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ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

THE EFFECT OF COVID-19 ON THE INSURANCE SECTOR OF EMERGING MARKET COUNTRIES

COVID-19'UN GELİŞMEKTE OLAN ÜLKELERİN SİGORTA SEKTÖRÜ ÜZERİNDEKİ ETKİSİ

Burak ALAN*
Aslı AYBARS**

Abstract

The fear and uncertainty that arose during the COVID-19 pandemic caused an increase in volatility in financial and commodity markets. This study is conducted to show the impact of the number of COVID-19 cases on the insurance sector of developing countries. In the period between the first case dates and March 23, 2021, the relationship between the increase in the number of cases and the increase in the insurance sector index or company return is examined in the selected countries. According to the results, a negative relationship is revealed in all countries except Greece and Hungary, which is not significant.
Keywords: Insurance Industry, Time Series Analysis, Financial Performance, COVID-19, Emerging Countries
JEL Classification: C22, L10, G22

Öz

COVID-19 salgını sırasında ortaya çıkan korku ve belirsizlik, finans ve emtia piyasalarında oynaklığın artmasına neden olmuştur. Bu çalışma, COVID-19 vaka sayısının gelişmekte olan ülkelerin sigorta sektörü üzerindeki etkisini göstermek amacıyla gerçekleştirilmiştir. İlk vaka tarihleri ile 23 Mart 2021 arasındaki dönemde, seçili ülkelerdeki vaka sayısındaki artış ile sigorta sektörü endeksi veya şirket getirisi arasındaki ilişki incelenmiştir. Sonuçlara göre Yunanistan ve Macaristan dışındaki tüm ülkelerde negatif bir ilişki ortaya çıkmıştır.
Anahtar Kelimeler: Sigorta Sektörü, Zaman Serisi Analizi, Finansal Performans, COVID-19, Gelişmekte Olan Ülkeler
JEL Sınıflandırması: C22, L10, G22

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1. Introduction

The New Coronavirus Disease (COVID-19) is a virus that was initially found on January 13, 2020, as a result of research undertaken in a group of patients in Wuhan Province who had respiratory symptoms (shortness of breath, cough, fever) in late December. Those working in the seafood and livestock markets in this area were the first to be affected by the outbreak. Later, it spread from person to person and in many cities in Hubei province, particularly Wuhan, as well as other provinces of China and other nations (World Health Organization, 2021).

On January 30, 2020, World Health Organization (WHO) declared the coronavirus a Public Health Emergency of International Importance (MacKinnon et al., 2020). By this time, the epidemic has increased between 100 and 200 times (The Associated Press, 2020). On January 31, 2020, Italy confirmed its first two cases, which were tourists from China (Severgnini, 2020). It was reported by WHO on 13 March 2020 that Europe has become the epicenter of the coronavirus crisis (Fredericks, 2020).

Stock exchanges move up or down with relevant control measures or incentive packages, such as direct financial support or a reduction in interest rates in the aftermath of the COVID-19 pandemic. As an example, The Dow Jones Industrial Index (DJI) had its second-worst day ever on March 16, and three of the US market's 15 worst days ever occurred between March 9 and 16. However, this was also the period of one of the top ten market surges in history (Wagner, 2020). Other international factors contributing to systematic risk escalation are thus contributing to the mobilization of the securities markets with COVID-19 (Ashraf, 2020).

The measures taken by central administrations for COVID-19 can affect stock market returns through two possible main channels. The first channel, the rational channel, is associated with the restructuring of portfolios. The measures of central governments point to the changes in the future economic conditions, so events may occur that affect the cash flow expectations of the companies and thus the stock prices. Sudden portfolio configurations can increase both an asset class and price volatility across asset classes. The second channel, the irrational channel, can appear behaviorally. Such a deterioration in the economic environment can lead to an escape to treasury bills and bonds, which are safe investment tools (Baele et al., 2020).

Coronavirus outbreaks, such as that in Turkey, caused movements affecting the business world and, thus, investments in developing countries (Sharif et al., 2020). Significant events cause significant changes in stock market returns (Zach, 2003). Developing countries, including Turkey, and all other countries are facing the new COVID-19 outbreak these days. This problem may cause a long-term decline in the countries' economies and consequently a recession in the global economy (Nakiboğlu & Işık, 2020).

The COVID-19 pandemic has certain consequences like business close-downs, stops in production, decreases in consumption, and increases in the unemployment rate. Unfortunately, the economic effects of the pandemic are being felt seriously between countries and sectors, and this situation negatively affects the financial markets. The COVID-19 pandemic did not affect each sector at the same level. While some sectors turn this situation into an opportunity, some sectors come to the point of bankruptcy. This study aims to contribute to the literature by examining the relationship between the insurance industry and the COVID-19 pandemic. Consequently, the purpose of this study is to investigate the relationship between returns of insurance indices or company shares in selected countries and the number of COVID-19 cases.

The second section of the paper summarizes the available literature on the link between the COVID-19 pandemic and financial markets. In the third chapter, the methodology and data utilized are introduced. The association between the number of COVID-19 cases and industrial indices is econometrically examined in the fifth chapter. The study is completed with the conclusion section where the empirical analysis results are evaluated.

2. Literature Review

It is possible to divide the factors affecting stock prices into two as being internal and external. Internal factors include the performance of the company, the change in the structure of the board of directors, the appointment of new management, and the creation of new assets, dividends, earnings, etc. External factors, on the other hand, consist of government policies, economic conditions, investor behavior, market conditions, competition, strikes, lockouts, uncontrolled environmental conditions that directly affect the production of the company, natural disasters, and unexpected situations (Al-Tamimi et al., 2011; Özlen & Ergun, 2012; Sharif et al., 2015). In this context, factors affecting stock prices are also classified as microeconomic and macroeconomic factors. Microeconomic characteristics such as liquidity, profitability, activity, leverage, and stock market performance ratios can all be listed. Exchange rates, inflation rates, money supply, interest rates, GDP, gold, oil, foreign trade balance, industrial output index, crises, and stock price indices are all macroeconomic elements (Mokhova & Zinecker, 2014). These factors affect the value of the exchanges directly or indirectly. In this context, the results of some studies conducted in various countries regarding the effect of COVID-19 on stock market indices and the factors affecting the insurance stock market index are summarized in this section.

Gülhan (2020), in his research on the impact of the COVID-19 pandemic on the BIST100 index, discovered that the COVID-19 death rate, US Dollar to Turkish Lira exchange rate, and the volatility index (VIX) had a long-term link.

Al-Awadhi et al. (2020) investigate whether the COVID-19 virus impacts stock market performance using panel data analysis. The authors prove that the COVID-19 virus adversely affects the stock returns of Chinese capital markets. Furthermore, Zaremba et al. (2020), Okorie and Lin (2021), and Ashraf (2020) note that the global stock market has received strong influence from the COVID-19 outbreak and that there are certain volatility-related impacts.

Haroon and Rizvi (2020) analyze the relationship between news related to the COVID-19 outbreak, financial behavior, and stock market volatility. In the study, the authors emphasize that the COVID-19 epidemic increased uncertainty, causing an increase in price volatility for financial markets, and it is determined that overwhelming panic occurred. Baker et al. (2020) study the impact of the COVID-19 outbreak on the Spanish capital market and highlight the unprecedented strong impact of the epidemic on this market.

Albulescu (2020) investigates the impact of official announcements on new infection and mortality rates on the VIX of financial markets 40 days after the start of international monitoring of COVID-19. The mortality rate positively affects the VIX, although new cases reported in the findings in China and outside China are found to have a mixed effect on financial volatility.

Onali (2020) investigates the changes in transaction volume and volatility expectations by examining the impact of COVID-19 cases and related deaths on the US stock market. As a result, the author finds that changes in the number of cases and deaths in the US and six other countries heavily affected by the COVID-19 crisis have no impact on US stock returns, except for the number of cases reported for China. The number of fatalities recorded in Italy and France has a negative influence on stock returns but a favorable effect on VIX returns, according to vector autoregression (VAR) models.

Şenol and Zeren (2020) investigate the impact of the recent pandemic on global markets in their studies. There is a long-term association between stock markets and COVID-19, according to the research done with the Fourier Cointegration test.

Zeren and Hızarcı (2020) aim to reveal the possible effects of the COVID-19 outbreak, measured by COVID-19 daily deaths and cases, on stock markets by using a cointegration test in their studies. As a result, they show all exchanges examined with total mortality move together in the long term. They state that total cases were in a cointegration relationship with some indices, but not cointegrated with some indices.

Sansa (2020) tests the impact of the novel coronavirus in China and the USA on financial markets with regression analysis. In the study, a positive significant relationship is found between the COVID-19 cases and the prices of stocks traded in the Shanghai index and the New York Dow Jones index. In addition, when the findings of the article of Barut and Kaygın (2020) are examined; there is cointegration between BIST100 (Turkey), FTSE MIB (Italy), and IBEX35 (Spain), AEX (Netherlands), and Shanghai (China) indices and COVID-19 cases. On the other hand, it is determined that there is no cointegration between DAX (Germany), CAC40 (France), BEL20 (Belgium), SMI (Switzerland), FTSE 100 (England), and DOW 30 (USA) and COVID-19 cases. In the light of these findings, although the total number of cases and the total number of deaths is high, cointegration between the stock market indices of Germany, France, Belgium, Italy, Switzerland, and the USA and the total number of cases of COVID-19 is not detected in the period covering the analysis. This result is thought to have emerged due to the strong economic structure of these countries.

Liu et al. (2020) investigate the short-term impact of COVID-19 on 21 key stock market indexes in countries that are heavily affected such as Japan, Singapore, Korea, the USA, Italy, Germany, and the UK. A case study is conducted to investigate the abnormal returns (AR) and cumulative abnormal returns (CAR) of the selected stock indices. The findings of the study show that the stock markets fell rapidly after the COVID-19 outbreak. In addition, it is stated that countries in Asia experienced more negative abnormal returns compared to other countries. Zhang et al. (2020) conduct a correlation analysis of the weekly returns of stock markets and the number of COVID-19 cases in 12 countries. The study results show that the correlation between stock returns and the recent pandemic has increased significantly. In addition, the study reveals that the stock market responses are directly related to the high number of COVID-19 cases in that country.

Alber (2020) investigates whether COVID-19 cases and deaths affect stock returns. Data belonging to 6 countries; namely, China, France, Germany, Italy, Spain, and the USA with the highest number of cumulative cases is utilized in the analysis. According to the results, it has been determined that decreases in stock market returns are more susceptible to COVID-19 cases than deaths. The negative impact of the COVID-19 pandemic on stock returns has only been confirmed for China, France, Germany, and Spain. In a similar study, Ashraf (2020) studies the response of exchanges to the COVID-19 outbreak with the utilization of daily COVID-19 cases, death numbers, and stock returns from 64 countries. As a result of the examination, it is determined that as the number of COVID-19 cases increases, stock market returns decrease. It is also observed that stock markets respond more proactively to the increase in the number of cases compared to the increase in the number of deaths. A similar finding has been detected by Yan (2020) in that the COVID-19 outbreak has caused Chinese stock prices to drop sharply.

There are also studies in the literature examining the impact of the COVID-19 pandemic on Turkish markets. The impact of the COVID-19 outbreak on Borsa Istanbul sector index returns is revealed in the study of Göker et al. (2020). Case studies are conducted using the data belonging to 26 sectors in BIST. As a result of the study, it is observed that most sectors have obtained negative Cumulative Average Extraordinary Return (CAR) in most of the event periods examined, and CAAR values of different sectors are found to be positive in some periods. Although the rates fluctuate depending on the event window, it has been discovered that the Sports, Tourism, and Transportation sectors suffer the most losses.

Öztürk et al. (2020) investigate the impact of the novel coronavirus outbreak in Borsa Istanbul from an industrial perspective. According to the findings of the study, the pandemic has a detrimental influence on practically every industry. The three main sectors, namely, industry, services, and finance, are affected approximately equally on average, with variances at the sector level. Metal goods, manufacturing, sports, tourism, transportation, banking, and insurance are among the most heavily impacted industries. Food, beverage, wholesale, and retail commerce, on the other hand, have been highlighted as less impacted industries.

Tayar et al. (2020) examine the sectoral effects of the COVID-19 pandemic in Turkey. Simple linear regression analysis is performed using the daily change in the number of cases in Turkey and the daily change in the BIST sector indices. As a result of the analysis, it is determined that COVID-19 has significant and negative effects on Electricity, Transportation, Financial, Industrial, and Technology Sectors.

Kılıç (2020) analyzes the effects of the recent global pandemic on data belonging to Borsa Istanbul sector indices using the event study method. As a result of the analysis, it is determined that the COVID-19 outbreak had an overall negative effect on the BIST sector index returns. While it is determined that the textile and tourism sectors are exposed to the highest negative impact, it is concluded that the trade sector demonstrate positive returns during the pandemic period.

3. Data and Methodology

3.1. Data

In this study, the countries of the Morgan Stanley Capital International (MSCI) Emerging Markets Index in the European continent have been selected to determine the indices or the companies to be used in the empirical analysis (MSCI, 2021). Russia is not included in the dataset since there was no insurance company in this country's stock exchange market (MOEX). Five selected countries with their insurance index or company tickers are shown in Table 1 below.

Table 1: Indexes/Companies Included

Country	Ticker of Stock/Index	Explanation
Czech Republic	VIGR.PR	Vienna Insurance Group
Greece	ERER.AT	European Reliance General Insurance Co SA
Hungary	CIGP.BU	CIG Pannonia Life Insurance Plc
Poland	PZU.WA, EHG.WA, TLNX.WA, VOT.WA, EUC.WA	A price-weighted index created out of five stocks
Turkey	XSGRT.IS	BIST Insurance Index

The data is time-series and covers the duration between the first COVID-19 case, which can be seen in Table 2 below for each country, and March 23, 2021. The stock or index data are collected from Investing website (see https://www.investing.com); the COVID-19-related data are collected from the official WHO website for COVID-19 (see https://covid19.who.int).

Table 2: Period

Country	The First Case	Time Range (Inclusive)
Czech Republic	2nd of March, 2020	12/03/2020 – 23/03/2021 (386 days)
Greece	27th of February, 2020	27/02/2020 – 23/03/2021 (390 days)
Hungary	5th of March, 2020	06/03/2020 – 23/03/2021 (383 days)
Poland	4th of March, 2020	05/03/2020 – 23/03/2021 (384 days)
Turkey	11th of March, 2020	12/03/2020 – 23/03/2021 (377 days)

3.2. Model and Methodology

To test the effect of COVID-19 cases on the insurance sector of selected countries, a time series analysis can be applied.

The model can be formed as follows:

$$INR_t = \beta_1 COV19_t + \beta_2 VIX_t + \varepsilon_t \ (1) \qquad (1)$$

where t denotes the time; INR shows the daily logarithmic return of the insurance index/company for each country; COV19 is the logarithmic increase for daily cases; VIX is the daily logarithmic change in the Chicago Board Options Exchange Volatility Index, which measures the degree of fear in the markets, and ε is the constant term.

Table 3 below shows all variables; namely, dependent, independent, and control variables together with their abbreviations and explanations.

Table 3: Variable Explanations

Variable Name	Abbreviation	Explanation
Insurance Return	INR	Daily insurance index/company logarithmic return
COVID-19 Case Number Increase	COV19	Daily logarithmic increase/decrease in COVID-19 cases
Volatility Index Change	VIX	Daily logarithmic change in Chicago Board Options Exchange Volatility Index

In the first part of the analysis, the stationarity of the variables is examined with the ADF unit root test. Examining the stationarity of variables is essential in choosing the correct methods. Because the stability of the variables being I(0) or I(1) causes the use of different econometric methods. The use of non-stationary series may lead to spurious regression in regression analysis. For this reason, the stationarity of variables is examined in the study. ADF unit root test is based on Dickey-Fuller's (1979) study. The following table shows the unit root test result of countries' insurance sector returns, COVID-19 case, and volatility index. The table below shows that all the variables are stationary at level, rejecting the null hypothesis of the ADF unit-root test.

Table 4: ADF Unit-root Test Results

Variables	Test Statistics at Level
INR – Czech Republic	-20.954***
INR – Greece	-21.135***
INR – Hungary	-17.655***
INR – Poland	-21.887***
INR – Turkey	-20.391***
COV19	-19.315***
VIX	-23.863***

Note: *** shows $p<0.01$; ** shows $p<0.05$; * shows $p<0.1$

The Durbin Watson statistic is a number used to test whether the terms are correlated after a regression model has been estimated (Durbin and Watson, 1950). No autocorrelation exists in the models. After testing the autocorrelation and unit root test, the model has turned out to be suitable for the simple regression (OLS).

4. Empirical Results

The table below shows the relationship between the insurance sector index/company values of the countries included in the study and the number of COVID-19 cases and VIX. The study includes the Czech Republic, Greece, Hungary, Poland, and Turkey. The output results of each country and the statistical results of the model are also given in the table below.

It has been revealed that the insurance industry in the Czech Republic has been negatively affected by the increase in the number of COVID-19 cases at the 10% significance level and the VIX change at the 1% significance level.

It turns out that while the insurance sector in Greece and Hungary is negatively affected by the change in VIX at the 1% level, it is not affected by the change in the number of COVID-19 cases. The coefficient of changes in the number of COVID-19 cases in Greece is found to be negative, while that for Hungary is positive. But neither is significant.

According to the model, the insurance industry in Poland is only negatively affected by the COVID-19 case changes at a 1% significance level and not the change in VIX.

The table shows that the insurance industry index in Turkey is negatively affected by both COVID-19 case changes and VIX changes at a 1% significance level.

Table 5: Empirical Result

Model	Dependent Variable: INR	Coefficient		R-squared (F value)
Czech Republic	COV19	-0.0033796	*	6.92% (0.0000)
	VIX	-0.0573903	***	
	Constant	0.0001824		
Greece	COV19	-0.0023580		11.97% (0.0000)
	VIX	-0.0907225	***	
	Constant	-0.0000668		
Hungary	COV19	0.0034975		2.46% (0.0088)
	VIX	-0.0658485	***	
	Constant	0.0014789		
Poland	COV19	-0.0057861	***	2.21% (0.0142)
	VIX	-0.0052308		
	Constant	0.0000259		
Turkey	COV19	-0.0151316	***	9.04% (0.0000)
	VIX	-0.0345904	***	
	Constant	0.0013796	*	

Note: *** shows p<0.01; ** shows p<0.05; * shows p<0.1

When comparing the countries with each other, it has been revealed that the country most affected by the change in the number of COVID-19 cases is Turkey. It has been shown that the least affected is the Czech Republic. There are no significant results in Greece and Hungary.

In the VIX changes, the table shows that Greece is the most affected and Turkey is the least affected country. Only in Poland, no significant result is detected.

5. Conclusion

Pandemics have consequences that affect the economy and social life in various ways. Apart from the economic depression they have created, they can create fear in people and cause individuals to exhibit abnormal behaviors in many respects. With the worldwide rapid spread of the new type of coronavirus, which emerged in China at the end of December 2019, the number of cases increased to over one million and the number of deaths rose to over one hundred thousand in a short time. Prohibitions related to the virus have also started to be put in a very short time by the states. The bans had a very rapid effect on the economies of the countries and in general, contractions began to be experienced in many sectors. There were also traumatic declines in financial markets. Even in the world's largest stock exchanges, the declines exceeded 10%.

While the crises generally affect the country's economies and financial markets, they may have positive results for some sectors. For this reason, the indices of these sectors may move in the opposite direction of the market index in various markets. However, the insurance sector, which is investigated in this study, is found to be badly affected by the number of COVID-19 cases. Accordingly, in this study, the effect of coronavirus on the insurance sector indices of European countries included in the MSCI is analyzed by the time series regression method. In the analysis, which is conducted for the period starting from the day of the first case to March 23, 2021, in the selected countries, a negative effect on the number of cases is found, except for Greece and Hungary, which are not significant. Considering the coefficients, it is seen that Turkey is the most affected country.

Political interventions are needed to constrain the virus and regulate stock markets; however, unconventional policy interventions such as unlimited monetary expansion by countries create more uncertainty and may cause long-term problems. In addition, countries are unable to act together to meet these challenges, as markets in the group of countries studied here respond differently to policies at the national level and the overall evolution of the pandemic.

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ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

INDEX DECOMPOSITION ANALYSIS AND ENERGY CONSUMPTION OF TURKEY: 2000-2014

TÜRKİYE'NİN ENDEKS AYRIŞTIRMA ANALİZİ VE TÜRKİYE'NİN ENERJİ TÜKETİMİ: 2000-2014

Aynur YILMAZ ATAMAN*

Abstract

Index decomposition analysis (IDA) has been one of the important tools in energy and environmental studies in identifying the level of contribution of the driving factors of a change in an aggregate of interest during a time period or across different units such as countries or regions. Aiming to be an informative source for further studies conducted with this methodology, this paper provides a general review covering its historical development and mathematical formula. To see the contribution of economic growth, sectoral composition and energy intensity to the energy consumption change in Turkey between 2000-2014, based on the energy and socio-economic accounts of the WIOD LMDI-I method is used as it is the most preferred IDA method due to its simplicity and ability to provide perfect decomposition.

Keywords: Decomposition Analysis, Divisia Index, LMDI, Energy Consumption, Turkey
JEL Classification: C43, Q43, Q48

Öz

Endeks ayrıştırma analizi (EAA), enerji ve çevre ile ilgili çalışmalarda, bir değişkenin belirli bir dönemdeki veya ülke, bölge gibi farklı birimlere ait gözlem değerleri arasındaki değişiminde, bu değişkenin bileşenlerinin hangi düzeyde katkı yaptıklarının tespit edilebilmesi amacıyla başvurulan önemli araçlardan bir olmuştur. Bu çalışma, analizin tarihsel gelişimi ve matematiksel formülü hakkına temel bir değerlendirme sunarak; ileride EAA'nın kullanılacağı diğer çalışmalar için de kaynak olmayı amaçlamaktadır. Ekonomik büyüme, sektörel yapı ve enerji yoğunluğundaki değişimlerin, Türkiye'de üretim faaliyetlerinden kaynaklanan enerji tüketiminin 2000-2014 yılları arasındaki değişimine etkisi ise DGÇV'nin enerji ve sosyo-ekonomik hesaplarından yararlanılarak incelenmiştir. Çalışmada basitliği ve tam ayrıştırma sağlaması nedeniyle en fazla tercih edilen EAA metodu olan LMDI-I yöntemi kullanılmıştır.

Anahtar Kelimeler: Ayrıştırma Analizi, Divisia Endeksi, LMDI, Enerji Tüketimi, Türkiye
JEL Sınıflandırması: C43, Q43, Q48

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1. Introduction

As ecological constraints, rapidly increasing production and consumption activities, as well as their changing structures make continuous access to energy supply more critical than ever, energy policies are gaining increased attention not just for climate-related issues but also for reasons related to energy security. For this reason, breaking down energy demand into its driving factors becomes essential in evaluating the impact of each and thus the effectiveness of economic and energy policies to meet the growing demand for energy.

It is especially after the world oil crisis in the 1970s that energy security has become an important issue, especially in countries with high energy dependency and factors affecting industrial energy consumption and intensity have taken attention, leading to the emergence of decomposition analysis as a new line of research in energy studies (Ang, 2004a; Ang & Goh, 2019a).

Decomposition analysis is a descriptive technique enabling to explain of an observed change of an aggregate indicator of interest by distributing this change into its driving forces (Wang et al., 2017b), and studies are mainly divided into two independently developed categories; *structural decomposition analysis (SDA)* in which the link between different driving forces, such as population, sectoral production, sectoral energy intensity etc., are explored from the demand perspective by taking into account the production and consumption linkages within the economy and *index decomposition analysis (IDA)* in which these driving forces are quantified from the production perspective. Although the underlying concept behind these analyses is the same, their methodological bases and results differ from each other. In that light, SDA offers an in-depth analysis based on input-output tables. However, it has high-level data requirements and is limited by the availability of input-output tables. In a comprehensive study aiming to summarise the fundamental differences and similarities between them, Hoekstra & van den Bergh (2003) also emphasises the advantage of SDA in including the spill-over effects of demand as input-output tables enable to see the indirect need for inputs from other sectors when there is an increase in the direct demand of an industry, whereas IDA can only assess the impact of immediate demand. On the other hand, IDA has a straightforward mathematical formula and requires lower-level data since time series can be used. It also provides more flexibility regarding application areas, periods, and methods (de Boer & Rodrigues, 2020; Hoekstra & van den Bergh, 2003; Su & Ang, 2012; Wang et al., 2017a, 2017b) Due to these reasons, IDA has found an increasing place in the literature of energy studies for distinguishing the contributing factors to energy consumption either at country or regional levels and monitoring the improvement in energy efficiency. IDA literature contains many application examples, but several studies are solely focused on methodological aspects. These studies include but are not limited to the development of new methods (Ang et al., 1998, 2003, 2004; Ang & Choi, 1997; Ang & Liu, 2001; Boyd D. et al., 1987; Boyd et al., 1988; Boyd & Roop, 2004; Chung & Rhee, 2001; F. L. Liu & Ang, 2003; Reitler et al., 1987; Sun, 1998) and their comparisons (Ang, 2004b, 2015; de Boer & Rodrigues, 2020; Shenning, 2020), establishing linkages between different methods (Ang et al., 2009; Choi & Ang, 2003) as well as the improvement of existing ones for more insightful analysis (Ang, 1995b; Ang & Goh, 2019b; Ang & Wang, 2015; Xu & Ang, 2014).

In light of this vast literature, this study has two primary objectives. Firstly, it aims to provide an informative framework for IDA by bringing together the main conceptual and methodological information. Thus, the second part offers a historical insight into how IDA methods developed and were improved. It is followed by recommended criteria for method selection and other implementation issues in the third part. The next part focuses on the mathematical formulae of methods linked to the Divisia index.

In Turkey, IDA has recently become a widely used methodology for energy and emission studies, but relatively few studies have focused on energy consumption. And these studies are based on the energy balance tables, whose statistical approach is different from the national accounting framework. Thus, the second aim of this study is to contribute to this literature by providing an analysis based on a coherent dataset in terms of statistical approach and sectoral classification. Due to this, this study uses the energy and socio-economic accounts of the World Input-Output Database as its main data source. In that light, the fifth part of the study provides a brief overview of the literature of Turkey-related studies with a focus on energy consumption followed by the results of the analysis of Turkish energy consumption for the period 2000-2014 using the additive form of LMDI-I. The last two parts of the study are reserved for discussion and concluding remarks.

2. Historical Development of Index Decomposition Analysis

The term "index decomposition analysis" was used firstly by Ang & Zhang (2000) to distinguish what had formerly been known as "decomposition analysis" or "factorisation analysis" from the SDA. Ang (2004a) and Ang & Goh (2019a) summarise its application areas in six categories: (1) *energy supply and demand*, (2) energy-related *carbon/GHG emissions*, (3) *material use and other new areas,* (4) *national energy efficiency trend monitoring,* (5) *cross country comparison* and *(6) prospective studies.* Until the 1990s, the decomposition studies were mainly related to industrial energy demand and later expanded to cover economy-wide or sector-specific energy demand such as transportation and residential activities. It was after the 1990s that growing concerns about the environment and sustainability also led the scope of index decomposition to cover energy-related gas emissions, primarily carbon dioxide emissions. The number of these studies spurred considerable volume in the literature, especially after the 2000s. Decomposition studies of material use and resource consumption apply this methodology similar to those in energy or emission studies since the aggregate of interest is replaced by resource or material consumption such as water, oil etc. However, it is stated that IDA still needs to be well-established in other new areas like investment, agriculture, or natural capital because interpreting the drivers of the aggregate variables can be problematic. In national energy efficiency trend monitoring, a variety of index decomposition methods are used to separate out the impact of energy intensity and create more reliable energy efficiency indicators. In cross-country studies, the comparison is made between countries or regions based on the difference in the aggregate of interest, such as energy intensity or energy-related CO2 emissions. In these studies, data for two different years are substituted for the data for two countries, but factors contributing to the difference in the aggregate of interest stay similar to those affecting changes over time in one country. In addition to these areas, IDA has been used for prospective analyses as the most recent application area to make forecasts about aggregate indicators based on the decomposed effects in historical studies (Agnolucci et al., 2009; Lescaroux, 2013; O'Mahony, 2010; Saygin et al., 2013), to quantify the contributions of driving factors to changes in the aggregate of interest over a future period (Hasanbeigi et al., 2014; Köne & Büke, 2019) or to illuminate projection results across different scenarios (Förster et al., 2013; Smit et al., 2014). [1]

Ang (2004a) also categorises the methodological developments in index decomposition analysis within three periods; *introduction, consolidation, and further refinement*. Before 1985, in the "introduction phase", techniques applied to identify the impact of changes in sectoral production/ energy intensity on aggregate energy intensity are referred to as the "Laspeyres index-related decomposition approach". Initially, these techniques were developed independently from the index number theory but were later found similar to the Laspeyres index approach. In these studies, the contribution of changes in a specific factor to the aggregate energy variable is determined through the difference between a hypothetical and an observed value of the aggregate energy variable calculated by letting only one factor change and keeping other factors unchanged at their respective base year values during the analysed period. As an example of this approach, Bossanyi (1979) subdivides the change in the aggregate energy intensity into two contributors: the effect of changes in product mix (sectoral production share) and the impact of changes in the energy intensities. To separate these two effects, contributions of these two factors for a base year are calculated first. Then a hypothetical energy consumption level at a particular year is estimated if the product mix would have changed only, keeping the sectoral energy intensities unchanged. And the difference between actual aggregate energy consumption and this hypothetical aggregate energy consumption in the target year is attributed to the contribution of changes in energy intensity to the total change. The same approach can be seen in (Jenne & Cattell, 1983) analysing the changes in the energy intensity of industrial production in the UK from 1960 to 1980. Hankinson & Rhys (1983) utilises a similar approach to examine the UK industrial electricity consumption changes at 3-level disaggregation to see the impact of output growth and sectoral and intensity changes on electricity consumption.

In the "consolidation phase" over the years 1985-1995, attempts gained pace to establish a general framework for decomposition methods. Amongst those studies, Reitler et al.(1987) propose a new approach in the Marshall-Edgeworth index form as a refinement of the decomposition method of Hankinson & Rhys (1983). However, Park (1992) criticises the calculation of the structural effect in (Reitler et al., 1987) and formulates an approach based on the Laspeyres index used in previous

1 Further information on classification and review of studies in which index decomposition is used for prospective analysis can be found in (Ang, 2015; Ang & Goh, 2019b)

studies. Howarth et al. (1991) propose a similar approach and calculate the impact of changes in production structure or energy intensity on total energy use by keeping other variables constant at their initial levels. The first method based on the Divisa index was also proposed in this period by Boyd D. et al. (1987) and Boyd et al. 1988) and later referred to as the Average Mean Divisia Index (AMDI) as the arithmetic mean weight function is used in the decomposition of changes in the energy intensity into its components.

In this period, (X.Q.Liu et al., 1992) consolidated common methods, including those based on Laspeyres, Paasche or Marshal-Edgeworth indices, by proposing two general parametric Divisia methods and also offering a new technique called the Adaptive Weighting Divisia Method (AWDM) in which parameter values or weights of other variables vary through the time. Ang & Lee (1994) further develop five specific parametric Divisia methods as well as the multiplicative version of the AWDM and state that previous techniques proposed by different researchers such as Boyd et al. (1988), Park (1992), Reitler et al.(1987) and X.Q.Liu et al. (1992) were either identical or similar to these parametric methods. Ang (1994) extends their work by taking the energy intensity as an aggregate indicator instead of energy consumption and proposes a multiplicative decomposition framework based on two general parametric Divisia methods using time series data. Lastly, Ang (1995a) provides a methodological framework for previous decomposition studies covering three different approaches. In spite of the increasing number of new methods and efforts to improve the existing ones, decomposition studies conducted during this period left unexplained residuals.

After 1995, in the so-called "further refinement period", unexplained residual problems and the inability to handle zero values in big data sets led to the improvement of decomposition methods. The first technique, proposed by Ang & Choi(1997) was another Divisia index method using a logarithmic weight function in the decomposition of an aggregate index that was able to leave zero residual and deal with zero values in the data set. Ang et al. (1998) propose another Divisia index decomposition method using a different logarithmic weight function to extend this method by decomposing the differential change in the aggregate of interest in energy studies. These two methods were later referred to as Log-Mean Divisia Index II and I (LMDI-II and LMDI I), respectively (Ang et al., 2003; Ang & Liu, 2001).

Further improvements were also made in methods based on the Laspeyres index. Sun (1998) equally allocates residuals into contributing factors to resolve the residual problem. This method, named as "refined Laspeyres index method by Ang & Zhang (2000), was later found by Ang et al. (2003) to be identical to the Shapley decomposition technique that had long been used in cost-allocation problems and introduced to energy studies by Albrecht et al. (2002) and thus referred to as the Shapley/Sun method in (Ang, 2004b). Based on the geometric average of both Laspeyres and Paasche indices, the generalised Fisher Index technique was another perfect decomposition technique introduced to energy studies in this period by Ang et al. (2004). And, in decomposition with two factors, Shapley/Sun and generalised Fisher index methods became equivalent to the Marshall-Edgeworth and the conventional Fisher ideal index methods (Boyd & Roop, 2004;

F.L.Liu & Ang, 2003) respectively. Though the generalised Fisher ideal index and the Shapley/ Sun methods are able to overcome the residual problem, they have a common weakness: the number of factors necessary to distribute the residuals increases with the number of elements in the decomposition identity(Ang & Goh, 2019a).

During that period, another residual-free index, named the Mean Rate of Change Index (MRCI), was developed to be incorporated into the decomposition studies by Chung & Rhee (2001). By that time, this method had superiority over all Divisia index methods in dealing with negative values in the data set and thus specifically suited to analyses using input-output tables. Later on, the zero and negative value problems of LMDI were resolved by Ang & Liu (2007a) and Ang & Liu (2007b) providing a general guideline to deal with deviations in the large data sets by using analytical limits and small values. [2]

3. Method Selection for the Application of IDA

In energy-related studies, there are several index decomposition methods, which are divided into two groups by Ang (2004b). As shown in Figure 1 [3] methods derived from the Laspeyres index concept where the contribution of a factor is calculated while keeping other factors at their respective base years are categorised as "methods linked to Laspeyres index", while all other methods are categorised as "methods linked to Divisia index".

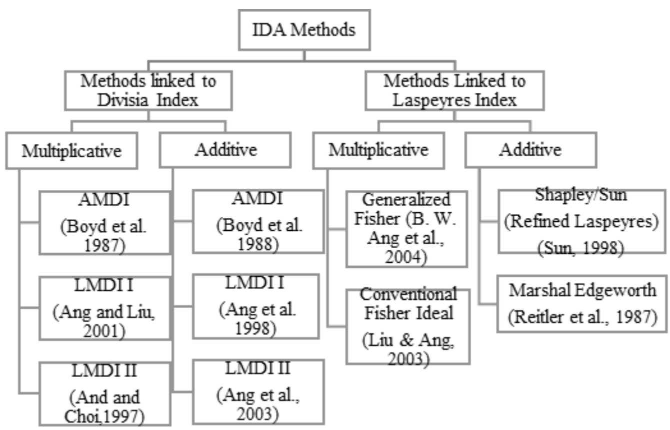

Figure 1: Classification of Index Decomposition Methods

Source: Prepared by the author according to (Ang, 2004b, 2015)

2 While Ang et al.(1998) and Ang & Choi (1997), proposed replacing zero values in the data set with positive values to resolve the zero value problem of LMDI Method, Ang & Liu (2007a) provides a general framework for all possible cases involving zero values.

3 Following (Ang, 2004b), methods linked to conventional Laspeyres index are not included into this classification because of large residual problems, and AWDM and MRCI methods are also left outside because of their complicated formulae.

Since the relative contributions of the factors to the energy-related aggregate of interest are measured in each method differently, Ang (2004b) recommends four criteria to be taken into account in assessing the desirability of a decomposition method: (a) theoretical foundation (b) adaptability (c) ease of use and (d) ease of result interpretation.

As methods in IDA have a strong affinity with index numbers, their theoretical foundation is highly related to index number theory. In that light, Ang & Zhang (2000) consider two desirable properties of index numbers and zero-robustness to identify an appropriate method for decomposition. The most crucial desirable property in the index number theory is factor reversal; that is, the multiplication of all decomposed components can give the aggregate's observed ratio. The equivalent of this property in index decomposition analysis is to leave no residual terms, i.e., being perfect in decomposition. Time reversal is another desirable property of index numbers, which requires that an index number calculated from one period to another is the reciprocal of an index number calculated backwards. In index decomposition analysis, this property means that the results of the analysis should be consistent independently from its application prospectively or retrospectively. Except for AMDI, all methods linked to the Laspeyres and Divisia Indices in Figure 1 possess these two desirable properties, whereas AMDI passes only the time reversal test (Ang, 2004b; Ang et al., 2004; Ang & Zhang, 2000).

The adaptability of methods refers to being easily applicable for a variety of cases as well as suitable for different decomposition techniques. In that sense, decomposition methods that can be used for various analyses such as time-series and cross-country comparisons are accepted to have this property. On the other hand, methods that cannot meet the criterion of factor reversal, e.g., AMDI, are also recommended not to be applied when there are significant variations in the data sets; such as in cross-country comparisons or period-wise analyses where the size of the change in the data can be large (Ang, 2004b). In addition to the type of analysis, decompositions can be carried out in two ways: additively or multiplicatively. Additive decomposition is performed for analysing a difference change of aggregate indicators, such as energy consumption or carbon emission, whereas, in multiplicative analysis, a ratio change of an aggregate indicator is decomposed, such as energy or carbon intensity. Within that context, convertibility between these different decomposition techniques can also be accepted as a positive indicator of the adaptability of the method of interest. In that regard, LMDI methods have superiority over other methods since the results of different techniques can be directly converted to each other by a simple formula. In contrast, in methods based on the Laspeyres index, there is not such a direct relationship (Ang et al., 2009).

Another parameter accepted as a positive indicator for the adaptability of the decomposition method is the ability to deal with differences in the data set, such as zero/negative values. Zero value problems frequently occur, particularly in emission studies, as fuel types are considered amongst the contributing factors to emission change, and the amount of specific kind of fuels can be equal to zero at some time point or place, whereas negative values are relatively rare, especially in energy studies (Ang & Liu, 2007b). Both methods linked to the Laspeyres index and

Divisia index, except AMDI, are zero-and negative-value robust (Ang, 2004b; Ang & Goh, 2019a; Ang & Zhang, 2000). However, if zero or negative values prevail in the data set, Laspeyres-based methods can still be recommended over Divisa-based methods (Ang & Goh, 2019a).

Ease of use relates to the ability of a specific method to be applied to different problems and the simplicity of its formula. In that sense, one of the common disadvantages of processes linked to the Laspeyres index is that the formulae used in these methods get complex if the number of factors exceeds three, whereas LMDI methods carry the same form irrespective of the number of factors taken into account (Ang, 2004b; Ang & Goh, 2019a).

Ease of result interpretation is directly linked with the decomposition performance of the method. In other words, results of an index decomposition analysis that meet the criterion of the factor reversal test are easier to understand as there is no factor left unexplained, and these decomposition methods can cover all of the changes in the related aggregate. In addition, the technique of the decomposition analysis, whether it is additive or multiplicative, also affects the understandability of the results. Additive analysis may be preferred to multiplicative analysis as the explanation of differential changes in physical units can be perceived more easily than ratio changes (Ang & Zhang, 2000).

Regarding the four criteria mentioned above, both methods have some strengths and weaknesses. Especially for analyses based on two factors and with no zero/negative value in the data set, all methods passing factor reversal can be applicable. However, the decomposition results will be different because of the difference in their mathematical formula. On the other hand, for environmental and emission studies in which there are generally more than three factors contributing to the changes in the related aggregate, the LMDI method is recommended as the most appropriate choice (Ang, 2004b). It is also preferable when the conversion between additive and multiplicative decompositions is needed and to ensure the comparableness if there is a possibility to extend the analyses with added factors in the future depending on the data availability [4].

There are also subtle differences between these two different LMDI methods (-I and – II), which become essential when decomposition is conducted with sophisticated data sets. The first difference is being perfect in decomposition at the sub-category level. For example, if an analysis focuses on changes in total energy consumption that is divided by industrial sectors; this property means that decomposition is consistent, leaving no residual at each sector (sub-category) level, and only the LMDI-I method ensures this property (Ang et al., 2009; Ang & Wang, 2015). Another feature is being consistent in aggregation, meaning that aggregation of decomposition results at each sub-category to higher levels of aggregations can be realised consistently; in other words, decomposition results obtained at the higher aggregate level, i.e., at the country level, are equal to the aggregation of decomposition results at the sub-category levels, e.g., at industry or

4 For a recent and more comprehensive overview of index decomposition methods, please also see (Ang & Goh, 2019a; de Boer & Rodrigues, 2019; Shenning, 2020)

regional levels. Still, only LMDI-I possess this feature (Ang & Liu, 2001), making this method specifically useful for multidimensional and multilevel analyses (Ang & Wang, 2015) [5]. In the LMDI-II formula, on the other hand, weights in the decomposition formula can be summed into unity, meeting a different desirable property in the index construction (Ang & Choi, 1997). [6] Based on this property, (Choi & Ang, 2012) proposes an extended LMD-II method to measure sub-sectors' contribution to total percentage changes in real energy intensity – and structural change-related components of aggregate energy intensity. However, in this paper, the LMDI-I method has been preferred for the illustration of index decomposition analysis for its extensive usage and simple formula compared to other methods and its availability for multilevel analysis for future studies.

In addition to method selection, there are additional issues related to applying index decomposition analysis in energy studies. As explained before, the aggregate indicator of interest can either be a quantity (i.e., energy consumption and emissions) or a ratio (i.e., energy intensity or CO2 emissions per unit GDP). Although a quantity indicator is easy to decompose and it always has one additional factor (that is, industrial/national output showing the production effect; and takes place as the denominator in a ratio indicator-e.g., energy intensity.), it has the disadvantage of having a disproportionately large impact of this additional factor in the analysis, leading to surpass the effects of other factors (Ang & Zhang, 2000). On the other hand, when research focuses on absolute changes and/or the additive decomposition approach is to be used, a quantity indicator is recommended for decomposition analysis as it is easier to understand (Ang, 2015).

Another issue concerning the application of IDA is the time period. In a chaining analysis, time series data are analysed every two years and decomposition results are computed cumulatively, while a non-chaining analysis covers the difference between specific dates. In a chaining basis analysis, decomposition results change relatively less than in a non-chaining basis analysis because decomposition is path dependent. However, non-chaining analysis can be recommended if there is a lack of data, especially if a large number of subcategories are included (Ang, 2004a).

4. Mathematical Formulae of Index Decomposition Analysis

As Ang & Zhang (2000) states that there is a strong affinity between index numbers and index decomposition analysis as the impact of production structure and energy intensity on aggregate energy intensity is quite similar to the effects of the commodity quantity and price on the aggregate commodity consumption. For that reason, the mathematical formula of index decomposition analyses is explained by using the index number concept in many studies [7]. Following Ang et al. (2009) and Choi & Ang (2003);

5 Detailed explanations for multilevel IDA applications and further details regarding the necessary transformation of formulae are given in (Xu & Ang, 2014) and its Appendix A-B, respectively.

6 (Ang, 2015) provides a detailed guidance for the method selection between 8 different LMDI formulae.

7 Other examples for these studies include (Ang, 2004b, 2005; Ang et al., 2009; Ang & Zhang, 2000; de Boer & Rodrigues, 2019).

V represents an aggregate of interest with n components:

$$V_i = X_{1,i} X_{2,i} X_{3,i} \ldots . X_{n,i} \text{ and } V = \sum_i^m V_i = \sum_i^m X_{1,i} X_{2,i} \ldots X_{n,i} \quad (1)$$

Aggregate indicators are generally energy consumption or energy intensity in energy studies, and *n* refers to the different components of the total change in these aggregate indicators, such as changes in economic activity, the sectoral composition of the economy or sectoral energy intensity. On the other hand, subscript *i* denotes sub-categories of the related aggregate, such as different sectors or regions in economy-wide studies or countries in cross-country studies, and *m* represents the number of these sub-categories. And the values of the aggregate in time periods 0 and T are shown below:

$$V^0 = \sum_i^m X_{1,i}^0, X_{2,i}^0 \ldots \ldots \ldots X_{n,i}^0 \quad (2)$$

$$V^T = \sum_i^m X_{n,i}^T, X_{2,i}^T \ldots \ldots \ldots X_{n,i}^T \quad (3)$$

As stated in the third part, the decomposition of a change in the aggregate of interest in the time period (0-T) can be carried out multiplicatively and additively:

Multiplicative Decomposition:

$$D_{tot} = \frac{V^T}{V^0} = D_{X1} D_{X2} \ldots . D_{Xn} D_{rsd} \quad (4)$$

Additive Decomposition:

$$\Delta V_{tot} = V^T - V^0 = \Delta V_{X1} + \Delta V_{X2} + \cdots + \Delta V_{Xn} + \Delta V_{rsd} \quad (5)$$

D_{rsd} and ΔV_{rsd} represent the residual terms and are equal to zero when there is perfect decomposition. In this study, total energy consumption will be used as an aggregate indicator, and thus analysis will be conducted in additive form because of its simplicity and ease of interpretation.

To explore how this energy-related aggregate is affected by the changes in its components by using the Divisia index, firstly, the differentiation of Eq. (1) is taken with respect to time:

$$\frac{dV}{dt} = \sum_i^m \frac{dV_i}{d_t} = \sum_i^m \frac{dX_{1,i}}{d_t} X_{2,i} .. X_{n,i} + \sum_i^m X_{1,i} \frac{dX_{2,i}}{d_t} .. X_{n,i} + \cdots + \sum_i^m X_{1,i} X_{2,i} .. \frac{dX_{n,i}}{d_t} \quad (6)$$

With some manipulation, the right side of the equation gives logarithmic growth rates of each of the variable:

$$\frac{dV}{dt} = \sum_i^m \frac{dV_i}{d_t} = \sum_i^m \boldsymbol{X_{1,i}} \frac{\boldsymbol{dX_{i,1}}}{\boldsymbol{d_t}} \frac{\boldsymbol{1}}{\boldsymbol{X_{1,i}}} X_{2,i} .. X_{n,i} + \sum_i^m X_{1,i} \boldsymbol{X_{2,i}} \frac{\boldsymbol{dX_{i,2}}}{\boldsymbol{d_t}} \frac{\boldsymbol{1}}{\boldsymbol{X_{2,i}}} .. X_{n,i} + \cdots + \sum_i^m X_{1,i} X_{2,i} .. \boldsymbol{X_{n,i}} \frac{\boldsymbol{dX_{i,n}}}{\boldsymbol{d_t}} \frac{\boldsymbol{1}}{\boldsymbol{X_{n,i}}} \quad (7)$$

$$\frac{dV}{dt} = \sum_i^m \frac{dV_i}{d_t} = \sum_i^m X_{1,i}X_{2,i} \dots X_{n,i} \frac{dlnX_{1,i}}{d_t} + \sum_i^m X_{1,i}X_{2,i} \dots X_{n,i} \frac{dlnX_{2,i}}{d_t} + \cdots + \sum_i^m X_{1,i}X_{2,i} \dots X_{n,i} \dots \frac{dlnX_{n,i}}{d_t} \quad (8)$$

$$\frac{dV}{dt} = \sum_i^m \frac{dV_i}{d_t} = \sum_i^m X_{1,i}X_{2,i} \dots X_{n,i} \left[\frac{dlnX_{1,i}}{d_t} + \frac{dlnX_{2,i}}{d_t} + \cdots + \frac{dlnX_{n,i}}{d_t}\right] \quad (9)$$

$$dV = \sum_i^m dV_i = \sum_i^m V_i \left[dlnX_{1,i} + dlnX_{2,i} + \cdots + dlnX_{n,i}\right] \quad (10)$$

As Eq. (10) shows the instantaneous change, it is integrated over a discrete time period, from 0 to T in Eq. (11) and then approximated in Eq. (12), where appropriate functions replace the asterisked variables:

$$\Delta V = \sum_i^m \left(\int_0^T V_i dlnX_{1,i} + \int_0^T V_i dlnX_{2,i} + .. + \int_0^T V_i dlnX_{n,i}\right) \quad (11)$$

$$\Delta V \cong \sum_i^m V_i^* \ln\left(\frac{X_{1,i}^T}{X_{1,i}^0}\right) + \sum_i^m V_i^* \ln\left(\frac{X_{2,i}^T}{X_{2,i}^0}\right) + .. + \sum_i^m V_i^* \ln\left(\frac{X_{k,i}^T}{X_{k,i}^0}\right) + .. + \sum_i^m V_i^* \ln\left(\frac{X_{n,i}^T}{X_{n,i}^0}\right) \quad (12)$$

There are different functional forms proposed for asterisked variables and these functional forms differentiate Divisia index-linked decomposition methods from each other as well as determining their ability to leave zero residual. For example, the first method linked to the Divisia index, AMDI, proposed by (Boyd, D. et al., 1987), uses the arithmetic mean of the energy-related aggregate between different years in the additive form of the analysis. However, as this method provided imperfect decomposition, various functional forms based on logarithmic weight functions were developed later, as explained in the second part.

w_i^* being a weight function showing the share of the component in the total energy-related aggregate, Eq. (13) shows that the total change of energy-related aggregate equals the energy weighted average of the growth rates of each of the component:

$$\Delta V \cong \sum_i^m w_i^* \ln\left(\frac{X_{1,i}^T}{X_{1,i}^0}\right) + \sum_i^m w_i^* \ln\left(\frac{X_{2,i}^T}{X_{2,i}^0}\right) + .. + \sum_i^m w_i^* \ln\left(\frac{X_{k,i}^T}{X_{k,i}^0}\right) + .. + \sum_i^m w_i^* \ln\left(\frac{X_{n,i}^T}{X_{n,i}^0}\right) \quad (13)$$

And the magnitude of a specific component, *k*, is shown as

$$\Delta V_{X_k} = \sum_{i=1}^m w_i^* \ln\left(\frac{X_{i,k}^T}{X_{i,k}^0}\right) \quad (14)$$

Table 1 shows different types of the Divisa-linked decomposition methods and their weight function, w_i. In the additive form of the LMDI-I, the weight function equals the logarithmic average of the aggregate of interest in two periods [8]:

$$\bar{w_i} = L(V_i^T, V_i^0) \quad (15)$$

8 In a recent study(Chen et al., 2020) this weight function is changed to capture the effects of changes that occur during a research period.

Table 1: Decomposition Formulas in Methods Linked to Divisa Index

IDA	*MD*	*WF(MD)*	*AD*	*WF (AD)*
AMDI	$Dx_k = exp\left(\sum_i w_i \ln\left(\frac{X_{i,k}^T}{X_{i,k}^0}\right)\right)$	$w_i = \frac{V_i^T/V^T + V_i^0/V^0}{2}$	$\Delta V x_k = \left(\sum_i w_i \ln\left(\frac{X_{i,k}^T}{X_{i,k}^0}\right)\right)$	$w_i = \frac{V_i^T + V_i^0}{2}$
LMDI-I	$Dx_k = exp\left(\sum_i w_i \ln\left(\frac{X_{i,k}^T}{X_{i,k}^0}\right)\right)$	$w_i = \frac{L(V_i^T, V_i^0)}{L(V^T, V^0)}$	$\Delta V x_k = \left(\sum_i w_i \ln\left(\frac{X_{i,k}^T}{X_{i,k}^0}\right)\right)$	$w_i = L(V_i^T, V_i^0)$
LMDI-II	$Dx_k = exp\left(\sum_i w_i \ln\left(\frac{X_{i,k}^T}{X_{i,k}^0}\right)\right)$	$w_i = \frac{L(V_i^T/V^T, V_i^0/V^0)}{\sum_i(L(\frac{V_i^T}{V^T}, V_i^0/V^0))}$	$\Delta V x_k = \left(\sum_i w_i \ln\left(\frac{X_{i,k}^T}{X_{i,k}^0}\right)\right)$	$w_i = \frac{L\left(\frac{V_i^T}{V^T}, \frac{V_i^0}{V^0}\right)}{\sum_i(L(\frac{V_i^T}{V^T}, V_i^0/V^0))} L(V^T, V^0)$

Source: Prepared by the author based on (Ang, 2004b; Ang et al., 2003, 2009)
MD-AD: Multiplicative-Additive Decomposition; WF: Weight Function

As the logarithmic average of two positive numbers is calculated as;

$$L(x, y) = \frac{x-y}{\ln x - \ln y} \ ; for\ x \neq y; L(x,y) = x, if\ x = y.$$

the general formula used to decompose the underlying effects of energy consumption in the additive form of the Divisia index takes the form below:

LMDI-I (Additive) [9]

$$\Delta V_{X_k} = \sum_{i=1}^{m} w_i \ln\left(\frac{X_{i,k}^T}{X_{i,k}^0}\right) = \sum_{i=1}^{m} L(V_i^T, V_i^0)\ ln\left(\frac{X_{i,k}^T}{X_{i,k}^0}\right) = \sum_{i=1}^{m} \frac{V_i^T - V_i^0}{lnV_i^T - \ln V_i^0}\ ln\left(\frac{X_{i,k}^T}{X_{i,k}^0}\right) \quad (16)$$

5. Index Decomposition Analysis of Energy Consumption in Turkey

Turkey's dependence on fossil fuels and lack of self-sufficiency has not changed over the past 30 years, which has made energy supply security an important pillar of national energy policy (IEA, 2021). As of 2020, fossil fuels accounted for 83.3% of the total energy supply, up from 81.7% in 1990. Hard coal, oil and gas import rates [10] rose to 97.8%, 91.4% and 98.6% in 2020 from 69.6%, 87.6% and 95.3% in 1990 (MENR, 2022). Accordingly, continuous, sustainable and secure provision of energy supply with high quality and low cost is set as the main aim for the energy sector by the 11th Development Plan (2019-2023) (PSB, 2019).

9 The transformation of additive decomposition to multiplicative decomposition can be realized through this formula(Ang, 2004b): $\frac{\Delta V_{Xk}}{\ln D_{Xk}} = L(V^T, V^0) = \frac{V^T - V^0}{\ln(V^T/V^0)} = \frac{\Delta V_{tot}}{\Delta D_{tot}}$

10 Exports and bunker fuels are included in the calculation of import rates.

In that light, the expansion of upstream oil and gas activities and domestic sources have been the main strategies for achieving this objective. Even so, the slight increase in domestic energy sources' share in total energy supply, from 33.3% in 2000 to 36% in 2020 (MENR, 2022), along with limited upstream energy resources and climate-related concerns, indicates that measures in increasing energy efficiency and changes in the composition of production activities are equally needed to meet the energy demand expected to increase with economic growth and population. And for this reason, decomposing changes in energy consumption into its driving forces both at aggregate and sub-sectoral level provides valuable inputs for energy policies.

The analysis will be preceded by a review of Turkish literature on decomposing changes in energy – or emission-related aggregates in Turkey.

Table 2: Brief Summary of Turkey Related Studies in the Literature

Author	Scope	Period	Aggregate	Method
1.(Alkan& Binatlı, 2021)	Economy wide	1990-2015	Emissions	SDA-A
2.(Bektaş, 2021a)	Economy wide with 4 sub-sectors	1998-2017	Emissions	LMDI-I – A
3.(Bektaş, 2021b)	Economy wide with a focus iron and steel industry	1999-2017	Emissions	LMDI-I – A
4.(Isik et al., 2021)	Electricity	1990-2018	Emissions	Multilevel LMDI-I-A
5.(Rüstemoğlu, 2021)	Economy wide&Electricty-Heat	1990-2017	Emissions	R.Laspeyres-A
6.(Türköz, 2021)	Economy wide with 4 sub-sectors	1970-2018	EC	LMDI-I – A
7.(Akyürek, 2020)	Manufacturing with 10 sub-sectors	2005-2014	EC	LMDI-I-M
8(Isik et al., 2020)	Transportation Sector	2000-2017	Emissions	LMDI-I – A
9.(Karakaya et al., 2019)	Economy wide	1990-2016	Emissions	LMDI-I-A +Decoupling
10.(Köne & Büke, 2019)	Economy wide	1971-2014& 2015-2060	Emissions	LMDI-I-A
11.(Özşahin, 2019)	Economy wide and industrial sector with 12 sub-sectors	2003-2017	EI	Extended LMDI-II – M
12.(Akbostancı et al., 2018)	Economy wide Manufacturing &Construction	1990-2013	Emissions	LMDI-I – A
13.(Selçuk, 2018)	Industry with 12 sub-sectors	2003-2011	EI	Extended LMDI-II – M
14.(Özçağ et al., 2017)	Industry and agriculture	1990-2014	Emissions	LMDI-I-A
15.(Köne & Büke, 2016)	Economy wide	1971-2010	Emission Intensity	R.Laspeyres-A
16.(Rüstemoğlu, 2016)	Economy wide (Turkey and Iran)	1990-2011	Emissions	LMDI-I-A +Decoupling
17.(Yılmaz et al., 2016)	Industry with 13 sub-sectors	1981-2011	EC	LMDI-I – A

18.((Kumbaroğlu, 2011)	Electricity,Manufacturing,Transportation, Household,Agriculture	1990-2007	Emissions	R.Laspeyres-A
19.(Akbostancı et al., 2011)	Manufacturing with 51 sub-sectors	1995-2001	Emissions	LMDI-I – A
20.(Yilmaz & Atak, 2010)	Economy wide in 4 sub-sectors	1980-2005	EC	C.Laspeyres-A
21.Çermikli & Öztürkler (2009)	Industry with 7 sub-sectors	1981-2000	EC	R.Laspeyres-A
22.(Tunç et al., 2009)	Economy wide with 3 sub-sectors	1970-2006	Emissions	LMDI-I – A
23.(Ediger & Huvaz, 2006)	Economy wide with 3 sub-sectors	1980-2000	EC	LMDI-I – A
24.(Lise, 2006)	Economy wide with 4 sub-sectors	1980-2003	Emissions	R.Laspeyres-A
25.(Karakaya & Özçağ, 2003)	Economy wide	1973-1980	Emissions	R.Laspeyres-A

EC: Energy Consumption, EI: Energy Intensity, M: Multiplicative, A: Additive, R: Refined, C: Conventional and Emissions: CO2 or GHG

Table 2 summarises studies decomposing changes in energy – or emission-related aggregates in Turkey. To the best of the author's knowledge, (Karakaya & Özçağ, 2003) is among the first studies to use index decomposition to analyse Turkey's carbon emissions changes. The study uses a refined Laspeyres index in the additive form to see the driving factors of the changes in carbon emissions between 1973 and 1980. It was after 2011 that studies applying decomposition analysis became more widespread in Turkey, and the majority of studies focused on the changes in carbon emissions. It is also noticeable that most studies apply decomposition methods linked to the Divisa index in parallel with general literature. And the majority of these studies are based on the additive form of the LMDI-I method, whereas there are only two studies that analyse the changes in energy intensity of Turkey with the LMDI-II approach in the multiplicative form. Other studies using the decomposition technique linked to the Laspeyres index mainly use the refined Laspeyres index to overcome the residual problem. Furthermore, most studies deal with changes at the national level, while sectoral studies concentrate mainly on the industrial and manufacturing sectors.

In regards to studies focusing on energy consumption, Ediger & Huvaz (2006) utilises index decomposition to examine the changes in energy consumption in the Turkish economy between 1980-2000 with three sub-sector details covering agriculture, industry and services and find that the activity effect, i.e., economic growth is the major contributor to changes in energy consumption. Çermikli & Öztürkler (2009) focuses on changes in industrial energy consumption with seven sub-sector detail during five sub-periods between 1981-2000 and finds that the change in the structure and sub-sectoral intensity in the industrial sector led to significant savings in energy consumption in this period. Yilmaz & Atak (2010) is the only study that uses the conventional Laspeyres index as used in (Park, 1992). It is found that output effect has a dominant feature and structural effect has a positive contribution to the energy consumption in the entire period, energy intensity has a reducing impact, except in the period between 2000-2005. Yılmaz et al.,

(2016) analyse the changes in energy consumption in the industrial sector with 12 sub-sectors for the period 1981-2011 and find that, except in years of economic crisis and reduction in real added value, the activity effect contributes positively to energy consumption whereas the intensity and structural effects differ in contributions (positive or negative) in different years. Applying LMDI-I to the manufacturing industry with ten sub-sector details between 2005-2014, Akyürek (2020) finds few structural changes, so increasing production and changing energy intensity are dominant factors affecting manufacturing energy consumption. In the non-metallic minerals and primary metals sectors, structure and intensity effects were observed along with activity effects, while in other sectors, the activity effect dominated. Türköz (2021) analyses changes in national energy consumption with three sub-sector detail for the period between 1970-2018 using an additive form of LMDI. Energy consumption during this period was impacted mainly by increases in production, while structural changes (to a large extent) and intensity changes (to a smaller extent) had a reducing effect. It is also found that between 1970-1979 and 1980-1999, both activity and structural effects increased energy consumption, whereas, in the other sub-period covering 2000-2018, only activity effect led energy consumption to increase.

In all these studies, economic activity is found to be the main contributor to changes in energy consumption. It is not only because the aggregate of interest is a quantity indicator, which outweighs the impact of other indicators, but also because it is still hard to mention that there is a permanent resource decoupling between energy and growth.

Figure 2 illustrates the parallelism in changes between energy consumption and value-added. It is seen that energy consumption decreased in all recession years, namely 1994, 1999, 2001, 2008-2009, and 2019. In 2009 and 2019, only the industrial sector experienced negative growth, resulting in a decrease in industrial energy consumption. However, in some years, namely 1998, 2005, 2008, 2013, and 2018, energy consumption decreased independently from the value added, indicating a temporary decoupling between these two factors.

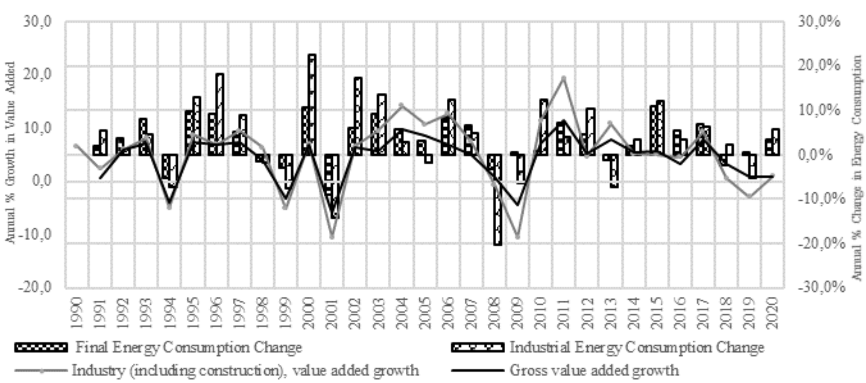

Figure 2: Annual Changes in Energy Consumption and Gross Value-Added, 1990-2020

Source: (MENR, 2022; World Bank, 2022)

Another common point of these studies is that energy data are obtained from national energy balance tables using the territorial principle. In territorial principle, emissions and energy use of an economic actor are allocated to countries where these activities occur, regardless of whether their economic actors are residents or non-residents of these countries. On the other hand, the system of national accounts (SNA) is based on the residential principle, and economic units producing value added are required to be resident in countries engaged in production. In that light, the energy accounts of the World Input-Output Database (WIOD) (Timmer et al., 2015), an extensive database based on harmonised national input tables to analyse global production networks and their socio-economic and environmental impacts, aims to serve as a link between SNA and energy balance statistics by identifying and reconciling the differences between the two statistical systems. While the WIOD energy database is based initially on extended energy balances of the International Energy Agency (IEA), it has later been transformed to provide coherency between economic and energy information. The first transformation is realised by adding activities of residents operating abroad and reducing the activities of foreign entities operating in the national territory. The second transformation is performed by distributing some energy flows into related sectors in accordance with the classification used in SNA, as some energy flows in energy balance tables are categorised irrespective of the agent doing this transport. For example, "road transport" and "commerce and public services" items in energy balances are distributed across several industries, services, plus households in the WIOD energy accounts to set up a link between energy data and economic activities (Corsatea et al., 2019; Genty et al., 2012)

For these reasons, in this study, the analysis of energy consumption changes in Turkey [11] will be conducted with data obtained from the 2016 release of the WIOD using the additive form of the LMDI-I method. WIOD 2016 Release covers the 2000-2014 period with NACE Rev.2 sectoral classification. Gross energy use data in WIOD Environmental Accounts are used for energy consumption. Even though the gross energy concept implies double counting as intermediate energy inputs used for energy transformation are counted, it is considered useful for providing the total amount of consumed energy inputs and thus total energy intensity. Value-added is used as an indicator of production, and real value-added is obtained by deflating gross value added at current prices with the gross value-added price index (2010=100) in the WIOD Socio-Economic Accounts.

In this framework, following (Ang, 2005) the decomposition identity for change in energy consumption between 2000-2014 is set up as follows:

$$E = \sum_i^m E_i = \sum_i^m Q \frac{Q_i}{Q} \frac{E_i}{Q_i} = \sum_i^m Q S_i I_i \tag{17}$$

E = Total energy consumption in the economy

Q = Total activity level $(= \sum_i Q_i)$

11 As the study focuses on the production activities, final energy consumption by households is excluded.

S_i = Activity share ($^{Q_i}/_{Q}$) and

I_i = Energy intensity of the related sector ($^{E_i}/_{Q_i}$)

i refers to different sectors and m refers to the total number of these sectors. Energy consumption is measured in an energy unit (Joule), and output level is in a monetary unit (national currency).

The above identity divides the sources of changes in total energy consumption (ΔE_{tot}) between 2000-2014 into three categories: changes in total production (ΔE_{act}, activity effect) show the contribution of output change to the change in energy consumption. Changes in the shares of sectoral output (ΔE_{str}, structural effect) and changes in energy intensity (ΔE_{int}, intensity effect) reflect the role of structural and energy intensity changes in total energy consumption change.

Following Eq. (5), total energy consumption change in the additive analysis is demonstrated as follows:

$$\Delta E_{tot} = E^T - E^0 = \Delta E_{act} + \Delta E_{str} + \Delta E_{int} \quad (18)$$

And, to see the contribution of each of these components, the following LMDI-I formulae are applied.

$$\Delta E_{ACT} = \sum_i^m L\,(E_i^T, E_i^0)\ln\left(\frac{Q^T}{Q^0}\right) = \sum_i^m \frac{E_i^T - E_i^0}{\ln E_i^T - \ln E_i^O}\ln\left(\frac{Q^T}{Q^0}\right) \quad (19)$$

$$\Delta E_{STR} = \sum_i^m L\,(E_i^T, E_i^0)\ln\left(\frac{S_i{}^T}{S_i{}^0}\right) = \sum_i^m \frac{E_i^T - E_i^0}{\ln E_i^T - \ln E_i^O}\ln\left(\frac{S_i{}^T}{S_i{}^0}\right) \quad (20)$$

$$\Delta E_{INT} = \sum_i^m L\,(E_i^T, E_i^0)\ln\left(\frac{I_i{}^T}{I_i{}^0}\right) = \sum_i^m \frac{E_i^T - E_i^0}{\ln E_i^T - \ln E_i^O}\ln\left(\frac{I_i{}^T}{I_i^O}\right) \quad (21)$$

6. Results

Along with the results of the IDA analysis, it is considered useful and complementary to look at the sectoral shares and changes in total energy consumption, as given Table 3**.** According to the energy accounts provided in the WIOD tables, total energy demand related to production activities increased by 59% in this period, accounting for a total change of 2.35 million TJ. In 2000, total energy consumption was 3.9 million TJ, and 50% of total demand arose from manufacturing activities. Other industrial activities, covering mining and quarrying, and electricity, gas and water supply, turns out as another important sector in terms of energy consumption with a 28% share in total energy consumption in 2000 and is followed by the services sector with a 12% share. Between 2000-2014, the largest percentage increase in sectoral energy demand was realised in the services sector, leading to the share of services in total energy demand to rise to 19%. This increase constituted 32% of the total change in energy demand. However, the primary source of the rising energy demand was the other industrial activities comprising 45% of total change as the largest increase in absolute terms realised in this sector. And the second largest percentage increase occurred by 94% in the same sector resulting in a rise in its weight in total demand to 34% in 2014. In the manufacturing sector, on the other hand, energy demand increase stayed limited to 22%, constituting only 19% of the total increase in energy demand, and the share of the sector in total energy consumption decreased by 11 points to 39% in 2014 (Corsatea et al., 2019).

Table 3: Energy Consumption Change, 2000-2014

	2000		***2014***		***2000-2014***	
	*E*_Tot	Sectoral Shares in *E*_Tot	*E*_Tot	Sectoral Shares in *E*_Tot	% Δ*E*_ Tot	Sectoral Share in Δ*E*_Tot
Total	3,999.8		6,348.4		59%	
Agriculture	227.6	6%	323.0	5%	42%	4%
Manufacturing	2,014.2	50%	2,450.7	39%	22%	19%
Other industry	1,123.7	28%	2,182.7	34%	94%	45%
Construction	152.9	4%	166.1	3%	9%	1%
Services	481.4	12%	1,225.9	19%	155%	32%

Source: (Corsatea et al., 2019)

Notes: Energy consumption values are given Thousand TJ
Other Industry includes Mining and quarrying and Electricity, gas and water supply.

Applying the additive form of IDA to the change in energy consumption shows that the increase in total energy demand mainly arisen from the activity and structural effect. In contrast, the intensity effect has a reducing impact on total change. Figure 3 shows the driving factors of this change, and it is seen that if energy intensity had stayed the same during this period, the total increase in energy consumption would be 26% higher than the actual change, reaching 2,962 thousand TJ, instead of staying at the level of 2,348 thousand TJ.

According to the WIOD database, the overall value added increased by 75% in this period, causing an activity effect of 2,838 thousand TJ. In other words, without structural and intensity impact, increase in total energy demand would be 71%, instead of the actual increase of 59%. Since the activity effect equals the weighted sum of the difference change in total output by changes in sectoral energy consumption, as shown in Eq. (19), it is not possible to see the contribution of changes in sectoral value added to changes in total energy demand [12]. However, in other driving factors showing the structural and intensity effects, it is possible to see the impact of changes in

12 Without taking into consideration the structure of the formula, activity affect can easily be interpreted as the effect of change in sectoral value added on the aggregate indicator (total energy demand, emissions, etc.), which could be misleading. The structural effect also needs to be interpreted carefully, since it shows only the impact of changes in sectoral shares on the aggregate indicator rather than the impact of sub-structural changes on these sectoral indicators (sectoral energy demand, emission etc.)

sectoral shares and intensities on the total change in energy demand which is shown in detail in Table 4.

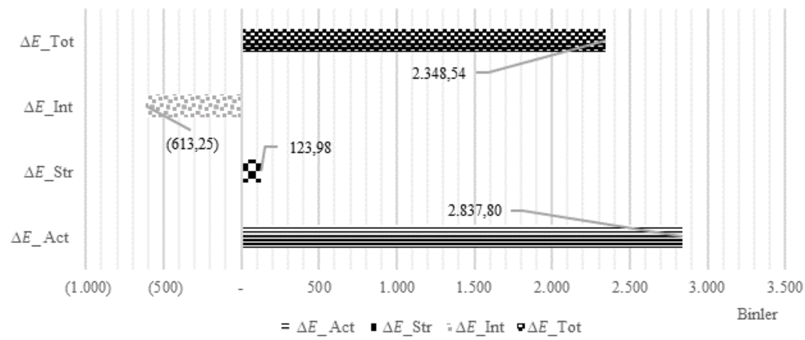

Figure 3: Decomposition of Total Energy Consumption Change, 2000-2014

As seen in Figure 3, the change in the economic structure, reflected by the total impact of each change in sectoral shares of production activities, contributed to the increase in total energy consumption by 123.98 thousand TJ, equalling 5% of the total change in energy demand.

Components of structural and intensity effects are shown in Table 4. The first column (A) shows the % change in the sectoral value-added shares through which the structural impact is calculated in IDA. And the next column (B) gives the structural effect (ΔE_Str) associated with each sector, and the sum of these effects gives the final structural effect. The following column (C) shows the contribution of changes in sectoral shares to total energy demand, which is measured by the percentage of the sectoral structural effect in total energy demand change. In column (D), the % change in sectoral energy intensity is given, and the sectoral intensity effects sum of which equals the total intensity effect is provided in column (E). And the last column (F) shows the contribution of sectoral intensity effects to total energy demand change, equalling to the share of sectoral intensity effect in total energy demand change.

It is seen that a 13% increase in the weight of manufacturing in total value added resulted in 265 thousand TJ increase in energy consumption, accounting for 11% of the total energy demand change. And despite the increase in its weight in total value added, the share of the sector in total energy demand decreased, as stated before, mainly resulting from the gains from improvements in energy efficiency. Another structural change causing an increase in energy demand came from the rise in services and construction sectors' shares. The 3% increase in the share of the services in total value-added resulted in 22 thousand TJ increase in energy demand, equalling the 1% of the total rise in total energy consumption. On the other hand, 29% and 4% decrease in the shares of agricultural and other industries in total value added, respectively, had a reducing impact on energy demand equalling 7% of total change.

Table 4: Components of Structural and Intensity Effects

	% Changes in Sectoral Value – Added Shares *(A)*	***ΔE_Str*** *(B)*	***% Contribution to ΔE_tot through ΔE_Str*** *(C)*	***% Changes in energy intensity*** *(D)*	***ΔE_Int*** *(E)*	***% Contribution to ΔE_Tot through ΔE_Int*** *(F)*
Agriculture	-29%	(93.89)	-4%	14%	36.07	2%
Manufacturing	13%	264.98	11%	-38%	(1,079.24)	-46%
Other Industry	-4%	(71.56)	-3%	16%	234.00	10%
Construction	1%	2.04	0.1%	-39%	(78.52)	-3%
Services	3%	22.41	1%	41%	274.45	12%
Total Effects (Str.& Int.)	-	**123.98**			**(613.25)**	

Source: (Corsatea et al., 2019)
Notes: Energy consumption values are given Thousand TJ
Other Industry includes Mining and quarrying and Electricity, gas and water supply

As mentioned before, the total impact of changes in sectoral energy intensities led to a decrease in the total energy demand during this period. Looking at these sectoral components of total intensity effect, it is seen that the significant decline in energy intensity occurred in manufacturing activities with 38% and had a reducing impact on energy demand by 1.08 million TJ, equalling 46% of total change. In other words, if there had not been any improvement in energy efficiency in the manufacturing sector, the total energy consumption increase would be 46% higher than its actual level. However, the impact of this energy saving was lessened by the rise in sectoral energy intensities in other industrial activities and the service sector. The %41 increase in sectoral energy intensity of services resulted in 274.4 thousand TJ rise in total energy demand, equalling 12% of total energy demand change, whereas only a 16% increase in energy intensity of other industrial activities led to a rise in total energy demand by 234 thousand TJ, constituting the 10% of total change. On the other hand, in the construction sector the impact of the 39% decrease in energy intensity led to a relatively small reducing impact on total energy demand by only 3%, equalling 78.5 thousand TJ, and in the agricultural sector, energy intensity increased by 14% leading to 36 thousand TJ rise in total energy demand, equalling to 2% of total change.

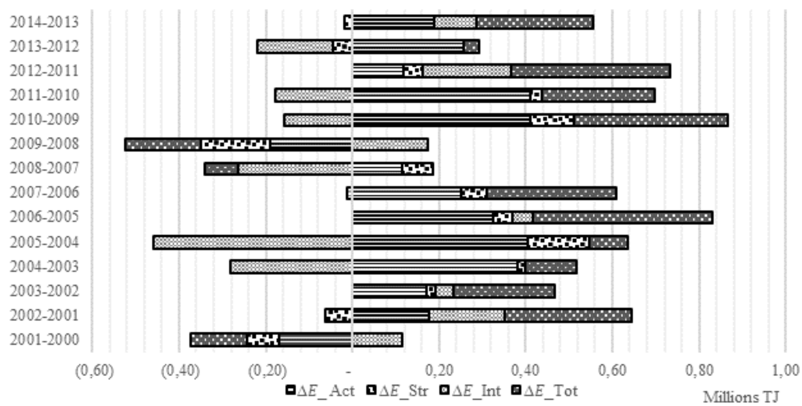

Figure 4: Decomposition of Annual Changes in Energy Consumption, 2000-2014

Figure 4 shows the decomposition of annual changes in total energy consumption in this period. It is seen that in three recession years, total energy consumption declined and only in 2008 energy intensity decrease was the primary source of this decline, while in other years, 2001 and 2009, structural change and decrease in total value added were the main driving factors behind this change. Similar to the analysis of the whole period, structural changes had relatively limited effects in each year and only in 2001, 2002, 2009, 2013 and 2014 it had a reducing impact on total energy demand. A detailed analysis of (Corsatea et al., 2019) depicts that in 2001, 2002 and 2009, the decline in the weight of manufacturing activities was the main source of this structural effect, whereas in 2013 and 2014, it mainly arose from the decrease in the weight of other industrial activities. On the other hand, in half of the analysed years, namely in 2004, 2005, 2007, 2008, 2010, 2011, and 2013 energy intensity had a reducing effect on energy demand and changes in manufactural energy intensity (in 2004, 2005, 2007, 2008 and 2011) and other industrial activities (in 2010 and 2013) was the main source of this impact.

7. Discussion

Findings of the decomposition of both period-wise and annual changes in energy consumption in Turkey are coherent with previous studies, showing that the activity effect is the main contributing factor to the increase in energy demand during this period. As stated previously, this finding can be attributed to two factors: Firstly, decomposing a difference change of an aggregate results in a disproportionately significant impact of an additional variable. Additionally, there is still a strong relationship with the production and energy consumption, as seen in Figure 2 while only in some years a temporary decoupling is observed due to the substantial decrease in energy intensity as annual decomposition analysis demonstrates for 2005,2008 and 2013.

It is also worth emphasising that structural effect generally has a very limited impact on changes in energy consumption, in contrast to the intensity effect which turns out to be the main reason behind the large amount of energy savings during this period. For the annual analysis, this finding can be explained by the low-level sub-sectoral detail of the study, as significant shifts in the shares of these main sectors are less likely to happen annually. Instead, these structural changes are more likely to be observed in the medium and/or long term. In Table 4, we can see a shift from both other industries and agriculture to manufacturing during the entire period. However, the impact of this change was also limited, and this can be explained by the indirect effect of the decrease in sectoral energy intensity. Nevertheless, the effect of structural changes on total energy consumption, while limited, differs from the finding of Türköz (2021) for the sub-period covering 2000-2018, which may be due to differences in the data source as well as sub-sectoral details.

In both period-wise and annual analyses, the primary energy-saving source is the decrease in energy intensity, consistent with the findings of other studies. This is due to a 38% reduction in the sectoral energy intensity of the manufacturing sector, which led to an energy savings of 1.079 thousand TJ, 46% of the overall energy consumption change.

It is noticeable that the impact of changes in the sectoral shares or energy intensities on the total change in energy consumption is related to the percentage of this economic activity in total energy demand. For example, the change in the share of agriculture in total value added (-29%) is more than two times the change in manufactural shares (13%), but its impact on change in total energy demand (-4%) was significantly lower than the impact of manufactural change (11%). Similarly, almost equal reductions in energy intensities of construction (-39%) and manufacturing activities (-38%) had different impacts on change in total energy demand. This indicates that structural changes and energy improvements in sectors of which shares in total energy consumption are higher than others have a larger impact on total energy demand than those with a small weight in total energy consumption.

8. Conclusion

Not only the biophysical limits on natural resources and climate-related concerns but also the distribution of these resources makes continuous access to energy more critical than ever as fossil fuels continue to dominate the world economy. And with the growing energy demand triggered by growth-oriented economic policies and increasing population, analysis of energy consumption becomes more important to understand its driving factors truly and thus establish efficient demand-oriented energy policies to achieve a sustainable level of consumption within supply constraints.

In that regard, the primary aim of this study was to provide an informative framework for IDA, index decomposition analysis, a methodology that has become a widely accepted tool in energy and emission studies and is also being tested in other areas. It is explained that, since its emergence in the 1980s, this methodology transformed substantially through the development of several methods and the improvement of existing ones to carry out more insightful and accurate analyses. Consequently, the methods linked to the Divisia index have emerged as the most preferred methods for various reasons. Among them, LMDI-I was used in this study to analyse the changes in energy consumption from 2000-2014.

While many other studies examining the energy consumption changes in Turkey have utilised the same method, this study differs from them and contributes to a few existing studies by using the WIOD as the sole data source for energy and value-added variables in a county level study. As energy accounts in the WIOD database have been transformed from extended energy balance tables of IEA to achieve the same recording principle and sectoral classification with the national accounting framework, decomposition analysis of the change in energy consumption is considered to be more coherent as energy data is based on the same statistical approach and sectoral classifications with value-added. However, the restriction with using the WIOD database was the limited time period. This issue remains one of the improvement areas depending on the enhancements of WIOD with up-to-date data.

As the analysis shows, IDA can be a very beneficial tool to distinguish the impacts of different factors on the change in energy consumption from each other. Knowing the extent of changes in value-added share and energy intensity of an analysed sector affect total energy demand would provide valuable input in establishing sectoral energy policies. In that regard, a multilevel analysis showing the impact of changes in value-added shares and energy intensity of sub-sectors at the lower hierarchical level on total demand can be more beneficial for in determination of targeted sectors. In addition, as the climate-related concerns are as critical as the supply constraints on energy resources, a study combining the findings of the decomposition of changes in emissions and energy consumption would also be a valuable guide for energy policies.

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ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

HUMAN CAPITAL AND ECONOMIC GROWTH: EVIDENCE FROM WESTERN EUROPEAN AND CEECS COUNTRIES

BEŞERİ SERMAYE VE EKONOMİK BÜYÜME: BATI AVRUPA VE CEE ÜLKELERİNDEN KANITLAR

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Abstract

In the economic literature, human capital is examined as a factor of economic growth by enhancing labor productivity. Human capital increases the marginal product of physical capital, which leads to further accumulation of physical capital, thereby increasing production and economic growth. In this study, the effects of human capital factors on economic growth is examined for European countries for the periods of 2008 to 2017. The European countries are categorized into two groups according to their location. The human capital factors to be tested include educational and training side of human capital. Panel data analysis is used for the estimation of the relationship. It is concluded that the quality of mathematics and science schools has a positive effect on the growth of CEECs and the extension of staff training has a positive effect on growth in Western European countries.

Keywords: Human Capital, Economic Growth, European Countries, CEECs, Panel Data
JEL Classification: F00, R1, E24, F43

Öz

Ekonomi literatüründe beşeri sermaye, emek verimliliğine yol açması nedeniyle ekonomik büyümeye neden olan faktörlerden biri olarak ele alınmaktadır. Beşeri sermaye, fiziksel sermayenin marjinal ürününü artırarak gelecek dönemde fiziksel sermayenin birikimine neden olmakta, böylelikle üretim

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miktarı ve ekonomik büyüme artmaktadır. Bu çalışmada beşeri sermayenin, ekonomik büyüme üzerindeki etkileri 2008-2017 döneminde Avrupa ülkeleri açısından incelenmiştir. Avrupa ülkeleri coğrafi açıdan iki grupta ele alınmıştır. Beşeri sermaye faktörleri eğitim ve mesleki tecrübe yönleriyle test edilmiştir. Analiz sürecinde panel veri yöntemi kulanılarak tahminler yapılmıştır. Sonuç olarak matematik ve bilim okullarının CEE (Orta ve Doğu Avrupa) ülkelerinde ekonomik büyümeyi pozitif yönde etkilediği ve çalışanların mesleki tecrübelerinin Batı Avrupa Ülkelerinde ekonomik büyümeyi pozitif yönde etkilediği sonuçlarına ulaşılmıştır.

Anahtar Kelimeler: Beşeri Sermaye, Ekonomik Büyüme, Avrupa Ülkeleri, CEECs, Panel Veri

JEL Sınıflandırması: F00, R1, E24, F43

1. Introduction

The educational structure of the European region differs according to the influence of the Soviet Union. Soviet domination mainly affected the countries of Central and Eastern Europe (CEECs) such as the economic, social, governance, and educational aspects of these countries. Contemporary European countries located to the west of Europe established their education system based on the need of industries. In these countries, the practical aspect of education comes to the fore. However, the education system in CEEC countries is heavily dependent on central government planning, these systems being almost far from meeting the demands of the market economy. Formal education which includes schools, hierarchical structures, and diplomas has mainly shaped the CEECs countries' educational system.

The objective of this study is to examine the effects of human capital on economic growth in European countries. European countries are held separately by groups from Western Europe (Germany, France, Netherlands, Denmark, and Italy) and Central and Eastern European Countries (CEECs) (Romania, Bulgaria, Hungary, Czech Republic, and Poland). Data is collected from the Global Competitiveness Report published by the World Economic Forum. The analysis covers the period from 2008 to 2017, and the assessment of panel data was used in the analysis process.

In general, knowledge capital originates from cognitive skills. Cognitive skills are mainly formed in schools and decently measured by the results of international math and science tests. Conversely, test results do not accurately measure the effect of cognitive skills on the labor market. Other factors impact skill development (Diebolt and Hippe 2018). Gundlach (1996) criticized human capital studies because they mainly used indicators of formal education. He argued that these indicators pose certain measurement problems when examining the effects of human capital on the economy and that to solve measurement problems, other human capital factors should be taken into account, such as the quality of education, workforce experience, health status, etc. In this regard, we established our model by adding education and training variables so the effects of human capital on economic growth are captured more accurately.

In the literature, studies that applied panel data approaches in examining the effects of human capital on growth are based on estimation of fixed effect (Pelinescu 2015; Tahir et al. 2020) and the estimation of pooled panel data (Bassanini and Scarpetta 2001; Vinod and Kaushik 2007). These studies did not clarify the discrepancies in the basic assumptions in OLS such as autocorrelation and heteroskedasticity. In this study initially, we determine the fixed and random effects by using Hausman's test. After that, autocorrelation, heteroscedasticity, and correlation between unit tests were implemented. Finally, a robust estimation test was applied to achieve accurate results.

2. Theoretical View

Under the standard neoclassical production function with decreasing returns to capital, Solow (1956) considered savings and population growth rates as exogenous variables in the growth model. According to this model, savings and population growth rates determine the equilibrium level of per capita income. The levels of these variables differ from country to country and therefore, different countries reach different levels of steady-state. As a consequence, higher savings rates lead countries to be richer and higher population rates lead to countries being poorer. Mankiw et al. (1990) extended Solow's model by incorporating the accumulation of human capital in the same way as physical capital. They claimed that when the accumulation of human capital is added, higher savings or lower population growth lead to a higher level of income and a higher level of human capital. Therefore, physical capital and population growth have important income effects. Otherwise, human capital accumulation is probably correlated with savings rates and population growth rates. In this regard, human capital should be taken into account to overcome the gaps in the coefficients for estimating savings and population growth.

Mincer (1958) argued that education increases productivity, which can be observed by increasing wages. He further pointed out that wage rates and productivity levels differ from country to country due to the difference in the education and training of the countries' workforce. The growth of human capital increases the marginal product of physical capital which leads to further accumulation of physical capital, thereby increasing production and economic growth. Likewise, the accumulation of physical capital increases the marginal product of human capital. Hence, if human capital is more related to physical capital than to unskilled labor, this process increases the demand for skilled labor (human capital) than for unskilled labor.

In the recent growth literature, the importance of the accumulation of human capital comes to the fore in growth models. Becker (1962) reveal fundamental theory on human capital and he emphasis that investment in education is the main engine of long run growth. Lucas (1988) considered human capital as an input in the production process like other inputs. Human capital accumulation refers to the deepening of capital during the period of a new stable growth path of production. Romer (1990) and Aghion and Howitt (1992) shared the same view that human capital is essential for the discovery of new technologies and therefore, human capital is persistently associated with the growth rate of production.

Theoretically, human capital contributes to economic growth in two different ways. First, referred to as the level effect, human capital, can participate directly in the production process as a factor of production. Thus, human capital plays a significant role in constituting production growth. Second, called the rate effect, human capital can be indirectly affected by economic growth. In this situation, while education facilitates innovation, diffusion, and adoption of new technologies, technical advances may have occurred (Freire-Seren 2001).

Nelson and Phelps (1966) discussed the effect of human capital on technological progress. They argued that investing in people through education is the definition of human capital and that human capital drives technological progress. In this sense, the accumulation of human capital has a more dynamic effect on technological progress than the accumulation of tangible capital. Collin and Weil (2018) suggested that increasing investment in human capital can be an effective policy argument for increasing income and reducing poverty. However, the time dimension is important because it takes a long time to obtain the benefits of human capital, which requires upgrading the skills of the workforce through education and training over a long period. They found that the output growth response is more sensitive to investment in physical capital than to invest in human capital. Investing in physical capital brings growth benefits faster than investing in human capital. On the other hand, the costs of these types of investments differ. Investing in human capital costs less than investing in physical capital.

3. Literature Review

From a theoretical point of view, human capital plays a crucial role in the growth process, because developed countries also have a high accumulation of human capital. However, the empirical evidence is unclear. Results are varying in terms of the variables used and the methods applied. Studies that examined the effect of human capital on growth for a group of countries have primarily used the pooled panel data methodology. Bassanini and Scarpetta (2001) and Awad (2020) used the Pooled Mean Group (PMG) estimation that allows short-run coefficients, error variances, and speed of adjustment to differ from country to country.

The PMG estimator increases the efficiency of the estimates compared to the estimators of the Mean Group (MG) under long-term homogeneity (Pesaran et al. 1999). Vinod and Kaushik (2007) implemented an estimation of pooled panel data and found significant heteroskedasticity and correlation between countries. Pelinescu (2015) used a pooled least squares model with fixed effects in terms of national and specific changes during different periods affecting the relationship between indicators. However, Bassanini and Scarpetta (2001), Vinod and Kaushik (2007) and Pelinescu (2015) did not specify the robustness of the results. Tahir et al. (2020) applied Hausman's test to determine fixed or random effects and they used the fixed-effect (FE) procedure in processing panel data. They applied the FE estimation to control for the serial correlation and White Robust estimation to tackle the heteroscedasticity problem. Additionally, the panel co-integration process was implemented by Mehrara and Musai (2013), and Akpolat (2014) in examining the relationship between human capital and economic growth.

In the literature, different explanatory variables are considered as representative of human capital. Freire-Seren (2001) used the level of education of the population aged 25 and over, the average number of years education, Pelinescu (2015) used education expenditure in GDP, number of employees with secondary education, number of patents, Vinod and Kaushik (2007) used the percentage of literate adults, Akpolat (2014) implemented education expenditure and life expectancy at birth, Bassanini and Scarpetta (2001) used the average number of years of formal education of the working-age population, Diebolt and Hippe (2018) considered literacy and numeracy for human capital, patent applications per million inhabitants for innovation, Mehrara and Musai (2013) used the enrollment rate at all levels of education, public spending education in relation to total public expenditure, Tahir et al. (2020) used human capital in two aspects. One is the human capital index which derives from years of schooling and returns to education and the other is the annual average of hours worked by full-time employees.

Most of the studies reported a positive effect from human capital on economic growth. Benhabib and Spiegel (1994) estimated per capita growth rates using physical and human capital in the aggregate Cobb-Douglas production function, but they did not find a significant effect. They specified another model which is the rate of growth of total factor productivity linked to the level of the stock of human capital. Then, they concluded a positive effect from human capital on economic development.

Freire-Seren (2001) studied three groups (oil producers, small countries, OECD countries) of countries and found that education has a level effect on growth and that production has a positive effect on the accumulation of human capital. Pelinescu (2015) analyzed the impact of the number of patents and secondary education on economic growth in EU countries and found a positive effect. However, expenditure on education has a negative effect on growth. Vinod and Kaushik (2007) focused on the study on developing countries and found that human capital has a significant positive effect on economic growth. Akpolat (2014) examined the long-run effect of physical capital and human capital on economic growth in developed and developing countries. He concluded that in developed countries the effect of physical capital and education expenditures on GDP is higher than that in developing countries. In addition, the effect of life expectancy at birth on GDP is much higher in developing countries.

Bassanini and Scarpetta (2001) focused on 21 OECD countries and found that human capital accumulation has a positive and significant effect on the growth of output per capita. Similar results were obtained by Ogbeifun and Shobande (2021). They found that human capital, the savings rate, and the openness of trade play a vital role in OECD countries' economic growth. Diebolt and Hippe (2018) examined the European regions and found that the historical human capital formation is significantly related to recent economic welfare in the European regions.

Mehrara and Musai (2013) investigated developing countries and concluded that there is a long-run relationship between human capital and GDP. In addition, there is a one-way causality between GDP and investment and human capital. Awad (2020) investigated the influence of human capital on the economic growth of countries in the Middle East and North Africa (MENA). He finds that education has a positive long-term effect and that health has a positive short-term effect on economic growth. Tahir et al. (2020) examined the OECD countries and found that the human capital index has a negative significant effect on economic growth. They linked this result to the findings of Pelinescu (2015) that heterogeneity between countries might be the reason for this conclusion. Another aspect of human capital, the average working time has a positive but with no significant effect on growth.

4. Data and Methodology

The data of human capital are collected from The Global Competitiveness Report published by the World Economic Forum. The WEF collected the data by using survey methodology. These data are treated as the independent variables and they consist of quality of the education system (EDU), quality of schools of mathematics and science (QMS), local availability of research and training services (LOA), and extent of staff training variables (EST). Dependent variable is GDP per capita growth (GDPG) obtained from the World Bank Data Base. Data are collected separately for Western European countries (Germany, France, Netherlands, Denmark, and Italy) and CEEC groups (Romania, Bulgaria, Hungary, Czech Republic, and Poland). The data are in an annual frequency ranging from the year 2008 to 2017. The period is limited due to a lack of data because after 2017 the content of the Global Competitiveness Report does not include this data.

In accordance with the theoretical perspective, it is expected that human capital affects growth positively. Thereby, the model of the study established as Equation (1)

$$GDPG_{it} = \beta_0 + \beta_1 EDU_{it} + \beta_2 QMS_{it} + \beta_3 LOA_{it} + \beta_4 EST_{it} + u_{it} \quad (1)$$

Balance panel data set was used in the analysis process which implies that all year's data have been acquired for each country. There is no missing data. In the Equation (1) I symbolizes country and t symbolizes time; for developed EU countries, i=1-5 (5 countries) and t=2008-2017 (10 years), total number of observations in data set (i x t = 50); for developing EU countries, i=1-5 (5 countries) and t=2008-2017 (10 years) total number of observations in data set (i x t = 50).

5. Analysis Process

To assess the stationary properties of the variables we use ADF unit root test. The unit root test results shown in Table 1.

Table 1: Unit Root Test Results

Variable	ADF – t statistics Levels	ADF – t statistics First differences
GDPG	-1.192 (1)	-4.770 (1)***
EDU	-2.184 (1)***	
EST	-3.265 (1)***	
QUA	-1.820 (1)***	
LOC	-2.791 (1)***	

Notes: Lag lengths are determined by SIC and are in parentheses, ***,**,* denote significance at 10, 5 and 1% levels, respectively.

It is clear from Table 1 that quality of the education system (EDU), extent of staff training (EST), quality of schools of mathematics and science (QUA), local availability of research and training services (LOA) are *I(0)* and GDP per capita growth (GDPG) is *I(1)*.

Equation (1) is estimated separately for Western European and CEECs countries. If the data are homogenous, pooled OLS method is applicable in estimating Equation (1). If the data exhibit cross-section and/or time effects, fixed-effects or random-effects models can be applied (Yerdelen Tatoğlu 2012). The likelihood ratio (LR) test was used to test for the existence of cross-section and time effects. In the LR test, it is determined whether the variance of standard error of cross-section effect and the variance of time effect are equal to zero (H_0: σμ= 0; H_0: σλ = 0). If unit and time effects are not specified in the LR test, then pooled OLS model can be established.

Table 2: LR Test

	Western EU Countries	**CEECs**
Cross-section Effect	χ^2 0.00 *prob.* 1.000	χ^2 0.00 *prob.* 1.000
Time Effect	χ^2 45.03 *prob.* 0.000	χ^2 16.20 *prob.* 0.000

From the results reported in Table 2, the LR test fails to reject the null hypothesis of the existence of cross-section effect but rejects the null hypothesis of the existence of time effect. This result holds for both groups of countries. Hence, there is only a time effect should be included in the estimation function. The Hausman test is implemented to specify whether the time effect is fixed or random.

The Hausman test indicates that both fixed effects and random effects estimators are appropriate if there is no correlation between error components (u_i) and explanatory variables (x_{kit}). However, a random effects estimator is inappropriate if there is a correlation between error components and explanatory variables. In the Hausman test, the null hypothesis infers that there is no correlation between error components and explanatory variables (Hill et al. 2011). It can be said that random effects are appropriate if there is no correlation between u_i and x_{kit}, and fixed effects are appropriate when there is a correlation between u_i and x_{kit} (Gujarati 2003).

Table 3: Hausman Test

Western EU Countries	CEECs
χ^2 1.57 *prob.* 0.81	χ^2 0.18 *prob.* 0.99

In Table 3, the results of the Hausman test indicate that the time effect is random for the two models. Thereby, analysis is made with a one-sided random effect model for both models.

Then, the models are examined in the context of deviations from the basic assumptions. The Levene, Brown and Forsythe test is used to determine heteroskedasticity, Modified Bhargava et al. Durbin-Watson test, and Baltagi-Wu LBI test are implemented to specify autocorrelation and finally, Pesaran test is used to identify the correlation between units.

Table 4: Tests of Deviation from Assumptions

	Western EU Countries	CEECs
Levene, Brown and Forsythe Test	W_0 0.990 *prob.* 0.42 W_{50} 0.804 *prob.* 0.52 W_{10} 0.868 *prob.* 0.48	W_0 0.997 *prob.* 0.41 W_{50} 0.853 *prob.* 0.49 W_{10} 0.993 *prob.* 0.42
Modified Bhargava et al. Durbin-Watson Test and Baltagi-Wu LBI Test	2.044 2.105	1.854 2.143
Pesaran Test	Cross. Sect. Indep. 28.331 *prob.* 0.000	Cross. Sect. Indep. 5.371 *prob.* 0.000

According to the results represented in Table 4, there are no heteroscedasticity and autocorrelation issues for the two models. However, it can be seen that there is a correlation between the units. Parks-Kmenta estimator is used to resolving the correlation between units.

6. Analysis Results

Parks-Kmenta estimator is used to resolving the correlation between units. Table 5 represents the results of this process.

Table 5: Analysis Results

	Western EU Countries			CEECs		
Explanatory Variables	**Coef.**	**z-stat**	**p-value**	**Coef.**	**z-stat**	**p-value**
EDU	-1.8537	-2.90	0.004***	-1.9060	-2.76	0.006***
QMS	-0.7532	-1.50	0.133	0.9084	1.67	0.009***
LOA	2.3265	2.93	0.003***	1.1638	2.74	0.006***
EST	1.2104	2.89	0.004***	-1.0336	-1.21	0.228
Wald χ^2 *prob.*	*25.42* *0.000*			*43.95* *0.000*		

Note: significance at (***) %1, (**) %5, (*) %10.

According to the results of the analysis for Western European countries, EDU negatively and statistically significantly affects GDP. The 1% increase in EDU results in a 1.8% decrease in GDP. LOA and EST have a positive and statistically significant effect on GDP. It can be concluded that a unit increase in LOA leads to an increase of %2.3 in GDP and a unit increase in EST leads to an increase of 1.2% of the GDP. However, QMS has a statistically insignificant effect on GDP.

The results for CEE countries show that EDU has a statistically significant and negative impact on GDP. A unit increase in EDU causes a decline of 1.9% of GDP. QMS and LOA affect GDP positively and this effect is statistically significant. A unit increase in QMS leads to an increase in GDP of 0.9%, and an increase in LOA leads to an increase in GDP of 1.1%. However, EST has a statistically insignificant effect on GDP.

The results show that the quality of the education system has a negative and statistically significant effect on economic growth in both Western Europe and the CEECs. A possible explanation can be put forward that the efforts and expenditures devoted to improving the quality of the education system do not correspond exactly to the requirements of economic growth. It can be said that the structure of the education system is not related to the production side of the economies of EU countries. This result could be related to high expenditure to invest in education expenditure, causing higher cost relative to output.

The local availability of research and training services has a positive and statistically significant effect on the economic growth of all Western European and CEEC countries. This result implies that the framework of research and training services leads to the enhancement of the productivity of human capital for these groups of countries. However, Local availability of research and training services contribute to much more positive effect in Western European Countries than CEECs countries. The possible reason might be due to the availability of institutional and opportunities of educational and training in Western European countries than in CEECs countries.

For Western European countries, the quality of mathematics and science schools has no statistically significant effect on economic growth. However, this observation is contrary to the CEECs that this variable positively affects economic growth. This result can be explained by different implications for the education system in Western Europe and in the CEECs. The extent of staff training has a positive and significant effect on economic growth in Western European countries, but there is no significant effect for CEECs. It can be said that staff training services are more effective in Western European countries than in CEECs.

When we compare the education systems of these two groups of countries, the educational experiences are different from each other. After the industrial revolution, the countries of Western Europe for the most part based their education systems on the training process and governments oriented their citizens towards jobs in which they have more productive jobs. However, the Soviet domination affected the education system of the CEECs as the system depended mainly on central planning and was insufficient to meet the demands of the market. Formal education stands out in those countries which include schools, hierarchical structures, and degrees. Therefore, the effects of human capital on economic growth differ in the European region depending on the educational experiences and implications of these countries.

7. Conclusion

From a theoretical point of view, human capital is mainly considered as an important factor in contributing to economic growth. This process occurs because human capital leads to the improvement of education, training, and the discovery of new technologies. We used human capital in the model on both the education and training side for Western European countries and CEECs during the period 2008-2017. The results revealed that both quality of Mathematics and science and the local availability of research and training services contribute positively to the GDP growth in the developing CEE countries. On the other hand, the local availability of research and training services and extent of staff training stimulates GDP growth in the developed Western European countries. The quality of mathematics and science does not have significant contribution to growth in the Western European countries. However, the quality of educational system adversely deteriorates GDP growth in both groups of countries. The differences of results might be due to the different educational system, funding availability, educational cost and opportunities in both groups of countries. In terms of policy implication and implementation through human capital to foster economic growth, our recommendations are as follows:

The combination of education expenditure could be reconsidered in the context of the qualification of lecturers who are well educated in their fields. To lead these highly qualified individuals from the private sector to the education system, high wage policy implementation could be used for all country groups. After then education expenditure might have improved the quality of education structure and this variable could have a positive effect in Western European and CEECs countries.

When we considered that the effect of the quality of math and science schools on economic growth, it can be seen that contemporary Western European countries do not have a goal about the inducement of students to the production side of the economy. However, after the school term, these countries have had success to lead the individuals to the staff training process to adopt them to be more productive in the economy. Conversely, the CEECs countries could have allocated a more budget to extent of staff training to enhance labor productivity. To enhance the effect of local availability of research and training services in the CEECs countries, governments could have spread these services across the country. After then individuals will have more opportunities to reach the research and training services that they could have contributed to the production side of the economy. In accordance to resolve the human capital differences between Western Union and CEECs countries, European Union could have focused on to financing the CEECs countries' training service infrastructure.

This study has revealed the new findings on the different effects of human capital factors in the developing versus developed European countries in enhancing economic growth. However, it should be noted that many educated people, especially in mathematics and engineering, have moved from the CEEC countries, as well as other less developed countries, to the countries of Western Europe. The study can be extended to test other human-related factors such as technology/knowledge transfer, the effectiveness of policy to attract the migration of professional/skillful workers, etc. This study does not cover these factors due to the data availability constraint.

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ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

INDUSTRIAL STRUCTURAL TRANSFORMATION IN TURKEY

TÜRKİYE'DE ENDÜSTRİYEL YAPISAL DÖNÜŞÜM

Yasemin ÖZERKEK*

Abstract

This study investigates and presents some facts about the characteristics of industrial structure adjustment in Turkey. These characteristics are examined by the measures of industrial structure upgrading and industrial structure optimization. The analyses are performed both at the country and regional levels. The results show that the industrial structure upgrading decreases during 1991-2019 in Turkey. The index of industrial structure optimization has a downward trend signaling a reduction in the imbalances in sectoral development. The findings also show the regional differences in the transformation of industrial structure.

Keywords: Industrial Structure Upgrading, Industrial Structure Optimization

JEL Codes: L60, O14

Öz

Bu çalışma, Türkiye'deki endüstriyel yapının özelliklerini inceleyerek birtakım tespitler sunmaktadır. Endüstriyel yapının yükseltilme ve optimizasyonu endeksleri Türkiye geneli için ve bölgesel düzeyde hesaplanmıştır. 1991-2019 dönemi için yapılan analiz sonuçları, endüstriyel yapının yükseltilme endeksinin zamanla azaldığını göstermektedir. Endüstriyel yapının optimizasyonunu gösteren endeks ise sektörler arasındaki dengesizliklerde azalmaya işaret etmektedir. Bulgular, endüstriyel yapının dönüşümündeki bölgesel farklılıkları da göstermektedir.

Anahtar Kelimeler: Endüstriyel yapının yükseltilmesi, endüstriyel yapının optimizasyonu

JEL Sınıflandırması: L60, O14

1. Introduction

The capacity of firms to attain high levels of productivity and to increase productivity over time are important aspects of improving the standard of living in a country. Sustained productivity growth requires a constantly upgrading economy. Companies must develop essential capabilities by improving product quality, creating desirable attributes, raising product technology, or increasing production efficiency. This is crucial to compete in new sophisticated industries (Porter, 1990).

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One meaning of upgrading in the literature is relative innovative performance (Kaplinsky and Readman, 2005). Kaplinsky and Readman (2005) and Humphrey and Schmitz (2002) widened the interpretation of this term and specified four types of upgrading (process upgrading, product upgrading, functional upgrading, and intersectoral upgrading) in a conceptual framework. Gereffi (2005: 171) defines industrial upgrading as "…the process by which economic actors—nations, firms, and workers—move from low-value to relatively high-value activities in global production networks. Different mixes of government policies, institutions, corporate strategies, technologies, and worker skills are associated with upgrading success." Taglioni and Winkler (2016) define economic upgrading and densification as getting more value-added from a country's productive factors.

Structural transformation or structural change implies the shift of a country's productive resources from low-productive to high-productive economic activities. Structural change can be most beneficial for developing countries as their economies are typically characterized by some inter-sectoral productivity gaps. The lack of high-productivity activities slows down the development in these countries (UNCTAD, 2018). As mentioned by Kuznets, "It is impossible to attain high rates of growth of per capita or per worker product without commensurate substantial shifts in the shares of various sectors (Kuznets, 1979: 130)." In other words of Kuznets (1957: 56), "…Industrial structural aspects of economic growth carry with them wide and far-reaching implications for other aspects of the economic structure of nations in the process of their growth." The shift implies switching to large-scale productive units and larger economic management units, urbanization, and several other changes in the mode of lives, changes in the structure of final use of the national product including its allocation between consumption and investment, and a more complex economic structure which gives rise to expanding economic activities (Kuznets, 1957).

Syrquin (1988) points out that the changes in the sectoral composition of production are the most important characteristic of structural transformation. When the factor returns are not equal across sectors, which is a state of disequilibrium, the reallocation of resources from low-productivity to high-productivity sectors triggers economic growth. This situation is especially beneficial for developing countries which are more likely to experience the disequilibrium. Therefore, the disparity in factor returns across sectors make structural change a crucial component of economic growth (Syrquin, 1988). The allocation of production factors between industries influences the evolution of industrial structure and then has effects on economic growth by means of the optimization of industrial structure (Shi, 2021). The optimization of the industrial structure represents the balance between the parts of the industry (Zhao et al., 2022).

The transformation of the industrial structure of an economy encompasses two aspects: industrial structure upgrading and industrial structure optimization. Industrial upgrading is defined as the process of moving towards higher value-added and more productive activities. The reallocation of labor and other productive resources such as capital, natural resources, land, and know-how can be at the firm and the country level. This process of structural transformation gives rise to economic growth. Empirical evidence shows that countries which upgrade their productive structures export more sophisticated goods, thereby contributing to their economic growth (UNIDO, 2016; Monga and Lin, 2019).

The analyses of industrial structures in developing countries have attracted much attention in recent years. Several studies focus on the relationship between industrial structure upgrading and carbon emission reduction. The transformation of industrial structure from secondary to tertiary industry is crucial for policymakers to lower carbon emissions for green economic development. The optimization and upgrading of the industrial structure save energy and reduce the greenhouse effect. Most of these studies related to industrial structure upgrading and optimization are analyses of the Chinese economy (Zhou et al., 2013; Zhang et al., 2014; Wang et al; 2019; Wu et al., 2021; and Zhao et al., 2022, among others). In addition, Dong et al. (2021) provide evidence of the effect of industrial structure upgrading on global carbon dioxide emissions by using a group of countries. Jiang et al. (2018) investigate the impact of industrial structure on energy consumption in China. Wang et al. (2019) evince the effect of capital markets on industrial structure upgrading in China. Some studies dwell on the increased benefits of participating in gross value chains. Among these, Tian et al. (2019) adopt the gross value chains method to measure industrial upgrading, reflecting its multidimensionality. They also provide quantitative elements of industrial upgrading such as process upgrading, skill upgrading, and product upgrading (Tian et al., 2019).

The purpose of this study is to investigate the characteristics of industrial structure adjustment in Turkey. These characteristics are examined by using the measures of industrial structure upgrading and optimization indices for Turkey. To the best of my knowledge, this study is the first attempt to calculate these measures for Turkey. The analysis exploits data of employment and gross value added for the three main industries of Turkey both at the country and regional levels. The study aims to present a general overview toward a better understanding of developments underlying the process of industrial structure transformation in Turkey. To this end, it is expected to be a preliminary analysis and pave the way for further examinations of industrial structural transformation.

The study is organized as follows. Section 2 presents some basic facts about the industrial structure in Turkey. Section 3 delineates the concepts of industrial structure upgrading and industrial structural optimization and presents the results of the analyses at both the country and regional levels. The last section recapitulates the results.

2. Overview of Industrial Structure

To shed some light on the transformation of industrial structure in Turkey, this section reveals some facts about how the shares of three main sectors have evolved in the last two decades. [2] Figures 1 and 2 illustrate the sectoral shares of employment and the value added per worker in Turkey, respectively. The employment share of services has the highest share and exhibits an upward trend during the period 1991-2020. While the employment shares of industry and agriculture have almost the same until 2003, the share of agriculture diverges by falling under that of industry thereafter. During that period, the industry is relatively stable. Sectoral shares of services and agriculture move in opposite directions, suggesting a reallocation between them (Figure 1).

2 For the literature about the structural change in Turkey, see Cecen et al., (1994) and Atiyas and Bakis (2015), among others.

Figure 2 shows that the share of value added per worker in the service sector has the highest share until 2014. As of 2015, the ongoing increase in industry and decrease in services result in a higher share in the industry value added per worker. The average growth rate in industry value added per worker is 4.2%, while the corresponding rate for services is 2% during the period 1992-2019. Comparing the 1990s and the 2000s reveals that the growth in industry value added per worker declines from 4.7% to 4%, whereas the related rate for the services sector changes from 3% to 1.5%. Although average growth rates decline during the period, the fall in the services sector is more pronounced.

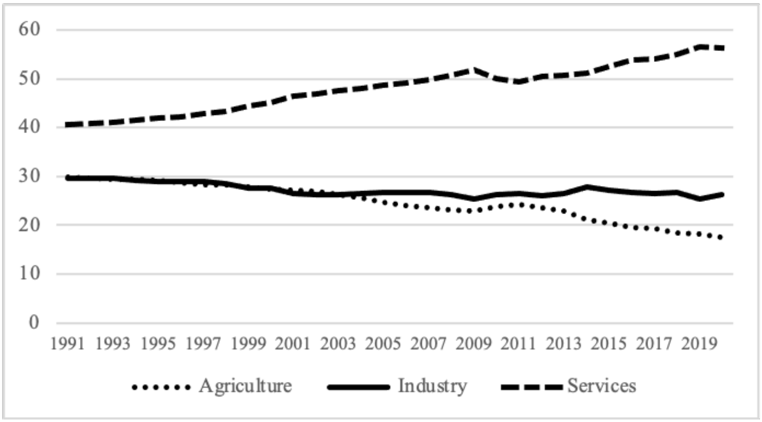

Figure 1: Sectoral Shares of Employment (% of total employment) (1991-2020)
Source: World Development Indicators (2022)

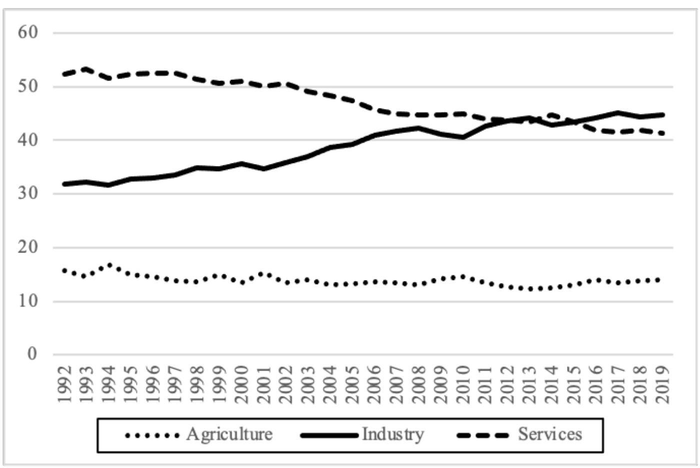

Figure 2: Sectoral Shares of Value Added per worker (constant 2015 US$) (1992-2019)
Source: World Development Indicators (2022) 3

3 "Value added per worker is a measure of labor productivity-value added per unit of output. Value added denotes the net output of a sector after adding up all outputs and subtracting intermediate inputs." See https://databank.worldbank.org/metadataglossary/world-development indicators/series/NV.AGR.EMPL.KD, Retrieved by: 1 August 2022.

Zhao et al. (2022), referring to Yu (2015) and Li and Su (2016), suggest that industrial structure adjustment involves the key concepts of industrial structure upgrading and industrial structure optimization. [4] They also mention that previous studies on industrial structure adjustment dwell on industrial structure upgrading and disregard industrial structure optimization. It is essential to scrutinize the industrial structure of the economy to understand the dynamics of the structural transformation. To this end, the following section presents and analyzes the upgrading and optimization of industrial structure indices in Turkey.

3. Industrial Structure Upgrading and Industrial Structural Optimization

Industrial structure upgrading is defined as the shift from low-productivity activities to high-productivity activities in the economy. Some studies measure the upgrading of the industrial structure by using the proportion of the output value of the tertiary industry to the secondary industry (Zhou et al., 2013; Li and Su, 2016; Zhao et al., 2022). However, Wu et al. (2021) argue that the traditional measurement cannot reflect the upgrading of industrial production factors. Therefore, they use the ratio of labor productivity of the tertiary industry to that of the secondary industry to measure the upgrading of industrial production factors.

Upgrading of industrial production factors is computed with the following ratio:

$$\text{Industrial Upgrading (ISU)} = \frac{Y_3/L_3}{Y_{2/L_2}} \quad [1]$$

where Y_2 and Y_3 represent the output value of the secondary and tertiary industries, respectively. [5] L_2 and L_3 are the employment in the secondary and tertiary industries, respectively. A ratio greater than 1 indicates higher labor productivity in the tertiary sector and the industrial structure upgrading is increasing towards the overall efficiency (Wu et al., 2021). This process is usually accompanied by the development of high-technology industries.

In this section, the two measures of industrial structural upgrading (ISU) are computed and presented in Figure 3. ISU1 is calculated by the ratio of value added in the tertiary industry to the secondary industry. ISU2 is computed by using Equation [1] based on the labor productivity of two sectors. Economic output is represented by value added (constant 2015 US$) in the analysis. The data for the value added of each industry and the number of employees is obtained from World Development Indicators.

4 Zhao et.al (2022) refer to Yu (2015) and Li and Su (2016), which are in Chinese. This study uses these references as cited by Zhao et.al (2022).

5 Secondary industry denotes the industry sector (including construction), and tertiary industry denotes the service sector.

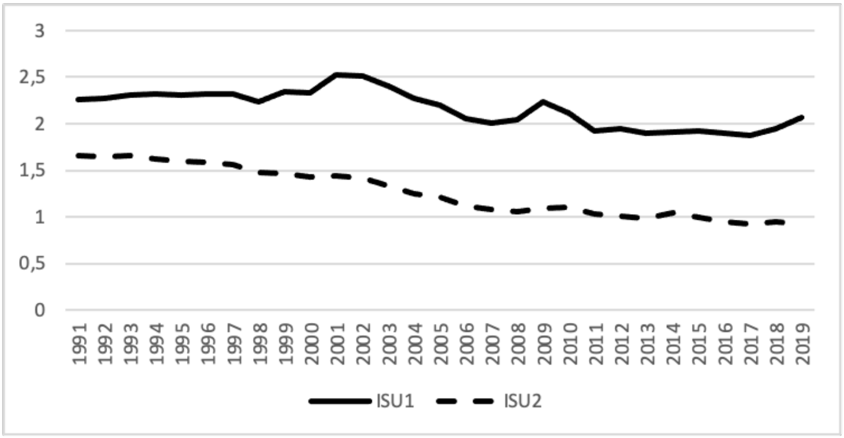

Figure 3: Industrial Structure Upgrading

Source: Calculated by the author by using data from World Development Indicators (2022).

As Figure 3 demonstrates, both ISU1 and ISU2 have declining trends. ISU1 value is 2.52 in 1968, attains its highest value of 2.65 in 1982 and is 2.05 in 2020. [6] The highest ISU2 value occurs in the early 1990s and continues to decline over time. ISU2 value is 1.65 for 1991 and 0.92 for 2019. The upswing in the values of ISU1 in 2001-2002 and 2008-2009 can be explained by the fact that the decrease in the industry value added is more than the decrease in the services sector.

As Wu et al. (2021) point out, the measure of ISU2 reflects the upgrading of industrial production factors. One of the most prominent differences between ISU1 and ISU2 arises in the year 2009, right after the economic crisis. Although there is a jump in industrial upgrading in terms of ISU1, there is almost no change in the value of ISU2. ISU2 reflects the degree of industrial upgrading considering labor productivity. Therefore, it is a more comprehensive measure.

2012 is the year where the productivity of the industry sector (Y_2/L_2) is equal to that of the services sector Y_3/L_3 (i.e., ISU value is 1) (Figure 3). Since then, the value is below 1. This is clearly consistent with Figure 2 which shows the rising industry value added per worker and falling services value added per worker coincide in 2012.

Furthermore, the allocation of production factors across industries has an important role in the advancement of industrial structure and fostering economic growth (Shi, 2021). The optimization of the industrial structure represents the balance between different parts of the industry and indicates the degree of coordinated development of various industries (Zhao et al., 2022).

Based on the study of Yu (2015), this study employs the Theil index (Theil, 1967) to analyze "the level of balanced growth among various parts of the industry" (cited by Zhao et al., 2022: 5). This

6 ISU1 value is 2.06 in 2019.

measure considers the heterogeneity of various industries by using weights that are assigned to different industries in an economy (Zhou et al., 2013). [7]

The index of industrial structure optimization (ISO) can be measured with the following equation:

$$ISO = \sum_{i=1}^{n} (\frac{Y_i}{Y}) In(\frac{Y_i}{L_i} / \frac{Y}{L}) \qquad [2]$$

where i represents the i^{th} industry, and n indicates the number of industries, Y indicates total output value, L denotes total employment in the economy. If the economy is at equilibrium, the index value is equal to 0, otherwise the industrial structure deviates from equilibrium. The higher the value of the Theil index, the greater the existence of imbalances among various segments of the industry (Zhao et la., 2022). When the value of the ISO index is close to 0, this means that the industrial structure is close to the equilibrium state and the industrial structure is more reasonable (Shi, 2021).

In the calculation of the index, the number of industrial sectors n is set to three to reflect the primary, secondary and tertiary industries in the economy. Figure 4 illustrates the industrial structure optimization index before and after the year of 2004 in Turkey. [8] The most striking fact is that the industrial upgrading index has a downward trend both before and after 2004. Declining in the value of the index implies a reduction in the imbalances among the sectors. Another fact that draws attention is that the index is more volatile before 2004 than after 2004. Also, the 2001 crisis seems to affect the optimization towards a more imbalanced condition among sectors.

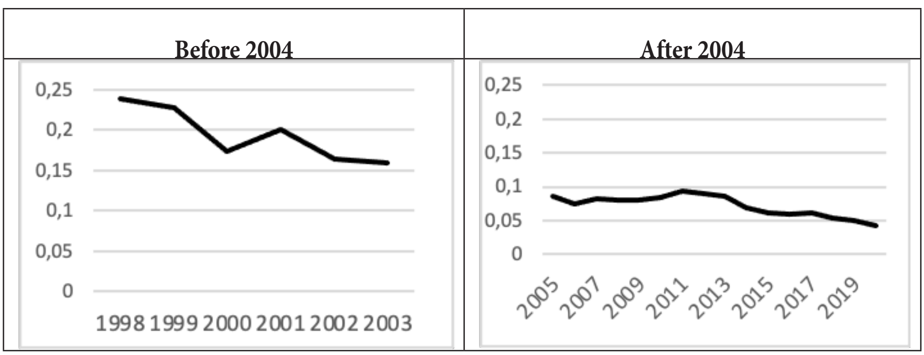

Figure 4: Industrial Structure Optimization

Source: Calculated by the author by using data from TURKSTAT (2022).

After examining the upgrading and optimization indices for Turkey, the relevant index values are computed at the regional level in Turkey. The data is at NUTS2 level, including the 26 regions of Turkey for the period 2004-2020 (Table 1). [9] The regions are ranked according to the annual

7 The Theil index, which is mainly used for measuring regional income inequality.

8 The GDP calculations were revised by TURKSTAT in 2004. Since the data is not comparable, two separate graphs are drawn. The year 2020 is not included due to the possible economics effects of the Covid-19 pandemic.

9 Industrial structure upgrading is calculated by using Equation [1]. The year 2020 is not included due to the possible economics effects of the Covid-19 pandemic.

average indices of industrial structure upgrading and industrial structure optimization. The results show the differences across various regions. [10]

Table 1: The Industrial Structure Upgrading and Optimization Indices (2004-2019)

Industrial Structure Upgrading		Industrial Structure Optimization	
Region	Value	Region	Value
TRB2 Van, Muş, Bitlis, Hakkari	1.879	TR90 Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane	0.277
TRA2 Ağrı, Kars, Iğdır, Ardahan	1.641	TR81 Zonguldak, Karabük, Bartın	0.247
TR10 İstanbul	1.481	TRA1 Erzurum, Erzincan, Bayburt	0.219
TR83 Samsun, Tokat, Çorum, Amasya	1.322	TRA2 Ağrı, Kars, Iğdır, Ardahan	0.172
TR82 Kastamonu, Çankırı, Sinop	1.127	TRB2 Van, Muş, Bitlis, Hakkari	0.151
TR52 Konya, Karaman	1.068	TR83 Samsun, Tokat, Çorum, Amasya	0.142
TR62 Adana, Mersin	1.068	TR82 Kastamonu, Çankırı, Sinop	0.134
TR81 Zonguldak, Karabük, Bartın	1.066	TRB1 Malatya, Elazığ, Bingöl, Tunceli	0.133
TR90 Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane	1.05	TR22 Balıkesir, Çanakkale	0.086
TR61 Antalya, Isparta, Burdur	1.049	TR33 Manisa, Afyonkarahisar, Kütahya, Uşak	0.084
TR32 Aydın, Denizli, Muğla	1.041	TR42 Kocaeli, Sakarya, Düzce, Bolu, Yalova	0.08
TR41 Bursa, Eskişehir, Bilecik	1.014	TR72 Kayseri, Sivas, Yozgat	0.078
TR72 Kayseri, Sivas, Yozgat	1.011	TR63 Hatay, Kahramanmaraş, Osmaniye	0.062
yiTRC2 Şanlıurfa, Diyarbakır	1.01	TR32 Aydın, Denizli, Muğla	0.061
TR31 İzmir	1.007	TR61 Antalya, Isparta, Burdur	0.059
TRB1 Malatya, Elazığ, Bingöl, Tunceli	1.003	TRC1 Gaziantep, Adıyaman, Kilis	0.059
TRC1 Gaziantep, Adıyaman, Kilis	0.996	TR21 Tekirdağ, Edirne, Kırklareli	0.046
TRC3 Mardin, Batman, Şırnak, Siirt	0.974	TR71 Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir	0.044
TR63 Hatay, Kahramanmaraş, Osmaniye	0.896	TRC2 Şanlıurfa, Diyarbakır	0.038
TR22 Balıkesir, Çanakkale	0.864	TR62 Adana, Mersin	0.033
TR33 Manisa, Afyonkarahisar, Kütahya, Uşak	0.831	TR41 Bursa, Eskişehir, Bilecik	0.029
TR42 Kocaeli, Sakarya, Düzce, Bolu, Yalova	0.815	TRC3 Mardin, Batman, Şırnak, Siirt	0.027
TRA1 Erzurum, Erzincan, Bayburt	0.788	TR52 Konya, Karaman	0.022
TR71 Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir	0.77	TR10 İstanbul	0.021
TR51 Ankara	0.763	TR31 İzmir	0.016
TR21 Tekirdağ, Edirne, Kırklareli	0.703	TR51 Ankara	0.012

Source: Author's own calculations by using data from TURKSTAT (2022).

The highest three ISU indices are in TRB2 Van, Muş, Bitlis, Hakkari, TRA2 Ağrı, Kars, Iğdır, Ardahan, and TR10 İstanbul. This implies that these regions are characterized by their relatively higher labor productivities in the service sector. TRA2 and TRB2 are classified in the group of non-industrialized regions in Turkey (Karahasan, 2021). Furthermore, they have scores far beyond in the regional competitiveness index (Didin Sönmez, 2018). [11] Since they are relatively more service – oriented regions,

10 There are several studies examining the disparities between regions in Turkey from different perspectives (Doğruel and Doğruel (2020), Karahasan (2021), Eriş Dereli and Düzgün Öncel (2021), among others).

11 See OECD (2016) for detailed information about the components of regional competitive index.

they are expected to have relatively higher ISU index values. Shi (2021) emphasizes that a service-oriented industrial structure is an important characteristic of industrial upgrading Also, Zhou et al. (2013) point out that the measurement of ISU indicates whether an industrial structure is upgrading with an expanding service sector.

The regions TRB2 Van, Muş, Bitlis, Hakkari, TRA2 Ağrı, Kars, Iğdır, Ardahan, and TR82 Kastamonu, Çankırı, Sinop are characterized by both relatively high ISU and high ISO index values. However, it is worth mentioning that there is no correlation between upgrading and optimization indices when all regions are considered. The three regions with the lowest index values of ISU are TR21 Tekirdağ, Edirne, Kırklareli, TR51 Ankara, and TR71 Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir.

The first three regions with the highest index values of industrial structure optimization are TR90 Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane, TR81 Zonguldak, Karabük, Bartın, and TRA1 Erzurum, Erzincan, Bayburt. Therefore, there is still potential for balanced growth among the industries in these regions. (Zhao et.al, 2022)

Figures A1 and A2 in Appendix show the ISU and ISO indices at the regional level. The regions with relatively high GDP per capita such as TR51 Ankara, TR31 İzmir, TR10 İstanbul, and TR41 Bursa, Eskişehir, Bilecik have lower industrial structure optimization index values indicating that they have relatively balanced growth among various parts of the industry. TRC3 Mardin, Batman, Şırnak, Siirt is among the regions with the lowest GDP per capita, but it has also a low ISO value. In this region, the share of the service sector increased rapidly along with a rising share of employment in that sector. The regions with high ISU index values have more service-oriented regions than industry-oriented.

Özerkek and Didin Sönmez (2021) analyze that there are prominent shifts between service and agriculture sectors in Turkey, except for the regions with relatively high GDP per capita such as TR51 Ankara, TR31 İzmir, TR10 İstanbul, and TR41 Bursa, Eskişehir, Bilecik. In the regions with high income and high shares of industry and services sectors, employment shifts occur between industry and services sectors.

In a nutshell, the findings show that the index of industrial structure upgrading slowly decreases or follows a steady course in many regions (in particular, with the exceptions of regions TRA2 and TRB2). On the one hand, the index of industrial structure optimization follows a fluctuating course for several regions (Figure A2 in Appendix)

4. Concluding Remarks

Upgrading and optimization of the industrial structure have been key concepts in the discussion of industrial structural transformation literature in recent years. With structural transformation, the production factors shift from low productivity sectors to high productivity sectors which improves the productivity level of the whole economy. These, in turn, have important effects on the process of economic growth and development. This study aims to highlight the basic facts about this process in Turkey by measuring the indices of industrial structure upgrading and optimization. The results indicate that the industrial structure upgrading decreases during 1991-2019 in Turkey. The index of industrial structure optimization has a downward trend signaling a reduction in the imbalances among the parts of the industries. The findings also signal the regional differences in the transformation of industrial structure. This is an initial analysis to fathom the overview of the industrial structure and its evolution with available data. These findings are expected to serve as a preliminary analysis and pave the way for further examinations of industrial structure upgrading and optimization with a more comprehensive perception. These concepts can be analyzed together with the components of sustainable development to help policymakers in implementing policies.

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Appendix

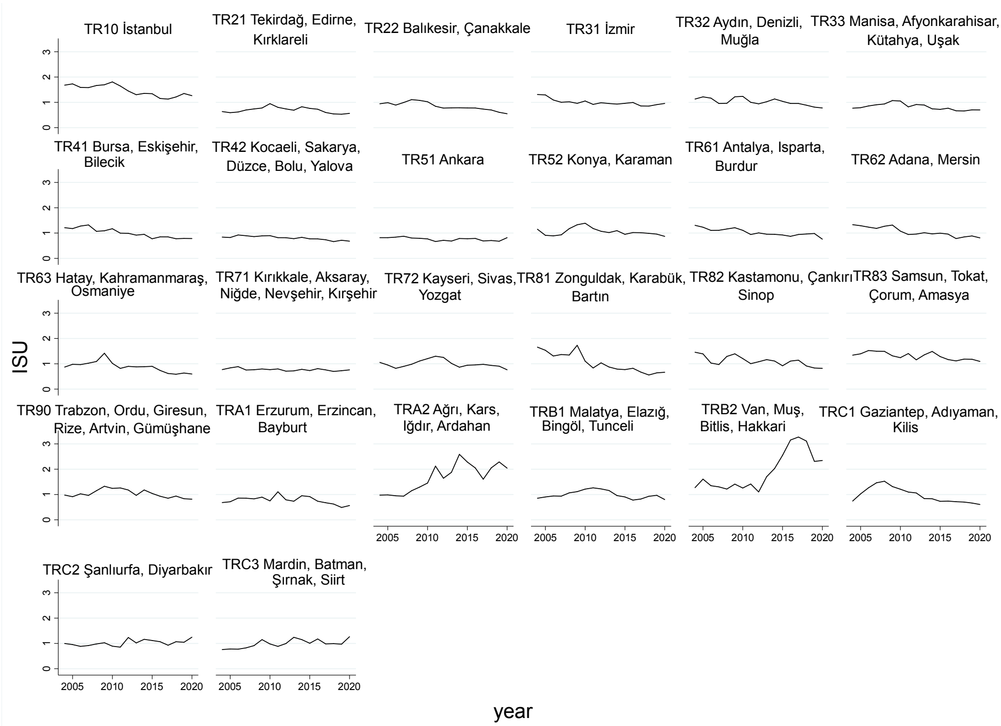

Figure A1: Industrial Structure Upgrading by Regions

Source: Author's own calculations by using data from TURKSTAT (2022).

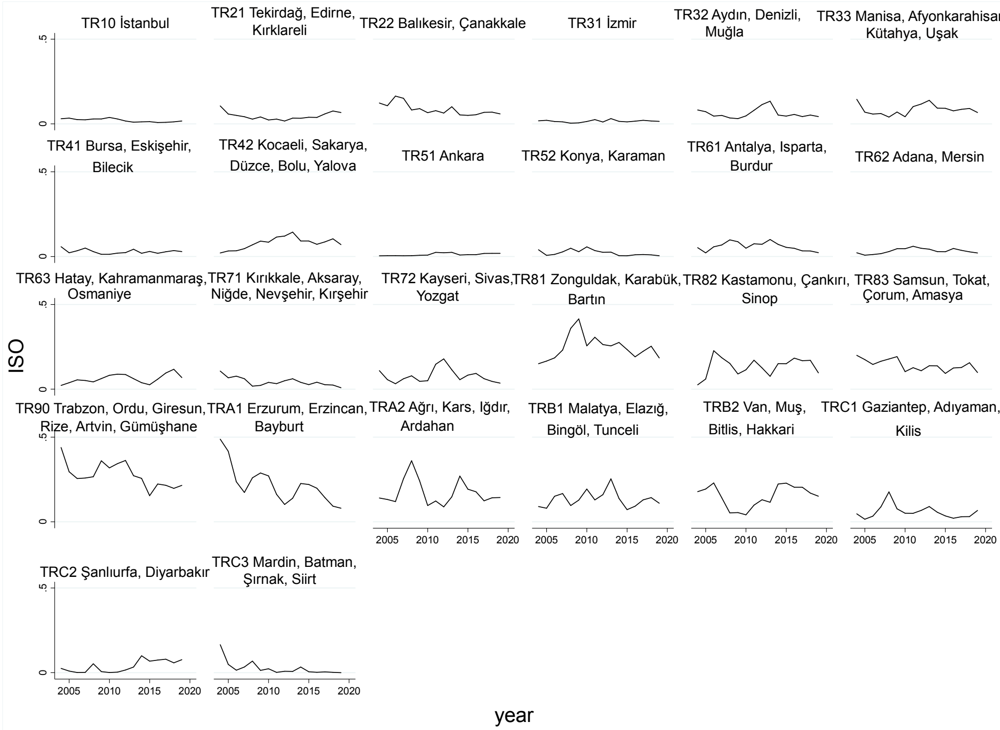

Figure A2: Industrial Structure Optimization by Regions

Source: Author's own calculations by using data from TURKSTAT (2022).

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ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

IMPACT OF FDI AND DEVELOPMENT POLICIES ON WELFARE IN ZAMBIA

DYY VE KALKINMA POLİTİKALARININ ZAMBİYA'DA REFAH ÜZERİNE ETKİSİ

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Abstract

In its quest to realize vision 2030 of middle – income status, the Zambian government instituted several developmental policies. These were enabled in order to accelerate economic growth and improve human development. This paper looked at the Human Development Index (HDI) and its components, Foreign Direct Investment (FDI) and other economic trends. These were analyzed from 1990 to 2017 and also compared with specific countries. Over time there were improvements in the said indicators for Zambia. However, concerns still existed on issues such as insufficient levels of innovation and the slow decline in the poverty levels. The average years of schooling were seven, which also contributed to the country's low Global Innovation ranking. It was noted that Multi-National Corporations (MNCs) when bringing investments mainly focussed on sectors such as mining and manufacturing. Education and health received insignificant attention in this regard. In support of the Endogenous Growth Model, which advocated for investing in human capital, the priorities of MNCs ought to be revisited. This article applied inductive reasoning to descriptive analysis. Policies and economic trends were reviewed. In order to improve from the current economic trends, investment should be directed towards areas which have a direct impact on welfare. The government through the Zambia Development Agency (ZDA) also ought to redirect investment towards social aspects such as education and health. Lastly, for the impact of external investment to be much more realized, the management of institutions needs improvement.

Keywords: HDI, FDI, Developmental Policies, Economic Trends, Zambia
JEL Classifications: O10, I0, A1

Öz

Zambiya hükümeti 2030 orta gelir statüsü vizyonunu gerçekleştirme arayışında, birkaç kalkınma politikası kurdu. Bunlar ekonomik büyümeyi hızlandırmak ve insani gelişmeyi iyileştirmek için mümkün kılındı. Bu tez, İnsani Gelişme endeksi ve bileşenlerine, Doğrudan Yabancı Yatırım'a ve

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diğer ekonomik eğilimlere bakmıştır. Bunlar 1990'dan 2017 yılına kadar analiz edilmiş ve ayrıca belirli ülkelerle karşılaştırılmıştır. Zamanla söz konusu göstergelerde Zambiya için iyileşmeler oldu. Ancak, yetersiz inovasyon seviyeleri ve yoksulluk seviyelerinin yavaş düşmesi gibi konularla ilgili endişeler halen mevcuttur. Ortalama eğitim süresi yedi yıl idi ve bu da ülkenin Küresel İnovasyon sıralamasında düşük sıralamada yer almasına katkıda bulundu. Çok uluslu şirketler yatırımlar getirirken esas olarak madencilik ve imalat sektörlere odaklandığı belirtildi. Eğitim ve sağlığa bu konuda önem verilmedi. Beşeri sermayeye yatırım yapmayı savunan İçsel Büyüme Modelini desteklemek için çok uluslu şirketlerin öncelikleri gözden geçirilmelidir. Bu tez betimleyici analiz için tümavarımlı usavurmaya başvurmuştur. Politikalar ve ekonomik eğilimler gözden geçirildi. Mevcut ekonomik eğilimlerin iyileştirilmesi için yatırımlar refah üzerinde doğrudan etkisi olan alanlara yönlendirilmelidir. Aynı zamanda Zambiya Kalkınma Ajansı aracılığıyla hükümetin, yatırımları eğitim ve sağlık gibi sosyal alanlara yönlendirmesi de gerekiyor. Son olarak, dış yatırımın etkisinin çok daha fazla gerçekleşmesi için kurumların yönetiminin iyileştirilmesi gerekiyor.

Anahtar Kelimeler: İnsani Gelişmişlik Endeksi, Yabancı Doğrudan Yatırım, Kalkınma Politikaları, Ekonomik Eğilimler, Zambiya

JEL Sınıflandırması: O10, I0, A1

1. Introduction

Sustainable economic growth is a global phenomenon that all nations aspire to attain. In order to realize this goal, countries around the world, particularly developing countries attract as much FDI as possible. According to Borensztein et al. (1995), FDI has contributed immensely to economic growth as well as wealth creation in various countries. This is believed to contribute to the improvement of welfare, which will be measured using the Human Development Index (HDI) through the United Nations Development Program (UNDP)'s HD, and economic growth as a proxy. The HDI will also stand as a proxy for human development, which will be used interchangeably with welfare and regarded as a measure of the quality of life. On 23rd October 2018, during the United Nations Conference on Trade and Development (UNCTAD) World Investment Forum, Global Leader's Summit I, Namibian President said, "Globalization has brought enormous benefits to mankind by providing a tremendous opportunity for economic growth which has improved the quality of life around the world. However, globalization has its own challenges. The greatest challenge for Southern Hemisphere countries is the lack of industrial capabilities to take full advantage of the benefits associated with globalization. African countries are even more challenged because of the compounded effect of the advent of the Fourth Industrial Revolution that manifested in characteristics such as 3D printing, the Internet of Things, Big Data Analysis, robotics, cloud computing, and competition between human beings and machines to name but a few." (Geingob, 2018). He also lamented that FDI was amongst the key sources of funding developing countries and cardinal for the realization of the Sustainable Development Goals (SDGs) which involves the attainment of middle – income status for Sub – Saharan African (SSA) countries. This was in his speech with a famous quote, "inclusivity spells peace and harmony, while exclusivity spells discord and conflict", were he and other African leaders including those of Zambia acknowledged that the benefits of globalization need to be more widespread.

This was an important realization that FDI is essential for economic growth but most importantly for improving people's living standards in line with the United Nations as well as Africa's post-development agenda. Henceforth, the priorities of FDI should be directed towards improving the quality of life, which is part of human development.FDI refers to direct investment equity flows in a reporting economy and is supposed to boast an increment in export earnings, promotes global best practice and sustainable growth facilitated by capital formation (World Bank, 2018). It should further accelerate technology transfers as well as opportunities in the domestic market. Earlier theories of growth such as the Harrod – Domar and the Solow Growth Model suggested that economic growth can be realized through increasing savings (Harrod, 1939) as well as capital and ideas (Solow, 1956) respectively. The new growth theory attributed to Romer (1986) has a different departure point. Romer (1986) regarded human capital through innovation and education as a catalyst for growth. This underlines the significance of well-directed investment as well as improved levels of human development. Institutional FDI Fitness Theory indcated that FDI determined by hosts institutions and four pillars, government market, educational, and social and cultural fitness (Wilhems, 1998). Several studies have observed relationship and impact of FDI on the HDI in developing countries. This proved to be in support of the arguments in favor of the endogenous growth model. FDI in a pro-poor labor-intensive state is likely to have its greatest effect. Also when the net revenue transfers are positive, it is highly assumed to positively impact economic growth (Soumaré, 2015).Soumaré (2015) further concluded that there is a positive and significant relationship between FDI inflows and welfare improvements in North Africa though with some notable differences as per country scenario. In a similar study on Africa, Gohou and Soumaré (2012) noted similar results as Soumaré (2015) with variations amongst individual countries and observed a greater impact of FDI on the Welfare of Poorer Countries than it does on Wealthier Countries. For example, they found a positive and significant relationship in Central and East Africa, but an insignificant one in Northern and Southern Africa and in the case of West Africa an ambiguous one. They further concluded that prioritization of FDI towards sectors that improve human development is cardinal for the upliftment of welfare. Further, they noted that besides encouraging FDI, government expenditure, the openness of an economy and infrastructure development were extra ingredients though poor institutional quality proved to be a stumbling block. According to Tamer (2013), FDI is amongst the highest sources of funding for external growth in Africa and having a significant effect particularly in the 21st century. Tamer noted significant differences in its impact on a low income, lower middle income, upper middle income, and high-income countries. On the part of the lower middle income, upper middle income, and high-income countries, FDI had a positive and significant effect on the HDI, which suggests that FDI has been instrumental for the development of countries in those income brackets. On the part of the low – income countries, Tamer (2013) concluded that those countries require internal adjustments to their institutional and developmental policies in order to have full realization of the benefits from FDI. Tamer used a similar approach to three different scenarios which were applied to Africa as a whole, lower income countries as well as lower and upper-middle-income countries together with high-income countries. In their findings on the effects of FDI on the Inequality-Adjusted HDI. Cao et al. (2017) noted that the FDI did not significantly affect HDI from a general perspective at all income bracket levels. Moreover, they observed that FDI contributed to the increment in the levels of inequality from an aggregated perspective though noting that it did help in alleviating inequality in education. In addition, they also discovered that higher institutional quality, such as a stable political environment and laws were cardinal for the upliftment of human welfare. Minhaj et al. (2007) found that FDI is cardinal in affecting the HDI though not the sole determinant. They also observed that FDI plays a key role in both enhancing economic growth and uplifting the welfare of the people. Further, they noted that this development can be accelerated in the presence of technological advancements and skills transfers, which in the long run are cardinal for the improvement of social economic conditions. Assadzadeh and Pourqoly (2013) found that FDI has a positive and significant impact on poverty measured through the HDI. This was by noting how it contributes to skills transfer and job creation through been diversified across other sectors and incorporated with good governance. Sharma and Gani (2004) noted a positive and insignificant effect on both groups of countries. Surprisingly, they observed that government expenditures on military and defense had a positive and significant effect on welfare. When studying this impact in the case of Nigeria, for the disaggregated components of the HDI, Apinran et al. (2018) found a negative and significant relationship between FDI and life expectancy. However, in assessing the impact of FDI on school enrollment as well as GNI per capita, that relationship was both positive and significant. They further noted that this relationship can further be enhanced by prioritizing FDI in areas that are more beneficial to the domestic economy. Looking at the contributions of openness to trade as well FDI on the life expectancy in Pakistan, Alam et al. (2016) found a positive and significant impact in the long – run. In the short – run this effect was insignificant. These observations concluded that this effect can be realized with directing investments towards sectors that are beneficial to the health industry. Also in looking at the impact of FDI on health, Burns et al. (2017) discovered that FDI has beneficial effects on health, particularly life expectancy. They further concluded that this effect was more pronounced in the adult population. In areas were endogeneity was controlled for in their study, this relationship was weaker. Baghirzade (2012) did research on, "The impact of Foreign Direct Investment on Human Development Index in Commonwealth Independent States (CIS)", were they individually looked at each of the CIS countries. This and the following paragraphs review those findings. In Azerbaijan, Baghirzade noted a positive and insignificant impact of FDI on the disaggregated components of the HDI, namely, school enrollment, GNI per capita, life expectancy as well as expenditure on health. In the case of Armenia, Belarus, and Russia, this impact across all components was both positive and significant. In the case of Kyrgyzstan and Georgia, the impact of FDI on school enrollment as well as life expectancy was positive and insignificant though it proved to be significant in the case of GNI per capita as well as health expenditure. For Moldova, Baghirzade noted that FDI positively and significantly affected school enrollment, GNI per capita and health expenditure with an exception of life expectancy, which is proved insignificant.

In Ukraine, the effect of FDI on school enrollment, GNI per capita and health expenditure was both positive and significant but was insignificant in the case of life expectancy. In Turkmenistan, the effect of FDI on GNI per capita and on life expectancy was positive and significant though insignificant on health expenditure. In the case of Uzbekistan, the effect of FDI on GNI per capita, life expectancy and health expenditure were both positive and significant. Baghirzade concluded the empirical review by looking at this relationship in Kazakhstan and Tajikistan were the effect of FDI on GNI per capita, life expectancy and health expenditure were both positive and significant but insignificant in the case of school enrollment. Pérez-Segura (2014) looked at how FDI, as well as other factors such as aid, corruption, and governance, affected the HDI as well as its disaggregated components in other countries. FDI had a positive and significant effect on HDI as well as on the GNI per capita. In the context of education and health, He examined a positive insignificant and negative insignificant effect respectively. Looking at the influence of FDI policy and corruption on the HDI, Reiter, and Steensma (2010) noted that FDI flows in the presence of restrictive and discriminative FDI and without corruption has a positive impact on the HDI. The observation was also noted on the impact of FDI on life expectancy. In a survey of 34 countries, for the period 1981 to 2013, Azam et al. (2015) discovered that an increase in FDI has a significant effect on the human development level and school enrollment and that education is promoted resulting from the FDI. With regards to the impact FDI on the HDI, Muhammad et al. (2010) in their study concluded that FDI, though not the only determinant, contributed to improvements of the socio-economic development of a nation in the case of Pakistan. Agusty and Damayanti (2015) who carried out a study on the effects of foreign direct investment and official development assistance on the human development index of developing countries both proved that the two variables have a positive and significant effect on human development in those countries. On the effect of FDI on human development in Sub – Saharan Africa, (Boman, n.d.) did not find a significant relationship between the FDI and the HDI. However, he did observe a positive correlation between FDI and government expenditure on health.

The results by Ökten & Arslan (2013) indicate that there is cointegration relationship from FDI to social economic conditions including the HDI in Turkey suggesting that that Investment is a key ingredient for improving welfare. Sanchez-Loor and Zambrano-Monserrate (2015) did not observe a causal relationship between FDI and HDI in the countries Colombia, Ecuador as well as Mexico. According to Emmanuel (2015), FDI significantly increased HDI, infant mortality rate, life expectancy, mean years of schooling, access to water as well as sanitation indicating that FDI was an important element in improving human welfare in Sub–Saharan Africa. Korwa and Djazuli (2014) who looked at this and other relationships in Papua Province, Indonesia noted that FDI and Business Development are essential elements in supplementing government efforts to improve welfare if well prioritized. Magombeyi and Odhiambo (2017) who carried out a comprehensive review of literature on this relationship noted that most results suggest that FDI helps aid welfare and regarded it as an important component needed to improve human development. In the case of de Groot (2014), the relationship between FDI and HDI was observed to be negative and significant. This boils down to the priorities of foreign investment, where human development has been seen to be of a lesser priority. Rojas (2015), in the case of Peru, observed a positive and insignificant impact from FDI to HDI, though, acknowledging that foreign funds are cardinal for the uplifting of welfare in the economy. According to Edrees et al. (2015), the effect of FDI on HDI is both positive and significant with a further submission that government policies should be investment driven. Colen et al. (2008) noted that FDI directed towards employment creation in developed countries helps in improving the living standards of the people. According to Tintin (2012) who carried out a study on the effects of FDI amongst various sectors of development observed a positive and significant effect on HDI as well as on education for developed, developing and least developing countries. In the case of its effect on health, the effect was all positive and significant for developed and developing countries but insignificant for least developed countries.

Concerning these investments, the government has an obligation to ensure that the benefits of FDI are realized, especially on improving the social-economic wellbeing of its electorate. According to the World Bank's Africa's Doing Business Report 2018, Zambia has one of the best investment climates, ranked 7 and 85 in Africa and the world respectively. Despite the high economic growth trajectory and a good rating on the World Bank Doing Business Report, the living standards of the majority of Zambians is still a point of great concern. According to the World Food Program 2018, at least 63 percent of the Zambian population is languishing in poverty, and 40 percent of the under 5 populations is stunted (UNICEF, 2019). This raises concerns for policymakers as well as the national electorate. The alarming rates of poverty and the lower HDI ranking, which is paradoxical with the flow of FDI needs to be explored further. This welfare and investment paradox saves the motivation for this article. Much research has been done on human development, FDI and economic growth in various countries. However, concerning there trends, relationships, and how developmental policies have impacted them, that area is untapped from the Zambian perspective. With that in mind, this paper has aspirations of filling that research gap. This paper also grows on the fact that impact of FDI on areas like longevity, literacy and poverty alleviation is not prioritized despite the fact that it believed to be enriching Multi National Corporations (MNCs) at the expense of the domestic economy. In recommendations, it intends on ensuring accelerated economic growth, higher levels of FDI and human development. The objectives of this paper are to address the investment and welfare paradox, first by examing the trends and performance of the HDI as well as its components, FDI, and economic trends in Zambia and compare it with other countries, make policy recommendations on how government development policies can be directed towards escalating the levels of human development, FDI and economic growth. Concerning the methodology and Analysis Approach, this article applied Inductive reasoning to descriptive statistics (Gray, 2019) [1]. Much of the paper is narrative and discussion based, where exploratory data analysis visualization was applied in a limited manner. Due to insufficient time series data in line with my study's objectives, an econometrics model could not be used. Instead of only looking at Zambia as an isolated case, its HDI as well economic

1 The inductive process: Through the inductive approach, plans are made for data collection, after which that data are analyzed to see if any patterns emerge that suggests relationships between variables. From these observations it may be possible to construct generalizations, relationships or even theories. (Gray, 2019).

trends were compared with selected countries such as Angola, Malawi, Sub–Saharan Africa including a good example of Botswana. The review of literature helped in drawing effective and workable policy recommendations. This article is divided into four sections. Section two which follows is the economic development trends. This includes an overview of the HDI, economic growth trajectories, FDI inflows as well as FDI by sectors and pledge by amounts and employment creation. Section three covers cover the countries developmental policies and current situation. This includes the National Developmental Plans (NDPs) including the role of the ZDA, as well as the nation's current situation. Section four concludes and makes some policy recommendations.

2. Economic Development Trends (Zambia and Selected Countries)

This section looks at the overview of HDI and its components, GDP growth trends, and FDI inflows in Zambia and makes comparisons with Angola, Malawi, SSA, and the globe. This section also looks at FDI inflows and pledges across different sectors in Zambia.

2.1. Overview of HDI in Zambia

As of 2017, Zambia's HDI value was 0.588, which is in the medium category, and ranked at number 144 of the total ranked nations. Over the time period 1990 to 2017, the country's HDI increased from 0.401 to 0.588, which was a 46.7 percent increment. During the same period, the life expectancy at birth increased by 17.3 years up to 62.3 years by the year 2017.There was a 5-year increment in expected years of schooling from 7.5 years in 1990 to 12.5 years in 2017. In the same time period, the mean years increased from 4.7 years to 7.0 years, which was an increment of 2.3 years. Between 1990 to 2017, Zambia's GNI per capita increased by 17.3 percent from \$2 076 to \$3 557 in purchasing power parity dollars. In the prescribed period, 1990, 1995, 2000, 2005, 2010, 2015, 2016 and 2017, the values of the HDI were, 0.401, 0.412, 0.432, 0.480, 0.544, 0.583, 0.566 and 0.588 respectively. Tables 1 and 2 elaborate the country's trends in the HDI as well as other components of the HDI over the above prescribed period. As indicated in the table 2, Zambia's performance in the HDI, as well as the disaggregated components of the HDI, namely, life expectancy, mean and expected years of schooling as well as per capita Gross National Income (GNI), performed better than Angola, Malawi as well as the rest of Sub – Saharan Africa for the year 2017.

Table 1: Zambia's HDI Trends Based on Consistent Time Series Data and New Goalposts

Year	Life Expectancy at birth	Expected years of schooling	Mean years of schooling	GNI per capita (2011 PPP$)	HDI Value
1990	45.0	7.5	4.7	2 076	0.401
1995	43.2	8.7	6.0	1 900	0.412
2000	44.7	9.8	5.9	2 102	0.432
2005	49.6	10.9	6.3	2 294	0.480
2010	56.6	12.0	6.6	3 059	0.544
2015	61.4	12.5	6.9	3 568	0.583
2016	61.9	12.5	7.0	3 522	0.586
2017	62.3	12.5	7.0	3 557	0.588

Source: UNDP (2018)

Table 2: Zambia's HDI and Component Indicators for 2017 Relative to Selected Countries and Groups HDI Values

Country/ Region	HDI Value	HDI Rank	Life expectancy at birth	Expected years of schooling	Mean years of schooling	GNI per capita (PPPUS$)
Zambia	0.588	144	62.3	12.5	7.0	3 557
Angola	0.581	147	61.8	11.8	5.1	5 790
Malawi	0.477	171	63.7	10.8	4.5	1 064
Sub – Saharan Africa	0.537	-	60.7	10.1	5.6	3 399
Global mediım	0.645	-	69.1	12.0	6.7	6 849

Source: UNDP (2018)

2.2. GDP Growth Trajectory Of Zambıa Relative to Other Selected Countries

Zambia's Gross Domestic Product (GDP) growth trajectory was compared with other selected countries and regions namely Angola, Malawi, Sub – Saharan Africa (SSA), and the world. Just as in the comparison years for HDI in table 2, the years of comparison were 1990, 1995, 2000, 2010, 2015, 2016 as well as 2017. Figure 1 shows the economic growth trajectory of all the selected countries between 1990 and 2017.

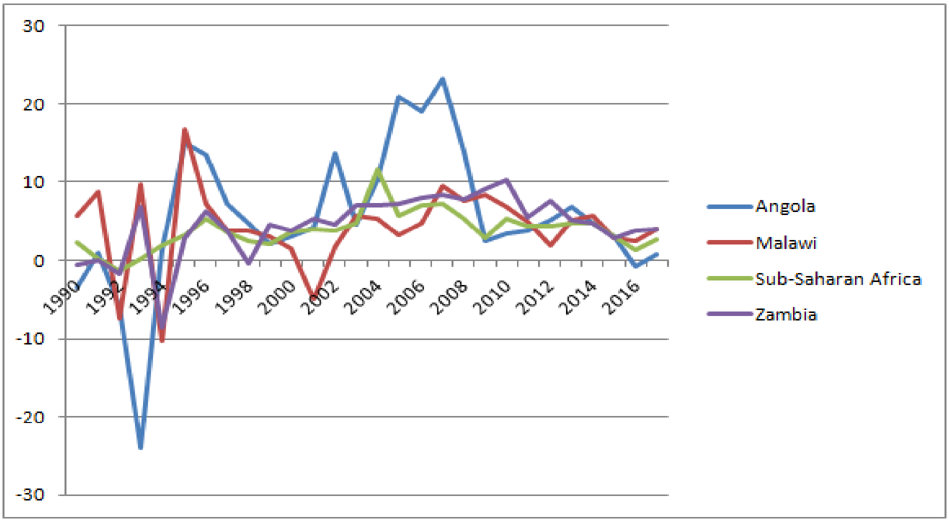

Figure 1: GDP Growth Trajectory (Annual %): Zambia Relative to Selected Countries and Region
Source: World Bank (2018).

In 1990, the GDP growth rates for Zambia, Angola, Malawi, and SSA were – 0.48, – 3.45, 5.69, and 2.28 respectively. In 1995, these countries GDP growth rates rose by 2.90, 15, 16.73, and 3.3 for Zambia, Angola, Malawi, and the SSA respectively. By 2000, Zambia, Angola, Malawi, and SSA had respective GDP growth rates of 3.90, 3.05, 1.58, and 3.59. As of 2005, this escalating growth trajectory continued to 7.24, 20.91, 3.29, and 5.63 for the same countries in their respective order as before. In 2010, Zambia, Angola, Malawi, and the SSA respectively recorded GDP growths of 10.30, 3.45. 6.87, and 5.40. The start of the 2015 Post – Development Agenda saw Zambia, Angola, Malawi, and the SSA respectively record 2.92, 3.00, 2.80, and 3.11 growth rates. The years 2016 and 2017 saw Zambia growth rates of 3.75 and 4.08 respectively. In the same periods, Angola recorded – 0.81 and 0.72 respectively, while Malawi recorded 2.48 and 4 percentages respectively. During these last two focus periods 2016 and 2017, the SSA region recorded average GDP growth rates of 1.33 and 2.61 respectively.

2.3. Zambia's FDI Net Inflows Related to Selected Countries

This article also compared the flow of FDI net inflows related to a few selected countries as those compared with HDI as well as economic growth trajectory. Table 3 shows a summary of some of the information on the net FDI inflow for Zambia summarized for the years 1990, 1995, 2000, 2005, 2010, 2015, 2016, and 2017. This information is compared with the net FDI inflows for the countries Angola and Malawi.

Table 3: Zambia's Fdi Net Inflows (Bop, Current Us$) Relative to Selected Countries And Years

YEAR	ZAMBIA	ANGOLA	MALAWI
1990	202 700 000	-334 800 000	23 300 000
1995	97 000 000	472 427 000	5 643 045.579
2000	121 000 000	878 620 000	25 999 996.36
2005	356 940 000	-1 303 836 930	139 696 707.4
2010	1 729 300 000	-3 227 211 182	97 010 028.45
2015	1 582 666 667	9 282 167 512	516 092 796.5
2016	662 813 935.4	-179 517 618.9	325 632 351
2017	865 903 085.2	-7 397 295 409	277 112 167.4

Source: World Bank (2018)

As indicated in Table 3 above, the FDI net inflow for Zambia, Angola, and Malawi in 1990 amounted to 202 700 000, – 334 800 000, and 23 300 000 in millions of dollars for the respective countries. In 1995, Zambia's and Malawi's FDI inflow reduced to 97 000 000 and 5 643 045.576 respectively, with Angola's rising to 472 427 000. By 2000, the FDI inflows for Zambia, Angola and Malawi rose to 121 000 000, 878 620 000, and 25 999 996.36 respectively. In 2005, there was a de-escalation in Angola's FDI inflow to – 1 303 836 930, while Zambia and Malawi continued rising to 356 940 000 and 139 696 707.4. Five years later, Angola still recorded of – 3 227 211 182 with Zambia and Malawi recording amounts up to 1 729 300 000 and 97 010 028.45 respectively. In 2015, Zambia, Angola and Malawi recorded 1 582 666 667, 9 282 167 512, and 516 092 796.5 respectively. The year after, Angola recorded a decline to – 179 517 618.9, with Zambia and Malawi also recording reductions to 662 813 935.4 and 325 632 351 respectively. By 2017 Angola and Malawi continued recording reductions in FDI inflows of – 7 397 295 469 and 277 112 167.4 respectively, while Zambia recorded an increment to 863 903 085.2. Overall, Zambia seemed to have outperformed the other two countries in terms of attracting FDI inflows.

2.4. FDI in Zambia by Sector (US$ Millions)

Table 4 shows the various FDI inflows by sector (million US$) between 2009 and 2012. During the stipulated period, the highest investment went to the mining industry with 367.2, 1141.2, 955.6 and 933.7 in 2009, 2010, 2011 and 2012 respectively. The manufacturing industry was second recording 285.7, 373.9 and 469.6 in 2009, 2010 and 2012 though it notably recorded – 177.8 in 2011. In the years 2009, 2010, 2011 and 2012, Agriculture, Forestry and Fishing received – 14.1, 13.2, 31.7 and 28.3 respectively. Wholesale and retail trade had 65.0, – 2.2, 76.6 and 38.3 in the years 2009, 2010, 2011 and 2012. In the same respective period, the Construction industry recorded 44.2, 17.4, 39.2 and 54.6. Real Estate activities received an investment of – 0.4, – 4.5, 42.8 and 4.9 in the respective years of 2009, 2010, 2011 and 2012. Tourism had an investment of 40.9, 4.3, 13.6 in the years 2009, 2010, and 2011. Deposit-taking corporations inflows were 71.2 and 184.4 in the years 2011 and 2012 respectively. In the same respective period, Electricity Gas and Steam had an estimated investment of 13.3 and 6.5. In the year 2012, information and communication, as well as other financial institutions, had – 18.4 and 9.2. The other areas had investments of 0.6, 17.8, 1.0 and 0.8 in the respective years 2009, 2010, 2011 and 2012. The sectors education and health among others had insignificant investment amounts and were under "other expenses" mentioned above, with less than a percentage of the total FDI during the period 2009 and 2012. Unfortunately, data for investment by sector for prolonged time period was unavailable at the time of this article. After several initiatives by the Zambian government through the ZDA to stimulate FDI flows and employment creation, several pledges were made by various MNCs as elaborated in the next section

Table 4: Zambia's Foreign Direct Investment Inflows by Sector (In US $ Million)

	2009	2010	2011	2012
Mining & Quarrying	367.2	1,141.3	955.6	933.7
Agriculture. Forestry & Fishing	-14.1	13.2	31.7	28.3
Manufacturing	285.7	373.9	-177.8	469.6
Wholesale and Retail Trade	65.0	-2.2	76.6	38.3
Tourism	40.9	4.3	13.6	0.0
Transport & Communication	-10.7	179.3	41.6	19.7
Information and Communication	0.0	0.0	0.0	-18.4
Construction	44.2	17.4	39.2	54.6
Real Estate Activities	-0.4	-4.5	42.8	4.9
Finance & Insurance	-83.5	-11.2	-0.2	0.0
Electricity, Gas and Steam	0.0	0.0	13.3	6.5
Deposit Taking Corporations	0.0	0.0	71.1	184.4
Other Financial Institutions				9.2
Other	0.6	17.8	1.0	0.8
Total	694.9	1,729.3	1,108.5	1,731.6

Source: Foreign Private Investment and Investor Perceptions Surveys 2010, 2011, 2012 and 2013

2.5. FDI Pledges and Employment Creation by Category

In the years 2014 and 2015, a substantial amount of recorded investment applications and pledges were diverted towards the manufacturing industry with a prospective employment generation of at least 3039 and 3624 employees in those respective years. The construction industry recorded employment pledges of 8738 and 1531 in 2014 and 2015 respectively. In the same respective period, the Real estate industry pledged 700 and 4137. Tourism investment pledged to employ 1074 and 1057 person in the same periods as above. The mining and quarrying industries pledged 1643 and 545 respectively. The service industry pledged to generate 1097 and 690 jobs in 2014 and 2015 respectively. In the same respective period, the Agriculture, Forestry and Fishing industries pledged to create jobs of up to 1495 and 1288. In 2014 and 2015, the transport sector pledged to generate 196 and 478 respectively. In the same respective period, the information and communications received minimal employment pledges of 49 and 35. Education and Health were yet again on the lower end of FDI, with the former receiving employment pledges of 0 and 166 in 2014 and 2015 respectively. In the same focus period, the latter received respective pledges of 38 and 69. All the above pledges were inspired by the government through ZDA in there quest to attract across all sectors of the economy. A summary of these pledges is indicated in Table 5 below:

Table 5: Investment and Employment Pledges. January – September 2014 and 2015

	January – September 2014			January – September 2015		
Sector	Number of Applications	Value US$ (Millions)	Pledged Employment	Number of Applications	Value US$ (Millions)	Pledged Employment
Agriculture, Forestry and Fishing	27	114.5	1495	27	82	1288
Construction	15	3172	8738	20	127.4	1531
Education	0	0	0	5	27.2	166
Energy	3	26	175	2	1.2	43
Finance	0	0	0	1	3.4	17
Health	1	1.74	38	2	5.2	69
Information and Communication	2	174	49	3	1.3	35
Manufacturing	68	231.8	3039	66	496	3624
Minning and Quarrying	15	17.8	1643	8	26.4	345
Real Estate	21	181.1	700	40	512.9	4137
Service	34	94.8	1097	22	38	690
Tourism	21	94.5	1074	26	173.2	1057
Transport	9	20.6	196	21	26.1	478
Total	216	4188	18244	243	1520	13680

Source: Zambia Development Agency (2015)

The next section looks at government development policies and recent developments.

3. Government Developmental Policies and Current Situatıon

Government development policies were implemented hand in hand with the Millenium Development Goals (MDGs), Sustainable Development Goals (SDGs) as well as Africa's Agenda 2063 in order to attain middle-income status [2].

The government set NDPs, which were usually reviewed every five years. Some of the notable NDPs and timeframes included the following:

2 Development policies in the context of this article entail policies mainly directed towards three objectives, increasing the level of FDI, accelerating the level of GDP growth as well as improving standards of welfare for the people and the economy at large.

1. Implemented between 2006 and 2010. (*Fifth National Development Plan 2006 – 2010*, 2006)
2. Implemented between 2011 and 2016. (*Sixth National Development Plan*, 2011)
3. Implemented between 2017 up to 2021 (*Seventh National Development Plan 2017 – 2021*)
4. Implemented between 2021 up to 2026, which is the current status quo (*Eighth National Development Plan 2021 – 2026*)

In order to facilitate economic growth and investment creation, the government institutionalized the promotion of investment through the ZDA Act of 2006, which was later amended in 2011. Below is a brief summary of some of the previous National Developments Plans.

3.1. Fifth National Development Plan(FNDP)

The FNDP policy targets included Macroeconomic, Social, Rural, Urban, Structural as well as cross-cutting issues like HIV/AIDS, gender, sanitation, and environment. The objectives of this paper focussed on Macroeconomic, Social, and Structural Policies. Some earlier Macroeconomic policy were related to the Washington consensus and in order to qualify for debt relief. Others enabled Macroeconomic and Social stability. In order to improve the social welfare conditions, increasing the availability of medicines, including health and educational facilities had to take precedence. Recruitment of medical and health personnel, as well as infrastructure development, was a matter of urgency. These challenges still exist until the present day. The FNDP instituted vocational training programs and adult literacy in order to help alleviate the existent illiteracy and education burden. The FNDP also experiences external shocks like crude oil prices, unfavorable weather which had an effect on the FNDP implementation though the effect was not significant [3].

3.2. Sixth National Development Plan (SNDP)

The SNDP inherited some external shocks and other problems such as a higher disease burden resultant from shortages of medical logistics and personnel. Despite improvements in immunization from the previous FNDP, the SNDP had other notable disease illnesses such as malaria, HIV/AIDS and Tuberculosis which had an effect on the labor force. In order to improve education, the 1966 Education Act and the 1999 University Act were revised and substituted with a more comprehensive Higher Education Act. The Acts facilitated the establishment, organization, governance, and financing of all educational institutions. There were increased options of education, addition vocational education, adult literacy as well as entrepreneur and innovation training under the revised education act. Concerning health, some strategies included the improvement on laboratory and nutritional services, promotion outreach services, accelerate Public Private Partnerships (PPP) as well the as training personnel in the health and corporate

3 *Fifth National Development Plan 2006 – 2010*. (2006). Ministry of Finance and National Planning.

sectors. And also, more boreholes were constructed to enable accessibility to clean and safe drinking water in both rural and urban areas [4].

3.3. The Role of The Zambia Development Agency (ZDA)

Amongst the functions of the ZDA related to FDI includes the following:

Increase employment in Zambia, formulate investment promotion strategies, facilitate government policies on investment in Zambia, undertake economic and sector studies to preview investment prospects as well as plan, manage, implement and control the privatization of state-owned enterprises and monitor its progress.

Some strategies it applied to attract FDI included the following:

- Tax incentives and land provision.
- Extra incentives, exemptions, and promotions for high-cost investments.
- Accelerated immigration assistance including provision of legal guidance and assistance
- Assistance with the quick provision of utility services such as water, electricity, and communication.

3.4. Discussion and Current Situation

From the 1990s up to the period before the commencement of the NDPs, the country's HDI and its components were below the medium range category. By 2017, there were some notable improvements in the HDI value, life expectancy as well as the per capita GNI. However, concerns still exist in the level of literacy, with the mean years of schooling still at seven. Compared with other countries such as Angola, Malawi, and the SSA region as well as the global medium, the 2017 performance of the HDI and its components outperformed the other countries except for that of the global average. This could be attributed to developmental planning and government priorities particularly after the NDPs era. Tables 1 and 2 as alluded to in earlier sections showed those developments. The story of Zambia's economic growth rate isn't as vivid as that of the HDI and its components. Between 1990 and 2017, Zambia's economic growth trajectory was better that of Malawi and the SSA region. Over the last decade, it has also outperformed Angola. These GDP growth rates comparisons were illustrated in Figure 2. Judging the country's development policies by comparing the country's economic trends against other countries. So far, it is safe to conclude that the nation is on the right development trajectory and that the NDPs have played a key role in that regard.

Over the last centuries including times of crisis, developing countries have received an increment in FDI as compared to segments such as Portfolio Investments and loans (Lougani and Razin,

4 *Sixth National Development Plan*. (2011). Ministry of Finance and National Planning.

2001). Zambia also attracted more FDI inflows than Malawi and Angola. The terms of its own FDI inflows, the mining and manufacturing industries received the lions share, while education, health, and other areas directly related to human development had insignificant inflows of FDI. The same can be said about pledges coming from external investments as Tables 4 and 5 earlier demonstrated. Concerning development planning, the previous NDPs faced challenges such as:

- Delays in the release of funds for implementation of developmental projects
- A mismatch between the programs and budgeting (Prioritization failure)
- The failure of the decentralization policy at all levels
- Continued inequality and the existence of corruption

The state under the implementation of the Seventh National Development Plan (SENDP) ran from 2017 to 2021 [5]. Within the objectives of the SENDP, the government wants to spearhead the attainment of vision 2030 as well as the African Union's Agenda 2063 [6]. The SENDP has an ambitious quest of creating 1 million productive employment opportunities, accelerating economic growth as well as improving the living standards of the people. The SENDP also intends on addressing the lack of innovation amongst the citizens as well as the problem of the existence of corruption [7]. In view of the challenges of the previous NDPs as well as the desire of the government to accelerate development, the state instigated an Integrated Development Approach (IDA). The priority areas, as well as the policy objectives of the IDA, are summarized in figure 2 below.

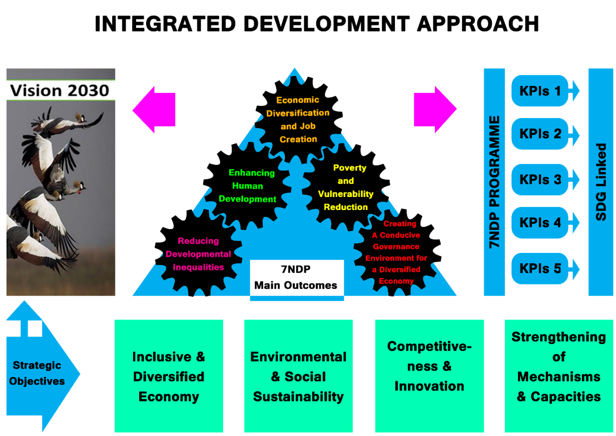

Figure 2: Integrated Development Approach

Source: Ministry of National Development Planning (2017)

5 *Seventh National Development Plan 2017 – 2021*. (2017). Ministry of National Development Planning.

6 What is Agenda 2063? "It is a strategic framework for the socio – economic transformations of the continent over the next 50 years. It builds on and seeks to accelerate the implementation of past and existing continental initiatives for growth and sustainable development". Its objectives work hand in hand with those of the SDGs.

7 For the 2016 Corruption Perception Index, Zambia ranked 87 out of 178 countries. Concerning the Global Innovation Index for the same year, the country ranked 125 out of 128 countries. (Dutta et al., 2016).

As elaborated above, human development is a key ingredient for the acceleration of the economic and social development of a nation. Sadly, the role of FDI is not elaborate in the IDA. As we discuss how the country can improve its welfare and the level of FDI, it is important to derive lessons from other countries. Specific countries in the SSA region namely Botswana, South Africa, and Morocco have improved in the both their HDI and the level of FDI net inflows. Botswana's HDI rose from 0.581 in 1990 to 0.717 in 2017 and is currently ranked fourth in the SSA region (UNDP, 2018). Botswana has specific policies beneficial for improving welfare and escalating the level of FDI. These policies will save as a practical example for Zambia.

Concerning FDI, Botswana introduced zero foreign exchange controls and also had a much more double tax avoidance policy with strategic countries such as South Africa, United Kingdom, Sweden, France, Mauritius, Namibia, Zimbabwe as well as Russia (Nordeatrade, 2019). The stability of its institutions and governance including its accessibility to regional markets such as the Southern African Development Community (SADC) stimulated its competitive advantage in attracting FDI (Nordeatrade, 2019).

Concerning welfare, the Botswana government ensured that developmental policies helped in improving the countries level of education and health. The government ensured proper planning and the involvement of the state, civil society, and all the relevant stakeholders in the provision of education including curriculum review so as to meet international standards (Meyer et al, 1993). The recruitment of expatriates in order to modernize the education system and train domestic staff was also instituted, and now the economy has a highly educated workforce (Meyer et al, 1993). Currently, the educated workforce and including the English speaking literate is at least 82 percent (Nordetrade, 2019).

Health is another area which has improved immensely over the years. The government of Botswana ensured the availability of health facilities in all parts of the country. The included referral hospitals, district hospitals, primary hospitals, maternity clinics, health posts, mobile hospitals, private hospitals, and private medical clinics (AHO, 2019). Besides the initial planning, which was implemented sometime back, the Botswana government has always been a good example for the SSA countries in the area of policy implementation.

Unlike other countries compared with Zambia in earlier aspects of this article, Botswana outperformed Zambia in almost every regard including making the economy investment friendly through infrastructure development. In that regard, the two states were compared in aspects that involve information communication technology as well as the service industry. This was through the measurements of citizens accessibility to internet and usage of mobile subscription. Concerning access to internet services, the percentage of Botswana citizens with such a privilege was 0.06, 3.26, and 39.36 percentages in the years 1995, 2005, and 2016 respectively. This was much better than Zambia, which was 0.008, 2.28, and 25.5 percentages for the same respective period. Mobile subscription per 100 persons was also more for Botswana being 30.38 and 146.16 in 2005 and 2016 respectively. For the same respective period, that of Zambia was 7.879, and

72.429. The underpins the significance of infrastructure development in order to attract FDI and improve welfare (Gohou and Soumaré, 2012; Soumaré, 2015; Minhaj et al., 2007). This information comparing selected sections of infrastructure variations between Botswana and Zambia is summarized in table 6 below:

Table 6: Botswana and Zambia Selected Infrastructure Indexes Comparisons

VARIABLE	COUNTRY	1995	2005	2016
Internet Users/ Percetange of Population	Botswana	0.06	3.26	39.36
	Zambia	0.008	2.28	25.50
Mobile Subscription (per 100 persons)	Botswana	-	30.38	146.16
	Zambia	0.02	7.88	72.43

Source: World Bank (2018)

With this in mind, we can safely conclude that the level of infrastructure development played a key role in attracting FDI and enhancing human development for Botswana compared to Zambia. This confirms the fact that both physical development as well as effective development policies are key in attracting FDI as well as improving the level of HDI in an economy

4. Conclusion and Policy Recommendations

The Endogenous Growth Model was a strong motivation for this paper. This is because for development to be realized, capital, both physical and human are cardinal. Having compared Zambia's HDI and its components, GDP growth rate, and the inflow of FDI, it observed that Zambia outperformed Angola, Malawi, and the SSA region. Over the years, there were some improvements in Zambia's HDI levels. However, the pledges of MNCs towards Zambia showed that FDI did not make a significant contribution to education and health.

Despite affirmative developments, the nation still had challenges. Amongst the challenges noted were corruption, lack of innovation, and delays in the release of funds which were meant for the implementation of the NDPs and necessary for the improvements of welfare as well as accelerating FDI inflows.

The review of the literature showed some notable recommendations which are beneficial for developing countries including Zambia based on its similar challenges as earlier alluded to. Concerning the allocation of the proceeds from FDI, Alam et al. (2016), Apinran et al. (2018), Bezuidenhout (2009), de Groot (2014), Edrees et al. (2015) and Soumaré (2015) concluded that the HDI can only be improved if resources are allocated rightfully and towards the sectors which have a direct impact on the HDI. Against the background of this recommendation, Zambia can advocate for policies which advocate for the redirection of FDI towards sectors related to the HDI such as education and health. Further, Asiedu, (2004); Blonigen, (2005); Mukherjee & Chakraborty, (2010) acknowledged the role of the Endogenous Growth Model in their findings and noted that investors have to support the government in its quest to improve human development and skills. This policy recommendation does not exempt Zambia as all countries have similar economic characteristics. In a similar regard, Assadzadeh and Pourqoly, (2013); Borensztein et al., (1995) urged developing countries to consider directing FDI towards areas of Teaching Vocational and Entrepreneurship Training (TEVET) and Information Communication Technology (ICT). This will help Zambia on improving skills and resultantly its Global Innovation ranking which is not desirable. Improving the performance of the country's institutions will make the impact of FDI on the HDI to be more pronounced. One way is by fighting the rising levels of corruption as Tamer (2013) concluded on his research on African states. Some studies have concluded that adequate infrastructure development will help increase FDI and improve welfare in an economy (Gohou and Soumaré, 2012; Soumaré, 2015; Minhaj et al., 2007).

There have been improvements in the levels of HDI and its components, an increase in FDI inflows, and a reduction in poverty levels down the years. However, there is more to be desired. With the country's Doing Business Ranking on the continent, concerns of inequality, corruption, and lack of innovation shouldn't be prevalent.

As discussed in the previous chapter, Botswana is an ideal example of how FDI and development policies can be used to improve welfare and national output. Concerning FDI, zero exchange rate controls and also effective double taxation avoidance policies are good for acceleration the flow of investment from outside. Also, the quality of institutions and governance plays a key role. In order to succeed like in the case of Botswana, the state needs to deescalate the rising levels of corruption as earlier alluded to by Tamer (2015). Concerning education, incorporating expatriates into the reviewing of our education system so as to reach global standards will go a long way. As far as health is concerned, the example of Botswana has also taught us that it would be more beneficial to spread all health facilities across the entire nation instead of only urban areas. In that regard, the Zambian government needs to address the failure of the Decentralization policies, the NDPs, and also establish a better way forward.

In addition to the example of Botswana and by way of conclusion, four policy recommendations are cardinal. These are:

1. Directing FDI towards areas that have a positive bearing on the HDI. These could include TEVET, ICT, and other areas of education as well as the delivery of services in the health sector.
2. Compelling foreign investors to also support education and health, by providing them with investment incentives as well giving them social responsibility in that regard.
3. Improving on the nation's level of innovations as well as the quality of its governance and institutions.
4. Improve the country's infrastructure to attract more FDI and to improve the domestic economy's HDI.

FDI supported by proper planning, implementation, and directed development policies will put the country on the right trajectory towards the realization of vision 2030 as well as Africa's Agenda 2063.

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