DETERMINANTS OF CO2 EMISSIONS IN TURKEY, FRANCE AND POLAND DEPENDING ON THE IPCC'S EMISSIONS SCENARIOUS

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Abstract- The atmospheric concentration of carbon-dioxide emissions (CO_2) is increasing as the result of a variety of human activities, of which the burning of fossil fuels is the most significant. Since early 1990s, steping into action due to control greenhouse gases has been on the world's agenda. According to The Intergovernmental Panel on Climate Change (IPPC) reports, by 2100 the world temperature will rise 1 to 3,5 degrees around. This situation points to an increase of about 0,1 degrees per decade. Taking into account all of these, using of energy more efficient and effective requires an understanding of the rules played by the different factors affecting CO_2production. The objective of this study is to identify factors in Poland, France and Turkey by utilizing Log Mean Divisia Index (LMDI) method by Ang (2005). As a result, in the A2 scenario, Poland and Turkey are influenced by the same effects, however these contributors are different for France. Moreover, the economic activity effect and the population effect for France and Poland contribute to increase in CO_2 emission while the energy intensity effect and the carbon intensity effect contribute to decrease in the B1 scenario. Nevertheless, the energy intensity effect and the carbon intensity effect are positive contributors for Turkey, but the population effect and the economic activity effect are caused a fall.

Index Terms- Carbon Dioxide Emissions, Log Mean Divisia Index, Policies, The Decomposition Method.

I. INTRODUCTION

The natural greenhouse effect plays a crucial role in terms of allowing life on Earth to exist. When the sunlight reaches the Earth's atmosphere, part of it is reflected back into space and the rest is absorbed by the Earth and re-radiated by greenhouse gases which include water vapour, carbon dioxide, methane, nitrous oxide, ozone and some artificial chemicals such as chlorofluorocarbons (CFCs). These greenhouse gases collect the heat energy and hold it in the atmosphere, delaying its passage back out of the atmosphere. Contrary to common belief, the natural greenhouse effect does not pose a threat to the living organisms in the ecological sense. Moreover, this effect is conducive to maintain the optimum temperature on Earth. However, increasement of the amount of carbon dioxide and other greenhouse gases due to the industrial revolution has become a major problem today. Mainly, the burning of fossil fuels, industry, transport, land use change, deforestation, solid waste management and environmental issues arising from agricultural and other similar human activities are reasons for this increasement that cause global warming. Not all of these gases make an equal contribution to the greenhouse effect. For instance, one molecule of methane (CH_4) has 20 times the impact of a molecule of carbon dioxide; nitrous oxide (N_2O) 200 times; ground-level ozone 2,000 times; and a chlorofluorocarbon molecule has from 13,000 to 20,000 times the impact of a molecule of carbon dioxide(CO_2) [1].

According to The Intergovernmental Panel on Climate Change (IPPC) reports, by 2100 the world temperature will rise 1 to 3,5 degrees around. This situation points to an increase of about 0,1 degrees per decade [2]. In order to determine the impact of climate change in the future, we need to have an idea of the concentrations of greenhouse gases and other pollutants in the atmosphere. For this purpose, they assist in climate change analysis, including climate modeling and the assessment of impacts, adaptation, and mitigation. There are 40 different scenarios, each making different assumptions for future greenhouse gas pollution, land-use and other driving forces. These emissions scenarios are organized into families, which contain scenarios that are similar to each other in some respects. A set of scenarios was developed to represent the range of driving forces and emissions in the scenario literature so as to reflect current understanding and knowledge about underlying uncertainties. They exclude only outlying "surprise" or "disaster" scenarios in the literature [3].

After the oil crisis, decomposition analysis is enhanced for developing policies in order to ensure the use of energy more efficient and effective. At the same time, after the analyzes done by the available data, future projections in terms of energy can be generated, it is simply a method frequently resorted to working environment and the economy [4].

In this paper, the global total CO_2 emissions in Turkey, France and Poland are decomposed by the mathematical model which is equated with the Logarithmic Mean Divisia Index Method by using the total primary energy supply, the gross domestic product according to the parity of purchasing power and population from 2012 to 2050. While solving the model, rate of increase has taken from A2 and B1 scenarios which are two of the SRES scenarios. Increasing CO_2 emissions has shown that effects are done the positive contribution when it comes to

defining influence. On the other hand, when the effects contributed to the CO_2 emissions with a negative value, this means that they help to decrease energy related CO_2 emissions.

II. DECOMPOSITION ANALYSIS

A. Analysis along Kaya factors

The carbon dioxide (CO_2) emissions are expressed as a product of four driving factors by the Kaya identity. [5,6,7]

$$CO_2 = P \times \frac{GDP}{P} \times \frac{TPES}{GDP} \times \frac{CO_2}{TPES} \quad (1)$$

The right hand side of the (1), where P is the population, per capita income G = (GDP/P), energy intensity of economic activity E = (TPES/GDP) and carbon intensity of energy use F = (CO_2 / TPES).

B. Decomposition of carbon emissions

Inourcasestudy, LogarithmicMean Divisia Index (LMDI),
estimatingeachindividualeffectthroughformulations in terms of theweightedaveragelogarithmicchanges of therelevantvariables,
waschosenowingtoitsleavingnoresiduals in theanalysis.

$$(\Delta CO_2) = (CO_2)^t - (CO_2)^0$$
$$(\Delta CO_2) = \Delta C_{p-effect} + \Delta C_{g-effect} + \Delta C_{e-effect} + \Delta C_{f-effect} \quad (2)$$

Thechange of CO_2 emissionbetween a baseyear*0*and a targetyear t , denotedby (ΔCO_2) , can be decomposed to four effects namely the changes in the population effect, the changes in the economic activity effect, the changes in the energy intensity effect and the changes in the carbon intensity effect in additive form, as shown in (2).
If the result of an effect is positive, the change in the quantity and the driver are the same direction, if the result of an effect is negative, the change in the quantity and the driver are the opposite direction.
Log Mean Divisia Index Method is developed through the logarithm icmean operator L (a,b), which is shown in (3).

$$L(a,b) = \frac{a-b}{\ln\left(\frac{a}{b}\right)} \quad (3)$$

Accordingtothecompletedecomposition model givenby LMDI methodeacheffect in therighthandside of (2) can be computed as follows.

(4) calculatesthepopulationeffect:

$$\Delta C_{p-effect} = \frac{C_t - C_0}{\ln C_t - \ln C_0} \ln\left(\frac{P_t}{P_0}\right) \quad (4)$$

Populationeffect: Itmeasurestheinfluence of thepopulationgrowthalone. Populationgrowth is also an important determinant of emissionsincreases. However, thepopulationeffect is lesspronouncedthantheeffect of outputpercapita.

(5) calculatestheeconomicactivityeffect:

$$\Delta C_{g-effect} = \frac{C_t - C_0}{\ln C_t - \ln C_0} \ln\left(\frac{G_t}{G_0}\right) \quad (5)$$

Economicactivityeffect:Incomepercapita is themostimportant determinant of CO_2 emissionspercapita, but otherfactorsalsoaffectthecalculation. Reducinggrowth in per-capitaoutputmayhave a mitigatinginfluence on emissions, but governmentsgenerallypursuepoliciestoincreaserathert hanreduceoutputpercapita in ordertoadvanceobjectivesotherthangreenhousegasmiti gation.

(6) calculatestheenergyintensityeffect:

$$\Delta C_{e-effect} = \frac{C_t - C_0}{\ln C_t - \ln C_0} \ln\left(\frac{E_t}{E_0}\right) \quad (6)$$

Energy intensityeffect: Theenergyintensity of economicactivity is a measure of energyconsumptionperunit of economicactivity as measuredbygrossdomesticproduct. Itrelateschanges in energyconsumptiontochanges in economicactivity. As a country'senergyintensitychanges, sodoestheinfluence of a givenlevel of economicactivity on CO_2emissions. Increasedenergyuseandeconomicgrowthgenerally ocur together, althoughthedegreetowhichtheyarelinkedvariesacrossr egionsandstages of economicdevelopment.

(7) calculatesthecarbonintensityeffect:

$$\Delta C_{f-effect} = \frac{C_t - C_0}{\ln C_t - \ln C_0} \ln\left(\frac{F_t}{F_0}\right) \quad (7)$$

Carbonintensityeffect:Thecarbonintensity of energysupply is a measure of theamount of carbondioxideassociatedwitheachunit of energyused. Itdirectlylinkschanges in carbondioxideemissionslevelswithcahnges in energyusage. Carbonemissionsvarybyenergysource, withcoalbeingthemostcarbon- intensivefuel, followedbyoilandnaturalgas. As changes in thefuel mix altertheshare of total energydemand met bymorecarbon-intensivefuelsrelativetolesscarbon-intensiveor "carbon-free" energysources, overallcarbonintensitychanges.

III. DATA MANAGEMENT

The data used in the study as a reference for CO_2 emissions of France, Poland and Turkey for the period

1971-2012 have been collected from the International Energy Agency [8]. Then this data has been used for generating the values of A2 and B1 scenarios between 2012 and 2050. The Special Report on Emissions Scenarios (SRES), published by the IPCC in 2000, describes the emissions scenarios that have been used to make projections of possible future climate change. There are 40 different scenarios, each making different assumptions for future greenhouse gas pollution, land-use and other driving forces. These emissions scenarios are organized into families, which contain scenarios that are similar to each other in some respects. The following are the major families of SRES emissions scenarios:

The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid spread of new and efficient technologies. Major underlying themes are convergence among regions, capacity building, and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income.

The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population. Economic development is primarily regionally oriented and per capita economic growth and technological change are more fragmented and slower than in other storylines.

The B1 storyline and scenario family describes a convergent world with the same global population that peaks in mid-century and declines thereafter, as in the A1 storyline, but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives.

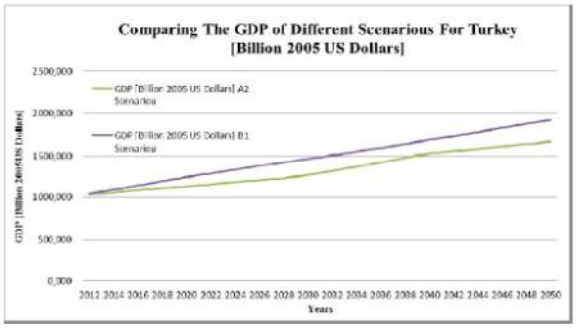
The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with continuously increasing global population at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels.

In this study, we utilize the storylines of A2 and B1 due to the fact that they are the most diversified scenarios comparing to four of them. Rate of increases has been taken from Special Report on Emissions Scenarios (SRES) Homepage [9] and they are used for producing the all years between 2012 and 2050.

IV. CASE ANALYSIS IN TURKEY, POLAND AND FRANCE

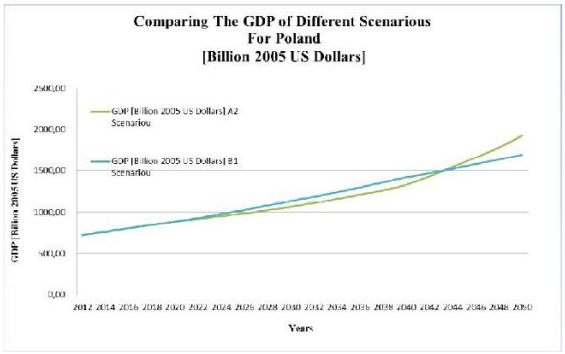
A. Economic development

Table 1 ComparingThe GDP of Different Scenarios For Turkey [Billion 2005 US Dollars]



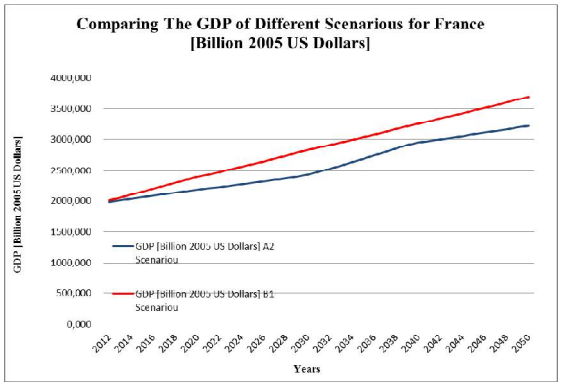
GDP of Turkey has increased from 1027,385 billion 2005 US Dollars in 2012 to 1666,810 billion 2005 US Dollars in 2050 in constant 2005 prices, growing by 1,241% per year in A2 scenario. However, in B1 scenario, this growing rate would be 1,573% per year.

Table 2 Comparing The GDP of Different Scenarios For Poland [Billion 2005 US Dollars]



GDP of Poland has increased from 724,892 billion 2005 US Dollars in 2012 to 1928,596 billion 2005 US Dollars in 2050 in constant 2005 prices. Moreover, A2 and B1 scenarios growing rates would be 2,509 % per year and 2,186 % per year respectively.

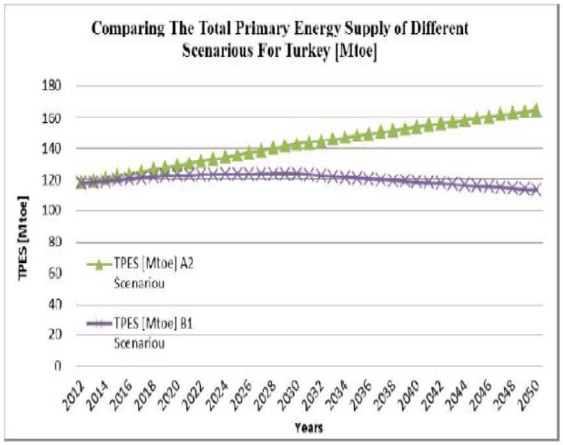
Table 3 Comparing The GDP of Different Scenarios For France [Billion 2005 US Dollars]



Comparing with the GDP of Poland, in the B1 scenario the growing rate is higher than the A2 scenario. The growing rates would be 1,2408 % per year for the A2 scenario and 1, 5733% per year in the B1 scenario.
Therefore, it can be seen that in the A2 scenario, Poland would be the first (2,509 % per year) and the growing rates of Turkey and France (1,241% per year, 1,2408 % per year) show the similar result. Like the results of A2 scenarios, in the B1 scenarios of Turkey and France give the close results (1,573% per year), however the GDP of Poland would be higher than others (2,186 % per year).

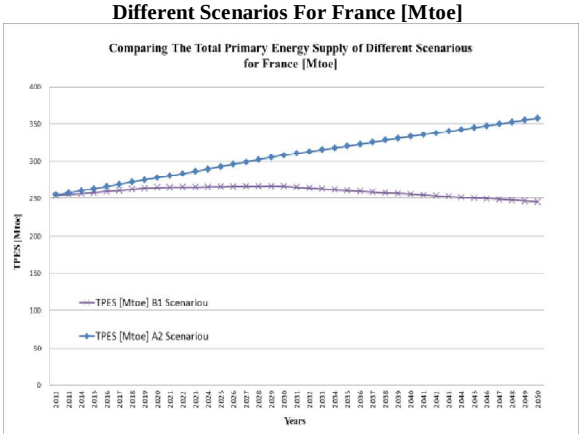
V. ENERGY CONSUMPTION AND CARBON EMİSSİONS

Table 4 ComparingThe Total Primary Energy Supply of DifferentScenariosForTurkey [Mtoe]



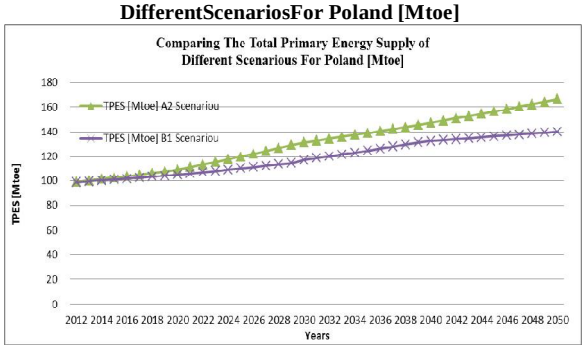
The Total Primary Energy Supply of Turkey has increased from 118,175 Mtoe in 2012 to 165,419 Mtoe in 2050, growing by 0,862 % per year in A2 scenario. However, in the B1 scenario of Turkey the rate takes a negative value -0,090 % per year.

Table 5 Comparing The Total Primary Energy Supply of Different Scenarios For France [Mtoe]



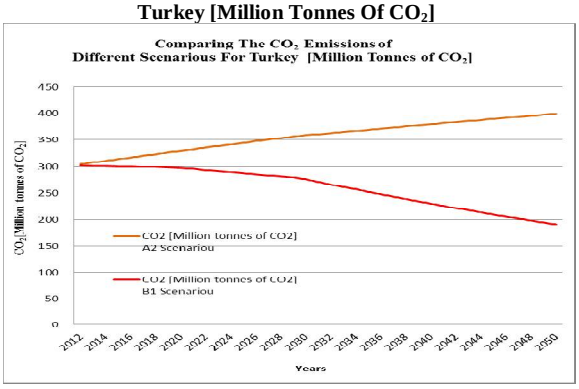
The Total Pimary Energy Supply of France has decreased from 253,757 Mtoe in 2012 to 244,968 Mtoe in 2050 in the B1 scenario. However, in A2 scenario, this growing rate would be 0,8623% per year while it is -0,0904% per year in B1 scenario.

Table 6 ComparingThe Total Primary Energy Supply of DifferentScenariosFor Poland [Mtoe]



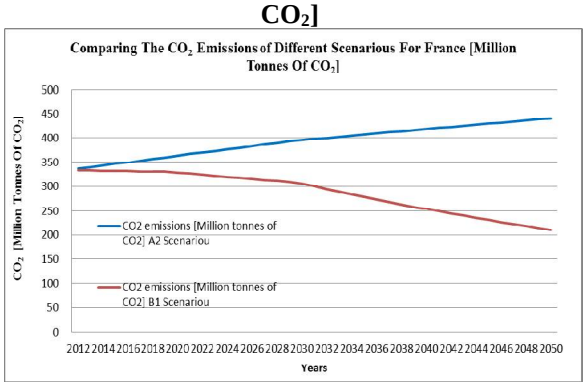
The Total Primary Energy Supply of Poland values have risen from 99,005 Mtoe in 2012 to 166,205 Mtoe in 2050 in the A2 scenario with 1,328 % per year. However, in the B1 scenario, growing rate would be 0,901 % per year.
According to the results, Turkey and France show the same growing rates per year in the A2 scenario and also have negative rates in B2 scenario. Though, comparing Poland with these, it has positive and higher growing rates in A2 & B1 scenario.

Table 7
Comparing The CO_2 Emissions of Different Scenarios For Turkey [Million Tonnes Of CO_2]



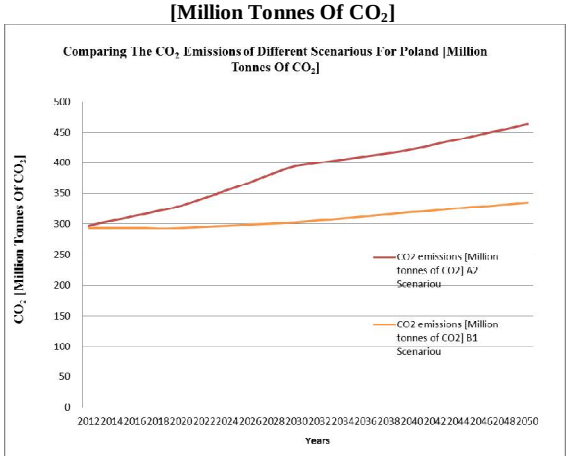
The CO_2emissions [Million tonnes of CO_2] of Turkey has increased from 305,320123 Million tonnes of CO_2in 2012 to 399,045645 Million tonnes of CO_2 in 2050, growing by 0,686 % per year in the A2 scenario. Though, in the B1 scenario is with a negative rate, -1,177 % per year.

Table 8 ComparingThe CO_2Emissions of DifferentScenariosFor France [Million Tonnes Of CO_2]



Evaluating the CO_2 emissions [Million tonnes of CO_2] of France, in A2 scenario has the increasing growing rate 0,6864 % per year, while -1,1774 % per year is the rate for the B1 scenario.

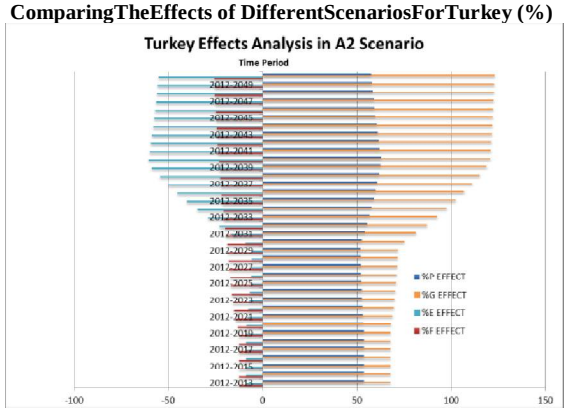
Table 9
ComparingThe CO_2Emissions of DifferentScenariosFor Poland [Million Tonnes Of CO_2]



Evaluating the CO_2 emissions [Million tonnes of CO_2] of Poland, in A2 scenario has the increasing growing rate 1,1406 % per year, while it is lower than that in the B1 scenario with 0,336 % per year.

VI. EFFECT ANALYSIS OF DIFFERENT SCENARIOS FOR TURKEY, FRANCE AND POLAND

Table 10
ComparingTheEffects of DifferentScenariosForTurkey (%)



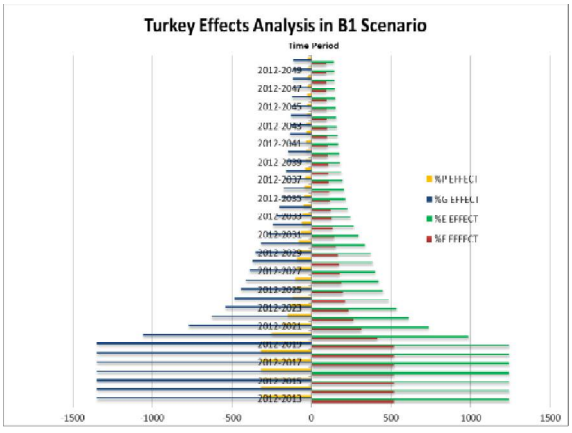
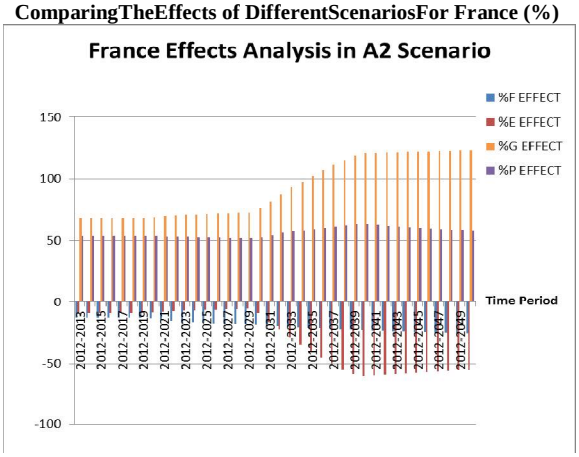


Table 11
ComparingTheEffects of DifferentScenariosFor France (%)



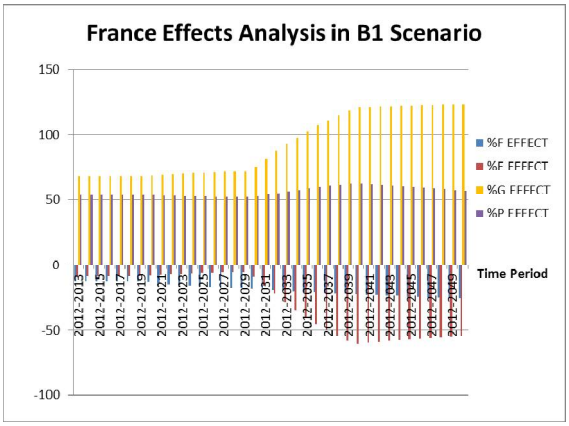
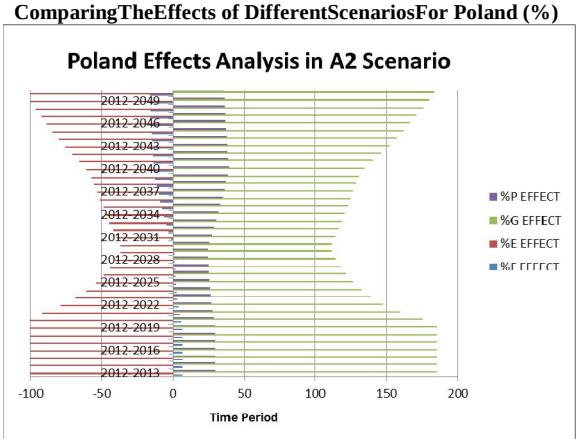
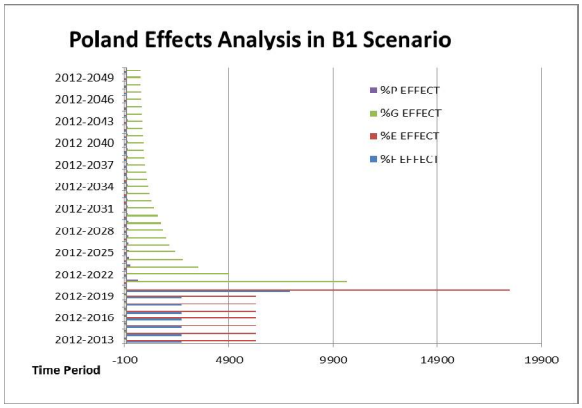


Table 12
ComparingTheEffects of DifferentScenariosFor Poland (%)





CONCLUSIONS AND DISCUSSIONS

In this study, we used the Logarithmic Mean Divisia Index (LMDI) method to analyze the CO_2 emissions in Poland, France and Turkey during the period 2012 to 2050. The four decomposition factors are population growth, economic activity, energy intensity and carbon intensity. The main conclusions are presented as follows:

When it comes to the A2 scenarios for three countries, the results showed that the economic activity effect and the energy intensity effect were the two biggest contributors to CO_2 emissions. The economic activity and the population contributed to increase in CO_2 emission in Turkey and Poland, though this increase for France is provided by the carbon intensity effect and the energy intensity effect. Moreover, it can be said that the energy intensity effect and the carbon intensity effect made a negative contribution in terms of CO_2 emissions for the 2012-2050 period. In the view of such information between 2012 and 2050, in the A2 scenario, Poland and Turkey are influenced by the same effects, however these contributors were different for France.

In the B1 scenario, the economic activity effect and the population effect for France and Poland contributed to raise in CO_2 emission while the energy intensity effect and the carbon intensity effect contributed to decrease. Therefore, in this scenario they are affected by the similar effects. Nevertheless, for Turkey the energy intensity effect and the carbon intensity effect are positive contributors, but the population effect and the economic activity effect caused a fall.

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