because hard and soft infrastructure are required. By the way the multidimensional aspects of sustainability—technical, economic, social, environmental, and institutional—are considered in the report. There are two main conditions to access the cleaner energy by the poor: first is existence of energy resource, second is affordability. The affordability assessment estimates the energy burden, which is defined as the ratio of energy expenditure and the total household income-$\left[C_{Energy}^{Household} / Y^{Household}\right]$. So a household is considered as energy poor if its energy burden exceeds an acceptable level. Hence this assessment gives information about size of energy-poor population and energy burden, and the amount of change of them.

Figure 1.6: Sustainable Energy Access Planning Framework: Overall Flow Diagram



Source: Ram M. Shrestha & Jiwan S. Acharya, 2015, pp.7

The figure 1.6 illustrates a kind of order between the assessments. After a consideration about current situation by energy poverty assessment, demand assessment gives idea about the size of investment and production/supply of energy. At that point cost determination is essential. Resource and sustainability assessments are two assessments that affect the cost as well. After accessing the energy, affordability and its benefits are the questions.

So these initiatives address the problems about; access to energy, affordability, energy security and clean energy, energy poverty in particular in the favour of disadvantaged groups, renewable energy. The overall aim is reduction of inequality in accessing clean and affordable energy services through achieving an absolute improvement in these areas. But there is a subject which is neglected by them except post 2015 goals framework: the external dependence on energy. The local and national possibilities are vital for sustainability, because countries can never continue as import-dependent in energy provision.

High cost of energy is a reason to worsen an economy which is external dependent in energy. Hence sustainability is harmed either in energy provision or in whole economy in countries which have high energy demand and scarce energy resources. So for sustainability in energy provision, getting rid of external dependence is needed. Therefore native policies and national/regional acting plans are necessity. By the way continuous and low cost energy supply become possible and higher energy security is achieved.

1.3. Total Factor Productivity And Inclusive Growth

Productivity, in general terms, is capability to produce more while productivity growth is more production under the current possibilities. As to economic aspect, increase in output under given amount of input is explained with the concept of total factor productivity (TFP). More proper combination of inputs or new ideas and innovations in production process are from sources of TFP growth or increase in productivity. We will analyze TFP in detail in the next chapter but we can make a brief explanation at least by a few sentences. The concept of TFP, which belongs to neoclassical school, is based on the idea that a shift in production function without increase in quantity of inputs under constant returns to scale, and it is explained by a kind of multiplier effect in the economy. This multiplier effect is called as technical improvement. The term 'technical' is used for any factor which is leading to increase in output under given amount of inputs. So it captures more than its word sense. Improvement in management and human skills, innovation in production technology or increase in efficiency of inputs are some of instances to reason for TFP growth.

Unlike neoclassicals, it was accepted that productivity and productivity growth is in direct proportion only with the amount of input until 1940s and 50s. The industrialization process, which was started after geographical discoveries, was the basis of this way of thinking. But the technological improvement increased productivity after World War 2 (WW2), and productivity growth was accelerated by revolutionary improvements in the information and communication technologies (ICT) since 1980s. Encouragement for free trade and mobility in the international trade brought about technology transfers and spill overs, by this way increase in productivity became contagious among advanced economies. But a slowdown in productivity-especially in labor productivity- has been seen by the mid-1990s and 2000s in both developed and developing countries, and it was deepened especially by the decrease in capital labor ratio during and after the 2007/08 financial crisis which is arising from some of factors such as under-investment in assets with high spill-over effects, growing business investment in knowledge-based capital, less competitive commodity market, uncontrolled financial systems, and increasing uncertainty.[22]

[22] OECD, **The Productivity-Inclusiveness Nexus**, Meeting of the OECD Council at Ministerial Level, Paris, 1-2 June 2016, pp. 14

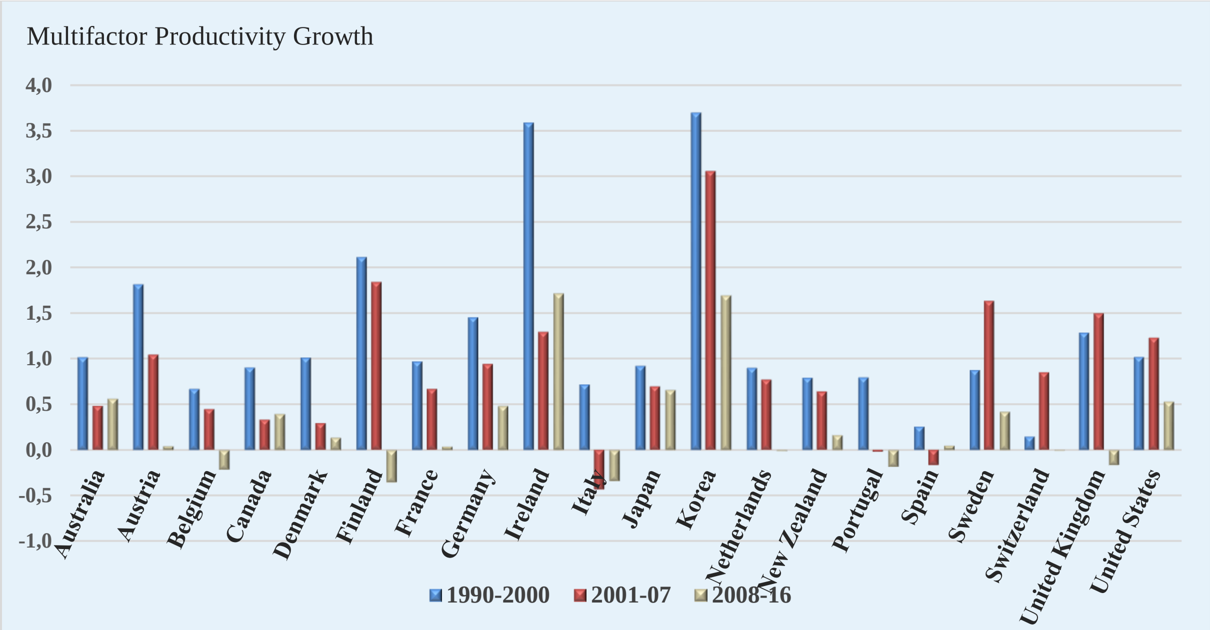
So technical improvement which is single-handed is not enough for increase in productivity and its growth. It should be supported by improvement in labor factor or qualifying the labor force because improvement in labor and technology are like the two pans of a scale for production and productivity. Equal opportunities; investment in human capital, education, health, and infrastructure such as transportation, communication, and logistics; access to energy are some of vital requirements for improvement in labor factor. Otherwise inequality in income, wealth and welfare is occurred among individuals, social groups and societies. Because inequality of opportunity, underinvestment in human capital and others create advantaged and disadvantaged groups. The people -who are facing inequalities from the aspects of; education, health, nourishment, possibilities of infrastructure that they access, residence and environment where they live and etc.- are disadvantaged and they can't get the level of quality and skill for high income jobs. This leads to; increase in inequality on income and non-income dimensions, decrease in labor productivity and total productivity. These two constitute a vicious circle at the end.

1.3.1. Decreasing Productivity Growth And Inequality

Technological improvement has a substantial effect on creating positive productivity growth. In particular growing informatics and digital technology have contributed much to productivity and productivity growth since 1980s. Yet things have started to change since mid-1990s and 2000s. Productivity growth began to experience slowdown in spite of the technical improvement. The decreasing trend in productivity can be obviously seen in figure 1.7. The multifactor productivity growth of 20 developed and developing countries follows a decreasing trend between 1990 and 2016, and 2007/08 financial crisis contributed to decrease in labour productivity. Figure 1.8 also can be proof to slowdown in productivity, the deceleration in labour productivity is seen via the red line which is trend of OECD total. Labour productivity is an indicator which is measured as an index with 2010=1, and it is defined as real GDP per hour worked. This captures the use of labour inputs better than just output per employee, through labour input that is defined as total hours worked by all persons involved[23]. The rapid increase in labour productivity was occurred until oil crisis, and it started to slowdown as it is seen in the figure.

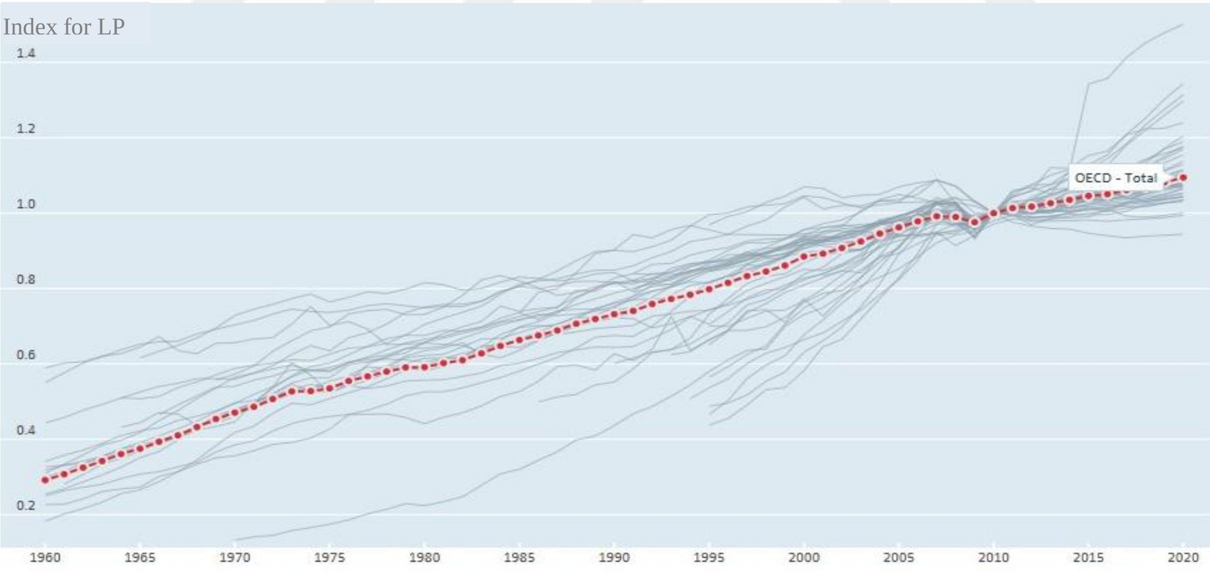
[23] https://data.oecd.org/lprdty/labour-productivity-forecast.htm

Figure 1.7: Annual Growth of Multifactor Productivity between 1990-2016



Source: OECD data, databases, **GDP per capita and productivity growth**, multifactor productivity

Figure 1.8: Estimated Labor Productivity of OECD Countries between 1960-2020

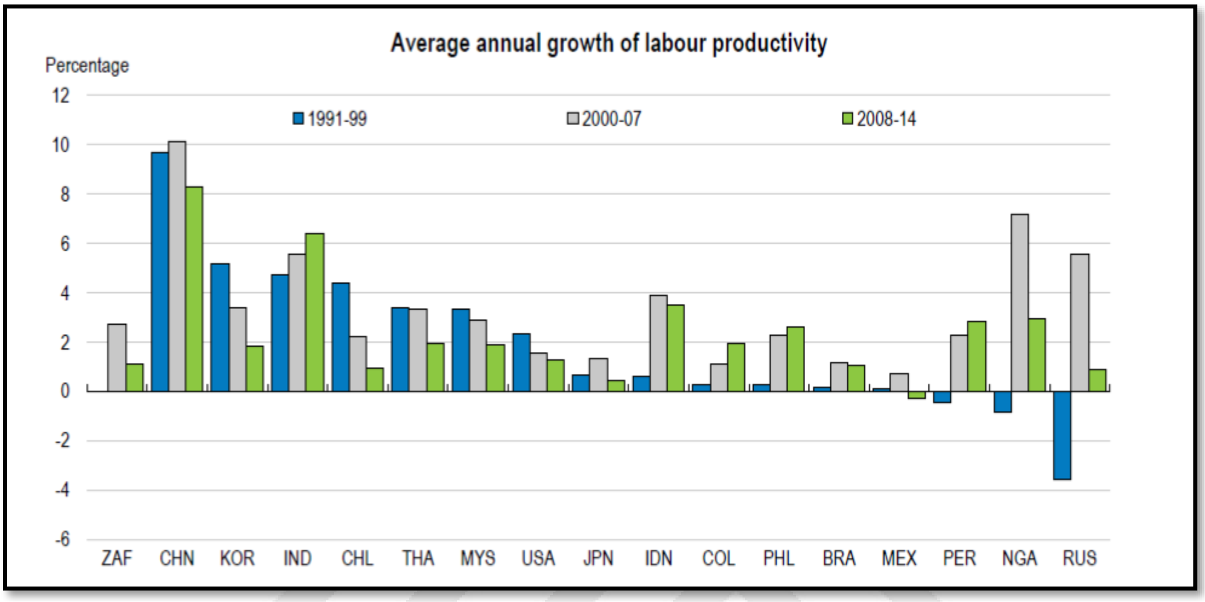


Source: OECD data, indicators, labour productivity forecast

After the crisis a speedup in trend is observed until 2000s, hence the trend began to slower again and after the 2007/08 financial crisis the slowdown in productivity transform to negative growth for a few years.

Downward growth of labor productivity is similar in emerging market economies as well. Figure 1.9 illustrates the labor productivity performance of developing countries between 1991 and 2014, and it is obviously seen that productivity growth of labor is tended to decline.

Figure 1.9: Average Annual Growth of Labor Productivity in Emerging Market Economies



Source: OECD, "**The Productivity-Inclusiveness Nexus**", Meeting of the OECD Council at Ministerial Level, Paris, 1-2 June 2016, pp.17

We can link the slowdown which is seen in the figures above with the oil crisis between mid of 1970s and mid of 80s, but what about the slowdown since 2000s. We will try to illustrate the reasons.

The imbalances and dispersion in economic performance among individuals, firms, and regions; market conditions; breakdown of diffusion mechanism; skill-mismatches; stagnation in business; financialization; low human capital are from the reasons of slowdown in productivity[24]. For the global context, the inadequate level of investment in; assets like physical and digital infrastructure, broadband, internet or other network systems whose effects are reflected in many areas have been the substantial reasons for slower productivity. The attraction of more earning under lower risk promoted people to capital income. This is also an important factor of decreasing investment. For this reason some structural and seasonal problems like demand deficiency, slower or insufficient capital accumulation may occur. Weak product market competition, non-operating or insufficiently operating financial markets, and high levels

[24] OECD, **The Productivity-Inclusiveness Nexus**, 2016, pp. 6-7

of uncertainty have also played a role. So more resolute and balanced global demand, supported competition and empowered markets, and reduced uncertainty are vital to increase investment for the aim of better productivity performance and higher economic growth.[25]

Another important (and more related with the title) reason of slowdown in productivity is the divergence of economic performance which also has a historical part between:

- Emerging and advanced economies
- Advantaged and disadvantaged regions
- Pioneer and lagging firms
- Wealthier and poorer individuals

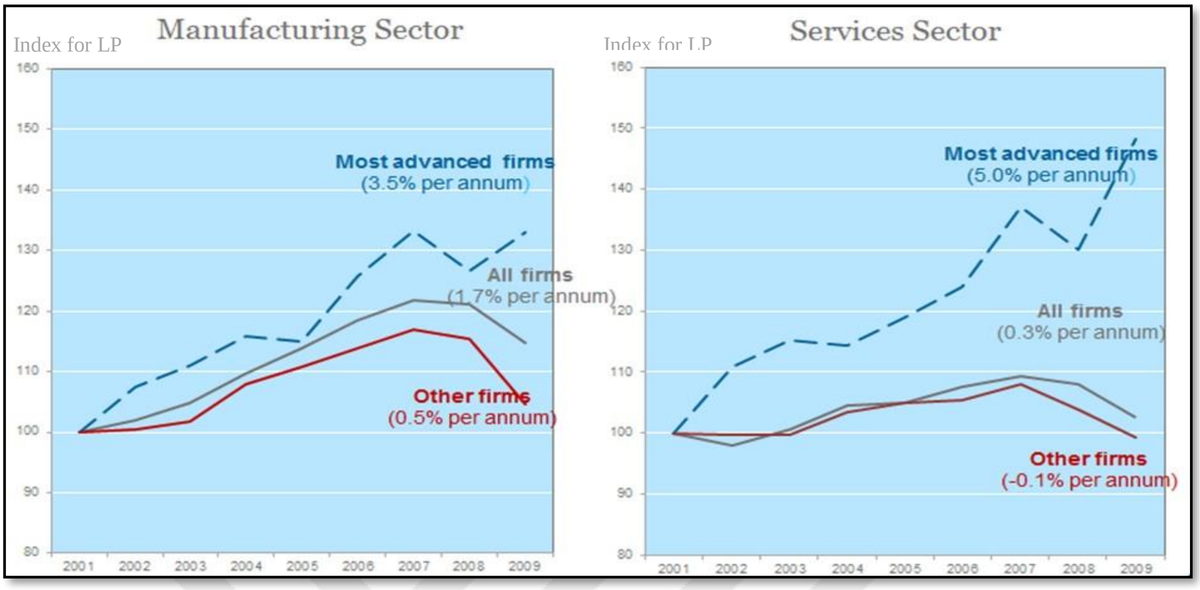
We can briefly explain what does it mean historical part of divergence. Advanced economies realized the industrial revolution after geographical discoveries and they got an important economic advantage across the globe. Following the revolution, the technological improvement which can be counted as second revolution for the science of economics after WW II, and finally the improvement in the information and communication technologies since 1980s made the advanced economies much stronger against other countries than past. Today emerging economies are not yet able to success to catch up their rivals which are frontiers in the economy. Near the divergence between them, there are unequal situations within the countries. The socioeconomic inequalities or divergences lead to lower productivity growth-in particular labor productivity. The problems below are responsible for this:

- Unfair distribution of wealth in the emerging and advanced economies
- The level of technological spill over which is less than expected among the world
- Non-functioning or weakly functioning diffusion mechanism

The three articles above are the subjects of inequality. The unequal conditions between global firms and others lead the companies to diverge in the sense of productivity. Due to the divergence between global companies and others, productivity slower. Because they act as oligopoly in both international and domestic markets. Capital accumulation, wide individual and institutional network, social relations that they have provide them a huge comparative advantage against their competitors and this constitutes as a natural endowment for them.

[25] OECD, **The Productivity-Inclusiveness Nexus**, 2016, pp. 14

Figure 1.10: Divergence in Productivity Performance among Firms in The World (2001 is the base year)[26]



Source: OECD, **The Productivity-Inclusiveness Nexus**, Meeting of the OECD Council at Ministerial Level, Paris, 1-2 June 2016, pp.18

The gap between frontier (a category comprised of firms from different countries, reflecting varying patterns of comparative advantage and natural endowments [27]) and laggard firms can be obviously seen in figure 1.10 in the sectoral basis. Average annual growth of 3.5% in manufacturing sector and 5% in services sector is obtained by global frontiers whereas a trend of 0.5% in manufacturing sector and -0.1% (negative growth) in services sector is realized by other firms.

There can be several causes of dispersion of productivity among firms, but the link between dispersion of productivity and breakdown of diffusion mechanism is an appropriate indicator under the current conditions. Spreading of innovation and technology among firms are less than the expected level. The social and spatial advantage of pioneer companies make them in forefront in production (industry and services sector) and commerce. The advantages

[26] Notes from the original source: “Frontier firms” corresponds to the 100 globally most productive firms in each 2-digit sector. “Non-frontier firms” is the average of all other firms. “All firms” is the sector total. The average annual growth rate of average labour productivity (value added per worker) is shown in parentheses. The broad patterns depicted in this figure are robust to: i) using different measures of productivity (e.g. TFP based on the Solow residual from a value added production function containing tangible capital and employment, using uniform factor shares across countries and over time for comparability); ii) following a fixed group of frontier firms over time; and iii) excluding firms that are part of a multi-national group (i.e. headquarters or subsidiaries) where profit shifting activity may be relevant. Source: Andrews, Criscuolo and Gal (2015).
[27] OECD, **The Productivity-Inclusiveness Nexus**, 2016, pp. 17

like ability to operate in different countries, wide financial opportunities, high profitability and their individual and institutional social network provide them an important privilege against the lagging firms in all markets. So their innovation capacity becomes stronger. They have better and much more options and opportunities to make investments in:

- R&D and high technology,
- High quality production process which contains objectives to make improvement in technological, organizational, operational areas and in human capital.

This advantaged positions of global firms also create a positive cycle in the favor of knowledge-based capital, innovation and new investment projects. For example, they become more capable on accessing, using and spreading the digital technologies, and their ability to invest and apply the new ideas in production, marketing, trading etc. raise. Because knowledge has a cumulative structure and no need to reproduce once it is produced. This leads to positive externality in the production. Moreover this lowers the cost of new technologies and cost of putting into practice of new ideas. So the more production of knowledge the less cost of its production, hence increasing returns to scale in knowledge-based capital is occurred.

Wide network of the firm with several public and private firms, managers, and consumers provide a substantial advantage to the firm more comprehensive than knowledge-based capital as well during its stages of establishment, getting input, and production. Network is very important for the things like position in the sector, maintaining in the market, getting into different markets, customer portfolio and etc. This is like a positive externality. But technologically pioneer firms have permanent advantage in competition, and this leads to technological spill-over to remain short. By the way inequality in this area is occurred and some of the firms are advantaged to earn more both within and out of production. This allows the frontier firms to pay higher to their employees and income inequality sharpens.[28]

Another reason of unfair competition among companies is the imperfect knowledge in the markets. Higher ability to access to information is an important advantage for the pioneer companies in production and trading against their lagging competitors. So competition in obtaining information set is in question as well, and getting the knowledge before the rivals is an important factor for lowering the cost and providing extra gain. Such a market structure leads to different problems. For example rental income increases due to the positive externality of global companies which is arising from their social and institutional network, and this makes

[28]OECD, **The Productivity-Inclusiveness Nexus**, 2016, pp. 53

the sectors or markets that they operate more attractive for investors. Oligopolistic structures may be shaped because of the imperfect knowledge and imperfect competition. By the way share of capital increases in the favor of pioneers. This is a real advantage for global companies but it is not valid for the sectors and economy as a whole. Because dispersion of productivity among firms and income inequality deteriorate.

From the perspective of laggard firms, the things go wrong. Because it is very difficult and costly to learn from the pioneers. First, there is a time lag that is needed to settle of technological improvements. Non-frontier firms may not access quickly and easily the new technologies because of their insufficient financial and institutional structure. Second, conditions and competition are not fair most of time market, there is imperfect knowledge in the markets, and the conditions are carried out in the favor of pioneers.

Not only accessing the new technologies but also adopting and applying the technology by the laggard firms is very important for productivity. There are unfavorable environment for adoption of technology by the lagging firms such as; the smaller firms' habits, expectations, capability, inadequate financing and human capital, imperfect market conditions, markets which are operating in an unfair and faulty way, the policy implications that are consistent with the markets, the low level of operational and organizational structure/capacity of the firm.

So the improvements, which are expected to serve as multiplier for the economy and to satisfy increase in added value, do not work by themselves unless government intervention. Policies are needed to prevent the firms and markets from dispersions of productivity and productivity growth, and to reinforce the diffusion mechanism among firms and regions.

According to OECD there are five determinants of international diffusion mechanism[29]:

- International network on the production, business and finance areas, and perfect mobility of skilled labour around the world,
- Information transfer and properly functioning communication channels in the domestic markets in the sectoral and institutional basis,
- The opportunity and capability of firms to access and use the new technologies and business models,
- Investments in R&D, skills, organisational training for decision makers and other forms of knowledge-based capital,

[29] Ibid, pp. 27

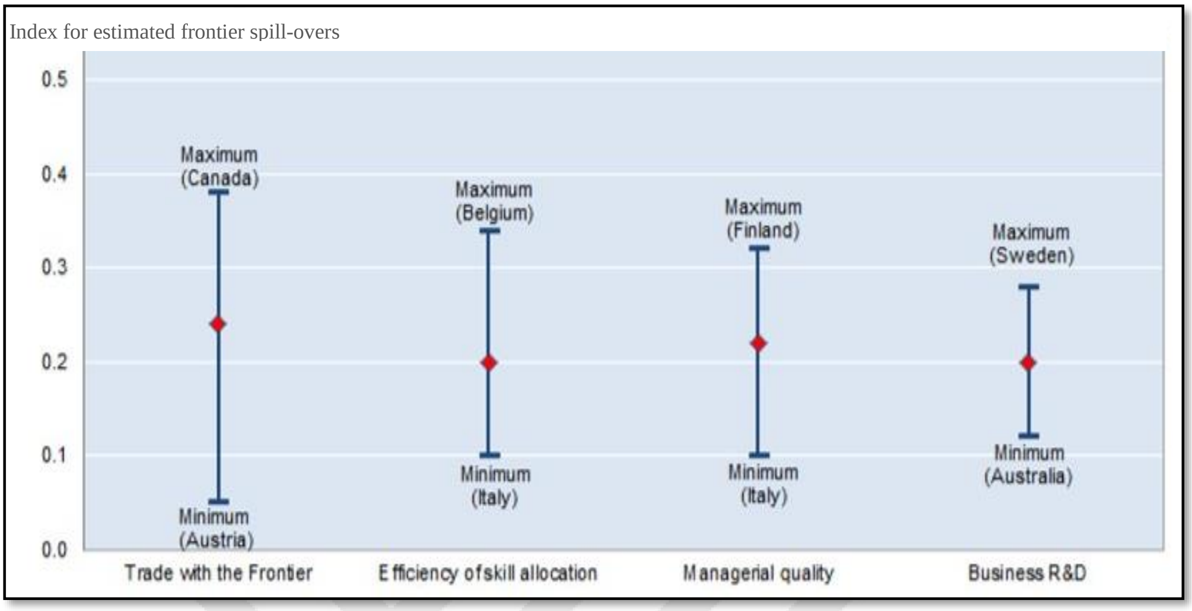
- Efficient reallocation of scarce resources.

When the one or more of above are not properly carried out due to the reasons which are arising from negative conditions in domestic and international markets and unequal opportunities among firms, diffusion mechanism breaks down. Under the absence of perfect knowledge; frontier firms, which have advantages from lots of aspects in production and trading, become more advantaged against their rivals because of progresses of the increasing mobility of capital and labor and encouraging free trade by globalization process, and improvement in technology and popularization of digitalization. Hence divergence in productivity among firms is occurred. This reflects to regional perspective because big companies make the region where they operate as a center of attraction for labor force, entrepreneurs, and investors. By this way the developmental comparison between regions started to be substituted for comparison between countries, in this context demonstration in figure 1.11 is significant. If it is needed to repeat, the main source of this is economic activities that have gone beyond the borders by the globalization process under imperfect market conditions.

On the other hand the effectiveness of the five shaping factors of diffusion mechanism changes relative to countries' market conditions, policy applications, demand structure etc. The annual percentage of spillover, which is arising from 2% increase in multi-factor productivity (MFP) growth in the global pioneers, is shown in figure 1.11. The expected frontier spill-over effect, which is related with 2% MFP growth at the frontiers, is shown by red points. These points are the average rates of effect of the shaping factors among the OECD countries. The structural factors that are shaping productivity diffusion are:

- Trade with the frontier
- Efficiency of skill allocation
- Managerial quality and
- R&D Business.

Figure 1.11: Different structural factors shape productivity diffusion from the global frontier across OECD countries

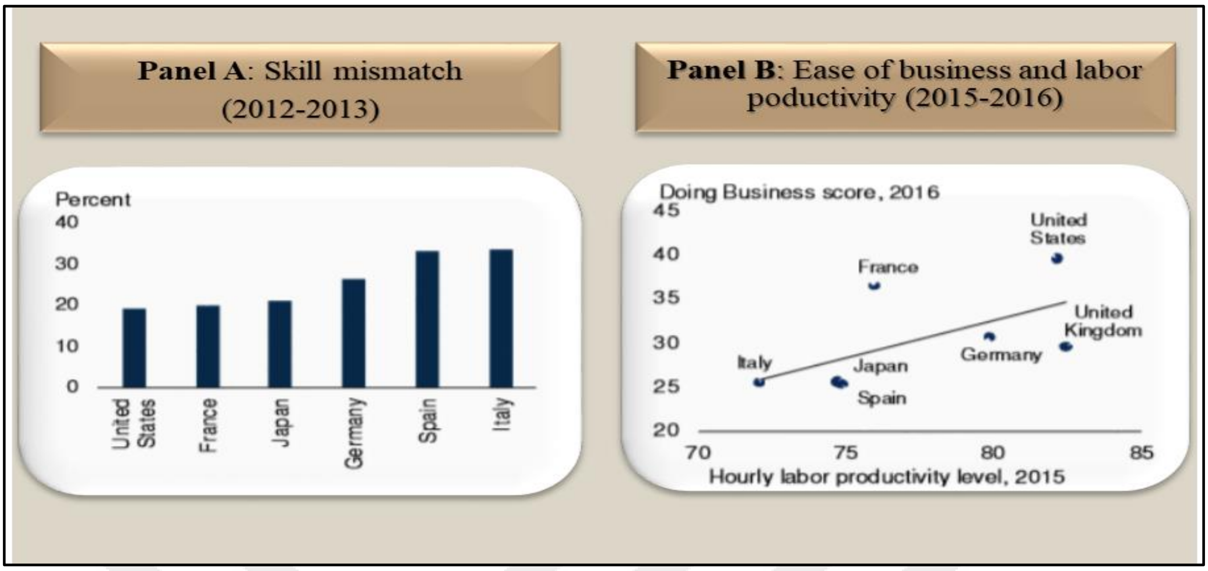


Source: OECD, **The Productivity-Inclusiveness Nexus**, 2016, pp. 27

The countries which have extreme values are shown in limits of vertical lines by the labels of minimum and maximum. These are the countries that show the best or worst performance in shaping factors.

Except the breakdown of diffusion mechanism and dispersion of productivity growth, there are other reasons of productivity slowdown as well. High cost of investment in technology and human capital constitute as barrier to exit. Because once a firm make these investments it is not easy to decide to leave the market. Furthermore skill mismatch in the firm, and neglecting the competency of employees decrease the productivity and productivity growth. It is easily seen in panel A of figure 1.12 that the rate of skill mismatch is as high as at least 20 % even in developed countries. On the other hand when we consider the linear and powerful relationship between the ease of doing the business and labor productivity in panel B of figure 1.12, the importance of human capital and learning effect of labor become more visible. Because as people are getting experienced and as HC increase, labour productivity increase. So reallocation of factors of production, and to not to get risk higher than the capacity of the firm are really important for good performance of productivity growth with regard to skill mismatch and difficulties of exit in order.

Figure 1.12: Skill-Mismatch and Labour Productivity in Advanced Economies

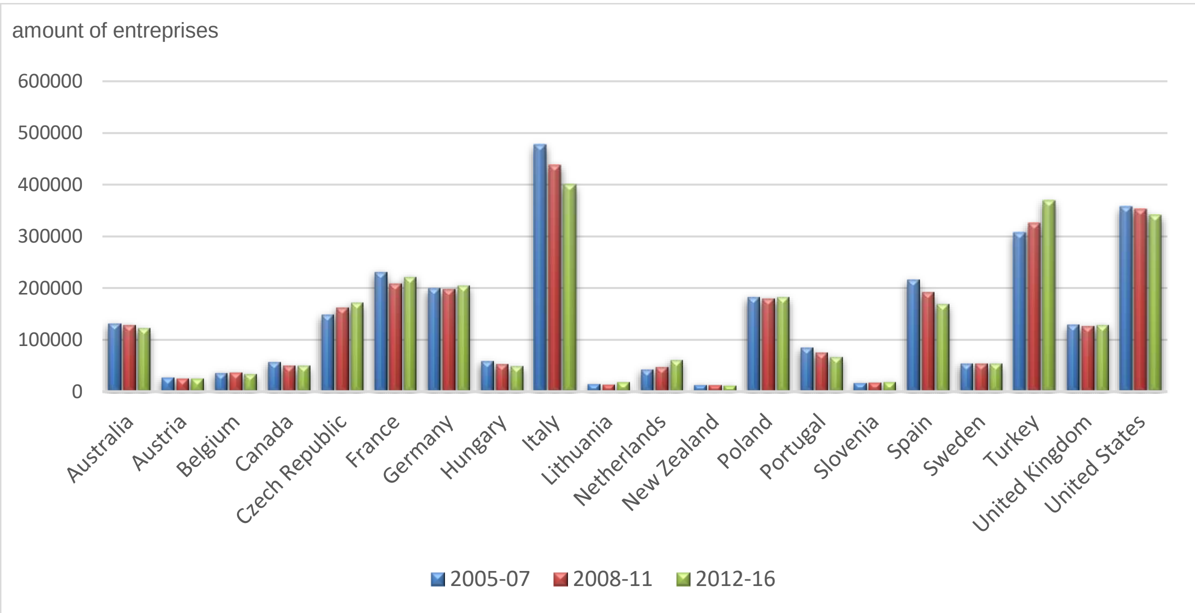


Source: WB, **Global Economic Prospects Divergences and Risks**, June 2016, pp. 3

Another motivation for positive productivity growth is the organic structure of the business, it is changing and transforming pursuant to the societies during time. So when a stability or stagnation in business is the situation, productivity growth is affected negatively.

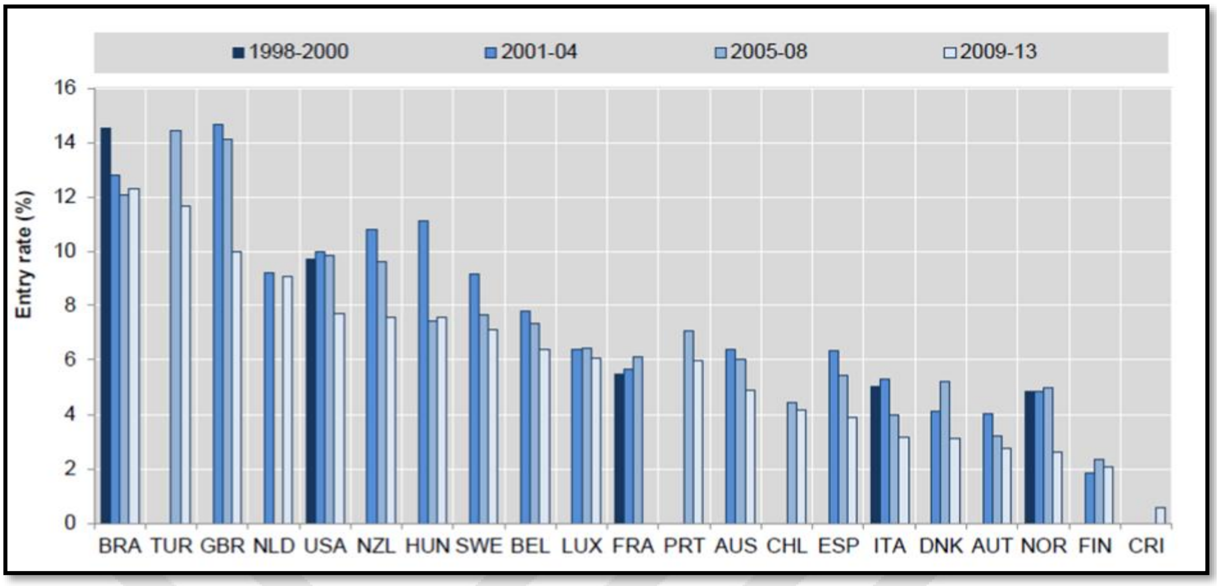
Figure 1.13: The Convergence between Productivity Growth and Business

Panel A: Number of Enterprises in Manufacturing Sector in OECD Countries btw 2005-2016



Source: OECD data, database, **structural business statistics ISIC Rev. 4**, number of enterprises, 10_33, SSIS

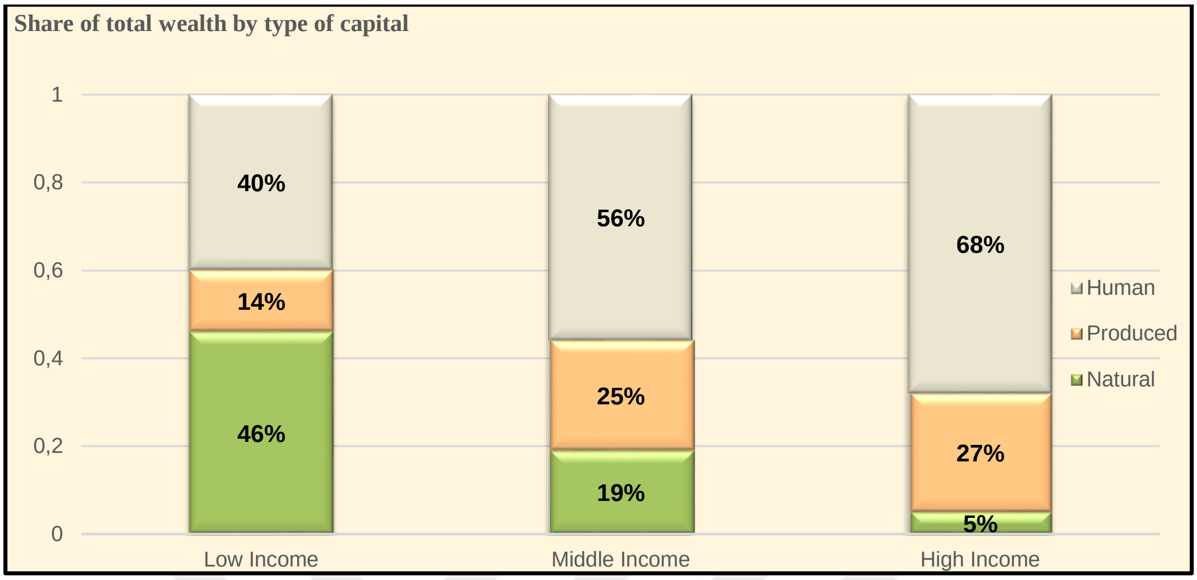
Panel B: The Percentage of Startup Relative to Countries between 1998 and 2013



Sources: OECD, "**The Productivity-Inclusiveness Nexus**", Meeting of the OECD Council at Ministerial Level, Paris, 1-2 June 2016, pp.29

The figure 1.13 illustrates that a steadiness is seen in business. The stable trend of number of enterprises in most of the OECD countries in panel A, and decreasing trend in business startups since the beginning of 2000s feed each other in panel B. We mentioned about difficulties for exit the markets. Additionally the slowdown in entries (startup) shows the lowering deceleration in dynamism of business among different countries in the last two decades. This is surprised because it is realized in spite of technological improvement. Why business and productivity conformably slower while technology, in particular ICT and digital technology, is improving. The answer is low level of human capital. Because technological development in the imaginary and material equipment basis is not enough for better economic performance, there is necessity for human factor to use this technology, so investment in human capital is vital for higher productivity growth and better economic performance. According to data, which is sourced from web site of WB, the share of type of capitals from total wealth is highest in high income countries by the percentage of 68% whilst the lowest in low income countries by the share of 40%. If we consider the correlation among income level, productivity growth and economic advance of the countries, a significant result can be deduced from figure 1.14. It is seen that pioneer countries, which are higher productive and wealthier, reserve more of their total wealth for human capital than laggings. That's why the low and middle income countries should redistribute their total wealth and should increase the share of human capital.

Figure 1.14: Distribution of Total Wealth Among Types of Capital in Different Income Groups of Countries in 2014



Source: World Bank, Year in Review: 2017 in 12 Charts

Moreover importance of education and training is another donnee for human capital and it is one of most important sorts of disparity. *"The 2018 World Development Report finds that the quality and quantity of education vary widely within and across countries. In the poorest countries, fewer than 1 in 5 primary school kids are proficient in math and reading. Hundreds of millions of children around the world are growing up without even the most basic life skills. A forthcoming study will look at the effects of education on economic mobility between generations. For example, about 12% of adults born in the 1980s in some low-income or fragile economies of Sub-Saharan Africa have more education than their parents, compared to more than 80% of the same generation in parts of East Asia."*[30]. This information which is obtained from WB gives clue about the relationship between human capital and productivity growth as well.

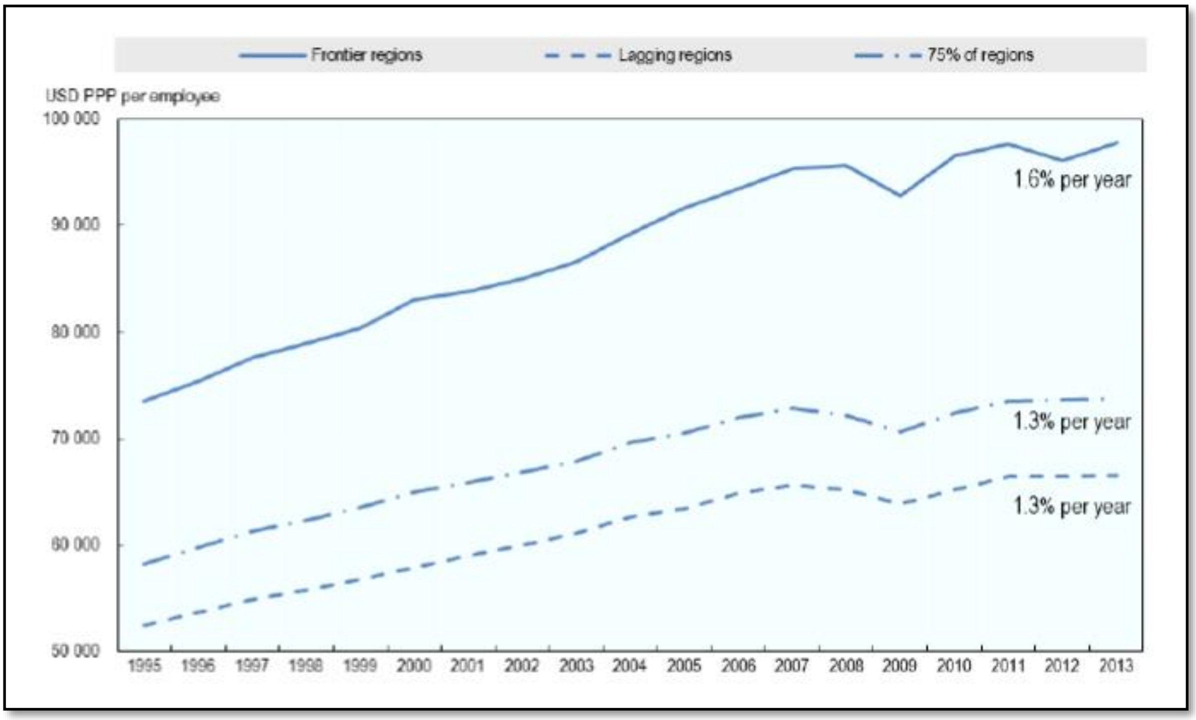
The financialization is also another substantial determinant for dynamism of business sectors. The expansion of financialization raise the importance of financial sectors and make it integral part of business in last few decades. But inadequately functioning financial institutions or speculative actions and discourses in the financial markets lead to the dynamism of business

[30] World Bank, **Year in Review: 2017 in 12 Charts**, http://www.worldbank.org/en/news/feature/2017/12/15/year-in-review-2017-in-12-charts

be harmed through damaging of the exit and entry of markets. The circulation in the markets stagnate from the side of suppliers and producers.

We said that there are several reasons for productivity slowdown before, and one another is regional dispersion in productivity growth. We have already told about the reflection of firm based divergence in productivity among regions as a result of breakdown of diffusion mechanism. The figure 1.15 is helpful to give the possibility of seeing this convergence between productivity differentiations under the basis of firm and region.

Figure 1.15: The Labour Productivity Dispersion between Frontier and Lagging Regions from The Mid-1990s Until 2013



Source: OECD, "**The Productivity-Inclusiveness Nexus**", pp.30

The labour productivity which is measured in GDP per worker obviously differs regionally. The dispersion is approximately higher than 20000 USD PPP per worker in beginning balance between frontier and lagging regions. Their growth trend also differ as well. 1.6% per annum growth in GDP per worker is occurred in frontier regions (top 10%) while 1.3% per annum is the fact for the lagging regions (sum of bottom 75% and lowest 10%) and the bottom 75% regions. At that point urbanization is an important factor as both reason and result.

The frontier or more developed regions are urban areas generally while the less developed or underdeveloped ones are rural. Two assumptions are valid in selection of region by firm; first the firm may be established in an urban area because of the higher possibilities of infrastructure like transportation, communication etc. Second the firm is established in rural area because of several priorities like closeness to raw material or energy sources etc. and make the region as a center of attraction. The population start to gather around the region and urbanization process begins. The second one has been common condition in Turkey since 1950s. For instance when a factory is established in a suburb area of industrial cities like Istanbul, Kocaeli of Turkey or in a city whose level of industry is low, a dynamism starts in the area. Thus the urbanization process begins by increase in actions of construction and infrastructure in the region. According to the OECD report "The Productivity-Inclusiveness Nexus", the urbanization of frontier regions is 71% whereas the lagging regions are predominantly rural with a percentage of 64%, and 81% of predominantly urban frontier regions contain very large cities.[31]

The urbanized frontier regions may also be separated each other as developed and well developed. An innovative company, which produces or uses cutting edge technology, offers better conditions to employees. This may create a similar effect and lead to regional differentiation. In such a case, beyond urbanization, creating a new market area is the subject, market entries begin. Gathering of other firms around the region is the condition whereas gathering population was current in urbanization process. A well-known example of this is Silicon Valley in the USA.

So present data and OECD report-"The Productivity-Inclusiveness Nexus" show that policy implications are needed to eliminate dispersion in productivity among firms and regions. Otherwise it seems impossible to not to fail by laggings to do like frontier firms and regions in near future. Because:

- Failure of diffusion mechanism is very important in productivity dispersion. This kind of inequality have to be decreased for better productivity performance.
- Low level of human capital lowers the productivity growth and feeds the divergence in productivity growth under both firm and of region basis. In particular, since high skilling is a distinguishing factor in the labor market, investment in human capital should be increased.

[31] OECD, "**The Productivity-Inclusiveness Nexus"**, pp.31

- There are regions where capital inflow is very low, and naturally they cannot perform in a good way. Productivity growth and economic performance decrease automatically in these regions.
- Lack of political stability, structural deficiencies, low institutionalization, wrong or incomplete policy implications affect economy negatively. If policy/decision makers do not properly do their work, productivity growth slower and it disperse relative to firm and region.
- There is; individually and regionally dispersion in access to energy, inadequacy for fulfillment of needs in heating, lightning and cooking. So governors should invest on sustainable energy.

1.3.2. Inequality Of Opportunity And Human Capital

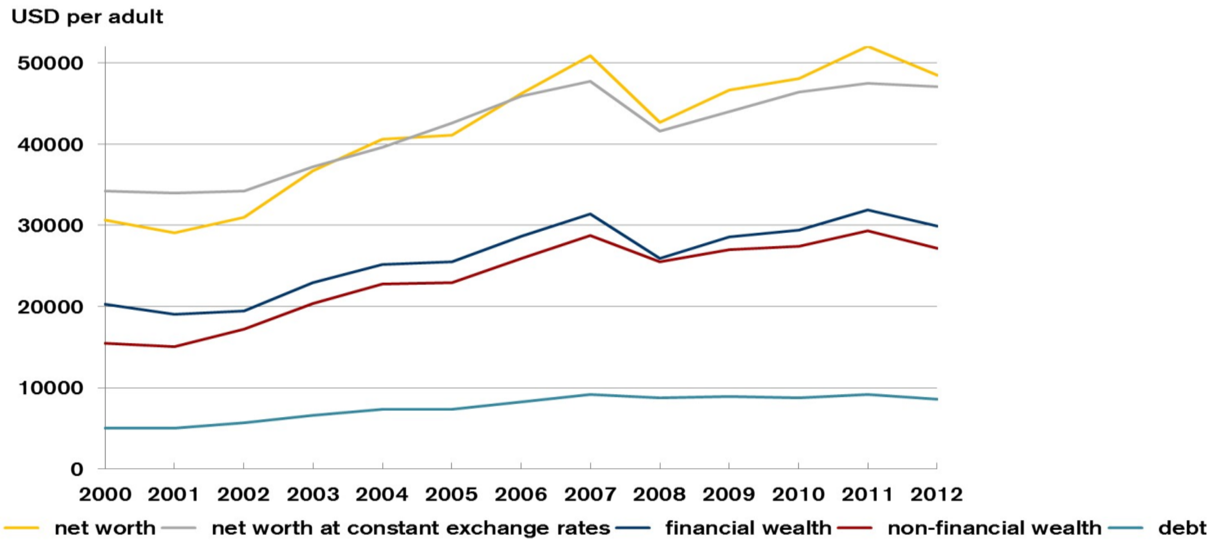
Inequality of opportunity is one of the main problems which constitute foundation for inequality in every areas. Inequality in; income, wealth and welfare are affected not surprisingly by unequal opportunities. Social, political and spatial environment where people live; the tradition that people came from; religion; language; race; gender; the financial and cultural structure of families that people have grown up and their background; and related separations in education, health, and culture among people lead to and arise from -naturally or by discriminative practices- inequality of opportunity. Namely a vicious circle is occurred between unequal opportunities and inequality.

Inequality of opportunities have outcomes on productivity and economic growth through human capital, and economy as a whole by both its reasons and results. Improvement in technology- especially in skill-based technology, globalization and increase in population caused a transformation in labor market. Because, augmenting necessity for qualified/skilled labor by skill-based technology, increase in labor supply by growing population, and raising mobility of capital and labor by globalization have promoted the competition in labor market. Labour have to be more attractive than others even for routine jobs. This situation which is called as job polarization brings about to wage dispersion. High skilled labor-high paid jobs and low/middle skilled labor-low paid jobs conditions are occurred. The point of view is disability of some people for high skill level because of unequal opportunities and related income inequality problem. On the other hand market segmentation has occurred in the labor market and relatedly the supply and demand conditions of non-standard form of jobs took its share because of the articles below:

- The growth of services sector and knowledge based works, and prevailing use of ICT,
- Reforms on labour market regulations which make the labor more flexible on making decision about job, and this is caused by setting free of nontraditional links between employee and employer.

Temporary, part-time jobs and self-employment began to be prominent. There are advantages and disadvantages for workers in these type of jobs. Although additional possibilities of job are appeared by this way for both skilled and non-skilled labor, it may worsen the situation of non-skilled labor. Because they have to accept lower income, weak or absent job security and fewer opportunities to access to training. Wage penalties, instable salary and slower wage growth problems are often encountered as well. So again unequal opportunities lead to fostering the income inequality because of distinctiveness of skilling among workers. These problems affect economy negatively by slower productivity growth.

Figure 1.16: World Trends in Wealth per Adult, 2000-2012[32]



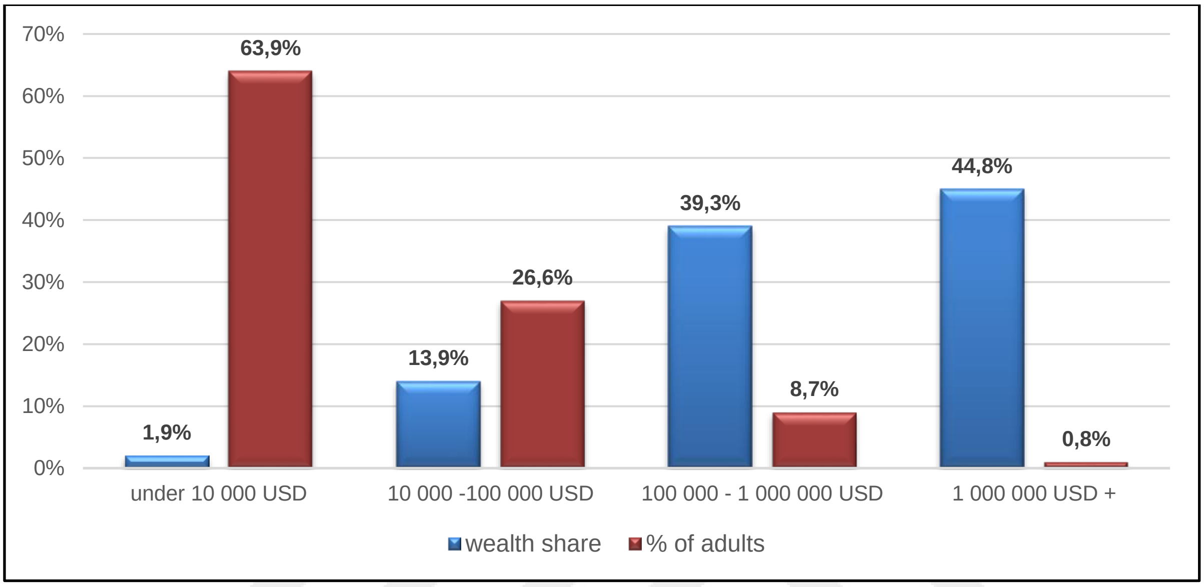
Source: 2012 OECD World Forum New Delhi, Measuring the Global Distribution of Wealth

As it is shown in figure 1.16, trend in total wealth in the globe is increased after technological improvement however 2007/08 financial crisis lead to some decrease. But unfortunately there are problems about distribution of wealth. Inequality in distribution of

[32]Davies J, Lluberas R, and Shorrocks A F, **Measuring the Global Distribution of Wealth**, 2012 OECD World Forum New Delhi, 17 October 2012

wealth is seen in net in the figure 1.17. According to the figure, 63.9% of total population who have personal wealth under 10000 USD have got the 21.9% of total wealth whereas the top wealthiest 0.8% of the world population who have more than 1 million USD as personal wealth have got the 44.8% of total wealth.

Figure 1.17: World Distribution of Wealth in 2018



Source: Credit Suisse, **Global Wealth Data-book 2018**, pp.117-118

Financialization process is also one of the responsibles. Higher income parties in the society get much more gains in saving and investment projects than the ones who are poorer. The financial system offers more and better opportunities to high income groups to invest in and to save for housing, education, health, and others. This is a kind of unequal opportunities which is arising from risk factor in the financial system.

If the substantial effects of unfair distribution of wealth on equal opportunities and on economic growth are the subjects, then it can be said that households with low income should invest in both their and their children's education, training and skills rather than saving to raise their current wealth. Investing in human capital is more proper for those whose income is lower. Thus this can be called as a type of future investment, saving for wealth in the next.

From the side of productivity, the relationship between distribution of wealth and equal opportunities are very important. Demand for higher wealth of the poorer can positively affect productivity and the economy if it would be incentive to invest on human capital but focusing on wealth accumulation particularly by the wealthier can be reason for increasing of demand for capital income while it may lead to decrease investment, economic growth and productivity.

That's already one of the conditions for slowdown in productivity which we mentioned in the previous title. Because potential of economy will not be used efficiently because of[33]:

- Imperfect reflecting of individuals' potential (saving) to the production process
- Demotivating the entrepreneurs, investors for making business and investment
- Decreasing the endurance and recovery capacity of the economy against recessions, shocks etc.

In addition to income and wealth inequality, unfair situations in non-income dimensions such as health, education, social and spatial environment, access to job and acquisition of skills, job quality etc. are present[34]. A reciprocal relation between inequality and unequal opportunities can be said, because they can be both the reason and the result each other. Inequality of opportunities can reflect directly to wellbeing or it may cause an income based non-income dimension inequality. As we mentioned above the situations like divergence in skill level, job polarization and wage dispersion are some of the reasons of increase in income and wealth inequality. This is surely lowers the level of welfare of the poorer and increase inequality in wellbeing. Unequal opportunities that is arising from natural or discriminative practices cause to pose an obstacle against acquisition of prestige, career, and class as well. These are also important losses for people as much as tangible / substantive ones.

The lower the level of welfare the higher the inequality of opportunity. Because people's opportunities are shaped by their socioeconomic situations. It constitutes an unfair situation in job selection, earnings and income, and wealth through unequal opportunities for a person who comes from an economically or socially disadvantaged group. Hence unequal circumstances among individuals in the context of human capital lead to lower human capital in total and relatedly lower productivity and productivity growth.

Up to now we discussed the topic individually, but human capital have also impacts on the relationship between productivity and inequality on the basis of firm and region. Low level of skilling and deficiency of human capital decrease the labour productivity. This makes firm's productivity and productivity growth decreased. Unequal opportunities, as a reason of deficient human capital, may exist among firms like individuals as well. The determinants such as:

- Financial magnitude of the firm,
- Network of the firm with other firms, suppliers, public officials and consumers,

[33] OECD, **The Productivity-Inclusiveness Nexus**, 2016, pp. 41
[34] Ibid, pp. 5-8, 41-48, 50, 87-88

- The place where the firm is established in the context of distance to the raw material and energy resources,
- Access to and cost of input to the firm.

are some of the reasons of inequality of opportunity among firms. According to scale effect there is a negative relationship between scale of firm and its unit cost. Because as the production capacity increase, the average cost decrease until marginal costs of firm excess its average costs[35]. Besides, as the amount of intermediate goods increase, through higher production; suppliers apply some discounts and the cost of providing input decrease. Thus big companies become more advantaged against small ones. Access to raw material and energy sources is also crucial for cost and production. As firms become closer to raw material and energy sources, cost is reduced in the context of logistic and transportation.

Another cost to firms is following the high technology. Since the financial problems exist to buy and follow the developing technology for the smaller companies, digital dispersion increase and human capital decrease. This surely has regional reflections. Digital dispersion is obviously seen in the poor regions where income and non-income dimension inequality is high. Usage of ICT and internet access are important indicators for inequality in the context of technology among firms, individuals and regions. The two indicators about internet use which are fixed broadband subscription and the percentage of individual internet usage are useful to show the divergence in the area of technology among regions. According to Table 1.1, it is easily seen that there is a huge gap between low and high income countries.

[35] Pindyck R S, Rubinfeld D L, **Microeconomics**, 7th edition, 2009, pp.231

Table 1.1: Fixed Broadband Subscription and Individual Internet Usage (% of Population)

	Fixed Broadband Subscription		**Individual Internet Usage (% of Population)**	
	2015	**2016**	**2015**	**2016**
LOW INCOME COUNTRIES	1605916	1681910	10,2	12,5
SUB-SAHARAN COUNTRIES	3601544	4006146	17,8	20
LEAST DEVELOPED COUNTRIES	7160692	8466458	13	15,6
ARAB WORLD	16575189	18419019	39,9	42
CENTRAL EUROPE &BALTICS	23357622	23980982	67,2	71,2
SOUTH ASIA	24615627	27671379	23,2	26,5
MIDDLE EAST & NORTH AFRICA	27423934	30035794	44,2	47,6
LOWER MID-INCOME COUNTRIES	58777275	68116839,1	26,8	29,9
LATIN AMERICA & CARIBBEAN	66614587	71176834	54,3	56,4
EUROZONE	113426651	116862972	78,7	80,4
NORTH AMERICA	115254000	119572000	75,9	77,5
EU COUNTRIES	163774023	168270874,4	78,4	80,8
EUROPE & CENTRAL ASIA	224218999	232068295,4	71,2	73,9
HIGH INCOME COUNTRIES	367751341	378930217,4	80	82
OECD COUNTRIES	373091645	386446916,4	76,5	78,6
EAST ASIA & PACIFIC	380234474	432138622,1	49,8	52,8
UPPER MID-INCOME COUNTRIES	413828634	467940104	52,6	55,7
MID-INCOME COUNTRIES	472605909	536056943,1	38,9	41,9
WORLD	841963166	916669070,5	43,2	45,9

Source: WB, open data catalog

Table 1.2 is a substantial instance although it doesn't provide the possibility to make comparison in that only some of developed and developing countries' ICT access & usage by business of is shown in. Because the high level of ICT access & usage in business gives an idea about the development level and the relative advantaged position of the firms and regions.

Table 1.2: ICT Access & Usage by Business (% of total) in 2017

ICT USAGE & ACCESS BY BUSINESS	
AUSTRIA	85,55
BELGIUM	82,6
FRANCE	66,53
GERMANY	87,53
NETHERLAND	85,59
NORWAY	79,82
SWEDEN	91,18
TURKEY	72,86
UK	83,63

Source: OECD, Database in the website: OECD Telecommunications and Internet Statistics

Financialization process contributes to unequal opportunities as well. As we mentioned in the previous article financialization is important for entry and exit of firms. Financial institutions, which are not properly operating, leads to inequality between the ones who have more capital, wealth or money and poorer which can be counted in the inequality of opportunity.

On the other hand possibilities of new digital technology may contribute to social inclusion and reduction in inequality of opportunity. The digital platforms (i.e. website, DVD, VCD) may foster the increasing the levels of education, training or skilling through gathering the educator and learner, accordingly unequal opportunities may be reduced via new opportunities of education under favour of digitalization. Furthermore digital technologies may help to increase the households' and firms' level of knowledge about the markets that they operate[36]. Transactions like shopping, commerce, production, hiring employer, finding job, financial operations of buyers & sellers, lenders & borrowers, and intermediaries are positively affected by digital technologies through easing the access to knowledge. By this way unequal opportunities is reduced in accessing the knowledge about market condition. Lower cost by better knowledge, higher human capital accumulation provide productivity, productivity growth and economic growth to increase while inequality is reduced. But it is obvious that digital technology by itself isn't enough to make things better. Social and economic policies by policy makers are needed like; market regulations, investment on education, health, transportation and communication, policies to reduce pollution, investment and infrastructure works on technology for the aim of making it more extending to a broad range. These policies provide economic growth and make the economy better off under proper demand conditions. Furthermore consolidation of economic growth in the short term; sustainability, inclusiveness in the long term are achieved through lower inequality of opportunity and higher human capital.

[36] OECD, **The Productivity-Inclusiveness Nexus**, 2016, pp.7, 68

PART TWO

TOTAL FACTOR PRODUCTIVITY, ENERGY INTENSITY AND INCLUSIVE GROWTH

2.1. Energy Intensity And Total Factor Productivity Nexus

2.1.1. Total Factor Productivity

The determinants and resources of economic growth have been questioned for centuries. Various economic schools have propounded different approaches and they have developed several growth theories. Especially after great depression, sustainable economic growth gained importance. Economic growth that we can describe as improvement in real variables of the economy is typically based on access and efficient use (productivity) of factors of production. Productivity - the more attention grabbing one – appears as the concept of total factor productivity which is introduced by Solow.

Total factor productivity is the essential concept which is originating from growth accounting framework. The improvements in management skills, production technology, and efficiency are represented by TFP. Studies proved that output growth is deeply associated with the total factor productivity growth and any element affecting total factor productivity has an important explanatory power on output, as well.[1] We live in a limited world which resources are scarce, that's why distribution and efficient use of resources are crucial for economies. In this regard TFP is an important indicator; about efficient use of resources for a higher level of welfare, to explain the variations in performance of economic growth among countries, and to determine which factor is more effective in production process.

Rise in level of real output with given quantity of factors of production is typically accepted as improvement in TFP. In other words unexplained increase in output level by factors of production are expressed by TFP. Econometrically it is measured by derivative of translog of production function. This method, which is called as the residual or Solow residual, is interpreted in different ways by several economists during time.

[1] Can Tansel Tugcu & Aviral Kumar Tiwari, **Does Renewable and-or Non-Renewable Energy Consumption Matter for TFP Growth Evidence from BRICS**, Renewable and Sustainable Energy Reviews, Vol. 65, 2016, pp. 610–616

2.1.1.1.Growth Accounting And Solow Residual

Sustainable growth doesn't occur in absence of technological improvement according to neoclassical growth theory. Because rise in quantity of inputs without technical progress does not satisfy continuity of capital accumulation by reason of diminishing returns. Improvements in technology eliminate the diminishing returns and capital accumulation becomes continuous, therefore labor productivity grows. Solow used the method of production function to interpret productivity, TFP, which is also called as growth accounting.

Solow *(Technical Change and Aggregate Production Function, 1957)* was not the first who was fastening the aggregate production function and productivity. This link goes back at least as far as Tinbergen (1942). However, Solow's original contribution basically is theoretical link between the production function and the index number approach. Solow began with the production function and deduced from (and constraints on) the productivity index whereas earlier studies on index number had interpreted their results in light of a production function. Using the Hicksian-neutral productivity term and under constant returns to scale condition he began by postulating the production function:

$$Q = A_t\, F(K, L)$$

According to the function, A_t is the shifting parameter (Hicksian-neutral term) for output level at time t when inputs are given. Then Solow used nonparametric index number approach (i.e., an approach that does not impose a specific form on the production function) to measure A_t[2]. He arrived the solution for A_t by differentiating logarithm of production function:

$$\ln Q = \ln A + \ln F\ (K, L)$$

$$\frac{\dot{Q}}{Q} = \frac{\partial Q}{\partial K}\frac{K}{Q}\frac{\dot{K}}{K} + \frac{\partial Q}{\partial L}\frac{L}{Q}\frac{\dot{L}}{L} + \frac{\dot{A}}{A}$$

The obtained equation means that output growth depends on weighted average of capital and labor growths and technological improvement (growth rate of the Hicksian-neutral productivity term). After the elasticities determined as coefficients like α and β, equation gets the form of below:

---

[2] Charles R. Hulten, **Total Factor Productivity: A Short Biography**, National Bureau of Economic Research, University of Chicago Press, http://www.nber.org/chapters/c10122, ISBN: 0-226-36062-8, 2001, pp.8

$$\frac{\dot{Q}}{Q} = \alpha \frac{\dot{K}}{K} + \beta \frac{\dot{L}}{L} + \frac{\dot{A}}{A}$$

The difference between output growth and sum of growths of labor and capital (technological improvement) is the Solow residual—the output growth which cannot be explained by the growth of inputs.

$$\frac{\dot{A}}{A} = \frac{\dot{Q}}{Q} - \alpha \frac{\dot{K}}{K} - \beta \frac{\dot{L}}{L}$$

In theory it is an index number which corresponds to Hicksian efficiency parameter, since it is computed with input and output prices and quantities. But residual either may wanted conditions such as technical improvement or may be caused by unwanted conditions which are arising from model misspecification, inability to access available data, omitted variable, and etc. Jorgenson and Griliches focused on this issue and they investigated if residual can be disappeared in the case of accurately clarifying of real input and output.

"*In the terminology of the theory of production, if quantities of output and input are measured accurately, growth in total output is largely explained by growth in total input. Associated with the theory of production is a system of social accounts for real product and real factor input. The rate of growth of TFP is the difference between the rate of growth of real product and rate of growth of real factor input. Within the framework of social accounting the hypothesis is that if real product and real factor input are accurately accounted for, the observed growth of TFP is negligible.*"[3]

Jorgenson and Griliches reached the conclusion that their hypothesis is true. According to their study real output growth can be explained by growth of real factor inputs under the condition of proper measurement and without model misspecification. But Edward Denison supported Solow's opinion against Jorgenson and Griliches about TFP and output growth. He indicated that advancement in technical, managerial and organizational information, which is concluded as positive technical improvement, leads to increase in output input is given during post-war period, and this means that a qualitative change in input is occurred (*Denison, 1969*). He stated the reason of divergence between prevailing wisdom and hypothesis of Jorgenson

[3] Jorgenson D and Griliches Z, **Explanation of Productivity Change,** The Review of Economic Studies, Vol. 34, No. 3, 1 July 1967, pp. 249–283; 249

and Griliches about residual (TFP) as; difference in time periods between his study and their study, and capacity-utilization adjustment based on electricity use (*Hulten, 2001*).

2.1.1.2. Determinants Of Total Factor Productivity

Studies from past to present shows that determinants of TFP can be counted as human capital, activities of R&D, commercial openness, domestic and foreign investments, efficient use of resources, inflation, and other institutional factors. We will try to briefly explain these in this title.

Acquisition and application of new technologies and innovations in technology are accelerated by human capital which can be either innate ability or skills learned by doing. Indicators about education are generally used for measuring human capital. Studies showed that one additional year in education leads to raise in productivity.

R&D as another factor for productivity can be defined as systematic and investigative activities which are developing new products or discovering and creating new knowledge about scientific and technological areas. Its effect on productivity occurs as innovation and creation of new knowledge. Developing new products is generally carried out by studies of private sector institutions whereas discovering and creating new knowledge is performed by studies of universities and public sector institutions.

Liberalization on trading also affects TFP through satisfiing benefits for the economy by:

- Increase in ability to access foreign markets,
- Raising competitive pressures
- Increasing possibility to access new technologies and technological improvements
- Knowledge transfers from developed to developing countries
- Spillovers.

Investments on ICT and activities of R&D, which are promoting innovations and leading to increase in productivity, are generally domestic investments whereas effect of foreign investment occurs as technology transfer and relatedly knowledge transfer. Learning, increasing knowledge and diffusion of technology, that is satisfied by the technology transfer, affects the domestic markets positively in the aspect of productivity.

Efficient use which means more product with less material is very important because like any other tangible and intangible things resources are finite as well. Since energy is an important and high cost resource, efficiency of energy is especially important. The importance is doubled in energy intensive sectors. Two aspects contributing productivity can be said; first reducing cost raise the production and productivity, second and more important one is that it serves as saving for future production and it is a protectionist approach for environment.

The effect of inflation on productivity occurs through macroeconomic stability. It can be said that inflation has distortionary effect on productivity due to its impact leading instability in the economy. So lower inflation and price stability is important for TFP.

Moreover determinants of productivity can be categorized as levers-factors within a business control- and external factors in the basis of firm. Levers can be counted as managerial practices/talent, higher-quality labor and capital, IT (information technologies) and R&D, learning-by-doing, product innovation, firm structure decisions whereas external factors are productivity spillovers, competition—both intra-market and through trade, regulatory environment, input market flexibility.[4]

So we can separate the determinants as two stages:

- Existence of proper conditions for productivity which are: i) Liberalization for international trade satisfies the necessary knowledge and technology transfers which are supported by foreign investments as well ii) Economic stability and relatedly price stability which is associated with inflation.
- Process of innovative operations for productivity which can be satisfied by human capital, activities and domestic investments in R&D.

2.1.2. Energy Intensity And Total Factor Productivity

Energy have been a necessity for humanity during the history. Need for energy has followed an ever increasing trend approximately for last two centuries in particular by industrialization and urbanization periods. Increasing economic growth rates and rise in social welfare level, improve in standards of living containing longevity, quality and expectancy of life, and related result with population increase are occurred in the period. These have become the reasons of increase in energy need. So demand for energy raised in parallel line and today it is an attractive input for production.

[4] Chad Syverson, **What Determines Productivity?**, University of Chicago Booth School of Business and NBER, Presentation at OECD, November 5, 2012, pp. 7-8, 19

As an intermediate input, energy affects output through capital and more likely labor. Various econometric studies show that positive relationship exist between energy consumption and output level whereas negative, nonlinear even U-shaped connection are occurred between energy intensity and TFP. That means, as the amount of output is increased necessity for energy consumption increase as, and that make firms/industries/countries more energy intensive.

We can describe this attractive input by two ways economically. These are; i) capability and power of human to produce ii) fuels needed by labor and capital in the production process. But fuel is the first thing that is coming to mind broadly when energy is mentioned while first one is called as human capital. But there are some difficulties about energy like[5]:

- Scarcity of energy sources,
- Imbalanced allocation of energy sources among the earth,
- Negative externalities in progressing and using the energy,
- Low qualified human capital.

At that point cost factor on accessing and using the energy appears. As the amount of energy needed/used per unit of output increase cost will increase too. Increase in energy intensity directly means increase in operating costs and this adversely reflects to the investment and production. So the main ground of the negative relationship between energy intensity and TFP is cost factor.

The cost of human capital is time and money which is spent on acquiring skills. But there are two kinds of cost to use and access the energy by means of fuels:

- Price of energy is a real inconvenience, especially for energy poor countries.
- Negative externalities on economies which are lower efficiency, harm of quality of productive agents, deterioration of natural resources and environment. Because of these high costs, efficient use of energy is really important subject.[6]

Lower energy intensity to decrease these kinds costs because, we mentioned above that energy intensity is broadly defined as amount of energy used per unit of output, so it is an oneiromancy about usage of energy in production. Since energy intensity is quantity of energy

[5] Fatma Fehime Aydın, **Enerji Tüketimi Ve Ekonomik Büyüme**, Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, Vol. 35, 2010, pp. 317-340; 319

[6] Sharma H, Sahu S K, Productivity, **Energy Intensity and Output A Unit Level Analysis of the Indian Manufacturing Sector**, Journal of Quantitative Economics, Vol. 14, 2016, pp. 283–300

per output, it is higher in the energy intensive sectors and countries which have to import most of energy that they use. That's why these sectors and countries have to save from energy, in other word they must increase efficiency level of energy input to decrease the energy intensity. Thus positive results such as less import, slower spending of resources (more efficient use of resources), less negative externality and reducing cost are occurred. At that point factors investment in sustainable energy is vital.

In developmental context energy intensity and efficient use of energy is vital subjects in the modern world. Energy intensity is higher in developing countries than developed countries, because the high energy demand cannot be compensated due to lower rate of development and inefficiency in the economy . In this case energy demanded per unit of output is higher in developing countries than others. Near that the increase in demand for energy without capacity improvement leads to problems about supply of energy. Following problems which are boosting cost such as poorness of energy resources, raise in energy prices decrease the competitiveness of countries. This negatively reflects to international trade of the countries, and relatedly it reflects to their growth/development conditions, and even their political decisions.

Besides, dominance of public sector on energy leads to some problems. Since energy is a high cost input, it reflects negatively to budget and it causes to budget deficit. Plus slowness of bureaucracy makes difficult and costly the supply and distribution of energy. Moreover deficiency of infrastructure leads to increase in energy intensity that's why technical equipment, skills and education of labor is firmly important. In this case privatization is an important option for energy sector.

So to get rid of these negative situations, import dependent sectors on energy and high energy intensive countries should find solutions to increase energy efficiency such as[7]:

- Accelerating privatization activities in energy sector,
- Escaping the dependence on a single source or country on energy supply,
- Minimum loss in transmission, distribution, and consumption of energy,
- Renewable energy as an alternative to the fossil fuels,
- Skilled labor and proper technological equipment,

[7] *The first three articles are inspired from: M. Ozturk , N. C. Bezir, N. Ozek, **Turkey's Energy Production, Consumption, and Policies, until 2020**, Energy Sources, Part B: Economics, Planning, and Policy, Vol. 4, No. 3, 2009, pp. 316,317
*The following five articles are inspired from: Nevzat Şimşek, **Environmental Efficiency and Total Factor Productivity of Turkey: A Comparative Analysis**, Ege Academic Review, Vol. 11, No. 3, 2011, pp. 379-396; 389

- Economic, social and environmental long term policies which are appropriate for domestic conditions,
- Considering domestic sources and international progress together,
- Safe and clean energy.

So these are basically stuffs which will increase energy efficiency. Avoiding wastage and considering renewable energy resources in the production can be summarized as efficient use of energy. So, like any other inputs, saving on energy is very important for productivity improvement. On the other hand separation of energy as renewable and non-renewable should be considered because use of renewable energy resources have positive externalities on the aspects of [8]:

- Social; higher standard of living, social solidarity, and stability,
- Macroeconomic; security of product & risk diversification, regional growth, potential of export, and equalized trade balance between regions,
- Supply side; raised productivity, labor mobility, enhanced competitiveness, and infrastructure,
- Demand side; employment, new income and wealth channels, incentive for investment and relatedly support for associated industries.

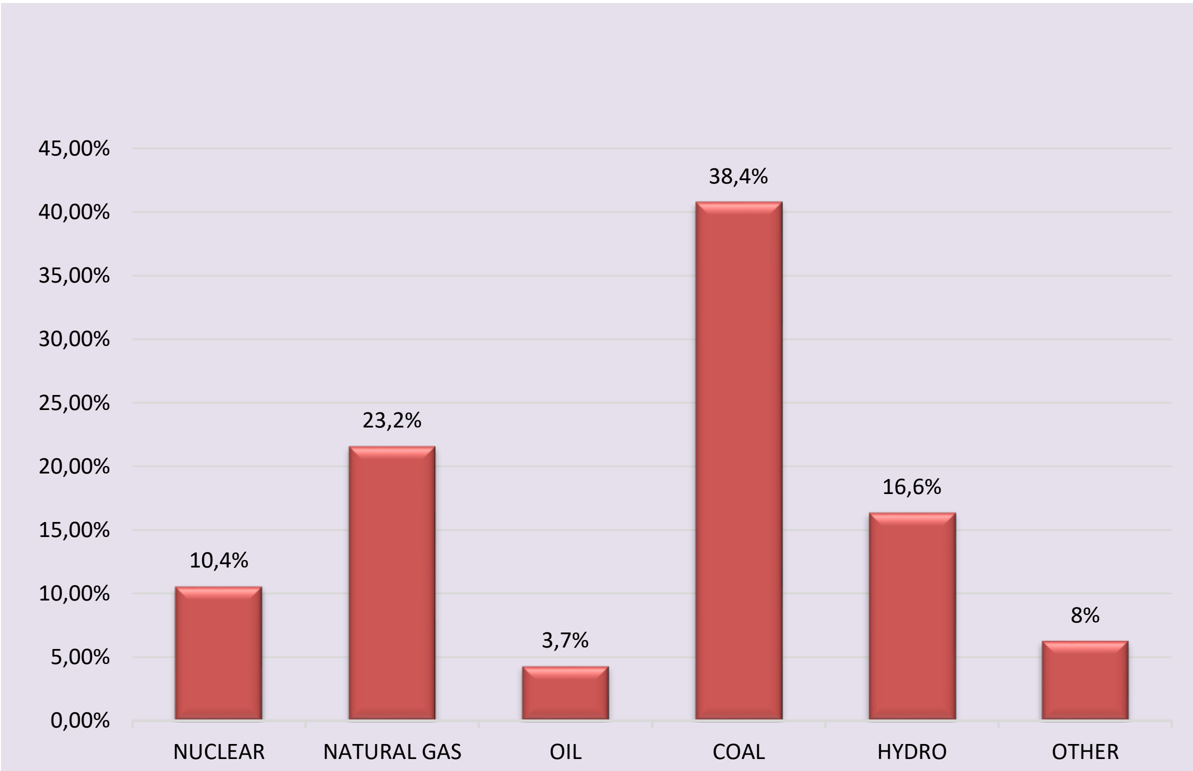
In addition to articles above renewable energy sources are alternative against fossil (nonrenewable) fuels to lower negative effects on environment. CO_2 emissions as a result of burning fossil fuels damage the environment on the various aspects. For example global warming and air pollution are from the major problems. That’s why renewable is a source of energy which has ever increasing importance, and countries should verge it as much as their geographical and climatic possibilities. Although it is non-renewable, nuclear energy serve as alternative against fossil fuels as well because of its high yield. Security of energy supply, competitiveness of electricity generation caused by increasing energy demand, and increasing demand for low carbon energy sources are also the reasons making nuclear attractive. But there are also strong public and political concerns about nuclear energy. Safety and disposal of nuclear waste are the major ones among societies. Especially nuclear leakage in Fukushima after the earthquake in Japan in March 2011 is an important reason. Technical complexity, long term management necessity, complicated regulatory and legal requirements, need for large

[8] Tuğcu & Tiwari, 2016, pp.610

scale investment to build nuclear power plants are the other concerns about monetary and managerial topics.[9] It had better to discuss the renewable and nuclear through hard data.

As it is shown in figures 2.1 hydropower is dominant on electricity generation by 16.6% among renewables whereas the lion's share belongs to fossil fuels. The share of coal is 38,4 percent of total, natural gas has the share of 23,2 percent, and the most productive energy source among fossil fuels-nuclear energy has a share of 10,4 percent. Oil has the least share on electricity generation among fossil fuels by 3,7 percent.

Figure 2.1: Share of Fuels on Electricity Generation among the World in 2016

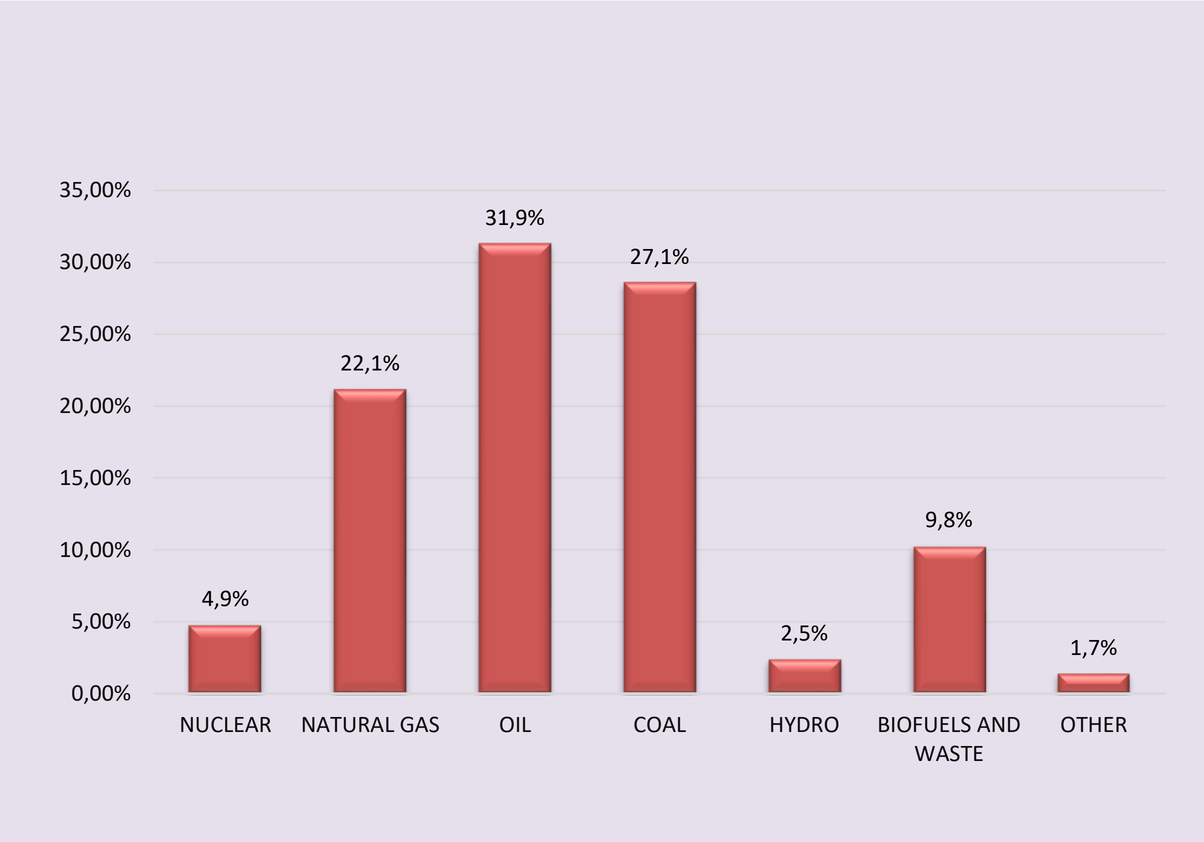


Source: IEA, **Key World 2018**, pp.14

As to total primary energy, it is seen in figure 2.2 that the share of renewable energy sources are too little in contrast with fossil fuels. Biofuels & waste has a share on total primary energy supply by 9,8%, and hydro has a share by 2,5 percent whereas oil and coal has shares by 31,9 percent and 27,1 percent respectively. Following them natural gas has the biggest share by 22,1 percent, and finally the smallest share belongs to nuclear by 4,9 percent. This is even lower than the share of biofuels and waste.

[9] OECD, **Nuclear Energy Data**, Nuclear Energy Agency (NEA) No. 7300, 2016

Figure 2.2: Share of Fuels on Total Primary Energy Supply (TPES) among the World in 2016

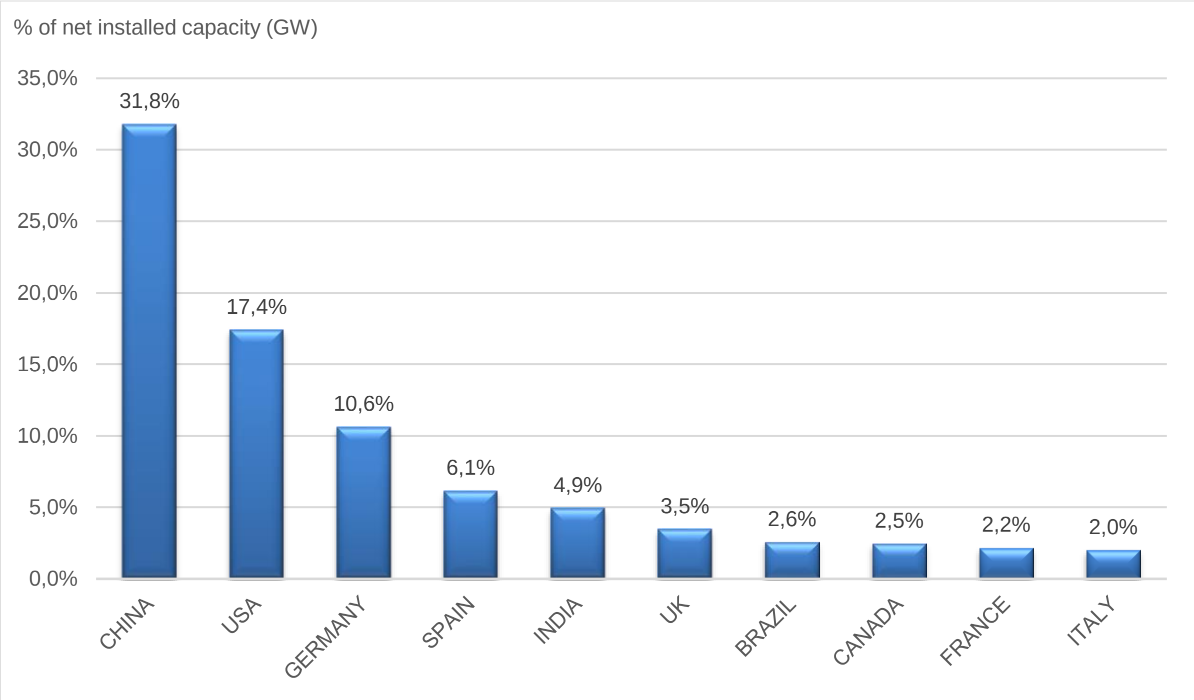


Source: IEA, **Key World 2018**, pp.2

Another important renewable energy sources, which is not present in the figures above, is wind power. World wind power generation capacity has reached 467,4 GW in 2016. Global wind electricity generation amounted to 958 TWh in 2016, 3,8% of total global power generation.[10] Potential of wind power differs regionally depending on climatic and geographically (land form) characteristics, and amount of investments. It can be seen in figure 2.3 that China is the leader with the share of 31,8 percent, USA follows China with the share of 17,4 percent, Germany has the share of 10,6 percent, Spain has the share of 6,1 percent, India has 4.9 percent, UK has the share of 3,5 percent and the other four countries Brazil, Canada, France, and Italy follow them respectively and they have the shares between 2,6 and 2 percent.

[10] IEA, **Key World 2018**, pp.10

Figure 2.3: Net Wind Installed Capacity in Countries Which Are Top 10 in 2016

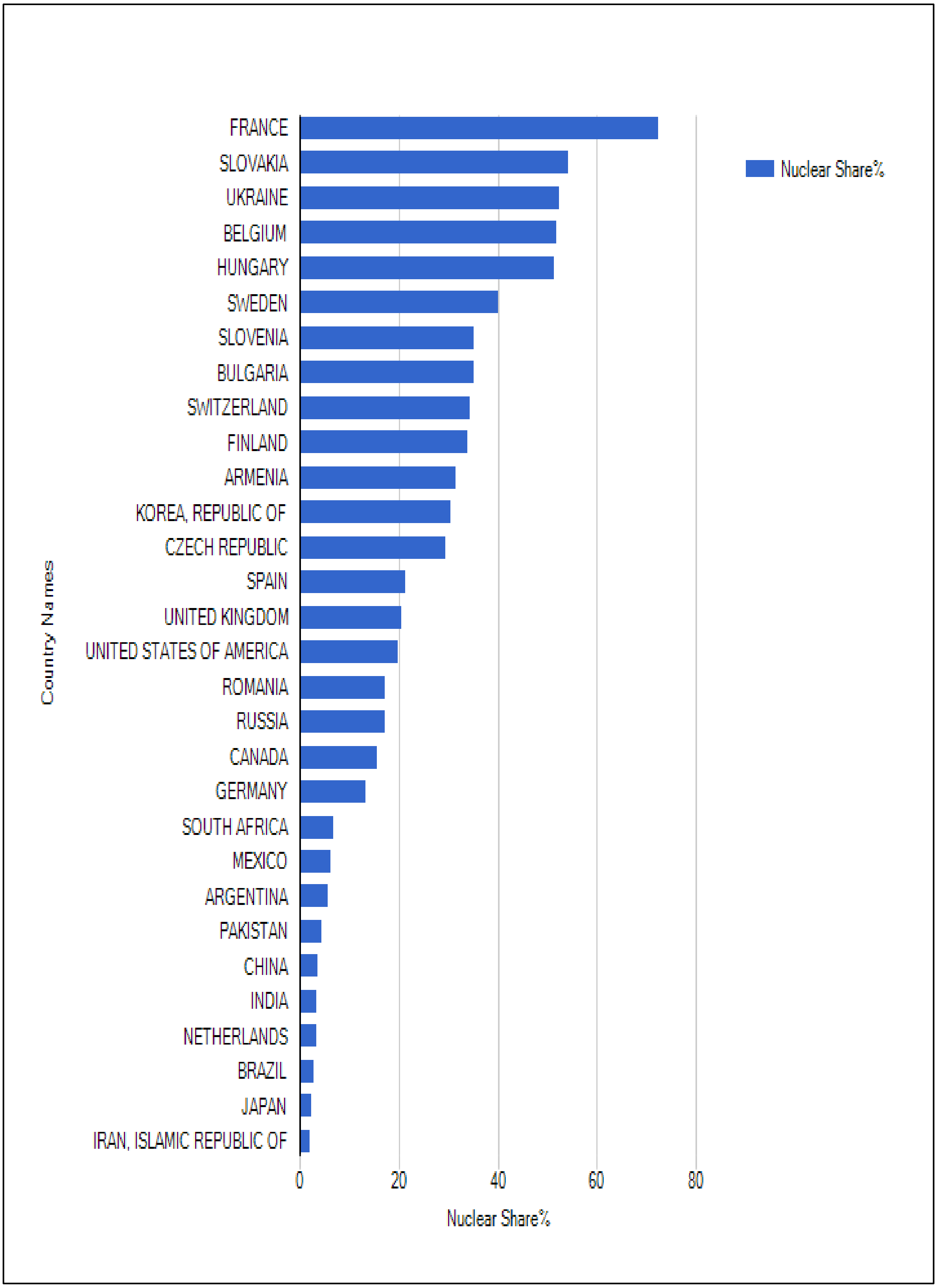


Source: IEA, **Key World 2018**, pp.10

As we mentioned, nuclear energy is another alternative energy source against fossil fuels. According to IEA dataset that we can see in the figures 2.1 and 2.2, nuclear energy share on total primary energy supply is 4.9%, and its share on electricity generation is 10.4% in 2016. As to OECD dataset, nuclear share on electricity generation is 11.1%. Although there are environmental concerns about it, nuclear energy is an important alternative against fossil fuels in addition to renewables. As it is seen in figure 2.4 and figure 2.5, most of the countries which use nuclear in generation of electricity (by the share of 30% at least) use renewable energy remarkably in primary energy production.[11]

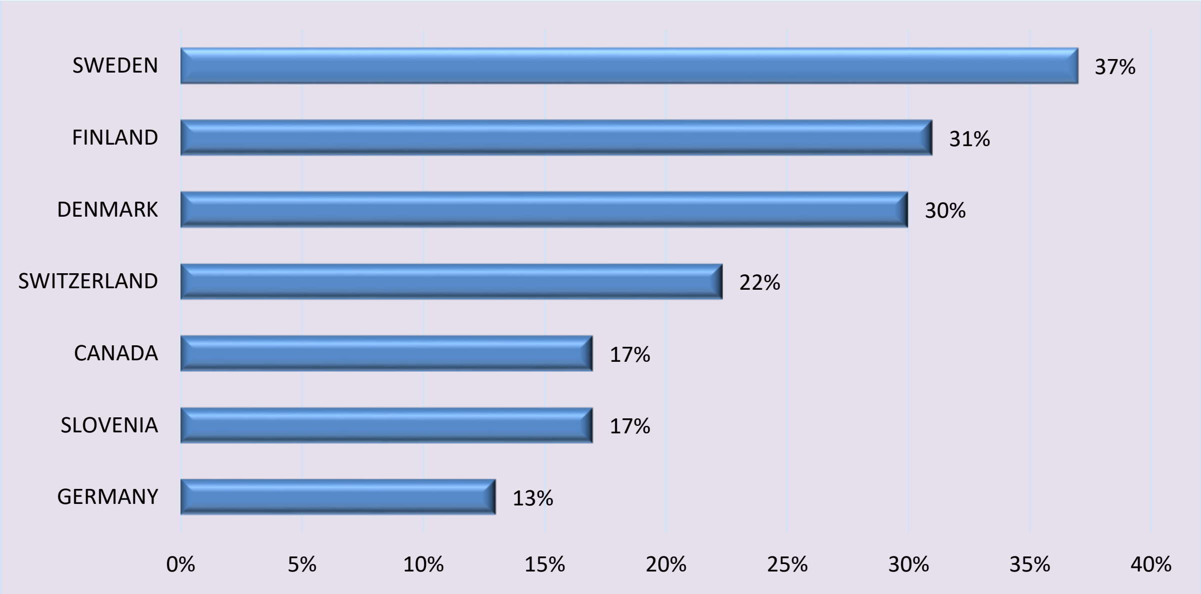
[11] OECD, Renewable energy data, 2015, https://data.oecd.org/energy/renewable-energy.htm#indicator-chart

Figure 2.4: Nuclear Share of Electricity Generation Across Countries in 2016



Source: IAEA; Power Reactor Information System PRIS; World Statistics, Nuclear Share

Figure 2.5: Renewable Share on Total Primary Energy Supply in 2016



Source: IEA, Atlas of Energy, Share of Renewables in TPES (%), http://energyatlas.iea.org/#!/tellmap/-1076250891/3

Nuclear and renewable energies are very important for sustainable energy just like energy efficiency and reduce energy intensity[12]. It is needed to invest as much as possible for the reason of increasing demand for energy all around the world.

As a result efficient use of energy is very important. Increase in efficiency level of energy sources positively affects TFP[13]. The increase in TFP improves the economy and by the way possibility to allocate more fund for and to invest more in efficient use of energy goes up. So TFP and energy efficiency becomes interrelated.

Consumption of energy under increasing demand condition, external dependence on energy, high energy intensity are the factors that makes the energy provision unsustainable. But these force the countries to invest in sustainable energy at the same time. Because these are the elements which are raising the negative externality due to increasing usage of energy under inadequate physical, technical and human capital conditions. Further they are increasing the financial cost of energy. So sustainable energy not just promote the provision of low cost and

---

[12] *Şimşek N, **Environmental Efficiency and Total Factor Productivity of Turkey: A Comparative Analysis**, Ege Academic Review, Vol: 11, no: 3, pp. 379-396, July 2011, pp.389-390
*SE4ALL, **Progress toward Sustainable Energy 2017 Summary**, 2017, pp.iii, iv

[13] Sahu S K, Narayanan K, **Total Factor Productivity and Energy Intensity in Indian Manufacturing: A Cross-Sectional Study**, International Journal of Energy Economics and Policy, Vol. 1, No. 2, pp.47-58, 2011, pp.57

clean energy by all, it fosters TFP through reduction of inequality, higher efficiency, and (the most important one) lower cost.

2.2. Inclusive Growth And Interaction Between Energy And Total Factor Productivity

The subjects of energy and TFP have substantial impacts on inclusive growth either respectively or commonly. TFP improves by higher human capital (HC) through equal opportunities, and some other social and economic investment policies, and it enables IG. Furthermore advancement in energy, which is occurred via; sustainability, indigenousness, higher efficiency and lower intensity, and reduction in negative externality, fosters the economy as an important input and it also enables IG. We will explain these in detail under this title.

TFP is associated with inclusiveness through level of HC, and equality or inequality of opportunities which are determinant on HC. Some sources of unequal opportunities are as follows[14]:

- Income and non-income dimension inequalities among individuals and regions,
- Negative feedback in the context of wellbeing,
- Regional differences in possibilities of education, health, infrastructure etc. ,
- Some differences among firms such as; financial magnitude, social network, capital accumulation that they have, access to energy and technology, human resources.

These are factors that lowering HC, so unequal opportunities should be eliminated as much as possible. Better education and health services for all, rendering prosperous the socioeconomically disadvantaged regions, better infrastructure services, improving the cultural level are from types of investment in HC. By the way it is satisfied through labor factor that participation of different groups in the society to the processes of production and economic growth. So inclusiveness is occurred economically.

Increase in HC provides increase in productivity of labour which is one of the fundamental input of production and this lead to rise in TFP. So investing in human make the economic performance better off, by the way recovery and higher growth in the economy is occurred. Otherwise neither the productivity growth nor the economic performance which are desired may be achieved. Furthermore situation of disadvantaged groups, high poverty rate and high income inequality down the economy. So near the cost reduction and eliminating

[14] OECD, **The Productivity-Inclusiveness Nexus**,2016, pp. 39-47, 51-52

slowdown, the negative effects of low HC will be eliminated. By the way a broad based process is occurred in the economy.

Broader participation of different social segments provide to fair distribution of benefit from economic growth in comparison with non-inclusive growth models. By this way increase in wealth and welfare reflects more fair to the society. This positive actions in the economy raise the capacity of saving and investment, and this positively affects the business cycle and economy as a whole in both long and short run. On the other hand permanence of investment in HC and fair distribution of increase in income, wealth and welfare raise the sustainability of the economic growth. Eventually HC serve as a bridge between TFP and IG, and provide the economic growth to be sustainable and inclusive. At that point it had better to discuss the link between these subjects and energy.

Energy is a substantial input, most particularly in the era that technology and industry is improved so much. If countries want to grow, to be developed, and to be a worldwide economy; they have to solve the energy problem. It can be said that sustainable energy is a necessary step for the solution of this problem[15]. But, in the both absolute and relative contexts: What changes in the case of solving this problem? How does it affect income and non-income dimension inequality? How does it lead to absolute changes?

First thing to say is that energy as both renewable and non-renewable depend on conditions of climate and geography. So the possibilities of energy and natural resources are up to location of the country. This can be count as a kind of inequality or unequal opportunity. Additional to geographical differences, financial inadequacy and underdevelopment level are also factors that create inequality for provision of energy. Because energy is a high cost input. Purchasing, investing in, and producing energy are expensive. That's why, having different developmental levels is a factor to cause unequal opportunities among regions. So there is unequal opportunities for provision of energy in the contexts of climate, geography and level of development among countries and this adversely reflects to the economies.

Energy intensity should be decreased as a cost-reducing action. As it is said before energy intensity is higher in emerging market economies because of high energy demand. Under the condition of scarce natural resources countries need to lower the social, financial and

[15]*Koç, E, Şenel, M C, **Dünyada Ve Türkiye'de Enerji Durumu - Genel Değerlendirme**, Mühendis ve Makina, vol. 54, no. 639, pp. 32-44, 2013, pp.42
*Şimşek N, 2011, pp. 389

environmental cost of energy. So countries should carry out policies to increase energy efficiency and energy saving.

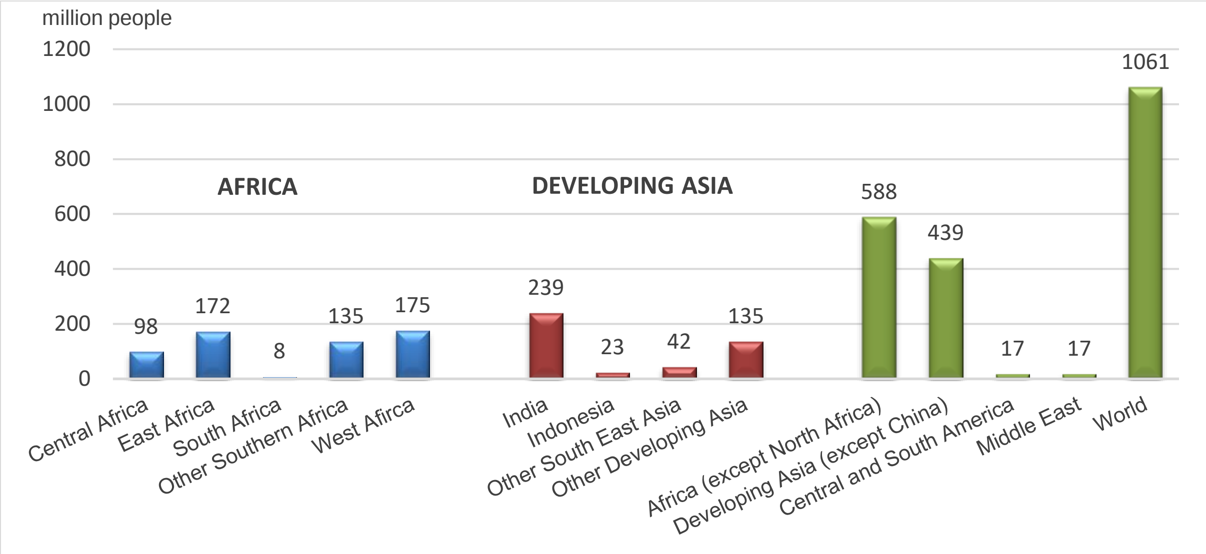
Indigenousness is important in policy making because, hand being external dependent on energy and import intensive growth models are real risks for energy poor countries. Using national and native possibilities in energy provision is as important as high energy efficiency and low energy intensity. Sustainable energy gain importance at that point because, sustainable energy comprise subjects of native, affordable and clean energy. Hence renewable and nuclear energy sources are necessary because these are high efficient energy provision possibilities. Near that renewable and nuclear energies are useful for provision of clean energy since they are alternative to fossil fuels. But these energy sources are required cutting age technology services and that's why investment in technology and R&D are necessary as well.

There, when higher energy efficiency and lower energy intensity, lower external dependence are occurred, the economic performance of countries improve via affordable and clean energy provision (seventh aim of SDG). Furthermore a fair condition is occurred between regions due to sustainable energy. So both absolute and relative improvements in energy provision and economic performances are achieved. Thus access to energy is accrued by much more people that is one point which ties inclusiveness and energy.

People suffer from famine of energy even for vital necessities like heating, lightning and cooking in underdeveloped regions, and a considerable amount of people are in such a condition. 1,061 billion people are living without electricity by the year of 2016 according to *world energy outlook 2017*. The figure 2.6 shows the location of these unfortunate people. 588 million of them are living in Africa, this is the highest number among the regions. The second highest amount of people are living in developing Asia with the number of 439 million[16]. 17 million people for each of middle east, and central and south America. It is possible to separate Africa to 5 region, and a balanced distribution is seen except south Africa. West and east Africa are worst areas in the region with the numbers of 175 and 172 million people without electricity respectively. 135 million people in southern Africa, 98 million in central Africa are deprived from electricity. The developing Asia is considered as four region and the worst one is India with the population of 239 million. 23 million in Indonesia, 42 million in other south east Asia, and 135 million in other developing Asia live without electricity according to 2016 data. So 1,061 billion people are deprived from electricity in total.

[16] The term "developing Asia" belongs to the source 'Energy Access Outlook 2017-From Poverty to Prosperity'

Figure 2.6: Population Without Access to Electricity by Region in 2016



Source: OECD/IEA, **Energy Access Outlook 2017-From Poverty to Prosperity**, World Energy Outlook | Special Report, 2017, pp. 49

Another intersection of inclusiveness and energy is occurred through the reduction of negative externality. Because quality of input is better off when deterioration of natural resources is decreased, whereas health problems depending on environmental reasons are lowered, and productivity of labor input raised.

So provision of clean and affordable energy and its sustainability decrease the unequal opportunities, and relatedly it leads to lower inequality and higher HC whereas lower cost in production, operation and usage is occurred. By the way fair conditions to access higher standard of living is more possible for individuals, and high efficiency of; labor, natural resources, and energy foster the economic performance, and the economic growth becomes inclusive.

As a result TFP and sustainable energy affect the sustainability and inclusiveness of growth process, and economy as a whole separately. But the interaction between energy and TFP also affect them positively. The positive improvements like lower energy intensity, transition to high technology opportunities and its spill-over among the sectors, higher energy efficiency, better health and environment conditions, provision of affordable and clean energy; are satisfied by investment for sustainable energy and these foster TFP through firm and individual basis like below:

1) Better health and environment conditions, high technology and its spill-over, provision of affordable energy make the health and education services better off and more accessible. So HC increase and labor input becomes more productive, and TFP raise due to broader participation of society to the production and growth process is occurred.
2) Cleaner and safer natural resources and relatedly higher input quality which are arising from better environment conditions, multiplier effect in the economy which is caused by transition to high-tech possibilities and its spill-over, higher energy efficiency and lower energy intensity, and increase in HC that we mentioned in the previous article are the factors that reduce the cost and they all together provide inclusiveness among firms, and they make TFP raised.

So inclusive growth may be achieved by the interaction between energy and TFP, and broader participation to the economic processes in both firm and individual basis. The negative externalities which interconnect IG, TFP, and energy is tried to be illustrated.

Negative externality is the cost of an action by an economic agent that is reflecting to another. And it is positive if the action of economic agent benefits the others. Externalities may occur among producers, among consumers or between consumers and producers.[17] By this way it may be called as production externalities- if the impact of action is on an input, and it may be called as consumer externalities- if the impact of action is on a consumption good.[18] A brief explanation through an example would be appropriate. For instance a pharmaceutical company- company P and a food company- Eat & Eat (E&E) are two neighbour companies. Supposing that company P drains its chemical waste to the water which E&E uses to farm its own plants and company P pollute the water. In this case the input quality of E&E decrease and they need to solve the problem of clean water. So both pollution of current water resource and necessity to clean up or to find a new water resource are additional cost to E&E, and this additional cost is named as Marginal External Cost (MEC). MEC lead to increase in marginal cost (MC) of E&E that means transformation of MC to Marginal Social Cost (MSC) which is the sum of MEC and MC[19]:

$$MSC = MEC + MC \ , \ \Delta MEC > 0$$

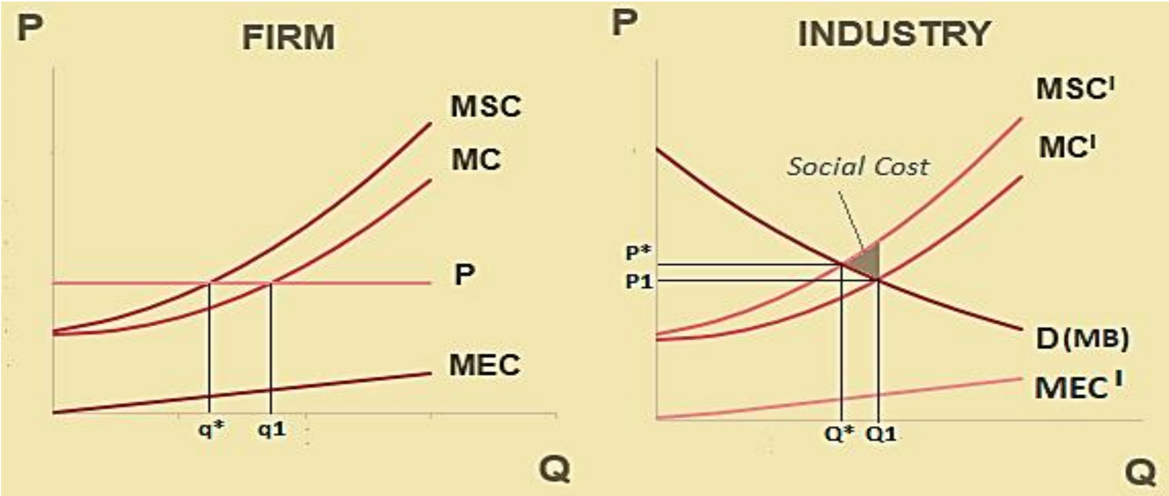
---

[17] Pindyck R S & Rubinfeld D L, **Microeconomics**, Pearson International Edition (7th edition), chapter 18, pp. 645
[18] Varian H R, **Intermediate Microeconomics- A Modern Approach**, Norton International Student Edition (3rd Edition), chapter 31, pp. 545
[19] Pindyck et al. 647

Hence, because of increase in cost, production level of E&E decrease from q^1 to q* under constant price level that is shown in panel A of figure 2.7 for firm case.

Figure 2.7: Externalities

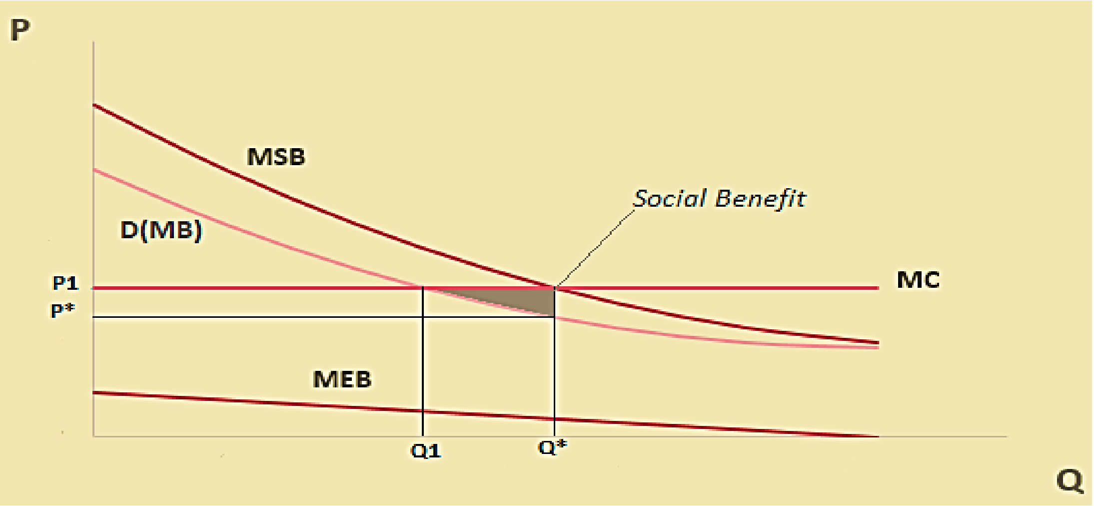
Panel A: Negative Externality



Source: Pindyck et al, pp.646

There can be external cost among the industries or sectors independently of this example. In panel A of figure 2.7, MC in the industry (MC^I) is supply curve (S). MSC in the industry (MSC^I) is steeper S, which is the sum of MEC of the industry (MEC^I) and MC^I. On the other hand price doesn’t remain constant because of law of demand, and P increase from P_1 to P* whereas quantity of output decrease from Q_1 to Q*. So fewer output and higher price level are realized in the sector or industry. The diagram of industry in panel A of figure 2.7 shows that MEC^I cause to transformation of MC^I to MSC^I that means steeper S, and this lead to social cost which is shown by shaded area in the diagram. Because, decrease in welfare is occurred due to lower output with higher price.

Panel B: Positive Externality



Source: Pindyck et al, pp.648

External cost is not the only effect of economic agents between each other, external benefit may also be occurred. For example when a hospital or a school or any other institution that gives public service is built, there will be necessary for some infrastructure investment in that area and the infrastructure investments lead to area to improve. As another example, when a company is established in a region, the region becomes center of attraction and the region starts to be developed and prosperous. Technological spillovers, innovation activities are also examples that are creating external benefit. These are instances for positive externalities and Panel B of figure3.7 illustrates positive externality and social benefit. Under fixed price (fixed MC) marginal external benefit (MEB) lead to steeper demand curve (D), which is marginal benefit (MB) or marginal private benefit (MPB). That means D (MPB) transforms to marginal social benefit (MSB), which is total of MPB and MEB[20]:

$$MSB = MPB + MEB\ ,\ \Delta MEB < 0$$

Here MEB is decreasing because of diminishing marginal utility, so D (MPB) and MSB are convergence each other. Under fixed price level, increasing demand bring about to increase in output and the higher welfare level is named as social benefit which is shown by shaded area in panel B of figure 2.7.

[20] Pindyck et al, pp.648

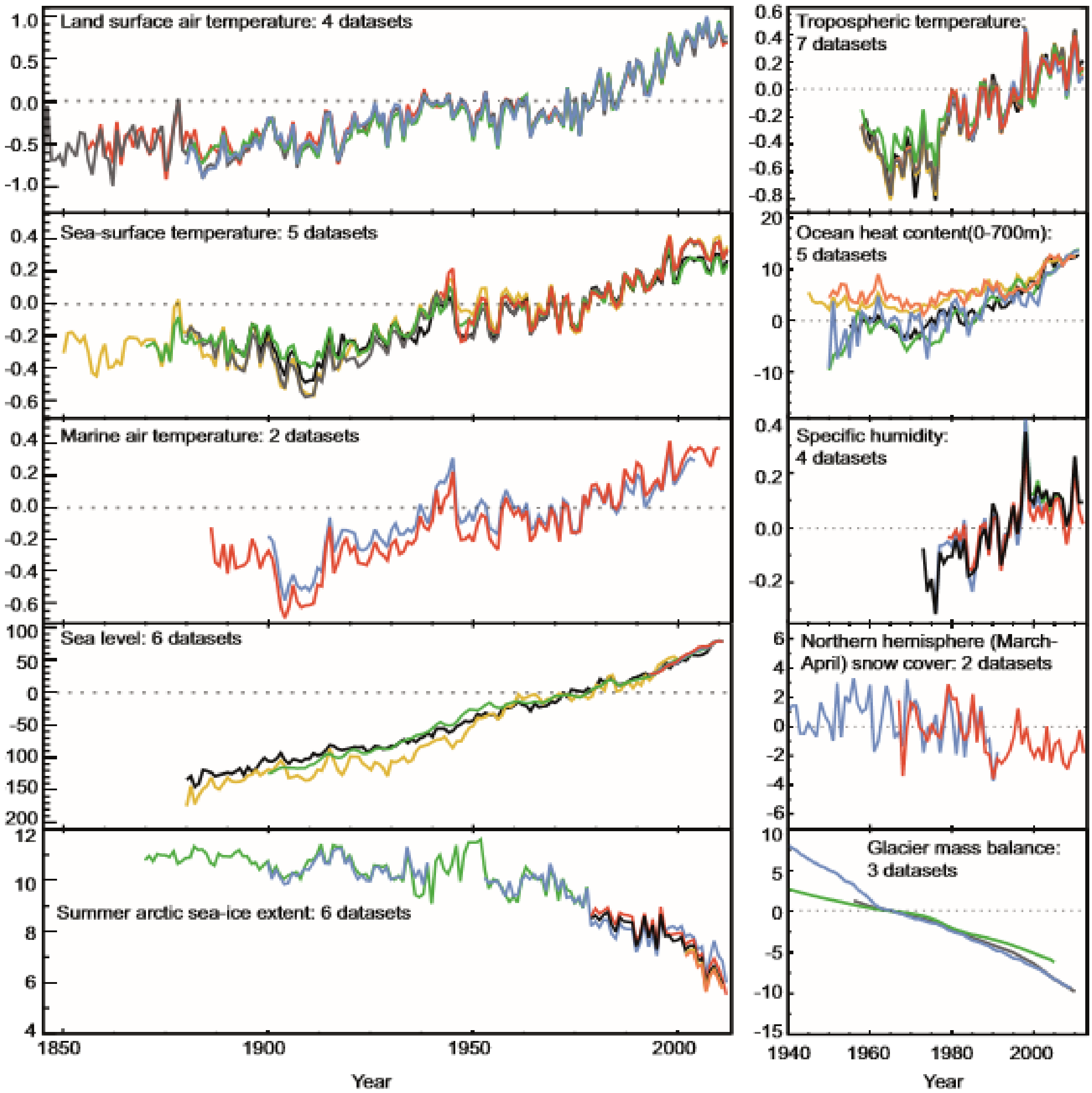
In the light of these theoric informations we will investigate the relationship between energy and negative externalities. The post-war era has witnessed improvements in technology and production possibilities, and increase in population all around the world. These lead to increase in demand and supply. Hence the higher the production, the higher the energy consumed.

Higher economic activities require higher energy demand especially in emerging market economies. Because energy is an essential production input. But near its positive impacts on production it is a high cost input. There are two type of cost for provision of energy as we mentioned before: financial cost and negative externalities. Negative environmental impacts threaten the human health and ecology by harmful gas emissions and its waste during production and processing of energy. The two impacts are pollution and global warming, and fixing the destruction and avoiding its impacts are additional cost to harming. This cost is kind of social, economic and environmental cost, and precautions should be taken and this cost must be decreased.

Under this demand conditions it is impossible to decrease the damage through reducing production. It is almost null and void too for supply side and for countries which are focused on better economic performance. Making the most of technological opportunities to reduce energy intensity and to increase energy efficiency, preventive policies, and substituting the renewable energy sources for fossil fuels to reduce the greenhouse gas (GHG) emissions are some of necessities to negative externalities. Because the adverse effects are seen in air, water, and land as a whole.

According to report of Intergovernmental Panel on Climate Change (IPCC), climate change and global warming is obviously seen through data of different periods between 1850 and 2012. Indicators of *i)* land and sea surface temperature, *ii)* ocean heat content, *iii)* marine air temperature, *iv)* summer arctic sea-ice extent, *v)* sea level, *vi)* glacier mass balance, *vii)* northern hemisphere snow cover, *viii)* tropospheric temperature, *ix)* specific humidity show the increase in temperature in our world. There is an apparent trend in increase in temperature of water, land and air. Increase in humidity (proof for higher vaporization), decrease in ice mass and relatedly increase in sea level around the world are proof of global warming. According to figure 2.8 the trend in temperature rise is accelerating since last few decades. This situation threatens the ecology seriously. Precautionary warnings and rehabilitation policies should be applied in the regional, national and international basis to make things better off. Coordination and cooperation among public and private sectors globally is vital to be able to get result.

Figure 2.8: Some Indicators For Climate Change



Source: Intergovernmental Panel on Climate Change (IPCC), **Climate Change 2013: Technical Summary**, pp. 38

The usage of fossil fuels lead to pollution, in particular air pollution, as well. Basically fossil fuels are used in two area: production and consumption. The main source of air pollution is the industrial usage of fossil fuels in developed and developing regions whereas heating, cooking and lightning are the main sources for fossil fuel usage and air pollution in under-developed regions. So development level is a bench mark for the type of pollution. This kind of environmental disaster threatens human health and it leads to; lung disease and a wide range of respiratory illnesses-especially lung cancer on adults and chronic bronchitis on children, cardiovascular disease, premature born and miscarriage, unfortunately wide range of disease on new born infants. Lead exposure is also one of sources of air pollution due to the use of leaded gasoline. Although no symptoms in lower level of exposure, it may lead children to have learning disability and difficulty on building social contacts[21].

The pollution in the air not only damage the environment by air and respiratory but also it may lead to acid rain through dropping of acids in the air to the earth. Especially sulfuric and nitric acid are the most seen ones that damage the agriculture through harming crops, forests, rivers, and lakes. Just as global warming, pollution is required to act regional, national and international basis. Because these are really comprehensive worldwide problems and they interest the globe as a whole.

As a result social, environmental and economic negative externalities are occurred because of use of fossil fuels. Harming:

- Human health leads to negative social impacts,
- Natural resources (land, water etc.) and human capital lead to lower the quality of input so this is economically negative impact,
- Environment through emission of damaging gases and pollution lead to environmentally negative externality.

These are interrelated problems and they are not separated each other. As we mentioned above public and private sectors should make strategies in coordination and cooperation. But one another problem exists: inequality. From two aspects inequality is occurred:

1) Precaution and rehabilitation is high cost, so the regional and firm based financial differences lead to inequalities,
2) Quotas for carbon emission may be forceful for producers who use predominantly fossil fuel in production. Producer may choose to invest on higher technology to reduce the carbon emission or may prefer to bear the sanctions. Both are the additional cost factors to the producer and the one who can tolerate these is counted as advantaged.

So region and firm based inequality may be occurred for the both cases of avoiding and neglecting damages. In this context encouragements, supports and subsidies to the private

[21] Jamal Saghir and Kyran O'Sullivan, **Towards a Sustainable Energy Future-Note for Participants**, World Bank Global Issues Seminar Series, WB

sector; national and international cooperation; high enough financial sanctions that will not to lead inequality are really important actions to eliminate such inequalities. This serves for reducing negative externalities of using fossil fuels at the same time.

PART THREE

TFP, ENERGY INTENSITY AND INCLUSIVE GROWTH: A COMPARISON BETWEEN TURKEY AND ASIAN COUNTRIES

3.1.Introduction

As we mentioned in the second chapter energy enables! So energy is very important for both production and consumption sides. That’s why it is an interesting topic to discuss, and its association with economy have been studied for years. Hence the subject of energy does not belong just today. The world had experienced two world wars for the sake of energy provision during the last century since division of energy resources was one of the most important motivations. So as a sufficient input, energy engages firms’ and governments’ attention, and the relationships of energy and productivity, energy and economic growth are subject to most of researches for years.

Researchers are generally interested in the link between energy, productivity and economic growth from both macro and micro perspectives but the inclusiveness of the economic growth is usually missed. This econometric study investigates whether the economic growth is inclusive or not through human capital and negative externality of energy usage differently from the studies. The relationships between energy intensity, TFP, and inclusive growth are the subjects. Three bivariate functions for each of Turkey and weighted average of six Asian countries (China, India, Kazakhstan, Kyrgyzstan, South Korea and Thailand) are modelled between the variables as follows; HC-TFP, HC-GHG, EI-TFP. Here HC is human capital, GHG is greenhouse gases, EI is energy intensity and TFP is total factor productivity. ADF unit root test, Johansen cointegration test and vector error correction model (VECM) are applied to these bivariate functions to test if there is any relationship between the variables in the long run and E-views 9 is used as econometric package programme.

3.2. Literature Review

The studies are generally built on the relationship between energy consumption and economic growth. They handle the subject from the aspects of productivity, pollution, energy supply and security. Energy prices, CO_2 emission, alternative energy sources and substitutability of them, TFP, labour productivity, energy efficiency, and energy intensity are parameters which are used to scrutinise the energy-growth nexus. These are important ingredients of the searches of energy and economics, and various combinations of have been investigated by researchers.

The studies in table 3.1 from “a” to “r” are based on the link between energy consumption and economic growth independently from productivity or environment. ***Asafu-Adjaye J. (2000)***[a] is estimating the causal relationships between energy consumption and income for India, Indonesia, the Philippines and Thailand through using energy prices. ***Chien-Chiang Lee & Yi-Bin Chiu (2011)***[b] are examining the short-run dynamics and long-run equilibrium relationships among nuclear energy consumption, oil prices, oil consumption, and economic growth for developed countries covering the period 1971–2006. ***Wietze Lise & Kees Van Montfort (2007)***[c] are unfolding the linkage between energy consumption and GDP by undertaking a co-integration analysis for Turkey with annual data over the period 1970–2003. ***Hanan Naser (2015)***[d] is examining the causal relationship between nuclear energy consumption and economic growth for four industrialised countries; the US, Canada, Japan, and France between 1965 and 2010. ***Nicholas Apergis & Chor FoonTang (2013)***[e] are re-investigating the validity of the energy-led growth hypothesis using a different model specification and different stages of economic development for 85 selected countries around the globe. ***J. Y. Heo & S. H. Yoo & S. J. Kwak (2011)***[f] are investigating the long and short run causality issues between nuclear energy consumption and economic growth in India by employing the annual data covering the period 1969–2006. ***Wankeun Oh & Kihoon Lee (2004)***[g] are investigating the causal relationship between energy consumption and economic growth. ***Seung-HoonYoo & Kun-Oh Jung (2005)***[h] are investigating the short- and long-run causality issues between nuclear energy consumption and economic growth in Korea by employing annual data covering the period 1977–2002. ***Ramazan Sarı & Uğur Soytaş (2004)***[ı] are examining how much of the variance in national income growth can be explained by the growth of different sources of energy consumption and employment in Turkey. ***Seung-Hoon Yoo (2006)***[i] is investigating the short and long run causality issues between oil consumption and economic growth in Korea for the period 1968–2002. ***Fatma Fehime Aydın (2010)***[j] is examining the relationship between energy consumption and economic growth by aggregated and decomposed equations. ***Salih Katırcıoğlu & Sami Fethi & Demet Beton Kalmaz & Dilber Çağlar (2016)***[k] are investigating the empirical relationship between energy consumption, international trade, and real income in Canada. ***Hanan Naser (2015)***[l] is scrutinizing the long-run relationship and the causal linkage between oil consumption, nuclear energy consumption, oil prices and economic growth using time series data for four emerging economies: Russia, China, South Korea and India. ***Seung-Hoon Yoo & Se-Ju Ku (2009)***[m] are investigating the causal relationship between nuclear energy consumption and economic growth using the data for Argentina, France, Germany, Korea, Pakistan, and Switzerland. ***Cengiz Aktaş & Veysel Yılmaz (2008)***[n] are examining the short- and long-run causality between oil consumption and gross national product for Turkey using annual data for the period of 1970-2004. ***Halil Altıntaş & Mehmet Mercan (2015)***[o] are investigating; the relationship between electricity consumption and economic growth through Cobb-Douglass production function, and the relationship between capital accumulation and labor force through panel cointegration in the case of G11 countries of OECD during the period 1980-2011. ***Augustine C. Osigwe & Damilola Felix Arawomo (2015)***[p] are examining the Granger causality of energy consumption, oil price, and economic growth in Nigeria by using two sub-categories of energy (kerosene and electricity). ***Muhittin KAPLAN & İlhan ÖZTÜRK & Hüseyin KALYONCU (2011)***[r] are examining the causal relationship between energy consumption and economic growth for Turkey during 1971–2006. The studies in the table from "s" to "w" are about productivity, TFP and energy intensity. These mention the subjects of productivity and energy efficiency, and the effect of these to the economic growth. ***Santosh Kumar Sahu & Himani Sharma (2016)***[s] are calculating total factor productivity and they are determining factors related to energy intensity for the pre-existing manufacturing plants in India, using data from the annual survey of industries from 2002 to 2008. ***Santosh Kumar Sahu & Krishnan Narayanan (2011)***[t] are estimating the transcendental logarithmic production function and analyse the relationship between energy intensity and total factor productivity (TFP). ***Can Tansel Tuğcu & Aviral Kumar Tiwari (2016)***[u] are examining the causal relationship between different types of energy consumption and TFP growth in the BRICS from 1992 to 2012. ***M. H. Bala Subrahmanya (2006)***[v] is probing the role of labour efficiency in promoting energy efficiency and economic performance with reference to small scale brick enterprises' cluster in Malur, Karnataka State, India. ***María del P. Pablo-Romero & Antonio Sánchez-Braza (2015)***[w] are analysing the role of energy in economic growth from a geographical standpoint by estimating an aggregate translog production function. They are employing human and physical capitals, and productive energy use as production factors, within a growth framework by using Panel data of 38 major countries for the period from 1995 to 2007. Finally the last three in the table, from “x” to “z”, are about energy consumption and economic growth through environment by considering CO_2 emission as parameter. ***Hsiao-Tien Pao & Hsiao-Cheng Yu & Yeou-Herng Yang (2011)***[x] are examining the dynamic relationships between pollutant emissions, energy use, and real output during the period between 1990 and 2007 for Russia. ***Usama Al-Mulali (2011)***[y] is examining the impact of oil consumption on the economic growth of the MENA countries during the period 1980–2009. ***Behnaz Saboori & Jamalludin Sulaiman (2013)***[z] are examining the cointegration and causal relationship between economic growth, carbon dioxide (CO_2) emissions and energy consumption in selected Association of Southeast Asian Nations (ASEAN) countries for the period 1971–2009.

Table 3.1: The Colophon of the Studies

Panel A: Studies that are Based on Purely Energy Consumption and Economic Growth - 1

	TITLE	AUTHOR	METHOD	AIM	FINDINGS
a	The Relationship Between Energy Consumption, Energy Prices and Economic Growth: Time Series Evidence from Asian Developing Countries	Asafu-Adjaye J.	• Cointegration • Granger causality • Error-Correction Modelling Techniques	To estimate the causal relationships between energy consumption and income for India, Indonesia, the Philippines and Thailand.	In the short-run: unidirectional Granger causality runs from energy to income for India and Indonesia, while bidirectional Granger causality runs from energy to income for Thailand and the Philippines. The results do not support that energy and income are neutral with respect to each other, with the exception of Indonesia and India in the short-run.
b	Oil Prices, Nuclear Energy Consumption, and Economic Growth: New Evidence Using A Heterogeneous Panel Analysis	Chien-Chiang Lee & Yi-Bin Chiu	• Panel Cointegration Analysis • Panel causality	To examine the short-run dynamics and long-run equilibrium relationships among nuclear energy consumption, oil prices, oil consumption, and economic growth for developed countries covering the period 1971 –2006.	In the long run, oil prices have a positive impact on nuclear energy consumption, suggesting the existence of the substitution relationship between nuclear energy and oil. The long-run elasticity of nuclear energy with respect to real income is approximately 0.89, and real income has a greater impact on nuclear energy than do oil prices in the long run. Furthermore, the panel causality results find evidence of unidirectional causality running from oil prices and economic growth to nuclear energy consumption in the long run, while there is no causality between nuclear energy consumption and economic growth in the short run.
c	Energy Consumption and GDP in Turkey: Is There A Co-Integration Relationship	Wietze Lise & Kees Van Montfort	• Cointegration	To unfold the linkage between energy consumption and GDP by undertaking a co-integration analysis for Turkey with annual data over the period 1970–2003.	The analysis shows that energy consumption and GDP are co-integrated. We establish that there is a unidirectional causality running from GDP to energy consumption indicating that energy saving would not harm economic growth in Turkey. In addition, we find that energy consumption keeps on growing as long as the economy grows in Turkey.
d	Can Nuclear Energy Stimulates Economic Growth? Evidence from Highly Industrialised Countries	Hanan Naser	• Granger Causality Test [Developed by Toda and Yamamoto (1995)]	To examine the causal relationship between nuclear energy consumption and economic growth for four industrialised countries; the US, Canada, Japan, and France, between 1965 and 2010.	There is one-way causality from nuclear energy consumption to economic growth in Japan denoting that an energy conservation policy that aims to minimise nuclear energy consumption may adversely affect economic growth. Oppositely, increasing real GDP causes additional nuclear energy consumption in France. In the US and Canada, there is evidence that support the neutrality hypothesis. Looking at the other investigated channels, the level of real oil prices seems to have a vital role in deriving the demand for nuclear power in three out of four countries. There is also a causal linkage between oil and nuclear energy consumption in the US, Japan, and France, suggesting that the uncertainty surrounding the global oil market plays a key role in determining the demand for nuclear energy.
e	Is The Energy-Led Growth Hypothesis Valid? New Evidence From A Sample of 85 Countries	Nicholas Apergis & Chor FoonTang	• Granger Causality	To re-investigate the validity of the energy-led growth hypothesis using a different model specification and different stages of economic development for 85 selected countries around the globe.	In particular, Granger causality models with three and four variables are more likely to support the hypothesis compared to their counterparts that contain only two variables. In addition, both developed and developing countries are more likely to support the energy-led growth hypothesis compared to the less developed or low income countries. Therefore, causality results are very sensitive to the choice of the model specification along with the stages of economic development. Finally, energy conservation policies should only focus on low income countries as these policies may not retard the process of economic growth.

Table 3.1: The Colophon of the Studies

Panel B: Studies that are Based on Purely Energy Consumption and Economic Growth - 2

	TITLE	AUTHOR	METHOD	AIM	FINDINGS
f	The Causal Relationship Between Nuclear Energy Consumption And Economic Growth In India	J. Y. Heo & S. H. Yoo & S. J. Kwak	• Cointegration • Error-Correction Models	To investigate the long-run and short-run causality issues between nuclear energy consumption and economic growth in India by employing the annual data covering the period 1969–2006.	There is a unidirectional causality running from nuclear energy consumption to economic growth without any feedback effect. Thus, considering the fact that nuclear energy consumption fosters economic growth, policies for increasing nuclear energy supply investment is, therefore, likely to enhance economic growth in India.
g	Energy Consumption and Economic Growth in Korea: Testing The Causality Relation	Wankeun Oh & Kihoon Lee	• Granger Causality • Vector Error Correction Model (VECM)	To investigate the causal relationship between energy consumption and economic growth by applying two multivariate time series models: a demand side model of energy, GDP and real energy price and a production side model of GDP, energy, capital, and labor for the period 1981:1–2000:4.	Empirical results from the two models for Korea suggest no causality between energy and GDP in the short run and a unidirectional causal relationship running from GDP to energy in the long run. It implies an energy conservation policy may be feasible without compromising economic growth in the long run. It also implies that a sustainable development strategy may be feasible with lower level of CO2 emissions from fossil fuel combustion.
h	Nuclear Energy Consumption and Economic Growth in Korea	Seung-HoonYoo & Kun-Oh Jung	• Cointegration • Test for Unit Root • Granger Causality	Investigating the short- and long-run causality issues between nuclear energy consumption and economic growth in Korea by employing annual data covering the period 1977–2002.	The results show that unidirectional causality runs from nuclear energy consumption to economic growth in Korea without any feedback effect. This means that in order not to adversely affect economic growth, the Korean government should endeavour to overcome the constraints on nuclear energy consumption.
ı	Disaggregate Energy Consumption, Employment and Income in Turkey	Ramazan Sarı & Uğur Soytaş	• Generalized Forecast Error Variance Decomposition Technique	To contribute to literature on energy consumption and economic growth relationship by examining how much of the variance in national income growth can be explained by the growth of different sources of energy consumption and employment in Turkey.	Waste seems to have the largest initial impact, followed by oil. However, over a 3-year horizon lignite appears to explain the largest forecast error variance of GDP. The total energy consumption explains 21% of forecast error variance of GDP. Energy consumption appears to be almost as important as employment in Turkey. Therefore, policy-makers may be interested in identifying the energy dependencies of economic growth in allocating the energy investment budget.
i	Oil Consumption and Economic Growth: Evidence from Korea	Seung-Hoon Yoo	• Granger Causality • Test for Unit Root • Cointegration	Investigating the short- and long-run causality issues between oil consumption and economic growth in Korea for the period 1968–2002.	Bidirectional causality runs from oil consumption to economic growth in Korea. This means that an increase in oil consumption directly affects economic growth and that economic growth also stimulates further oil consumption.

Table 3.1: The Colophon of the Studies

Panel C: Studies that are Based on Purely Energy Consumption and Economic Growth - 3

	TITLE	AUTHOR	METHOD	AIM	FINDINGS
j	Energy Consumption and Economic Growth	Fatma Fehime Aydın	• OLS • Unit Root Test	To examine the relationship between energy consumption and economic growth both in theoretical and practical framework.	The relationship between energy consumption and economic growth is first examined by aggregated equations and then by using decomposed equations the effect of the sources that form primary energy consumption on the economic growth is analysed. Additionally, in the first analysis using 1996:01-2004:04 term's three months data and in the second analysis using 1980-2004 term annual data we get limitation by time. According to aggregated equations positive relationship between energy consumption and economic growth is observed. One percent increase in energy consumption leads to improvement in economic growth by 1.03 percent. On the other hand negative relation is observed between growth and consumption of natural gas and wooden except other primary energy sources as it is resulted from decomposed equations.
k	Interactions Between Energy Consumption, International Trade, And Real Income In Canada: An Empirical Investigation from A New Version of The Solow Growth Model	Salih Katırcıoğlu & Sami Fethi & Demet Beton Kalmaz & Dilber Çağlar	• Bound Tests to Level Relationships • Conditional Error Correction Models Through ARDL Specification	To investigate the empirical relationship between energy consumption, international trade, and real income in Canada which has an important role in global energy and trade by using annual data of the 1960 –2010 period.	Results reveal a long-term relationship between energy consumption, international trade, and real income in Canada. It is also found that energy exporting activity is the determinant (driver) of energy consumption through the channel of real income and energy consumption is the determinant (driver) of exports through the channel of real income in the long term of the Canadian economy. Exports and energy use are the determinants (drivers) of real income in the long term of the Canadian economy; therefore, as conditional Granger causality tests suggest there is feedback relationship between energy consumption, international trade, and real income in the long term of the Canadian economy. The present study suggests that any energy conservation policies are likely to have negative influence on output and international trade in Canada.
l	Analysing The Long-Run Relationship Among Oil Market, Nuclear Energy Consumption, and Economic Growth: An Evidence From Emerging Economies	Hanan Naser	• Johansen Cointegration Technique	To scrutinize the long-run relationship and the causal linkage between oil consumption, nuclear energy consumption, oil prices and economic growth using time series data for four emerging economies: Russia, China, South Korea and India, over the period from 1965 to 2010.	There is a long-run relationship between the proposed variables in each country. Exclusion tests show that both energy sources enter the cointegration space significantly (except for Russia), which suggests that energy has a long-run impact on economic growth. Results of the causal linkage between the variables point that energy consumption (i.e., oil or nuclear) has either a predictive power for economic growth, or a feedback impact between with real Gross Domestic Product (GDP) growth in all countries. Hence, energy conservation policies might harmful negative consequences on the growth of economic for this group of countries.
m	Causal Relationship Between Nuclear Energy Consumption and Economic Growth: A Multi-Country Analysis	Seung-Hoon Yoo & Se-Ju Ku	• Granger Causality • Test for Unit Root • Cointegration	To investigate the causal relationship between nuclear energy consumption and economic growth using the data for Argentina, France, Germany, Korea, Pakistan, and Switzerland	The causal relationship between nuclear energy consumption and economic growth is not uniform across countries. In the case of Switzerland, there exists bi-directional causality between nuclear energy consumption and economic growth. So an increase in nuclear energy consumption directly affects economic growth and that economic growth also stimulates further nuclear energy consumption. The unidirectional causality runs from economic growth to nuclear energy consumption without any feedback effects in France and Pakistan, and from nuclear energy to economic growth in Korea. However, any causality between nuclear energy consumption and economic growth in Argentina and Germany is not detected.

Table 3.1: The Colophon of the Studies

Panel D: Studies that are Based on Purely Energy Consumption and Economic Growth - 4

	TITLE	AUTHOR	METHOD	AIM	FINDINGS
n	Causal Relationship Between Oil Consumption And Economic Growth In Turkey	Cengiz Aktaş & Veysel Yılmaz	• Granger Causality	To examine the short- and long-run causality between oil consumption and Gross National Product for Turkey using annual data covering the period of 1970-2004.	In this study was found that exists bidirectional Granger causality between oil consumption and economic growth in the short and long run.
o	The Relationship Between Electricity Consumption and Economic Growth: Co-integration and Causality Application in the Case of G-11 Countries	Halil Altıntaş & Mehmet Mercan	• Cobb-Douglass Production Function • Panel Co-Integration • Panel Granger Causality Test	To investigate the relationship between electricity consumption and economic growth through Cobb-Douglass production function and the relationship between capital accumulation and labor force variables through panel co-integration in the case of G11 countries of OECD during the period 1980-2011.	The positive impact of electricity consumption, capital accumulation and labor force on economic growth were observed in accordance with our theoretical expectations. Moreover, the results of causality test in the long-run reveal that there is a bidirectional causality relationship between electricity consumption and economic growth.
p	Energy Consumption, Energy Prices and Economic Growth: Causal Relationships Based on Error Correction Model	Augustine C. Osigwe & Damilola Felix Arawomo	• Granger Causality Test • ECM	To examine the Granger causality of energy consumption, oil price and economic growth in Nigeria by using two sub-categories of energy (kerosene and electricity).	The results for the total energy showed bidirectional causality between energy consumption and economic growth. As regards electricity, bidirectional causality was found between electricity consumption and economic growth as well as between electricity consumption and electricity price. No causal relationship exists among kerosene consumption, kerosene price and economic growth. Based on our findings, we recommend that policies that promote energy consumption and economic growth be introduced. One way of achieving this is through the adoption of appropriate energy pricing framework that takes cognisance of both the present and the future generation.
r	Energy Consumption and Economic Growth in Turkey: Cointegration and Causality Analysis	Muhittin Kaplan & İlhan Öztürk & Hüseyin Kalyoncu	• Granger Causality • Cointegration • VECM	To examine the causal relationship between energy consumption and economic growth for Turkey during 1971–2006.	It is employed two multivariate models, namely demand model and production model, based on vector error correction model. The results indicate that energy consumption and economic growth are co-integrated and there is bidirectional causality running from energy consumption to economic growth and vice versa. This means that an increase in energy consumption directly affects economic growth and that economic growth also stimulates further energy consumption. Consequently, we conclude that energy is a limiting factor to economic growth in Turkey and, hence, shocks to energy supply will have a negative impact on economic growth and vice versa.

Table 3.1: The Colophon of the Studies

Panel E: Studies that are Interested in Productivity and Envionment - 1

	TITLE	AUTHOR	METHOD	AIM	FINDINGS
s	Productivity, Energy Intensity and Output: A Unit Level Analysis of the Indian Manufacturing Sector	Santosh Kumar Sahu & Himani Sharma	• Levinsohn and Petrin (2003) [A Modified Version of Production Function] • OLS	To calculate total factor productivity and determine factors related to energy intensity for the pre-existing manufacturing plants in India, using data from the annual survey of industries from 2002 to 2008.	Most of the industries achieved positive TFP growth except a few, and thus, within plant ef?ciency exists in the Indian manufacturing sector. In case of determinants of energy intensity, we found plants with higher TFP and higher output are energy ef?cient. Also, there exists a nonlinear relationship between energy intensity and output, which validates the productivity dilemma hypothesis for the Indian manufacturing sector.
t	Total Factor Productivity and Energy Intensity in Indian Manufacturing: A Cross-Sectional Study	Santosh Kumar Sahu & Krishnan Narayanan	• Four-Input Translog Production Function • OLS	To estimate the transcendental logarithmic production function and analyse the relationship between energy intensity and total factor productivity (TFP).	Labour and material inputs play major role as compared to the capital and energy input. Age of the firm, export intensity and disembodied technology import are positively related to the TFP, whereas ownership, energy intensity, embodied technology import and R&D intensity are negatively related to TFP of the Indian manufacturing industries. In addition, energy efficient firms also found to have high levels of TFP. This implies the need for fostering energy efficiency at firm level in Indian Manufacturing.
u	Does Renewable and/or Non-Renewable Energy Consumption Matter for Total Factor Productivity (TFP) Growth? Evidence from the BRICS	Can Tansel Tuğcu & Aviral Kumar Tiwari	• Panel Boots Trap Granger Causality Test by Kónya (2006)	To examine the causal relationship between different types of energy consumption and TFP growth in the BRICS from 1992 to 2012.	Results show that no remarkable causal link exists between renewable energy consumption and TFP growth in the BRICS. However, in the case of non-renewables, energy consumption creates a positive externality that contributes economic development in Brazil and South Africa by the growth of TFP as well as energy use itself. In this respect, policies that promote coal and non-renewable electricity consumption in South Africa and natural gas consumption in Brazil may be beneficial for their economic development.
v	Labour Productivity, Energy Intensity and Economic Performance in Small Enterprises: A Study Of Brick Enterprises Cluster in India	M. H. Bala Subrahmanya	• OLS • Cobb-Douglas	To probe the role of labour efficiency in promoting energy efficiency and economic performance with reference to small scale brick enterprises' cluster in Malur, Karnataka State, India.	In the bricks industry, the technology in use being similar, labour efficiency has a negative influence on energy cost. Therefore, those enterprises that exhibited higher labour productivities had lower average energy intensity and higher returns to scale as compared to those that had lower labour productivities. Considering this, improvement of labour efficiency can be an alternative approach for energy efficiency improvement in energy intensive small scale industries in developing countries like India, which face the obstacle.

Table 3.1: The Colophon of the Studies

Panel F: Studies that are Interested in Productivity and Envionment - 2

	TITLE	AUTHOR	METHOD	AIM	FINDINGS
w	Productive Energy Use and Economic Growth: Energy, Physical and Human Capital Relationships	María del P. Pablo-Romero & Antonio Sánchez-Braza	• Four Factor Translog Production Function • Panel Data Techniques	To analyse the role of energy in economic growth from a geographical standpoint by estimating an aggregate translog production function, with human and physical capital and productive energy use as production factors, within a growth framework by using Panel data of 38 major countries for the period from 1995 to 2007.	The strength of the link between energy and growth is analysed for the whole sample and the following relevant country groups: OECD, BRIC, NAFTA, East Asian, East European and EU15 countries. Obtained results show that the calculated productivity elasticities with respect to energy use are positive for all country groups. BRIC countries have higher elasticities, around 0.37, and EU15 countries have lower elasticities, around 0.12.Weak substitutability relationships between energy and capital are observed for all groups, except for BRIC and East European countries, which show complementarity relationships.
x	Modelling The CO2 Emissions, Energy Use, and Economic Growth In Russia	Hsiao-Tien Pao & Hsiao-Cheng Yu & Yeou-Herng Yang	• Granger Causality Test • Cointegratin	To examine the dynamic relationships between pollutant emissions, energy use, and real output during the period between 1990 and 2007 for Russia.	In the long-run equilibrium, emissions appear to be energy use elastic and output inelastic. The output exhibits a negative significant impact on emissions and does not support EKC hypothesis. So both economic growth and energy conservation policies can reduce emissions and no negative impact on economic development. There is a bidirectional strong Granger-causality running between output, energy use and emissions, and whenever a shock occurs in the system, each variable makes a short-run adjustment to restore the long-run equilibrium. The average speed of adjustment is as low as just over 0.26 years. Hence, in order to reduce emissions, it is needed to increase energy efficiency by infrastructure investment and lowering the wastage by conservative policies. That is, energy conservation is expected to improve energy efficiency, thereby promoting economic growth.
y	Oil Consumption, CO2 Emission and Economic Growth In MENA Countries	Usama Al-Mulali	• Granger Causality Test • Cointegratin	To examine the impact of oil consumption on the economic growth of the MENA countries during the period 1980–2009.	It was found that CO2 emission, and oil consumption has a long run relationship with economic growth. Moreover, there is also a bi-directional Granger causality between oil consumption, CO2 emission and economic growth in both the short run and the long run. The results of this study show clearly that oil consumption plays an important role in the economic growth of the MENA countries.
z	CO2 Emissions, Energy Consumption and Economic Growth In Association of Southeast Asian Nations (ASEAN) Countries: A Cointegration Approach	Behnaz Saboori & Jamalludin Sulaiman	• Autoregressive Distributed Lag (ARDL) • VECM • Granger Causality	To examine the cointegration and causal relationship between economic growth, carbon dioxide (CO2) emissions and energy consumption in selected Association of Southeast Asian Nations (ASEAN) countries for the period 1971–2009.	There was cointegration relationship between variables in all the countries under the study with statistically significant positive relationship between carbon emissions and energy consumption in both the short and long-run. The long-run elasticities of energy consumption with respect to carbon emissions are higher than the short-run elasticities. This implies that carbon emissions level is found to increase in respect to energy consumption over time in the selected ASEAN countries. A significant non-linear relationship between carbon emissions and economic growth was supported in Singapore and Thailand for the long-run which supports the Environmental Kuznets Curve (EKC) hypothesis. The Granger causality results suggested a bi-directional Granger causality between energy consumption and CO2 emissions in all the five ASEAN countries. This implies that carbon emissions and energy consumption are highly interrelated to each other. All the variables are found to be stable suggesting that all the estimated models are stable over the study period.

3.3. Methodology, Model And Data

3.3.1. Methodology And Modelling

It is aimed in this study that an economic growth can be inclusive through the positive effect of improved human capital on TFP and lowered energy intensity. So three bivariate functions are used to investigate whether there is a meaningful relationship among TFP, inclusive growth and energy intensity each for Turkey and weighted average of six Asian countries(China, Kazakhstan, Kyrgyzstan, India, South Korea and Thailand) by using Johansen cointegration test and vector error correction model (VECM). The data of Asian countries are weighted through their current GDPs during the period. Firstly we found their share in total GDP among them for each year, and we multiplied every single data with these percentages. After that we conclude the calculation through summing the obtained values in each year of six Asian countries. The bivariate functions are established between the variables; HC (human capital) – TFP, HC – GHG (greenhouse gases), and EI (energy intensity) – TFP.

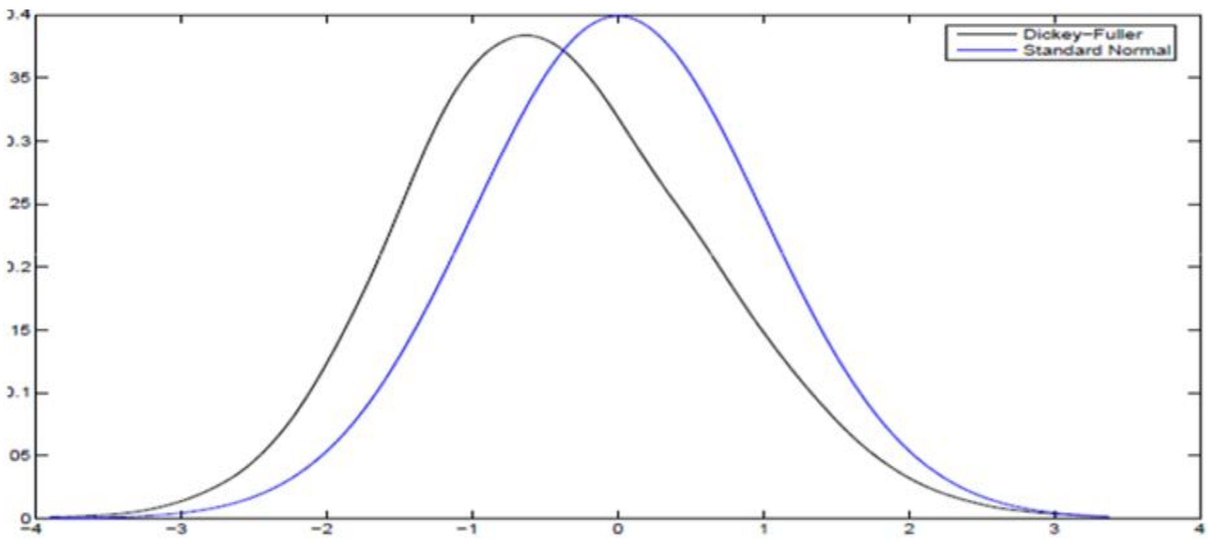
Here TFP, GHG and EI are collected data from different resources whereas HC is computed as harmonic mean of three data – percentage of access to electricity by population, school enrolment at primary level and life expectancy at birth. Time series data is used for Turkey, and panel data of six Asian countries are transformed to time series by weighted average method through their current GDPs. Dataset transformed to their natural logarithms to use these different unit variables in the same model. The bivariate models that we mentioned above are established as VEC models, and the aim is to investigate whether there is any long run relationship among them. In this pattern, it was needed to test cointegration relation among the series and to test unit root or stationarity of the variables. So unit root, cointegration and VECM are tried to separately and clearly be explained in the following titles.

3.3.1.1.Unit Root (Augmented Dickey And Fuller) Test

Stationarity of a time series is required for reliable and satisfactory results, and to test stationarity it is needed to check the unit root. Granger and Newbold (1974) proved that nonstationary time-series data does not follow the Standard distribution, and a rightward shift is observed in standard distribution as it is shown in figure 3.1. Then spurious results are attained and the significance is broken. By the way unit roots in time series data lead to stochastic trend and this should be eliminated by ‘augmenting’ the model using change in lag values of dependent variables in the amount of “m”. One of the unit root tests which is in great demand, augmented Dickey & Fuller test, determines non-stationary series as null hypothesis. As a summary, augmented Dickey & Fuller test is t test of coefficient “δ” in the equation below:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + \varepsilon_t$$

Figure 3.1: Distribution of Dickey & Fuller Test Statistics



Source: Yıldız Teknik Universitesi Iktisat Bölümü Ekonometri II Ders Notları, http://www.yildiz.edu.tr/~tastan/teaching/18.pdf

where Y_t is the variable at time t; t is time trend; Δ is sign for first difference; ε_t is stationary random error term. The logic is that if the coefficient of Y_{t-1} is zero (which is the null hypothesis according to ADF) the difference in Y_t is independent from lag value and it is non-stationary or has a unit root. But if there is a negative relationship (alternative hypothesis) between the first difference of the dependent variable at time t and its lagged value, then this variable is stationary in the long run, and it may be talked about cointegration in the long run between the variables that were checked by unit root test.

3.3.1.2.Johansen Cointegration Test

The notion of cointegration makes regressions involving I (1) variables potentially meaningful [1] and it is interested in the long term relation of nonstationary variables.

[1] Jeffrey M. Wooldridge, **Introductory Econometrics: A Modern Approach**, 3rd Edition, pp.652

Cointegration of variables are valid when the I (1) variables have stationary residuals in level values or in other words if linear combinations of I (1) variables are stationary in level values, the variables are cointegrated. Hence I (1) variables whose linear combinations have a common β vector are cointegrated.

Johansen cointegration is the method that explains the cointegration relation between the variables which are stationary in the same degree through maximum likelihood approach. Let's assume a VAR model like below:

$$Y_t = C_0 + \pi_1 Y_{t-1} + \pi_2 Y_{t-2} \ldots + \pi_k Y_{t-k} \quad (1)$$

After making assumption below, we arrive the final form of the VAR model:

$$Y_{t-1} \cong \pi_2 Y_{t-2} \ldots + \pi_k Y_{t-k} \quad (2)$$

$$Y_t \cong C_0 + (\pi + 1) Y_{t-1} \quad (3)$$

It is needed to transform Y_t to first difference form to investigate long run relation between variables in this linear system as below:

$$Y_t - Y_{t-1} = C_0 + (\pi + 1) Y_{t-1} - Y_{t-1}$$

$$\Delta Y_t = C_0 + \pi Y_{t-1} \quad (4)$$

But the difference in lag values are neglected unless including them into the model. So the error correction should be made through attaching difference in lag values to the model like below:

$$\Delta Y_t = C_0 + \pi Y_{t-1} + (1 - \pi_1)\Delta Y_{t-1} + \ldots + (1 - \pi_{k-1})\Delta Y_{t-k+1}$$

$$\Delta Y_t = C_0 + \pi Y_{t-1} + \sum_{i=1}^{k-1} \tau_i \Delta Y_{t-i} \qquad [\pi = \alpha\beta' \text{ and } 1 - \pi_i = \tau_i] \quad (5)$$

where π is a coefficient matrix which is (n x n) dimension with r rank. Then there are (n x r) matrices α and β such that $\pi = \alpha\beta'$, and $\beta' Y_t$ is stationary even Y_t is non-stationary. So the question is whether a β vector exists or not ($H_2 : \pi = \alpha\beta'$). If there is such a β vector, there is cointegration relation between variables with the amount of r. By the way it allows us to investigate their link in the long run through a model like equation (5) which is called as vector error correction model (VECM).

3.3.1.3.Vector Error Correction Model (VECM)

One of the dynamic models is vector-autoregressive (VAR) model which investigates the interrelationship among stationary variables. Here the key term is stationary; VAR model is not useful if the variables are non-stationary. But as a second way, it is checked whether the variables are stationary in their differences (mostly I (1)) or not. Hence a special case of VAR is obtained to investigate the long run relationship among I (1) variables. Furthermore cointegration is a necessity in these models. Otherwise it is impossible to talk about a long run relation for this modified VAR model. As a result, the VAR model is converted to a new model, which is known as the vector error correction model (VECM) through cointegrated and I (1) series [2]:

$$\Delta Y_t = C_0 + \pi Y_{t-1} + \sum_{i=1}^{k-1} \tau_i \Delta Y_{t-i}$$

This model is adopted in the econometric program as a model which has not only lag values of the dependent variable but also independent variables like below:

$$\boldsymbol{\Delta Y_t = C_1(Y_{t-1} + \delta_1 X_{t-1} + \delta_2 \mu_{1t} + \mu_0) + \left[\sum_{i=1}^{k-1} C_{i+1}\Delta Y_{t-i} + C_{i+k}\Delta X_{t-i}\right] + C_{i+p+1}}$$

Now a cointegration equation is in question rather than a lag variable. The coefficient of this equation-C_1 is error correction term (ECT) which is originally π, X_{t-1} is the 1 year lagged values of independent variable(s), μ_{1t} is trend variable, δ_1 and δ_2 are the coefficients and μ_0 is the constant term of the cointegration equation. The error correction part which is inside of the parentheses is also little bit different from the original. There is sum of changes in dependent variable with the portion of C_{i+k} from first year to year *k-1*. The coefficients C_{i+1} and C_{i+k} are originally$\tau_i = 1 - \pi_i$, and the C_{i+p+1} is constant term of the equation. Finally statistically meaningful and negative C_1 is proof of long-run relation between variables.

Econometrically it is expected that the error correction term (ECT) "π" must be between zero and minus one, and statistically significant. Because when any deviation occurs in one direction, it is expected that adjustment would be pulled back to other direction by a percentage

[2] http://www.learneconometrics.com/class/5263/notes/Vector%20Error%20Correction%20Models.pdf

within the period for maintaining LR equilibrium. ECT is also named as *speed of adjustment* because it is the speed at which Y returns to equilibrium after a change in X, so absolute value of ECT is the percentage of error correction within the period of variables. On the other hand the coefficient of the difference in the lag values, from the beginning until time “k-1”, gives information about short run relationships through applying F test to the coefficients. Ordinary least squares (OLS) method is used to estimate a VEC model.

3.3.2. Data

In this study, to investigate whether there is a meaningful relationship among TFP, inclusive growth and energy intensity, three bivariate functions are modelled for each of Turkey and weighted average of six Asian countries which are China, India, Kazakhstan, Kyrgyzstan, South Korea and Thailand between the variables as follows; HC-TFP, HC-GHG, EI-TFP. Annual data is used for the period 1990-2014. HC is human capital which is calculated by harmonic mean of access to electricity, school enrollment, and life expectancy at birth. These data are obtained from the website of World Bank Open Data. The access to electricity is the percentage of population with access to electricity and its data are aggregated by the weighted average method. It is collected from industry, national surveys and international sources. The school enrollment is , regardless of age, the ratio of total enrollment in the primary level to the population of the age group that officially corresponds to the level of education shown. It is centuple of the division of the number of students enrolled in primary education and the population of the age group which officially corresponds to primary education, and the data are collected by the UNESCO Institute for Statistics from official responses to its annual education survey. It is aggregated by the weighted average method as well. Life expectancy at birth, which is obtained from WB- World Development Indicators[3], is defined as the number of years a new-born infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. The annual data of TFP (Productivity level across countries in each year) is obtained from Penn World Table (version 9.0)[4] which is available in the cite of University of Groningen. Here TFP is the TFP level at current PPPs (USA=1), and it is calculated by a linear model that rely on neoclassical assumptions. Productivity level is not the

[3] Original sources that WB obtained the data: (1) United Nations Population Division. World Population Prospects: 2017 Revision, or derived from male and female life expectancy at birth from sources such as: (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) United Nations Statistical Division. Population and Vital Statistics Reprot (various years), (5) U.S. Census Bureau: International Database, and (6) Secretariat of the Pacific Community: Statistics and Demography Programme.

[4] A database that is created with information on relative levels of income, output, input and productivity, covering 182 countries between 1950 and 2014

same across the countries because of difference in factor endowments and technology levels. They established a relative model on the basis of this opinion. Output-side real GDP (using prices for final goods, exports, and imports that are constant across countries), Capital stock (using prices for structures and equipment that are constant across countries), the share of labor income of employees and self-employed workers in GDP, and data of labor input are used. GHG is greenhouse gases and they are composed of CO2 totals excluding short-cycle biomass burning (such as agricultural waste burning and Savannah burning) but including other biomass burning (such as forest fires, post-burn decay, peat fires and decay of drained peatlands), all anthropogenic CH4 sources, N2O sources and F-gases (HFCs, PFCs and SF6). Each year of data shows the percentage change to that year from 1990.[5] EI is energy intensity is obtained from the Shift Project Data Portal.[6] It is the ratio between energy supply and gross domestic product measured at purchasing power parity. Energy intensity is an indication of how much energy is used to produce one unit of economic output. Lower ratio indicates that less energy is used to produce one unit of output. This indicator is the ratio of total primary energy supply and gross domestic product measured in billions of (constant 2005) US dollars at purchasing power parity, and this annual data is aggregated by weighted average method.[7]

[5] World Bank staff estimates from original source: European Commission, Joint Research Centre (JRC)/Netherlands Environmental Assessment Agency (PBL). Emission Database for Global Atmospheric Research (EDGAR): http://edgar.jrc.ec.europa.eu/.

[6] http://www.tsp-data-portal.org/Energy-Intensity-of-GDP#tspQvChart

[7] All of the identifications and information about GHG, EI, and components of HC are totally obtained from the source of **databank of World Bank-world development indicators**.

3.4. Empirical Results

The aim of this study is to investigate whether there is a meaningful link between inclusive growth, TFP and energy intensity. The subject of this study is whether an economic growth can be inclusive through the positive effect of improved human capital on TFP and lowered energy intensity. So two bivariate VEC models are established with the combinations of HC-TFP and EI-TFP for both Turkey and six Asian countries. On the other hand the role of equal opportunities and negative externalities of energy usage are in question. Therefore GHG is used for negative externalities whilst life expectancy, school enrollment and access to electricity are used to calculate HC regarding equal opportunities. So the third bivariate VEC model is HC-GHG combination for Turkey and Asian countries. We'll focus on long run relationships since the variables are long run variables. That' why we'll not analyse the short run relations which should be investigated through applying F-test to coefficients of lag values of changes in variables. The logarithms of the series were used in the study but for simplicity we'll call them HC, TFP, EI, GHG rather than using letter 'L' for signing logarithm.

3.4.1. Empirical Results Of Asian countries

3.4.1.1.Relationship Between HC And TFP

3.4.1.1.1. Unit Root (ADF) Test

The series that are investigated by VEC model must be cointegrated and stationary in first differences. Unit root tests are used to test stationarity and one of the most commonly used one is augmented Dickey and Fuller test. The results for the variables TFP and HC are below. In table 3.2, it is seen that TFP is stationary in first difference since augmented Dickey-Fuller test statistic is lower than test critical values in all percentage levels. Another clue is the p-value (Prob.) which requires to be lower than 1%, and it is approximately zero. That means TFP is I (1).

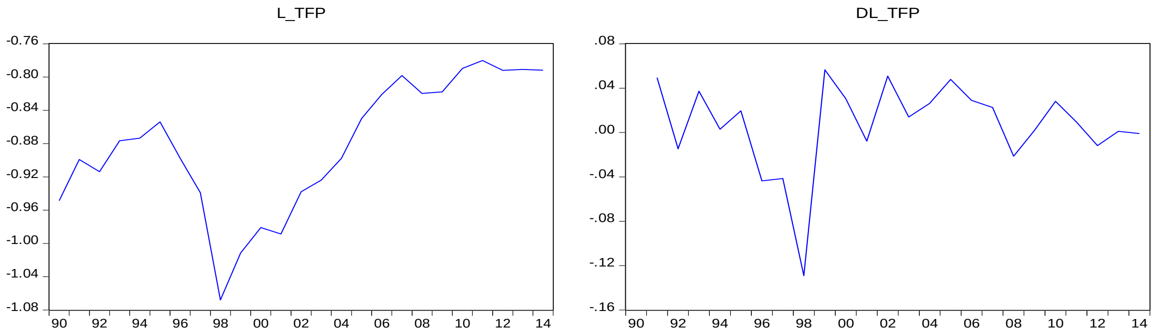
Table 3.2: ADF unit root test for TFP (Asia)

Null Hypothesis: **D (L_TFP)** has a unit root

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.417483	0.0022
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

When we look at the difference between the graphs of TFP in figure 3.2, it is obviously seen how it's being stationary in first difference.

Figure 3.2: Stationarity of TFP (Asia)



Source: Groningen growth and development centre (GGDC), Productivity, Penn World Table, the series CTFP in excel form

Table 3.3 shows that HC is also I (1). Because augmented Dickey-Fuller test statistic is again absolutely lower than test critical values in all percentage levels and p-value is totally lower than 1%. So HC is stationary in first difference.

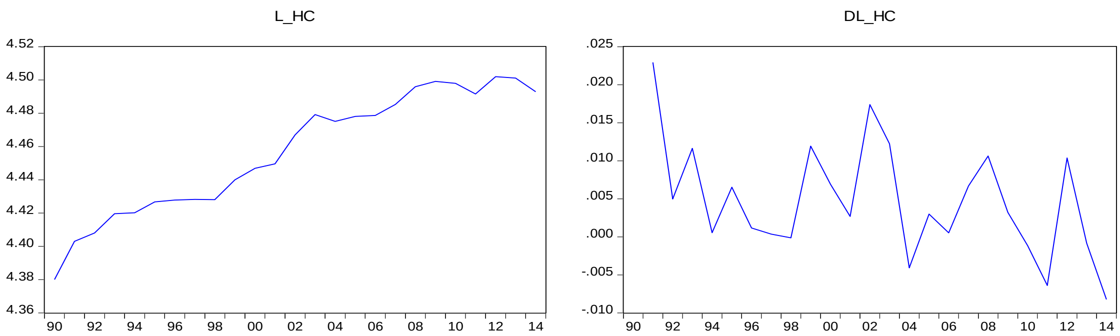
Table 3.3: ADF unit root test for HC (Asia)

Null Hypothesis: **D (L_HC)** has a unit root

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.734728	0.0011
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

Stationarity of HC is seen in figure 3.3. When we compare the graphs of level values and first difference values of HC, the becoming stationary of HC is clearly seen.

Figure 3.3: Stationarity of HC (Asia)



Source: World Bank Open Data[8]

[8] The components of HC; life expectancy at birth, school enrollment in primary level without an age restriction, and access to electircity (% of population) were got from the source.

3.4.1.1.2. Johansen Cointegration Test

One another condition to use VEC model is cointegrated series as we mentioned before. Table 3.4 shows the cointegration relation between HC and TFP. As it is seen in the table, these series have two cointegration relations in the long run, because the trace statistics of trace test and maximum eigenvalue test are higher than 5% critical values for “none” and “at most one”. Moreover p-value under 5% is another proof of two cointegration relations. So since HC and TFP are I (1) and cointegrated, we can apply VEC model for these series.

Table 3.4: Johansen Cointegration between HC and TFP (Asia)

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.545978	21.66382	15.49471	0.0052
At most 1 *	0.254412	5.871637	3.841466	0.0154

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.545978	15.79219	14.26460	0.0285
At most 1 *	0.254412	5.871637	3.841466	0.0154

3.4.1.1.3. VECM

The results of VEC model in table 3.5, show that HC and TFP are in relation in the long run. ECT, which is C (1), is between zero and minus one, and it is statistically meaningful which is required p-value under 5%. So they converge to each other in the LR. C (1) is equal to -0.073 so the speed of adjustment is 7.3 percent per a year since these are annual data. The short run coefficients are all around zero.

Table 3.5: The estimation of VECM for HC and TFP (Asia)

	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**
C(1)	-0.073060	0.024414	-2.992522	0.0082
C(2)	0.003707	0.243692	0.015213	0.9880
C(3)	-0.279799	0.221742	-1.261825	0.2241
C(4)	0.000638	0.037741	0.016908	0.9867
C(5)	0.050115	0.037544	1.334817	0.1995
Determinant residual covariance		3.00E-05		

Equation: D(L_HC)=C(1)*(L_HC(-1) + 0.292300685259*L_TFP(-1) -4.27260010229) + C(2)*D(L_HC(-1)) + C(3)*D(L_HC(-2)) + C(4)*D(L_TFP(-1)) + C(5)*D(L_TFP(-2))

Observations: 22

R-squared	0.276049	Mean dependent var	0.003859
Adjusted R-squared	0.105708	S.D. dependent var	0.006592
S.E. of regression	0.006233	Sum squared resid	0.000661
Durbin-Watson stat	2.077341		

3.4.1.2.Relationship Between HC And GHG

3.4.1.2.1. Unit Root

The results of unit root for the variables GHG and HC are below. In table 3.6, it is seen that GHG is stationary in first difference. Because augmented Dickey-Fuller test statistic is lower than test critical values in all percentage levels, and the p-value is zero. So GHG is I (1).

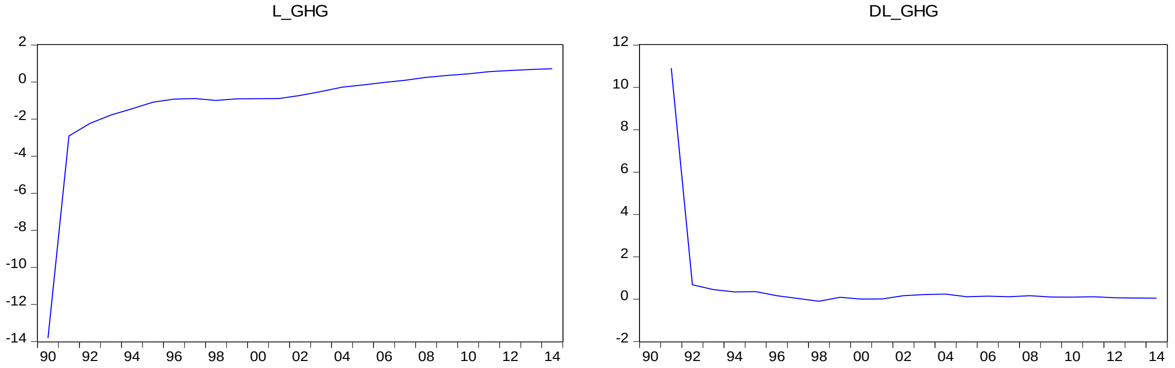
Table 3.6: ADF unit root test for GHG (Asia)

Null Hypothesis: **D (L_GHG)** has a unit root

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-83.92030	0.0000
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

The figure 3.4 is also demonstrates that GHG is I (1). GHG has an increasing trend at level values while it is stationary in first differences.

Figure 3.4: Stationarity of GHG (Asia)



Source: World Bank Open Data

However we mentioned about HC above, it had better to repeat. It is seen that HC is stationary in first difference in table 3.7, just as in table 3.3. Because augmented Dickey-Fuller test statistic is under the test critical values in all percentage levels, and the p-value (Prob.) is approximately zero which satisfies to be under 1%. So HC is I (1).

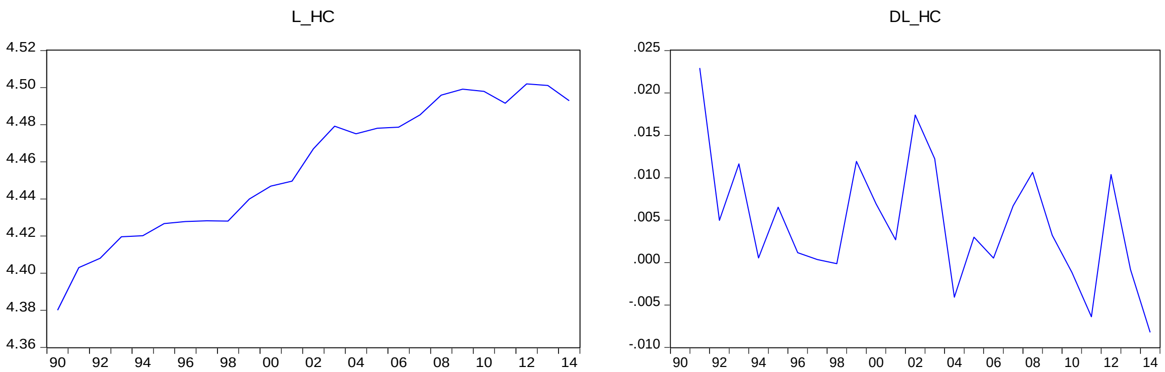
Table 3.7: ADF test for HC (Asia)

Null Hypothesis: **D (L_HC)** has a unit root

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.734728	0.0011
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

The figure 3.5 shows the separation between level values and values in first differences. HC is stationary in first difference whilst it is increasing in level values. So HC is I (1).

Figure 3.5: Stationarity of HC (Asia)



Source: World Bank Open Data

3.4.1.2.2. Johansen Cointegration

Table 3.8 shows the cointegration relation between HC and GHG. According to the table, these series are cointegrated in the long run, because the trace statistics of trace test and maximum eigenvalue test are higher than 5% critical values. Moreover p-value under 5% is another proof of a cointegration relation, they are nearly zero. So since HC and GHG are I (1) and cointegrated we can apply VEC model for these series.

Table 3.8: Johansen Cointegration for HC and GHG (Asia)

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.614822	23.53977	15.49471	0.0025
At most 1	0.067064	1.596640	3.841466	0.2064

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.614822	21.94313	14.26460	0.0025
At most 1	0.067064	1.596640	3.841466	0.2064

3.4.1.2.3. VECM

The results of VEC model below, table 3.9, show that HC and GHG converge to each other in the LR. ECT, which is C (1), is between zero and minus one, and it is statistically meaningful which is required p-value under 5%. C (1) is approximately equal to -0.0218, so the share of correction is 2.18 percent per a year. The short run coefficients are all between one and minus one.

Table 3.9: The estimation of VECM for HC and GHG (Asia)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.021769	0.010125	-2.149985	0.0472
C(2)	-0.018352	0.012796	-1.434218	0.1708
C(3)	0.001305	0.000914	1.427447	0.1727
C(4)	-0.398819	0.323286	-1.233644	0.2352
C(5)	-0.560350	0.285310	-1.964003	0.0671
C(6)	0.010880	0.003489	3.118477	0.0066
Determinant residual covariance		2.78E-05		

Equation: D(L_HC) = C(1)*(L_GHG(-1) - 21.0896050173*L_HC(-1) + 94.5701885248) + C(2)*D(L_GHG(-1)) + C(3)*D(L_GHG(-2)) + C(4) *D(L_HC(-1)) + C(5)*D(L_HC(-2)) + C(6)

Observations: 23

R-squared	0.329666	Mean dependent var	0.003859
Adjusted R-squared	0.120186	S.D. dependent var	0.006592
S.E. of regression	0.006183	Sum squared resid	0.000612
Durbin-Watson stat	2.181122		

3.4.1.3.Relationship Between EI And TFP

3.4.1.3.1. Unit Root

The ADF results for the variables EI and TFP are below. Table 3.10 shows that EI is stationary in first difference. Because augmented Dickey-Fuller test statistic is less than test critical values in all percentage levels, and the p-value is nearly zero which is required to be lower than 1%. So EI is I (1).

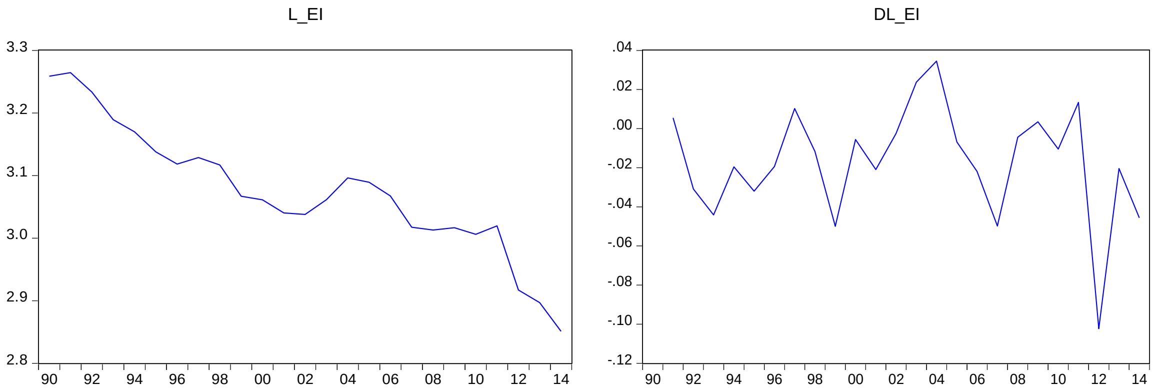
Table 3.10: ADF test for EI (Asia)

Null Hypothesis: **D (L_EI)** has a unit root

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.310508	0.0028
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

Separation between level values and values in first differences is shown in the figure 3.6. EI is stationary in first difference whilst it is decreasing in level values. So EI is I (1).

Figure 3.6: Stationarity of EI (Asia)



Source: Data is collected from http://www.tsp-data-portal.org/Energy-Intensity-of-GDP#tspQvChart

Table 3.11 shows that TFP is stationary in first difference just as table 3.2. We made mention of this above but it is good to repeat. Augmented Dickey-Fuller test statistic is less than test critical values in all percentage levels, and the p-value is nearly zero. So TFP is I (1).

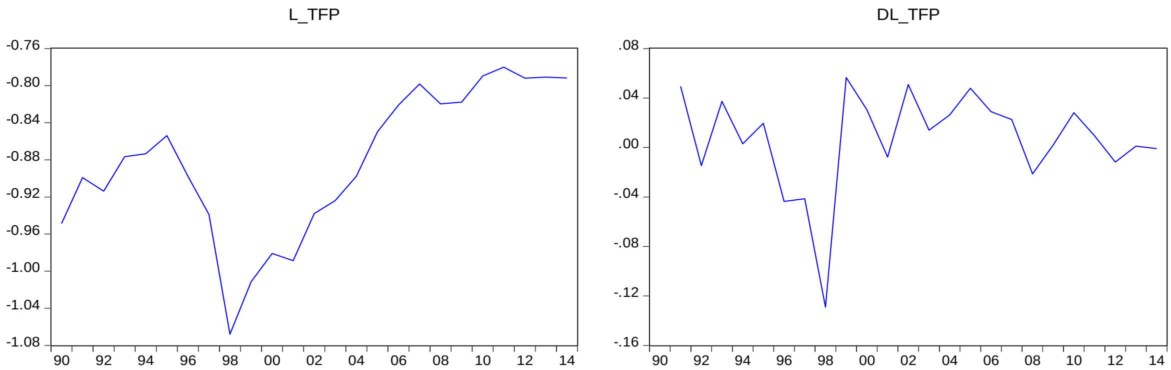
Table 3.11: ADF test for TFP (Asia)

Null Hypothesis: **D (L_TFP)** has a unit root

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.417483	0.0022
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

When we look at the difference between the graphs of TFP in figure 3.7, it is seen how it's being stationary in first difference.

Figure 3.7: Stationarity of TFP (Asia)



Source: Groningen growth and development centre (GGDC), Productivity, Penn World Table, the series CTFP in excel form

3.4.1.3.2. Johansen Cointegration Test

Table 3.12 shows the cointegration relation between EI and TFP. According to the table, these series are cointegrated in the long run, because the trace statistics of trace test and maximum eigenvalue test are higher than 5% critical values. Moreover 0.0239 and 0.0354 p-values are the indicators for one cointegration relation between TFP and EI. So since TFP and EI are I (1) and cointegrated we can apply VEC model for these series.

Table 3.12: Johansen Cointegration for EI and TFP (Asia)

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.639698	28.36936	25.87211	0.0239
At most 1	0.328106	7.953107	12.51798	0.2555

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.639698	20.41626	19.38704	0.0354
At most 1	0.328106	7.953107	12.51798	0.2555

3.4.1.3.3. VECM

The results of VEC model below, table 3.13, show that EI and TFP have long run relationship. ECT, which is C (1), is between zero and minus one, and it is statistically meaningful which is required p-value less than 5%. So they converge to each other in the LR. C (1) is approximately equal to -0.894, so the speed of adjustment is 89 percent per a year. The short run coefficients are all between one and minus one.

Table 3.13: The estimation of VECM for EI and TFP (Asia)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.893974	0.341220	-2.619935	0.0186
C(2)	0.648500	0.297749	2.178008	0.0447
C(3)	0.656900	0.307003	2.139718	0.0481
C(4)	0.097677	0.149941	0.651435	0.5240
C(5)	-0.101855	0.146750	-0.694072	0.4976
C(6)	0.003905	0.010539	0.370504	0.7159
Determinant residual covariance		0.000546		

Equation: D(L_EI) = C(1) * (L_EI(-1) - 0.380205311596 * L_TFP(-1)+ 0.014721824785*@TREND(90)-3.60262405848)+C(2)*D(L_EI(-1))+C(3)*D(L_EI(-2)) + C(4)*D(L_TFP(-1)) + C(5)*D(L_TFP(-2)) + C(6)

Observations: 22

R-squared	0.345193	Mean dependent var	-0.017371
Adjusted R-squared	0.140566	S.D. dependent var	0.029567
S.E. of regression	0.027411	Sum squared resid	0.012022
Durbin-Watson stat	1.892734		

3.4.2. Empirical Results Of Turkey

3.4.2.1. Relationship Between HC And TFP

3.4.2.1.1. Unit Root

The ADF results for the variables HC and TFP are below. Table 3.14 shows that TFP is stationary in first difference. Because augmented Dickey-Fuller test statistic is under the test critical values in all percentage levels, and the p-value is nearly zero that already satisfies the necessity of being under 1%. So TFP is I (1).

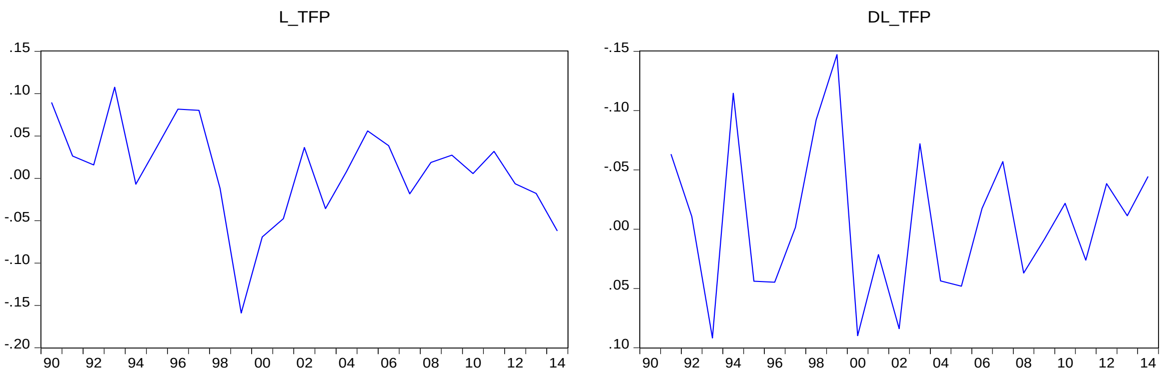
Table 3.14: ADF test for TFP (Turkey)

Null Hypothesis: **D (L_TFP)** has a unit root

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.603921	0.0008
Test critical values:	1% level	-4.416345	
	5% level	-3.622033	
	10% level	-3.248592	

When we look at the difference between the graphs of TFP in figure 3.8, it is obvious that TFP is stationary in first difference.

Figure 3.8: Stationarity of TFP (Turkey)



Source: Groningen growth and development centre (GGDC), Productivity, Penn World Table, the series *CTFP* in excel form

HC was not I (1) because of the break which is seen in figure 3.9. That's why we applied ADF unit root test through using the data since 1992 rather than 1990. Thus we get stationary HC in first difference, and table 3.15 shows that. Augmented Dickey-Fuller test statistic is under the test critical values in all percentage levels, and the p-value is nearly zero which means that it already satisfies the necessity of being under 1%. So HC is I (1).

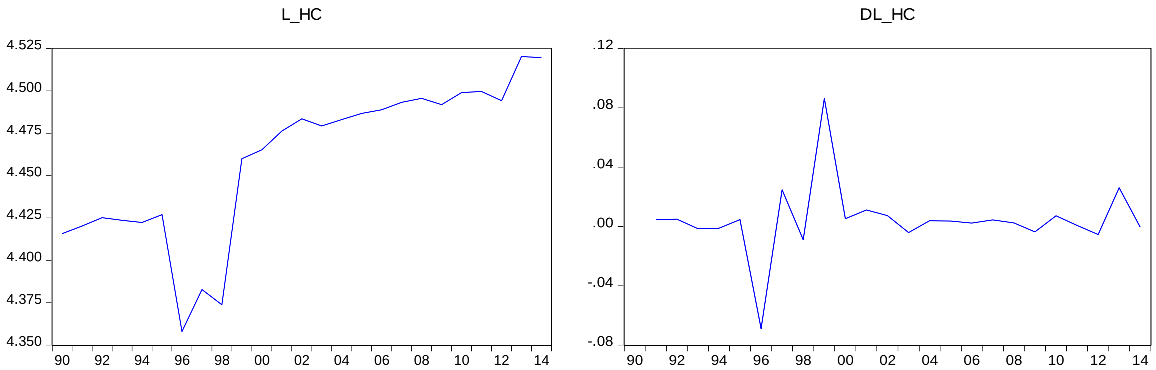
Table 3.15: ADF test for HC (Turkey)

Null Hypothesis: **D (L_HC)** has a unit root

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.841763	0.0061
Test critical values:	1% level	-4.571559	
	5% level	-3.690814	
	10% level	-3.286909	

When we look at the figure 3.9 separation between level values and the difference is seen. It is obvious that HC is stationary in first differences.

Figure 3.9: Stationarity of HC (Turkey)



Source: Own calculation by harmonic mean of life expectation, school enrollment (without age constraint), and access to electricity that are collected from World Bank Open Data

3.4.2.1.2. Johansen Cointegration Test

Table 3.16 shows the cointegration relation between HC and TFP. According to the table, these series are cointegrated in the long run, because the trace statistics of trace test and maximum eigenvalue test are higher than 5% critical values. Moreover p-values are under 5% with the indicators of 0.0190 and 0.0141, and this shows that there is a cointegration relation between TFP and HC. So since TFP and HC are I (1) and cointegrated we can apply VEC model for these series.

Table 3.16: Johansen Cointegration of HC and TFP (Turkey)

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.632563	29.12631	25.87211	0.0190
At most 1	0.232915	6.098613	12.51798	0.4479
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.632563	23.02770	19.38704	0.0141
At most 1	0.232915	6.098613	12.51798	0.4479

3.4.2.1.3. VECM

The results of VEC model below, table 3.17, show that HC and TFP have long run relationship. ECT, which is C (1), is between zero and minus one, and it is statistically meaningful which requires p-value under 5%. C (1) is approximately equal to -0.373, so the share of correction of the long run deviation is 37 percent per a year based on that ECT is speed of adjustment. The short run coefficients are all negative or positive decimal numbers.

Table 3.17: The estimation of VECM for HC and TFP (Turkey)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.373418	0.153352	-2.435046	0.0270
C(2)	0.428277	0.347938	1.230902	0.2361
C(3)	0.983045	0.301037	3.265529	0.0049
C(4)	-0.261563	0.082517	-3.169795	0.0059
C(5)	0.130781	0.084602	1.545839	0.1417
C(6)	-0.001113	0.004751	-0.234286	0.8177
Determinant residual covariance		0.000273		

Equation: D(L_HC) = C(1)*(L_HC(-1) - 0.791028591512*L_TFP(-1) 0.00628966756853*@TREND(90) - 4.36934868827) + C(2)*D(L_HC(-1)) + C(3)*D(L_HC(-2)) + C(4)*D(L_TFP(-1)) + C(5)*D(L_TFP(-2)) + C(6)

Observations: 22

R-squared	0.557443	Mean dependent var	0.004294
Adjusted R-squared	0.419143	S.D. dependent var	0.025400
S.E. of regression	0.019358	Sum squared resid	0.005996
Durbin-Watson stat	1.807819		

3.4.2.2.Relationship Between HC And GHG

3.4.2.2.1. Unit Root

The ADF results for the variables HC and GHG are below. Table 3.18 shows that GHG is stationary in first difference. Because augmented Dickey-Fuller test statistic is under the test critical values in all percentage levels, and the p-value is zero, and it already satisfies the necessity of being under 1%. So GHG is I (1).

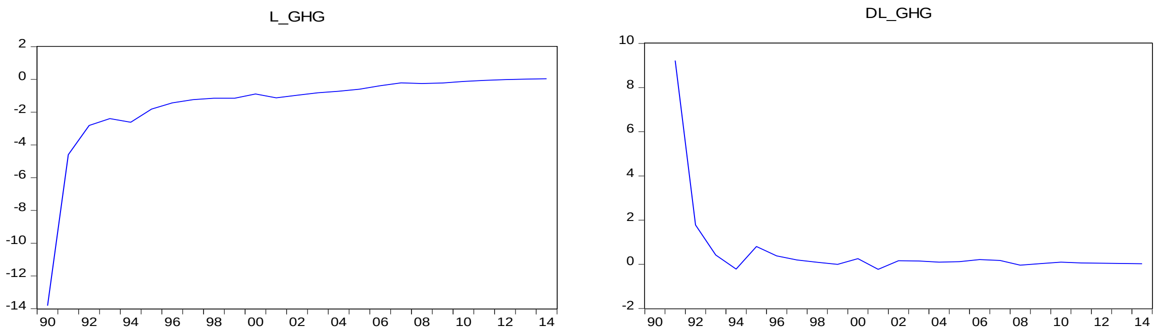
Table 3.18: ADF test for GHG (Turkey)

Null Hypothesis: **D (L_GHG)** has a unit root

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-31.27790	0.0000
Test critical values:	1% level	-4.416345	
	5% level	-3.622033	
	10% level	-3.248592	

The figure 3.10 shows clearly the stationary HC in first difference. The increasing trend in level values becomes stationary in first differences.

Figure 3.10: Stationarity of GHG (Turkey)



Source: World Bank Open Data

Table 3.19 shows that HC is stationary in its first difference just as the table 3.15. However the results are the same, it had better to repeat because this is a different model. HC was not I (1) because of the break as we mentioned above. That's why we applied ADF unit root test through using the data since 1992, and we got I (1) HC. According to the table, augmented Dickey-Fuller test statistic is under the test critical values in all percentage levels, and the p-value is nearly zero, and it already satisfies the necessity of being under 1%. So GHG is I (1).

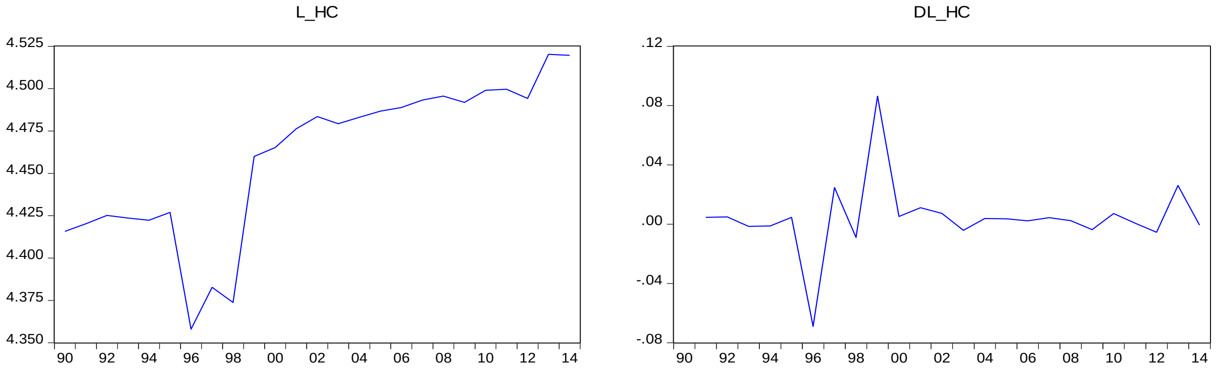
Table 3.19: ADF test for HC (Turkey)

Null Hypothesis: **D (L_HC)** has a unit root

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.841763	0.0061
Test critical values:	1% level	-4.571559	
	5% level	-3.690814	
	10% level	-3.286909	

The figure 3.11 shows clearly the stationary HC in its first difference while it is increasing in level values. The increasing trend in level values becomes stationary in first difference.

Figure 3.11: Stationarity of HC (Turkey)



Source: Own calculation by harmonic mean of life expectation, school enrollment (without age constraint), and access to electricity that are collected from World Bank Open Data

3.4.2.2.2. Johansen Cointegration Test

Table 3.20 shows the cointegration relation between HC and GHG. According to the table, these series are cointegrated in the long run. Because the trace statistics of trace test and maximum eigenvalue test are higher than 5% critical values. Moreover p-values are under 5% with the indicators of 0.0104 and 0.0085, and this shows that there is a cointegration relation between HC and GHG. So since GHG and HC are I (1) and cointegrated we can apply VEC model for these series.

Table 3.20: Johansen Cointegration of HC and GHG (Turkey)

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.670365	31.03704	25.87211	0.0104
At most 1	0.259926	6.622109	12.51798	0.3856

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.670365	24.41493	19.38704	0.0085
At most 1	0.259926	6.622109	12.51798	0.3856

3.4.2.2.3. VECM

The results of VEC model in table 3.21, show that HC and GHG converge to each other in the LR. ECT, which is C (1), is between zero and minus one, and it is statistically meaningful which requires p-value under 5%. C (1) is approximately equal to -0.621, so the long run deviation is corrected by 62 percent per a year, based on that ECT is speed of adjustment. The short run coefficients are all negative or positive decimal numbers.

Table 3.21: The estimation of VECM for HC and GHG (Turkey)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.620978	0.112471	-5.521246	0.0000
C(2)	0.086727	0.133673	0.648798	0.5257
C(3)	0.500691	0.126378	3.961860	0.0011
C(4)	-0.073608	0.013653	-5.391400	0.0001
C(5)	0.016594	0.002980	5.568120	0.0000
C(6)	0.007139	0.003448	2.070362	0.0550
Determinant residual covariance		0.000127		

Equation: D(L_HC) = C(1)*(L_HC(-1) - 0.037401014369*L_GHG(-1) - 0.00170265436437*@TREND(90) - 4.47306203818) + C(2)*D(L_HC(-1)) + C(3)*D(L_HC(-2)) + C(4)*D(L_GHG(-1)) + C(5)*D(L_GHG(-2)) +C(6)

Observations: 22

R-squared	0.793738	Mean dependent var	0.004294
Adjusted R-squared	0.729282	S.D. dependent var	0.025400
S.E. of regression	0.013216	Sum squared resid	0.002794
Durbin-Watson stat	1.940352		

3.4.2.3.Relationship Between EI And TFP

3.4.2.3.1. Unit Root

The ADF results for the variables EI and TFP are below. Table 3.22 shows that EI is stationary in its first difference. Because augmented Dickey-Fuller test statistic is under the test critical values in all percentage levels, and the p-value is nearly zero. So it already satisfies the necessity of being under 1%. So GHG is I (1).

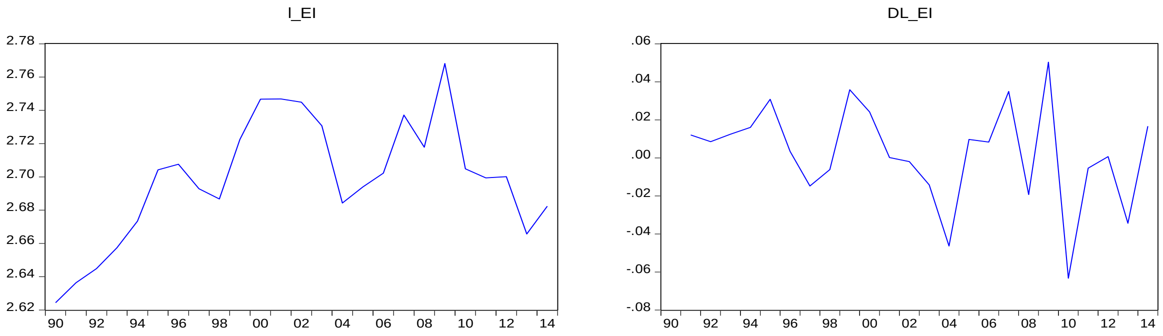
Table 3.22: ADF test for EI (Turkey)

Null Hypothesis: **D (L_EI)** has a unit root

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.936786	0.0004
Test critical values:	1% level	-4.416345	
	5% level	-3.622033	
	10% level	-3.248592	

The figure 3.12 shows that EI is I (1) while it is almost increasing in level values. The increasing trend in level values becomes stationary in first difference.

Figure 3.12: Stationarity of EI (Turkey)



Source: Data is collected from http://www.tsp-data-portal.org/Energy-Intensity-of-GDP#tspQvChart

The ADF results for the variables EI and TFP are below. Table 3.23 shows that TFP is stationary in first difference. Because augmented Dickey-Fuller test statistic is under the test critical values in all percentage levels, and the p-value is nearly zero, and it already satisfies the necessity of being under 1%. So GHG is I (1).

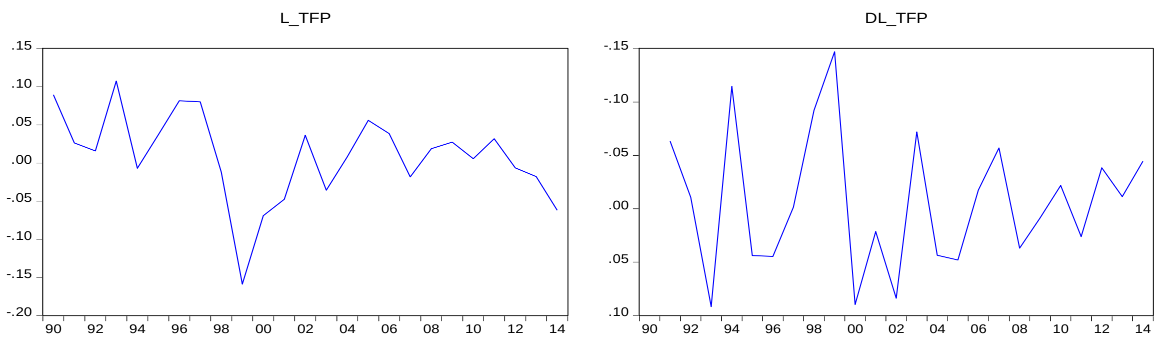
Table 3.23: ADF test for TFP (Turkey)

Null Hypothesis: **D (L_TFP)** has a unit root

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.603921	0.0008
Test critical values:	1% level	-4.416345	
	5% level	-3.622033	
	10% level	-3.248592	

The figure 3.13 shows the stationary TFP in first difference while it is decreasing in level values. The decreasing trend in level values becomes stationary in first differences.

Figure 3.13: Stationarity of TFP (Turkey)



Source: Groningen growth and development centre (GGDC), Productivity, Penn World Table, the series CTFP in excel form

3.4.2.3.2. Johansen Cointegration Test

Table 3.24 shows the cointegration relation between EI and TFP. According to the table, these series are cointegrated in the long run. Because the trace statistics of trace test and maximum eigenvalue test are higher than 5% critical values. Moreover p-values are under 5% with the indicator 0 for both, and this shows that there is a cointegration relation between EI and TFP. So since TFP and EI are I (1) and cointegrated we can apply VECM for these series.

Table 3.24: Johansen Cointegration of EI and TFP (Turkey)

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.992294	106.4174	25.87211	0.0000
At most 1	0.648783	18.83432	12.51798	0.0039
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.992294	87.58310	19.38704	0.0000
At most 1	0.648783	18.83432	12.51798	0.0039

3.4.2.3.3. VECM

The results of VEC model are in table 3.25, and they show that EI and TFP have long run relationship. ECT, which is C (1), is between zero and minus one, and it is statistically meaningful which is required p-value under 5%. C (1) is approximately equal to -0.231, so the speed of adjustment is 23 percent per a year. The short run coefficients are all negative or positive decimal numbers.

Table 3.25: The estimation of VECM for EI and TFP (Turkey)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.231395	0.110380	-2.096347	0.0497
C(2)	-0.202421	0.203514	-0.994633	0.3324
C(3)	0.091927	0.107627	0.854129	0.4037
C(4)	0.002794	0.005289	0.528179	0.6035
Determinant residual covariance		0.000525		

Equation: D(L_EI) = C(1)*(L_EI(-1) + 1.09718810675*L_TFP(-1) + 0.00255380497869*@TREND(90) - 2.7456103244) + C(2)*D(L_EI(-1)) + C(3)*D(L_TFP(-1)) + C(4)

Observations: 23

R-squared	0.227212	Mean dependent var	0.002001
Adjusted R-squared	0.105193	S.D. dependent var	0.026644
S.E. of regression	0.025203	Sum squared resid	0.012069
Durbin-Watson stat	1.935509		

Consequently similar results are obtained for both Turkey and weighted average of six Asian countries. The convergence of HC and TFP in both Turkey and Asian countries shows that HC should be invested in for higher TFP. Near that, investment in HC should be considered on the basis of equality of opportunities. Because the components of HC (school enrollment in primary level, life expectancy at birth, access to electricity) represent the equal opportunities in education, health, and access to energy. On the other hand the convergence of HC and GHG exhibits that not only equal opportunities but also negative externalities should be taken into account for investment in HC. Finally the convergence between EI and TFP is a result of this study for both Turkey and Asian countries. EI should be decreased for higher TFP.

In the light of these findings, we can say that higher HC (HC which is supported by equal opportunities and lower negative externalities) and relatedly higher TFP may provide IG. Because in such a case, a broad-based economic process is in question.

CONCLUSIONS

TFP and labor productivity, have slowed down in both developed and developing countries, especially since mid-1990 although technology really improved in last decades [1]. Because income and non-income dimension inequalities among individuals, financial and non-financial disparities among firms and regions exist, and one of the most important reason is unequal opportunities. So technical improvement is not enough by oneself, human factor should be invested in as well. On the other hand, dispersion in access to energy, high energy intensity (especially in emerging market economies) adversely affect TFP. In this study; energy, TFP and inclusive growth are investigated in the context of human capital, equal opportunities, and negative externalities.

TFP is a kind of junction among the relation of these notions. Higher HC based on equal opportunities, and lower energy intensity lead to higher TFP. When we consider that IG is contribution to and benefitting from economic growth by different parts of society, higher HC based on equal opportunities contributes to IG. Because this provides the economic process to be broad-based. Actually the major factor is higher TFP for better economic performance, but its association with HC renders the economic growth inclusive through human factor. On the other hand IG is linked with energy and its intensity through their impact on HC and TFP. Because access to energy and negative externalities bring together HC and energy by; equality in access to clean and affordable energy, decreased negative externalities and cleaner environment through lower EI.

The results of the case study supports these claims. The data of six Asian countries are weighted through their current GDPs ADF unit root test, Johansen cointegration, and VECM is applied to both Turkey and the weighted average of six Asian countries. Three bivariate models (HC-TFP, HC-GHG, and EI-TFP) are established for both of them. According to the results; four of the series are I (1) in Turkey and Asia cases. HC and TFP, HC and GHG, EI and TFP have the long run relationship both in Turkey and Asian countries. So these couples of series are cointegrated and convergent in the long run.

The convergence of HC and TFP supports the idea that HC should be invested in for higher TFP. As inspired by the components of HC (school enrollment in primary level, life

---

[1] *Antonin Bergeaud, Remy Lecat, and Gilbert Cette, **Total Factor Productivity in Advanced Countries: A Long Term Perspective**, International Productivity Monitor, no:32, pp. 6-24, 2017, pp.10-12
*Figure 1.7 (Average Multifactor productivity between 1990 and 2016), Figure 1.9 (Average Annual Growth of Labor Productivity in Emerging Market Economies)

expectancy at birth, access to electricity), equal opportunities in education, health, and access to energy are very important. So investments in these areas, which will increase qualitative and quantitative capacity, are vital for higher HC and higher TFP. The long run relation between HC and GHG shows that negative externalities are important for HC. So they must be decreased. Investment in renewable energy resources, environmental policies, efficient use of energy, and lowering wastage are required. By this way HC is increased on the basis of human health and better environmental conditions. Finally the convergence of EI and TFP supports the idea that EI should be decreased for higher TFP. Lowering EI have positive impact on TFP in two ways. First one is lower cost of energy. Productivity rises when energy, as an important input of production, becomes cheaper. Second, lower EI means that less share of energy in GDP or in other words fewer usage of energy. This yields environment and human health, hence it fosters TFP through higher HC as well. In this context investment in *sustainable energy* is a requirement for clean and affordable energy. Energy efficiency should be increased, renewable energy should be invested in, wastage of energy should be prevented, as a high yield resource nuclear energy should be invested in, energy resources should be diversified, local opportunities should be considered, and infrastructural and technical requirements should be invested in . These are important for both lower energy cost and higher productivity. So the case study also demonstrates that higher HC which relies on equality of opportunities, and lower EI lead to higher TFP, and IG is achieved. In the light of the empirical results, some suggestions are below on the basis of the individual, firm, and region.

Experiences in last two centuries have showed that markets and economies cannot come to equilibrium without regulations and policies even if many technological and structural improvements have come up. So necessity for policy making for better economic performance is vital universally. The increase in inequality and decrease in productivity growth in spite of the technological improvements are evidential reasoning of this. On the other hand the problems are in the basis of individual, firm, and region so the solutions must be in the individual, firm, and regional basis as well. On an individual basis, the governments should invest in propria persona and encourage to invest in human capital, infrastructure, knowledge based capital, R&D, new technologies, innovative actions, production of new age energy for better productivity growth. Near that policy makers should apply social, structural and inclusive policies to promote fair distribution, and to decrease dispersion among individuals, firms and regions.

higher quality education is needed for higher productivity and improvement. Thus policies in the areas as follow are very important to increase the quality of education:

- Quantity based targets as raising the schooling rate, number of schools, literacy rate,
- Qualitative infrastructure works on the areas like school administration, training capacity and capabilities, promoting and motivating high-quality teachers, and improving strategies for effective classroom learning,
- Aiming the decrease in discriminations

On the other hand implications like integrated education and labour market reforms with the aims of; improving the quality of education systems, achieving a better match between the needs of the labour markets and what students learn, and incorporating new horizontal skills satisfy both better education quality and contribution to labour market. This reflects positively to productivity growth and economic performance.[2]

Training and skilling programmes should be applied to enhance the skills of labour and entrepreneurs, in particular for those who are low educated and low skilled. Even if they are deprived of high level education, they should be benefited from high-quality lifelong learning programmes for higher labour productivity. The digital technologies are from most important learning subjects in our digital world.

Educating and training people are very important but not enough. There is one thing which is important as much as them, allocation of labour. Because preventing the labour from skill mismatches is vital for higher productivity and this can be achieved by non-discriminative lifelong learning. OECD estimates that increasing participation in lifelong learning programs from the low level in Italy to the median level in Estonia are associated with a 6 percentage point decrease in mismatch.[3] In addition higher dynamic of business environments provide better skill matches. Because the dynamism of business lead to higher circulation in the labour market, and reallocation of labour process operates more proper. So market regulations are needed both for more dynamic business sector to regulate exit and entry processes of the firms, and for better functioning labour market. Another subject to handle is health on individual basis. Strong health policies, which give attention to social and individual health care, should be implied. Increasing the number and quality of hospitals, health centers, medical personnel are in the center of health policies.

---

[2] OECD, **The Productivity-Inclusiveness Nexus**, 2016, pp.74
[3] Ibid, pp.76

The collaboration of public and private sectors is very important for the education and health policies. Because governments cannot cover the health and education problems of the society on its own due to high cost. Public and private sector should share the incumbency. On the other hand this is social responsibility for private sector. The policies which are aiming more healthy, educated and skilled society must be targeted, particularly for disadvantaged groups. Because the biggest source of inequality, which slower the productivity and economic growth, is in the health and education areas. As conclusion policies for individuals, which are raising the human capital and inclusion, increase total productivity, productivity growth, total welfare and economic well-being. Near that decreasing dispersion and inequality are the good results that will positively affect these economic indicators in the long run.

But, unless firm and region based policies, no matter how strong and well applied policies that are paying regard on individuals. Because the perspectives of individual, firm and region are like three feet of a trivet. If one of them is missed the yield of the policies will be lower than expected in every condition.

Fair competition and robust business dynamism are the most important conditions for better performance of firms. Otherwise deterioration of diffusion mechanism is appeared and inequality is fed while productivity is worsening. So inclusiveness is very important for firms as well as individuals. If entry-exit and growth-degrowth processes are not thoroughly carried out in a fair market condition, dynamism of business decelerate, and most of economic determinant- first and foremost the supply and demand equilibrium are negatively affected.

Faster structure of business dynamism is important for easing the entry and exit of the firms. Exit of firms are as important as entry because companies with low performance must leave the market to more productive ones in order that total productivity and its growth are increased. Relatedly decreasing the subsidies for unutilised sectors should be considered for more sufficient reallocation process. Again under a similar approach, promoting firms to shift their investment decisions to more productive sectors fosters the productivity via preventing them from misallocation of capital. So allocation of capital and labour is very important for dynamism of business, and this should be supported by governments.

Innovation is another key factor for higher productivity, and both public and private sectors have to be interested and included in innovative activities. For example investment in R&D, new age energy technologies and ICT are the most innovative sectors, and firms must be encouraged to deal with that sectors. But these are high cost investments so corporate activities may be a good option for small companies. There is a proverb in Turkish: "*What does have one* *hand by itself, but two hands have the voice*!" So joint actions and common project/strategies make small firms gained speed in their growth processes.

Notwithstanding there is an environment outside except economic agents and we have to be respectful to it. Sometimes production processes harm the environment, and negative externalities arise. Not surprisingly as a part of the nature this negatively affect people, from both physical and economical perspectives. Since our living spaces are worsening by air and environmental pollution, human health worsens as well. This inversely reflects to the economy through human as a factor of production. That's why policy makers should implement policies to protect the environment and human health. This is our responsibility for environment and exigency for our economic and physical health.

Another adverse effect was imperfect functioning financial institutions and markets in the economy as we mentioned before. The problem of inclusion is also the fact in these markets. Adequate financing for different economic activities, innovative and growth-oriented small businesses should be promoted and even be forced by policy makers. The leasing funds with low interest rates, new financial instruments and methods with low risk, risk sharing are some of instances to make the financial system more inclusive. Furthermore market regulations are needed in financial markets for decreasing the disparity in financing.

Every region have its own dynamic and policy makers should pay attention to this when they apply regional policies. National and local policies are needed for regional development and increase in productivity under regional perspective. Because only proper policy implications to the social, political and economic structure of the regions are spatially convenient. So categorizing the regions according to their geographical size, demographic or developmental structure is helpful for governors.

Developing or underdeveloped lagging regions are needed to attract the investment projects. Creating new markets in these areas make them more improved. So governors should improve policies that encourage the entrepreneurs to invest in these places. The infrastructure workings are vital at this point. Transportation, communication, accessing to energy and other resources are the main areas that are making infrastructure necessity. Additionally financing, subsidising the firms are another important encouragement for the firms. Because no fund means no investment.

From the demographic perspective, gathered areas are available for being metropolitan regions. They have important potential economically because of the possibility to bring together a variety of firms which are above or below the average in a specific area. So metropolitans satisfy the creations of many markets in given areas. Near firm diversification, an important advantage comes true in the context of human resource. Aggregation of a wide range of workers provide gathering the high skilled and high educated human resource. By this way spreading and spill over of human capital becomes more possible from two perspective. First, it would be easier that firms meet high quality human resources. Second, this allows people to learn by experience because they have convenient worker models to learn from. But the things may go wrong at the same time because, concentration of such different parties may lead to increase inequality. That' why policies which aim social inclusion, decreasing inequality, promoting equal opportunities and inclusive growth are essential for efficient and sustainable productivity and economic growth.

Regional structure is important too in policy making. So local economic agents need to be satisfied better opportunities in the context of equipment, resources, and factors of production to hit the equilibrium and to realize innovative strategies in both goods and labour markets. On the other hand common strategies among regions are important and necessity as well as firms for productivity and developmental targets. Because such projects are high cost, and they exceed the capacity of regions severally. So carrying out of them is related to acting jointly. No doubt, the harmony between these common strategies and the national policies of the regions is vital. The joint actions are complementary to the national and local policies at the same time when they applied in a coherent understanding.

REFERENCES

Aydın F. F. :	**Enerji Tüketimi Ve Ekonomik Büyüme**, Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, No. 35, Ocak-Temmuz 2010, pp. 317-340
Bergeaud A. , Lecat R. , Cette G. :	**Total Factor Productivity in Advanced Countries: A Long Term Perspective,** International Productivity Monitor, no:32, pp. 6-24, 2017
Boarini R. , Martin F. and Schreyer P. :	**Inclusive Growth**, The OECD Measurement Framework, OECD Statistics Working Paper 2015/06, June 2015 http://www.oecd-ilibrary.org/economics/inclusive-growth_5jrqppxjqhg4-en ,
Brooks C. :	**Introductory Econometrics for Finance**, Third Edition, 2014
Bustelo P. :	**Energy Security with a High External Dependence: The Strategies of Japan and South Korea**, MPRA, Paper No. 8323, 2008
Cirillo C. , Nogueira L. M. C. and Soares F. V. :	**Brazil–Africa Knowledge-Sharing On Social Protection And Food And Nutrition Security**, IPC-IG, Working Paper No: 143, June 2016, ISSN 1812-108x
Credit Suisse :	**Global Wealth Data-book 2018**, October 2018
Davies J. , Lluberas R. and Shorrocks A. F. :	**Measuring the Global Distribution of Wealth**, 2012 OECD World Forum New Delhi, 17 October 2012
Felipe J. :	**Total Factor Productivity Growth In East Asia:A Critical Survey**, Economics and Development Resource Center, EDRC Report Series No. 65, 1997
Gömleksiz M. , Şahbaz A. , Mercan B. :	**Toplam Faktör Verimliliğinin Belirleyicileri Üzerine Ampirik Bir İnceleme: Seçilmiş OECD Ülkeleri Örneği**, Eskişehir Osmangazi Üniversitesi İİBF Dergisi Ağustos 2017, V. 12, no. 2, pp. 65- 82
Gujarati D. N. and Porter D. C. :	**Basic Econometrics**, Fifth Edition, 2009

Hausmann R. , Rodrik D. , Valesco A. :	**Growth Diagnostics**, revised in 2005 http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.446.2212&rep=rep1&type=pdf
Hulten C.R. :	**Total Factor Productivity: A Short Biography**, NBER Working Paper No. 7471, January 2000
Ianchovichina E. and Lundstrom S. :	**Inclusive Growth Analytics: Framework and Application**, Policy Research Working Paper No. 4851, The World Bank Economic Policy and Debt Department Economic Policy Division, 2009
IBRD, WB, and IEA :	**Progress Toward Sustainable Energy 2017-Summary**, Sustainable Energy For All Global Tracking Framework, 2017 https://www.seforall.org/sites/default/files/GTF%20Executive%20Summary%202017.pdf
IEA :	**Renewables Information: Overview** (2017 Edition), IEA statistics
IEA :	**Key World Energy Statistics**, 2018
IPCC-IG :	**Technical Summary**, Climate Change 2013: The Physical Science Basis, 2013 https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_TS_FINAL.pdf
IPC-IG :	**Progress report on the implementation of outcome one of the project Brazil & Africa: fighting poverty and empowering women via South-South Cooperation**, 2017 https://www.ipc-undp.org/pub/eng/Progress_Report_Brazil_Africa.pdf
Jorgenson D. W. :	**The Role of Energy in Productivity Growth,** The Energy Journal , Vol. 5, No. 3, July 1984, pp. 11-26
Jorgenson D. W. and Griliches Z. :	**Explanation of Productivity Change**, The Review of Economic Studies, Vol. 34, No. 3, 1 July 1967, pp. 249-283

Kakwani N. & Son H. H. :	**Pro-poor Growth: Concepts and Measurement With Country Case Studies**, The Pakistan Development Review, Vol. 42, No. 4, Part I, Winter 2003, pp.417-444
Klasen S. :	**Measuring and Monitoring Inclusive Growth: Multiple Definitions, Open Questions, and Some Constructive Proposals**, ADB Sustainable Development Working Paper Series, No. 12, ISSN 2071-9450, 2010
Maria del P. ,Pablo R. and Antonio Sanchez-B. :	**Productive energy use and economic growth: Energy, Physical and Human Cpital Relations**, Energy Economics, V.49, 2015, pp. 420–429
Mercan M. and Altıntaş H. :	**Elektrik Tüketimi ve Ekonomik Büyüme İlişkisi: G-ll Ülkeleri Örneğinde Panel Eşbütünleşme ve Nedensellik Uygulaması**, TİSK Akademi, 2015/II, PP. 318-347
Nicole Bates-Eamer, Barry Carin, Min Ha Lee, Wonhyuk Lim, and Mukesh Kapila :	**Post-2015 Development Agenda: Goals,** Targets and Indicators-Special Report, The Centre for International Governance Innovation | Korea Development Institute, 2012
OECD and Post-2015 Reflections :	**Enabling Investment in Sustainable Energy Infrastructure**, Element 4, Paper 2, 2013
OECD :	**Nuclear Energy Data 2016**, Nuclear Energy Agency (NEA), No. 7300, 2016
OECD :	**Report On The OECD Framework For Inclusive Growth**, Meeting Of The OECD Council At Ministerial Level, Paris, 6-7 May 2014 https://www.oecd.org/mcm/IG_MCM_ENG.pdf
OECD :	**The Productivity-Inclusiveness Nexus**, Meeting of the OECD Council at Ministerial Level, Paris, 1-2 June 2016 https://www.oecd.org/global-forum-productivity/library/The-Productivity-Inclusiveness-Nexus-Preliminary.pdf
OECD/IEA :	**Energy Access Outlook 2017 From Poverty to Prosperity**, World Energy Outlook Special Report, 2017

Öztürk M. , Bezir N. Ç. and Özek N. :	**Turkey's Energy Production, Consumption, and Policies, until 2020**, Energy Sources, Part B: Economics, Planning, and Policy, Vol. 4, No. 3, 2009, pp. 315-331
Pindyck R. S. and Rubinfeld D. L. :	**Microeconomics**, Pearson International Edition (7th edition), by Pearson Education, Inc., Upper Saddle River, New Jersey, 07458, 2009
Ranieri R. and Ramos R. A :	**After All, What is Inclusive Growth?**, IPC-IG One pager no:188, 2013
Ranieri and Ramos :	**Inclusive Growth: Building Up A Concept**, International Policy Centre for Inclusive Growth (IPC-IG), Working Paper number 104, 2013
Saghir J. and O'Sullivan K:	**Towards a Sustainable Energy Future-Note for Participants**, World Bank Global Issues Seminar Series, WB, 2005
Sahu S. K. , Sharma H. :	**Productivity, Energy Intensity and Output: A Unit Level Analysis of the Indian Manufacturing Sector**, Journal of Quantitative Economics, Vol. 14, Issue 2, 2016, PP. 283–300
Shrestha R. M. and Acharya J. S. :	**Sustainable Energy Access Planning: A Framework**, Asian Development Bank, ISBN 978-92-9254-965-7, 2015
Suryanarayana M. H. :	**What is Inclusive Growth? An Alternative Perspective**, IPC-IG One pager no:205, 2013 http://www.ipc-undp.org/pub/IPCOnePager205.pdf
Syverson C. :	**What Determines Productivity?**, NBER Working Paper No. 15712, January 2010
Şimşek N. :	**Environmental Efficiency and Total Factor Productivity of Turkey: A Comparative Analysis**, Ege Academic Review, Vol. 11, No. 3, 2011, pp.379-396
Tatoğlu, Ferda Yerdelen :	**İleri Panel Veri Analizi (Stata Uygulamalı)**, 2nd Edition, 2013
Tuğcu C. T. and Tiwari A.K:	**Does Renewable and-or Non-Renewable Energy Consumption Matter for TFP Growth Evidence from BRICS**, Renewable and Sustainable Energy Reviews, Vol. 65, 2016, pp.610-616

Varian H. R. :	**Intermediate Microeconomics- A Modern Approach**, Norton International Student Edition (3rd Edition), Publisher: W.W. Norton & Company, 1993
Wooldridge J. M. :	**Introductory Econometrics A Modern Approach**, Third Edition, 2005
World Bank :	**Global Economic Prospects Divergences and Risks**, June 2016
World Bank :	**Year in Review: 2017 in 12 Charts,** http://www.worldbank.org/en/news/feature/2017/12/15/year-in-review-2017-in-12-charts

web sites:

http://databank.worldbank.org/data/reports.aspx?source=2&series=EG.EGY.PRIM.PP.KD#

http://databank.worldbank.org/data/reports.aspx?source=2&series=EG.FEC.RNEW.ZS

http://databank.worldbank.org/data/reports.aspx?source=2&series=IT.NET.USER.ZS

http://databank.worldbank.org/data/reports.aspx?source=2&series=IT.NET.BBND

http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators#

http://edgar.jrc.ec.europa.eu/.

http://iktisat.biz/2015/10/18/finansal-gelismislik-gelir-esitsizligi-ve-yoksulluk/

http://microdata.worldbank.org/index.php/catalog/1777/get_microdata

http://positivepsychology.org.uk/subjective-well-being/

http://stats.oecd.org/viewhtml.aspx?datasetcode=EO102_INTERNET&lang=en

http://stats.oecd.org/viewhtml.aspx?datasetcode=ICT_BUS&lang=en

http://stats.oecd.org/viewhtml.aspx?datasetcode=PDB_GR&lang=en#

http://www.keepeek.com/Digital-Asset-Management/oecd/nuclear-energy/nuclear-energy-today_9789264179233-en#page9

http://www.keepeek.com/Digital-Asset-Management/oecd/nuclear-energy/nuclear-energy-data-2016_ned-2016-en-fr#page1 http://www.learneconometrics.com/class/5263/notes/Vector%20Error%20Correction%20Models.pdf

http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199325818.001.0001/oxfordhb-9780199325818-e-15#oxfordhb-9780199325818-e-15-div1-109

http://www.tsp-data-portal.org/Energy-Intensity-of-GDP#tspQvChart

http://www.worldbank.org/en/news/feature/2017/12/15/year-in-review-2017-in-12-charts

http://www.yildiz.edu.tr/~tastan/teaching/18.pdf

https://data.oecd.org/energy/renewable-energy.htm#indicator-chart

https://data.oecd.org/lprdty/labour-productivity-forecast.htm

https://fred.stlouisfed.org/categories/33404/downloaddata

https://pris.iaea.org/PRIS/WorldStatistics/NuclearShareofElectricityGeneration.aspx

https://www.quora.com/What-are-scale-effect-economics-What-are-some-examples

https://www.rug.nl/ggdc/productivity/pwt/

https://www.rug.nl/ggdc/productivity/pwt/related-research-papers/the_next_generation_of_the_penn_world_table.pdf

https://www.seforall.org/sustainable-development-goal-7

https://www.statista.com/chart/1657/32-million-people-control-41-percent-of-the-worlds-wealth/

https://www.worldenergy.org/data/resources/resource/wind/

https://www.worldenergy.org/data/resources/resource/wind/

APPENDIX: ECONOMETRIC OUTPUT

A) ASIAN COUNTRIES

1. ADF Unit Root Test

Null Hypothesis: **D(L_TFP)** has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.417483	0.0022
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(L_TFP,2)
Method: Least Squares
Date: 05/13/19 Time: 15:30
Sample (adjusted): 1992 2014
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(L_TFP(-1))	-0.936989	0.212109	-4.417483	0.0002
C	0.004237	0.008565	0.494679	0.6260

R-squared	0.481663	Mean dependent var	-0.002191
Adjusted R-squared	0.456980	S.D. dependent var	0.054930
S.E. of regression	0.040478	Akaike info criterion	-3.493184
Sum squared resid	0.034408	Schwarz criterion	-3.394445
Log likelihood	42.17161	Hannan-Quinn criter.	-3.468351
F-statistic	19.51416	Durbin-Watson stat	1.939981
Prob(F-statistic)	0.000239		

Null Hypothesis: **D(L_HC)** has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.734728	0.0011
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(L_HC,2)
Method: Least Squares
Date: 05/13/19   Time: 15:34
Sample (adjusted): 1992 2014
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(L_HC(-1))	-0.945779	0.199754	-4.734728	0.0001
C	0.003622	0.001729	2.094769	0.0485

R-squared	0.516326	Mean dependent var	-0.001355
Adjusted R-squared	0.493294	S.D. dependent var	0.009250
S.E. of regression	0.006584	Akaike info criterion	-7.125290
Sum squared resid	0.000910	Schwarz criterion	-7.026552
Log likelihood	83.94084	Hannan-Quinn criter.	-7.100458
F-statistic	22.41765	Durbin-Watson stat	1.845892
Prob(F-statistic)	0.000112		

Null Hypothesis: **D(L_GHG)** has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-83.92030	0.0000
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(L_GHG,2)
Method: Least Squares
Date: 05/13/19 Time: 15:38
Sample (adjusted): 1992 2014
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(L_GHG(-1))	-0.946127	0.011274	-83.92030	0.0000
C	0.123959	0.025765	4.811158	0.0001

R-squared	0.997027	Mean dependent var	-0.472327
Adjusted R-squared	0.996885	S.D. dependent var	2.128226
S.E. of regression	0.118772	Akaike info criterion	-1.340274
Sum squared resid	0.296245	Schwarz criterion	-1.241535
Log likelihood	17.41315	Hannan-Quinn criter.	-1.315442
F-statistic	7042.616	Durbin-Watson stat	0.930102
Prob(F-statistic)	0.000000		

Null Hypothesis: **D(L_EI)** has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.310508	0.0028
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(L_EI,2)
Method: Least Squares
Date: 05/13/19 Time: 15:42
Sample (adjusted): 1992 2014
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(L_EI(-1))	-0.947784	0.219878	-4.310508	0.0003
C	-0.017139	0.007088	-2.417884	0.0248

R-squared	0.469435	Mean dependent var	-0.002223
Adjusted R-squared	0.444170	S.D. dependent var	0.039795
S.E. of regression	0.029669	Akaike info criterion	-4.114494
Sum squared resid	0.018485	Schwarz criterion	-4.015756
Log likelihood	49.31668	Hannan-Quinn criter.	-4.089662
F-statistic	18.58048	Durbin-Watson stat	1.918564
Prob(F-statistic)	0.000309		

2. Johansen Coinegration

Series: **L_HC, L_TFP**
Sample (adjusted): 1995 2014
Included observations: 20 after adjustments
Trend assumption: Linear deterministic trend
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.545978	21.66382	15.49471	0.0052
At most 1 *	0.254412	5.871637	3.841466	0.0154

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.545978	15.79219	14.26460	0.0285
At most 1 *	0.254412	5.871637	3.841466	0.0154

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

L_HC	L_TFP
-56.22225	9.534041
3.930566	-26.24156

Unrestricted Adjustment Coefficients (alpha):

D(L_HC)	-0.000132	0.002512
D(L_TFP)	-0.026907	0.004533

1 Cointegrating Equation(s): Log likelihood 123.6158

Normalized cointegrating coefficients (standard error in parentheses)

L_HC	L_TFP
1.000000	-0.169578
	(0.13086)

Adjustment coefficients (standard error in parentheses)

D(L_HC)	0.007395
	(0.08857)
D(L_TFP)	1.512779
	(0.46458)

Series: **L_HC, L_GHG**
Sample (adjusted): 1992 2014
Included observations: 23 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.616657	26.71694	25.87211	0.0392
At most 1	0.183543	4.663969	12.51798	0.6451

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.616657	22.05297	19.38704	0.0200
At most 1	0.183543	4.663969	12.51798	0.6451

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

L_HC	L_GHG	@TREND(91)
87.30931	-4.880066	0.065611
-153.0040	-1.339173	0.848780

Unrestricted Adjustment Coefficients (alpha):

D(L_HC)	0.002078	0.002445
D(L_GHG)	0.086222	-0.006938

1 Cointegrating Equation(s):	Log likelihood	113.8602

Normalized cointegrating coefficients (standard error in parentheses)

L_HC	L_GHG	@TREND(91)
1.000000	-0.055894	0.000751
	(0.01302)	(0.00158)

Adjustment coefficients (standard error in parentheses)

D(L_HC)	0.181459
	(0.11894)
D(L_GHG)	7.527987
	(1.39977)

Series: **L_EI, L_TFP**
Sample (adjusted): 1995 2014
Included observations: 20 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.639698	28.36936	25.87211	0.0239
At most 1	0.328106	7.953107	12.51798	0.2555

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.639698	20.41626	19.38704	0.0354
At most 1	0.328106	7.953107	12.51798	0.2555

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

L_EI	L_TFP	@TREND(91)
54.30101	-41.63045	0.932445
-99.06393	23.80395	-1.333641

Unrestricted Adjustment Coefficients (alpha):

D(L_EI)	0.009878	0.011309
D(L_TFP)	0.026152	-0.010288

1 Cointegrating Equation(s):	Log likelihood	94.45106	

Normalized cointegrating coefficients (standard error in parentheses)

L_EI	L_TFP	@TREND(91)
1.000000	-0.766661	0.017172
	(0.10991)	(0.00123)

Adjustment coefficients (standard error in parentheses)

D(L_EI)	0.536359
	(0.36214)
D(L_TFP)	1.420077
	(0.45684)

3. VECM

Series: **L_HC, L_TFP**
System: UNTITLED
Estimation Method: Least Squares
Sample: 1993 2014
Included observations: 22
Total system (balanced) observations 22

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.073060	0.024414	-2.992522	0.0082
C(2)	0.003707	0.243692	0.015213	0.9880
C(3)	-0.279799	0.221742	-1.261825	0.2241
C(4)	0.000638	0.037741	0.016908	0.9867
C(5)	0.050115	0.037544	1.334817	0.1995

Determinant residual covariance 3.00E-05

Equation: D(L_HC) = C(1)*(L_HC(-1) + 0.292300685259*L_TFP(-1) - 4.27260010229) + C(2)*D(L_HC(-1)) + C(3)*D(L_HC(-2)) + C(4) *D(L_TFP(-1)) + C(5)*D(L_TFP(-2))

Observations: 22

R-squared	0.276049	Mean dependent var	0.003859
Adjusted R-squared	0.105708	S.D. dependent var	0.006592
S.E. of regression	0.006233	Sum squared resid	0.000661
Durbin-Watson stat	2.077341		

Series: **L_HC, L_GHG**
System: UNTITLED
Estimation Method: Least Squares
Sample: 1993 2014
Included observations: 22
Total system (balanced) observations 22

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.021769	0.010125	-2.149985	0.0472
C(2)	-0.018352	0.012796	-1.434218	0.1708
C(3)	0.001305	0.000914	1.427447	0.1727
C(4)	-0.398819	0.323286	-1.233644	0.2352
C(5)	-0.560350	0.285310	-1.964003	0.0671
C(6)	0.010880	0.003489	3.118477	0.0066
Determinant residual covariance		2.78E-05		

Equation: D(L_HC) = C(1)*(L_GHG(-1) - 21.0896050173*L_HC(-1) + 94.5701885248) + C(2)*D(L_GHG(-1)) + C(3)*D(L_GHG(-2)) + C(4)*D(L_HC(-1)) + C(5)*D(L_HC(-2)) + C(6)
Observations: 22

R-squared	0.329666	Mean dependent var	0.003859
Adjusted R-squared	0.120186	S.D. dependent var	0.006592
S.E. of regression	0.006183	Sum squared resid	0.000612
Durbin-Watson stat	2.181122		

Series: **L_EI, L_TFP**
System: UNTITLED
Estimation Method: Least Squares
Sample: 1993 2014
Included observations: 22
Total system (balanced) observations 22

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.893974	0.341220	-2.619935	0.0186
C(2)	0.648500	0.297749	2.178008	0.0447
C(3)	0.656900	0.307003	2.139718	0.0481
C(4)	0.097677	0.149941	0.651435	0.5240
C(5)	-0.101855	0.146750	-0.694072	0.4976
C(6)	0.003905	0.010539	0.370504	0.7159
Determinant residual covariance		0.000546		

Equation: D(L_EI) = C(1)*(L_EI(-1) - 0.380205311596*L_TFP(-1) + 0.0147218247849*@TREND(90) - 3.60262405848) + C(2)*D(L_EI(-1)) + C(3)*D(L_EI(-2)) + C(4)*D(L_TFP(-1)) + C(5)*D(L_TFP(-2)) + C(6)
Observations: 22

R-squared	0.345193	Mean dependent var	-0.017371
Adjusted R-squared	0.140566	S.D. dependent var	0.029567
S.E. of regression	0.027411	Sum squared resid	0.012022
Durbin-Watson stat	1.892734		

B) TURKEY

1. ADF Unit Root Test

Null Hypothesis: **D(L_TFP)** has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.603921	0.0008
Test critical values:	1% level	-4.416345	
	5% level	-3.622033	
	10% level	-3.248592	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(L_TFP,2)
Method: Least Squares
Date: 05/13/19 Time: 18:19
Sample (adjusted): 1992 2014
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(L_TFP(-1))	-1.211645	0.216214	-5.603921	0.0000
C	0.000855	0.030146	0.028348	0.9777
@TREND("1990")	-0.000438	0.002061	-0.212420	0.8339

R-squared	0.613178	Mean dependent var	0.000819
Adjusted R-squared	0.574496	S.D. dependent var	0.100357
S.E. of regression	0.065464	Akaike info criterion	-2.493533
Sum squared resid	0.085710	Schwarz criterion	-2.345425
Log likelihood	31.67563	Hannan-Quinn criter.	-2.456284
F-statistic	15.85171	Durbin-Watson stat	2.122871
Prob(F-statistic)	0.000075		

Null Hypothesis: **D(L_HC)** has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.841763	0.0061
Test critical values:	1% level	-4.571559	
	5% level	-3.690814	
	10% level	-3.286909	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 18

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(L_HC,2)
Method: Least Squares
Date: 05/13/19 Time: 18:20
Sample (adjusted): 1997 2014
Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(L_HCC(-1))	-1.676155	0.346187	-4.841763	0.0004
D(L_HCC(-1),2)	0.492759	0.280006	1.759817	0.1039
D(L_HCC(-2),2)	0.672914	0.238567	2.820651	0.0154
D(L_HCC(-3),2)	0.264927	0.166446	1.591665	0.1374
C	0.028056	0.012503	2.243993	0.0445
@TREND("1990")	-0.001035	0.000768	-1.347584	0.2027

R-squared	0.876968	Mean dependent var	0.003794
Adjusted R-squared	0.825705	S.D. dependent var	0.040197
S.E. of regression	0.016782	Akaike info criterion	-5.075876
Sum squared resid	0.003379	Schwarz criterion	-4.779085
Log likelihood	51.68288	Hannan-Quinn criter.	-5.034953
F-statistic	17.10712	Durbin-Watson stat	2.364281
Prob(F-statistic)	0.000043		

Null Hypothesis: **D(L_GHG)** has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-31.27790	0.0000
Test critical values:	1% level	-4.416345	
	5% level	-3.622033	
	10% level	-3.248592	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(L_GHG,2)
Method: Least Squares
Date: 05/13/19 Time: 18:20
Sample (adjusted): 1992 2014
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(L_GHG(-1))	-0.833778	0.026657	-31.27790	0.0000
C	0.205827	0.115345	1.784442	0.0895
@TREND("1990")	-0.008009	0.007552	-1.060549	0.3015

R-squared	0.983313	Mean dependent var	-0.399818
Adjusted R-squared	0.981644	S.D. dependent var	1.592236
S.E. of regression	0.215723	Akaike info criterion	-0.108533
Sum squared resid	0.930731	Schwarz criterion	0.039575
Log likelihood	4.248125	Hannan-Quinn criter.	-0.071284
F-statistic	589.2573	Durbin-Watson stat	2.683461
Prob(F-statistic)	0.000000		

Null Hypothesis: **D(L_EI)** has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.936786	0.0004
Test critical values:	1% level	-4.416345	
	5% level	-3.622033	
	10% level	-3.248592	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(L_EI,2)
Method: Least Squares
Date: 05/13/19 Time: 18:21
Sample (adjusted): 1992 2014
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(L_EI(-1))	-1.303527	0.219568	-5.936786	0.0000
C	0.020856	0.012522	1.665565	0.1114
@TREND("1990")	-0.001408	0.000859	-1.639003	0.1168

R-squared	0.638774	Mean dependent var	0.000203
Adjusted R-squared	0.602651	S.D. dependent var	0.040916
S.E. of regression	0.025792	Akaike info criterion	-4.356426
Sum squared resid	0.013304	Schwarz criterion	-4.208318
Log likelihood	53.09890	Hannan-Quinn criter.	-4.319177
F-statistic	17.68347	Durbin-Watson stat	1.973400
Prob(F-statistic)	0.000038		

2. Johansen Cointegration

Series: **L_HC, L_TFP**
Sample (adjusted): 1992 2014
Included observations: 23 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.632563	29.12631	25.87211	0.0190
At most 1	0.232915	6.098613	12.51798	0.4479

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.632563	23.02770	19.38704	0.0141
At most 1	0.232915	6.098613	12.51798	0.4479

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

L_HC	L_TFP	@TREND(91)
-9.070267	24.60212	0.069850
45.52395	10.98832	-0.265890

Unrestricted Adjustment Coefficients (alpha):

D(L_HC)	-0.003391	-0.009910
D(L_TFP)	-0.037195	0.018436

1 Cointegrating Equation(s): Log likelihood 102.4496

Normalized cointegrating coefficients (standard error in parentheses)

L_HC	L_TFP	@TREND(91)
1.000000	-2.712392	-0.007701
	(0.50828)	(0.00298)

Adjustment coefficients (standard error in parentheses)

D(L_HC)	0.030754
	(0.04307)
D(L_TFP)	0.337366
	(0.09899)

Series: **L_HC, L_GHG**
Sample (adjusted): 1993 2014
Included observations: 22 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.670365	31.03704	25.87211	0.0104
At most 1	0.259926	6.622109	12.51798	0.3856

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.670365	24.41493	19.38704	0.0085
At most 1	0.259926	6.622109	12.51798	0.3856

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

L_HC	L_GHG	@TREND(91)
39.91743	-1.492952	-0.067966
-27.49398	-3.418247	0.415773

Unrestricted Adjustment Coefficients (alpha):

D(L_HC)	-0.015557	0.001444
D(L_GHG)	0.069001	0.088395

1 Cointegrating Equation(s): Log likelihood 73.97795

Normalized cointegrating coefficients (standard error in parentheses)

L_HC	L_GHG	@TREND(91)
1.000000	-0.037401	-0.001703
	(0.02044)	(0.00245)

Adjustment coefficients (standard error in parentheses)

D(L_HC)	-0.620978
	(0.11247)
D(L_GHG)	2.754345
	(1.79634)

Series: **L_EI, L_TFP**
Sample (adjusted): 1997 2014
Included observations: 18 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Lags interval (in first differences): 1 to 6

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.992294	106.4174	25.87211	0.0000
At most 1 *	0.648783	18.83432	12.51798	0.0039

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.992294	87.58310	19.38704	0.0000
At most 1 *	0.648783	18.83432	12.51798	0.0039

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

L_EI	L_TFP	@TREND(91)
148.0485	101.9860	-0.617353
-207.8192	-66.14668	0.532341

Unrestricted Adjustment Coefficients (alpha):

D(L_EI)	0.019550	-0.004762
D(L_TFP)	-0.029258	-0.021188

1 Cointegrating Equation(s):	Log likelihood	123.7310

Normalized cointegrating coefficients (standard error in parentheses)

L_EI	L_TFP	@TREND(91)
1.000000	0.688869	-0.004170
	(0.01514)	(0.00010)

Adjustment coefficients (standard error in parentheses)

D(L_EI)	2.894288
	(0.45584)
D(L_TFP)	-4.331644
	(1.95658)

3. VECM

Series: **L_HC, L_TFP**
System: UNTITLED
Estimation Method: Least Squares
Sample: 1993 2014
Included observations: 22
Total system (balanced) observations 22

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.373418	0.153352	-2.435046	0.0270
C(2)	0.428277	0.347938	1.230902	0.2361
C(3)	0.983045	0.301037	3.265529	0.0049
C(4)	-0.261563	0.082517	-3.169795	0.0059
C(5)	0.130781	0.084602	1.545839	0.1417
C(6)	-0.001113	0.004751	-0.234286	0.8177
Determinant residual covariance		0.000273		

Equation: D(L_HC) = C(1)*(L_HC(-1) - 0.791028591512*L_TFP(-1) - 0.00628966756853*@TREND(90) - 4.36934868827) + C(2)*D(L_HC(-1)) + C(3)*D(L_HC(-2)) + C(4)*D(L_TFP(-1)) + C(5)*D(L_TFP(-2)) + C(6)

Observations: 22

R-squared	0.557443	Mean dependent var	0.004294
Adjusted R-squared	0.419143	S.D. dependent var	0.025400
S.E. of regression	0.019358	Sum squared resid	0.005996
Durbin-Watson stat	1.807819		

Series: **L_HC, L_GHG**
System: UNTITLED
Estimation Method: Least Squares
Sample: 1993 2014
Included observations: 22
Total system (balanced) observations 22

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.620978	0.112471	-5.521246	0.0000
C(2)	0.086727	0.133673	0.648798	0.5257
C(3)	0.500691	0.126378	3.961860	0.0011
C(4)	-0.073608	0.013653	-5.391400	0.0001
C(5)	0.016594	0.002980	5.568120	0.0000
C(6)	0.007139	0.003448	2.070362	0.0550
Determinant residual covariance		0.000127		

Equation: D(L_HC) = C(1)*(L_HC(-1) - 0.037401014369*L_GHG(-1) - 0.00170265436437*@TREND(90) - 4.47306203818) + C(2)*D(L_HC(-1)) + C(3)*D(L_HC(-2)) + C(4)*D(L_GHG(-1)) + C(5)*D(L_GHG(-2)) + C(6)
Observations: 22

R-squared	0.793738	Mean dependent var	0.004294
Adjusted R-squared	0.729282	S.D. dependent var	0.025400
S.E. of regression	0.013216	Sum squared resid	0.002794
Durbin-Watson stat	1.940352		

Series: **L_EI, L_TFP**
System: UNTITLED
Estimation Method: Least Squares
Sample: 1992 2014
Included observations: 23
Total system (balanced) observations 23

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.231395	0.110380	-2.096347	0.0497
C(2)	-0.202421	0.203514	-0.994633	0.3324
C(3)	0.091927	0.107627	0.854129	0.4037
C(4)	0.002794	0.005289	0.528179	0.6035
Determinant residual covariance		0.000525		

Equation: D(L_EI) = C(1)*(L_EI(-1) + 1.09718810675*L_TFP(-1) + 0.00255380497869*@TREND(90) - 2.7456103244) + C(2)*D(L_EI(-1)) + C(3)*D(L_TFP(-1)) + C(4)
Observations: 23

R-squared	0.227212	Mean dependent var	0.002001
Adjusted R-squared	0.105193	S.D. dependent var	0.026644
S.E. of regression	0.025203	Sum squared resid	0.012069
Durbin-Watson stat	1.935509		