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# Regional Analysis of Death Rate due to Air Pollution in Turkey and its Neighbors

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**Abstract**—Air pollution is the contamination of the internal or external environment of any chemical, physical or biological material and altering the natural properties of the atmosphere. Air pollution is caused by natural causes such as volcanic eruptions, forest fires, or excessive evaporation, as well as by increasing traffic density, especially by artificial causes such as fuel types used by urban inhabitants and industrialization. Each year, countries keep statistics of deaths caused by different types of direct air pollution or indirectly by diseases caused by these different types of pollution. In this study, the impact of countries' geographical region and population density on mortality rates due to air pollution is analyzed. A dataset of Turkey and the twenty six countries covers information such as the population density, different types of pollution rates, number of deaths caused by each type of pollution and their ratios to current population number throughout a time period between 1990-2017. In the data analysis, air pollution types were examined one by one and it was sought to identify the similarities among countries. As a result of these analysis, it was shown that there are similarities between Turkey and the different neighbour countries on the death cases observed due to different types of air pollution.

**Index Terms**—air pollution data analysis, data analysis methods, data similarity, data science

## I. INTRODUCTION

The World's air consists of %78,084 Nitrogen ( $N_2$ ), % 20,946 Oxygen ( $O_2$ ), %0,934 Argon (Ar), %0,035 Carbon Dioxide ( $CO_2$ ).The remaining % 0,001 contains Neon (Ne), Methane ( $CH_4$ ), Helium (He), Hydrogen ( $H_2$ ) and Crypton (Kr). The deterioration of this chemical equilibrium and the mixing of substances that should not be in the air are called air pollution.

Air pollution emerges with the growth of the population, urban growth and the development of the industry. Especially in urban centers, air quality deteriorates with the energy consumption, the combustion of fossil fuel and dramatic increase of motor vehicles' number. Factors arising from traffic, transportation, industry and heating are the causes of air pollution. The causes of the air pollution can be grouped under two main titles: Natural Sources and Artificial Sources : Natural Sources: There are some substances that harm the atmosphere due to nature's own structure such as Volcanic Eruptions, Big Forest Fires, Steaming. Artificial Sources: Unfortunately, they are the sources of air pollution caused by human beings intentionally or unintentionally such as: Traffic, Industry, Global warming.

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In the case where the air pollution reaches dangerous level, the mortality rate due to heart and lung diseases increases as well. The prevalence of chronic airway diseases such as Asthma or Chronic Obstructive Pulmonary Disease (COPD) is increasing in areas where air pollution is intense. The United Nations (UN) and World Health Organization (WHO) reports clearly state that air pollution is more harmful than smoking [1]–[3].High level of air pollution has become the most important environmental factor triggering global disease [4]–[6].

In this study, the data of mortality rate related to air pollution which occurred between the 1990-2017 in Turkey and neighboring countries, is analyzed. Population, Land area, Population Density (number of people per square kilometer), air pollution rates of 3 different types of air pollution (ozone pollution, pollution caused by toxic gases and dust particles), the number of people who died from relevant air pollution and the total deaths of that year declared by the countries were gathered together.

On this dataset, a regional analysis was performed in order to reveal the similarity between Turkey and neighboring countries. First a linear regression method is performed on the data and a coefficient matrix is produced. Then a preliminary study of correlation is executed on this matrix.

The rest of the paper is divided as follows. In Chapter 2, the studies about the effects of air pollution on mortality are introduced. In Chapter 3, the types of air pollution and the dataset studied are described. Chapter 4 interprets the analysis performed on the dataset and the results obtained. Evaluation, discussion and prospective studies of the results are presented in Chapter 5.

## II. SIMILAR WORKS

The impact of air pollution on our daily life and on our health becomes more significant day by day. Researchers are mostly focused on examining the relationship between air pollution data and mortality rates [7]. Lelieveld and his colleagues present the statistics of early deaths caused by air pollution in the world. The study is based on the data concerning to those who died below the average age of death which is called premature death/mortality. At the end, a detailed analysis and sub-groups of deaths related to air pollution have

been revealed. There is also continental geographic analysis offered.

Silva et al. develop a chemical chemical-meteorology simulation model in the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP) and with this simulation model, they try to estimate the early mortality rates due to air pollution in 2030, 2050 and 2100 [8], [9].

Chen et al. investigate the relationship between public health and air pollution in China using big data techniques. Air pollution values collected from 116 cities between 2006 and 2012 are analyzed together with health data and the impact of air pollution on mortality rates is determined [10].

Fotopolou et al. conduct data analysis study in both smart cities and rural areas and examined the effects of air pollution on human life with data mining techniques [11].

Rohde et al.'s study presents a regional analysis of intense air pollution in China. By analyzing the numerical data of air pollution from different centers, it is aimed to put forward policies to reduce air pollution. Due to the fact that measuring stations do not work properly in the whole country, the analyzed data is limited with 4 months [12].

In this study, based on data of outdoor pollution, air pollution data in Turkey and Turkey's neighbors in the simulation it is performed. By linear regression, the relationship between population density and air pollution and mortality rates is quantified.

### III. AIR POLLUTION DATA

There are different types of air pollution:

#### A. Air Pollution with Particulate Matter (PM)

Particulate matter in the air is one of the most important pollutants affecting human health. Particle size is directly proportional to its negative impact on human health. PMs bigger than  $10\mu\text{M}$  are kept in the nose and nasopharynx. PMs smaller than  $10\mu\text{M}$  accumulates in the bronchi, while those with a diameter of 1-2 microns diffuse in the alveoli. The PMs with a diameter of 0.1 microns diffuse from the alveoli into the intracapillary space.

In addition to the physical properties, the Particulate Matters' chemical compositions are also very important for human health. Particulate substances can contain heavy metals such as mercury, lead, cadmium, and carcinogenic chemicals and may pose a significant threat to health. These toxic and cancerous chemicals combine with moisture and turn into acid. Since soot, fly ash, gasoline and diesel vehicle exhaust particles which contain carcinogenic substances such as benzo (a) pyrene, long-term inhalation of these substance can cause cancer. In 2017, particulate matter concentrations in the air are given in Figure 1.

#### B. Ozone ( $O_3$ ) Pollution

Ozone found in the natural composition of the atmosphere, is a highly reactive gas which reaches peak concentrations in the stratosphere layer. Since ozone is insoluble in water, it reaches the depths of the respiratory system and shows its

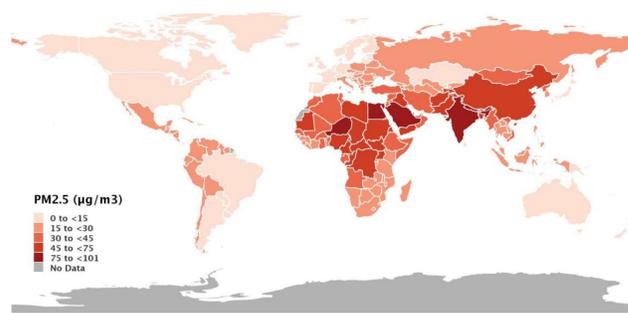


Fig. 1. Average Annual Population-Weighted PM 2.5 Concentrations in 2017 [13]

negative effects on the lungs. Figure 2 represents the pollution in the ozone layer in 2017.

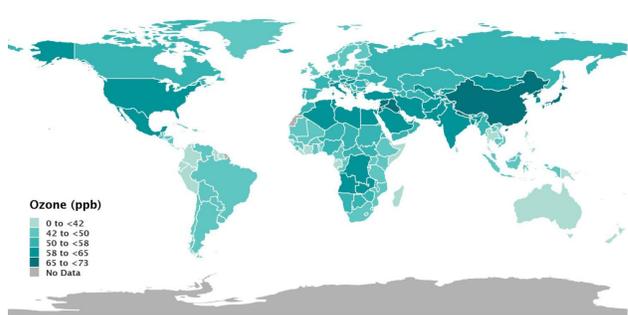


Fig. 2. Ambient Ozone Pollution in 2017 [13]

#### C. Air Pollution with Solid Fuel

In our country, the widespread use of low-calorie and high-sulfur coals with wrong combustion techniques for heating cause air pollution. Sulfur dioxide ( $\text{SO}_2$ ) is a colorless, non-combustible and non-flammable gas. Every year, approximately 60% of the sulfur oxides emitted are raised as result of burning coal. Thermal power plants, in which coal is used as fuel, are the major sources of  $\text{SO}_2$  emissions. Forest fires, volcanic activities are the examples for  $\text{SO}_2$  emission's natural resources.  $\text{SO}_2$  may cause irritation in the nose and pharynx or may cause spasm in the main respiratory tract. Since this gas is soluble in water, it is largely eliminated in the nose and pharynx before reaching the endpoints of the respiratory system. It forms sulphate aerosols and particles in atmosphere. These particles can be transported by winds over very long distances. Dissolution in moisture forms sulfuric acid in the presence of sunlight and some chemicals [14].

In this study, the air pollution data presented by State Global Air<sup>1</sup> is used. In addition, the death rate dataset due to air pollution was obtained from Our World In Data<sup>2</sup>, the forest area data was obtained from The World Bank<sup>3</sup>, the industry annual % growth data was obtained from The World Bank<sup>4</sup>

<sup>1</sup><https://www.stateofglobalair.org/>

<sup>2</sup><https://ourworldindata.org/air-pollutiondeath-rates-in-2017-vs-1990>

<sup>3</sup><https://data.worldbank.org/indicator/AG.LND.FRST.ZS?locations=P>

<sup>4</sup><https://data.worldbank.org/indicator/NV.IND.TOTL.KD.ZG>

and finally the motor vehicle registered data obtained from CEIC<sup>5</sup>.

According to the regional segmentation realized by Global State Air, Turkey is located in North Africa and the Middle East region. In contrast, Greece and Cyprus are located in Eastern Europe and Bulgaria in Central Europe. We believe that the organization has justified grounds for making such a classification by taking the different components into consideration. On the other hand, when examined in terms of natural resources which cause air pollution, Turkey is much more similar with Cyprus, Greece or Bulgaria rather than Afghanistan or Jordan. For example widespread forest fires occurred in Greece in recent years, have an undeniable fact on Turkey's air pollution's rate.

In this study, firstly, the mortality rates related to air pollution declared by the countries in the last 27 years are analyzed and multiple linear regression equations are formed over this data. Based on the general structure of these equations Turkey's similarity with the neighboring countries is examined.

If the resulting increased similarity with Turkey's neighbors, according to the results to be "state global air" as the organization to Turkey to remove North Africa and the Middle East from the country list will be made references to add eastern European countries list.

#### IV. DATA ANALYSIS

In the first stage, air pollution data obtained from State of Global Air, country population and surface area information were combined to make it more meaningful and ready for analysis. Dataset contain population data from 1990-2017 for other countries and Turkey, the number of people per km<sup>2</sup> depending on the country's surface area, the above three different air pollution values for those years (Ozone pollution (OP), Household Pollution (HHP), Particula Matter Pollution (PM)) and the ratio of deaths due to these pollution to total deaths of that year.

In addition, new features obtained from The World Bank and CEIC websites were added to the dataset. New added features contains, from 1990-2017 for other countries and Turkey, the percentage growth of the industry (IG), the percentage forest area (FA) and the number of registered motor vehicles (MVR).

As a result, the variables used are as follows: [Country], [Year], [Population], [Land Area (km<sup>2</sup>)], [PD], [OP (parts per billion - ppb)], [OP\_Ratio], [Household P (percentage of people using solid fuel)], [HH\_Ratio], [PM ( $\mu\text{g}/\text{m}^3$ )], [PM\_Ratio], [FA], [IG], [MVR].

##### A. Covariance Analysis

Covariance analysis is a method used to determine whether the variables in the dataset are related to each other. [15]. The covariance formula is given in Equation 1. If the value calculated by covariance formula is positive, it means that

there is a positive relationship, and if negative, it means that there is a negative relationship.

$$cov_{x,y} = \frac{\sum_{i=1}^N (x_i - \bar{x})(y_i - \bar{y})}{N - 1} \quad (1)$$

Independent variable: Usually indicated by  $x$ . It is the (descriptive) variable that is not influenced by another variable, but which is the cause or thought to affect it.

Dependent variable: Usually indicated by  $y$ . Depending on the variable  $x$ , it is the variable that can be changed or affected.

##### B. Correlation Analysis

Covariance reports the direction of the relationship between the two variables. Correlation reports the severity of the relationship between these variables. The correlation formula is given in Equation 2. Correlation is the standardized state of covariance. As a result of correlation analysis, whether there is a linear relationship and the degree of this relationship, if any, is calculated with the correlation coefficient. The correlation coefficient is indicated by 'r' and takes values between -1 and +1. [16], [17].

$$r = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 (y_i - \bar{y})^2}} \quad (2)$$

##### C. Significance of correlation coefficient

$r^2$  is a statistical measure representing the variance ratio for a dependent variable described by independent variable or variables in a regression model. Correlation describes the strength of the relationship between an independent and dependent variable, while R-square explains how much of the variance of a variable explains the variance of the second variable. The effect of the independent variable on the dependent variable as a percentage can be explained by the significance of correlation coefficient [18].

##### D. Regression Analysis

The covariance is the direction of the relationship between the two variables, the correlation indicates the severity of the relationship between these two variables and the regression is the analysis of the mathematical model of this relationship. The scatter graph is plotted in order to determine how the two variables affect each other. Regression analysis is the study of calculating the mathematical equation of a line or a curve passing through the points on the scatter plot. In this way, prediction and forecasting can be made [19]–[21].

In the regression analysis, if the linear regression model is used, the equation which is tried to be obtained is given in Equation 3. In this equation,  $Y$ ; The dependent variable is assumed to have a certain error.  $X$ ; independent (cause) variable is assumed to be measured without error.  $a$ ; It is constant. When  $X = 0$ ,  $a$  is the value  $Y$  takes.  $\epsilon$  is the error term.

$$f(x) = aX + b + \epsilon \quad (3)$$

<sup>5</sup><https://www.ceicdata.com>

Regression models with multiple arguments are called multiple regression models. In multiple regression analysis, there is one dependent variable and more than one independent variable which is thought to affect this dependent variable. When multiple regression analysis is performed with one dependent, two independent variables, the equation sought to be obtained is shown in Equation 4.

$$f(x) = a_1X_1 + a_2X_2 + b + \epsilon \quad (4)$$

Data sets including Turkey's and neighboring countries' land area and population information, together with quantitative measurements of different kind of air pollutions and number of death caused by these air pollutions are analyzed. With Python, data are processed using pandas, numpy, matplotlib, sklearn, statsmodels, scipy and seaborn libraries [22]. The relationships between the variables listed below are examined and significant results are obtained.

- PD (independent variable) with OP (dependent variable)
- PD (independent variable) with HHP (dependent variable)
- PD (independent variable) with PM (dependent variable)
- OP (independent variable) with OP\_Ratio (dependent variable)
- HHP (independent variable) with HHP\_Ratio (dependent variable)
- PM (independent variable) with PM\_Ratio dependent variable)
- PD and OP (independent variables) with OP\_Ratio (dependent variable)
- PD and HHP (independent variables) with HHP\_Ratio (dependent variable)
- PD and PM (independent variables) with PM\_Ratio (dependent variable)
- FA (independent variable) with OP (dependent variable)
- FA and OP (independent variables) with OP\_Ratio (dependent variable)
- IG (independent variable) with OP (dependent variable)
- IG and OP (independent variables) with OP\_Ratio (dependent variable)
- IG (independent variable) with PM (dependent variable)
- IG and PM (independent variables) with PM\_Ratio (dependent variable)
- MVR (independent variable) with OP (dependent variable)
- MVR and OP (independent variables) with OP\_Ratio (dependent variable)
- MVR (independent variable) with PM (dependent variable)
- MVR and PM (independent variables) with PM\_Ratio (dependent variable)

#### E. Analysis Results

Turkey and other data from 9 countries were examined. Firstly, independent and dependent variables were determined by covariance analysis and the direction of the relationship between these variables was determined. Then, the correlation

analysis between the independent variables and the dependent variables was used to calculate the correlation coefficients. Then, the equations of the relations were obtained by regression analysis. The obtained equations are classified based on the continentals. Table I and Table II show the regression analysis and obtained equations of Western Asia countries. Table III presents the equations of Northern Africa countries, Table IV introduces the equations of South Central Asia countries and finally Table V shows the results of Europe countries.

#### F. Interpretation of Results

The relations obtained as a result of the analyzes are interpreted below. The aim here is to identify the countries that results close to Turkey.

a) *PD-OP Relation*: Syria and Bulgaria, and Turkey showed similar characteristics. When considering the impact on the population density of ozone pollution it was emerged as Bulgaria and Syria's have results similar to Turkey.

b) *PD-HHP Relation*: Turkey is the country that most closely resemble Iran. The effect of population density on solid fuel pollution was investigated.

c) *PD-PM Relation*: Syria and Georgia were shown the similarities to Turkey.

d) *OP - OP\_Ratio Relation*: Ozone pollution and the proportion of people dying for this reason have been investigated. When these values are examined, the countries with the most similar characteristics with Turkey are Syria and Iran.

e) *HHP - HH\_Ratio Relation*: The mortality rate due to solid fuel pollution and solid fuel have been investigated. When these values are examined, Iran has the most similar characteristics with Turkey.

f) *PM - PM\_Ratio Relation*: Georgia and Iran were shown the similarities on Turkey.

g) *(PD,OP) - OP\_Ratio Relation*: The most similarity between Turkey and Iraq was found.

h) *(PD,HHP) - HH\_Ratio Relation*: Cyprus and Iraq were shown the similarities on Turkey.

i) *(PD,PM) - PM\_Ratio Relation*: Armenia and Iran were shown the similarities on Turkey.

#### V. CONCLUSION AND DISCUSSION

In this study, data on population density, air pollution rates, number of deaths due to this pollution and their ratio to total death of Turkey and 25 countries from 1990 to 2017 were examined. In the data analysis, air pollution types were examined separately and similarities were tried to be found between countries.

In the study, dataset is used to discover whether there is a relationship between these data variables. Firstly covariance analysis is performed to explore the existence of dependency between the data. In case of existence of a relation, correlation analysis is performed to figure out the direction of that relation. Finally linear regression analysis is performed to predict future air pollution and potential death rate due to the air pollution. Besides the equations found after the linear regression analysis

for each country is compared to discover the similarities with Turkey's neighbors.

In the following studies, it is foreseen that the types of similarity between Turkey and neighboring countries, an application will be made to State Global Air and/or other similar organizations to locate Turkey in a relevant European group instead of North Africa and Middle East group. In order to support our prediction, North African and Middle Eastern countries on similar work performed and also, it should be put forward affinity with Turkey.

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	Turkey	Azerbaijan	Armenia	Georgia	Iraq	Cyprus	Syria	Yemen	Bahrain
PD - OP	$y = 56.003 + 0.0176 X + 0.004$	No Relation	$y = 31.913 + 0.044 X + 0.012$	$y = 54.572 - 0.008 X + 0.006$	$y = 64.386 + 0.051 X + 0.006$	No Relation	$y = 62.829 + 0.015 X + 0.006$	$y = 48.814 + 0.0577 X + 0.006$	$y = 69.332 + 0.0003 X + 0.0001$
PD - HHP	$y = 0.517 - 0.005 X + 0.0002$	$y = 1.103 - 0.008 X + 0.0004$	$y = -0.918 + 0.012 X + 0.001$	$y = 0.081 + 0.007 X + 0.001$	$y = 0.046 - 0.0005 X + 3.378$	$y = 0.067 - 0.0004 X + 2.340$	$y = 0.007 - 4.984 X + 9.879$	$y = 1.067 - 0.015 X + 0.0005$	$y = 0.026 - 1.0007 X + 6.549$
PD - PM	$y = 41.423 + 0.013 X + 0.019$	$y = 32.138 - 0.096 X + 0.013$	$y = 32.565 + 0.034 X + 0.046$	$y = 15.502 + 0.162 X + 0.036$	$y = 63.133 + 0.004 X + 0.028$	$y = 27.049 - 0.068 X + 0.008$	$y = 56.724 - 0.144 X + 0.017$	$y = 48.891 + 0.008 X + 0.053$	$y = 65.910 + 0.001 X + 0.001$
OP - OP_Ratio	$y = 0.107 - 0.001 X + 0.001$	No Relation	$y = -0.764 + 0.016 X + 0.006$	$y = 0.023$	$y = 0.316 - 0.004 X + 0.001$	No Relation	$y = 0.328 - 0.004 X + 0.001$	$y = 0.312 - 0.005 X + 0.0007$	$y = 58.841 - 0.827 X + 0.275$
HHP - HH_Ratio	$y = -0.005 + 0.235 X + 0.017$	$y = -0.155 + 2.522 X + 0.111$	$y = -0.315 + 4.008 X + 0.200$	$y = -1.145 + 0.222 X + 0.190$	$y = -0.008 + 1.462 X + 0.078$	$y = -0.069 + 11.489 X + 0.676$	$y = -0.002 + 2.256 X + 0.313$	$y = -0.488 + 2.128 X + 0.162$	$y = -0.279 + 31.318 X + 2.465$
PM - PM_Ratio	$y = 0.095 - 0.001 X + 0.004$	$y = -0.405 + 0.049 X + 0.007$	$y = 0.728 + 0.028 X + 0.015$	$y = -1.145 + 0.222 X + 0.190$	$y = 0.759 - 0.006 X + 0.017$	$y = -14.576 + 0.923 X + 0.114$	$y = -1.725 + 0.050 X + 0.005$	$y = 0.115 + 0.002 X + 0.001$	$y = 18.852 - 0.078 X + 0.682$
PD*OP - OP_Ratio	$y = 0.001 X2 - 0.040$	$y = 0.001 X1 + 0 X2 + 0.154$	$y = 0.002 X1 - 0.003 X2 + 0.093$	$y = 0.003 X1 - 0.009 X2 + 0.787$	$y = -0.001 X1 + 0.001 X2 - 0.066$	$y = -0.007 X1 + 0 X2 + 1.154$	No Relation	$y = 0.001 X1 - 0.001 X2 + 0.060$	$y = -0.001 X1 - 0.221 X2 + 18.181$
PD*HHP - HH_Ratio	$y = 2.626 X1 + 2.403 X2 - 0.008$	$y = 0.012 X1 + 3.389 X2 - 1.400$	$y = -0.018 X1 + 0.038 X2 + 2.198$	$y = -0.016 X1 + 1.966 X2 + 0.024$	$y = 1.494 X1 + 1.703 X2 - 0.020$	$y = -2.065 X1 + 7.553 X2 + 0.209$	$y = -1.420 X1 + 8.464 X2 + 0.014$	$y = -0.058 X1 - 1.474 X2 + 3.415$	$y = -2.150 X1 + 2.938 X2 - 0.226$
PD*PM - PM_Ratio	$y = -0.002 X1 + 0.002 X2 + 0.163$	$y = 0.003 X1 + 0.025 X2 + 0.491$	$y = -0.018 X1 + 0.038 X2 + 2.198$	$y = -0.007 X1 + 0.019 X2 + 0.903$	$y = -0.012 X1 - 0.003 X2 + 1.341$	$y = -0.078 X1 + 0.108 X2 + 10.176$	$y = -0.008 X1 + 0.006 X2 - 40.944$	$y = -0.002 X1 + 0.002 X2 + 0.193$	$y = -0.018 X1 + 0.719 X2 - 13.471$
FA - OP	$y = 55.450 + 0.192 X + 0.054$	$y = 55.703 + 2.336 X + 0.058$	$y = -41.161 + 8.357 X + 1.712$	$y = 49.259 + 0.119 X + 0.085$	$y = 16.540 + 27.150 X + 6.254$	No Data	$y = 60.813 + 1.428 X + 0.373$	No Data	$y = 68.853 + 1.630 X + 0.449$
FA * OP - OP_Ratio	$y = -0.001 X1 + 0.001 X2 - 0.019$	$y = -0.006 X1 + 0.124$	$y = 0.487 X1 - 0.011 X2 - 4.888$	$y = 0.052 X1 - 0.008 X2 - 1.583$	$y = -0.222 X1 - 0.001 X2 + 0.502$	No Data	$y = -0.025 X1 + 0.001 X2 - 0.024$	No Data	$y = -4.771 X1 + 0.154 X2 - 6.965$
Ind_grw - OP	$y = 8.100 + 0.001 X + 0.009$	No Relation	$y = 56.511 - 0.010 X + 0.004$	$y = 54.041 - 0.001 X + 0.009$	No Relation	No Relation	$y = 64.149 + 0.020 X + 0.010$	$y = 51.031 - 0.037 X + 0.010$	$y = 69.730 + 0.025 X + 0.045$
Ind_grw * OP - OP_Ratio	$y = -0.00002 X1 - 0.001 X2 + 0.107$	$y = -0.00002 X1 + 0.014 X2 - 0.650$	$y = -0.001 X1 + 0.014 X2 - 0.650$	$y = -0.001 X1 + 0.021 X2 - 1.124$	$y = 0.003 X1 + 0 X2 + 0.383$	$y = 0.003 X1 + 0 X2 + 0.383$	$y = 0.0001 X1 - 0.005 X2 + 0.318$	$y = -0.00001 X1 - 0.005 X2 + 56.730$	$y = -0.069 X1 - 0.795 X2 + 56.730$
Ind_grw - PM	$y = 42.545 + 0.004 X + 0.029$	$y = 22.769 + 0.003 X + 0.012$	$y = 36.145 - 0.002 X + 0.016$	$y = 25.167 + 0.038 X + 0.071$	$y = 19.977 - 0.016 X + 0.028$	$y = 19.977 - 0.016 X + 0.028$	$y = 43.140 + 0.016 X + 0.051$	$y = 49.282 - 0.081 X + 0.048$	$y = 67.953 - 0.294 X + 0.248$
Ind_grw * PM - PM_Ratio	$y = -0.001 X1 + 0.0940$	$y = 0.001 X1 + 0.048 X2 - 0.389$	$y = 0.002 X1 + 0.028 X2 + 0.698$	$y = -0.005 X1 - 0.001 X2 + 0.952$	$y = 0.055 X1 + 0.366 X2 - 15.476$	$y = 0.055 X1 + 0.366 X2 - 15.476$	$y = 0.001 X1 + 0.049 X2 - 1.722$	$y = 0.001 X1 + 0.003 X2 + 0.043$	$y = -1.120 X1 - 0.273 X2 + 34.407$
MV_R - OP	$y = 57.851 + 3.433e-08 X + 9.807e-09$	No Relation	No Data	$y = 54.0152 + 2.391e-08 X + 1.919e-08$	$y = 63.600 + 1.991e-07 X + 2.977e-08$	$y = 63.600 + 1.991e-07 X + 2.977e-08$	$y = 45.494 - 6.524e-07 X + 1.844e-07$	$y = 50.143 + 1.621e-06 X + 1.906e-07$	$y = 69.506 + 9.998e-07 X + 3.469e-07$
MV_R * OP - OP_Ratio	$y = 0.0008 X2 - 0.042$	No Relation	No Data	$y = 0.012 X2 - 0.621$	No Relation	No Relation	$y = 0.005 X2 - 0.351$	$y = 0.0003 X2 + 0.038$	$y = -0.050 X2 + 5.510$
MV_R - PM	$y = 42.368 + 2.726e-08 X + 3.607e-08$	No Relation	No Data	$y = 25.820 - 4.575e-07 X + 1.189e-07$	$y = 25.195 - 1.0591e-05 X + 1.400e-07$	$y = 25.195 - 1.0591e-05 X + 1.400e-07$	$y = 49.159 + 1.033e-07 X + 1.504e-06$	$y = 49.159 + 1.033e-07 X + 1.504e-06$	$y = 66.737 + 2.091e-06 X + 2.165e-06$
MV_R * PM - PM_Ratio	$y = 0.002 X2 - 0.001$	$y = -0.0000008 X1 + 0.022 X2 + 0.268$	No Data	$y = 0.00000001 X1 + 0.004 X2 + 0.788$	$y = -0.00001 X1 + 0.102 X2 + 8.062$	$y = -0.00001 X1 + 0.102 X2 + 8.062$	$y = -0.00000004 X1 + 0.031 X2 - 0.781$	$y = -0.00000007 X1 + 0.002 X2 + 0.146$	$y = -0.00003 X1 + 0.572 X2 - 14.020$

TABLE I  
EQUATIONS OBTAINED FROM WESTERN ASIA COUNTRIES 1/2

	Turkey	UAE	Jordan	Kuwait	Palestine	Qatar	Saudi Arabia	Oman
PD - OP	$y = 56.603 + 0.0176 X + 0.004$	$y = 66.804 - 0.025 X + 0.001$	$y = 60.922 + 0.039 X + 0.003$	$y = 66.825 + 0.018 X + 0.001$	$y = 63.125 + 0.002 X + 0.001$	$y = 72.817 - 0.017 X + 0.001$	$y = 63.467 - 0.026 X + 0.031$	$y = 60.880 - 0.425 X + 0.024$
PD - HHP	$y = 0.517 - 0.005 X + 0.0002$	$y = 0.0359 - 0.0002 X + 2.503$	$y = 0.006 - 6.138 X + 8.099$	$y = 0.029 - 0.001 X + 9.877$	$y = 0.022 - 2.533 X + 8.893$	$y = 0.001 - 2.083 X + 3.416$	$y = 0.257 - 0.017 X + 0.001$	$y = 0.282 - 0.021 X + 0.002$
PD - PM	$y = 41.423 + 0.013 X + 0.019$	$y = 39.940 - 0.002 X + 0.004$	$y = 36.103 - 0.034 X + 0.008$	$y = 59.274 + 0.011 X + 0.006$	$y = 35.186 - 0.003 X + 0.001$	$y = 88.557 - 0.010 X + 0.011$	$y = 54.241 + 2.125 X + 0.292$	$y = 38.847 + 0.141 X + 0.067$
OP - OP_Ratio	$y = 0.107 - 0.001 X + 0.001$	$y = -4.425 + 0.069 X + 0.006$	$y = 1.124 - 0.016 X + 0.001$	$y = 1.067 - 0.014 X + 0.001$	$y = 0.370 - 0.004 X + 0.007$	$y = -23.245 + 0.335 X + 0.045$	$y = 0.013 + 2.258 X + 0.002$	$y = -0.578 + 0.0109 X + 0.001$
HHP - HH_Ratio	$y = -0.005 + 0.235 X + 0.017$	$y = -0.04 + 5.435 X + 0.499$	$y = 0.001 + 3.889 X + 0.264$	$y = -0.010 + 2.578 X + 0.220$	$y = -0.101 + 20.859 X + 1.699$	$y = -0.004 + 21.527 X + 1.374$	$y = -0.010 + 0.511 X + 0.049$	$y = 0.032 + 0.196 X + 0.014$
PM - PM_Ratio	$y = 0.095 - 0.001 X + 0.004$	$y = -10.311 + 0.315 X + 0.288$	$y = -0.021 + 0.335 X + 0.056$	$y = 9.874 - 0.131 X + 0.072$	$y = 16.506 + 0.561 X + 0.155$	$y = -92.553 + 1.214 X + 0.416$	$y = 0.750 - 0.006 X + 0.001$	$y = 102.48 - 0.196 X + 0.122$
PD*OP - OP_Ratio	$y = 0.001 X2 - 0.040$	$y = -0.002 X1 - 0.034 X2 + 2.567$	$y = 0.001 X1 + 0.010 X2 - 0.499$	$y = -0.001 X1 + 0.004 X2 - 0.175$	$y = -0.001 X1 + 0.005 X2 - 0.054$	$y = -0.009 X1 - 0.190 X2 + 15.125$	$y = -0.001 X1 - 0.001 X2 + 0.147$	$y = -0.005 X1 - 0.001 X2 + 0.123$
PD*HHP - HH_Ratio	$y = 2.626 X1 + 2.403 X2 - 0.008$	$y = 7.888 X1 + 7.731 X2 - 0.135$	$y = 1.239 X1 + 4.028 X2 - 0.003$	$y = -4.144 X1 + 2.284 X2 - 0.001$	$y = -9.192 X1 - 1.429 X2 + 0.720$	$y = 3.809 X1 + 2.260 X2 - 0.005$	$y = 0.004 X1 + 0.726 X2 - 0.069$	$y = -0.003 X1 + 0.091 X2 + 0.069$
PD*PM - PM_Ratio	$y = -0.002 X1 + 0.002 X2 + 0.163$	$y = -0.0325 X1 + 0.162 X2 - 2.506$	$y = 0.019 X1 + 0.124 X2 - 1.818$	$y = -0.014 X1 - 0.016 X2 + 4.852$	$y = -0.005 X1 + 0.040 X2 + 3.924$	$y = -0.116 X1 + 0.852 X2 - 49.065$	$y = -0.017 X1 + -0.001 X2 + 0.516$	$y = -0.247 X1 + 0.055 X2 + 2.321$
FA - OP	$y = 55.450 + 0.192 X + 0.054$	$y = 72.764 - 1.771 X + 0.388$	$y = 4497.50 - 348.923 X + 36.164$	$y = 66.488 + 10.320 X + 2.451$	No Data	No Data	No Data	No Data
FA * OP - OP_Ratio	$y = -0.001 X1 + 0.001 X2 - 0.019$	$y = -0.109 X1 - 0.042 X2 - 2.170$	$y = 1.734 X1 - 0.012 X2 - 1.040$	$y = -0.140 X1 - 0.009 X2 + 0.725$	No Data	No Data	$y = -1.735 X1 + 2.288 X2 + 0.013$	No Data
Ind_grw - OP	$y = 58.100 + 0.001 X + 0.009$	$y = 64.697 + 0.127 X + 0.108$	$y = 68.299 - 0.066 X + 0.043$	$y = 70.308 - 0.132 X + 0.030$	No Data	$y = 71.078 - 0.001 X + 0.035$	$y = 63.167 + 0.003 X + 0.010$	$y = 56.345 + 0.221 X + 0.078$
Ind_grw * OP - OP_Ratio	$y = 0.00002 X1 - 0.001 X2 + 0.107$	$y = -0.001 X1 + 0.070 X2 - 4.448$	$y = -0.0003 X1 - 0.016 X2 + 1.154$	$y = -0.001 X1 - 0.019 X2 + 1.390$	No Data	$y = -0.026 X1 + 0.335 X2 - 23.004$	$y = 0.0001 X1 - 0.0001 X2 + 0.026$	$y = 0.001 X1 + 0.010 X2 - 0.554$
Ind_grw - PM	$y = 42.545 + 0.004 X + 0.029$	$y = 40.206 - 0.097 X + 0.096$	$y = 33.783 + 0.001 X + 0.040$	$y = 60.705 + 0.036 X + 0.074$	No Data	$y = 89.570 - 0.291 X + 0.103$	$y = 77.845 - 0.058 X + 0.165$	$y = 40.180 - 0.021 X + 0.075$
Ind_grw * PM - PM_Ratio	$y = -0.001 X1 + 0.0940$	$y = 0.167 X1 + 0.380 X2 - 13.702$	$y = 0.015 X1 + 0.335 X2 - 10.318$	$y = 0.048 X1 - 0.143 X2 + 10.326$	No Data	$y = -0.178 X1 + 1.070 X2 - 78.720$	$y = 0.001 X1 - 0.005 X2 + 0.739$	$y = 0.123 X1 - 0.178 X2 + 9.117$
MV_R - OP	$y = 57.851 + 3.435e-08 X + 9.807e-09$	$y = 66.201 - 1.081e-06 X + 7.306e-08$	$y = 63.622 + 2.755e-06 X + 1.954e-07$	$y = 68.486 + 1.073e-06 X + 1.645e-07$	No Data	$y = 72.238 - 2.875e-06 X + 1.623e-08$	$y = 63.254 - 2.222e-08 X + 3.641e-08$	$y = 58.309 - 2.966e-06 X + 1.731e-07$
MV_R * OP - OP_Ratio	$y = 0.0008 X2 - 0.044$	$y = 0.004 X2 - 0.111$	$y = 0.006 X2 - 0.355$	$y = 0.005 X2 + 0.475$	No Data	$y = 0.298 X2 + 22.648$	$y = 0.001 X2 + 0.104$	$y = -0.001 X2 + 0.153$
MV_R - PM	$y = 42.568 + 2.726e-08 X + 3.867e-08$	$y = 39.791 - 6.304e-09 X + 1.991e-07$	$y = 34.707 - 1.893e-06 X + 3.580e-07$	$y = 60.634 + 6.079e-07 X + 4.798e-07$	No Data	$y = 88.586 - 2.630e-06 X + 1.864e-06$	$y = 69.279 + 2.452e-06 X + 3.227e-07$	$y = 39.817 + 7.140e-07 X + 4.925e-07$
MV_R * PM - PM_Ratio	$y = 0.002 X2 - 0.001$	$y = -0.000001 X1 + 0.306 X2 - 8.812$	$y = -0.000001 X1 + 0.054 X2 - 0.258$	$y = -0.000009 X1 - 0.045 X2 + 5.481$	No Data	$y = -0.00002 X1 - 0.660 X2 - 34.633$	$y = -0.000002 X1 - 0.0001 X2 + 0.367$	$y = -0.000001 X1 - 0.021 X2 + 3.892$

TABLE II  
EQUATIONS OBTAINED FROM WESTERN ASIA COUNTRIES 2/2

	Turkey	Sudan	Egypt	Algeria	Libya	Morocco	Tunisia
PD - OP	$y = 56.603 + 0.0176 X + 0.004$	$y = 45.791 + 0.260 X + 0.021$	$y = 49.208 + 0.142 X + 0.008$	$y = 57.822 + 0.172 X + 0.028$	$y = 49.635 + 2.594 X + 0.376$	$y = 45.419 + 0.121 X + 0.017$	$y = 59.370 + 0.046 X + 0.010$
PD - HHP	$y = 41.423 + 0.013 X + 0.019$	$y = 1.087 - 0.019 X + 0.003$	$y = 0.233 - 0.002 X + 0.0001$	$y = 0.057 - 0.003 X + 0.0001$	$y = 0.038 - 0.010 X + 0.0004$	$y = 0.078 - 0.0007 X + 0.001$	$y = 0.396 - 0.005 X + 0.001$
PD - PM	$y = 41.423 + 0.013 X + 0.019$	$y = 49.205 + 0.099 X + 0.145$	$y = 38.082 + 0.226 X + 0.061$	$y = 37.904 - 0.106 X + 0.159$	$y = 34.151 + 4.099 X + 1.047$	$y = 27.520 + 0.043 X + 0.027$	$y = 36.779 - 0.019 X + 0.040$
OP - OP_Ratio	$y = 0.107 - 0.001 X + 0.001$	$y = 0.103 - 0.001 X + 0.001$	$y = 0.0154 - 0.001 X + 1.219$	$y = 0.131 - 0.002 X + 0.001$	$y = 0.079 - 0.001 X + 0.001$	$y = 0.032 - 0.001 X + 6.346$	$y = 0.522 - 0.007 X + 0.002$
HHP - HHL_Ratio	$y = -0.005 + 0.235 X + 0.017$	$y = -0.573 + 1.219 X + 0.330$	$y = -0.003 + 0.282 X + 0.030$	$y = -0.002 + 0.582 X + 0.062$	$y = -0.002 + 1.630 X + 0.127$	$y = -0.012 + 1.346 X + 0.244$	$y = -0.012 + 1.744 X + 0.106$
PM - PML_Ratio	$y = 0.095 - 0.001 X + 0.004$	$y = 0.051 + 0.001 X + 0.001$	$y = 0.331 - 0.002 X + 0.001$	$y = -0.046 + 0.005 X + 0.005$	$y = 2.270 - 0.023 X + 0.009$	$y = 0.494 - 0.008 X + 0.006$	$y = -0.007 + 0.015 X + 0.013$
PD*OP - OP_Ratio	$y = 0.001 X2 - 0.040$	$y = -0.001 X1 + 0.001 X2 - 0.012$	$y = -1.950 X1 - 4.424 X2 + 0.009$	$y = -0.001 X1 + 0.001 X2 - 0.005$	$y = -0.016 X1 + 0.003 X2 - 0.106$	$y = 7.860 X1 - 5.272 X2 + 0.015$	$y = -0.001 X1 + 0.002 X2 - 0.032$
PD*HHP - HHL_Ratio	$y = 2.626 X1 + 2.403 X2 - 0.008$	$y = -0.064 X1 - 0.389 X2 + 1.709$	$y = -0.001 X1 - 0.059 X2 + 0.083$	$y = -0.002 X1 - 0.271 X2 - 0.049$	$y = -0.026 X1 - 0.794 X2 + 0.095$	$y = -0.001 X1 + 0.310 X2 + 0.132$	$y = -1.310 X1 + 1.535 X2 + 0.074$
PD*PM - PML_Ratio	$y = -0.002 X1 + 0.002 X2 + 0.163$	$y = -0.005 X1 + 0.002 X2 + 0.088$	$y = -0.002 X1 + 0.001 X2 + 0.232$	$y = -0.020 X1 + 0.002 X2 + 0.363$	$y = -0.397 X1 + 0.012 X2 + 1.834$	$y = -0.005 X1 + 0.001 X2 + 0.523$	$y = -0.014 X1 + 0.009 X2 + 1.078$
FA - OP	$y = 55.450 + 0.192 X + 0.054$	No Data	No Data	$y = 56.687 + 4.892 X + 0.764$	No Data	$y = 40.905 + 1.070 X + 0.227$	$y = 60.606 - 0.278 X + 0.073$
FA * OP - OP_Ratio	$y = -0.001 X1 + 0.001 X2 - 0.019$	No Data	No Data	$y = -0.009 X1 - 0.001 X2 + 0.004$	No Data	$y = -0.001 X1 + 0 X2 + 0.026$	$y = -0.006 X1 + 0 X2 + 0.038$
Ind_gtw - OP	$y = 58.100 + 0.001 X + 0.009$	$y = 49.938 + -0.001 X + 0.015$	$y = 61.429 - 0.352 X + 0.121$	$y = 60.210 + 0.001 X + 0.053$	No Data	$y = 53.758 - 0.046 X + 0.067$	$y = 62.305 - 0.053 X + 0.020$
Ind_gtw * OP - OP_Ratio	$y = -0.0002 X1 - 0.001 X2 + 0.107$	$y = 0.00009 X1 - 0.001 X2 + 0.103$	$y = -0.0002 X1 - 0.0002 X2 + 0.016$	$y = 0.001 X1 - 0.002 X2 + 0.130$	No Data	$y = 0.00001 X1 - 0.001 X2 + 0.052$	$y = 0.0004 X1 - 0.006 X2 + 0.405$
Ind_gtw - PM	$y = 42.545 + 0.004 X + 0.029$	$y = 51.117 - 0.040 X + 0.041$	$y = 78.035 - 0.677 X + 0.337$	$y = 36.432 - 0.001 X + 0.195$	No Data	$y = 30.509 - 0.013 X + 0.066$	$y = 35.565 + 0.002 X + 0.069$
Ind_gtw * PM - PML_Ratio	$y = -0.001 X1 + 0.0940$	$y = 0.001 X2 + 0.053$	$y = 0.002 X1 - 0.001 X2 + 0.283$	$y = 0.004 X1 + 0.005 X2 - 0.060$	No Data	$y = 0.001 X1 - 0.008 X2 + 0.490$	$y = 0.013 X1 + 0.015 X2 - 0.030$
MV_R - OP	$y = 57.851 + 3.433 - 0.8 X + 9.807e-09$	$y = 46.796 + 3.913e-05 X + 3.360e-06$	$y = 57.871 + 8.393e-07 X + 5.486e-08$	$y = 59.721 + 1.793e-07 X + 3.032e-08$	$y = 56.397 + 1.070e-06 X + 9.838e-08$	$y = 52.407 + 6.803e-07 X + 1.007e-07$	$y = 61.555 + 6.773e-07 X + 1.534e-07$
MV_R * OP - OP_Ratio	$y = 0.0008 X2 - 0.042$	$y = 0.00064319 X2 - 0.014$	No Relation	$y = 0.003 X2 - 0.009$	$y = 0.005 X2 - 0.256$	No Relation	$y = 0.001 X2 - 0.070$
MV_R - PM	$y = 42.368 + 2.726e-08 X + 3.867e-08$	$y = 49.801 + 1.230e-05 X + 2.201e-05$	$y = 71.828 + 1.363e-06 X + 3.615e-07$	$y = 36.752 - 1.178e-07 X + 1.680e-07$	$y = 44.818 + 1.704e-06 X + 3.493e-07$	$y = 30.052 + 2.336e-07 X + 1.558e-07$	$y = 35.931 - 3.906e-07 X + 6.031e-07$
MV_R * PM - PML_Ratio	$y = 0.002 X2 - 0.001$	$y = -0.0000008 X1 + 0.002 X2 + 0.076$	$y = -0.00000001 X1 + 0.001 X2 + 0.082$	$y = -0.00000002 X1 + 0.002 X2 + 0.140$	$y = -0.00000001 X1 + 0.017 X2 - 0.540$	$y = -0.00000003 X1 + 0.001 X2 + 0.239$	$y = -0.00000002 X1 + 0.006 X2 + 0.502$

TABLE III  
EQUATIONS OBTAINED FROM NORTHERN AFRICA COUNTRIES

	Turkey	Iran	Afghanistan
PD - OP	$y = 56.603 + 0.0176 X + 0.004$	$y = 54.086 + 0.156 X + 0.017$	$y = 58.624 + 0.052 X + 0.005$
PD - HHP	$y = 0.517 - 0.005 X + 0.0002$	$y = 0.207 - 0.004 X + 0.000$	$y = 1.006 - 0.004 X + 0.0003$
PD - PM	$y = 41.423 + 0.013 X + 0.019$	$y = 35.619 + 0.062 X + 0.017$	$y = 69.458 - 0.150 X + 0.038$
OP - OP_Ratio	$y = 0.107 - 0.001 X + 0.001$	$y = 0.015 - 0.001 X + 5.844$	$y = 0.650 - 0.010 X + 0.001$
HHP - HH_Ratio	$y = -0.005 + 0.235 X + 0.017$	$y = -0.002 + 0.246 X + 0.017$	$y = -4.912 + 7.092 X + 0.902$
PM - PM_Ratio	$y = 0.095 - 0.001 X + 0.004$	$y = 0.641 - 0.014 X + 0.004$	$y = -0.549 + 0.011 X + 0.004$
PD*OP - OP_Ratio	$y = 0.001 X2 - 0.040$	$y = -9.550 X1 + 2.703 X2 - 0.008$	$y = -0.001 X1 + 0.003 X2 - 0.164$
PD*HHP - HH_Ratio	$y = 2.626 X1 + 2.403 X2 - 0.008$	$y = 8.977 X1 + 2.654 X2 - 0.006$	$y = -0.060 X1 - 3.539 X2 + 6.120$
PD*PM - PM_Ratio	$y = -0.002 X1 + 0.002 X2 + 0.163$	$y = -0.003 X1 + 0.002 X2 + 0.111$	$y = -0.006 X1 - 0.004 X2 + 0.727$
FA - OP	$y = 55.450 + 0.192 X + 0.054$	No Data	$y = 55.809 + 2.285 X + 2.76$
FA * OP - OP_Ratio	$y = -0.001 X1 + 0.001 X2 - 0.019$	No Data	$y = 0.0302 X1 - 0.010 X2 + 0.587$
Ind_grw - OP	$y = 58.100 + 0.001 X + 0.009$	$y = 60.696 - 0.015 X + 0.020$	$y = 61.642 - 0.115 X + 0.015$
Ind_grw * OP - OP_Ratio	$y = -0.00002 X1 - 0.001 X2 + 0.107$	$y = 0.00001 X1 - 0.0001 X2 + 0.0152$	$y = 0.00009 X1 - 0.0009 X2 + 0.616$
Ind_grw - PM	$y = 42.545 + 0.004 X + 0.029$	$y = 38.230 - 0.004 X + 0.012$	$y = 59.776 + 0.439 X + 0.075$
Ind_grw * PM - PM_Ratio	$y = -0.001 X1 + 0.0940$	$y = 0.001 X1 - 0.014 X2 + 0.628$	$y = 0.009 X1 - 0.001 X2 + 0.176$
MV_R - OP	$y = 57.851 + 3.433e-08 X + 9.807e-09$	$y = 59.709 + 1.528e-07 X + 1.254e-08$	$y = 59.797 + 1.016e-06 X + 1.128e-07$
MV_R * OP - OP_Ratio	$y = 0.0008 X2 - 0.042$	No Relation	$y = 0.001 X2 + 0.099$
MV_R - PM	$y = 42.368 + 2.726e-08 X + 3.867e-08$	$y = 37.849 + 5.966e-08 X + 1.573e-08$	$y = 66.568 - 3.536e-06 X + 6.549e-07$
MV_R * PM - PM_Ratio	$y = 0.002 X2 - 0.001$	$y = 0.003 X2 - 0.025$	$y = -0.0000001 X1 - 0.008 X2 + 0.861$

TABLE IV  
EQUATIONS OBTAINED FROM SOUTH-CENTRAL ASIA COUNTRIES

	Turkey	Bulgaria	Greece
PD - OP	$y = 56.603 + 0.0176 X + 0.004$	$y = 52.391 + 0.0162 X + 0.020$	$y = 51.512 + 0.082 X + 0.044$
PD - HHP	$y = 0.517 - 0.005 X + 0.0002$	$y = -0.337 + 0.007 X + 0.001$	$y = 0.295 - 0.003 X + 0.0003$
PD - PM	$y = 41.423 + 0.013 X + 0.019$	$y = -10.065 + 0.481 X + 0.044$	$y = 47.724 - 0.346 X + 0.124$
OP - OP_Ratio	$y = 0.107 - 0.001 X + 0.001$	$y = 0.073 - 0.001 X + 0.001$	$y = -0.178 + 0.003 X + 0.001$
HHP - HH_Ratio	$y = -0.005 + 0.235 X + 0.017$	$y = -0.107 + 1.595 X + 0.096$	$y = -0.002 + 0.621 X + 0.035$
PM - PM_Ratio	$y = 0.095 - 0.001 X + 0.004$	$y = 0.323 + 0.013 X + 0.003$	$y = -0.188 + 0.024 X + 0.002$
PD*OP - OP_Ratio	$y = 0.001 X2 - 0.040$	$y = -9.447 X1 - 6.166 X2 + 0.073$	$y = 0.002 X2 - 0.177$
PD*HHP - HH_Ratio	$y = 2.626 X1 + 2.403 X2 - 0.008$	$y = 0.013 X1 + 0.042 X2 - 0.707$	$y = -0.001 X1 + 0.430 X2 + 0.070$
PD*PM - PM_Ratio	$y = -0.002 X1 + 0.002 X2 + 0.163$	$y = 0.009 X1 - 0.002 X2 + 0.050$	$y = -0.005 X1 + 0.020 X2 + 0.365$
FA - OP	$y = 55.450 + 0.192 X + 0.054$	$y = 54.730 - 0.036 X + 0.047$	$y = 52.904 + 0.187 X + 0.029$
FA * OP - OP_Ratio	$y = -0.001 X1 + 0.001 X2 - 0.019$	$y = -0.001 X2 + 0.057$	$y = 0.001 X2 - 0.100$
Ind_grw - OP	$y = 58.100 + 0.001 X + 0.009$	$y = 53.542 + 0.004 X + 0.006$	$y = 58.299 - 0.030 X + 0.011$
Ind_grw * OP - OP_Ratio	$y = -0.00002 X1 - 0.001 X2 + 0.107$	$y = 0.00002 X1 - 0.0008 X2 + 0.079$	$y = -0.0001 X1 + 0.002 X2 - 0.114$
Ind_grw - PM	$y = 42.545 + 0.004 X + 0.029$	$y = 23.902 - 0.044 X + 0.029$	$y = 19.337 + 0.042 X + 0.038$
Ind_grw * PM - PM_Ratio	$y = -0.001 X1 + 0.0940$	$y = 0.013 X2 + 0.325$	$y = 0.001 X1 + 0.023 X2 - 0.167$
MV_R - OP	$y = 57.851 + 3.433e-08 X + 9.807e-09$	$y = 53.675 - 6.468e-08 X + 9.729e-08$	$y = 54.784 + 6.0183e-07 X + 9.799e-08$
MV_R * OP - OP_Ratio	$y = 0.0008 X2 - 0.042$	$y = -0.001 X2 + 0.068$	$y = 0.001 X2 - 0.065$
MV_R - PM	$y = 42.368 + 2.726e-08 X + 3.867e-08$	No Relation	$y = 30.752 - 1.958e-06 X + 2.613e-07$
MV_R * PM - PM_Ratio	$y = 0.002 X2 - 0.001$	$y = -0.00000005 X1 - 0.006 X2 + 0.908$	$y = -0.00000004 X1 + 0.011 X2 + 0.280$

TABLE V  
EQUATIONS OBTAINED FROM EUROPE COUNTRIES