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Economic Performance Evaluation of Fragile 5 Countries after the Great Recession of 2008-2009 using Analytic Network Process and TOPSIS Methods

Emrah Önder[1], Nihat Taş[2] and Ali Hepşen[3]

Abstract

Economic performance evaluation problem consists many criteria and sub criteria. Therefore it is a kind of multi-criteria decision making (MCDM) problem. It is very important for a country to monitor performance parameters in order to ensure that appropriate and timely decisions and plans can be made. Suitable performance measures can ensure that governments adopt a long-term perspective and allocate the country's resources to the most effective activities. Fragile five (F5) countries namely Brazil, Turkey, India, Indonesia and South Africa have large and fast growing economies. These developing countries are the members of the G20 countries. But F5 countries have also some economic problems such as current account deficit, external credit and currency. The aim of this study is to evaluate the economic performance model of F5 countries during 2001-2013 periods. Both Analytical Network Process (ANP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methodologies are used for the outranking of countries using macroeconomic indicators including gross domestic product, current account balance, general government gross debt, general government revenue, general government total expenditure, gross national savings, inflation (average consumer prices), population, total investment, unemployment rate, volume of exports of goods and services, volume of imports of goods and services. In this study, subjective and objective opinions of economy expert turn into quantitative form with ANP.

JEL classification numbers: C53, E00, E27, E29
Keywords: Fragile Five Countries, Economic Crisis, Macro Economic Parameters, Economic Performance Evaluation, Analytic Network Process, TOPSIS

[1]Dr., Istanbul University, School of Business, Department of Quantitative Methods. Istanbul.
[2]Dr., Istanbul University, School of Business, Department of Quantitative Methods. Istanbul
[3]Assoc. Prof. Dr., Istanbul University, School of Business, Department of Finance. Istanbul.

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1 Introduction

An emerging market is a country that has some characteristics of a developed market but is not yet a developed market. This includes countries that may be developed markets in the future or were in the past. It may be a nation with social or business activity in the process of rapid growth and industrialization. The four largest emerging and developing economies by gross domestic product (GDP) are the BRIC countries (Brazil, Russia, India and China); the next four largest markets are MIKT (Mexico, Indonesia, South Korea and Turkey) and finally there is a new terminology named Fragile 5 (Brazil, India, Indonesia, Turkey and South Africa) in the emerging market.

According to the International Monetary Fund (IMF), there are 25 countries classified as emerging market economies. They exhibit varying levels of economic growth, inflation, trade and fiscal conditions. Ten years ago, Goldman Sachs declared Brazil, Russia, India and China (BRIC) as the emerging markets with the brightest economic growth prospects. In the year 2013, Morgan Stanley declared the Brazilian real, the Indian rupee, the Indonesian rupiah, the South African rand and the Turkish lira as the "Fragile Five", or the troubled emerging market currencies under the most pressure against the U.S. dollar. According to [1],these countries have important things in common-high inflation, weakening growth, large external, and high dependence on fixed income inflows leave these currencies vulnerable. The risks associated with these particular five currencies are also evident from the fact that central banks in these countries have been among the most aggressive in their bid to support their currencies.

The main purpose of this study is to evaluate economic performance of Fragile 5 Countries in order to identify the fragility of them in economic recession period and beyond. The rest of this article is organized as follows. The next two sections present a literature review and give brief information for the Great Recession of 2008-2009. The following section provides overview of fragile five countries and selected macroeconomic parameters. Section five and six explain the theoretical framework adopted in this study and the results. The final section is the conclusion.

2 Literature Review

[2] studied the rank of performance of selected Middle East and North Africa (MANA) countries by employing Multiple Attribute Decision Making (MADM). The results of the study indicated that the MENA countries achieved higher values of desirable attributes and lower values of undesirable attributes. [3] adopted analytic network process to study the influence of Reverse Logistics practices in corporate performance in Brazil. They obtained coherent results to the reality of Brazilian companies and recommended the usage of ANP to identify how different Reverse Logistics programs can affect corporate performance indicators. [4] proposed an analytical network process approach based on balanced scorecard (BS) to evaluate banking performance. They chose twenty three indices fit for banking performance evaluation by using expert questionnaires and showed that their suggested ANP evaluation model for banking performance is both useful and effective assessment tool. [5] altered the modified Delphi and the analytic network process (ANP) methods to build an evaluation method and to ascertain ANP effectiveness. They concluded that ANP is an effective tool to provide an accurate solution for the decision makers. [6] developed a model to forecast the likelihood of a

financial crisis based on an analytic network process framework. They argued their framework is more flexible and is more comprehensive than traditional methods and previous models. [7] investigated the impacts of the changes in the number of business owners on three measures of economic performance which are employment growth, GDP growth and labor productivity growth for twenty-one OECD countries. They showed the net effect is positive for employment and GDP growth but no effect on labor productivity. [8] examined the impact of liberal policies on the economic performance of labor and capital productivity in the Middle East and North African (MENA) countries, by using nonlinear panel least squares regression with regional dummies and period fixed effects (LSDV) for a sample of 18 MENA countries over the period 1995-2009. He estimated the impact of different aspects of economic freedom on labor and capital productivity. [9] evaluated the performance of OECD countries and identified the most critical science and technology factors in these countries by using the indicators of science and technology progress suggested by World Bank and exploiting Data Envelopment Analysis (DEA). They measured the efficiency of these countries. They ranked the countries and performed the sensitivity analyses of the factors by Norm-2 method in order to identify the most important factors. [10] examined growth rates (GDP) in developed and developing countries that is implement of inflation targeting strategy show how a change in the period before and after the crisis (2005-2011). They took into account the inflation performance of those countries for the same period. They compared growth and inflation performances of the countries by means of table and graphical form. [11] ranked stock exchange development level of forty countries including twenty developed and twenty developing countries by means of TOPSIS method during 2004-2008. They used depth, width and sophistication and considered these three criteria as indices of stock exchange development using TOPSIS method. They found average ranks of the countries based on depth, width and sophistication indices during the research time period.

3 The Great Recession of 2008-2009

The financial crisis that began in the US in the year 2007 became a full scale crisis in the year 2008 and 2009 which, in turn, affected each and every economy in some way or the other including the ones which were not directly related to the crisis. The year 2008 and 2009 is now known as the extreme recession time in the history of global economy, with major adverse consequences for banks and financial markets around the world. According to IMF report regarding GDP growth rate in the world, it had been growing around 5% since 2004. However, by the end of 2008, GDP growth declined to 3.1%, which was the lowest growth rate in the period 2003-2008. IMF also released 1.5% GDP growth rate in the year 2009. Most of all emerging countries have undergone through the volatile situation as a result of great recession, which made the shrinkage of growth rate and total investments, increase in inflation, unemployment and current account deficit.

4 Fragile Five Countries and Selected Macroeconomic Parameters

As mentioned, Morgan Stanley declared Brazil, India, Indonesia, South Africa and Turkey as the "Fragile Five" countries in the year 2013 due to their vulnerable economies.

The first country among them is Brazil. Brazil is recovering gradually from the growth slowdown that started in mid-2011, but the recovery remains uneven and inflation elevated. Output is estimated at potential with supply-side constraints, linked to tight labor market conditions and protracted weak investment since 2011, limiting near term growth. Excessive fine tuning of fiscal policy (including through public banks) has weakened the credibility of Brazil's long-standing fiscal framework, while broader policy uncertainty has weighed on investment. On the other hand, global financial conditions and commodity prices may directly affect Brazilian GDP growth rate for the following years[12].

The tightening of global liquidity has increased external pressures and heightened the focus on India's macroeconomic imbalances (high inflation, large current account and fiscal deficits) and structural weaknesses (particularly supply bottlenecks in infrastructure, power and mining). Growth is expected to slow to 5.4% in the year 2014, reflecting global developments and domestic supply constraints. The current account deficit is narrowing, driven by a significant improvement in exports, robust remittances flows, and a rapid diminution of gold imports. High and persistent inflation is a key macroeconomic challenge facing India. If external pressures from global financial market volatility resume, Indian rupee flexibility should be the first line of defense, complimented by use of reserves, increases in short-term interest rates, actions on the fiscal front, and further easing of constraints on capital inflows[13].

A slowdown in growth in major emerging market economies (EMEs) and decline in commodity prices, and more recently, a reversal in push factors tied to a prospective exit from extraordinarily easy global monetary conditions, has put pressure on Indonesia's balance of payments and heightened its vulnerability to shocks. Domestic policy accommodation and rising energy subsidies have also given rise to increased external and fiscal imbalances. Recent policy tightening, fuel price hikes, and exchange rate flexibility have been firmly aimed at reducing these pressures. Growth is projected to slow to 5.36% in 2014. Inflation will likely peak at just below 10% at end2014, due mainly to the one-off effect of June 2013 fuel price increases and rupiah depreciation. The current account deficit is expected to exceed 3 percent of GDP in 2014 on weak commodity exports. Reserves have also come under pressure, partly due to Bank Indonesia's heavy intervention in the foreign exchange market in mid-2013. Recent market volatility and reserve losses highlight the need to deal decisively with macroeconomic imbalances and contain financial stability risks [14].

South Africa has made impressive strides in economic development over the past two decades. But in recent years, lower growth has exacerbated high unemployment, inequality, and vulnerabilities. Although weak trading partner growth contributed, domestic factors were an important reason why South Africa's growth has been below that of other emerging markets. Large current account and fiscal deficits, so far easily financed by global liquidity, have raised vulnerabilities[15].

Finally, Turkey has a stronger domestic demand, with the current account deficit is widening again from a high level, and inflation remains well above target (7.6%). Increasing national savings and improving competitiveness are central to addressing vulnerabilities. On the other hand, economic growth lost momentum in the course of 2013, as capital market tensions pushed interest rates up. Credit and private demand decelerated. Export growth fell, notably due to rapidly declining gold sales. Political tensions have dented confidence, provoking capital outflows and forcing the central bank to raise interest rates sharply in early 2014. Growth is projected to remain subdued

through mid-2015, while the current account deficit will remain very high. Sustaining domestic and international confidence is crucial. Monetary, fiscal and financial policies should remain prudent. Improving fiscal transparency with timely general government accounts and comprehensive reporting on the activities of quasi-fiscal institutions is recommended. Disinflation is essential to preserve the bulk of recent competitiveness gains and to allow Turkey to benefit more from the projected recovery in global trade. Increasing the share of foreign direct investment inflows by improving business conditions in the formal sector would help reduce external vulnerability[16].
Our model comprises eleven variables that are received from [17] [gross domestic product (constant prices), current account balance, inflation (average consumer prices), unemployment rate, total investment, gross national savings, general government revenue, general government total expenditure, volume of export of goods and services, volume of imports of goods and services, and general government gross debt]to evaluate economic performance of these countries in order to identify the fragility of them in economic recession period and beyond.

5 Proposed Methodology

In this part of the study, the Analytic Network Process, TOPSIS method and proposed converting scale method will be given.

5.1 Analytical Network Process

ANP proposed by [18] is a general form of the Analytic Hierarchy Process (AHP). ANP is one of the multi criteria decision making techniques which consider the dependence among criteria and alternative. Therefore it offers several advantages over other MCDM techniques. There are mainly six steps in ANP.

Step 1. Define decision problem
Step 2. Determine dependencies among clusters (outer dependence) and elements of the clusters (inner dependence)
Step 3. Pairwise comparisons of the elements and clusters
Step 4. Determine the supermatrix and weighted supermatrix
Step 5. Calculate the limit supermatrix.
Step 6. Select the best alternative.

The general form of the supermatrix can be described as follows:

$$
W = \begin{array}{c}
 \\
 \\
C_1 \\
 \\
 \\
 \\
C_2 \\
 \\
 \\
 \\
C_m \\
 \\
 \\
 \\
\end{array}
\begin{array}{c}
\begin{array}{cccccccccccc}
 & & C_1 & & & & C_2 & & & & C_m & \\
 & e_{11} & e_{12} & \cdots & e_{1n_1} & e_{21} & e_{22} & \cdots & e_{2n_2} & \cdots & e_{m1} & e_{m2} \quad \cdots \quad e_{mn_m}
\end{array} \\
\begin{bmatrix}
W_{11} & & W_{12} & & \cdots & & W_{1m} \\
 & & & & & & \\
 & & & & & & \\
 & & & & & & \\
W_{21} & & W_{22} & & \cdots & & W_{2m} \\
 & & & & & & \\
\vdots & & \vdots & & \ddots & & \vdots \\
 & & & & & & \\
W_{m1} & & W_{m2} & & \cdots & & W_{mm}
\end{bmatrix}
\end{array}
\begin{array}{l}
 \\
 e_{11} \\
 e_{12} \\
 \vdots \\
 e_{1n_1} \\
 e_{21} \\
 e_{22} \\
 \vdots \\
 e_{2n_2} \\
 \vdots \\
 e_{m1} \\
 e_{m2} \\
 \vdots \\
 e_{mn_m}
\end{array}
\tag{1}
$$

Where C_m denotes the m_{th} cluster, e_{mn} denotes the n_{th} element in the m_{th} cluster and W_{ij} is the principal eigenvector of the influence of the elements compared in j_{th} cluster to the i_{th} cluster. If the j_{th} cluster has no influence on the i_{th} cluster, then $W_{ij}=0$ [19]. After forming the supermatrix, the weighted supermatrix is derived by transforming all column sums to unity exactly. This step is very similar to the concept of a Markov chain for ensuring the sum of these probabilities of all states is equal to 1[20]. Next, we raise the weighted supermatrix to limiting power such as $\lim_{k\to\infty} W^k$ to get the global priority vectors.

5.2 Using Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to rank the alternatives

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was first presented by [21] and [22], for solving multiple criteria decision making (MCDM) problems based upon the concept that the chosen alternative should have the shortest Euclidian distance from the positive ideal solution (PIS) and the farthest from the negative ideal solution (NIS). For instance, PIS maximizes the benefit and minimizes the cost, whereas the NIS maximizes the cost and minimizes the benefit. It assumes that each criterion require to be maximized or minimized. TOPSIS is a simple and useful technique for ranking a number of possible alternatives according to closeness to the ideal solution. Expanded developments of TOPSIS were done by [23] and [24]. This MCDM technique is widely used in many fields, including financial performance evaluation, supplier selection, tourism destination evaluation, location selection, company evaluation, selecting the most suitable machine, ranking the carrier alternatives [25]. One of the advantages of TOPSIS is that pair-wise comparisons are avoided. TOPSIS is conducted as follows [26].

Step 1.Establish a decision matrix for the ranking. TOPSIS uses all outcomes (x_{ij}) in a decision matrix to develop a compromise rank. The viable alternatives of the decision process are A_1, A_2, ..., A_n. The structure of the decision matrix denoted by $X = (x_{ij})_{n\times m}$ can be expressed as follows:

$$X = \begin{array}{c} \\ \\ \\ \\ \\ \\ \end{array} \begin{array}{c} \begin{array}{cccccc} m & & & Criteria & & \\ C_1 & C_2 & \cdots & C_j & \cdots & C_m \end{array} \\ \left[\begin{array}{cccccc} x_{11} & x_{12} & \cdots & x_{1j} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2j} & \cdots & x_{2m} \\ \vdots & \vdots & \cdots & \vdots & \cdots & \vdots \\ x_{i1} & x_{i2} & \cdots & x_{ij} & \cdots & x_{im} \\ \vdots & \vdots & \cdots & \vdots & \cdots & \\ x_{n1} & x_{n2} & \cdots & x_{nj} & \cdots & x_{nm} \end{array}\right] \end{array} \begin{array}{l} A_1 \\ A_2 \\ \vdots \\ A_i \\ \vdots \\ A_n \end{array} \Bigg\} n \quad Alternatives \tag{2}$$

x_{ij} is the outcome of i[th] alternative with respect to j[th] criteria. $W = (w_1, w_2, \ldots, w_j, \ldots, w_m)$ is the relative weight vector about the criteria, and w_j represents the weight of the j[th] attribute and $\sum_{j=1}^{m} w_j = 1$.

Step 2.Normalize the decision matrix using the following equation:

$$r_{ij} = \frac{w_{ij}}{\sqrt{\sum_{k=1}^{n} w_{ij}^2}} \text{ i=1,2,3,…,n} \quad \text{j=1,2,3,…,m} \tag{3}$$

Step 3.Weighted normalized decision matrix is calculated by multiplying the normalized decision matrix by its associated weights as:

$$v_{ij} = w_j r_{ij} \text{ i=1,2,3,…,n} \quad \text{j=1,2,3,…,m} \tag{4}$$

Step 4.Identify the positive ideal solution (PIS) and negative ideal solution (NIS), respectively, as follows:

$$PIS = A^* = \left\{v_1^*, v_2^*, ..., v_m^*\right\} = \left\{\left(\max_i v_{ij} \mid j \in \Omega_b\right), \left(\min_i v_{ij} \mid j \in \Omega_c\right)\right\} \tag{5}$$

$$NIS = A^- = \left\{v_1^-, v_2^-, ..., v_m^-\right\} = \left\{\left(\min_i v_{ij} \mid j \in \Omega_b\right), \left(\max_i v_{ij} \mid j \in \Omega_c\right)\right\} \tag{6}$$

Ω_b is associated with benefit criteria, and Ω_c is associated with cost criteria.

Step 5.Determine the Euclidean distance (separation measures) of each alternative from the ideal and negative-ideal solution as below respectively:

$$d_i^* = \sqrt{\sum_{j=1}^{m} \left(v_{ij} - v_j^*\right)^2} \text{ , i=1,2,3,…,n} \tag{7}$$

$$d_i^- = \sqrt{\sum_{j=1}^{m} \left(v_{ij} - v_j^-\right)^2} \text{ , i=1,2,3,…,n} \tag{8}$$

Step 6. Calculate the relative closeness of the i[th] alternative to ideal solution using the following equation:

$$RC_i = \frac{d_i^-}{d_i^* + d_i^-},\ \text{i=1,2,3,…,n} \quad RC_i \in [0,1] \tag{9}$$

Step 7.By comparing RC_i values, the ranking of alternatives are determined. The higher the closeness means the better the rank. Ranked the alternatives starting from the value that closest to 1 and in decreasing order.

5.3 Converting Simple Correlation Matrix into Saaty's 1-9 Scale

The method which is used to generate number of n score matrices from simple correlation matrix as an alternative to expert's scores is briefly summarized below:
For each of n criteria of $x_1, x_2, ..., x_n$,

Step 1. Simple correlation matrix (R) is calculated. Hypothesis testing for each simple correlation coefficient is performed at 10% significance level and the tested coefficient is replaced by zero when decision is "do not reject H_0". (H_0: Coefficient of correlation is zero.)

$$R = \left[r_{ij} \right]_{n \times n} \tag{10}$$

Step 2. A number named as scaling multiplier (SM) is defined:

$$\text{Scaling Multiplier} = SM = \frac{n}{|r_{\max}| - |r_{\min}|} \tag{11}$$

Step 3. $\forall k = 1, 2, ..., n$, Upper triangular score matrix UN_k is obtained for x_k:

$$UN_k = \left[n_{ij} \right]_{(n-1)\times(n-1)} \tag{12}$$

and

for $\{i \neq k,\ \ j \neq k \text{ and } i < j\}\ \forall \{i = 1, 2, ..., n \text{ ve } j = 2, 3, ..., n\}$,

$$score_{ij} = n_{ij} = \begin{cases} RS_{ij}, & \text{if } RS_{ij} > 0 \\ \dfrac{1}{|RS_{ij}|}, & \text{if } RS_{ij} < 0 \end{cases} \tag{13}$$

where

$$RawScore_{ij} = RS_{ij} = \begin{cases} SM.AD_{ij} + \operatorname{sgn}(AD_{ij}), & \text{if } AD_{ij} \neq 0 \\ 1, & \text{if } AD_{ij} = 0 \end{cases} \tag{14}$$

and

$$AbsoluteDifference_{ij} = AD_{ij} = |r_{ki}| - |r_{kj}| \tag{15}$$

are defined as given.

$\operatorname{sgn}(\ )$: Represents the sign (or signum) function that extracts the sign of a real number. For any real number c, it is defined as

$$\operatorname{sgn}(c)=\begin{cases}\dfrac{|c|}{c}, & c\neq 0\\ 0, & c=0\end{cases} \tag{16}$$

Step 4. Lower triangular score matrix $LN_k=\left[l_{ji}\right]_{(n-1)\times(n-1)}$ (17)

is obtained for x_k :

$$l_{ji}=\frac{1}{n_{ij}} \tag{18}$$

Step 5. Score matrix M is calculated and used instead of expert's scores:

$$M=\left[LN+UN+I_{(n-1)\times(n-1)}\right]_{(n-1)\times(n-1)} \tag{19}$$

5.4 Proposed Method

In analyzing the data, Analytical Network Process (ANP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methodologies are used for the outranking of F5 countries. Figure 1 shows the steps of the proposed method.

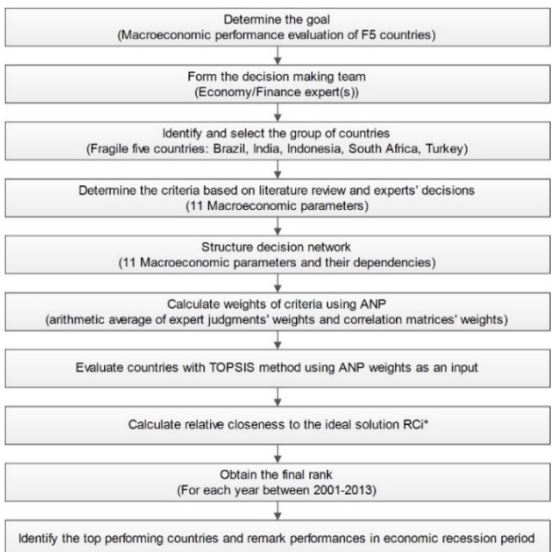

Figure1: Steps of proposed method

6 Combining ANP and TOPSIS to Determine the Rank of F5 Countries

The proposed model of this paper uses an combined method of correlation analyze, Analytical Network Process (ANP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) for ranking the F5 countries depends on their macroeconomic performances. Figure 1 shows the steps of the proposed method. In this macroeconomic performance evaluation there are 11 criteria. An interview was performed with the economy expert in order to identify weight coefficients. Past experience and the back-

ground of the economy expert are utilized in the determination of the criteria and 11 criteria to be used for F5 countries evaluation are established. The outputs of the ANP are determined as the input of TOPSIS method. Macroeconomic parameters have been grouped as “Gross domestic product, constant prices”, “Current account balance”, “Inflation, average consumer prices”, “Unemployment rate”, “Total investment”, “Gross national savings”, “General government revenue”, “General government total expenditure”, “Volume of export of goods and services”, “Volume of imports of goods and services” and “General government gross debt”.

As a result, 11 criteria were used in evaluation and decision model is established accordingly. After forming the ANP diagram for the problem, the weights of the criteria to be used in evaluation process are calculated by using ANP method. In this phase, supermatrix is obtained by converting correlation matrix data into Saaty’s 1-9 scale. This transformation is possible, because all criteria data are quantitative. Also the economy expert is given the task of forming individual pairwise comparison matrix by using the Saaty’s 1-9 scale. Both output of the ANP method and expert judgments are used to calculate final weight values (arithmetic average of two outputs) of criteria.The limit supermatrix is derived by raising the supermatrix to powers.

Table 1: Simple Correlation Matrix

	X1	**X2**	**X3**	**X4**	**X5**	**X6**	**X7**	**X8**	**X9**	**X10**	**X11**
X1	1.0000										
X2	0.9132	1.0000									
X3	-0.1600	-0.0916	1.0000								
X4	0.1966	0.1398	-0.2467	1.0000							
X5	0.2247	0.1827	0.0328	0.5187	1.0000						
X6	-0.4089	-0.4687	-0.1317	-0.0816	-0.1711	1.0000					
X7	-0.7288	-0.8361	0.0805	-0.0253	-0.0410	0.0704	1.0000				
X8	-0.6036	-0.6835	0.3496	-0.0861	0.0948	-0.0332	0.8730	1.0000			
X9	0.0760	0.2236	0.2369	-0.0061	0.3185	-0.4490	0.0106	0.3350	1.0000		
X100	0.0344	0.4388	0.1281	-0.0908	-0.0477	-0.2477	-0.4434	-0.3451	0.3808	1.0000	
X11	0.5574	0.4761	-0.2573	0.6966	0.5033	-0.2393	-0.3446	-0.3732	0.0545	-0.0615	1.0000

Table 2: Modified Simple Correlation Matrix According to the Results of Hypothesis Testing

	X1	**X2**	**X3**	**X4**	**X5**	**X6**	**X7**	**X8**	**X9**	**X10**	**X11**
X1	1.0000										
X2	0.9132	1.0000									
X3	0.0000	0.0000	1.0000								
X4	0.0000	0.0000	-0.2467	1.0000							
X5	0.2247	0.0000	0.0000	0.5187	1.0000						
X6	-0.4089	-0.4687	0.0000	0.0000	0.0000	1.0000					
X7	-0.7288	-0.8361	0.0000	0.0000	0.0000	0.0000	1.0000				
X8	-0.6036	-0.6835	0.3496	0.0000	0.0000	0.0000	0.8730	1.0000			
X9	0.0000	0.2236	0.2369	0.0000	0.3185	-0.4490	0.0000	0.3350	1.0000		
X100	0.0000	0.4388	0.0000	0.0000	0.0000	-0.2477	-0.4434	-0.3451	0.3808	1.0000	
X11	0.5574	0.4761	-0.2573	0.6966	0.5033	-0.2393	-0.3446	-0.3732	0.0000	0.0000	1.0000

The modified simple correlation matrix given in Table 2 is obtained from the calculated correlation matrix (in Table 1) by testing each coefficient if the true value is zero at 10% significance level. Value is replaced by zero when H_0 cannot be rejected.

Table 3: Supermatrix obtained from simple correlation matrices

	X1	**X2**	**X3**	**X4**	**X5**	**X6**	**X7**	**X8**	**X9**	**X10**	**X11**
X1	0.0000	0.2850	0.0507	0.0424	0.1052	0.1789	0.1849	0.1534	0.0359	0.0374	0.1694
X2	0.3173	0.0000	0.0507	0.0424	0.0410	0.2245	0.2454	0.1936	0.0885	0.2040	0.1228
X3	0.0227	0.0197	0.0000	0.1193	0.0410	0.0376	0.0246	0.0673	0.0936	0.0374	0.0521
X4	0.0227	0.0197	0.1540	0.0000	0.2594	0.0376	0.0246	0.0217	0.0359	0.0374	0.2693
X5	0.0496	0.0197	0.0507	0.2342	0.0000	0.0376	0.0246	0.0217	0.1321	0.0374	0.1371
X6	0.0821	0.0807	0.0507	0.0424	0.0410	0.0000	0.0246	0.0217	0.2268	0.0990	0.0486
X7	0.1984	0.2283	0.0507	0.0424	0.0410	0.0376	0.0000	0.3170	0.0359	0.2080	0.0731
X8	0.1397	0.1513	0.2330	0.0424	0.0410	0.0376	0.2746	0.0000	0.1421	0.1404	0.0821
X9	0.0227	0.0398	0.1474	0.0424	0.1428	0.2080	0.0246	0.0635	0.0000	0.1616	0.0228
X100	0.0227	0.0730	0.0507	0.0424	0.0410	0.1019	0.0969	0.0661	0.1731	0.0000	0.0228
X11	0.1220	0.0828	0.1615	0.3496	0.2467	0.0987	0.0753	0.0741	0.0359	0.0374	0.0000

Supermatrix must be a column stochastic matrix. The powers of the Supermatrix converge to Limit Matrix which is also stochastic with all columns equal. Limit Matrix is shown in Table 4.

Table 4: Limit Supermatrix

	X1	**X2**	**X3**	**X4**	**X5**	**X6**	**X7**	**X8**	**X9**	**X10**	**X11**
X1	0.1306	0.1306	0.1306	0.1306	0.1306	0.1306	0.1306	0.1306	0.1306	0.1306	0.1306
X2	0.1499	0.1499	0.1499	0.1499	0.1499	0.1499	0.1499	0.1499	0.1499	0.1499	0.1499
X3	0.0441	0.0441	0.0441	0.0441	0.0441	0.0441	0.0441	0.0441	0.0441	0.0441	0.0441
X4	0.0695	0.0695	0.0695	0.0695	0.0695	0.0695	0.0695	0.0695	0.0695	0.0695	0.0695
X5	0.0612	0.0612	0.0612	0.0612	0.0612	0.0612	0.0612	0.0612	0.0612	0.0612	0.0612
X6	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620
X7	0.1315	0.1315	0.1315	0.1315	0.1315	0.1315	0.1315	0.1315	0.1315	0.1315	0.1315
X8	0.1214	0.1214	0.1214	0.1214	0.1214	0.1214	0.1214	0.1214	0.1214	0.1214	0.1214
X9	0.0634	0.0634	0.0634	0.0634	0.0634	0.0634	0.0634	0.0634	0.0634	0.0634	0.0634
X100	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620
X11	0.1045	0.1045	0.1045	0.1045	0.1045	0.1045	0.1045	0.1045	0.1045	0.1045	0.1045

By analyzing the limit supermatrix, the macroeconomic parameter with maximum weight, namely “Gross national savings” is found. The results obtained from the calculations based on the pairwise comparison matrix of economy expert’s choice values are presented in Table 5. Consistency ratios of the expert’s pairwise comparison matrixes are calculated less than 0.1. So the weights are shown to be consistent and they are used in the economic performance evaluation.

Table 5: Results of criteria by expert judgments and correlation matrices

Criteria	Code	Correlation Matrices' Weights	Expert Judgments' Weights	Arithmetic Mean
X1: Total investment	NID_NGDP	0.1306	0.0423	0.0865
X2: Gross national savings	NGSD_NGDP	0.1499	0.0145	0.0822
X3: Inflation	PCPIPCH	0.0441	0.1490	0.0966
X4: Vol.of imports of goods	TM_RPCH	0.0695	0.0585	0.0640
X5: Vol.of exports of goods	TX_RPCH	0.0612	0.0856	0.0734
X6: Unemployment rate	LUR	0.0620	0.1200	0.0910
X7: General gov. revenue	GGR_NGDP	0.1315	0.0185	0.0750
X8: General gov. expend.	GGX_NGDP	0.1214	0.0257	0.0735
X9: General gov. gross debt	GGXWDG_NGDP	0.0634	0.0356	0.0495
X10: Current account bal.	BCA_NGDPD	0.0620	0.1936	0.1278
X11: Gross domest. product	NGDP_RPCH	0.1045	0.2567	0.1806

According to expert's judgments, "Gross domestic product, constant prices" (0.2567) was the most important macroeconomic parameter influencing countries' economies followed by "Current account balance" (0.1936) and "Inflation, average consumer prices" (0.1490). The least important priorities are "Gross national savings" (0.0145) and "General government revenue" (0.0185).

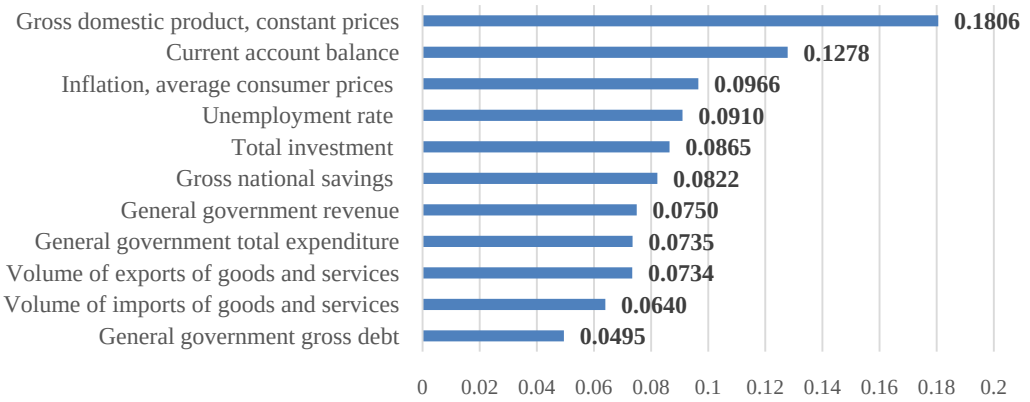

Figure 2: Resulting weights obtained with correlation matrix based ANP and expert judgments

"Gross domestic product, constant prices" (0.1806), "Current account balance" (0.1278), "Inflation, average consumer prices" (0.0966) and "Unemployment rate" (0.0910) are determined as the four most important macroeconomic parameters for the economic performance of the F5 countries. "General government gross debt" (0.0495), "Volume of imports of goods and services" (0.0640), "Volume of export of goods and services" (0.0734) and "General government total expenditure" (0.0735) are determined as the four least important macroeconomic parameters for the economic performance of the F5 countries.

Table 6: Input values of the TOPSIS analysis for the year 2013

Weights		**0.087**	**0.082**	**0.097**	**0.064**	**0.073**	**0.091**	**0.075**	**0.074**	**0.050**	**0.128**	**0.181**
Countries	Criteria	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
Brazil		18.285	14.656	6.204	8.628	3.118	5.383	37.223	40.480	66.335	-3.628	2.284
India		34.733	32.743	9.478	-2.116	5.030	10.253	19.999	27.255	66.717	-1.990	4.351
Indonesia		33.642	30.373	6.413	-0.442	2.173	6.250	17.854	20.003	26.105	-3.269	5.781
South Africa		19.363	13.539	5.752	4.732	4.221	24.742	28.900	33.180	45.231	-5.824	1.891
Turkey		21.574	13.716	7.493	8.370	0.471	9.728	36.057	37.561	35.849	-7.858	4.290

Finally, TOPSIS method is applied to rank the F5 countries. The priority weightsof macroeconomic indicators, calculated by using pairwise comparison of expert, correlation matrix and ANP shown in Figure 2, can be used as input of TOPSIS (Table 6). The weighted normalized decision matrix can be seen from Table 7.

Table 7: Weighted performance evaluation for the year 2013

Countries	Criteria	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
Brazil		0.027	0.024	0.037	0.042	0.030	0.017	0.043	0.041	0.029	-0.042	0.046
India		0.051	0.053	0.057	-0.010	0.049	0.032	0.023	0.028	0.029	-0.023	0.088
Indonesia		0.049	0.049	0.039	-0.002	0.021	0.019	0.021	0.020	0.011	-0.038	0.117
South Africa		0.028	0.022	0.035	0.023	0.041	0.076	0.033	0.034	0.020	-0.067	0.038
Turkey		0.032	0.022	0.045	0.041	0.005	0.030	0.042	0.038	0.016	-0.090	0.087
Min or Max		+	+	-	-	+	-	+	-	-	-	+
A^*		0.051	0.053	0.035	-0.010	0.049	0.017	0.043	0.020	0.011	-0.090	0.117
A^-		0.027	0.022	0.057	0.042	0.005	0.076	0.021	0.041	0.029	-0.023	0.038

By using TOPSIS method, the ranking of countries are calculated. Table 8 shows the evaluation results and final ranking of countries.

Table 8: TOPSIS results for the year 2013

Countries	d_i^*	d_i^-	$\mathbf{RC_i}$
Brazil	0.0127	0.0055	**0.3970**
India	0.0069	0.0109	**0.5570**
Indonesia	0.0042	0.0142	**0.6490**
South Africa	0.0133	0.0044	**0.3661**
Turkey	0.0074	0.0098	**0.5353**

Depends on the RC_i values, the rankings of the alternatives for the years 2001-2013 are shown in Table 9.Columns for the years 2008 and 2009 show the economic performance of F5 countries for the economic recession period.

Table 9: Performance rankings for the period 2001-2013

Countrie	200 1	200 2	200 3	200 4	200 5	200 6	200 7	2008	2009	201 0	201 1	201 2	201 3
Brazil	1	1	4	4	5	5	4	4	3	3	4	4	4
India	2	2	2	3	2	2	1	2	1	2	2	1	2
Indonesi	4	5	5	5	4	4	5	5	2	4	3	2	1
S.Africa	3	4	3	2	3	3	3	1	4	5	5	5	5
Turkey	5	3	1	1	1	1	2	3	5	1	1	3	3
								Recession					

Although Turkey has the most fragile economy, Turkish economy recovers quickly after 2008-2009 recession periods (Table 9).

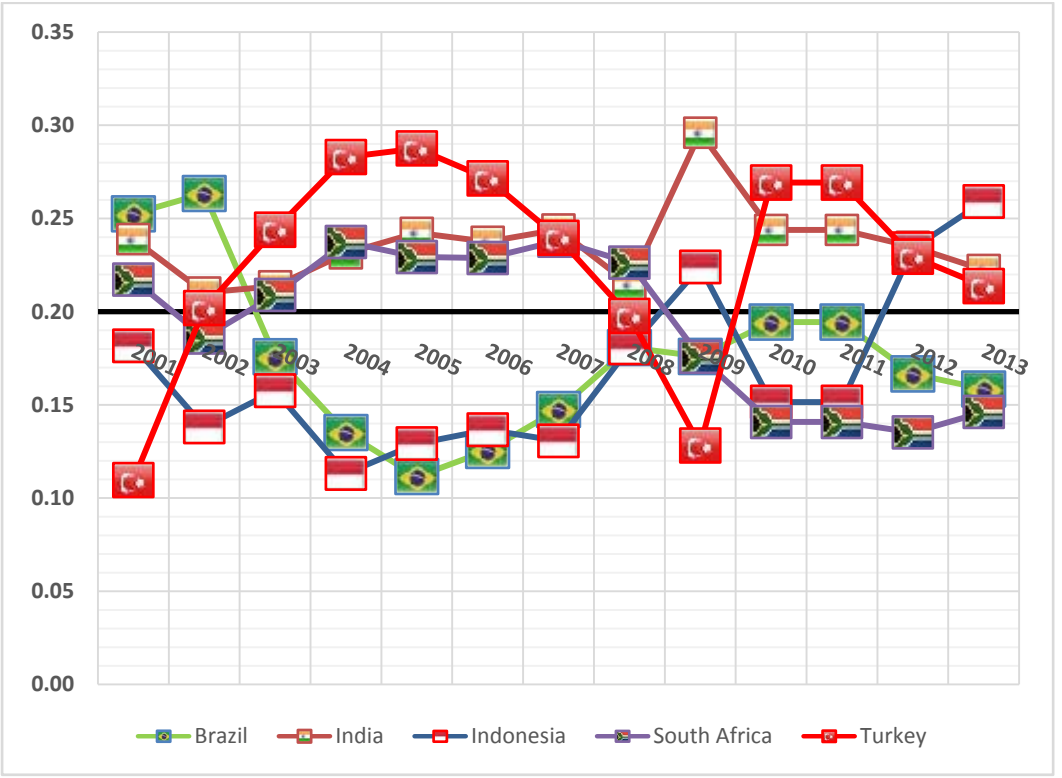

Figure 3: Economic performance changes of F5 countries during 2001-2013

7 Conclusion and Suggestions

This research aims to apply integrated ANP and TOPSIS to evaluate economic performance of Fragile 5 Countries in order to identify the fragility of them in economic recession period and beyond. After a comprehensive literature review and economy expert's guidance 11 macroeconomic parameters were determined for evaluating economic performance of F5 countries. The proposed method takes advantage of ANP to determine weights using dependencies. Supermatrix is obtained by converting correlation

matrix data into Saaty's 1-9 scale. After ANP and correlation analysis most important ratios are found. "Gross domestic product, constant prices" (0.1806), "Current account balance" (0.1278), "Inflation, average consumer prices" (0.0966) and "Unemployment rate" (0.0910) are determined as the four most important macroeconomic parameters for the economic performance of the F5 countries. "General government gross debt" (0.0495), "Volume of imports of goods and services" (0.0640), "Volume of export of goods and services" (0.0734) and "General government total expenditure" (0.0735) are determined as the four least important macroeconomic parameters for the economic performance of the F5 countries. Finally, TOPSIS method is applied to rank the Fragile 5 countries. Our model shows that although Turkey has the most fragile economy during great recession period (2008-2009), but afterwards the performance of Turkish economy is relatively high. India has stable economy and generally it has a rank of 1 and 2. Indonesia is the best performing country in 2013 (Figure 3). Looking beyond, according to OECD and the IMF predictions, Indonesia is projected to be the fastest-growing economy within Fragile 5 countries, with an average annual growth rate of 6.0%, followed by India with the growth 5.9% in 2014-18. For the rest of three countries, annual average GDP is expected no more than 3%. The biggest impact would be on GDP growth and on external and fiscal sustainability, which could be undermined by weaker external demand, lower commodity prices, political uncertainty, and greater global risk aversion. The findings of this paper would help governments for taking necessary precautions and foreign investors for creating more effective investment strategies.

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Appendix

Country	Year	NID_NGDP	NGSD_NGDP	PCPIPCH	TM_RPCH	TX_RPCH	LUR	GGR_NGDP	GGX_NGDP	GGXWDG_NGDP	BCA_NGDPD	NGDP_RPCH
Brazil	2001	18,028	13,839	6,840	2,941	9,529	11,265	33,539	36,143	70,786	-4,189	1,315
Brazil	2002	16,196	14,687	8,450	-12,193	8,644	11,683	34,717	39,166	79,382	-1,509	2,656
Brazil	2003	15,771	16,527	14,714	-3,614	15,717	12,317	33,752	38,984	74,605	0,756	1,147
Brazil	2004	17,117	18,877	6,598	18,345	19,047	11,475	33,203	36,103	70,663	1,760	5,714
Brazil	2005	16,206	17,791	6,870	5,356	9,391	9,833	34,146	37,723	69,331	1,585	3,157
Brazil	2006	16,756	18,008	4,184	16,146	3,341	9,983	34,410	38,040	66,956	1,252	3,955
Brazil	2007	18,328	18,441	3,641	22,004	5,482	9,275	35,604	38,401	65,154	0,113	6,096
Brazil	2008	20,694	18,989	5,678	17,625	-2,464	7,892	36,731	38,304	63,451	-1,705	5,169
Brazil	2009	17,838	16,340	4,888	-17,538	-10,755	8,083	34,824	38,104	66,821	-1,498	-0,328
Brazil	2010	20,239	18,033	5,039	38,183	9,501	6,742	37,102	39,904	64,981	-2,206	7,534
Brazil	2011	19,726	17,606	6,636	8,873	2,925	5,983	36,630	39,236	64,651	-2,120	2,733
Brazil	2012	17,523	15,109	5,404	-2,279	-0,338	5,483	37,686	40,448	68,181	-2,413	1,032
Brazil	2013	18,285	14,656	6,204	8,628	3,118	5,383	37,223	40,480	66,335	-3,628	2,284
India	2001	24,244	24,932	4,315	-0,161	2,650	8,800	16,946	26,762	78,728	0,688	4,824
India	2002	24,750	25,962	3,975	12,234	17,737	9,500	17,732	27,481	82,850	1,211	3,804
India	2003	26,831	29,109	3,857	7,655	16,193	9,200	18,195	28,521	84,243	2,277	7,860
India	2004	32,818	32,476	3,831	34,647	27,218	8,900	18,897	27,174	83,289	-0,342	7,923
India	2005	34,650	33,463	4,411	15,109	17,739	7,800	19,062	26,235	80,894	-1,187	9,285
India	2006	35,659	34,651	7,268	10,494	16,003	7,200	20,338	26,505	77,108	-1,008	9,264
India	2007	38,114	36,843	6,125	19,403	18,640	6,800	21,962	26,369	74,025	-1,271	9,801
India	2008	34,305	32,023	8,879	7,336	6,697	10,700	19,708	29,669	74,536	-2,282	3,891
India	2009	36,480	33,684	13,048	6,589	-2,609	10,800	18,518	28,269	72,527	-2,797	8,480
India	2010	36,502	33,813	10,532	14,511	26,592	9,800	18,821	27,223	67,458	-2,689	10,260
India	2011	35,525	31,368	9,553	7,902	8,892	10,560	18,706	26,667	66,753	-4,157	6,638
India	2012	34,699	29,956	10,209	1,930	1,531	10,400	19,483	26,867	66,619	-4,743	4,736
India	2013	34,733	32,743	9,478	-2,116	5,030	10,253	19,999	27,255	66,717	-1,990	4,351
Indonesia	2001	22,539	26,840	11,502	-9,353	-9,856	8,100	19,300	21,996	80,161	4,300	3,643
Indonesia	2002	21,404	25,402	11,780	1,919	-0,454	9,060	17,871	18,738	67,802	3,998	4,499
Indonesia	2003	25,598	29,051	6,773	0,894	-2,732	9,500	18,342	19,716	60,519	3,452	4,780
Indonesia	2004	24,056	26,102	6,062	13,118	-7,003	9,860	19,308	19,931	55,826	2,046	5,031
Indonesia	2005	25,081	25,641	10,459	22,938	11,805	11,240	19,384	18,753	46,346	0,559	5,693
Indonesia	2006	25,400	28,019	13,104	-5,188	3,103	10,280	20,346	20,120	38,989	2,619	5,501
Indonesia	2007	24,920	26,493	6,662	5,939	-3,720	9,110	19,291	20,325	35,050	1,572	6,345
Indonesia	2008	27,816	27,841	9,777	20,926	-1,452	8,390	21,280	21,283	33,238	0,025	6,014
Indonesia	2009	30,985	32,958	5,047	-10,496	7,604	7,870	16,495	18,255	28,636	1,973	4,629
Indonesia	2010	32,316	33,041	5,140	25,930	8,172	7,140	16,993	18,234	26,086	0,725	6,224
Indonesia	2011	32,902	33,102	5,344	13,731	6,078	6,560	17,835	18,463	24,381	0,200	6,486
Indonesia	2012	34,743	31,960	3,981	11,283	-0,997	6,140	18,059	19,722	24,032	-2,782	6,264
Indonesia	2013	33,642	30,373	6,413	-0,442	2,173	6,250	17,854	20,003	26,105	-3,269	5,781
South Africa	2001	15,045	15,327	5,700	0,250	2,393	26,300	24,696	25,856	43,488	0,281	2,735
South Africa	2002	15,872	16,699	9,177	5,342	0,989	28,150	24,696	25,810	36,949	0,827	3,668
South Africa	2003	16,652	15,662	5,806	8,085	0,109	28,000	24,631	26,491	36,909	-0,990	2,949
South Africa	2004	18,075	15,040	1,392	15,508	2,833	25,450	25,294	26,513	35,884	-3,035	4,555
South Africa	2005	17,958	14,489	3,393	10,879	8,568	25,000	26,543	26,891	33,201	-3,469	5,277
South Africa	2006	19,689	14,382	4,688	18,261	7,463	23,850	28,893	28,162	30,968	-5,307	5,604
South Africa	2007	21,240	14,269	7,090	8,986	6,552	23,250	29,732	28,433	28,331	-6,971	5,548
South Africa	2008	22,705	15,532	11,536	1,513	1,754	22,525	29,624	30,102	27,232	-7,155	3,622
South Africa	2009	19,530	15,499	7,125	-17,391	-19,532	23,700	28,100	33,021	31,579	-4,031	-1,526
South Africa	2010	19,057	17,089	4,271	10,970	8,998	24,875	27,462	32,388	35,313	-1,968	3,140
South Africa	2011	19,093	16,771	5,000	9,988	6,775	24,800	27,871	31,874	38,820	-2,322	3,599
South Africa	2012	19,404	14,162	5,654	5,995	0,386	24,875	28,296	32,564	42,091	-5,242	2,467
South Africa	2013	19,363	13,539	5,752	4,732	4,221	24,742	28,900	33,180	45,231	-5,824	1,891
Turkey	2001	15,084	17,002	54,246	-24,680	3,977	8,335	30,744	46,016	77,936	1,918	-5,697
Turkey	2002	17,614	17,345	45,134	17,284	8,193	10,333	28,751	43,190	74,000	-0,269	6,164
Turkey	2003	17,597	15,105	25,338	18,135	17,000	10,495	30,995	41,444	67,698	-2,492	5,265
Turkey	2004	19,390	15,770	8,598	20,833	18,036	10,250	31,214	35,597	59,612	-3,620	9,363
Turkey	2005	19,990	15,546	8,179	12,384	12,881	10,592	32,359	33,170	52,710	-4,443	8,402
Turkey	2006	22,055	16,040	9,597	7,608	7,156	10,212	32,772	33,462	46,524	-6,015	6,893
Turkey	2007	21,068	15,223	8,756	13,372	10,829	10,244	31,645	33,595	39,907	-5,845	4,669
Turkey	2008	21,782	16,256	10,444	-1,322	7,208	10,945	31,836	34,506	39,985	-5,526	0,659
Turkey	2009	14,938	12,964	6,251	-12,355	-7,812	14,028	32,583	38,594	46,073	-1,973	-4,826
Turkey	2010	19,523	13,315	8,566	17,607	8,763	11,887	33,270	36,715	42,335	-6,209	9,157
Turkey	2011	23,556	13,865	6,472	11,260	6,010	9,792	34,623	35,277	39,137	-9,691	8,773
Turkey	2012	20,070	13,915	8,892	1,234	12,759	9,208	34,460	36,269	36,178	-6,154	2,171
Turkey	2013	21,574	13,716	7,493	8,370	0,471	9,728	36,057	37,561	35,849	-7,858	4,290