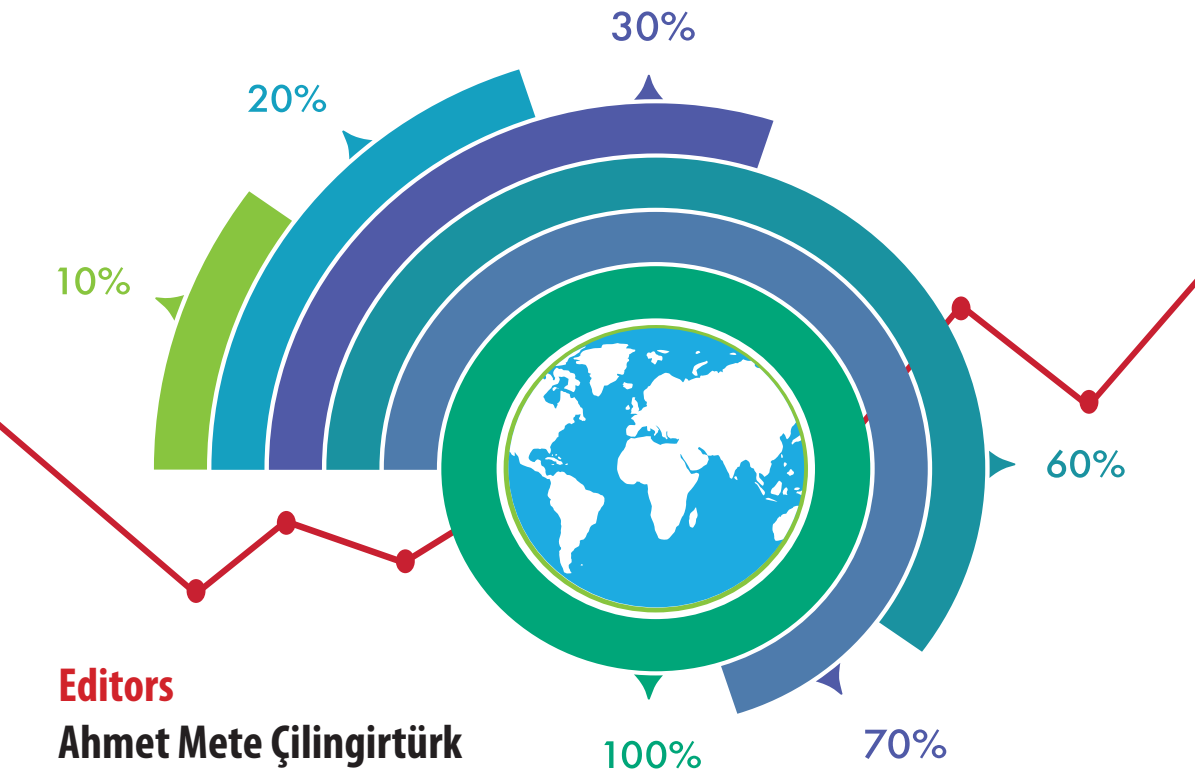
# Economics Management & Econometrics




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# Economics, Management, & Econometrics

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*(Edited by: Ahmet Mete Çilingirtürk, Anne Albrychiewicz-Słocińska, Besim Bülent Bali)*

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# Introduction
# Economics, Management, & Econometrics

*Ahmet Mete Çilingirtürk*

Knowledge is the understanding of a subject, which has been gained by experience or scientific study. Experiences have been recorded under unique conditions and they are open to perceptions. Than the rational and the only source of information should have been gained by the scientific research. The state of knowing about a subject is not enough for survival, so a general knowledge is a much-needed exigency to cope with the life problems. However, governments and institutions requires more deep and detailed information about relevant problems. The universities and research institutions are the basis of the knowledge and they are also obliged to distribute this information and resources freeley and accessible.

As Francis Bacon quoted "knowledge is power" and man conquered the nature mentally and physically, further manage it. The human dispose to change the environment to solve the problems for better life, which causes different conditions to cope with or problems to be solved. The attitude against the needs of human persisted to change as our knowledge permanently changes. Information sharing allows to share the power among people and communuties. Hence, the importence of international scientific meetings and platforms emerged long before of the century of knowledge. The rationalism and empiricism coelesced by modern scientist and the methodologie comprised quantitative methods. The measurement has been needed either for the reliable and valid implication or for the control of he performance. They are called statistics, econometrics and operations research in social sciences but in a broader sense mathematical measurement of sciences. However, there are problems of measuring the behavioural results and testing them for generalisation or theorem development as mentioned that "There are two excesses to avoid in regard to hypotheses: the one of

valuing them to much, the other of forbidding them entirely. – the Encyclopedie of Diderot and D'Alembert".

At the beginning of the twentieth century, economists criticised the use of probabilistic methods on economic time series. The supporters of these methods tried to justify the results of the application. Among the economists, the attitude that disdained these supporters was quite common. Keynes's econometric studies have been referred to as "conclusions of a sadly misinformed and misguided man" by the opponents (Lawson, 1989). In fact, economists are still reluctant to apply the natural requirements of econometrics. In econometric analyzes it is often stated that philosophical thinking is neglected in general. The result obtained in this case is an exploratory first step of a scientific study with an optimistic approach. Here are two important opposing approaches, realism and instrumentalism. The methodological doctrine guided by realism will be the right source of information and will enable the development of successful theorems. The efforts to measure and model the relations between economic variables are almost entirely in the domination of econometric methodologies. The problems that have arisen and solved in the analyzes have become extremely important in the development of econometrics. In most cases, proving the significance of the econometric model defined by theory is a difficult task. If the rational definition is strong, the only remaining task is the estimation of parameters. Traditionally, the search for better estimators and efforts for understanding their properties has led to the rational expectations approach. First, the studies initially focused on large non-dynamic models. On the other hand, the models have been formed dynamically with little or no attention to economic theory and only a few variables. Over the years these two approaches have interacted with one another, learned from one side and influenced by the other. Larger models have become more dynamic, and concerns of unit root and cointegration were included in the analyses (Granger; 2001). Time series models have evolved to include more variables regarding much to the economic theory. Many empirical questions in economics and other social sciences are based on the causal effects of programs or policy interventions. Over the last two decades, much research has been done on the econometric and statistical analysis of the effects of such programs or improvements. Current theoretical literature is based on both statistics and econometrics. These methods have reached a level of maturity that makes them an important tool in many areas of economic empirical research, including business economics, public finance,

development economics, industrial organization, and other areas of empirical microeconomics (Imbens, Wooldridge; 2008).

Contemporary scientific reaserach diverse in various areas of life in broad meaning. Men are socially a part of community and constitute the public. This was the first and indispensable stage of life. The democracy was found the best known way of forming communities and the democracy requires governance and protection. This obligation was funded through economics governed by public finance. The commercial institutions are one of the main actors of the economies in all industries. So, their management became important for the sustainable and healty economy. According to various researchs education is the root for solving a broad aspects of social phenomena.

The size of the economy of a country is defined as the gross domestic product. This value is equal to the sum of final goods and services produced in one year in a nation. GDP is the sum of either all consumption or all production in the economy. Demand partitioned in their own as consumption, savings, investment, government spending, exports and imports. Production in the country are durable products, non-durable products, services, infrastructure, and inventory. One has to measure the economy to understand the macroeconomics rationality. Although numerous items have been produced in the economy, GDP is simply measured by taking the quantities of all goods and services produced, multiplying them by their prices, and summing the total. After all, each of the market transactions that enter into GDP must involve both a buyer and a seller, so the GDP of an economy can be measured by the total domestic currency value. GDP is in many ways the central measure of an economy. For example, the faster the growth in real GDP, the faster the growth in jobs. Although the relationship between the measure and infl ation is more tenuous, it is generally acknowledged that if the level of real GDP exceeds that of potential real GDP, infl ation will increase. The ability to forecast GDP, and to understand how policy influences the series, is therefore of critical importance to the formulation of monetary and fiscal policy. These considerations make it all the more important to assess the limitations of the GDP measure and to examine possible alternatives. There is such efforts to construct an alternative measure of real GDP that differs from the standard series by expanding the scope of economic activity included. This alternative measure tries to present a different long-term trend than the published series, but it would likely be no more reliable than the existing figure as an indicator of short-term momentum in the economy (Hobijn, Steindel; 2009).

A GDP is also an indicator that represents the standard of living of the community. However, roughly is an indicator of the levels of environmental quality, health, education and of the activities conducted outside the market, the inequality of income, developments in technology and social normative values. However, the standard of living is all elements that affect people's happiness, whether these elements are bought and sold in the market or not. There are numerous academic and institutional reasearchs to overcome this measurement gap. So, can an increase in per capita national income buy some of this happiness or other elements? According to researches, when the working hours are reduced while the wage is constant, the expected life expectancy and education level are considerably increased thanks to the health. The extent to which economic growth generates broadly shared economic opportunity and outcomes is influenced by an interdisciplinary mixture of structural and institutional aspects of economic policy. A benchmarking framework compares indicators of performance and enabling environment conditions in principal policy domains on a cross-country basis. It is a tool intended to help make discussions about socioeconomic inclusion and inequality less vaguely aspirational and more concretely actionable by providing a clearer sense of the extent to which a country is exploiting available policy space across the full spectrum of levers potentially available to increase the contribution of economic growth to more broadly based progress in living standards based on the experience of its peers or other countries. In short current available economic indicators and revealed teories may unsatisfy to explain all human interactions and behaviors (Samans et.al; 2015).

A very illustrative work was published by Card and Kruger (2015). "A distinctive feature of Card and Krueger's research is the use of empirical methods borrowed from the natural sciences, including comparisons between the "treatment" and "control" groups formed when the minimum wage rises for some workers but not for others. In addition, the authors critically reexamine the previous literature on the minimum wage and find that it, too, lacks support for the claim that a higher minimum wage cuts jobs. Finally, the effects of the minimum wage on family earnings, poverty outcomes, and the stock market valuation of low-wage employers are documented. Overall, this book calls into question the standard model of the labor market that has dominated economists' thinking on the minimum wage. In addition, it will shift the terms of the debate on the minimum wage in Washington and in state legislatures throughout the country." The related quote came from a journalist: "Card and Krueger didn't just question the

conventional wisdom; they attacked it in a novel and powerful way. Instead of concocting a mathematical model and `testing' it with advanced statistical techniques, which is what most economists call research, they decided to test the theory in the real world. The work of Card and Krueger was worth a hundred theoretical models in The American Economic Review."-John Cassidy, The New Yorker. For this reason, there is a need for continuous research and development of new techniques or designs for measurements.

Are those attempts for measuring the economic activities just to benchmark the countries? The 1290s constitute "a major turning point in later-medieval economic history" (Munro, 1997). Across much of Europe, long-established processes of economic and demographic expansion and commercial integration attained their secular climax and countervailing tendencies first began to register a significant impact (Campbell, 2006). The ultimate aim must be to produce a coherent and internally consistent benchmark profile which in its relative and absolute orders of magnitude fits all benchmarked countries rather than just one and is capable to being extended to include others. As a result, the more important economic question states should be focused on is whether their economies are well positioned for robust growth and innovation over the next decade. Being well positioned means that state economies need to be firmly grounded in the New Economy. These New Economy factors have become a fundamental capacity that states need to have to find success and navigate the shoals of economic change (Atkinson, Andes; 2009). This information is necessary to provide international credit facilities. In addition, nations should strengthen their economic power on international platform, to ensure their social and economic independence, caring predominantly their own expediency. But this explains only a small part of the economic measurement efforts.

The national government is primarily engaged in economic activities to control, direct and plan these activities. A government that does not know the national income can not predict how much it will spend. In order to accumulate the amount of tax needed to meet the basic and social public needs, taxable resources must be predicted. This planning can be seen as a detailed accounting recording. However, random variations that may occur in production, changes in needs or preferences of public, variability in consumer behavior, variability in health conditions and in motivation to be effective in labor productivity, climate variability affecting agricultural production and even epidemic diseases that may occur in animal production should be added to these

accounts. So, the need for measurement was not just for the economic activities, it is further to estimate the variability and the interaction effects of changes among these activities. The concept became more complex when the sustainable economic growth is the subject. For instance, water footprints have been calculated for the production of oliven in Spain. That is an estimation of water amount the tree absorbs, the amount at the manufacturing process and the amount that one man required to survive eating, drinking, washing, dressing up per working hour collecting the olives from the trees. The aggregated behavioural activities became important beyond the considerations.

This book covers economical and managerial researchsin several aspects. The traditional economic models should be proved with contemporary states. May we validate for example the simple Keynesian macroeconomic model with up to date data? Does the financial market perform well with their institutions? How is the performance of different industries and how can be measured? Are there structurel or technological developments at the proccess? Or is there a need for innovation for real development and growth? How can we achieve sustainable development or permanent innovative knowledge? The readers may find some information and opinions relevant to mentioned questions.

*November 2017*
*Ahmet Mete Çilingirtürk*

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# PART I
# ECONOMICS
# &
# ECONOMETRICS

# 1 Macro Econometric Fiscal and Monetary Policy Panel Modelling of Chosen Balkan Countries

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**Abstract**

*Purpose: The aim of the work is to estimate and compare the fiscal and monetary policy model of selected several Balkan countries and Turkey. The research question is relevant to the recession periods after 2008-2009 international crises. Some governments had forcefully recourse fiscal policies to overcome the recession. There was a wide consensus that the financial markets had played a decisive role in the current economic problems. Method: A yearly 2009-2015 data was collected for Turkey, Romania, Bosnia-Herzegovina and Serbia, which includes consumer price inflation, policy interest rate or lending interest, broad money, government spending, gross fixed capital formation, GDP growth with 2010 constant prices, tax revenue, purchasing power parity conversion factor to local currency unit per international Dollar. The amounts have been calculated as the percent to GDP with fixed prices. A panel data analysis would be conducted to estimate the effect coefficients on growth. After estimating the robust variance component, the Arellano-Bond linear dynamic panel-data estimation has been used. It includes lags of dependent variable as covariates and contain fixed and random panel-level effects. The method derived a consistent generalized method of moments estimator with few periods. Expected Results and Implications: The macro economical Keynesian coefficients are expected to occur with the model. These coefficients are the main ones used to simulate the dynamic stochastic general equilibrium (DSGE) models used by the central governments to calibrate their policies. The response of*

*the output to fiscal and financial shocks might quantifiable through simulating the model. Furthermore, a similarity is expected among the selected countries, but the integration of the Balkan countries with the European Union shall support the economic stability through a more efficient and consistent fiscal and monetary governance.*

***Keywords:*** *Panel Data Econometrics, Arellano-Bond Estimation, Leeper Model*

## 1. Introduction

Some governments had forcefully recourse fiscal policies to overcome the 2008-2009 recession. There was a wide consensus that the financial markets had played a decisive role in the current economic problems. This crisis has left many governments primarily to make large-scale warning plans. Then they implemented actual consolidation strategies to ensure governments' financial stability. These practices again made current public debates on financial governance important. Monetary authorities are predominantly capable of increasing taxes and / or reducing public spending to keep fiscal balance. At this point, the problem is to decide which types of taxes should be increased and which types of government expenditures should be maintained. Germany, Greece, Portugal, Spain and others decreased public employment, public wages and public investments. On the other side, they carried out consolidation plans with increasing labour wages tax rates and VAT. As a result of these measures, appropriate changes in production, unemployment or international competitiveness will be expected. The economic policy consists of monetary policy, fiscal policy and foreign trade policy. Monetary policy is a component of an economic policy in which instruments such as money supply and interest rates are used by the Central Bank to reach certain economic and monetary targets. Foreign trade policy aimed at achieving the goal of external balance using tariffs and non-tariff instruments. The fiscal policy uses public revenues and expenditures to achieve certain financial, economic, social and political objectives. Economic stability refers to both price stability and full employment. Price stability means that the general level of prices does not increase or decrease very much, in other words it remains constant. Full employment refers to the level at which all production factors in the economy are utilized. For this reason, the state's economic stability means to overcome both inflation and unemployment. Economic growth, on the other hand, is an increase in the national income of the economy. The aims of the fiscal policy are the targets that a government aspires to as a whole. However, some contradictions may arise among these purposes.

A government that is fighting inflation for the sake of price stability, has reversed its motive for the purpose of economic growth when it is under pressure to suppress the underlying cause of inflation. Easing the tax burden on capital groups in order to ensure economic growth can adversely affect justice in income distribution by giving a result against low income groups. For this reason, policy makers should not contradict another reason while reaching an aim. This is also the case where it is difficult to implement the fiscal policy. For this reason, policy makers need to be very careful and apply fine-tuning policies by making serious and realistic calculations.

**2. Fiscal and Monetary Policies**

Public spending is one of the key components of the basic macroeconomic identity. It covers all kinds of expenditures (current, stock and transfer) the government has made. A change in the amount of public expenditure will certainly affect the objectives of the fiscal policy. However, when referring to the means of fiscal policy, it is not just the change in the amount of expenditures. At the same time, changes in the composition of expenditures are a means of fiscal policy. The implementation of an expanding fiscal policy to combat unemployment means to increase the amount of public expenditure. But at the same time, a composition change, such as increasing subsidies to low-income groups, is also considered an instrument of fiscal policy. Public revenues are monetary values that the state obtains reciprocally or unrecorded with or without the use of cash. Taxes are at the head of public incomes. The fiscal policy tool is not only to change the tax rate or amount, but also to change the distribution of tax types or to introduce new tax types. Public debt can be used as a fiscal policy tool for economic and social purposes, although it appears to be one of the financing ways of the government budget deficits. However, not only the decrease or increase in the amount of the debt, but also the determination of the debt and / or the source of the debt is a means of fiscal policy. A number of fiscal policy objectives can be achieved by giving surplus or deficit in the public budget. The deficit refers to the expanding fiscal policy as it means that the expenditures are overdue. The surplus on the contrary means the inflationist fiscal policy. The discussions of the state's intervention in the economy are based on ancient times. The fiscal policy instruments that the state implements for intervention are ineffective according to some views, and in some cases they are ineffective.

Today, as globalization and capital movements are increasingly liberalized, it is difficult to try to establish both internal balance and foreign trade and debt balance. It has become inevitable for a monetary policy, which is also aimed at price stability, to apply

a nominal peg to achieve success. At the end of the twentieth century various targets were tried as monetary policy options. In the first stage, narrow and broad money supply targets are presented. Fixed and floating exchange rate targeting was then proposed. All of them have seen advantages or failures over time. In recent years, open or implicit inflation targeting has been implemented by many countries. It has emerged that inflation targeting does not conform to every economic conjuncture. On the other hand, nominal GDP targeting is proposed and discussed. Another issue to be addressed is whether the levels of variables or change rates are targeted. It suggests that the level determination is more effective in terms of stability (Svenson, 1996; Mankiw and Hall, 1994). The disadvantage of specifying such a target is that it causes cyclical movements in demand conditions. Monetary targeting strategy has three important elements. These are based on the knowledge that monetary aggregates emerge in the management of monetary policy, the pre-declaration of monetary aggregate targets, and the operation of accountability mechanisms to prevent massive and systematic deviations from monetary targets (Mishkin, 2000). Monetary targeting has some advantageous aspects. The first of these is that the Central Bank has the power to apply an indefinite monetary policy taking into account domestic conditions. Secondly, monetary aggregate data can be easily accessed and tracked easily. It facilitates the determination of the level of attainment of these goals. It also has the advantage of reducing the problem of time inconsistency by providing transparency and accountability. However, benefiting from these advantages depends on whether the relationship between inflation or nominal income and the targeted monetary aggregates is strong and stable. However, new financial instruments arising from the financial institutions that emerged after the 1980s have led to an increase in money deposits. Thus, the demand for money and instability of the rate of circulation increased compared to the past. This led to a weakening of the short-run correlation between monetary aggregates and inflation. In the event of this unreliable weak relationship, the monetary magnitudes signal to the market and the transparency and accountability of the Central Bank are also at stake. Monetary targeting is the targeting of a large number of variables that fail. Failure to meet these expectations results in a loss of credibility. In successful cases, both monetary aggregates and inflation have been targeted together. In selecting the monetary size, the consistency of the variable with the controllability and the nominal GDP is taken into account. In determining monetary growth targets, the expected rate of circulation trends taking into account potential production and the Quantitative Theory equation, which determines the numerical inflation target policy (Bernanke and Mishkin, 1997, p. 106), have been used. The six monetary targets in Germany can be said to be a

Taylor-type rule rather than a Friedman type target (Clarida and Gertler, 1997, p. 401). Secondly, monetary targeting should be a very flexible application from a rigid rule. In addition to other objectives including production and exchange rate, long term struggle with inflation was targeted.

Fixed exchange rate targeting policies exemplify full dollarization. The semi-fixed exchange rate targeting can be implemented as binding the country currency to a currency basket. Alternatively, a crawling peg may be applied around a symmetrical or asymmetric band. This policy works well in the prerequisite of sufficient foreign exchange reserves of the country. In open economies, there is a close correlation between price level and exchange rate, which supplies a contracting variable. This approach is advantageous when there is no reliable money management understructure. In addition, since the exchange rate was a peg, the exchange rate risk was reduced. Therefore, the nominal interest rate in the country will decrease through the interest rate parity. As a result, inflation expectations will be broken in countries with high domestic debt burden. By means of the purchasing power parity, prices of goods subject to external trade will also decrease. Besides to these short-term effects, governments gain time for the disinflation policy. In the long term, it will cause the recession. However, when monetary magnitudes were targeted, there would first a recession and then growth is taking place. If inflation occurs above the devaluation rate, the country's currency will have overvalued and results in deterioration in the current account balance. It paves the way for financial crises, which are caused by the fall of credit volume due of economic actors' intention to borrow in foreign currency. Since the intervention force of the Central Bank falls, interest rates overreact to foreign capital movements.

The nominal GDP targeting policy has first and foremost political consequences when the target is low or high. Secondly, inflation and other variables can be measured more accurately at shorter intervals. Public understanding of the nominal and real world will also be problematic in terms of public communication. This policy is subject to criticism that creates instability in production and employment, as it does not allow as flexible implementation as others (Ball, 2000; Svensson, 1997). In the price-level targeting policy, systematic responses are given to keep the target in place when there are deviations from the set level. For this purpose, inflationary or deflationary policies are introduced quickly. For this reason, the inflation rate and the variability in production increase.

## 3. The Simple Theoretical Fiscal and Monetary Model

The Leeper (1991, 1993) model was employed to determine the exogenous and endogenous variables. The model was assumed as a neoclassical macro model. The money was presented in the utility function. The supply side modelled by the Lucas curve. It also includes the tax rule (Perez and Hiebert, 2002).

The model implies a simple form of national income identity given by equation (1).

$$y_t = c_t + g_t \tag{1}$$

The total demand consisted of the private consumption ($c_t$) and public spending ($g_t$), which summarizes the investment and external sector.

$$y_t = \lambda_0(1 - \lambda_2) + \lambda_1(\pi_t - E_{t-1}(\pi_t)) + \lambda_2 y_{t-1} + \epsilon_t \tag{2}$$

The Equation (2) is the aggregate supply function. The production ($y_t$) assumed to affected by the inflation ($\pi_t$) and its past expectations. The production is persisting as the percent level $\lambda_2$ of past production.

$$m_t^d = \delta_0 + \delta_1 R_t + \delta_2 c_t \tag{3}$$

The demand for real money ($m_t^d$) depends on interest rate ($R_t$) and consumption ($c_t$). Both variable coefficients in Equation (3) are positive real values. The money demand partitioned as the private consumption and investment requirements. The demand for government debt was written in Equation (4).

$$\frac{U\prime(c_t)}{P_t} = \beta R_t E_t \left(\frac{U\prime(c_{t+1})}{P_{t+1}}\right) \tag{4}$$

The utility function of the public was derived as the logarithm of the private consumption $u_t(c_t)=log(c_t)$. The discount factor $\beta \in (0, 1)$ was used to explain the steady state real interest rate $1/\beta$ with no growth. $P_t$ is the price level at time t. So, the change at the utility depends on the future expectations of the consumption ability.

$$R_t = \alpha_0 + \alpha_1 \pi_t + \alpha_2 y_t \tag{5}$$

The inflation rate $\pi_t=P_t/P_{t-1}$ and the equation describes the monetary policy rule, that the authority has to adjust the money supply to change the interest rate and responsively

the inflation rate. This model also consisted the cyclical behaviour of output where $\alpha_2>0$. The government budget constraint in Equation (6) describes government revenues at right-hand side. These are real debts, inflation corrected increase in money supply and tax collection. The expenditures are the government spending and inflation corrected debt services from the previous year.

$$b_t + m_t - m_{t-1}\frac{1}{\pi_t} + \tau_t = g_t + \frac{R_{t-1}b_{t-1}}{\pi_t} \tag{6}$$

The real debt $\pi_t=B_t/P_t$ was calculated by the division of the nominal debt by the price level coefficient. Many macroeconomic models describe the tax revenues as the income taxes, taxes on goods and services etc. However the model aggregates the tax revenues $\tau_t$. The tax system of the economy was described in Equation (7) where it combines some fixed level of revenue and income tax collected with a proportional tax rate ($\tau^y$) on income. Furthermore, the government should collect a lump-sum taxes ($\tau_t^{rule}$) to stabilise the dept.

$$\tau_t = \tau_0 + \tau^y y_t + \tau_t^{rule} \tag{7}$$

The equations (5) to (7) are the monetary and fiscal action policies. The random economic environment was formed in two exogenous behaviours. These are the aggregate supply in Equation (2) and government spending in Equation (8).

$$g_t = \left(1-\rho_g\right)g + \rho_g g_{t-1} + u_{gt} \tag{8}$$

The mean government spending (g) presents the customary routine behaviour of the government. The both stochastic models were assumed to track a first-order autoregressive structure. The written equations except these two models had deterministic nature. The whole model would have a steady-state solution when the residual mean set to zero. Than the variables y, c, m, b, R, $\tau$ and $\pi$ had a particular solution depending on the constant and variable coefficients in the model. In this case the multi equation model let to be solved for equilibrium values after linearization of the system. However, the models would have solved for purpose of behaviour estimation and for determination of a presence of country based fixed effect.

## 4. Arellano-Bond Dynamic Panel GMM Estimation

Autoregressive errors were expected as a priori reason in an economic environment by regression analysis. These type of models have been estimated through dynamic regression with non-linear common factor restrictions and uncorrelated disturbances (Sargan, 1980). The fundamental condition was the strict exogeneity of some of the explanatory variables for the identification in panel models.

Several econometric problems may arise from estimating an economic panel model equation with lagged dependent variable as explanatory variable, and when the causality flow runs in both direction, so they are assumed as endogenous. In this case, the regressors might correlated with residuals. Linear dynamic panel data analysis contains the lagged value of the model dependent variable and the effects of the unobserved constant or random panel level. The effects of this unobserved panel level are related to the lagged value of the dependent variable and thus override the random effect models with the standard fixed effect model. Because time invariant panel characteristics might also have correlated with explanatory variables. In case, the fixed effects were contained in error term. These two problems would have solved by using Two Stage Least Squares Method, which is fixed effects instrumental variables estimation. The estimators could be biased with weak instruments. Thirdly, the autocorrelation would arise because of the presence of the lagged dependent variable. That is also the result of weak instrumental explanation. The Arellano-Bond (1991) GMM estimator utilized all the linear moment restrictions of autocorrelation in a system that contains individual effects, lagged dependent variables and no strictly exogenous variables. The method uses also the lagged endogenous variables instead regressing them only against exogenous variables. This makes the endogenous variables pre-determined and therefore not correlated with the residuals. Furthermore, by transforming the regressors by first differencing the fixed panel specific effect would have removed. Finally, the Arellano-Bond estimator was designed for small time points with large number of panels.

As explained above when the dependent variable depends on its past realizations, than the dynamic panel data models used for estimation. General model written as:

$$y_{i,t} = \lambda y_{i,t-1} + x'_{i,t} + \mu_i + u_{i,t} \qquad i = 1, \dots, n; t = 1, \dots, T \tag{9}$$

The exogenous regressors $x_{i,t}$ and lagged dependent variable $y_{i,t-1}$ explain the dependent variable $y_{i,t}$ with fixed individual effects $\mu_i$ and random effect $u_{i,t}$, which has zero mean, constant variance and is uncorrelated across time $t$ and individuals $i$. As lagged dependent variable was correlated with fixed effects, GLS (Generalized Least Squares)

and OLS (Ordinary Least Squares) estimators would biased and inconsistent (cov ($y_{i,t}$, $\mu_i$)≠0). An alternative transformation instead taking differences from the mean, which is also biased and inconsistent ($cov(\overline{y_\iota}, \overline{u_\iota}) \neq 0$) namely WG (Within Group) estimators, was proposed to remove individual effects. It is called "first difference" transformation (Branas-Garza, et al., 2011).

$$\Delta y_{i,t} = \lambda \Delta y_{i,t-1} + \Delta x'_{i,t} + \mu_i + \Delta u_{i,t} \quad (10)$$

This model has the problem of endogeneity because of the dynamic structure. Anderson and Hsiao (1982) proposed to use second differences and second lagged values of the dependent variable for the controlling of the endogeneity arisen from the correlation between $\Delta y_{i,t-1}$ and $\Delta u_{i,t}$. The available instrument amount exceeds the unknown parameter number, when there are three or more time periods (Holtz-Eakin et al., 1988). Arellano and Bond (1991) obtained GMM (Generalized Method of Moments) estimators (Hansen, 1982). They used the moment conditions generated by lagged levels of the dependent variable with the differenced random residuals, which was called "difference GMM estimators".

## 5. Empirical Model and Findings

The data consisted of 2009-2015 yearly main macroeconomic indicators of Turkey, Serbia, Romania and Bosnia-Herzegovina collected from World Bank data set. The panel data set includes annual % inflation (P), lending interest rate (R), annual growth rate (y) with nominal prices, broad money % of GDP (m), government spending % of GDP (g), gross fixed capital formation % of GDP (i), tax revenues % of GDP (t), external debt stock % of GDP (b) and consumption expenditures % of GDP (c). Lending Rate is the average of end-of-period minimum and maximum rates charged by commercial banks on short-term loans to private nonfinancial enterprises; which was central bank policy rate percent per annum for Turkey. Broad money (IFS line 35L.ZK) is the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveller's checks; and other securities such as certificates of deposit and commercial paper. General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defence and security, but excludes government military expenditures that are part of government capital

formation. Average annual growth of gross fixed capital formation based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. Gross fixed capital formation (formerly gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. According to the 1993 SNA, net acquisitions of valuables are also considered capital formation. Tax revenue refers to compulsory transfers to the central government for public purposes. Certain compulsory transfers such as fines, penalties, and most social security contributions are excluded. Refunds and corrections of erroneously collected tax revenue are treated as negative revenue.

The economic amounts were selected as the ratio in GDP, to avoid currency conversion. The dependent variable was selected as the annual growth instead of Gross Domestic Production because of the same reason. Thus the monetary and fiscal policy model became inadequate to calculate for the panel data. In this case, there are two options to estimate behavioural policy models. One of them is to solve the simultaneous equation system by creating a reduced form. In this case, much of the information contained in the equations will be lost. The alternative is to estimate the equations in the system given below separately. These are stochastic behavioural models of the Equations (2-8) sequentially. The estimated coefficients would differ from the policy model; however, a similar notation was used. The identity equation will not valid anymore.

$$y_{it} = \lambda_{i0} + \lambda_{11}P_{it} + \lambda_{12}P_{i,t-1} + \lambda_2 y_{i,t-1} + \epsilon_{it} \tag{11}$$

$$m_{it} = \delta_{i0} + \delta_1 R_{it} + \delta_2 c_{it} + \delta_3 g_{it} + \epsilon'_{it} \tag{12}$$

$$c_{it} = \beta_{i0} + \beta_1 c_{i,t-1} + \beta_2 y_{it} + \beta_3 R_{it} + \epsilon''_{it} \tag{13}$$

$$R_{it} = \alpha_{i0} + \alpha_1 P_{it} + \alpha_2 y_{it} + \epsilon'''_{it} \tag{14}$$

$$b_{it} = \gamma_{i0} + \gamma_1 b_{i,t-1} + \gamma_2 m_{it} + \gamma_3 m_{i,t-1} + \gamma_4 g_{it} + \gamma_5 R_{it} + \epsilon''''_{it} \tag{15}$$

$$t_{it} = \tau_{i0} + \tau_1 t_{it-1} + \tau_2 y_{it} + \epsilon'''''_{it} \tag{16}$$

$$g_{it} = \rho_{i0} + \rho_1 g_{i,t-1} + \epsilon''''''_{it} \tag{17}$$

The estimations will be summarized in several tables for simple presentation. Some of the models were not statistically significant. As panel and time period amounts were restricted a ten percent level of significance was preferred.

**Table-1 Estimation of Empirical Model Equation Coefficients and Summary Statistics**

| Equation | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|
| Dependent | y | m | c | R | b | t | G |
| Y | | | 0.218 | -0.497 | | 158.66 | |
| Y(-1) | -0.134* | | | | | | |
| P | -0.180 | | | 0.066 | | | |
| M | | | | | -38.177* | | |
| M(-1) | | -4.178 | | | 44.119* | | |
| R | | 3.427 | 0.496 | | 26.403* | | |
| R(-1) | | | | 0.012 | | | |
| C | | -7.206 | | | | | |
| C(-1) | | | -0.505 | | | | |
| B(-1) | | | | | -4.947* | | |
| T(-1) | | | | | | 0.669* | |
| G | | 0.001 | | | | | |
| G(-1) | | | | | | | -290.03 |
| Constant | - | - | | 6.966* | | | 4741.6 |
| Wald $\chi 2$ | 26.82* | 19.44* | 7.65* | 4.29 | 206.13* | 356.93* | 0.01 |
| Instruments | 16 | 16 | 17 | 17 | 19 | 15 | 16 |

*The coefficients with an asterix are statistical significant at 5 percent level.*

All the models have generally statistical significance. However, some coefficients in the models are not statistical significant, which occurs often in economic models due of the mutual high correlations among them.

In this model, there is a negative relationship between external debt stock of GDP and broad money of GDP. Also there is negative relationship between external debt stock of GDP and the lagged value of external debt of GDP. The effect of Interest rate of GDP and the lagged value of broad money of GDP on the external debt stock of GDP are positive.

Hausman tests the coefficients of fixed and random effect models whether they are consistent or not. The null hypothesis is that their difference is not systematic. Its

rejection means that there is a fixed effect of observations that is the country specific differences. In this case the difference of coefficient covariance matrices is not positive definite. All the estimated models include fixed effects of country units. Pre-estimation Hausman test and post-estimation tests were summarized accordingly.

**Table-2 Tests of Assumptions**

| Model | Hausman χ2 | Prob. | Sargan χ2 | Prob. | AB test-1 | AB-test-2 |
|---|---|---|---|---|---|---|
| 11 | 7.860 | 0.0197 | 3.515 | 0.9977 | -1.878 | 1.775 |
| 12 | 7.830 | 0.0496 | 3.7E-25 | 1.000 | -1.130 | -0.247 |
| 13 | 11.73 | 0.0084 | 2.973 | 0.991 | -0.160 | -0.684 |
| 14 | 0.36 | 0.8357 | 6.8E-29 | 1.000 | -0.644 | -0.474 |
| 15 | 8.42 | 0.1345 | - | - | - | - |
| 16 | 10.37 | 0.0056 | 1.035 | 1.000 | -1.011 | 1.197 |
| 17 | 0.87 | 0.3507 | - | - | -0.903 | 0.814 |

Sargan test controls the overidentifying restrictions. The null hypothesis will not be rejected when these restrictions are valid. Arellano-Bond test for zero autocorrelation in first differenced errors will be rejected under null condition for no autocorrelation.

According to the Hausman test results, the null hypothesis is rejected in models 11,12,13 and 16. There is a fixed effect of observations that is the country specific differences. In model number 14,15 and 17 the null hypothesis isn't rejected. It means that models include random effect of country units. According to the Sargan test results, all model's null hypothesis are not rejected. It means that there is no problem of innerness, that is, the tool variables are extrinsic. The result is that the error terms are not correlated with the independent variables. In steps 1 and 2 of the Arellano Bond test the null hypothesis is not rejected. So there is no autocorrelation in our models.

In our fixed models there is a difference between countries. We have shown that the use of dynamic panel data models in the macroeconomic fiscal and monetary policy allows unravelling new relationships between macroeconomic variables.

**Conclusion**

The in the research included Balkan countries have an unsimilar economic structures, so we had a fixed effect model. That is their consumption and revenue behaviors differenced on the GDP, consumption habits, domestic Central Bank money

management and tax collection rules and regulations. However, international behoviors were similar during the period such as interest rates, which was managed by international money markets against arbitrage possibilities. Furthermore, government spending effects the economy according the Keynesian teorem, and had the similar impact with previous years' actuals planning. The governance for contemporary social needs required collective spending rationals. So the international growth was financed through domestic and international money markets. The reasoning of the dept stock of national accounts sourced due for similar results.

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# 2 Analysis of Financial Failures of Commercial Banks in Turkey:Panel Data Discrete Choice Models

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**Abstract**

*Using financial ratios, this study models the probability of financial failure for Turkish commercial banks. For this purpose, 49 financial ratios have been investigated for 10 commercial banks. It is observed that in the literature for similar works, generally discrete choice models have been used. However, since these models are related to a single period, they provide only limited interpretation for the period under consideration. In this study, to obtain detailed information, more than one period has been handled together, and panel data discrete choice models were used. These models enable factors that influence financial failure probabilities to be considered both for time and for units. We specified the financial ratios that significantly impact the probabilities of bank failures and the items that need to be focused on to overcome these failures.*

***Keywords:*** *Bank, Financial Failure, Panel Data Discrete Choice Models*

## Introduction

Individuals and institutions face both success and failure. A person can succeed at any stage of life. For example, high scores on exams, being promoted, and attaining a higher position are measurements of success. In short, achievements determine whether or not a person is successful. A similar metric can be used for corporations. For

example, success for an enterprise could be measured by growth or continuous profitability. These opposite concepts are subjective concepts. Criteria for success can be objective or determined by individuals. Except in exceptional cases, success is always the desired outcome, and failure is the undesired one.

In addition to formulating decision criteria for success or failure, for both people and corporations, it is important to specify how failures can be avoided because, in the end, failure is not a desired situation. One way to avoid an undesirable situation is to estimate outcomes beforehand and to take appropriate measures Estimating failures for individuals and corporations is important to take such measures and to avoid failures. It is also important to estimate failures with regards to the third parties. For example, one would not buy stock in a business if failure were expected, although one may make such a purchase if the price were adjusted to reflect this expectation.

An enterprise's economic and financial structures are important indicators. Failure impacts financial structure and could disrupt it over time. Balance sheets of enterprises anticipate gradual economic failures that ensue. Therefore, financial failures can be estimated with financial ratios. To prove this, one must review balance sheets over several time periods. If balance sheets and financial ratios change, and if they result in financial failure, these events could herald similar results for all enterprises. In other words, by investigating balance sheets of previous periods, companies' future failures or deterioration can be estimated.

Financial failures can be caused by numerous fundamental indicators such as bankruptcy, reduction of capital by 50% or more, losses for 2 consecutive years, and production stoppages. Econometric models using financial ratios can also estimate financial failures.

In econometric research, assuming that past events will continue in the future without change, models are established, and estimations and analysis relating to the future are conducted. This approach is also valid for financial failure. To investigate and estimate financial failure, different models can be used. In the literature, logit models are used predominantly for this subject. In these models, the dependent variable is a dummy variable whose 2 values specify whether or not a financial situation is successful. Independent variables are financial ratios. Even though many studies adopt these models, and because logit models have no time dimension, failure for only a single period can be analyzed, leading to only limited interpretations. To analyze successes

and failures within a certain time interval, as well as the financial status of enterprises, panel data discrete choice models have begun to be used.

Banks are enterprises providing services within the country economies. It is important to estimate financial failures of banks because mediation is one of banks' fundamental functions. Banks provide services to both individuals and corporations either directly or indirectly. We use financial ratios to analyze bank failures.

Our analysis and our models incorporate data about commercial banks traded on the Istanbul Stock Exchange (BIST). In these models, financial ratios are the independent variables. While the dependent variable is financial failure, in accordance with the literature, determinants of financial failure have been formed by using active profitability.

In the two sections following the introduction part, Turkish Banking System and financial failure concept of banks have been mentioned. In the following section notes the relevant studies in the literature, provides information about the data set and variables used in this study, and calculates banks' financial ratios. Then the panel data discrete choice model is explained theoretically. Lastly, the study's findings and analytical outcome are presented.

**The Turkish Banking System**

Entry into the Turkish banking system was limited until 1980, leading to a structure that was non-competitive, externally resticted, and operating with fixed interest rates. For this reason, it can be evaluated as a nonspecialised system meets the requirement of group of companies to which it is connected as being a financial intermediary. With the decisions taken on January 24, 1980, development policies based on free market economy and aiming for exports has been adopted. Flexible exchange rate and positive real interest policy began to be implemented.

The Turkish central bank began realizing open market transactions in 1987. This date is important in terms of increasing the competition by allowing new domestic and foreign banks to enter the sector. By liberalizing foreign currency and capital movements, borrowed funds entered the country. As a result, foreign debt and foreign exchange deficits increased.

To strengthen the capital structure of the banks, Basel I Regulations were announced in 1988 and then were also started to implement by Turkey. The 1990s were years of macroeconomic instability. Because of high public sector borrowing, problems occurred in the banking system, such as insufficient equity capital, vulnerability to market risks, and insufficient internal controls. This created a crisis for the Turkish banking system in 1994.

A new economic program was prepared to provide economic balance that was upset in 1999, to reduce the increasing inflation rate, and to create a healthy structure for public financing and Banking Regulation and Supervision Agency (BRSA) was established in 2000. However, because this program was not completely successful, another financial crisis occurred in 2001. During this period, interest rates increased extremely. In 2001 fluctuating foreign exchange system was adopted and the Turkish lira was devalued. When the "Program for Passing to a Powerful Economy" began to be implemented, positive developments were observed in the economy, and the banking sector began to recover (Özden, 2009).

Within the frame of Restructuring Program, performed after the 2001 crisis and largely completed in 2004, important regulations and inspection mechanisms for strengthening the structure of banking sector were implemented. The regulations aimed at strengthening the fragile nature of the banking sector have also formed the phases of adaptation process to the Basel II. Taking into account the shortcomings of Basel I in measuring capital adequacy, the structure of the capital adequacy concept has been expanded and more risk sensitive measures have been developed in Basel II.

As a result of restructuring implementations, the banking sector began to recover. Thus, up to recent years, there has been an increase in the performance of banks and efficiency measures. However, in recent years, the low growth trend in the economy also reflected on banks have resulted in decreases in the mentioned ratios. (Bumin, 2016; Sumer, 2016).

When crisis periods are examined, it is seen that some banks have experienced financial failures during these periods. While all banks in the Turkish banking system faced the same negative macroeconomic conditions, some managed to survive and continue to operate in a healthy manner. In the early 2000s, when the banking sector went through a transition stage, 25 banks were transferred to the Savings Deposit Insurance Fund (SDIF) (Ünvan & Tatlıdil, 2011). While the external reasons for the financial failures

of banks originated from the economic policies implemented in the country, the internal reasons originated from the qualities of bank's management and personnel (Özden, 2009). Failed banks that transferred to the Savings Deposit Insurance Fund had managerial problems and insufficient risk management systems, as well as problems related to negative macroeconomic conditions (Keskin Benli, 2005).

Different types of banks operate in Turkey. Deposit banks (commercial banks) make up the largest sub-sector of the banking sector. Other banks are development banks, investment banks, and participation banks, which are specified in the country's bank laws. Another criteria used in grouping banks is related to their capital. Accordingly, banks are grouped as having either public, private, or foreign capital. Using statistical reports provided by the Bank Association of Turkey (BAT), a list of deposit banks and development and investment banks as of 2015 is presented in Table 1.

**Table 1. Banks in Turkey in 2015**

| **Deposit Banks** | **Development and Investment Banks** |
|---|---|
| **State-Owned Deposit Banks** | İller Bankası A.Ş. |
| Türkiye Cumhuriyeti Ziraat Bankası A.Ş. | Türk Eximbank |
| Türkiye Halk Bankası A.Ş. | Türkiye Kalkınma Bankası A.Ş. |
| Türkiye Vakıflar Bankası T.A.O. | **Private-Capital Banks** |
| **Private-Capital Deposit Banks** | Aktif Yatırım Bankası A.Ş. |
| Adabank A.Ş. | Diler Yatırım Bankası A.Ş. |
| Akbank T.A.Ş. | GSD Yatırım Bankası A.Ş. |
| Anadolubank A.Ş. | İstanbul Takas ve Saklama Bankası A.Ş. |
| Fibabanka A.Ş. | Nurol Yatırım Bankası A.Ş. |
| Şekerbank T.A.Ş. | Türkiye Sınai Kalkınma Bankası A.Ş. |
| Turkish Bank A.Ş. | **Foreign Banks** |
| Türk Ekonomi Bankası A.Ş. | Bank Pozitif Kredi ve Kalkınma Bankası A.Ş. |
| Türkiye İş Bankası A.Ş. | Merrill Lynch Yatırım Bank A.Ş. |
| Yapı ve Kredi Bankası A.Ş. | Pasha Yatırım Bankası A.Ş. |
| **Banks Assigned to TMSF** | Standard Chartered Yatırım Bankası Türk A.Ş. |
| Birleşik Fon Bankası A.Ş. | |

| **Foreign-Capital Banks** |
|---|
| **Banks Established in Turkey** |
| Alternatifbank A.Ş. |
| Arap Türk Bankası A.Ş. |
| Bank of Tokyo-Mitsubishi UFJ Turkey A.Ş. |
| Burgan Bank A.Ş. |
| Citibank A.Ş. |
| Denizbank A.Ş. |
| Deutsche Bank A.Ş. |
| Finans Bank A.Ş. |
| HSBC Bank A.Ş. |
| ICBC Turkey Bank A.Ş. |
| ING Bank A.Ş. |
| Odea Bank A.Ş. |
| Rabobank A.Ş. |
| Turkland Bank A.Ş. |
| Türkiye Garanti Bankası A.Ş. |
| **Banks Opening Branches in Turkey** |
| Bank Mellat |
| Habib Bank Limited |
| Intesa Sanpaolo S.p.A. |
| JPMorgan Chase Bank N.A. |
| Société Générale (SA) |
| The Royal Bank of Scotland Plc. |

**Source:** The Bank Association of Turkey's Selected Ranking of the Turkish Banking System, July, 2016

While investigating and evaluating the Turkish banking system, the Turkish Banking Association makes use of certain ratios and rates. Fundamental ratios relating to banking sector show financial status about the banks' balance sheet for a specific period. These ratios are formed by the proportion of important items in the active and passive items. These ratios and rates could be listed as

- Financial Assets (Net)/Total Assets
- Total Credits and Receivables/Total Assets
- Total Credits and Receivables/Total Deposits

- Total Credits and Receivables/Total Deposits
- Total Credits and Receivables/Total Assets
- Total Credits and Receivables/Total Deposits
- Non-Performing Loans (Gross)/Total Credits and Receivables
- Non-Performing Loans (Gross)/Total Credits and Receivables
- Special Provisions/Non-Performing Loans (Gross)
- Non-Performing Loans (gross)/Total Credits and Receivables

As of 2015, 34 deposit banks, 13 development and investment banks, and 5 participation banks operated in Turkey. As the bank ratios are investigated, it is seen that ratio of total assets of deposit banks in the sector is over 95%. Banks with private capital have the highest ratio within the deposit banks. A similar distribution is observed regarding total credits and receivables. When amount of assets per branch is reviewed, it is seen that this ratio has risen more than three folds by the end of year 2015 as compared to the year of 2005. Active profitability of banking sector for the period of December,2015 has decreased when compared with the same period of previous year. Active profitability of banks has been 1.1%, while their return on equity was 10.2%. For the same period, capital adequacy ratio for the banks was at the level of 15.6%. The same ratio was observed as 15% for the deposit banks. When the banks are investigated as per their asset qualities, it is seen that the share of credits and receivables within total assets has increased by 5.2%. The ratio of financial assets within total assets was reduced to the level of 16%. When the period of last 10 years is investigated, a reduction is seen in the ratio of fixed assets within total assets and in non-performing loans within credits and receivables. Ratio of consumer credits within total credits and receivables was realized as 25.7%. When the ratios representing the balance sheet structure of banks are analyzed, it is observed that there is an increase in the ratio of assets and liabilities in terms of foreign currency when compared with the previous year. Share of assets in terms of Turkish currency within total assets is around 65% for deposit banks having public capital, whereas this ratio is around 60% for deposit banks with private capital. Deposits in terms of Turkish currency make up more than half of total deposits (BAT, 2017; BRSA, 2015).

**Financial Failure in Banks**

Banks have a significant importance in the financial sector. Therefore, failure of banks also has an important place in the financial failures. If a bank cannot fulfill its liabilities on time, it can be regarded as a financial failure.

Various factors give rise to bank failure, including microeconomic issues (low levels of capital, low asset quality and liquidity, poor management, audits, and insufficient revenue and profitability), as well as macroeconomic ones (variability in interest and foreign exchange rates, changes in foreign trade and payment balances, variations in inflation and economic growth rates, changes in capital movements), and structural factors (financial liberation, legal regulations, transparency, inspections, audits, deposit insurance, and ethical risk problems) (Suadiye, 2006).

Since 1960, it has become important to understand bank failures and to group banks as either successful or unsuccessful. This reduces the costs of banks' bankruptcies (Ünvan & Tatlıdil, 2011). When the heavy costs of banking crisis is considered, measurement of financial failure of banking sector becomes significantly important. As relating to their operations, banks are the institutions bearing the highest risks within financial sector. Due to their extensive operaing costs and market fluctuations, banks are faced with various risks such as foreign exchange, liquidity, and interest risks. Banks' financial failures are being evaluated both with respect to the relevant bank and the other banks. Specifying the factors that are influential on the financial failure of a bank, enables for the banks to be inspected and managed in a more efficient way. At the same time, the risk of financial failure that appears as a result of disruption of financial performances of banks, may spill over to other banks. Hence, banks' financial failures are being investigated by researchers.

**Literature Survey**

Although there are various studies in financial failure literature, where different methods have been used, among these methods the most frequently used one is Binary Discrete Choice Model. Logit and probit models are also frequently used in financial failure estimations and foresight just like in other areas. However, since Binary Discrete Choice Models only analyze a single specified period, they can provide only a limited interpretation for the relevant period. As a feature of panel data, when a financial failure analysis is performed for banks, a selected period can be examined. Thus, in the

emergence of a financial failure situation, the effects of differences arising from time and units examined, ie banks, can also be included in the model. Therefore, in recent times, Panel Data Discrete Choice Models began to be used as a new alternative. Some of the studies using Panel Data Discrete Choice Models to analyze banks' financial failures are presented below.

Wong et al. (2010) developed a panel probit model to determine the primary indicators of banks' burdens and to estimate the probability of a banking burden in EMEAP (Executives Meeting for East Asian and Pacific Central Banks) economies. In the study, the period between the second quarter of 1990 and the first quarter of 2007 was analyzed for 11 countries. They found that slowing GDP growth, rising inflation rate, an increase in money supply relative to foreign reserves, deteriorating creditworthiness of banks and non-financial companies, and significant asset price gaps in property and equity markets are useful leading indicators of banking distress.

Cipollini and Fiordelisi (2012) investigated the impact of various factors on the financial burden of banks on banking level (liquidity and credit risk, asset size, revenue variables, and market power) , on sectoral level (banking density) and on macro level (real GDP growth). This study, using information from 1996 to 2009, incorporated unbalanced panel data on 308 European commercial banks. They indicated a negative link between bank market power and distress and showed that a small share of liquid assets increases the probability of observing distressed values.

Apergis and Payne (2013) used a probit model with random effects to investigate the impact of credit risk and macroeconomic factors to estimate failures of European banks. In this study, 90 European Union (EU) banks in 21 countries were analyzed betwen 2010 and 2011. The result of their study indicated that both credit risk and macroeconomic factors are significant determinants of bank failures.

Messai and Jouini (2013), aimed to investigate internal and external factors to estimate banks' difficulties regarding regulations. This study used data from 2004 to 2007 and investigated 368 banks from 8 European countries. They found that financial ratios relating to the rating system (CAMEL) are correlated with the likelihood of problems measured by binary variables.

Lin and Yang (2016) used a divided population survival duration model and a fixed effect panel logit model to investigate the impact of bank fundamentals and economic

conditions on banks' failures and their survival. This study, encompassing 1999–2011, analyzed 347 local commercial banks in 11 markets in East Asia. They found that poor bank fundamentals and macroeconomic situations increase the probability of bank failure.

**Data Set and Variables**

In this study, 49 financial ratios of 2005 - 2015 for 10 commercial banks traded at BIST in 2017 are examined. Ratios were obtained from the Banks Association of Turkey (BAT, 2017) and are presented in Table 2.

**Table 2. Definition of Financial Ratios**

| | |
|---|---|
| **Capital Adequacy (CA)** | These ratios measure whether or not banks possess sufficient capital against risks. |
| **Liquidity (L)** | These ratios measure a bank's ability to pay debt obligations. |
| **Profitability (P)** | These ratios are used to assess a bank's ability to generate earnings compared to its expenses and other relevant costs incurred during a specific period of time. |
| **Asset Quality (AQ)** | These ratios are used to evaluate the credit risk associated with a particular asset and how efficiently banks use their assets. |
| **Activity Ratios (AR)** | Activity ratios measure a bank's ability to convert different accounts within its balance sheets into cash or sales. |
| **Balance Sheet Structure (BSS)** | These ratios determine relationships between different aspects of a bank's financial position i.e. liquidity vs. solvency. |
| **Revenue–Expense Structure (RES)** | These ratios show banks' revenue and expense distribution and how they compensate for each other. |

A period lag of 49 financial ratios gathered under these headings were used as independent variables in the model. The dependent variable ( $y_{it}$ ) was formed by using active profitability( $ROA_{it}$ ) of banks. If the active profitability of bank i for period t remained below the sectoral average for period t ( $Sector_Mean(ROA_t)$ ), then

the dependent variable takes the value of 1; otherwise, it is 0. In other words, the value of 1 defines financial failure.

$$y_{it} = \begin{matrix} 1 & if & ROA_{it} < Sector_Mean(ROA_t) \\ 0 & else & \end{matrix}$$

From the all financial ratios, only five financial ratios are found statistical significant in our model. These variables are given as follows:

- BSS_1 :TP Assets/Total Assets
- BSS_2 :TP Credits and Receivables/Total Credits and Receivables
- RES :Other Operational Expenses/Total Operational Expenses
- AQ :Consumer Credits/Total Credits and Receivables
- AR :(Personnel Expenses + Severance Pay)/Personnel Number (Thousands of TL)

**Econometric Method: The Panel Logit Model**

In the study, a panel logit model with random effect was used to estimate banks' financial failure. In binary discrete choice models, the dependent variable reveals cases such as "yes–no" or "successful–unsuccessful" and can take on 2 values. In these models, the influence of independent variables on the probability of realization of situation represented by the dependent variable is measured. In panel logit models, it is accepted that there is a nonlinear relation between the probability of realization of dependent variable and the independent variables. These models have logistic cumulative distribution function as follows:

$$F(\quad x_{it}) = \frac{e^{\ x_{it}}}{(1+e^{\ x_{it}})}$$

Panel logit models are generally divided into 2 groups as homogeneous and heterogeneous models. In homogeneous panel data models, it is assumed that parameters do not change as per units and time. In other words, these models contain no unit effect coefficients representing differences specific to the units. However, in

cases where such differences exist, but not including changes arising from these differences in the model, causes for inconsistent estimations to be made. Therefore, in heterogeneous panel data models, heterogeneity among the units is included in the model by means of coefficients that are specific to the units. Unit effects could be included in the model as a fixed or random effect. In models with fixed effect, these effects are included in the model with fixed coefficients and it is permitted for relations to take place between heterogeneities which can not be observed with independent variables. In these models, parameters are estimated using a maximum likelihood method. While time dimension is fixed in models with fixed effect, if the number of units becomes infinite, inconsistent estimations could be obtained. This is because the fixed variable for each unit is estimated separately, and as the number of units increases, the number of coefficients estimated also increases. In models with random effects, changes that occur as per the units are handled as a random component of failure term. It is important to find the averages and variances of failure components, not the coefficients, that are specific to the unit. In these models, it is assumed that there is a relation between the independent variables and heterogeneity.

Conditional probability of realization of an event in panel logit models with random effect as follows: $P(y_{it}=1|\ \ _i)=F(\ \ _i+\ \ \ x_{it})$ and

$$P(y_{it}=1|\ \ _i)=\frac{1}{(1+e^{(\ \ _i+\ \ x_{it})})}$$

The estimation method most widely used for these models is the marginal maximum likelihood method. This method is widely preferred because it permits coefficient estimations to be made for variables both fixed and changing with time. This method is based on maximizing a logarithmic likelihood function. Here, maximization is generally conducted with Newton – Raphson or Fisher scoring method. In panel logit models with a random effect, z test is used to assess the significance of coefficients separately, and a Wald Test is used to test the significance of estimators (Çağlayan Akay, 2015; Greene, 2012).

**Findings**

In the study, a panel logit model is used to determine which financial ratios influence banks' financial failures. We first assess whether any differences originated from the

units in the model. We found significant unit effects resulting from LR Test. It was determined how the unit effects will be incorporated in the model. In order to realize this, first of all panel logit models with fixed effect and random effect, in which unit effects were incorporated in the model as being fixed and random, were estimated. Implementing a Hausman Test based on these estimated models, we decided to use a model with random effect. At the final stage, the estimation results of panel logit model with random effect are presented in Table 3.

**Table 3. Panel Logit Model with a Random Effect**

| **Dependent Variable:** $y_{it}$ | | | **Wald chi2(5)= 14.83** | |
|---|---|---|---|---|
| **Number of Observations: 120** | | | **Prob > chi2 = 0.0111** | |
| **Variables** | **Coefficients** | **Std. Error** | **Z** | **P>\|z\|** |
| L1. BSS_1 | −0.14 | 0.0529 | −2.68 | 0.007 |
| L1. BSS_2 | 0.17 | 0.0629 | 2.67 | 0.008 |
| L1. RES | 0.08 | 0.0334 | 2.52 | 0.012 |
| L1. AQ | −0.08 | 0.0423 | −1.97 | 0.048 |
| L1. AR | −0.03 | 0.0151 | −2.07 | 0.038 |
| LR Test | rho = 0: | chibar2(01) = 12.39 | Prob >= chibar2 = 0.000 | |

When the model obtained as a result of analysis, is investigated, it is seen that 5 financial ratios had a statistically significant impact on banks' financial failures. Two of these ratios are variables relating to balance sheet structure. These are the TP Assets/Total Assets ratio and the TP Credits and Receivables/Total Credits and Receivables Ratio. Another ratio with a significant effect is the Other Operational Expenses/Total Operational Revenues ratio. The ratio of Consumer Credits/Total Credits and Receivables, which is one of the ratios representing the asset quality, is another variable influencing financial failure. Finally, the ratio of (Personnel Expenses + Severance Pay)/Number of Personnel, which is one of the activity ratios, also is significant. The marking of "L1" before the variable names denotes that the values of these variables for the previous period were used to explain the financial failure in the relevant period. According to Wald Test result, the obtained model is generally significant. Furthermore, z test outcomes, presented for each variable, reveal that the variables are statistically significant. The LR Test in the last line of the Table indicated significant unit effects in the model and that usage of classic model was not appropriate. Here, unit effect means that each one of the banks being analyzed influenced the model.

Since coefficients in the established discrete choice model cannot be interpreted directly, the marginal effects of each independent variable on financial failure (the dependent variable) have been calculated, and the results are presented in Table 4.

**Table 4. Marginal Effects**

| Variables | dy/dx | Delta-Method Std. Error | Z | P>\|z\| |
|---|---|---|---|---|
| L1. BSS_1 | –0.019 | 0.006 | –3.32 | 0.001 |
| L1. BSS_2 | 0.022 | 0.006 | 3.48 | 0.000 |
| L1. RES | 0.011 | 0.004 | 2.48 | 0.013 |
| L1. AQ | –0.011 | 0.006 | –1.96 | 0.050 |
| L1. AR | –0.004 | 0.002 | –2.20 | 0.028 |

Table 4 shows that financial ratios, being the independent variables, had statistically significant marginal influences. When the coefficients' signs were investigated, for the 2 variables providing information about balance sheet structure, the ratio of assets in Turkish currency to total assets had a negative coefficient, whereas the ratio of credits and receivables in Turkish currency to total credits and receivables had a positive coefficient. In other words, as the ratio of assets in Turkish currency to total assets increases, the probability of financial failure is reduced, meaning that the increase in this ratio has a positive impact. In contrast, an increase in the ratio of credits and receivables in Turkish currency to total credits and receivables raises the probability of financial failure. The ratio of Other Operational Expenses/Total Operational Revenues, a representation of the revenue–expense structure, has a positive coefficient. This means that when expenses allocated to secondary activities increase within total operational revenues, the probability of banks' financial failure gets increased. However, as the ratio of consumer credits to total credits and receivables rises, because it reflects a bank's asset quality, it has a positive influence. Finally, an increase in the activity ratio (Personnel Expenses + Severance Pay)/Number of Personnel had a negative coefficient. Meaning that, increases in the personnel expenses and severance pay as being proportionate to the number of personnel, this ratio reduced the probability of banks' financial failure. However, when the sizes of coefficients are considered, it was found out that the final ratio's impact was lower than that of other variables.

## Conclusion

In this study, a panel data discrete choice model was used to specify which financial ratios influenced banks' financial failures. Financial ratios, which represent banks' fundamental structures, can be significant indicators of financial success or failure. However, investigating the ratios only for a specific period and deriving conclusions from these ratios, gives rise to a restricting situation. The panel data discrete choice model allows investigation of historical and current ratios and attainment of more general conclusions. Because monitoring the situation as per time, can provide information about reaching success situation. In our model, period for 11 years was handled and by including 49 financial ratios in the model, the ones having significant impact and yielding the best outcomes were determined among these ratios. These outcomes enable to make some general conclusions. First, some of the ratios relating to balance sheet structure, revenues and expenses, asset quality, and operations significantly impacted banks' financial failure. Among these items, in general the influence of variables relating to balance sheet structure came to the forefront. Considering the items of bank balance sheet, it seen that credit items in general, especially consumer credits, determine the probability of failure. Another particular that is influential on the probability of financial failure is the ratio of transactions realized by banks in terms of Turkish currency. While the increase in bank assets in terms of Turkish currency reduces the probability of failure, increase in credits and receivables in terms of Turkish currency increased the probability of failure. In addition, it could be stated that another factor coming to the forefront as relating to the banks' financial success is the investments being realized for the personnel. As a matter of fact, it has been observed that the increase in personnel expenses and severance pay is a positive return, that is, it has a detrimental effect on the probability of failure. To increase their present success and to be more successful in the future, banks should focus on having a solid balance sheet structure and pay attention in using credit items. Furthermore, just like the case with all other sectors, it should not be disregarded that financial success is closely related with fundamental expenses and the situation of personnel for the banks as well

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# 3 Need for Education Reforms in Turkey: An Assessment of Pisa Results

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**Abstract**

*This paper explains middle-income trap and analyses Turkey's experience by focussing on the role of a high-quality education system to avoid the trap. Relation between education and economic growth is frequently discussed in economics literature. It is known that education is key to economic growth and development. Interpretation of technology in production processes, adopted in developed countries and technology transfer, can only be possible through quality education. A strong correlation is obversed between education and progress in developed and developing countries. International comparisons such as Programme for International Student Assessment (PISA) support the hypothesis that strong education systems lay the foundations for development of countries. This study examines theoretical fundamentals of the relation between education and economic growth and reviews the studies that examined the relation between growth and education. Further, it discusses the recent need for structural reform in Turkish economy within the framework of middle-income trap and the expected education reforms. Finally, the study uses PISA results to draw inference on public policies in education using optimization techniques.*

***Keywords:*** *Middle Income Trap, Education Reforms, Education-Economic Growth*

## Introduction

The relation between education and economic growth is frequently discussed in economics and finance literature. Education is the key to the creation of qualified workforce needed for economic growth and development. It is seen in developed countries that raising the quality of education encourages adoption and transfer of technology in the production processes. A strong correlation is observed between effective use of resources for raising quality of education and progress of developed and developing countries. International comparisons such as Programme for International Student Assessment (PISA), which measure the quality of education of countries support the thesis that their education systems are behind the development level of countries. This paper examines the theoretical foundations of relation between education and economic growth and the studies that investigate the relation between education and growth. It studies the need for structural reform in Turkish economy within the framework of middle-income trap evident in economy and the education reforms expected from the government. Finally, the study draws inferences using optimisation techniques on education reforms through PISA results.

## 1. Relation between education and economic growth

Studies on economic growth concentrate in two periods: (1) mid-1950s and late 1960s- and (2) late 1980s and 1990s. The studies in the first period gave birth to neo-classical growth theory. Solow made the largest contribution to growth theories during this period. This was followed theories by Robert Lucas from Chicago University and Paul Romer from Berkeley University, which are known as growth theory (Dornbusch and Fischer, 2010, p. 269).

In the neo-classical model, there was special emphasis on the impact of education on growth. Solow pointed out a remarkable feature of the Harrod-Domar model which explained economic growth with capital accumulation that it examined long-term problems with short-term instruments, which are his major criticisms. In addition, he adopted the assumptions of the Harrod-Domar model largely with the exception of fixed proportions and created a new model. This model considers, price-fee-interest reactions from a classical viewpoint and includes in the analysis. Solow explains economic growth in his model with capital accumulation, population increase and technological development (Solow, 1956, pp. 65-68).

Domestic growth theory internalises growth rate and determines it inside the model. It accepts that government policies and economic behaviour are effective on growth rate in the long run and an attempt is made to find the factors effective on growth (Solow, 1956, pp. 65-68).

According to both theories, impact on economic growth can be brought about by education and government policies on education. Indeed, several studies on growth models displayed that education had considerable impact on economic growth. Nelson and Pelps (1966) emphasised in their study that there is a very strong relation between economic growth and education. They claim that as technology grows more human capital than material capital is needed. Lucas (1998) emphasised the impact of the increase in human capital on economic growth. Barro (1997) claimed that education would improve democracy and contribute to economic growth. Barro and Lee (1992) expanded in 2010 the study they conducted in 1992 by using the data of 146 countries between 1950 and 2010 and found out that schooling had an obvious impact on economic growth. Aghion et al. (1999) determined that education contributed to economic growth by reducing inequalities. They claimed that education would increase access to opportunities, reduce the impact of family capital on the investment opportunities of individuals and thus make sure that a more equitable structure occurs between major dynasties. A more equitable society will in turn increase economic growth.

An examination based on historical perspective shows that the importance of education on national development is higher compared to the possession of natural resources. Countries that developed good education systems despite lacking natural resources raised their development to a great level. Many countries rich in oil, minerals and other natural resources have lower economic growth rates compared to countries that lack natural resources. For example, despite the rich oil reserves, the per capita gross domestic product of Nigeria could not exceed the level in 1960s when it gained its independence. This situation is not specific to Nigeria. Several countries rich in natural resources suffer from similar handicaps. For example, from 1965 to 1998, per capita GDP growth in Iran and Venezuela was 1 percent, in Libya it was 32 percent, in Iraq and Kuwait 3 percent and in Qatar 6 percent. Only four among the 65 countries classified as rich in natural resources (Botswana, Indonesia, Malaysia and Thailand) realised long-term investments exceeding 25 percent of GDP between 1970 and 1998. In East Asia, countries that have limited raw materials (Hong Kong, Singapore, South

Kore and Taiwan) showed better growth performance than countries with rich resources Indonesia, Malaysia and Thailand) (Gylfason, 2011, p. 848).

## 2. The need for structural reform in Turkish economy: Middle-Income Trap

Establishing a good education system is essential to permanent growth and increase in employment and efficiency. In particular, the current problem is growth and rise in quality in Turkish economy. Turkey can reach its long-term targets by avoiding the recently debated "middle-income trap[1]". Middle-income trap[2] means that a developing country, after reaching a certain national income level, enters into a vicious circle as it depends on traditional production models that do not include increase in efficiency and sufficient R&D spending and fails to acquire the national income level of a developed country. Expressed with a macroeconomic perspective, increasing national income to 10,000 USD is much easier compared to increasing it from 10,000 USD to 16,000 USD level. From this perspective, as of 2016, Turkey needs technological development, increase in human capital and structural reforms to increase its per capita income from 10.807 USDs to 16.000 USDs. Avoiding middle-income trap is a very challenging process for developing countries. Since 1960s, only 13 of the 101 middle-income economies could avoid the trap[3]. For Turkey, this situation makes clear the importance of strengthening its human capital stocks, elasticising its workforce market and improving its national technology and innovation capacity. Table 1 gives the classification made by World Bank based on the income levels of countries. Currently,

[1] Middle-income trap was first used by Gill and Kaharas (2007).

[2] There is no completely agreed definition of the term in the literature. Woo (2012) refers to one of his previous research and defined Middle-income Trap with the help of "Catch Up Index (CUI)" which is calculated in proportion to the income level of the USA that is the leader of world economy since 1920. (Wing Thye Woo, 2012, p. 14). Felipe et al. (2012) followed a different path and considered the passing of countries from low income to middle income within a year as the basic criterion. Accordingly, avoiding middle-income trap means growing sufficiently fast in order to surpass middle income in maximum 28 years and surpassing the top middle-income level in maximum 14 years. Eichengreen (2011, p. 410) studied Asian countries and took 16.700 USD per capita as the critical value for middle-income level and stated that rise in income showed a downward tendency after this point from 5.6 to 2.1 percent.

[3] These countries are Equatorial Guinea, Hong Kong, Ireland, Israel, Spain, Japan, Korea, Mauritius, Portugal, Puerto Rico, Singapore, Taiwan, and Greece.

Turkey is in high middle-income level and finding it difficult in reaching high income level.

**Table 1. World Bank Current Classification by Income**

| Country Groups | GNI per capita (USD) |
|---|---|
| Low-Income Economies | 1,025 or less |
| Lower-Middle-Income Economies | Between 1,026 and 4,035 |
| Upper-Middle-Income Economies | Between 4,036-12,475 |
| High-Income Economies | 12,476 or more |

***Source:*** *World Bank, https://datahelpdesk.worldbank.org/knowledgebase/articles/906519, (4 April 2017).*

From a wider perspective that includes Turkey, it is clear that technological development and innovation are needed to ensure economic growth and development in the modern world. This, in turn, can only be possible with an education system which creates technical expertise required to create a sound human resource. In this sense, the way to success passes from establishment of an education system with schools of high-quality education where scientific and mathematic skills are developed effectively, emphasis is put on problem solving and investigation spirit is encouraged. Currently, strong economies with developed education systems and excellent universities can reach high-income levels. This, in turn, is achieved by developing management, design and marketing skills required by dynamic industries such as production and services with the help of developed scientific, technological, engineering and mathematical skills (Yusuf, 2011, p. 100).

At this point, it is seen that developing countries cannot compete with countries that give new direction to industrial novelties, raise in efficiency and innovation. Middle-income trap emerges as a situation resulting from inability to make a breakthrough in this process. In particular, seeking solutions in traditional economic policies without making human capital reforms leads to middle-income trap and chronic problems such as high inflation, low growth and high unemployment. Therefore, middle-income trap occurs as a problem of process. Countries that cannot adapt to changing economic conditions and technological developments face this problem and find no exit. Figure 1 shows the situation of countries caught in middle-income trap and failing to resolve.

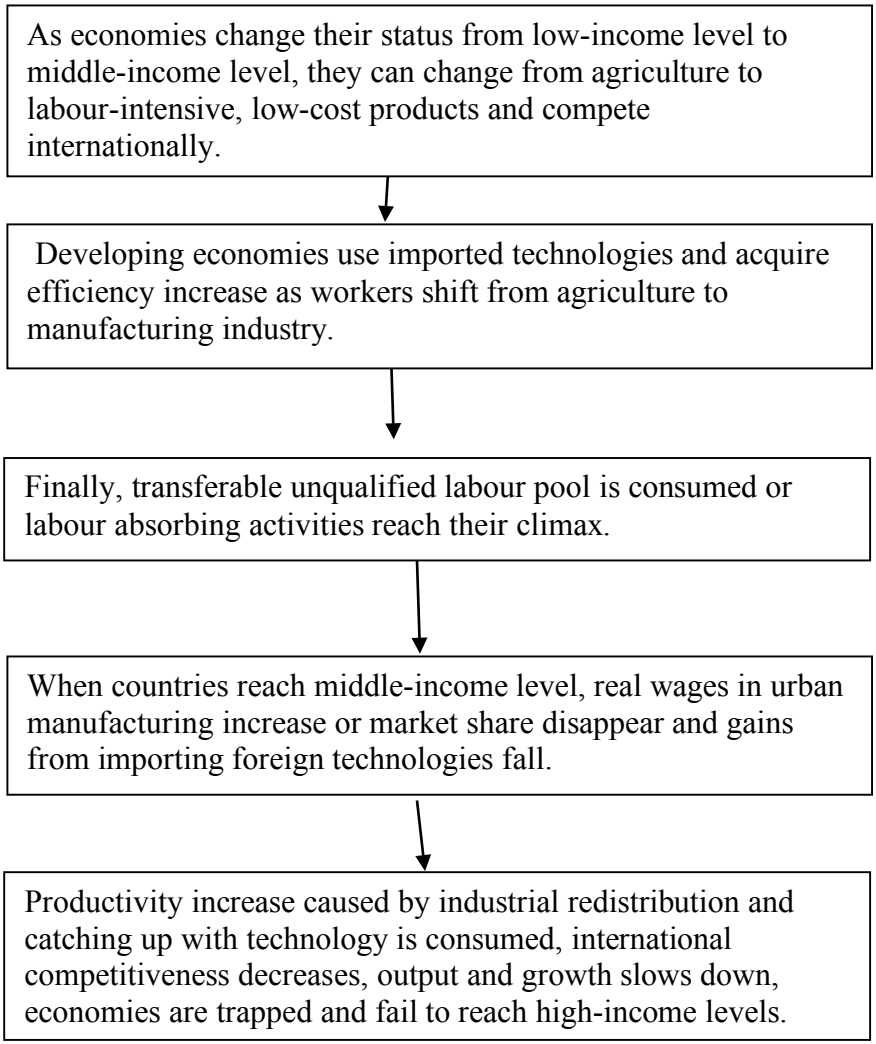



**Figure 1. Being Trapped in Middle-Income Trap**

***Source:*** *(Agénor, Canuto, Jelenic, 2012, p. 3)*

Here government assumes greater responsibilities. In present-day due to its public nature and externalities, government provides or fills the gaps in education services. Musgrave (1959, p. 44) states that especially in addition to the external economies created by educations services, government may assume considerable role in terms of imparting education in the society and solving opportunity inequalities. Good education leads to a more knowledgeable and educated civil society. This, in turn, changes civilian and political participation patterns and creates a demand for more accountability, openness, and equality in public services (UNESCO, 2015, p. 72). Emergence of such a structure creates the ground necessary for avoiding middle-income trap.

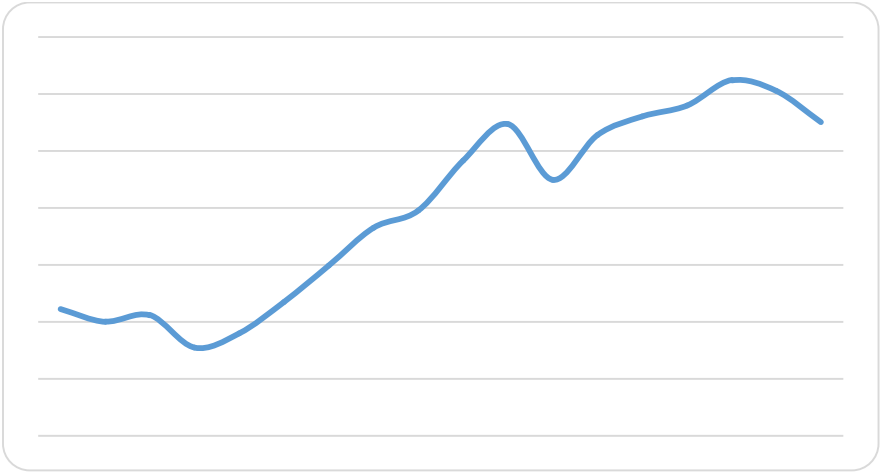
Table 2 presents an evaluation of Turkey's position in terms of middle-income trap, population and per capita national income values.

**Table 2. Per Capita Gross Domestic Product, 1998-2015**

| Year | Mid-Year Population (-000) | Value (TL) | (Change Rate) percent | Value ($) | (Change Rate) percent |
|---|---|---|---|---|---|
| **1998** | 62 464 | 1 151 | - | 4 442 | - |
| **1999** | 63 364 | 1 691 | 46,9 | 4 003 | - 9,9 |
| **2000** | 64 269 | 2 656 | 57,0 | 4 229 | 5,6 |
| **2001** | 65 166 | 3 766 | 41,8 | 3 084 | -27,1 |
| **2002** | 66 003 | 5 445 | 44,6 | 3 581 | 16,1 |
| **2003** | 66 795 | 7 007 | 28,7 | 4 698 | 31,2 |
| **2004** | 67 599 | 8 536 | 21,8 | 5 961 | 26,9 |
| **2005** | 68 435 | 9 844 | 15,3 | 7 304 | 22,5 |
| **2006** | 69 295 | 11 389 | 15,7 | 7 906 | 8,2 |
| **2007** | 70 158 | 12 550 | 10,2 | 9 656 | 22,1 |
| **2008** | 71 052 | 14 001 | 11,6 | 10 931 | 13,2 |
| **2009** | 72 039 | 13 870 | -0,9 | 8 980 | -17,8 |
| **2010** | 73 142 | 15 860 | 14,3 | 10 560 | 17,6 |
| **2011** | 74 224 | 18 788 | 18,5 | 11 205 | 6,1 |
| **2012** | 75 176 | 20 880 | 11,1 | 11 588 | 3,4 |
| **2013** | 76 148 | 23 766 | 13,8 | 12 480 | 7,7 |
| **2014** | 77 182 | 26 489 | 11,5 | 12 112 | -2,9 |
| **2015** | 78 218 | 29 885 | 12,8 | 11 014 | -9,1 |

***Source:*** *TUİK*

**Graph 1. Per Capita Gross Domestic Product, 1998-2015**



***Source:*** *TUİK*

Table 2 shows that Turkish economy increased its per capita income from 4442 USD in 1998 to 12480 USD in 2013; later, it decreased. These developments show there is a strong need for structural transformation in Turkey. In addition to high youth unemployment, the low level of women participation in workforce results in Turkey's failure to use critical potential at hand. According to TÜİK household research results, in 2016, employment rate among population aged 15 years of age or older was 46.3 percent. This rate was 72 percent for males and 32.5 percent for females (TUİK, 2017). Without making radical reforms in workforce market and in the field of education, it will not be possible to improve these data.

### 3. Education Status in Turkey

Frequently used variables in international comparisons for elementary and secondary education, net schooling rate, number of schools, number of teachers, number of students, number of classrooms, number of divisions, number of students per school, number of students per division and number of students per teacher are given in Tables 4 and 5 for Turkey.

**Table 4. Turkey Primary Education Statistics**

| Educational year | Net schooling ratio (%) | Number of schools | Number of teachers | Number of students | Number of classrooms | Number of division | Number of students per school | Number of students per division | Number of students per teacher |
|---|---|---|---|---|---|---|---|---|---|
| **1997-1998** | 84,74 | 47365 | 302254 | 9084635 | - | 317718 | 192 | 29 | 30 |
| **1998-1999** | 89,26 | 45102 | 317790 | 9609050 | - | 311871 | 213 | 31 | 30 |
| **1999-2000** | 93,54 | 33317 | 325140 | 10028979 | - | 321828 | 297 | 31 | 30 |
| **2000-2001** | 95,28 | 36072 | 345015 | 10480721 | - | 348135 | 286 | 30 | 30 |
| **2001-2002** | 92,40 | 35052 | 372687 | 10477616 | - | 370739 | 299 | 28 | 28 |
| **2002-2003** | 90,98 | 35133 | 373303 | 10331645 | - | 377609 | 294 | 27 | 28 |
| **2003-2004** | 90,21 | 36114 | 384170 | 10479538 | - | 386879 | 285 | 27 | 27 |
| **2004-2005** | 89,66 | 35611 | 401288 | 10565389 | - | 380126 | 290 | 27 | 26 |
| **2005-2006** | 89,77 | 34990 | 389859 | 10673935 | 297000 | 382061 | 297 | 27 | 27 |
| **2006-2007** | 90,13 | 34656 | 402829 | 10846930 | 307511 | 387351 | 305 | 27 | 26 |
| **2007-2008** | 97,37 | 34093 | 445452 | 10870570 | 315887 | 392521 | 310 | 27 | 24 |
| **2008-2009** | 96,49 | 33769 | 453318 | 10709920 | 320393 | 408221 | 307 | 25 | 23 |
| **2009-2010** | 98,17 | 33310 | 485677 | 10916643 | 332902 | 416930 | 316 | 25 | 22 |
| **2010-2011** | 98,41 | 32797 | 503328 | 10981100 | 339653 | 418334 | 322 | 25 | 21 |
| **2011-2012** | 98,67 | 32108 | 515852 | 10979301 | 344710 | 422751 | 323 | 25 | 20 |
| **2012-2013** | 98,86 | 29169 | 282043 | 5593910 | 234920 | 251027 | 192 | 22 | 20 |
| **2013-2014** | 99,57 | 28532 | 288444 | 5574916 | 243305 | 251801 | 195 | 22 | 19 |
| **2014-2015** | 96,30 | 27544 | 295252 | 5434150 | 237760 | 255451 | 197 | 21 | 18 |
| **2015-2016** | 94,87 | 26522 | 302961 | 5360703 | 246090 | 253714 | 202 | 21 | 18 |

***Source:*** *TUİK*

**Table 5. Turkey Secondary Education Statistics**

| Educational year | Net schooling ratio (%) | Number of schools | Number of teachers | Number of Students | Number of classrooms | Number of division | Number of students per school | Number of students per division | Number of students per teacher |
|---|---|---|---|---|---|---|---|---|---|
| **1997-1998** | 37,87 | 5624 | 140619 | 2129969 | - | 59929 | 361 | 34 | 14 |
| **1998-1999** | 38,87 | 5963 | 145903 | 2280676 | - | 65426 | 344 | 31 | 14 |
| **1999-2000** | 40,38 | 6000 | 143379 | 2316350 | - | 67710 | 344 | 30 | 14 |
| **2000-2001** | 43,95 | 6291 | 140969 | 2362653 | - | 71920 | 345 | 30 | 15 |
| **2001-2002** | 48,11 | 6367 | 144884 | 2579747 | - | 80528 | 405 | 32 | 18 |
| **2002-2003** | 50,57 | 6210 | 137956 | 3023602 | - | 86701 | 399 | 29 | 18 |
| **2003-2004** | 53,37 | 6941 | 147776 | 3014392 | - | 92238 | 389 | 29 | 18 |
| **2004-2005** | 54,87 | 6816 | 167614 | 3039449 | - | 96212 | 379 | 28 | 16 |
| **2005-2006** | 56,63 | 7435 | 185317 | 3258254 | 93488 | 100169 | 394 | 29 | 16 |
| **2006-2007** | 56,51 | 7934 | 187665 | 3386717 | 98748 | 105697 | 382 | 29 | 16 |
| **2007-2008** | 58,56 | 8280 | 191041 | 3245322 | 100853 | 105606 | 352 | 28 | 15 |
| **2008-2009** | 58,52 | 8675 | 196713 | 3837164 | 109042 | 123930 | 384 | 27 | 17 |
| **2009-2010** | 64,95 | 8913 | 206862 | 4240139 | 110310 | 139420 | 408 | 26 | 18 |
| **2010-2011** | 66,07 | 9281 | 222705 | 4748610 | 117760 | 146814 | 428 | 27 | 18 |
| **2011-2012** | 67,37 | 9672 | 235814 | 4756286 | 121914 | 148703 | 395 | 26 | 16 |
| **2012-2013** | 93,09 | 16987 | 269759 | 5566986 | 124584 | 193079 | 306 | 27 | 19 |
| **2013-2014** | 94,52 | 17019 | 280804 | 5478399 | 128551 | 195273 | 304 | 27 | 18 |
| **2014-2015** | 94,35 | 16969 | 296065 | 5278107 | 147693 | 201220 | 292 | 25 | 17 |
| **2015-2016** | 94,39 | 17343 | 322680 | 5211506 | 164943 | 205981 | 281 | 24 | 15 |

***Source:*** *TÜİK*

The data indicate considerable improvement in education indicators. Schooling rate that was 87.84 for elementary schools in 1997-1998 academic year increased to 94.87 percent in 2015-2016 academic year. Schooling rate that was 37.87 percent for secondary schools in 1997-1998 academic year increased to 94.39 percent in 2015-2016 academic year. In the same period, the number of students per teacher in elementary schools reduced from 30 to 18, while in secondary education the figure increased from 14 to 15.

The extent to which increase in quantity resulted in an improvement in quality can be found by comparing using international measurement techniques. The following section aims at comparing the improvement based on the quantity in education indicators in Turkey in an international context using PISA measurements. PISA stands

for Program for International Student Assessment a research that assesses the knowledge and skills acquired by 15-year-old students by the Organization of Economic Cooperation and Development (OECD) in three-year intervals. Based on the results of this study the effectiveness of usage of resources in the field of education in Turkey will be mathematically tested. With the results obtained from the analysis evaluations will be made on the economic aspect of education reforms.

## 4. Methodology

Efficiency and effectiveness analysis examines the relations between inputs, outputs and outcomes. Effectiveness measurement studies began with Farrell's (1957) research which emphasised that "there is a point where a given industry can increase its outputs by increasing effectiveness and without consuming more resources, and it is important to know the position of that industry vis-à-vis that point" and turned into a special area of interest for economists. Beginning with that pioneering study, several techniques were developed to measure effectiveness. It was a topic frequently debated by the industrial sector in particular.

It is not always easy to separate the concepts of efficiency and effectiveness. The concept of efficiency includes the concept "production possibilities frontier"; in other words, it is based on the scale of an economic activity and determines the level of output that can possibly be produced. The more output obtained with a certain amount of input, or the less input used to obtain a certain level of output defines, efficiency of an economic activity. Effectiveness, on the other hand, connects output or input to the final purposes (outcome).

Data enveloping analysis (DEA) is a non-parametric measurement method of measuring relative effectiveness of economic decision units that are similar in terms of the products and services they produce (Banker, 1992, p. 62). Being non-parametric means that, for a given production technology, it is not assumed that it belongs to a function class with finite parameters and determined functional form.

Relative effectiveness can be measured by DEA in two stages, summarised below:

1) Within any observation cluster, it determines the "best" observations that produce the maximum output using the minimum input.

2) It accepts the mentioned limit as "reference" and measures the distance of non-effective decision units to this limit (or their effectiveness levels) in radial (angular) terms (Yolalan,1993, p. 483).

DEA uses linear programming as an effectiveness measurement technique, which is based on a combination of multiple inputs and outputs. Linear programming is a mathematical technique used to determine the optimum distribution among various choices and effective use of limited resources to realise a given purpose. Linear programming is widely used in the solution of optimal resource distribution problems. Linear programming problem involves definition of a desired purpose as a linear function in a clear and measurable manner, knowledge of the degrees of limitation of the limited resources (restraints) that restrain the realisation degree of that purpose and expression as linear equalities or inequalities (Charnes, Cooper, Rhodes, 1978).

DEA ensures that multiple input and output variables are used in a linear programming model to obtain a single effectiveness score for each observation. The most important characteristic of this method is that it can define the ineffectiveness level and resources in each decision unit, and that as the effectiveness value of each decision unit is calculated vis-à-vis the others, the calculated effectiveness values are relative and that it does not make any functional assumption on the variables (Cooper, Seiford, Tone, 2000). The purpose of linear programming is classifying the decision units as 'effective' and 'ineffective' and whose purpose and function is equal to one or below one, respectively. DEA provides information to managers on the idle values that are among ineffective outcomes, and the performance of decision unit, and the need for input-output change in terms of resource allocation and usage to increase the performance of the decision unit to the effective reference decision units.

The present study attempts to overcome the inadequacies of other effectiveness measurement methods, which make comparing multiple inputs and outputs difficult. One of the important characteristics of the method is that it is able to measure without requiring any pre-set analytical production functions in production environments where multiple outputs are obtained using multiple inputs (Banker, 1992, p. 92). Using DEA, the level of ineffectiveness and its sources in each decision unit can be defined, which are determined in the study to be conducted. Thus, managers can decide to the level of decrease in inputs or increase in outputs of ineffective units (Tarım, 2001).

Based on these positive aspects, DEA was used with the purpose of effectiveness measurement and evaluation in several fields.

### 4.1. Data Enveloping Analysis

DEA is a non-parametric effectiveness method first developed by Charnes, Cooper and Rhodes with the purpose of measuring the relative effectiveness of economic decision-making units similar in terms of goods or services they produce. This method allows for measuring the relative total factor effectiveness of mentioned decision units in cases where decision units with different measurement units, multiple input and output variables exist that cannot be reduced to a common measure. The method is used for comparing the performances in production consisting of multiple inputs and outputs where classical regression analysis cannot be applied directly.

The DEA method was first developed by Charnes, Cooper and Rhodes in 1978 based on Farrell's production functions concept who devised fixed returns to scale. The CCR model measures the technical effectiveness of institutions. One of the most important criticisms for DEA was witnessed when Banker, Charnes and Cooper developed the BCC model, which is based on fixed returns to scale assumption and obtained by adding to the convexity restraint of the CCR model (Boussofiane, Dyson, Rhodes, 1991).

Basic concepts and principles of DEA introduced model diversification. A number of models such as the CCR ratio model, BCC returns to scale model, total model and multiplicative model were developed.

DEA can be used for both input-oriented and output-oriented analyses.

Input-oriented DEA model is used for reducing the input amount by keeping the output level constant so that the non-effective decision units can be approached to effectivity limits, whereas output-oriented DEA models is used for increasing the amount of output by keeping the level of input constant.

Output-oriented DEA model is exactly the opposite to input-oriented DEA model. For example, in input-oriented fractioned programming model, while trying to maximise the ratio of virtual output to virtual input, in its output-oriented form; it is attempted to minimise the ratio of virtual input to virtual output. The numerator and

denominator of input-oriented models switch places and the purpose function is made minimum instead of maximum.

In cases of returns to scale, effectiveness scores of decision units change depending on the output. Purpose function values of input-oriented models have to be ≤1.0 or less,whereas that of output-oriented models have to be ≥1.0 or more. In this case, if the score is equal to 1.0, it means that relevant decision units are effective in both input and output solutions, whereas those with lower than 1.0 effectiveness score indicate ineffectiveness in output-oriented analysis and those with higher than 1.0 score indicate ineffectiveness in input-oriented analysis.

**4.2. CCR Model**

The model proposed by Charnes et al. to measure the effectiveness of decision-making units (DMUs) is the ratio model. In an observation group consisting of N number of DMUs using (m) number of inputs, producing (s) number of outputs, the input-oriented ratio model of k.DMU is shown below (Cooper, Seiford, Zhu, 2004):

Purpose function $\quad \text{Mak } h_k = \sum_{r=1}^{s} u_{rk} Y_{rk}\ 1 \le k \le m, k \in \mathbb{R}$

Constraint functions $\quad \sum_{r=1}^{s} u_{rk} Y_{rj} - \sum_{i=1}^{m} v_{ik} X_{ij} \le 0\ j = 1,2,\dots,N$

$$\sum_{i=1}^{m} v_{ik} X_{ik} = 1$$

$u_{rk}, V_{ik} \ge 0 \quad r = 1,2,\dots,si = 1,2,\dots,m$

In the problem to be analysed, $X_{ij} \ge 0$ shows the I amount of input used by j decision unit. Similarly, $Y_{rj} \ge 0$, shows the r amount of outputs used by j decision unit. For this decision problem, variables are the weights to be given by k decision unit for I input and r outputs. These weights are relatively shown as $u_{rk}$ and $u_{rk}$. At this stage, the problem can be expressed as the formulation of n number of fractioned linear programming model for n number of decision units. Based on the definition of productivity, the purpose function of fractioned linear programming model is the maximisation of the ratio of total weighted outputs to total weighted inputs for k number of decision units.

By solving the CCR model for n times, the input and output weights and the effectiveness limits based on the above are obtained. This limit is defined as relative effectiveness criterion and it is believed that at least one decision unit will be effective. The CCR model can be organised for output maximisation and input maximisation purposes and in both the models separate effectiveness scores can be obtained for decision units (Banker, Charnes, Cooper, 1984).

### 4.3. BCC Model

In cases where effectiveness is affected by scale size, the BCC model is used instead of the CCR model that was developed under the assumption of variable alternate scale. The only difference between BCC and CCR models is that they function under variable alternate scale assumption instead of constant scale. It is obtained by adding convexity constraint to the CCR models.

This model was first introduced in 1984 by Banker, Charnes, and Cooper and is called BCC model after the initial letters of the surnames of its inventors. Output-oriented BCC model is as follows (Cooper, Seiford, Tone, 1999):

Purpose function $\text{Mak } h_k = \sum_{r=1}^{s} u_{rk} Y_{rk} - u_0$

Constraint functions $\sum_{r=1}^{s} u_{rk} Y_{rj} - u_0 - \sum_{i=1}^{m} v_{ik} X_{ij} \leq 0 \; j = 1,2,\dots,N$

$$\sum_{i=1}^{m} v_{ik} X_{ik} = 1$$

$u_{rk}, V_{ik} \geq 0 \qquad r = 1,2,\dots, si = 1,2,\dots,m$

Like the CCR models, the BCC models can also be grouped into input-oriented and output-oriented versions; it can also be classified as ratio, weighted model and enveloping model. They are interpreted similarly to CCR models.

### 4.4. Application

In the empirical analysis of the study, the positive impact of education expenditures on the economic growth, specified in the literature, will be taken into consideration. In this context, the quantitative and qualitative increase in the education expenditures will increase the human capital of the country; at the same time, economic growth and increase in per capita income will be witnessed with technological developments and

exportation of high-technology products. It is certain that the dynamic cyclical process here will be established in a bi-directional manner. Education will increase the economic growth, which in turn will increase the quality of education. In fact, it is seen that countries that overcome middle-income trap reserve higher shares of their budgets to R&D expenditures as a result of which they become exporters of high-tech products to the world. From this perspective, it can be claimed that the study aims at evaluating this relationship basically. If this relationship is verified, numerical analysis of education policies can be followed by Turkey to overcome middle-income trap and reach higher levels in the quality of education.

An effectiveness measurement will be made for some OECD countries and Turkey through the DEA method and effectiveness ranking of countries will be created. In the analysis, research and development expenditure (percent of GDP), GDP per capita growth (annual percent) and high-technology exports (percent of manufactured exports) were examined. As input, schooling rates, number of students per teacher, amount of public spending per person and the ratio of public education spending in GDP for the year 2013 as well as PISA 2015 results in the fields of mathematics, science and reading are used[4]. It was decided that the results of investments in education should be evaluated in a two-year delayed pattern. In other words, it was assumed that the input would be reflected in outputs at least three years later. Effectiveness measurements were based on variable returns to scale assumption (BCC model).

[4] OECD has been conducting Programme for International Student Assessment (PISA) tests, which is one of the tests that allow for international comparison, for measuring student achievement in OECD countries and other participants once in every three years since 2000. The test measures student achievement in such fields as social sciences-literature literacy, mathematics literacy and science literacy.

**Table 6. Inter-country effectiveness of education spending ranking according to PISA results**

| Ranking | Countries | Results | | Ranking | Countries | Results |
|---|---|---|---|---|---|---|
| 1 | China | 100 | | 15 | Belgium | 79,6 |
| 2 | Japan | 100 | | 16 | Spain | 78,9 |
| 3 | Netherlands | 100 | | 17 | France | 77,6 |
| 4 | Estonia | 98 | | 18 | Portugal | 75,6 |
| 5 | United States | 96,5 | | 19 | Poland | 73,9 |
| 6 | Germany | 92,9 | | 20 | Cyprus | 71,2 |
| 7 | New Zealand | 91,7 | | 21 | Hungary | 70,3 |
| 8 | Luxemburg | 91,1 | | 22 | Israel | 69,8 |
| 9 | Romania | 89,9 | | 23 | Costa Rica | 66,3 |
| 10 | Denmark | 87,9 | | 24 | Latvia | 65,3 |
| 11 | Italy | 83,5 | | 25 | Peru | 62,7 |
| 12 | Sweden | 82,9 | | 26 | Colombia | 61,1 |
| 13 | United Kingdom | 82,8 | | 27 | Brazil | 59,8 |
| 14 | Turkey | 80,6 | | 28 | Chile | 55,7 |

The results showed, Japan, China and Netherlands as effective while the Estonia and United States are very close to the effectiveness limit. Based on the selected data Chile, Brazil, Colombia, Peru and Costa Rica, which are southern and Central American countries, and Latvia and Hungary, two European countries, are among the most ineffective countries. One of the striking results of the analysis is that ineffective countries need serious reforms in education and are coming to the agenda with student incidents recently. Turkey ranks 14 with an effectiveness score of 80,6; it is rather distant from effectiveness rank but seems to be using public resources relatively well. The reference country is China. Turkey has the potential of catching up with the reference country if it realised 12.7 increase in research and development expenditures, 8.9% in high technology exports and 3% in per capita income.

As a result of the analysis, China's presence as a reference country to Turkey can be evaluated from different angles. First of all, China is trying to escape from the middle-income trap as Turkey does. Furthermore, China exports high-tech products and multiplies R&D spending alongside high growth rate. China's high-rankings in PISA results also indicates that China has been developing human capital as well. This result

proves that China has made necessary regulations to escape the middle-income trap. Hence, Stanley&Morgan's[5] detailed report dated March 2017 anticipates that China could escape the middle-income trap and reach to per capita income of 12.900 USD in the next ten years from 8.100 USD to be accepted as a high-income country. In this respect, it can be assumed that Turkey might be able to raise per capita income by adopting similar policies.

**Conclusion**

For economies of developing country sustaining economic grow in the long run becomes more difficult and the economy faces a problem called middle-income trap. This problem cannot be avoided only by applying monetary and fiscal policies; radical structural reforms are needed for solution. In the study, a solution is sought for the problem of raising Turkey to the level of developed countries in terms of per capita income with structural reforms in education. The analysis aimed at identifying Turkey's international place in education and making inferences that can direct public policies through effectiveness comparisons.

It is understood that Turkey is in need of an education reform in both qualitative and quantitative terms. In quantitative terms, it is possible to state that an increase in schooling rates, number of students per teacher, amount of public spending per person and the ratio of public education spending in GDP for the year will lead to positive results. However, it is clear that quantitative increase alone is not sufficient. In addition to the quantitative increase, quality of education also has to be improved. At this point, PISA scores can be used as criterion in that they provide international evaluations. Countries with high per capita income and high-technology exporters occupy higher ranks in PISA rankings. From this perspective, if Turkey establishes an education system, which will bring about high PISA scores, positive consequences in growth and technology will be obtained. As shown by the study, Turkey performs regulations aiming at quantitative increase merely, but fails to obtain adequate qualitative increase. From this perspective, Turkey can overcome middle-income trap only by materializing reforms, which will in turn improve the quality of education. Future reforms must pay attention to increasing the quality of education prior to university education to create

[5] Morgan Stanley, The Next Decade of China's Transformation, https://www.morganstanley.com/ideas/china-economic-market-transformation-bluepaper

qualified workforce by considering the balance between supply and demand in labour market. It is clear that students with sound foundations will increase the quality of university. In addition, education spending must be increased to the level of developed countries and the highest share from government budget must continue to be allocated to education services.

Thus, in the study, data enveloping analysis showed that countries with high education inputs and PISA scores had high level of advanced technology exports, per capita national income and R&D expenditures. In this respect, it can be claimed that Turkey will increase national income that is stuck in middle-income trap by increasing education inputs and applying the education methodologies that countries with high PISA scores implement. The analysis concluded that education inputs and PISA scores can provide the technological and human capital required to overcome middle-income trap and increase per capita national income. Developing a reform framework that will support this proposition will be determinant in the long-term development of Turkish economy.

Finally, it must be remembered that education is now a global problem, not a national one. Countries that educate skilled people obtain global competitive power whereas other countries only become markets for cheap labour. In this sense, it must be remembered that the answer to the question concerning how quality of education can be improved lies in the discipline of education sciences. However, as shown by the financial and econometric analysis of the issue, qualitative and quantitative increase in education stimulates the growth and technological development needed for overcoming middle-income trap.

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# 4 Effect of Innovation on Global Competitiveness: An Evaluation of Selected Countries

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**Abstract**

*Ability to innovate makes countries more competitive globally. Innovation accelerates production efficiencies, economic growth, and national and international development, thereby raising social wellbeing. This study examines country rankings of global competitiveness and innovation, resource utilization, and production quality with the graphics and tables constructed from national and international data and selected countries are compared. Furthermore, also in this study, examined correlation between innovation and global competitivity. At one time, costs were the factor underlying firms' competitive advantage. Today it is processes that improve products and service quality, meet market demand, satisfy customers, and welcome new management models. Factors that facilitate national economic growth, competitive power, and market share also include human capital, market structures, customer expectations, and financing. South Korea, Thailand, and Singapore undertook initiatives to spur economic growth and competitiveness at the same time as Turkey, yet today they surpass Turkey in growth and competitive advantage. As a result of the innovation activities, positive improvements in global competitivity of countries and resource utilization, production quality, and generating innovations are observed*

***Keywords:*** *Innovation Index, Global Competitiveness, Economic Structure*

## Introduction

In the current period, the factors that affect competitive advantage has a large diversity. In the previous periods, costs were the key factor that increased the competitive advantage of the firms. Now these factors include processes such as product and service quality, meeting the demand of the market, customer satisfaction, and new management models (Gaffard, 2009: 19). Firms are forced to adopt innovation and innovative activities due to the need for these factors. For example, a hotel that accepts online reservations, a company that produced anti-wrinkle textile or a transportation company that provides a fast delivery are considered to be successful to make difference in the sector of the company that would be a correct statement. Thus, firms and therefore the states can continue the operations with enhances competitive advantage and income (Elçi, 2006: 41).

It is nearly impossible to survive without realising innovation and creating innovation in the current economic environment. The main argument that will enable the firms to survive in the increasingly competitive conditions and today's competitive environment with globalization is to produce innovation, that is also names as innovation (Gault, 2011: 96).

As the competitiveness research conducted by the World Economic Forum shows Finland has been the country with the highest competitiveness in recent years. As a result of the innovative work that Finland has undertaken, Finland has succeeded in creating a country with a strong economy and a high-welfare society. Once again, as the results of the same study indicates the countries with the pioneering position in Innovation are in initiatives to encourage innovation over 20 years, and allocate a significant amount of resources for these enterprises. Countries that have an important position in the global competition index, do not restrict resource allocation for innovation and producing innovation even in the period of economic breakdown (Elçi, 2006: 32).

## 1. Definition of Innovation and Effects on Economic Structure

The Oslo Manual summarizes the dynamics that shape economic structure.

- Innovation involves novelty and outcomes that are not evident beforehand.

- Innovation requires investment in wages and services alongside acquisition of fixed and intangible assets.
- The benefits of innovation seldom accrue only to the innovator. Firms innovate by adopting the innovations of others and benefit from the dissemination of information. In some instances, imitation is less expensive than development. Therefore, novelty as it pertains to innovation entails using new information, reusing existing information, or both.
- Innovation reveals new information. Firms innovate internally (e.g., R&D) or through external channels (e.g., buying technology). Using new or existing information requires firms to distinguish the standard from routine.
- Innovation raises demand and reduces costs. Innovation generates competitive advantage (or retains competitiveness) by shifting demand (improving product quality, offering new products, opening new markets or customer groups), by reducing production, purchasing, distribution, or operating costs, or by improving capacity to acquire new information and to develop products and processes (Oslo Manual, 2005).

Innovation was first attempted to be defined by economist and policy scientist Joseph Schumpeter.

**Schumpeter**: The notion of innovation is the introduction of a new product of a product or an existing product that the customer does not already know; commencement of the implementation of a new production method; the opening of a new market; the availability of a new source of raw or semi-finished goods; it is expressed as the fact that a company has a new organization (Kılıç, Savrul and Ustaoğlu, 2011).

In addition to Schumpeter's definition there is numerous definitions of innovation appeared during the 1980s (Elçi, 2006: 24–26):

**Drucker (1985):** Innovation is the means by which entrepreneurs make changes to create a different business or service. This discipline can be presented as learning and practicing.

**Rothwell/Gardiner (1985):** Innovation implies both significant technological progress (radical innovation) and minor changes in technological knowledge (incremental innovation).

**Rickhard (1985):** Innovation is the introduction of new ideas. It is solving the problems of systems and issues using new approaches.

**Roberts (1987):** Innovation = innovative movement + use. Innovative movement includes all efforts to create ideas and render them operational. Use includes commercial development, application, and transfer. It covers focusing on ideas and inventions for specific objectives, evaluating those objectives, transferring the results of R&D, and broadening the use and dissemination of technological results.

In short, innovation is the process of transforming new ideas into commercial benefits. It is the combination of creativity and innovation (Gaffard, 2009: 13).

**2. Innovation and Global Competitiveness**

Innovation accelerates the competence and efficiency of countries and national and international institutions (Gault, 2011: 72).

The success of countries in the 21st century in transforming traditional economies into innovation economies determines sustainable economic growth and social development performance. Establishing national or regional innovation economies requires access to mechanics and capital that support innovation and that enable qualified entrepreneurs to produce and spread ideas. Here the state is a facilitator and accelerator. In this direction, such companies can be encouraged by investing in people, resources, research, technology development, and innovation. In such economies people and institutions cooperate while economic and social development policies are focused on innovation (Elçi, 2006: 41).

Firms and countries alike achieve long-term growth via innovation. Companies that innovate increase their market share and their nations' global competitiveness. Innovation raises productivity and customer satisfaction while reducing costs, thereby enhancing positive social and economic externalities (Turanlı and Sarıdoğan, 2010: 102). Innovation at the level of nations and societies enhances international competitiveness and prosperity.

As Schumpeter emphasized, innovation advances value-added socio-economic and political structures by eliminating inefficiencies (Amidon, 1995: 2). As Porter states "[T]he creation and inheritance of national wealth depends on the ability of a nation to compete globally and the capacity of the nation to innovate and to develop this

capacity." Porter argues that social, historical, cultural, and institutional structures influence national competitiveness, but the foremost factor in global competition is the ability to produce innovation (Turanlı and Sarıdoğan, 2010: 98). While promoting economic growth, countries upgrade services to their populace through innovation (Grossman and Helpman, 1997: 16).

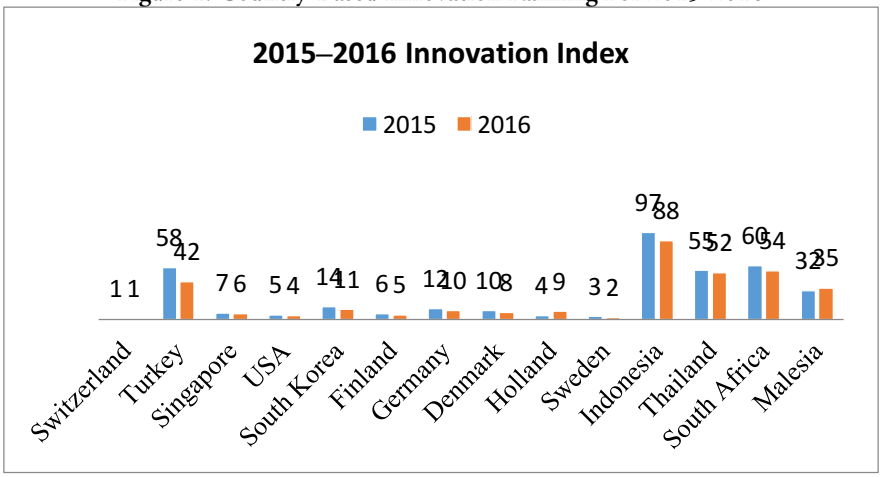
The ability to innovate influences countries' global competitiveness (Malerbo and Rsenigo, 2009). Countries with high production costs strengthen their global positions by using advanced technology in production. Countries with low production costs use their enthusiasm and advantages in reaching new technologies (Tüsiad, 2016: 36). Countries strengthen global competitiveness through the following advantages of innovation (Tüsiad, 2016: 41)

- Advanced cost efficiency
- High production speed and flexibility
- Quality production and low wastage
- Increased share of value-added products with advanced technology, know-how, and human resource value
- Development of workers to protect and strengthen global competitive position with attendant efficiencies and competencies
- Integration of production, customer relationships, and support units creates employment and jobs that a qualified workforce can fill

The Global Competitiveness Index Report by the WEF ranks Turkey's competitiveness from 2010 through 2016. The following figures reflect indexes of innovation and global competition for 14 countries from WEF data for indicated years. Using these data, we examine relations between innovation and global competitiveness.

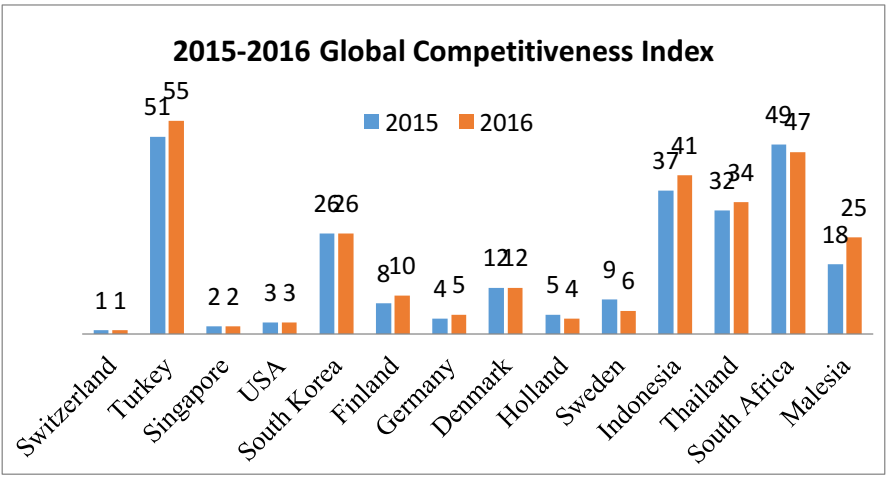
Figure 1 shows a positive relation between national economic development and innovation. Turkey ranked 12$^{th}$ among the 14 indicated countries in 2015 and 11$^{th}$ in 2016, and 42nd globally. In terms of innovation performance, Turkey is followed by Thailand, South Africa, and Indonesia. The most successful country in terms of innovation performance is Switzerland. Switzerland is followed by Sweden, Finland, America and Germany.

**Figure 1: Country-Based Innovation Ranking For 2015-2016**




***Source:*** *https://www.weforum.org/ E.T: 19/05/2017*

**Figure 2: Country-Based Global Competitiveness Index Ranking For 2015-2016**




***Source:*** *https://www.weforum.org/ E.T: 19/05/2017*

Figure 2 ranks the 14 indicated countries in a global competition index. Turkey stood last among the 14 selected countries in 2015 and 2016 (It ranked 51st in 2015 among all 138 countries in the WEF index and 55th in 2016). Turkey shows no improvement in competitiveness from 2015 to 2016. Among developing economies in Figure 2, Thailand, South Africa, and Indonesia stand ahead of Turkey. The foremost global competitors are the developed economies of Switzerland, Singapore, and the United States.

Note that Indonesia, Thailand, and Turkey improved their rankings for innovation from 2015 to 2016, but their rankings for global competitiveness fell. Our literature review suggests an explanation: global competitiveness relates not merely to innovation but also to economic and social factors such as infrastructure, macroeconomic stability, education, functioning markets, and overall business development (Archibugi and Lundvall, 2007).

Table 1 compares rankings for innovation and global competitiveness for the 14 countries in 2015.

**Table 1: Innovation and Global Competitiveness In 2015**

| Countries | 2015 Innovation Ranking | 2015 Global Competitiveness Index Ranking |
|---|---|---|
| **Switzerland** | 1 | 1 |
| **Turkey** | **58** | **51** |
| **Singapore** | 7 | 2 |
| **USA** | 5 | 3 |
| **South Korea** | 14 | 26 |
| **Finland** | 6 | 8 |
| **Germany** | 12 | 4 |
| **Denmark** | 10 | 12 |
| **Holland** | 4 | 5 |
| **Sweden** | 3 | 9 |
| **Indonesia** | 97 | 37 |
| **Thailand** | 55 | 32 |
| **South Africa** | 60 | 49 |
| **Malaysia** | 32 | 18 |

***Source:*** *https://www.weforum.org/ E.T: 19/05/2017*

Countries ranked high in innovation also ranked high in competitiveness, led by Singapore, Switzerland, and the United States. For Turkey, Indonesia, and South Africa, however, it is incorrect to assume a direct correspondence between competitiveness and innovation even though it is linear. Additional considerations are necessary when evaluating the relation between competitiveness and innovation in less developed economies, which often present structural problems in business, government, law, and education.

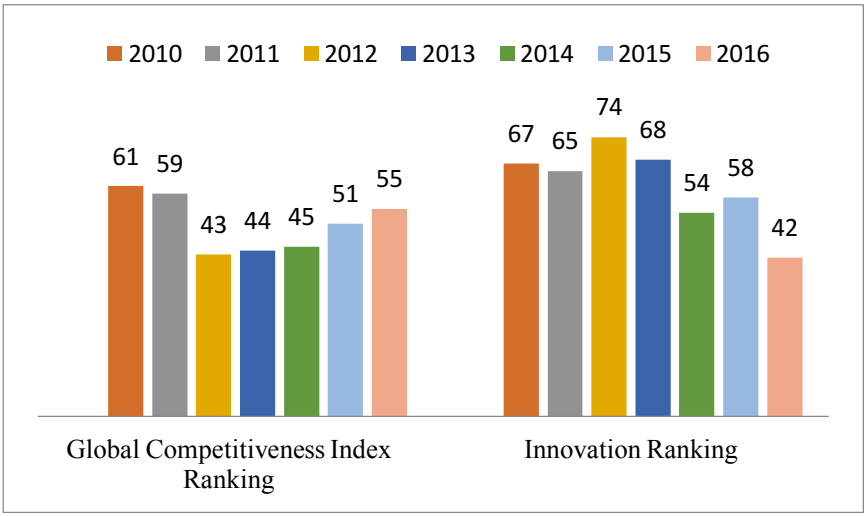
**Table 2: Innovation and Global Competitiveness in 2016**

| Countries | 2016 Innovation Ranking | 2016 Global Competitiveness Index Ranking |
|---|---|---|
| **Switzerland** | 1 | 1 |
| **Turkey** | 42 | 55 |
| **Singapore** | 6 | 2 |
| **USA** | 4 | 3 |
| **South Korea** | 11 | 26 |
| **Finland** | 5 | 10 |
| **Germany** | 10 | 5 |
| **Denmark** | 8 | 12 |
| **Holland** | 9 | 4 |
| **Sweden** | 2 | 6 |
| **Indonesia** | 88 | 41 |
| **Thailand** | 52 | 34 |
| **South Africa** | 54 | 47 |
| **Malesia** | 35 | 25 |

***Source:*** *https://www.weforum.org/ E.T: 19/05/2017*

Table 2 shows that the three highest-ranked global competitors in 2016 were unchanged from 2015. Indonesia ranked 88th among 138 countries in competitiveness and 42nd in innovation. Turkey ranked 55th in competitiveness. Results for these two countries indicate there is no assured relation between innovation and global competitiveness and again suggest that other variables drive this relationship. Nonetheless, greater intensity of innovation might explain the positive relation between competitiveness and innovation.

**Figure 3: Global Competitiveness Index and Innovation Ranking for Turkey (2010–2016)**




***Source:***
*http://www.mof.gov.il/ChiefEcon/InternationalConnections/DocLib3/Global_Competitiveness_Report_2015-2016.pdf and https://www.weforum.org/ E.T:15.04.2017.*

Figure 3 ranks Turkey's global competitiveness and innovation for 2010–2016. In 2010, Turkey ranked 61st in global competitiveness and 67th in innovation. In 2011, Turkey rose to 59th in global competitiveness and 65th in innovation. In 2012 it rose to 43rd in competitiveness but fell to 74th in innovation. The relation between innovation and global competition in Turkey is erratic and again suggests influence by other variables. Turkey's standing in these two indexes has fluctuated for years, in 2016 reaching 55th among 138 countries in competitiveness and 42nd in innovation, increasing 16 places over 2015. To achieve higher rankings in the global competition index, Turkey needs to take stable and continuous steps to innovate while instituting structural reforms.

## Results

Economic growth and development among countries that produce new technologies and services and dominate markets are testaments to innovation, and innovation has become a core value for countries seeking to engage the 21st century. This study has confirmed a relation between nations' abilities to innovate and their global competitiveness, but the data examined do not establish an indelible relation between them. The countries evaluated in this study are selected among developed countries and developing countries. As the global competitiveness index ranking and innovation abilities of developed countries such as Singapore, USA, and Switzerland are evaluating, the relationship between these two phenomena are easier to establish. On the other hand, this kind of relationship was hard to establish for the developing countries. Because the existence of various issues in these states prevents the establishment of a direct relationship between these two phenomena. This is also the case for Turkey. Many issues such as the existence of existing problems within the country, instability, uncertainty of political conjuncture, political worries prevent the relationship between innovation and global competition index to be evaluated on solid basis.

Policies that promote growth and innovation are important, but comparison shows that innovation is a necessary but not sufficient condition to drive global competitiveness. To be globally competitive, nations need policies that endorse innovation alongside structural reforms. Innovation is a time-consuming process that requires extended effort to provide significant results.

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# 5 Assessment of Turkey and European Union Countries in Terms of Innovation Indicators

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**Abstract**

*In today's information age, countries are in intense competition with each other. This situation leads to that countries which are trying to achieve superiority in world competition to give more importance to research and development (R & D) activities. The increase in R & D investments has led to countries becoming more competitive with other countries of the world and this competition is constantly driving countries to seek innovative and technological development. Such innovative and acquired technological developments are important in terms of increasing prosperity and productivity in the long term, and because of leading to the development of countries. In this study, the situation in the EU countries and Turkey has been assessed over the years according to innovation indicators, which provide a great advantage to compete primarily and have a great importance in terms of both countries and companies. In the next stage, Turkey and the EU countries were grouped according to their similarities in terms of innovation indicators by cluster analysis, At the same time in the study, the performance rankings of the countries were made in the light of the indicators by the TOPSIS method and suggestions were made about which areas priority should be given.*

***Keywords:*** *Innovation, EU Countries, Turkey, Cluster Analysis, TOPSIS*

## 1. Introduction

The experience gained during the history of mankind shows that knowledge is the most basic element that makes a nation superior to other nations. There is plenty of evidence that each piece of knowledge obtained is a continuation of previous knowledge. While the knowledge obtained throughout history provides technological developments; these technological developments increase the economic efficiency levels of the countries and make the production structures more stable. Therefore, this situation emerges as an important element in sustaining a stable growth that provides an increase in social welfare. In this context, research and development (R & D) and innovation activities, which are important actors in the capture of technological developments, have been accelerated by many countries and countries have tried to create more added value with lower cost. R & D can be defined as investing on increasing the knowledge (new product / service development and offering them to market), all the scientific and technical actions taken depending on new technologies or human capital and the existing knowledge (Karagöl & Karahan, 2014, p.9). According to the OECD, R & D is defined as the continuation of the creative activities that increase human, social and cultural knowledge and putting these into practice in new areas (OECD, 2002). It is stated that innovation has a positive effect on the labour and total factor productivity and increases the level of prosperity while R & D studies are among the most important input sources for innovation (Erkiletlioğlu, 2013, p.2).

## 2. Concept of Innovation and the European Union Innovation Scoreboard

The notion of innovation concept derived from the Latin word "innovatus" carries the meaning of innovation, innovating, renewal in the Turkish; defined as the novelty which causes social and economic added value (Akar, 2014 p.22). According to Schumpeter, a wider definition of innovation can be defined as developing a new or existing product or process, creating new organizational structures, using existing technology in new fields of work, or exploring new markets, organizations in external relationships and development of new supply sources for raw materials and other inputs (OECD, 2006, p.33) Two things are very important for innovation. The first is to develop a new and creative idea, the second is to provide an economic value to this idea. It is of no importance that technological studies are transformed into innovations but not into the economy. If new products and processes cannot succeed in the market, their impact will be limited and will not lead to change. Therefore, the new product or

the process can be defined as invention but for the new product or the new process to be called as innovation they must be developed commercially (Ersöz, 2009, p.6).

Nowadays, the concept of innovation has come to be more important among countries. The main cause of this is the desire of countries to benefit more from the advantages of globalization. Countries that produce information and make technological developments are able to produce goods and services that can be sold to other economies. Therefore, the sale of these goods and services produced at the global level means that the producer country integrates with the world economy, has a voice in the world economy and gets more share from the cake. This is another way of turning globalization into own advantage (Özbek & Atik, 2013, p.194). In other words, R & D and innovation activities in the world are gaining momentum and are among the driving dynamics for countries (Akar, 2014, p.23). Countries are entering the race to create more added value, using less resources. It has been observed that the innovation has a positive effect on the level of welfare and the increase in the total labour power and total factor productivity. R & D studies maintain their place among the most important inputs for innovation (Erkiletlioğlu, 2013, p.3).

Considering Turkey's experience in innovative innovation systems, Turkey has been aiming to become an expert in science and technology since the establishment of the Republic. With the establishment of TUBITAK in 1963, it is seen that Turkey aims to speed up this process. TUBITAK completed the "National Science and Technology Policies: 2003-2023 Strategy Document (Vision 2023)" project in July 2004, which includes new science and technology strategies for Turkey (Soyak, 2007, p.3). Within the framework of this project, Turkey has been among the countries with the fastest development in R & D and innovation indicators in recent years. However, the results are still far from satisfactory level. Turkey defines the vision of science, technology and innovation as "a country that transforms the information and technologies it produces and develops into innovative products, processes and services for the benefit of the country and humanity". Thanks to the efforts carried out in this framework, Turkey has become one of the fastest-developing countries in R & D and innovation indicators in recent years (Vardarlıer and Cakır, 2015, p.29).

Innovation has great importance to the European Union (EU), which aims to be one of the most competitive economies in the global economy, as it is in the whole world. The European Innovation Scoreboard which was named as Innovation Union Scoreboard from 2010 to 2015, is an important tool to guide EU member countries in

evaluating their research and innovation performance and in what areas they need to focus on to improve innovation performance (European Innovation Scoreboard, 2016).

**Table 1. Measurement Framework of the European Innovation Scoreboard**

| **Enablers** | **Firm Activities** | **Outputs** |
|---|---|---|
| **Human resources** | **Firm investments** | **Innovators** |
| 1.1.1 New doctorate graduates | 2.1.1 Business R&D expenditure | 3.1.1 SMEs introducing product or process innovations |
| 1.1.2 Population completed tertiary education | 2.1.2 Non-R&D innovation expenditure | 3.1.2 SMEs introducing marketing/organisational innovations |
| 1.1.3 Youth with upper secondary level education | **Linkages& entrepreneurship** | 3.1.3 Employment in fast-growing enterprises |
| **Open, excellent and attractive research systems** | 2.2.1 SMEs innovating in-house | **Economic effects** |
| 1.2.1 International scientific co-publications | 2.2.2 Innovative SMEs collaborating with others | 3.2.1 Employment in knowledge-intensive activities |
| 1.2.2 Scientific publications among top 10% most cited | 2.2.3 Public-private co-publications | 3.2.2 Medium and high-tech product exports |
| 1.2.3 Non-EU doctorate students | **Intellectual Assets** | 3.2.3 Knowledge-intensive services exports |
| **Finance and support** | 2.3.1 PCT patent applications | 3.2.4 Sales of new to market and new to firm innovations |
| 1.3.1 Public R&D expenditure | 2.3.2 PCT patent applications in societal challenges | 3.2.5 Licence and patent revenues from abroad |
| 1.3.2 Venture capital | 2.3.3 Community trademarks | |
| | 2.3.4 Community designs | |

***Source:*** *European Innovation Scoreboard 2016, http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_es*

The publication of the European Innovation Scoreboard, prepared for the EU including the Turkey's innovation score, clearly shows how important this concept for EU is. This report, which is composed of various criteria and prepared by the supervision of the

European Commission, is an official publication. Three main types of indicators, eight innovation dimensions and capturing in total 25 different indicators are used in the formation of this scoreboard, which has been published consistently since 2001. The names of the indicators will not be written explicitly in the progress of the study but will be indicated by their numbers.

Enablers; deal with the main driving forces behind innovation performance out of the firm and covers three innovation dimensions, "Human resources", "Open, excellent and attractive research systems" and "Finance and support".

*The human resources* dimension consists of three indicators measuring the presence of a high- skilled and educated workforce.

*Open, excellent and attractive research systems* include three indicators of size and measure the international competitiveness of science.

The dimension of *finance and support* is composed of two indicators, measuring funding opportunities for innovation projects and government support for research and innovation activities.

Firm activities; deal with the innovation performances at the firm level. This main indicator is composed of three innovation dimensions as "Firm investments", "Linkages and entrepreneurship" and "Intellectual assets".

*Firm investments* measure the size of R & D and non-R & D investments made by enterprises to produce innovations with two indicators.

The dimensions of *linkages and entrepreneurship* include three indicators measuring entrepreneurial and collaborative efforts between innovative businesses and the public sector.

The *Intellectual assets* dimension deals with different Intellectual Property Rights produced as an output in the innovation process.

Outputs; cover the effects of innovation activities of firms in two dimensions of innovation. These are "Innovators" and "Economic effects".

*Innovators* dimension is composed of three indicators measuring the number of initiatives that bring innovation to the market or organizations, including both

technological and non-technical innovations and the presence of high-growth businesses.

The *economic effects* dimension includes five indicators that address the economic success of employment, exports and sales innovation due to innovation activities (European Innovation Scoreboard, 2016, p.4).

Indicators show the innovation performances of Turkey, Ukraine, Iceland, Norway, Switzerland, Israel, Canada, Australia, USA and Japan, along with EU countries.

At the European Innovation Scoreboard (2016), countries were categorized into four groups according to their innovation performance. Countries are classified as below according to innovation indicators (European Innovation Scoreboard, 2016).

i. Innovation Leaders: Switzerland, Sweden, Denmark, Finland, Germany, the Netherlands.

ii. Strong Innovators: Ireland, Belgium, the United Kingdom, Luxembourg, Austria, Israel, Iceland, France, Slovenia.

iii. Moderate Innovators: Norway, Cyprus, Estonia, Malta, the Czech Republic, Italy, Portugal, Greece, Spain, Hungary, Slovakia, Serbia, Poland, Lithuania, Latvia, Croatia and Turkey.

iv. Modest Innovators: Bulgaria, Macedonia, Romania and Ukraine.

While the "innovation leaders" class is composed of countries which innovation performance well above the EU average; "strong innovators" are composed of the countries which innovation performance is above or close to the EU average. While the countries below the EU average are in the "moderate innovators" group; "modest innovators" are the countries well below the EU average.

As Turkey's report is examined from the point of view of Turkey, one of the changes that has been experienced since last years is that Turkey has moved from the modest innovator group to the moderate innovator group with the increasing performance.

According to the Innovation Report (2016), Turkey is a developing country. It is observed that Turkey is behind all EU member countries (except Bulgaria) and candidate countries finding its place at end of the list. On the other hand, it is stated in

this report that Turkey managed a slow but steady development between 2008 and 2014, and shows a sudden increase in 2015. It is stated that the indicator in which Turkey is best is sales of new-to-market and new-to-firm innovations as % of turnover, and recently with %5.4 of growth rate Turkey is above EU countries. It is stated that indicators like these moved Turkey from modest innovators list to moderate innovators list. (European Commission, 2016, p.30-81).

## 3. Literature Review

Ersöz (2009) applied cluster analysis in order to see in which clusters he participated in his study called "The Status of Turkey in Light of the Indicators of EU Innovation (EIS)". At the same time, he performed discriminant analysis to test the results of cluster analysis. As a result of multidimensional scaling analysis, it has been determined that Turkey shows low country characteristics in terms of innovation indicators upon EU countries, USA, Japan and Israel.

Ünlükaplan (2009) aimed to understand needs and identify appropriate strategies, and to identify in which areas priority should be given according to innovation indicators to make Turkey to reach the level of innovation of developed countries. In the study, multivariate statistical techniques were applied to European innovation indicators. On innovation indicators, according to the hierarchical clustering analysis it is concluded that Turkey is in the same cluster with Poland, Slovakia, Latvia, Greece, Lithuania, Hungary, Estonia, the Czech Republic, Slovenia, Spain, Portugal and Malta.

Buesa, Heijs and Baumert (2010) have examined the determinants of regional innovation in Europe by using factor analysis and regression. In the study patent was used as the dependent variable and five variables obtained as the result of factor analysis over 21 variables as the independent variables. As a result of the analysis, they came to conclusion of five factors on the dependent variable have statistically significant and different effects.

Burmaoğlu (2010) applied factor analysis to determine the innovation criteria and applied discriminant analysis to find the variables that make a difference between EU member and non-member countries. As a result of the analysis, Burmaoğlu has made suggestions about the innovation policy of Turkey.

Sheng and Wong (2012) set the innovation performance of China. In the study, using canonical correlation analysis, the key factors that were important to enhance the

innovation capacity of a country were identified, and at the same time, China's level of innovation was assessed in terms of innovation-enabling factors.

Özbek and Atik (2013) applied cluster analysis using 13 innovation indicators, which are the data of Turkey and according to these indicators, aimed to determine where Turkey was among the EU countries. As a result of the analysis, Turkey has a similar innovation performance as Bulgaria and Romania and took place in the same cluster with them.

Ünlü (2013) conducted a comparative analysis of Turkey with the selected EU countries and EU candidate countries in order to determine the situation of Turkey about the innovation performance criteria established by the EU.

Çakın and Özdemir (2014) innovation performances of 12 regions in Turkey NUTS Level 1 in 2010, 2011 and 2012 were evaluated by regression analysis, DEMATEL based Analytical Network Process (DANP) and TOPSIS methods, according to the basic R & D and innovation indicators. At first, the criteria were weighted and in the next phase, the performance line up of the regions was done by the TOPSIS method,

Cavdar and Aydin (2015) examine whether if the technological development indicators used as economic growth, innovation and development levels of countries are influenced by the variables determined in the study in their work such as R & D expenditures, high technology exports, long-term unemployment, patent applications, etc. As a result of the hierarchical clustering and multidimensional scaling analysis they carried out, they reached the conclusion that the variables such as patent applications-residents, health expenditures, national income per capita, the share of women employed in the non-agricultural sector, internet users, scientific and technical articles have important effects on innovation and technological development.

Gezer, Uzgören and Elevli (2015) aimed to reveal Turkey's position among the European Union countries according to the 2012 Basic Innovation Indicators. Conducting cluster analysis, they reached the conclusion that Turkey is in the same cluster as Romania, Greece and Italy.

Tezcan (2015) applied multidimensional scaling analysis and cluster analysis in order to compare the European Union (EU) and Turkey in terms of innovation performance

and to identify similar countries. As a result of the analysis, Turkey is among the countries with an upper middle-income level well below the EU27 average.

Hancıoğlu (2016) used canonical correlation analysis in order to determine the relationship between the innovation input and output sub-index variable clusters that form the 2011-2015 Global Innovation Index of OECD countries and came up with the result that both variable clusters have a significant relationship.

Inel and Türker (2016) using a decision model consisting of three criteria for innovation index evaluations of 28 countries they calculated the national innovation performance scores of the countries by analytical hierarchy process and Topsis techniques.

Baser, Özcan and Türe (2017) clustered 52 developing countries according to technology and innovation indicators with the fuzzy c-means cluster algorithm.

## 4. The Aim and the Scope of the Study

The aim of this study is to examine the performances and rankings of the performances of EU countries that are in the European Innovation Scoreboard, including Norway and Turkey the considering 3 main indicators. Analyses in the study were carried out using the indicators which take place on enablers, firm activities and outputs dimensions including the data about Turkey from 2015 European Commission European Innovation Scoreboard and which is described in the second part of the study. Greece is excluded from the study because there is not enough data about it. After missing data elimination operation and necessary arrangements, cluster analysis was applied to determine the groups of countries exhibiting similar structures based on the indicators determined in the study, and to determine the position of Turkey among the EU countries. In the later stage of the study, the order of the countries was also obtained with the help of the TOPSIS method according to 3 main indicators.

## 5. Methodology

In this part of the study, to analyse data for the purpose determined, TOPSIS, one of multi-criteria decision-making methods and cluster analysis from the multivariate statistical techniques is summarized.

### 5.1. Cluster Analysis

Cluster analysis, which has a wide range of applications in different disciplines such as biology, medicine, botany as much as it is in the field of social sciences such as archaeology, psychology, marketing and business, is one of the multivariate analysis techniques that divide units and objects into groups according to their similarities.

The general purpose of the cluster analysis is to reveal the similarities of the objects according to their specific characteristics and classify the objects into the correct categories based on these similarities (Çokluk, 2010, p.139). Objects in the same cluster are much similar then the objects between other clusters, therefore objects within the clusters are more homogeneous than objects between clusters. If the clustering is successful after the cluster analysis, the objects will be quite close to each other when marked geometrically and the different clusters will be quite far away from each other (Uçar, 2008, p.349).

Information about how close or how far the objects are to each other is a key factor in determining the clusters that may be present in the data.

The clustering process is based on the similarity or distance between the objects in the according to the determined purpose. There are a number of different distance and similarity measures that are used in the allocation of objects to clusters. Depending on the type of data and scale, the distance / similarity measure to be chosen is decided.

The next step following the selection of the similarity or distance measure, which is the first step of the cluster analysis, is to determine the clustering method to be used. While there are many methods in cluster analysis, it is seen that the most known methods are gathered under two headings as hierarchical and non-hierarchical methods (Tatlıdil, 2002, p.334). Hierarchical clustering methods are divided into two parts as *agglomerative methods* most widely used, where all objects are in one cluster at the end of a sequential join process and each unit is initially a separate cluster and *divisive methods* where clusters are created by step-by-step sub cluster as a result of partition of all units in a single cluster (Everitt et al., 2011, p.74). Hierarchical clustering methods frequently used to assign units to clusters are Single Linkage (Nearest Neighbour), Complete Linkage (Furthest Neighbourhood), Average Linkage, Centroid Linkage, Median Linkage and Ward's Method (Rencher and Christenses, 2012, p.506). In single linkage method, the two closest objects or clusters are merged using the distance or

similarity values. In complete linkage method, after two clusters are merged, this new cluster is merged with the maximum distant cluster. In average linkage method, the distance between two clusters is equal to the average of the distances between the observation pairs in each cluster.

In the centroid linkage method, the cluster centres of the objects in each cluster are calculated first, then the distance between these two cluster centres is defined. In the Ward's method, instead of calculating the distances between the clusters, clusters are formed with maximum homogeneity. In this method, the sum of squares within clusters is used as a measure of homogeneity and the within cluster sum of squares is tried to be minimized (Sharma, 1996, p.193).

There is no prior knowledge about the numbers of the clusters in hierarchical clustering methods. In hierarchical clustering methods, the number of clusters is determined by the results of the cluster analysis. The result of the analysis is graphically displayed with the aid of a dendrogram showing all the steps in the hierarchical clustering, including the distances at which the clusters are merged. Non-hierarchical clustering methods are designed so that objects can be divided into k number of clusters. Non-hierarchical techniques should be applied to larger data sets instead of hierarchical techniques (Johnson & Wichern, 2007, p.755) Contrary to hierarchical clustering methods, there is a priori information about the number of clusters in non-hierarchical methods. K-means is the most widely used in non-hierarchical clustering methods.

### 5.2. The TOPSIS Method

Decision-making is thought to be the process of choosing one or more of the alternative forms of behaviour that people or institutions come across to achieve a specific goal (Turanlı, 1988, p.2). Defining the problem, establishing the model, solving the model, testing the result and putting the decision into practice form the five basic steps of decision-making. Multi-criteria decision-making techniques can be defined as mathematical techniques that enable decision-makers to choose the best solution from a large number of alternatives in order to achieve an objective. The TOPSIS (The Technique for Order Preference by Similarity to an Ideal Solution) method is a Multi-criteria decision-making technique by Chen and Hwang (1992), referenced to the article of Hwang and Yoon (1981). The method determines the closest distance to positive ideal solution or in short ideal solution and farthest distance to the negative ideal solution without considering the relative importance of these distances (Opricovic

& Tzeng, 2004, p.448). The ranking of the alternatives is made by starting from the closest alternative according to the distance to the ideal solution. The best solution, which is expressed as an ideal or positive ideal solution, maximizes the benefit criteria, minimizes the cost criteria, and the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria (Wang & Elhag, 2006, p.310). The ideal solution, when all the criteria are considered, is that the chosen alternative fulfils these criteria at ideal levels. If the ideal solution cannot be reached, the closest point to the ideal is considered the ideal solution (Özden, 2009, p.76).

$\mathcal{A}^* = \left(x_1^*, \dots, x_j^*, \dots, x_n^*\right)$ is called the ideal solution and value $x_j^*$ is the best value among the alternatives of criteria $j$. $\mathcal{A}^- = \left(x_1^-, \dots, x_j^-, \dots, x_n^-\right)$ is called the negative ideal solution and value $x_j^-$ is the worst value among the alternatives of criteria, $j$.

In the first step, decision matrix is established, with alternatives $(n)$ to be sorted in the rows of the matrix and decision criteria $(m)$ in the columns.$\mathcal{X} = (x_{ij})_{nxm}$

$$\mathcal{X} = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1m} \\ x_{21} & x_{22} & \dots & x_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \dots & x_{nm} \end{bmatrix} \quad (1)$$

The second step is the normalization of the decision matrix. In this step, different criterion dimensions are transformed into dimensionless criteria. The aim here is to normalize the decision matrix values so that they can be compared independently off the unit of measure (Özden, 2009, p.68). According to the formula number (2), the decision matrix is normalized and the following matrix R is obtained.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}}, \quad i = 1, \dots, n \; ve \; j = 1, \dots, m \quad \dots (2)$$

$$\mathcal{R} = \begin{bmatrix} r_{11} & \dots & 1m \\ \vdots & \ddots & \vdots \\ r_{n1} & \dots & r_{nm} \end{bmatrix} \quad \dots (3)$$

A large number of criteria used in ordering alternatives may have different importance for decision makers. For this reason, after the normalization phase of the decision

matrix, weights will be assigned to each criterion to make their sum equal to 1. In this step, weights can be assigned for each criterion as well as can be headed for expert opinions.

The next step is to build the weighted normalized decision matrix by multiplying the normalized decision matrix by the weights. Weights can be calculated equally for each criterion, provided that their total equal to one, and if there are differences in the criterion, they can be determined differently. This matrix can be mathematically expressed as $\mathcal{V} = (v_{ij})_{nxm}$ and is calculated as below.

$$v_{ij} = w_j r_{ij}, \quad i = 1, \dots, n \; ve \; j = 1, \dots, m \; ; \sum_{j=1}^{m} w_{ij} = 1 \qquad \dots (4)$$

The next step is determination of the ideal solution $\mathcal{A}^*$ and negative ideal solution $\mathcal{A}^-$ according to equations (5) and (6) below. $\Omega_b$ is the sign for set of benefit criteria cluster, and $\Omega_c$ is the sign for set of cost criteria cluster.

$$\mathcal{A}^* = \{v_1^*, \dots v_m^*\}$$

$$= \left\{\left(\max_j v_{ij} \,\middle|\, j \in \Omega_b\right), \left(\min_j v_{ij} \,\middle|\, j \in \Omega_c\right)\right\} \qquad \dots (5)$$

$$\mathcal{A}^- = \{v_1^-, \dots v_m^-\}$$

$$= \left\{\left(\min_j v_{ij} \,\middle|\, j \in \Omega_b\right), \left(\max_j v_{ij} \,\middle|\, j \in \Omega_c\right)\right\} \qquad \dots (6)$$

In the calculation of the separation measurement step, the n-dimensional Euclidean distance method is applied to each separation distance measure of each alternative to the ideal solution and to the negative ideal solution (Özden, 2009, p.80). The distance of each alternative from the ideal solution according to the Euclidean concept is determined as $(\mathcal{D}_i^*)$ and the distance from the negative ideal solution according to the Euclidean concept is determined as $(\mathcal{D}_i^-)$ .

$$(\mathcal{D}_i^*) = \sqrt{\sum_{j=1}^{m}(v_{ij} - v_j^*)^2} \ , i = 1, \dots, n \quad (7)$$

$$(\mathcal{D}_i^-) = \sqrt{\sum_{j=1}^{m}(v_{ij} - v_j^-)^2} \ , i = 1, \dots, n \quad (8)$$

In the last step, the distance of each alternative relative to the ideal solution is calculated using the equation (9), according to this closeness ordering is made as the largest $\mathcal{RC}_i$ value is the best alternative.

$$\mathcal{RC}_i = \frac{\mathcal{D}_i^-}{\mathcal{D}_i^* + \mathcal{D}_i^-} \ , i = 1, \dots, n \quad \dots (9)$$

## 6. Findings

In the study, cluster analysis performed by R and the TOPSIS analysis were performed using Microsoft Office Excel 2016.

### 6.1. Cluster Analysis Findings

The dendrogram which is obtained as a result of the cluster analysis performed using the Ward's method, with the indicators in the dimension of enablers, is given below. When the figure is examined, the number of clusters is determined as three.

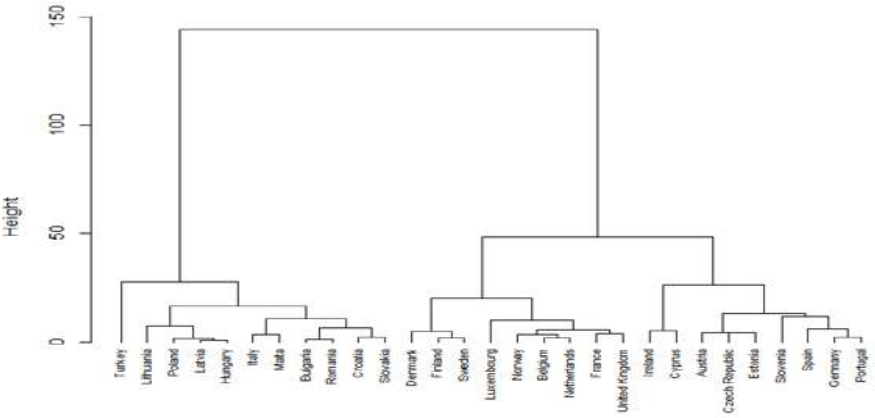



**Figure 1. Dendrogram For Enablers Dimension Indicators**

The distribution of the countries in three clusters is given in Table 2.

**Table 2. Countries in Clusters**

| Cluster Name | Countries |
|---|---|
| **Cluster 1** | Finland, Sweden, Denmark, Belgium, the Netherlands, Norway, France, the United Kingdom, Luxembourg |
| **Cluster 2** | Poland, Hungary, Lithuania, Italy, Malta, Bulgaria, Romania, Croatia, Slovakia, Turkey, Latvia |
| **Cluster 3** | Ireland, Cyprus, the Czech Republic, Estonia, Austria, Germany, Portugal, Spain, Slovenia |

The mean values of the clusters are given in Table 3.

**Table 3. Average Values of the Clusters**

| | Cluster 1 | Cluster 2 | Cluster 3 |
|---|---|---|---|
| **X111** | 2.2841328 | 1.1395914 | 2.106495 |
| **X112** | 47.3555556 | 33.4090909 | 40.788889 |
| **X113** | 81.3555556 | 83.2363636 | 84.477778 |
| **X121** | 1447.6360632 | 320.9924472 | 901.234069 |
| **X122** | 12.4158667 | 5.7651939 | 9.412138 |
| **X123** | 24.1651137 | 3.3290402 | 8.254091 |
| **X131** | 0.8222222 | 0.4418182 | 0.660000 |

When the first cluster is compared to the other clusters, the cluster formed by the ratio of scientific publications and Ph.D. students is the highest value. The second cluster is the cluster with the lowest values when compared to the other two clusters at the angle of the examined variables. This cluster is formed by the countries where moderate and modest innovators are involved. The identified feature of this cluster is that it has a lower value compared to the other country groups as sub-dimension of *clear, excellent and appealing research systems* measuring the number of people completing higher education and variables measuring science's international competitiveness. For this reason, Turkey should, attach importance to innovation in the education system by taking the initiative to improve its performance in terms of higher education and scientific publishing

The dendrogram obtained from the result of the cluster analysis carried out using innovation indicators in the aspect of the firm activities subjected to the study is given in the figure below.

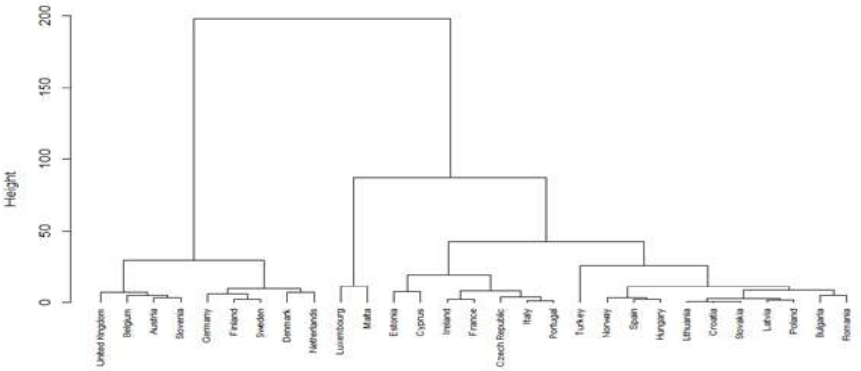



**Figure 2. Dendrogram for Firm Activities Dimension Indicators**

When the dendrogram is examined, it gives result that the countries are clustered in four clusters. The resulting clusters are as indicated in Table 4.

**Table 4. Countries in Clusters**

| **Cluster Number** | **Countries** |
|---|---|
| **Cluster 1** | Finland, Sweden, Denmark, Belgium, the Netherlands, the United Kingdom, Austria, Germany, Slovenia |
| **Cluster 2** | Poland, Hungary, Lithuania, Bulgaria, Romania, Croatia, Slovakia, Turkey, Latvia, Spain, Norway |
| **Cluster 3** | The Czech Republic, Estonia, Ireland, Italy, France, Cyprus, Portugal |
| **Cluster 4** | Malta, Luxembourg |

Indicators that are effective in the separation of clusters at this dimension are found to be innovative SMEs and patent applications. Especially the design-related indicator was effective on Luxembourg and Malta forming a separate cluster. Design, which plays an important role in the competition of countries, encourages national competition as well, not only for businesses but also for the brand image of the countries as a strategic tool to ensure innovation and growth.

As the dendrogram drawn according to the result of the cluster analysis carried out using innovation indicators in the dimension of the outputs subjected to the study is examined the countries are seen in three different clusters.

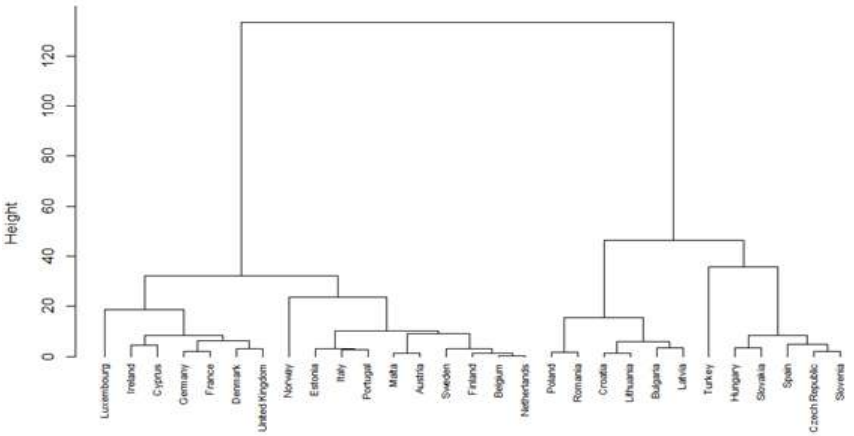



**Figure 3. Dendrogram for Output Dimension Indicators**

**Table 5. Countries in Clusters**

| Cluster Number | Countries |
|---|---|
| **Cluster 1** | Belgium, Denmark, Germany, Estonia, Ireland, France, Italy, Cyprus, Luxembourg, Malta, the Netherlands, Austria, Portugal, Finland, Sweden, the United Kingdom, Norway |
| **Cluster 2** | Bulgaria, Croatia, Latvia, Lithuania, Poland, Romania |
| **Cluster 3** | The Czech Republic, Spain, Hungary, Slovenia, Slovakia, Turkey |

Although Turkey has formed a cluster with the Czech Republic, Spain, Hungary, Slovenia and Slovakia, it has a different place among the countries in this cluster. This is due to the fact that Turkey has a score (%30) on above that of the European Union average (%12.4). in the Sales of new to market and new to firm innovations as % of

turnover. The countries in the first cluster differ from the other clusters from the angle that they have higher values in terms of the indicators being examined.

### 6.2. The TOPSIS Method Findings

Supporting the results of the cluster analysis, the countries were ranked according to the TOPSIS method using the criteria in three main headings as indicators in the dimension of the enablers, innovation indicators in the dimension of the firm activities and indicators in the output dimension in which the effects of the innovation activities were examined. Since there is no priority among the criteria, they are evaluated as equal weight.

First, a decision matrix was established in which the indicators of the countries on enablers dimension forming the criteria while the countries forming the alternatives and then the TOPSIS method is applied. Outputs regarding the ranking of the countries are as indicated in Table 6.

**Table 6. Ranking of Countries by the Indicators of Enablers Dimensions**

| Alternatives | Relative Proximity to Ideal Solution | Alternatives | Relative Proximity to Ideal Solution | Alternatives | Relative Proximity to Ideal Solution |
|---|---|---|---|---|---|
| Sweden | 0.7719 | Ireland | 0.4860 | Lithuania | 0.2807 |
| Norway | 0.7227 | Slovenia | 0.4835 | Croatia | 0.2173 |
| Denmark | 0.7035 | Portugal | 0.4804 | Latvia | 0.1933 |
| United Kingdom | 0.6691 | Germany | 0.4545 | Poland | 0.1888 |
| Netherlands | 0.6376 | Spain | 0.3685 | Hungary | 0.1872 |
| Belgium | 0.6173 | Estonia | 0.3454 | Malta | 0.1713 |
| Finland | 0.6078 | Czech Repub. | 0.3435 | Bulgaria | 0.1632 |
| France | 0.5822 | Italy | 0.3207 | Romania | 0.1459 |
| Luxembourg | 0.5568 | Cyprus | 0.3119 | Turkey | 0.1162 |
| Austria | 0.4872 | Slovakia | 0.2978 | | |

When the country rankings are examined, it is seen that Sweden, Norway and Denmark form the first three ranks, and the countries that are forming the last three ranks are Bulgaria, Romania and Turkey. Considering the ranking of countries according to enablers dimension indicators, innovation leaders such as Sweden, Norway, Denmark,

the Netherlands, Finland and Luxembourg seem to be in the top rankings in this analysis. However, again Germany, one of the leaders of innovation, appears to be in the middle of this size of rankings (14). It is noteworthy that Norway, which is in the strong innovator category, takes the second place in the ranking. As Turkey is in the last place and the indicators are related to education, it is argued that it is possible to achieve the top ranking in this category by increasing the attention to the education.

As the indicators related to the company dimension are selected as criteria, the table indicating the ranking of the countries are as indicated in Table 7.

**Table 7. Ranking of Countries by the Indicators of Firm Activities Dimension**

| Alternatives | Relative Proximity to Ideal Solution | Alternatives | Relative Proximity to Ideal Solution | Alternatives | Relative Proximity to Ideal Solution |
|---|---|---|---|---|---|
| Denmark | 0.5260 | United Kingdom | 0.3190 | Portugal | 0.1940 |
| Malta | 0.5084 | Cyprus | 0.2988 | Latvia | 0.1904 |
| Sweden | 0.5034 | Turkey | 0.2978 | Poland | 0.1800 |
| Finland | 0.4583 | France | 0.2956 | Spain | 0.1645 |
| Germany | 0.4543 | Estonia | 0.2933 | Lithuania | 0.1616 |
| Luxembourg | 0.4363 | Ireland | 0.2659 | Hungary | 0.1591 |
| Austria | 0.4157 | Italy | 0.2345 | Croatia | 0.1553 |
| Netherlands | 0.4083 | Czech Repub. | 0.2165 | Slovakia | 0.1307 |
| Belgium | 0.3773 | Norway | 0.2125 | Romania | 0.0299 |
| Slovenia | 0.3280 | Bulgaria | 0.1998 | | |

When the country rankings are examined, it is seen that Denmark, Malta and Sweden form the first three ranks, and the countries that forming the last three ranks are Croatia, Slovakia and Romania. Turkey ranks 13th among 29 countries according to these indicators. When these rankings are examined based on these indicators, the countries in the category of innovation leaders have taken the lead in ranking. It is worth noting here that Malta takes second place on the list. Despite being among the moderate innovator countries, high research and development expenditures in company activities and especially high level in community trademarks and community design indicators are leading Malta to higher ranks in this category. Turkey being on 13th place was mainly because of the high expenditure on non-research and development innovation.

As a result of the indicators in the output dimension where the innovation activities are examined are taking place in decision matrix as criteria, the ranking of the alternatives in other words the ranking of countries are as indicated in Table 8.

**Table 8. Ranking of Countries by the Indicators of Output Dimension**

| Alternatives | Relative Proximity to Ideal Solution | Alternatives | Relative Proximity to Ideal Solution | Alternatives | Relative Proximity to Ideal Solution |
|---|---|---|---|---|---|
| Denmark | 0.6303 | Sweden | 0.4613 | Norway | 0.3560 |
| Luxembourg | 0.5670 | Finland | 0.4589 | Hungary | 0.3558 |
| Germany | 0.5537 | Italy | 0.4581 | Estonia | 0.3460 |
| Turkey | 0.5478 | Slovakia | 0.4562 | Croatia | 0.2680 |
| Ireland | 0.5451 | Austria | 0.4517 | Poland | 0.2435 |
| United Kingdom | 0.5358 | Czech Repub. | 0.4402 | Romania | 0.2288 |
| France | 0.5004 | Malta | 0.4402 | Latvia | 0.2273 |
| The Netherlands | 0.4978 | Portugal | 0.4158 | Lithuania | 0.1726 |
| Belgium | 0.4853 | Slovenia | 0.3911 | Bulgaria | 0.1581 |
| Cyprus | 0.4770 | Spain | 0.3631 | | |

When these indicators are examined, it is seen that Denmark, Luxembourg and Germany form the first three places, Turkey takes the 4th place just behind these three countries, and the countries that form the last three are Latvia, Lithuania and Bulgaria. It is not coincidence that innovation leading countries are at the top of this category. However, the country that attracted attention in this category was Turkey, which ranked 4th in the list despite being included in the category of moderate innovators. The performance of Turkey on the sub-indicators in this category: "sales of new to market and new to firm innovations" is the most important factor for Turkey ranking up in this order.

## 7. Conclusion

For a country to develop, to compete with other countries and to be able to move forward, it is necessary to determine the position of the country among the other countries, to determine the missing aspects and consequently determine the necessary

strategies and to draw appropriate plans and programs for progress. In the study, to determine the similarities of countries according to innovation indicators, one of the multivariate statistical techniques, cluster analysis, and the TOPSIS, one of the multi-criteria decision-making techniques was applied and Turkey's position among these countries was revealed. Led by the results obtained, the determinations were the differences existing in the field of innovation and the necessary areas which should be focused and given the priority.

Regarding the indicators of countries as "enablers", Turkey ranks in the last place. The main reason why Turkey takes the last place at this dimension is that the indicators related to education in Turkey are very bad. It is observed that Turkey is in the last place with the lowest score in the classification of "new doctorate graduates" and "population completed tertiary education" within this dimension, and the countries in the top of the rankings have the highest scores on the mentioned criteria. Therefore, education as an innovation indicator represents an important aspect. Starting from the primary and secondary level, which is the preparation of higher education, Turkey should give more importance to education. Starting from primary school, programs should be developed for students on researching and developing, where creative ideas can emerge and team work can be strengthened. At the secondary level, by supporting the vocational high schools, more qualified individuals can be trained in vocational schools. Therefore, educated human power should be increased by making comprehensive education reforms in order to reach a qualified education level in Turkey. Policies should be developed to increase the number of scientists and engineers. In addition, necessary opportunities and encouragements should be provided for scientific articles and studies in Turkey. We are convinced that Turkey can bring itself to the higher stages only by this sort of classification.

The second-dimension indicator "firm activities", Turkey is positioned in the middle order (13th place among 29 countries). The most basic reason for this is the high non - R & D innovation expenditures of firms. Nevertheless, the fact that the expenditures of non-R & D innovations are so high has led Turkey to perform below the EU average in all dimensions except for firm investments. Taking Malta as the second rank in this dimension as an example, Turkey should allocate a larger share of its R & D development expenditure or develop policies that encourage innovation in R & D activities as well as non-R & D activities. Turkey should produce policies to develop the weakest sides such as, foreign license and patent incomes, public-private scientific

publications, community designs and community brands. To this end, it is necessary to further strengthen communication and information network, to produce high-tech products and to encourage exports, to increase incentives for inventions, to provide inventions, to obtain licenses and patents from international patent institutes and to develop policies to increase these works.

Turkey ranks fourth behind Denmark, Luxembourg and Germany in the last dimension of the research, 'The Effects of Innovation Activities' ". The most basic reason for this is that in the lower indications of this dimension, the performance of the "sales of new to market and new to firm innovation" indicator is high. A significant increase in non-R & D expenditures, an increase in the sales share of new product innovations, and a partial increase in community brands, placed Turkey at the top of this dimension. While Turkey continues to maintain its performance steadily on this final dimension, it must spread this success particularly to the first and second dimension indicators using the education reforms.

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## Appendix

### 1. The TOPSIS Method Outcomes According to Indicators of Enablers Dimension

**i. Decision Matrix**

| | 111 | 112 | 113 | 121 | 122 | 123 | 131 |
|---|---|---|---|---|---|---|---|
| **Belgium** | 1.778 | 43.100 | 84.300 | 1351.520 | 12.852 | 25.006 | 0.700 |
| **Bulgaria** | 1.381 | 32.000 | 85.200 | 173.419 | 3.516 | 2.973 | 0.270 |
| **Czech Republic** | 1.677 | 29.500 | 90.700 | 660.924 | 7.310 | 5.209 | 0.870 |
| **Denmark** | 3.243 | 46.700 | 73.400 | 2066.712 | 13.267 | 15.159 | 1.080 |
| **Germany** | 2.803 | 31.800 | 77.400 | 729.063 | 11.517 | 7.406 | 0.910 |
| **Estonia** | 1.126 | 45.200 | 82.600 | 907.657 | 7.302 | 4.427 | 0.800 |
| **Ireland** | 2.141 | 52.300 | 92.800 | 1080.226 | 11.713 | 14.300 | 0.400 |
| **Spain** | 1.755 | 41.100 | 67.900 | 645.200 | 9.245 | 11.950 | 0.580 |
| **France** | 1.699 | 44.900 | 87.300 | 651.159 | 11.334 | 33.639 | 0.760 |
| **Croatia** | 1.502 | 31.700 | 95.500 | 409.674 | 4.547 | 3.013 | 0.410 |
| **Italy** | 1.529 | 24.900 | 80.000 | 551.602 | 10.090 | 10.075 | 0.540 |
| **Cyprus** | 0.418 | 54.200 | 94.200 | 998.810 | 9.502 | 2.153 | 0.320 |
| **Latvia** | 0.939 | 41.000 | 86.200 | 221.037 | 6.301 | 2.909 | 0.450 |
| **Lithuania** | 1.110 | 56.400 | 91.300 | 355.326 | 4.542 | 1.415 | 0.720 |
| **Luxembourg** | 0.814 | 50.500 | 68.600 | 1598.698 | 11.676 | 23.529 | 0.590 |
| **Hungary** | 0.896 | 34.900 | 84.300 | 413.849 | 6.478 | 3.838 | 0.380 |
| **Malta** | 0.354 | 27.000 | 77.400 | 517.068 | 7.901 | 2.105 | 0.330 |
| **Netherlands** | 2.216 | 46.400 | 79.800 | 1449.642 | 14.507 | 19.301 | 0.870 |
| **Austria** | 1.952 | 39.100 | 88.700 | 1225.520 | 11.705 | 9.317 | 0.860 |
| **Poland** | 0.553 | 43.200 | 90.900 | 251.173 | 5.010 | 1.319 | 0.500 |
| **Portugal** | 3.140 | 31.300 | 75.900 | 794.809 | 8.991 | 13.855 | 0.660 |
| **Romania** | 1.356 | 25.500 | 79.900 | 172.848 | 4.744 | 2.111 | 0.220 |
| **Slovenia** | 3.949 | 42.600 | 90.100 | 1068.897 | 7.424 | 5.670 | 0.540 |
| **Slovakia** | 2.517 | 27.900 | 91.200 | 383.115 | 5.451 | 1.848 | 0.560 |
| **Finland** | 2.914 | 45.300 | 86.600 | 1485.630 | 10.917 | 12.838 | 1.000 |
| **Sweden** | 2.911 | 50.000 | 87.700 | 1774.122 | 11.686 | 24.470 | 1.040 |
| **United Kingdom** | 2.872 | 47.700 | 85.400 | 1059.427 | 14.200 | 30.032 | 0.570 |
| **Norway** | 2.111 | 51.600 | 79.100 | 1591.815 | 11.303 | 33.512 | 0.790 |
| **Turkey** | 0.400 | 23.000 | 53.700 | 81.806 | 4.837 | 5.012 | 0.480 |

**ii. Ideal and Negative Ideal Solutions Calculated by Equations [5] and [6]**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Id. ($\mathcal{A}^*$)** | 0.052 | 0.036 | 0.030 | 0.055 | 0.040 | 0.059 | 0.043 |
| **Neg.Id ($\mathcal{A}^-$)** | 0.005 | 0.015 | 0.017 | 0.002 | 0.010 | 0.002 | 0.009 |

**iii. Distance Values from Ideal and Negative Ideal Solution Calculated by Equations [7] and [8] ($\mathcal{D}_i^*$ and $\mathcal{D}_i^-$)**

| | $\mathcal{D}_i^*$ | $\mathcal{D}_i^-$ | | $\mathcal{D}_i^*$ | $\mathcal{D}_i^-$ | | $\mathcal{D}_i^*$ | $\mathcal{D}_i^-$ |
|---|---|---|---|---|---|---|---|---|
| **Belgium** | 0.042 | 0.067 | **Italy** | 0.073 | 0.035 | **Portugal** | 0.057 | 0.053 |
| **Bulgaria** | 0.094 | 0.018 | **Cyprus** | 0.084 | 0.038 | **Romania** | 0.095 | 0.016 |
| **Czech Republic** | 0.074 | 0.039 | **Latvia** | 0.090 | 0.022 | **Slovenia** | 0.063 | 0.059 |
| **Denmark** | 0.035 | 0.083 | **Lithuania** | 0.087 | 0.034 | **Slovakia** | 0.083 | 0.035 |
| **Germany** | 0.063 | 0.053 | **Luxembourg** | 0.052 | 0.065 | **Finland** | 0.044 | 0.068 |
| **Estonia** | 0.074 | 0.039 | **Hungary** | 0.088 | 0.020 | **Sweden** | 0.024 | 0.082 |
| **Ireland** | 0.056 | 0.053 | **Malta** | 0.093 | 0.019 | **Un.King.** | 0.037 | 0.076 |
| **Spain** | 0.067 | 0.039 | **Netherlands** | 0.039 | 0.069 | **Norway** | 0.031 | 0.082 |
| **France** | 0.051 | 0.071 | **Austria** | 0.057 | 0.054 | **Turkey** | 0.097 | 0.013 |
| **Croatia** | 0.087 | 0.024 | **Poland** | 0.094 | 0.022 | | | |

## 2. The TOPSIS Method Outcomes According to Indicators of Firm Activities Dimension

**i. Decision Matrix**

| | 211 | 212 | 221 | 222 | 223 | 231 | 232 | 233 | 234 |
|---|---|---|---|---|---|---|---|---|---|
| **Belgium** | 1.760 | 0.604 | 37.376 | 22.879 | 68.458 | 3.166 | 0.775 | 5.868 | 2.899 |
| **Bulgaria** | 0.520 | 0.486 | 11.605 | 2.315 | 2.070 | 0.481 | 0.078 | 7.071 | 9.870 |
| **Czech Repub.** | 1.120 | 0.730 | 27.333 | 11.633 | 13.793 | 0.912 | 0.240 | 3.832 | 3.102 |
| **Denmark** | 1.950 | 0.367 | 30.429 | 17.261 | 143.484 | 6.239 | 2.055 | 8.352 | 8.028 |
| **Germany** | 1.950 | 1.348 | 38.600 | 11.540 | 53.016 | 6.258 | 1.468 | 6.879 | 6.517 |
| **Estonia** | 0.630 | 1.555 | 27.433 | 15.779 | 6.840 | 0.996 | 0.197 | 11.564 | 3.076 |
| **Ireland** | 1.110 | 0.392 | 38.758 | 12.003 | 34.307 | 2.405 | 0.649 | 6.030 | 1.589 |
| **Spain** | 0.650 | 0.308 | 15.504 | 6.043 | 16.318 | 1.483 | 0.466 | 7.813 | 2.974 |
| **France** | 1.460 | 0.372 | 28.786 | 11.469 | 39.614 | 3.774 | 0.921 | 3.924 | 3.060 |
| **Croatia** | 0.380 | 0.951 | 19.326 | 7.451 | 10.596 | 0.544 | 0.204 | 1.871 | 0.901 |
| **Italy** | 0.720 | 0.569 | 36.630 | 4.807 | 17.999 | 1.959 | 0.471 | 5.964 | 5.933 |
| **Cyprus** | 0.080 | 0.576 | 27.925 | 15.280 | 6.993 | 0.626 | 0.061 | 25.841 | 1.982 |
| **Latvia** | 0.250 | 1.378 | 13.848 | 4.517 | 0.494 | 0.816 | 0.276 | 4.465 | 2.262 |
| **Lithuania** | 0.300 | 1.098 | 13.808 | 7.515 | 1.699 | 0.604 | 0.118 | 3.985 | 1.294 |
| **Luxembourg** | 0.660 | 0.141 | 37.213 | 8.925 | 40.023 | 1.389 | 0.678 | 29.885 | 15.356 |
| **Hungary** | 0.980 | 0.699 | 10.554 | 5.615 | 23.184 | 1.194 | 0.285 | 2.937 | 0.868 |
| **Malta** | 0.500 | 1.203 | 28.958 | 5.073 | 2.351 | 0.622 | 0.283 | 38.633 | 24.941 |
| **Netherlands** | 1.110 | 0.181 | 38.940 | 14.460 | 85.625 | 5.572 | 1.676 | 6.972 | 3.410 |
| **Austria** | 2.110 | 0.458 | 31.807 | 15.254 | 59.011 | 5.064 | 1.069 | 9.512 | 7.443 |
| **Poland** | 0.440 | 1.036 | 10.125 | 3.852 | 3.656 | 0.512 | 0.166 | 4.710 | 6.018 |
| **Portugal** | 0.590 | 0.600 | 33.776 | 6.791 | 7.097 | 0.658 | 0.231 | 5.831 | 4.380 |
| **Romania** | 0.160 | 0.296 | 4.669 | 1.200 | 2.607 | 0.173 | 0.038 | 2.017 | 0.586 |
| **Slovenia** | 1.850 | 0.476 | 25.791 | 14.597 | 65.985 | 2.730 | 0.585 | 6.822 | 3.374 |
| **Slovakia** | 0.330 | 0.795 | 15.005 | 6.727 | 8.124 | 0.647 | 0.088 | 2.987 | 1.509 |
| **Finland** | 2.150 | 0.375 | 36.462 | 14.284 | 69.892 | 8.165 | 1.610 | 7.217 | 5.440 |
| **Sweden** | 2.120 | 0.790 | 34.410 | 12.687 | 107.829 | 7.989 | 1.885 | 8.257 | 4.923 |
| **United Kingdom** | 1.090 | 0.303 | 17.635 | 22.355 | 50.162 | 3.295 | 0.797 | 6.208 | 3.127 |
| **Norway** | 0.920 | 0.237 | 20.301 | 7.922 | 50.901 | 2.564 | 0.555 | 1.473 | 0.350 |
| **Turkey** | 0.480 | 2.593 | 22.535 | 4.244 | 1.422 | 0.661 | 0.195 | 0.613 | 0.265 |

**ii. Ideal and Negative Ideal Solutions Calculated by Equations [5] and [6]**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Id ($\mathcal{A}^*$)** | 0.038 | 0.060 | 0.029 | 0.041 | 0.060 | 0.050 | 0.050 | 0.068 | 0.075 |
| **Neg.Id ($\mathcal{A}^-$)** | 0.001 | 0.003 | 0.004 | 0.002 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 |

**iii. Distance Values from Ideal and Negative Ideal Solution Calculated by Equations [7] and [8] ($\mathcal{D}_i^*$ ve $\mathcal{D}_i^-$)**

| | $\mathcal{D}_i^*$ | $\mathcal{D}_i^-$ | | $\mathcal{D}_i^*$ | $\mathcal{D}_i^-$ | | $\mathcal{D}_i^*$ | $\mathcal{D}_i^-$ |
|---|---|---|---|---|---|---|---|---|
| **Belgium** | 0.113 | 0.068 | **Italy** | 0.127 | 0.039 | **Portugal** | 0.135 | 0.032 |
| **Bulgaria** | 0.134 | 0.034 | **Cyprus** | 0.129 | 0.055 | **Romania** | 0.155 | 0.005 |
| **Czech Republic** | 0.132 | 0.037 | **Latvia** | 0.138 | 0.032 | **Slovenia** | 0.116 | 0.057 |
| **Denmark** | 0.092 | 0.102 | **Lithuania** | 0.141 | 0.027 | **Slovakia** | 0.143 | 0.021 |
| **Germany** | 0.096 | 0.080 | **Luxembourg** | 0.101 | 0.079 | **Finland** | 0.102 | 0.087 |
| **Estonia** | 0.124 | 0.051 | **Hungary** | 0.138 | 0.026 | **Sweden** | 0.094 | 0.095 |
| **Ireland** | 0.127 | 0.046 | **Malta** | 0.102 | 0.105 | **Un.King** | 0.120 | 0.056 |
| **Spain** | 0.134 | 0.026 | **Netherlands** | 0.109 | 0.075 | **Norway** | 0.135 | 0.036 |
| **France** | 0.121 | 0.051 | **Austria** | 0.101 | 0.072 | **Turkey** | 0.140 | 0.060 |
| **Croatia** | 0.142 | 0.026 | **Poland** | 0.135 | 0.030 | | | |

**3) The TOPSIS Method Outcomes According to Indicators of Outcome Dimension**

**i. Decision Matrix**

| | 311 | 312 | 313 | 321 | 322 | 323 | 324 |
|---|---|---|---|---|---|---|---|
| **Belgium** | 42.274 | 36.673 | 16.927 | 15.400 | 48.497 | 64.600 | 11.228 |
| **Bulgaria** | 13.569 | 17.626 | 16.515 | 9.400 | 31.220 | 27.100 | 4.222 |
| **Czech Republic** | 30.859 | 30.187 | 18.406 | 12.700 | 63.989 | 41.100 | 13.394 |
| **Denmark** | 33.939 | 40.447 | 20.128 | 15.400 | 47.746 | 75.100 | 22.102 |
| **Germany** | 42.441 | 46.226 | 21.019 | 14.600 | 67.432 | 69.600 | 12.972 |
| **Estonia** | 33.000 | 31.175 | 15.970 | 11.400 | 42.646 | 43.900 | 7.804 |
| **Ireland** | 35.673 | 49.633 | 23.445 | 20.200 | 52.060 | 88.500 | 9.315 |
| **Spain** | 18.430 | 22.562 | 16.187 | 12.300 | 47.708 | 42.200 | 14.335 |
| **France** | 32.358 | 41.183 | 21.659 | 14.000 | 58.539 | 58.600 | 13.476 |
| **Croatia** | 21.619 | 30.401 | 11.562 | 10.700 | 37.909 | 17.800 | 10.006 |
| **Italy** | 38.810 | 44.735 | 16.348 | 13.600 | 52.279 | 48.500 | 10.983 |
| **Cyprus** | 29.207 | 35.590 | 23.546 | 17.200 | 42.965 | 69.000 | 11.400 |
| **Latvia** | 15.700 | 23.062 | 12.335 | 10.900 | 32.087 | 49.800 | 5.017 |
| **Lithuania** | 16.076 | 25.173 | 11.610 | 8.800 | 34.352 | 18.300 | 5.470 |
| **Luxembourg** | 43.062 | 52.052 | 17.651 | 27.500 | 52.080 | 88.400 | 7.925 |
| **Hungary** | 12.823 | 25.336 | 19.243 | 12.300 | 69.488 | 38.300 | 9.740 |
| **Malta** | 32.043 | 43.258 | 19.987 | 17.900 | 56.684 | 25.900 | 10.183 |
| **Netherlands** | 40.861 | 35.161 | 16.903 | 17.300 | 47.962 | 65.300 | 11.841 |
| **Austria** | 35.687 | 44.708 | 19.448 | 14.700 | 57.426 | 43.200 | 9.846 |
| **Poland** | 13.072 | 14.194 | 18.230 | 9.900 | 49.558 | 36.700 | 6.327 |
| **Portugal** | 38.281 | 42.802 | 14.849 | 10.300 | 36.651 | 43.200 | 12.420 |
| **Romania** | 5.157 | 18.106 | 16.871 | 6.900 | 52.785 | 44.700 | 3.690 |
| **Slovenia** | 28.674 | 35.886 | 15.954 | 14.000 | 55.973 | 32.900 | 10.545 |
| **Slovakia** | 17.673 | 26.235 | 20.906 | 9.900 | 66.553 | 35.300 | 19.610 |
| **Finland** | 40.059 | 37.033 | 18.386 | 15.800 | 44.639 | 50.600 | 11.137 |
| **Sweden** | 39.910 | 38.194 | 19.610 | 17.900 | 54.736 | 65.000 | 6.105 |
| **United Kingdom** | 27.776 | 39.102 | 18.653 | 18.000 | 54.751 | 77.900 | 14.123 |
| **Norway** | 22.499 | 32.410 | 17.507 | 16.300 | 13.623 | 75.800 | 5.182 |
| **Turkey** | 24.026 | 43.196 | 13.980 | 5.700 | 36.562 | 27.700 | 33.554 |

**ii. Ideal and Negative Ideal Solutions Calculated by Equations [5] and [6]**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Id. ($\mathcal{A}^*$)** | 0.038 | 0.038 | 0.035 | 0.050 | 0.037 | 0.043 | 0.070 |
| **Neg.Id ($\mathcal{A}^-$)** | 0.005 | 0.010 | 0.017 | 0.010 | 0.007 | 0.009 | 0.008 |

**iii. Distance Values from Ideal and Negative Ideal Solution Calculated by Equations [7] and [8] ($\mathcal{D}_i^*$ ve $\mathcal{D}_i^-$)**

| | $\mathcal{D}_i^*$ | $\mathcal{D}_i^-$ | | $_i^*$ | $\mathcal{D}_i^-$ | | $\mathcal{D}_i^*$ | $\mathcal{D}_i^-$ |
|---|---|---|---|---|---|---|---|---|
| **Belgium** | 0.056 | 0.053 | **Italy** | 0.059 | 0.050 | **Portugal** | 0.063 | 0.045 |
| **Bulgaria** | 0.087 | 0.016 | **Cyprus** | 0.056 | 0.051 | **Romania** | 0.088 | 0.026 |
| **Czech Republic** | 0.059 | 0.047 | **Latvia** | 0.081 | 0.024 | **Slovenia** | 0.064 | 0.041 |
| **Denmark** | 0.037 | 0.064 | **Lithuania** | 0.086 | 0.018 | **Slovakia** | 0.059 | 0.049 |
| **Germany** | 0.050 | 0.063 | **Luxembourg** | 0.055 | 0.072 | **Finland** | 0.058 | 0.049 |
| **Estonia** | 0.070 | 0.037 | **Hungary** | 0.071 | 0.039 | **Sweden** | 0.063 | 0.054 |
| **Ireland** | 0.054 | 0.064 | **Malta** | 0.062 | 0.049 | **United Kingdom** | 0.049 | 0.056 |
| **Spain** | 0.064 | 0.036 | **Netherlands** | 0.054 | 0.054 | **Norway** | 0.074 | 0.041 |
| **France** | 0.053 | 0.053 | **Austria** | 0.061 | 0.050 | **Turkey** | 0.057 | 0.070 |
| **Croatia** | 0.076 | 0.028 | **Poland** | 0.081 | 0.026 | | | |

# PART II
# MANAGEMENTS

# 6 Average Spillover Behavior of Turkish Exchange Market Volatility

*Cüneyt Akar*

**Abstract**

*The aim of this paper is to examine the spillover behavior of Turkish exchange market volatility by taking the daily buying and selling prices of USD/TL, EUR/TL, GBP/TL, RUB/TL, JPY/TL, and CNY/TL. The sample period ranges from March 20, 2012, through January 3, 2017. In the study, univariate generalized autoregressive conditional heteroskedasticity (GARCH) (1,1) models were estimated for each currency to create conditional variance series. The volatility spillover index proposed by Diebold and Yilmaz (2009) was calculated as 42.98% by using these conditional series. The results show that about 43% of variance is explained by other exchange rates in the Turkish exchange rate market. The results also indicate that USD is the net transmitter exchange rate, while CNY, JPY, GBP, and EUR are the net receiver exchange rates in the Turkish exchange rate market.*

***Keywords:*** *Volatility, Turkish Economy, Spillover, Exchange Rate*

## 1. Introduction

One of the most important consequences of globalization is the rapid and intensive information flow from market to market. Therefore, it is highly possible for economic and political changes in developed countries to be rapidly transmitted to undeveloped or emerging economies. This situation can be expressed as "If the United States coughs, emerging economies get ill." Exchange rate

movements are among the practices in which such a transmission mechanism can best be observed.

The finance literature has discussed the above topic in the frame of the volatility spillover effect. Volatility spillover commonly relates to the information transmission between different markets or assets (Tse, 1999). Chan et al. (1991), Anderson (1996), and Sehgal et al. (2015) suggest that the volatility of exchange rates contains important information and such information can be transferred to the other markets or assets by the volatility spillover effect. In today's global finance world, the free flow of capital and information may not be a problem as long as the volatility of exchange rates can be controlled. However, any unexpected significant shock to any market or asset can create instability in the financial or economic system of other markets or assets if it leads to unexpected volatility. This is why understanding the volatility spillover process is important (Rajhans & Jain, 2015).

The main purpose of the study is to investigate the spillover behavior of Turkish exchange market volatility. The Turkish exchange market is an interesting market to investigate for volatility spillovers for two important reasons. First, Turkey is one of the fragile five economies (Brazil, Indonesia, South Africa, and India are the others) most affected by global changes, especially those in the United States. Second, Turkey has faced recent alterations in exchange rate volatility because of corruption claims, a coup attempt on July 15, 2016, negative developments in foreign trade and tourism due to conflict with Russia, and instability in the southern neighbors of Iraq and Syria.

In this study, daily buying and selling prices of USD/TL, EUR/TL, GBP/TL, RUB/TL, JPY/TL, and CNY/TL are used within the sample period from March 20, 2012, through January 3, 2017. The data are analyzed with the traditional generalized autoregressive conditional heteroskedasticity (GARCH) (1,1) univariate volatility model and volatility spillover index proposed by Diebold and Yilmaz (2009). According to the empirical results, we propose that RUSD is the net transmitter exchange rate and RCNY, RJPY, RGBP, and REUR are the net receiver exchange rates in the Turkish exchange rate market.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 introduces the data and empirical methodology used in the study. We report the empirical results in section 4. Section 5 concludes the study.

## 2. Literature Review

A large body of finance literature has examined volatility spillover. However, most of the studies handle the volatility spillover between stock markets. A limited number of studies has addressed the volatility spillover between exchange rates. Baillie and Bollerslev (1991) investigate the volatility spillover effects in four foreign exchange spot rates (GBP, JPY, DEM, and CHF) vs. USD and find little evidence of volatility spillover effects between the currencies. Rajhans and Jain (2015) examine the volatility spillover of exchange rate markets, namely, GBP, EUR, CAD, AUD, and JPY, against USD from June 2008 through December 2012. The results show a low possibility of volatility spillover (11.11%) among the investigated currency pairs.

In the literature, the findings of many previous studies provide evidence of volatility spillover. Hong (2001) points to unidirectional volatility spillover from the German mark to the Japanese yen. Inagaki (2007) examines the volatility spillover between the GBP and EUR over the sample from January 5, 1999, through December 30, 2004, by using the residuals cross-correlation approach. The results also support unidirectional volatility spillover from the euro to the British pound. Melvin and Melvin (2003) find significant intra- and inter-regional volatility spillovers in the DEM/USD and JPY/USD foreign exchange (forex) markets. Bubák et al. (2011) analyze the volatility spillover between Central European currencies and the EUR/USD foreign exchange using model-free estimates of daily exchange rate volatility. They find evidence of volatility spillovers among the Central European forex markets. Sehgal et al. (2015) investigate the volatility spillovers in India's forex market by using spot and futures prices of currencies: USD/INR, EURO/INR, GBP/INR, and JPY/INR. The findings indicate that the direction of the volatility spillover is from futures to spot in the short run, while it is from spot to futures in the long run. Nikkinen et al. (2006) show that the volatility of the euro has influenced the volatility of the British pound and the Swiss franc.

Antonakakis (2012) investigates volatility spillovers in the returns of the euro, the British pound, the Swiss franc, and the Japanese yen vis-à-vis the US dollar before and after introduction of the euro. The findings suggest significant volatility spillovers across the four exchange returns. In a recent study, Bajo-Rubio et al. (2017) examine volatility spillovers between the Turkish stock market with international stock, the exchange rate, and the commodity markets with spillover index methodology.

This study tries to identify the volatility spillover dynamics of the Turkish exchange market in the negatively changing and challenging political and economic conditions in recent times by using the univariate GARCH model and spillover index methodology.

**3. Data and Methodology**

The dataset used in the study covers the daily buying and selling prices of USD/TL, EUR/TL, GBP/TL, RUB/TL, JPY/TL, and CNY/TL within the sample period from March 20, 2012, through January 3, 2017. We gathered the data from the Turkish Central Bank by means of the Data Delivery System. We used the arithmetic average of buying and selling prices of exchange rates. The logarithmic change of prices is calculated as $Rprice_t = 100 * \ln(price_t / price_{t\ 1})$ for each currency. We provide the figures for logarithmic changes in Figure 1, and Table 1 reports the descriptive statistics for the investigated data.

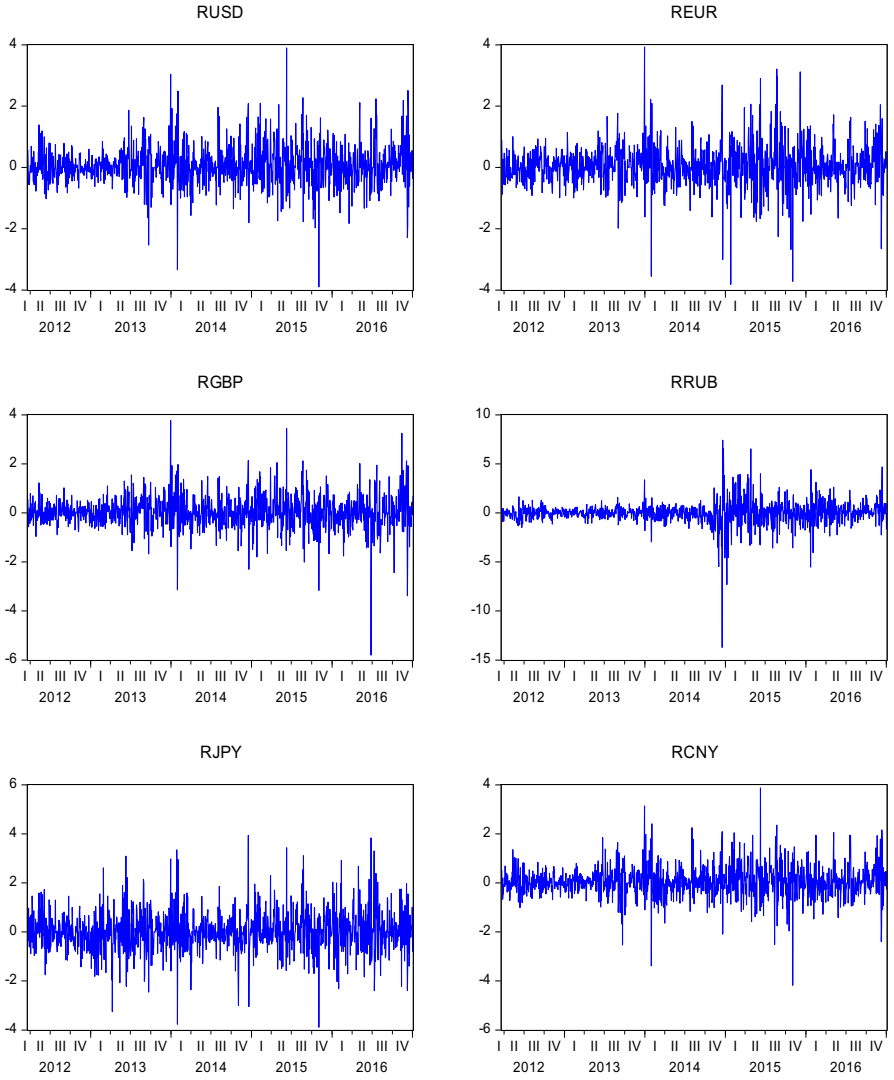



**Figure 1: Daily Logarithmic Change of Exchange Rates**

**Table 1. Descriptive Statistics for Logarithmic Changes**

| | RUSD | REUR | RGBP | RRUB | RJPY | RCNY |
|---|---|---|---|---|---|---|
| Mean | 0.053975 | 0.035880 | 0.033845 | -0.004996 | 0.026575 | 0.046787 |
| Maximum | 3.895378 | 3.931245 | 3.763851 | 7.419915 | 3.937605 | 3.869522 |
| Minimum | -3.898424 | -3.818384 | -5.801295 | -13.70959 | -3.887523 | -4.177388 |
| Std. Dev. | 0.632197 | 0.660324 | 0.667315 | 1.139159 | 0.827026 | 0.623278 |
| Skewness | 0.213854 | 0.014237 | -0.394604 | -1.225989 | 0.232233 | 0.101408 |
| Kurtosis | 7.451054 | 8.491588 | 11.04423 | 26.02369 | 5.838448 | 8.322701 |
| Observations | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 |

Although multivariate and univariate GARCH models have generally been used to investigate volatility spillovers, the study has tried to apply the method introduced by Diebold and Yilmaz (2009) for calculating the spillover index and analyzing the spillover mechanism. The main advantage of this method is that it does not need any explanatory variables at the beginning. First, we must obtain volatilities for each currency to create a spillover index. The present study has used the common univariate GARCH (1, 1) model to estimate the volatility series. The typical GARCH (1, 1) model developed by Bollerslev (1986) can be expressed as equations (1), (2), and (3).

$$Rprice_t = {}_0 + \sum_{i=1}^{s} {}_i Rprice_{t\ i} + u_t \quad (1)$$

$$u_t = h_t^{1/2}\ {}_t \quad (2)$$

$$h_t = {}_0 + \sum_{i=1}^{q} {}_i u_{t\ i}^2 + \sum_{j=1}^{p} {}_j h_{t\ j} \quad (3)$$

In this model, *Rprice* shows the logarithmic change of the corresponding currency. $u_t$ is the serially uncorrelated deviation term and ${}_t$ is the independent and identically distributed (i.i.d.) sequence. $h_t$ represents the conditional variance of *Rprice*. The GARCH model needs to specify both mean and conditional variance equations. In the empirical literature, the mean equation of GARCH models is generally identified as a simple autoregressive process (Akar, 2007). Therefore, the logarithmic change of exchange rates should be a stationary series. We perform augmented Dickey Fuller

(ADF), Philips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests to decide whether our time series are stationary or not. The results are reported in Table 2. According to the unit root test results, all investigated series are stationary.

**Table2. Unit Root Tests for Logarithmic Change of Exchange Rates**

| | RUSD | REUR | RGBP | RRUB | RJPY | RCNY |
|---|---|---|---|---|---|---|
| ADF | -33.799* | -32.934* | -30.506* | -30.909* | -34.216* | -33.836* |
| PP | -33.814* | -32.991* | -30.490* | -30.884* | -34.206* | -33.817* |
| KPSS | 0.197 | 0.076 | 0.074 | 0.198 | 0.299 | 0.080 |
| Observations | 1250 | 1250 | 1250 | 1250 | 1250 | 1250 |

The null of a unit root is tested with ADF and PP. The null of stationary is tested with KPSS test statistic.

All tests performed with intercept, trend and none of them. All results are the same. We report the results only with intercept. * Significant 1 % level

Table 3 shows the estimation results of the GARCH (1,1) models. All parameters except intercepts are statistically significant at the 5% level. Ljung-Box and ARCH-LM diagnostic tests provide evidence regarding sufficient specification of the variance equation.[1]

[1] The specification tests (serial correlation, normality) for mean equations are also performed, but the results are not reported to save space. According to the test results, the mean equations are correctly specified.

**Table 3.GARCH(1,1) Estimation Results**

| | RUSD | REUR | RGBP | RRUB | RJPY | RCNY |
|---|---|---|---|---|---|---|
| Mean Equation | | | | | | |
| $_0$ | 0.027* | 0.012 | 0.005 | -0.001 | 0.014 | 0.028* |
| $_1$ | 0.067* | 0.105* | 0.135* | 0.122* | | 0.065* |
| Variance Equation | | | | | | |
| $_0$ | 0.003* | 0.015* | 0.004* | 0.005* | 0.094* | 0.008* |
| $_1$ | 0.085* | 0.131* | 0.078* | 0.147* | 0.131* | 0.110* |
| $_1$ | 0.914* | 0.844* | 0.918* | 0.867* | 0.734* | 0.880* |
| | | | | | | Diagnostic Tests |
| Q(5) | 2.871 | 2.712 | 1.498 | 3.645 | 3.101 | 1.575 |
| Q(10) | 5.287 | 12.371 | 5.493 | 12.786 | 8.431 | 4.455 |
| Q(20) | 13.059 | 23.517 | 12.641 | 30.061 | 21.792 | 16.354 |
| $Q^2(5)$ | 4.368 | 1.059 | 2.045 | 2.887 | 4.124 | 1.252 |
| $Q^2(10)$ | 13.333 | 9.732 | 4.822 | 6.020 | 14.170 | 6.711 |
| $Q^2(20)$ | 21.997 | 15.187 | 7.947 | 15.160 | 22.824 | 16.721 |
| ARCH-LM(5) | 4.298 | 1.075 | 2.048 | 3.040 | 4.071 | 1.225 |
| ARCH-LM(10) | 12.624 | 9.341 | 4.546 | 5.759 | 14.578 | 6.411 |
| ARCH-LM(20) | 20.559 | 14.563 | 7.547 | 15.302 | 30.861 | 15.463 |

**statistically significant at the level of 5%*

We create a conditional variance series by using the estimation results of the GARCH (1,1) models. These conditional variance series, which are shown in Figure 2, represent the volatility of exchange rate changes and are used to calculate the volatility spillover index.

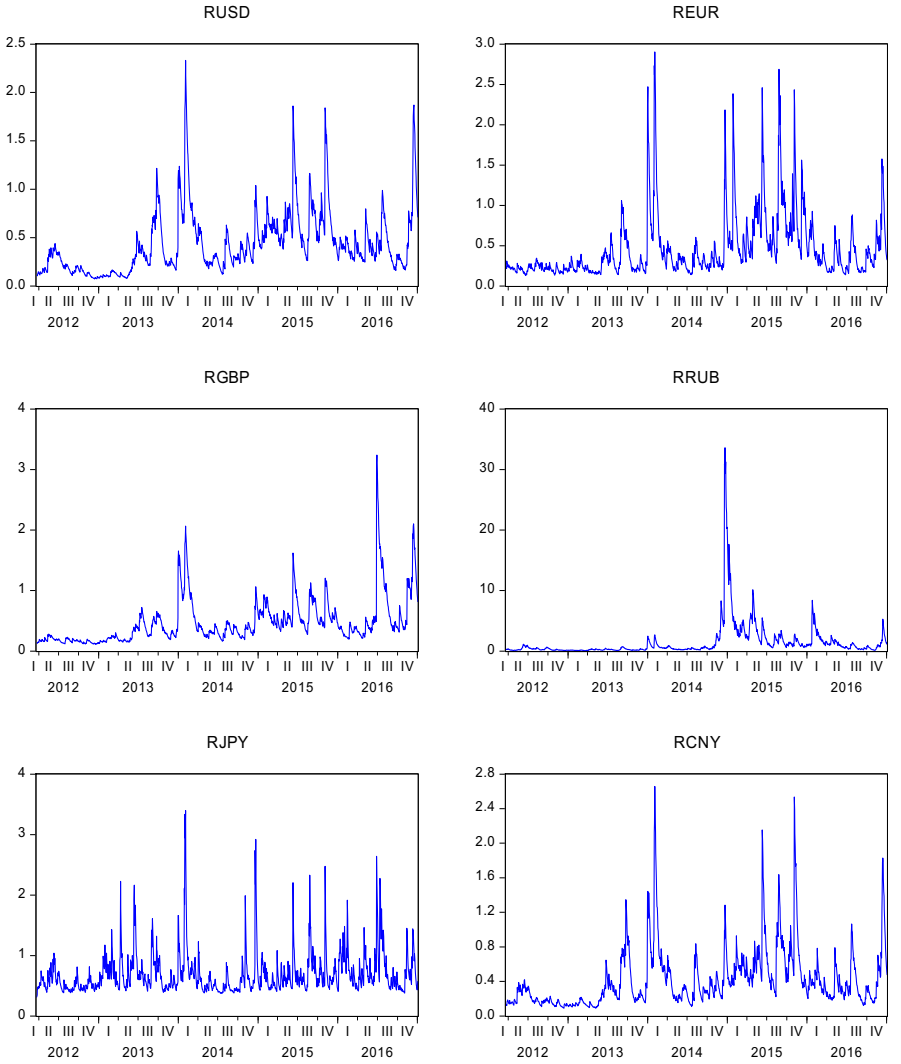



**Figure 2: Estimated Conditional Variances**

The volatility spillover index proposed by Diebold and Yilmaz (2009) uses a simple calculation methodology from a variance decomposition of the n- variable vector autoregression (VAR) model. The spillover index can be calculated as follows:

$$SI = \frac{Contribution\ to\ others}{Contribution\ including\ own} \tag{4}$$

In equation (4), the variance contribution to others constitutes the off-diagonal elements of the variance decomposition matrix. The diagonal elements of the variance decomposition matrix show the variance explained by its own shocks.

**4. Empirical Results**

We first estimated the six-variable VAR model by using the volatility series.[2] The lag length was determined to be 1 according to the Schwarz information criteria. The spillover table, which is calculated from the decomposition matrix of 10 step-ahead forecasts, is reported in Table 4.

**Table 4. Spillover Table**

| | RUSD | REUR | RGBP | RRUB | RJPY | RCNY | Contribution from others |
|---|---|---|---|---|---|---|---|
| RUSD | 94.317 | 4.786 | 0.443 | 0.021 | 0.293 | 0.138 | 5.681 |
| REUR | 47.890 | 51.268 | 0.004 | 0.224 | 0.079 | 0.535 | 48.732 |
| RGBP | 38.876 | 7.580 | 52.684 | 0.012 | 0.809 | 0.036 | 47.313 |
| RRUB | 6.162 | 2.757 | 0.052 | 90.852 | 0.172 | 0.002 | 9.145 |
| RJPY | 36.245 | 7.741 | 5.448 | 2.627 | 47.912 | 0.025 | 52.086 |
| RCNY | 88.961 | 5.456 | 0.078 | 0.001 | 0.421 | 5.082 | 94.917 |
| Contribution to others | 218.13 | 28.320 | 6.025 | 2.885 | 1.774 | 0.754 | 257.9 |
| Contribution including own | 312.45 | 79.588 | 58.709 | 93.737 | 49.686 | 5.836 | 600 |
| | | | | | Spillover Index = | | 42.98% |

[2] The results are not reported to save space.

As seen from Table 4, we calculated a volatility spillover index of 42.98%. This index value suggests that, on average, about 43% of variance can be explained by other exchange rates in the Turkish exchange rate market; the remaining 57% of variance is explained by its own shocks. Table 4 offers an important inference regarding RUSD and RCNY. The contribution of RUSD to RCNY, REUR, RGBP, RJPY, and RRUB is 88.96%, 47.89%, 38.87%, 36.24%, and 6.16%, respectively. On the other hand, the contribution of RCNY to other exchange rates is almost zero. The results also show that RUSD and RRUB are not influenced by the shocks to other exchange rates. While RRUB gets a 9.14% contribution from others, RUSD gets only 5.68%. Thus, we conclude that RUSD is the net transmitter exchange rate and RCNY, RJPY, RGBP, and REUR are the net receiver exchange rates in the Turkish exchange rate market.

**Table 5. Contribution to Other Exchange Rates**

| Exchange rates | RUSD | REUR | RGBP | RRUB | RJPY | RCNY |
|---|---|---|---|---|---|---|
| Contribution to other exchange rates(%) | 36.4 | 4.7 | 1 | 0.5 | 0.3 | 0.1 |

Table 5 summarizes the percentage of contribution to other markets of exchange rates. It is clear that the most significant volatility spillover effect arises from RUSD. Although the second most significant volatility spillover effect is derived from REUR, the value of the contribution from REUR is not as great as from RUSD. The other investigated exchange rates have no remarkable volatility spillover effect on other exchange rates.

## 5. Conclusion

The purpose of this study is to investigate the average volatility spillover behavior of the Turkish exchange rate market. The daily exchange rate prices of USD/TL, EUR/TL, GBP/TL, RUB/TL, JPY/TL, and CNY/TL are analyzed with the GARCH model and spillover index methodology over March 20, 2012, through January 3, 2017.

The findings of the study are threefold. First, the spillover index value is calculated as 42.98%, which indicates an average 43% of volatility is explained by external shocks in the Turkish exchange rate market. Second, USD and RUB are affected in a very limited manner by other exchange rate volatility. Third, USD is the net transmitter exchange rate in the Turkish exchange rate market.

The empirical findings provide useful implications for policy makers, foreign traders, and investors. It may be more beneficial to use USD and RUB in foreign trading as they are minimally influenced by external factors other than their own dynamics. In particular, RUB may be the first choice for foreign trading with Russia. On the other hand, as seen from the results, all currencies other than RUB are highly affected by volatility in USD. Therefore, policy makers should focus on USD to stabilize Turkish foreign exchange market volatility. They also should not neglect EUR due to its approximately 5% contribution to other exchange rates' volatility. Investors should pay heightened attention while taking a position, especially in CNY, as 88% of volatility is transmitted from the volatility of USD and about 5% comes from EUR. Thus, it is more suitable to diversify the portfolio with other exchange rates for investors who want to invest CNY.

Future studies can undertake the analysis of spillover behavior of other members of the fragile five economies to compare the findings with those of the present paper. This study can also be repeated for the Turkish future markets to compare the results with the spot market.

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# 7 Supplier Performance Evaluation by Using SWARA and MULTIMOORA

*Coşkun Karaca,*
*Alptekin Ulutaş*

**Abstract**

*Supplier performance evaluation is a significant process for companies to obtain competitive edge in global market. Many criteria, such as quality, delivery time and cost of product are considered by managers of companies to evaluate supplier performance. Additionally, these criteria are generally conflicted each other. Furthermore, judgements of many managers should be involved in the evaluation process to obtain rigor results. In this study, an integrated model consisting of SWARA and MULTIMOORA methods is used to evaluate supplier performance. An automotive manufacturing company is indicated as a numerical example in this study to verify the proposed integrated model. The future studies may extend this integrated model with using fuzzy numbers.*

## 1. Introduction

The performance of suppliers is one of the important factors affecting the competitiveness of the buyer company in the global market. Criteria such as delivery time, product quality and product cost of the supplier have great importance in the smooth operation of the production flow. However, these criteria are generally conflicted each other. For instance, while it is necessary to reduce the value of a criterion (product cost) to the greatest extent; on the other hand, another criterion (quality level of the product) needs to be maximized. Therefore, when evaluating

supplier performance, the solution should be tried to be achieved by dividing the criteria into beneficial and non-beneficial. In order to be able to evaluate the performance of suppliers and to consider a large number of criteria, it is necessary to use multi-criteria decision making methods. Through these methods all the criteria affecting the supplier performance are taken into account and the performance of suppliers is evaluated by consulting the expert opinions to obtain a rigor result. Additionally, the use of both objective and subjective data will contribute to obtain a stronger result. Thus, an integrated group decision-making model consisting of SWARA and MULTIMOORA methods will be used to evaluate the performance of suppliers in this study. The SWARA method is used to assess supplier performance criteria so as to obtain criteria weights and the MULTIMOORA method is used to evaluate the performance of suppliers in order to rank suppliers. The contribution of this study is that both objective and subjective data are considered in selecting suppliers and results are quickly reached due to SWARA and MULTIMOORA being simple. Besides, a different approach has been proposed for the last step of the MULTIMOORA method and it has been tried to eliminate the confusion that might arise in reaching the final result.

## 2. **Literature Review**

In the literature, there are many studies to evaluate supplier performance. Additionally, the best suppliers have been selected with respect to evaluation of supplier performance. Therefore, supplier performance evaluation and supplier selection are studied together in literature. Table 1 indicates some recent studies related to supplier performance evaluation and supplier selection.

In the literature many authors have written many articles related to supplier performance evaluation and supplier selection. In general, most of the authors have used multi-criteria decision making techniques to evaluate supplier performance. Different from these authors, SWARA and MULTIMOORA methods will be used to evaluate supplier performance. The main reason for preferring these two methods is that they do not have mixed algorithms, so the result has been obtained quickly and easily. The rest of this work continues as follows: The third section describes the methods used in this study. In the fourth part, a numerical example is presented to demonstrate the feasibility of the methods and the results of proposed model and suggestions for future studies are shared in the last part.

**Table 1: Recent Studies**

| Authors | Methods | Year |
|---|---|---|
| Keskin | Fuzzy DEMATEL and Fuzzy C | 2015 |
| Memon et al. | Grey Systems Theory and Uncertainty Theory | 2015 |
| Hashemi et al. | Grey Relational Analysis (GRA) and Analytic Network Process (ANP) | 2015 |
| Mahdiloo et al. | Data Envelopment Analysis (DEA) | 2015 |
| Tosun and Akyüz | Fuzzy TODIM | 2015 |
| Kuo et al. | DEMATEL, ANP and VIKOR | 2015 |
| Galankashi et al. | Balanced Scorecard and Fuzzy Analytic Hierarchy Process (AHP) | 2016 |
| Chen et al. | Fuzzy TOPSIS and Fuzzy AHP | 2016 |
| Jain et al. | Fuzzy TOPSIS and Fuzzy AHP | 2016 |
| Liao et al. | Fuzzy AHP, Fuzzy ARAS, Multi Segment Goal Programming | 2016 |
| Fahmi et al. | ELECTRE I | 2016 |
| Sang and Liu | Fuzzy TODIM | 2016 |
| Bakeshlou et al. | Fuzzy Multi-objective Linear Programming , Fuzzy ANP and DEMATEL | 2017 |
| Tavana et al. | ANP and Quality Function Deployment (QFD) | 2017 |
| Büyüközkan and Göçer | Fuzzy Axiomatic Design and Fuzzy AHP | 2017 |
| Wan et al. | ANP and ELECTRE II | 2017 |
| Zhong and Yao | ELECTRE I and Fuzzy Numbers | 2017 |
| Wang et al. | AHP and GRA | 2017 |

## 3. Methodology

The proposed model, which consists of SWARA and MULTIMOORA, are used in the study. The SWARA method was used to obtain the weights of criteria. The MULTIMOORA method is used to evaluate the performance of suppliers.

### 3.1. SWARA Method

The SWARA method was developed by Keršuliene and colleagues in 2010 (Keršuliene et al., 2010). The method has less algorithm than other methods (AHP and ANP) using for obtaining weights. This method consists of five following steps:

Step 1: Decision-makers (DMs) rank alternatives with respect to their estimated priorities.

Step 2: Starting from the second criterion, the criterion is compared with its above criterion. That is; criterion $j-1$ is compared with criterion $j$. This comparison gives comparative importance of average value ($s_j$). Table 2 presents linguistic scores and mathematical equivalents of them for use in comparing the criteria.

Step 3: Calculate the coefficient ($k_j$) by using below equation

$$k_j = \begin{cases} 1, & j = 1 \\ s_j + 1, & j > 1 \end{cases} \quad (1)$$

Step 4: Calculate the recalculated weight ($q_j$) by using following equation:

$$q_j = \begin{cases} 1, & j = 1 \\ \frac{q_{j-1}}{k_j}, & j > 1 \end{cases} \quad (2)$$

Step 5: In final step, the weight of criterion ($w_j$) is determined by using equation 3.

$$w_j = \frac{q_j}{\sum_{k=1}^{n} q_k} \quad (3)$$

**Table 2: Linguistic Scores for SWARA**

| Linguistic Scores | Numerical Scores |
|---|---|
| Equally Important | 1 |
| Moderately Less Important | 0,89 |
| Less Important | 0,52 |
| Very Less Important | 0,34 |
| Much Less Important | 0,25 |

After obtaining the weights of criteria, these weights are transferred to the MULTIMOORA method.

**MULTIMOORA Method**

The MULTIMOORA method consists of three approach which are ratio system approach, reference point approach and full multiplicative form. This method can be summarised as (Brauers and Zavadskas, 2006; Brauers et al., 2008; Balezentis et al., 2010).

Step 1: First, the decision matrix is constructed and each element of the decision matrix is normalized by the following equation.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n}(x_{ij})^2}} \tag{4}$$

Step 2: By the following equation the result is obtained for ratio system approach. In this approach the alternative with the greatest value is the best alternate.

$$y_i = \sum_{j\in\theta_{max}} w_j r_{ij} - \sum_{j\in\theta_{min}} w_j r_{ij} \tag{5}$$

Step 3: In order to carry out the reference point approach, the following reference point is obtained. Then, the result of the reference point approach is reached.

$$r_j = \begin{Bmatrix} max_i r_{ij}; & j \in \theta_{max} \\ min_i r_{ij}; & j \in \theta_{min} \end{Bmatrix} \tag{6}$$

Reference point approach;

$$t_i = min_i(max_j(w_j|r_j - r_{ij}|)) \tag{7}$$

The alternative with the lowest value is the best alternative in this approach.

Step 4: The full multiplicative form is calculated by the following equation.

$$u_i = \frac{\prod_{j\in\theta_{max}} w_j r_{ij}}{\prod_{j\in\theta_{min}} w_j r_{ij}} \tag{8}$$

In this approach the alternative with the greatest value is the best alternative. The alternatives are ranked with respect to all three approaches and the final order is made with respect to the dominance theory. In order to prevent confusion, which may arise in dominance theory, a fifth step has been added to this study to unite these three approaches.

Step 5: Combining the results of the three approaches (ratio system approach, reference point approach and full multiplicative form) is calculated with the following equation.

$$ts_i = (\frac{-1}{y_i}) \times (\frac{1}{t_i}) \times u_i \quad (9)$$

## 4. Illustrative Example

In an example, an automotive manufacturing factory would like to supply car headlight from the suppliers. There are 5 companies supplying car headlight. The factory would like to work with only one of these companies. It is assumed that information about "Quality" (percentage of unaccepted), "Cost" and "Delivery Time" of the products supplied by the supplier companies are taken directly from factory. These three criteria are identified as non-beneficial criteria and their values should be minimized. The necessary values for the other criteria (beneficial criteria) are assumed to be obtained from 5 decision makers with the using of Table 3. The values of beneficial criteria should also be maximized.

**Table 3: Linguistic Scores for Beneficial Criteria (MULTIMOORA)**

| Linguistic Score | Values |
|---|---|
| Perfect | 9 |
| Extremely Good | 8 |
| Very Good | 7 |
| Good | 6 |
| Medium | 5 |
| Bad | 4 |
| Very Bad | 3 |
| Extremely Bad | 2 |
| Unsuccessful | 1 |

The computing of the numerical example starts with the method of SWARA and weights of criteria used in supplier selection are obtained by using the SWARA method. First, decision makers (DMs) rank criteria with respect to their expected importance level. Table 4 shows the decision makers ranking the criteria with respect to their expected importance level.

**Table 4: The Order of Criteria with respect to Decision Makers**

| Decision Makers / Criteria | Decision Maker 1 | Decision Maker 2 | Decision Maker 3 | Decision Maker 4 | Decision Maker 5 |
|---|---|---|---|---|---|
| **C1 (Technological Capability)** | 7 | 7 | 6 | 7 | 5 |
| **C2 (Quality)** | 1 | 1 | 2 | 2 | 2 |
| **C3 (Technical Assistance)** | 5 | 5 | 5 | 4 | 3 |
| **C4 (Cost)** | 2 | 3 | 3 | 1 | 1 |
| **C5 (Discount Opportunities)** | 3 | 4 | 4 | 5 | 4 |
| **C6 (Delivery Time)** | 4 | 2 | 1 | 3 | 6 |
| **C7 (Reputation)** | 6 | 6 | 7 | 6 | 7 |

If the second step of the SWARA method is performed, Table 5 is obtained.

**Table 5: The Results of Step 2**

| Criteria | Decision Maker 1 | Criteria | Decision Maker 2 | Criteria | Decision Maker 3 | Criteria | Decision Maker 4 | Criteria | Decision Maker 5 |
|---|---|---|---|---|---|---|---|---|---|
| C2 | 0 | C2 | 0 | C6 | 0 | C4 | 0 | C4 | 0 |
| C4 | 0,52 | C6 | 0,25 | C2 | 0,34 | C2 | 0,25 | C2 | 0,34 |
| C5 | 0,25 | C4 | 0,34 | C4 | 0,52 | C6 | 0,25 | C3 | 0,25 |
| C6 | 0,34 | C5 | 0,34 | C5 | 0,52 | C3 | 0,34 | C5 | 0,25 |
| C3 | 0,25 | C3 | 0,25 | C3 | 0,25 | C5 | 0,34 | C1 | 0,25 |
| C7 | 0,52 | C7 | 0,25 | C1 | 0,34 | C7 | 0,34 | C6 | 0,25 |
| C1 | 0,25 | C1 | 0,34 | C7 | 0,25 | C1 | 0,34 | C7 | 0,52 |

If other steps of SWARA are applied, the weight of each criterion is calculated for each decision maker. The weights of the criteria are combined with the arithmetic mean. Table 6 indicates the criteria weights.

**Table 6: Criteria Weights**

| Decision Makers / Criteria | DM 1 | DM 2 | DM 3 | DM 4 | DM 5 | Total | Arithmetic Mean (A.M.) |
|---|---|---|---|---|---|---|---|
| C2 | 0,3 | 0,27 | 0,24 | 0,21 | 0,2 | 1,22 | 0,244 |
| C4 | 0,2 | 0,16 | 0,16 | 0,27 | 0,27 | 1,06 | 0,212 |
| C6 | 0,12 | 0,22 | 0,32 | 0,17 | 0,08 | 0,91 | 0,182 |
| C5 | 0,16 | 0,12 | 0,1 | 0,1 | 0,13 | 0,61 | 0,122 |
| C3 | 0,1 | 0,1 | 0,08 | 0,13 | 0,16 | 0,57 | 0,114 |
| C1 | 0,05 | 0,06 | 0,06 | 0,05 | 0,1 | 0,32 | 0,064 |
| C7 | 0,06 | 0,08 | 0,05 | 0,07 | 0,05 | 0,31 | 0,062 |

According to SWARA results, the most important criterion is "Quality". Once the criteria weights are available, the performance of the supplier will be assessed using the MULTIMOORA method. Some criteria (Technological Capability, Technical Assistance, Discount Opportunities, Reputation) cannot be measured by numerical data. In order to determine the performances of the suppliers on these criteria, the decision makers are asked to give a linguistic score for each supplier's performance on each criterion. Numerical values of linguistic scores are shown in Table 3. Table 7 shows the linguistic scores given by the decision makers on the performance of suppliers on criteria. These scores are combined with the arithmetic mean.

**Table 7: Linguistic Scores for Suppliers**

| Decision Makers / Criteria and Suppliers | DM1 | DM2 | DM3 | DM4 | DM5 | TOTAL | A.M. |
|---|---|---|---|---|---|---|---|
| C5- Supplier 1 | 5 | 5 | 4 | 5 | 6 | 25 | 5 |
| C5- Supplier 2 | 7 | 7 | 7 | 8 | 8 | 37 | 7,4 |
| C5- Supplier 3 | 4 | 5 | 4 | 5 | 5 | 23 | 4,6 |
| C5- Supplier 4 | 6 | 7 | 6 | 6 | 6 | 31 | 6,2 |
| C5- Supplier 5 | 7 | 8 | 7 | 8 | 8 | 38 | 7,6 |
| C3- Supplier 1 | 6 | 6 | 6 | 6 | 5 | 29 | 5,8 |
| C3- Supplier 2 | 8 | 7 | 7 | 8 | 7 | 37 | 7,4 |
| C3- Supplier 3 | 5 | 5 | 4 | 5 | 6 | 25 | 5 |
| C3- Supplier 4 | 7 | 6 | 6 | 7 | 6 | 32 | 6,4 |
| C3- Supplier 5 | 8 | 7 | 7 | 7 | 8 | 37 | 7,4 |
| C1- Supplier 1 | 6 | 6 | 6 | 7 | 7 | 32 | 6,4 |
| C1- Supplier 2 | 8 | 7 | 7 | 7 | 7 | 36 | 7,2 |
| C1- Supplier 3 | 6 | 5 | 5 | 6 | 5 | 27 | 5,4 |
| C1- Supplier 4 | 7 | 7 | 6 | 7 | 7 | 34 | 6,8 |
| C1- Supplier 5 | 8 | 8 | 8 | 8 | 8 | 40 | 8 |
| C7- Supplier 1 | 8 | 8 | 7 | 7 | 7 | 37 | 7,4 |
| C7- Supplier 2 | 9 | 8 | 9 | 9 | 7 | 42 | 8,4 |
| C7- Supplier 3 | 7 | 5 | 6 | 7 | 6 | 31 | 6,2 |
| C7- Supplier 4 | 7 | 7 | 6 | 6 | 6 | 32 | 6,4 |
| C7- Supplier 5 | 9 | 9 | 8 | 7 | 7 | 40 | 8 |

Table 8 shows performance of suppliers in terms of the all criteria. Quality, Cost and Delivery Time includes numerical values, which are assumed to be received directly from the factory. The other criteria are the values obtained by taking the arithmetic average of the scores given by the decision makers shown in Table 7.

**Table 8: Suppliers' Performance on all Criteria**

| Criteria / Suppliers | C2 | C4 | C6 | C5 | C3 | C1 | C7 |
|---|---|---|---|---|---|---|---|
| Supplier 1 | 0,03 | 24 | 1,5 | 5 | 5,8 | 6,4 | 7,4 |
| Supplier 2 | 0,02 | 22 | 1 | 7,4 | 7,4 | 7,2 | 8,4 |
| Supplier 3 | 0,03 | 25 | 2 | 4,6 | 5 | 5,4 | 6,2 |
| Supplier 4 | 0,02 | 23 | 2 | 6,2 | 6,4 | 6,8 | 6,4 |
| Supplier 5 | 0,02 | 20 | 1 | 7,6 | 7,4 | 8 | 8 |

Using the data in Table 8, the reference point approach is applied first. Table 9 shows the result of the reference point approach.

**Table 9: The Results of the Reference Point Approach**

| Criteria / Suppliers | C2 | C4 | C6 | C5 | C3 | C1 |
|---|---|---|---|---|---|---|
| Supplier 1 | 0,133 | 0,099 | 0,078 | 0,043 | 0,046 | 0,027 |
| Supplier 2 | 0,089 | 0,091 | 0,052 | 0,064 | 0,058 | 0,03 |
| Supplier 3 | 0,133 | 0,104 | 0,104 | 0,04 | 0,039 | 0,023 |
| Supplier 4 | 0,089 | 0,095 | 0,104 | 0,054 | 0,051 | 0,029 |
| Supplier 5 | 0,089 | 0,083 | 0,052 | 0,066 | 0,058 | 0,034 |

| | C7 | Total of non-beneficial Criteria | Total of beneficial Criteria | $y_i$ | $-1/y_i$ | Ranking |
|---|---|---|---|---|---|---|
| Supplier 1 | 0,028 | 0,31 | 0,144 | -0,166 | 6,024 | 4 |
| Supplier 2 | 0,032 | 0,232 | 0,184 | -0,048 | 20,833 | 2 |
| Supplier 3 | 0,023 | 0,341 | 0,125 | -0,216 | 4,63 | 5 |
| Supplier 4 | 0,024 | 0,288 | 0,158 | -0,13 | 7,692 | 3 |
| Supplier 5 | 0,03 | 0,224 | 0,188 | -0,036 | 27,778 | 1 |

Table 9 shows that the values of beneficial and non-beneficial criteria are summed among themselves. Then, the value sum of the beneficial criteria is subtracted from the value sum of the non-beneficial criteria. Therefore, the column "$y_i$" is obtained. Since the value of this column is negative, these values are divided by -1 in order to make them positive. This makes the difference between suppliers clear.

Table 10 indicates the results of reference point approach.

**Table 10: The Results of the Reference Point Approach**

| Criteria / Suppliers | **C2** | **C4** | **C6** | **C5** | **C3** |
|---|---|---|---|---|---|
| Supplier 1 | 0,044 | 0,017 | 0,026 | 0,023 | 0,013 |
| Supplier 2 | 0 | 0,008 | 0 | 0,002 | 0 |
| Supplier 3 | 0,044 | 0,021 | 0,052 | 0,026 | 0,019 |
| Supplier 4 | 0 | 0,013 | 0,052 | 0,012 | 0,008 |
| Supplier 5 | 0 | 0 | 0 | 0 | 0 |
| | **C1** | **C7** | $t_i$ | $1/t_i$ | **Ranking** |
| Supplier 1 | 0,007 | 0,004 | 0,044 | 22,72727273 | 3 |
| Supplier 2 | 0,003 | 0 | 0,008 | 125 | 2 |
| Supplier 3 | 0,011 | 0,008 | 0,052 | 19,23076923 | 4 or 5 |
| Supplier 4 | 0,005 | 0,008 | 0,052 | 19,23076923 | 4 or 5 |
| Supplier 5 | 0 | 0,001 | 0,001 | 1000 | 1 |

In this approach, the supplier with the largest row value is identified as the worst supplier, while the one with the smallest row value is identified as the best supplier. In Table 10, the positions of 4 and 5 are not fully determined. 1 is divided by the maximum row value "$t_i$" and the performance difference between suppliers is more easily observed. Once the results of the reference point approach are obtained, it is necessary to obtain the results of the full multiplicative form. Table 11 shows the results of the full multiplicative form.

**Table 11: The Results of the Full Multiplicative Form**

| Criteria / Suppliers | C2 | C4 | C6 | C5 | C3 | Ranking |
|---|---|---|---|---|---|---|
| Supplier 1 | 0,133 | 0,099 | 0,078 | 0,043 | 0,046 | 3 |
| Supplier 2 | 0,089 | 0,091 | 0,052 | 0,064 | 0,058 | 2 |
| Supplier 3 | 0,133 | 0,104 | 0,104 | 0,04 | 0,039 | 4 |
| Supplier 4 | 0,089 | 0,095 | 0,104 | 0,054 | 0,051 | 5 |
| Supplier 5 | 0,089 | 0,083 | 0,052 | 0,066 | 0,058 | 1 |
| | C1 | C7 | Multiplication of Beneficial Criteria | Multiplication of Non-beneficial Criteria | $u_i$ | Ranking |
| Supplier 1 | 0,027 | 0,028 | 1,49537E-06 | 0,001027 | 0,001456 | 3 |
| Supplier 2 | 0,03 | 0,032 | 3,56352E-06 | 0,000421 | 0,008461 | 2 |
| Supplier 3 | 0,023 | 0,023 | 8,2524E-07 | 0,001439 | 0,000574 | 4 |
| Supplier 4 | 0,029 | 0,024 | 1,91678E-06 | 0,000879 | 0,00218 | 5 |
| Supplier 5 | 0,034 | 0,03 | 3,90456E-06 | 0,000384 | 0,010165 | 1 |

In the full multiplicative form, beneficial criteria are multiplied and non-beneficial criteria are multiplied separately. Then, the multiplication of beneficial criteria is divided by the multiplication of non-beneficial criteria. Supplier with the highest score is identified as the best supplier in this approach. According the results of this approach, suppliers are ranked. However, as mentioned earlier, the suppliers in the 4th and 5th in Table 10 are not exactly identified. This makes a confusion in the model and dominance theory does not deal with this issue. In order to finish this confusion, geometric mean of the results of all three approaches are calculated. In Table 12, the final results are obtained by combining the three approaches with the geometric mean.

Accordingly, suppliers are ranked according to their performance as following; Supplier 5, Supplier 2, Supplier 4, Supplier 1 and Supplier 3.

**Table 12: Combined Results and Final Ranking**

| Results / Suppliers | $-1/y_i$ | $1/t_i$ | $u_i$ | Geometric Mean | Ranking |
|---|---|---|---|---|---|
| Supplier 1 | 6,024 | 22,72727273 | 0,001456 | 0,584162 | 4 |
| Supplier 2 | 20,833 | 125 | 0,008461 | 2,80351 | 2 |
| Supplier 3 | 4,63 | 19,23076923 | 0,000574 | 0,371034 | 5 |
| Supplier 4 | 7,692 | 19,23076923 | 0,00218 | 0,685731 | 3 |
| Supplier 5 | 27,778 | 1000 | 0,010165 | 6,560454 | 1 |

## 5. Conclusion and Suggestions

The performance of suppliers influences the performance of buyer companies. The performance of suppliers is crucial for these companies that purchase products from suppliers. Many criteria are used in evaluating the performance of the suppliers and these criteria are divided into beneficial and non-beneficial. In this study, Cost, Quality and Delivery Time include numerical data and these are identified as non-beneficial criteria. The other criteria include linguistic data and these are identified as beneficial criteria. In this study, an integrated group multi-criteria decision making model consisting of SWARA and MULTIMOORA methods is proposed to perform supplier performance evaluation. This study presents the following contributions to the literature: i) Both objective and subjective data are taken into consideration in selecting suppliers, and solutions are quickly achieved with methods that do not have complex algorithms such as SWARA and MULTIMOORA. ii) A final step has been added to the result process of the MULTIMOORA method, which eliminates any confusion that may arise in the results. Future publications may use these two methods for different multi-criteria decision making problems (material selection, warehouse location, etc.).

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# 8 Effects of Turkish IT Firms' External Growth Decisions on Firm Value

*Ozan Gönüllü*

**Abstract**

*Corporate mergers and acquisitions ("M&A") which gained global presence thanks to the liberalization of capital movements by 1980s is a significant driver of external growth for firms around the world. Firms often go with M&As when they want to grow, reduce costs, and gain advantage through increasing market share or if they want to shift their activities to different sectors in an attempt to mitigate risks by diversification. M&A decisions would have serious effects on firms' stock performance, and consequently on the wealth of the firms' stockholders. In this study, we investigate the factors affecting firms' stock performance and consequently on wealth of the firms' stockholders in the event of M&A deal announcements by studying 15 M&A deals that took place from 2005 through 2015 where at least one party of the deal was a publicly traded information and technology ("IT") firm on Istanbul Stock Exchange ("BIST"). The study identifies the return variations following announcement of M&A deals and presents findings on the potential effects of such return variations on wealth of stockholders.*

***Keywords:*** *Merger and Acquisitions, Stockholder Value, Event Study, External Growth.*

## Introduction

Modern finance theory defines the goal of the firm as maximization of firm value, which eventually means maximization of stockholder's wealth. Firms' strategies and plans are carried out to reach this goal, and all financial and managerial decisions are made to serve this purpose. Growth related decisions, similar to all other financial decisions maximize value when made on the right time and under the right conditions, on the other hand leads to value destruction when made under unsuitable conditions. Even though growth is an important concept for firms, growth should be planned, sustainable and balanced in order not to yield results that is incompatible with financial goals.

Firms face two alternatives, internal and external growth, when they make growth related decisions. Like internal growth, external growth aims maximizing stockholder's wealth (Shall & Haley, 1983, pp. 710-712) and internal growth represents increase in capital raised using resources obtained from firms' ordinary operations or capital obtained from debtors or stockholders. Internal growth and organic growth are often used interchangeably. Markets may commonly experience monopolistic industry structures and strategic alliances due to decreases in competition as a result of internal growth led capacity increases within the firm and the industry that the firm operations in (Sayılgan, 2003, p. 323). Internal growth includes strategies that require planning such as expansion of assets, utilizing technological innovations, seeing the gaps in the marketplace and investment accordingly, and the results of which would not be achieved in a short period of time (Bruner, 2004, pp. 35-60).

Whereas external growth refers to the corporate M&As. M&As are classified as vertical, horizontal, and conglomerate. For vertical mergers, firms at different stages of production process merge their operations, and buy side of the deal either expands operations backward in the production process towards raw material resources or forward towards the final product. The world's largest navigation devices manufacturer TomTom's acquisition of Tele Atlas in 2008 is an example of vertical merger. Following the merger TomTom starts using digital map data of Tele Atlas in order to provide real-time satellite-navigation updates (Brealey, Myers & Allen, 2011, p. 792).

Horizontal mergers are defined as merger of firms within the same industry and they are important in increasing firm's market share and creating synergy value. The most

significant benefit gained from horizontal mergers is revenue increases as a result of increased market share when operational costs go down (Sudarsanam, 2003, p. 127).

Conglomerate mergers happen when firms with no direct relationship among their core businesses merge. Such mergers are also classified as heterodox, or unrelated in the literature (İçke, 2007, p. 17). Conglomerate mergers are also known for their value destruction features.

M&As have positive impact on stockholders' wealth only under right circumstances. Sometimes managers may exhibit irrational decision making when entering into M&As. Overvaluing growth or avoiding to distribute dividends in an attempt to sustain managerial control over firm's cash flow would be the basis for such irrational decision making. Conflict of interest between stockholders and management impose transaction costs on the deals and such costs conflict with firm's goal of value creation. In the event of mergers being completed under wrong circumstances, stockholders may face significant loss in their wealth.

This study identifies the effects of M&A decisions taken by management on the performance of stock prices using event study methodology. First part of empirical application focuses on identifying any significant variation in firms' stock returns after announcements of M&A deals, while second part focuses on identifying any abnormal return for stockholders which holds the firm's stock during the whole event window.

**Literature Review**

Following Hogarty (1970), numerous studies examined the impact of M&A deals on stock prices. Jensen (1987) exhibits stockholders gain significant returns after M&A deals and noted that M&A deals had benefited target firm stockholders by 346 billion U.S. dollars from 1977 until 1986. However, Jensen claims that it is hard to estimate the gains of an M&A deal for a buyer firm.

Moeller and Zhu (2016) study the short term effects of cross-border M&As of UK firms by Chinese public firms from 2012 through 2016. Results of the study, which encompasses event study analysis for four separate sub-periods, identifies positive abnormal returns for Chinese buyer firms' stocks for the next day following the announcement of deals. However, study concludes that these positive abnormal returns are in reversal in later periods.

Elad and Bongbee (2017) investigate reaction of stock returns to M&A news. From July 2012 through May 2013 and for firms included on FTSE100 index, 51 events were identified and analyzed with an estimation window of [-100, -10] followed by an event window of [-5, -100, -10]. The study utilizes market model and applies linear regression model in order to estimate future stock returns and regression parameters. Furthermore, study identifies test statistic for average abnormal return ("AAR") excessively positive and higher than critical value, which consequentially implies that M&A deals have statistically significant effect on abnormal returns.

Çakır and Gülcan (2012) study effect of M&A activity from 2005 to 2009 on stock returns for non-financial firms listed on BIST. Study examines cumulative abnormal returns ("CAR") for event windows of ±5 days and ±20 days and concludes that (1) statistically significant differences exist for abnormal returns pre and post M&A announcements, and (2) CARs are significantly different than zero for whole event window.

Dodd and Ruback (1977) measure stock market reaction to M&A proposals, and examines effects of both successful and unsuccessful deals on stockholder returns. Their study finds out that target firm stockholders enjoy high levels of positive abnormal return irrespective of the outcome of deals while buyer firms' stockholders only obtain abnormal returns in successfully completed M&A deals.

Rani, Yadav and Jain (2015) identify that market reacts to deals prior to the announcement of M&As. Their analysis covers firms which were a party in an M&A deal for the period between 2003 and 2008, and listed on Bombay Stock Exchange ("BSE"). In this period, there were 5,504 M&A deal that went through. The study finds that investors react to public announcements of M&As, which leads to increase in share prices and eventual positive abnormal returns to the investors. In addition, the study notes that buyer firms' stock undergoes a strong correction following the announcement which eliminates any continuance in positive abnormal returns. The other findings of the study would be summarized as following; (1) investors can realize significant returns when stocks bought two days before the announcement and sold two days after the announcement, (2) cross-border deals yield higher abnormal returns, (3) acquisition announcements yield significantly higher returns than merger announcements for partial / majority control of the firm, (4) pre-announcement positive abnormal returns have a trend starting at seven days prior to the announcement

and continue to be positive for 14 days, and (5) returns turn to negative only for six days within this window.

Hiruta (2012) studies 77 M&A announcements to the public for Japanese firms from 2000 to 2005. In this study, transactions among holding firms and their subsidiaries, deals with minority stockholder involvement, and deals involving subsidies are removed from the sample population of announcements. The results of the analysis on refined sample of deals suggest positive abnormal returns for both buyer and target firms' stockholders and such returns have significantly contributed to stockholders' wealth.

Sachdeva, Sinha and Kaushik (2015) examined 85 M&A deals involving Indian buyer firms from 1991 through 2010 in order to assess effect of M&A deal announcements of buyer firms' stockholders. Results imply that buyer firms' stockholders realize insignificant negative return following the deal announcement while realizing a significant and positive abnormal return on the day of the announcement.

Shah and Arora (2014) research 37 M&A deal announcements from Asia-Pacific region for a period spanning from May 2013 to September 2013 in order to assess effects of announcements on both buyer and target firms' stock prices. The study uses cumulative average abnormal return ("CAAR") methodology for stock returns of buyer and target firms in different event windows. A paired samples t-test has additionally been performed on pre and post announcement returns of the target and buyer firms' stocks with an event window of ±2 days. For all event windows, target firms' yield positive CAARs that is significantly different than zero whereas, buyer firms do not exhibit significant CAARs over the event windows. As an indication of investors' immediate reaction to the announcement, target firms exhibit significantly higher rate of returns after the announcement when compared to post-announcement returns.

Yoruk and Ban (2006) calculate excess returns with varying analysis periods for firms involved in M&A activity and listed on BIST and test potential abnormal return for investors. Study includes 8 food industry firms that are publicly traded on BIST. Results suggest that long-term investments do not yield any abnormal returns whereas investments within ±5 days event window would yield abnormal returns.

Cummins and Weiss (2004) investigate effect of M&A deals within European insurance market on wealth of stockholders. They analyzed whether any significant abnormal returns exist for target and buyer firms' stockholders around and on the deal

announcement date through calculating CAAR. Their results indicate that buyer firm stockholders face small negative CAARs while target firm stockholders enjoy positive CAARs that vary between 12% and 15%. For buyer firms' stockholders, cross-border deals do not have a significant impact whereas local M&As lead to approximately 2% value decrease. However for target firms' stockholders, both cross-border and local deals create significant value.

Liargovas and Spyridon (2011) study impact of M&A deals on Greek banking industry. Their study, which applies event study methodology, concludes that semi-strong form efficiency of Efficient Markets Hypothesis ("EMH") do not hold in Athens Stock Exchange. Stockholders gain significant positive CAARs within the 10 days leading to the announcement of M&A deals. In addition, results show that horizontal and unrelated banking industry M&As yield positive CAARs following the announcement. However, the overall results of the study suggest that banking industry M&As do not increase wealth for buyer firms' stockholders. Furthermore, study evaluates performance of Greek banking industry operations using twenty financial ratios, and concludes that there were no betterment in banking industry performance after M&A deals.

Fatemi, Fooladi and Garehkoolchian (2016) investigate short-term wealth effects of M&A deals in Japan from 2000 to 2014 to buyer and target firms' stockholders and conclude that M&A deals do not have significant impact on wealth of buyer firms' stockholders while they have significant impact on the wealth of target firms' stockholders. However, their long-term analysis, specifically with event windows longer than 6 months show abnormal returns for buyer firms' stockholders. The study further explains that stockholder returns are closely related to the length of the event window.

Asquith and Kim (1982) analyze the impacts of merger offers on debtor and stockholder of the firms' that were a party of the offer. The study calculates monthly and daily returns on bonds and stocks based on the merger offer announcement date. Their analysis outlines that while target firms' stockholders enjoy returns thanks to the merger offer, other security holders (debtors) has no change in their wealth. Furthermore, they argue that the correlation between bond returns and merging firms' stock returns should be studied to obtain concrete evidence on the existence on diversification and subsidy effects in mergers.

**Data**

M&A deals data included in this study were obtained from "M&A Deals Report" published by Ernst & Young Turkey which is a part of Ernst & Young Global Limited and "M&A Outlook Reports" published by Turkish Competition Authority. Daily closing prices and return data for stocks and BIST-100 market index that were used in this study are obtained through Finnet Analysis Expert software available at Istanbul University Capital Markets Research and Implementation Center's ("SERPAM") Trademaster Investment Platform Research Laboratory.

The empirical study covers 15 cases of merging and acquisition operations that were realized between 2006 and 2015 by IT companies traded on BIST (Istanbul Stock Exchange). Table X shows the relevant transactions and the dates of public disclosure.

**Table 1: Event Dates and Companies**

| Date | Code | Company | Code | Company |
|---|---|---|---|---|
| 13.03.2006 | - | Karadeniz Örme Sanayi | INDES | İndex Bilgisayar |
| 7.10.2010 | - | TNB Bilgisayar | ESCOM | Escort Teknoloji Yatırım |
| 1.11.2011 | - | Coretech Bilgi Tek. Hiz. | LOGO | Logo Yazılım |
| 7.08.2008 | - | TNB Bilgisayar | ESCOM | Escort Bilgisayar |
| 22.09.2010 | ARENA | Arena Bilgisayar | | Redington Intl Hldg Ltd |
| 03.04.2012 | - | Alkim Bilgisayar | INDES | İndeks Bilgisayar |
| 24.01.2012 | - | Pavo Tasarım Üretim | ESCOM | Escort Teknoloji |
| 02.09.2013 | - | ADEO Bilişim | ARENA | Arena Bilgisayar |
| 21.03.2013 | INDES | Indeks Bilgisayar | - | MCI Management |
| 15.04.2013 | LOGO | Logo Yazılım | - | EAS Solutions SARL |
| 25.07.2013 | - | Netsis Yazılım | LOGO | Logo Yazılım |
| 15.10.2014 | ARMDA | Armada Bilgisayar | - | Ingram Micro |
| 24.12.2014 | - | T Bilgi Teknolojileri | ESCOM | Escort Teknoloji |
| 18.06.2015 | - | Sempa | LOGO | Logo Yazılım |
| 20.10.2015 | - | Vardar Yazılım | LOGO | Logo Yazılım |

**Methodology**

Event study methodology includes an event window, which covers a period before and after the date of event announcement and an estimation window, which covers a non-overlapping period prior to the event window. The purpose of constructing an estimation window is to determine expected return. The expected return estimated by a determined expected return estimation method is used to obtain abnormal returns within the event window. Average abnormal returns ("AAR") is the average of daily abnormal returns within the event window for each stock analyzed. Based on daily AARs, cumulative average abnormal return ("CAAR") is the sum of AARs from the first day to the last day of the event window. In event study literature, value creation following M&A deal announcements is measured by CAAR.

Empirical application used event study methodology for two different analysis. First part includes testing for statistically significant differences in cumulative abnormal returns before and after the announcements, while second part includes testing whether cumulative abnormal returns within the event window are significantly different than zero.

Daily returns are calculated using daily closing prices for stocks of the IT firms publicly traded on BIST and which were at least one party of an M&A deal that took place from 2005 through 2015. Calculation period includes estimation window of 360 days and event window of 61 days ($t_0 \pm 30$). Event and estimation windows are presented at Figure 1.

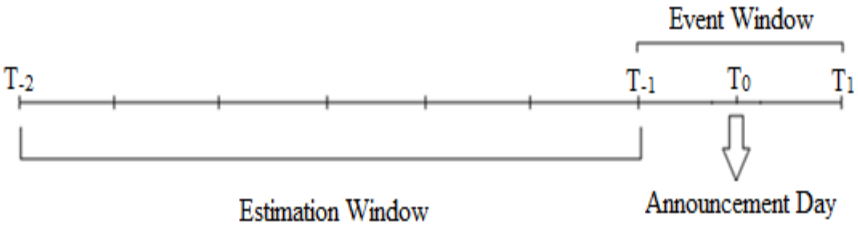



**Figure 1: Event Study Windows**

**Calculation of Abnormal Returns**

Abnormal return is defined as the difference between actual and expected returns, hence calculations for daily returns and expected returns are required in order to calculate abnormal returns.

$$AR_{i,t} = R_{i,t} - E[R_{i,t}]$$

$AR_{i,t}$; Abnormal return at day t,

$R_{i,t}$; Actual return at day t,

$E[R_{i,t}]$; Expected return at day t.

**Daily Returns**

In order to calculate daily abnormal returns for a determined event window, realized daily returns are calculated. Realized daily returns are logarithmic returns calculated by using daily closing stock prices.

$$R_{i,t} = \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right)$$

$R_{i,t}$; Return on Security i at day t,

$P_{i,t}$; Closing Price of the security on day t of company i

$P_{i,t-1}$; Closing Price of the security on day t-1 of company i

**Expected Returns**

Expected returns are estimated using the Market Model where $\alpha$ and $\beta$ coefficient estimates for each stock are obtained by applying linear regression on stock and market index returns within the estimation window. These estimated coefficients are then used in Market Model equation in order to obtain daily expected returns. The regression model is as follows:

$$R_{i,t} = \alpha_i + \beta_i (R_{m,t}) + \varepsilon$$

$R_{i,t;}$ Observed daily return for the security “i" on day “t”,

$R_{m,t}$ ; Observed daily return for the market index "m" on day "t",

$\alpha_i$ ; Intercept for the security "i",

$\beta_i$ ; Beta factor for the security "i"

$\varepsilon$ ; Statistical error term.

Estimated $\alpha$ and $\beta$ coefficients and daily BIST-100 index returns are applied on the following equation in order to calculate daily expected stock returns.

$$E[R_{i,t}] = \alpha_i + \beta_i (R_{m,t})$$

$E[R_{i,t}]$; Expected return of stock ar time t.

**Abnormal Returns, Average Abnormal Returns and Cumulative Average Abnormal Returns**

Abnormal Return ("AR"):

$$AR_{i,t,Pm} = R_{i,t} - (\alpha_i + \beta_i (R_{m,t}))$$

Average Abnormal Return ("AAR"):

$$AAR_{Pm} = \frac{1}{N} \sum_{i=1}^{N} AR_{i,t,Pm}$$

Pre-announcement daily cumulative average abnormal return is the sum of daily average abnormal returns from the first day of the event window to the announcement day and post-announcement daily cumulative average abnormal return is the sum of daily average abnormal returns from the announcement day to the last day of the event window. In addition, cumulative abnormal return for the whole event window is calculated. First part of the empirical analysis use the pre and post-announcement cumulative abnormal returns, while second part uses the cumulative abnormal returns for the whole event window.

Cumulative Average Abnormal Return ("CAAR") for $t_n - t_m$ event window is calculated as follows:

$$CAAR_{Rort,(t_n,t_m)} = \sum_{t=t_n}^{t_m} AAR_{Rort}$$

**Analysis and Findings**

Paired samples t-test is applied to measure the variations in pre and post-announcement CAARs in order to assess the impact of the M&A deal announcements on stock performance. Application of this test requires CAARs to be normally distributed. Table 2 presents the normality test results.

**Table 2: Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | Df | Sig. |
| CAAR_After | ,155 | 30 | ,063 | ,932 | 30 | ,055 |
| CAAR_Before | ,121 | 30 | ,200* | ,953 | 30 | ,205 |

*a. Lilliefors Significance Correction*

**. This is a lower bound of the true significance.*

Both CAAR series appears to be normally distributed according Shapiro-Wilk test. Table 3 shows Paired Samples t-Test results for the series.

**Table 3: Paired Samples Test**

| | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|
| | Mean | Std. Deviation | Std. Err.Mean | 95% Conf.Int. of the Diff. | | | | |
| | | | | Lower | Upper | | | |
| CAAR_Before CAAR_After | -6,12407 | 3,90997 | ,71386 | -7,58408 | -4,66407 | -8,579 | 29 | ,000 |

$H_{0,(\pm 30)}$: $CAAR_{-t} = CAAR_{+t}$

CAARs calculated for the stock of the firms that were a party to an M&A deal within the pre-announcement window of 30 days and post-announcement window of 30 days do not have statistically significant differences.

$H_{1,(\pm 30)}$: $CAAR_{-t} \neq CAAR_{+t}$

CAARs calculated for the stock of the firms that were a party to an M&A deal within the pre-announcement window of 30 days and post-announcement window of 30 days have statistically significant differences.

Test results suggest rejection of the null hypothesis (**$H_0$**). Pre and post-announcement abnormal return series are statistically different at the 1% significance level. To put it differently, M&A deals did have a significant impact on the stock performance.

In order to assess the impact of the M&A deal announcement on stockholders' wealth, CAARs calculated for the whole event window are tested whether they are statistically significantly different than zero. Event window of 61 days is spread symmetrically around the announcement date. Two different methods exist to find whether a stockholder, who owned any stocks during that period, yielded any abnormal returns. The first test, one-Sample t-test requires normality in CAAR series. The second test, Wilcoxon signed-ranks rest is applied on CAAR series that exhibit non-normal distribution. Table 4 shows the normal distribution test results for the CAAR series calculated for the event window of 61 days.

**Table 4: Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | Df | Sig. | Statistic | df | Sig. |
| CAAR | ,137 | 61 | ,006 | ,964 | 61 | ,069 |

*a. Lilliefors Significance Correction*

According to the normality test results, CAAR series which were calculated for the event window, $t_0 \pm 30$ days, do not exhibit normal distribution characteristics. Therefore, non-parametric Wilcoxon signed-ranks test is applied in order to find out whether the CAAR series are statistically different than zero. Table 5 presents the test results.

**Table 5: Test Statistics[b]**

| | CAAR |
|---|---|
| Z | -6,748[a] |
| Asymp. Sig. (2-tailed) | ,000 |

*a. Based on negative ranks.*

*b. Wilcoxon Signed Ranks Test*

**$H_0$:** $CAAR_{\pm 30} = 0$

CAARs calculated for the stock of the firms that were a party to an M&A deal within the event window of 61 days, 30 days prior to the announcement and 30 days after the announcement, equals to zero.

**$H_1$:** $CAAR_{\pm 30} \neq 0$

CAARs calculated for the stock of the firms that were a party to an M&A deal within the event window of 61 days, 30 days prior to the announcement and 30 days after the announcement, differs significantly from zero.

Test results suggest rejection of the null hypothesis (**$H_0$**). To put it differently, M&A deals did have a significant impact on the firm stockholders' wealth at the 1% significance level.

**Conclusion**

Firms drive their organizations to grow in order to sustain their advantages in competition-driven markets. Growth performance not only help companies increasing their market shares while reducing costs, but also exponentially impact the value of the firm. Growth strategies which are not developed in the right time and place might as well cause companies to destruct value. Willingness of the firm executives to bring in major growth figures for prestige may lead to some negative consequences for the stockholders of the firm. Stockholders' wealth for firms in IT industry, where growth and innovation are of paramount importance, would be particularly vulnerable to growth decisions made by the firm.

Mergers and acquisition, two main methods used by firms for external growth have key importance in modern day finance literature. In this study, we investigate the factors affecting firms' stock performance and consequently on wealth of the firms' stockholders in the event of M&A deal announcements. The results of empirical study that covered M&A deals of IT companies, which are traded on BIST and are a party to an M&A deal which took place between 2006 and 2015, show that stock performance after the announcement of an M&A deal differs significantly from the period prior to the announcement date. This finding points out the fact that markets are keeping an eye on these deals and respond to the announcement of M&As. Figure 2 shows the course of pre-announcement and post-announcement cumulative average abnormal returns. Accordingly, IT firms experience a negative trend in their abnormal returns for the 30 days prior to the announcement date while CAAR trend is positive for the 30 days following the announcement. The highest rate of abnormal return achieved during this event window is the period between the 10th and 20th days post-announcement.

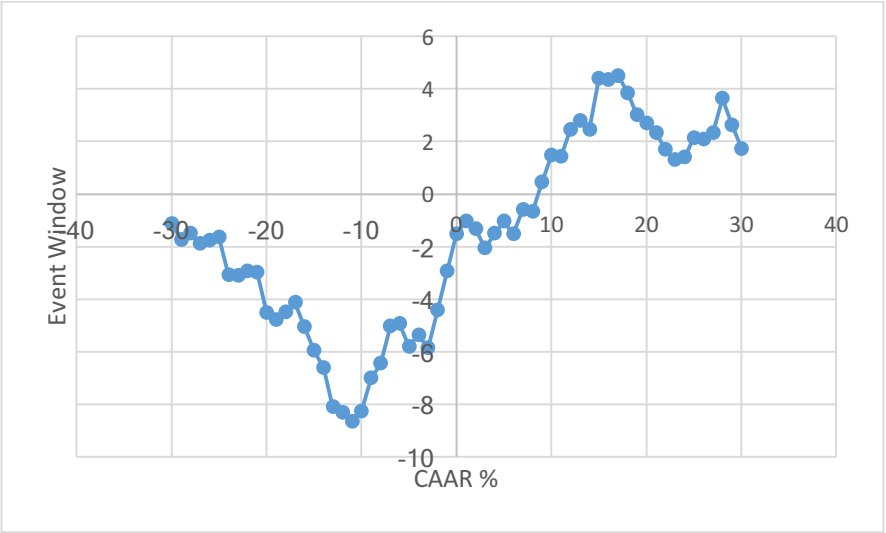



**Figure 2: Cumulative Average Abnormal Returns Trend**

Another finding of the study indicates that the market began responding to the M&A deal announcement 10 days prior to the announcement. We can argue that this kind

of reaction might be due to the possible leak of the information which was not made public yet, hence this would imply an instance of insider trading.

The results of the test from the second part of empirical study indicate that a stockholder who owns the stock involved in an M&A deal for the 61-day event window may yield abnormal returns that are statistically significantly different from zero. This finding leads to the conclusion that M&A decisions made by the Turkish IT firms have statistically significant impact on the wealth of their stockholders.

Finally, findings suggest that M&A decisions, which embody extensive cases of principal-agent problems, may influence wealth of relevant firms' stockholders. For that reason financial executives, as they plan for the growth, need to anticipate potential impact of M&A deal announcement across the market and on the firms' stock performance. Therefore, firm executives whose primary goal is maximize stockholders' wealth should assess existence of value creation opportunities when they make a decision to merge or acquire.

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# 9 Examination of The Regional Innovation Capacity by Using Normalization Method: Eastern Marmara of the Regional (Tr4) Example

*Erhan Duman,*
*Zeynep Karaçor*

**Abstract**

*Nowadays, financial determination -making units require resources that will supply and develop economical growth as to increase social benefit and rivalry. Inside the financial construct, these resources come out knowledge, technology and innovation. Especially regional innovation systems participate in a central role in appointment the requirements for the resources needed for economic growth. Therefore, it is important to examine the relationship of the innovation with the economic growth in the new world economy, where it appears like a production factor. In this study, the innovation capacity of the Eastern Marmara region has been examined by using the normalization methods. In this framework, it is focused on found criteria that are corresponding the Level 1 averages of the regions in Turkey.*

***Keywords:*** *Innovation, Innovation Index Calculation, Innovation Efficiency and Normalization Method.*

## 1. Introduction

The phenomenon of globalization of knowledge, tecnology and innovation continues to change the world with everyday. Therefore, units that arise in the process of globalization economic, political, social and cultural values are becoming a part of the evolving structure. In this context, it becomes possible to capture

the innovations in technology or innovations to keep up with and the vital importance of information in today's world are promoting innovation as an integral part of the growth of economies. In this context, economic growth in the countries or regions agree to a point: for scientific and technological innovation policies to closely monitör the progress as well as create the necessary infrastructure to these policies. Social, cultural, political and economic understanding in order to grasp the importance of innovation with in the system should make this dominant.

Technology and information evolving as a result of in the past centuries, in the 21st century have been the bases for the innovation policies. Innovation policies are described as a new product-process beginning the invention, until the scientific and technological advancement and then subsequently winner economic added value. The notion that covers up all of this product and process enquiries is innovation.

Numerous researches have been accomplished to interpret the idea of innovation in the history of economics. The reason for that is innovation's being in steady alteration. Accordingly, definite the idea of innovation as a technical word furnish ease for semiotic integrity. Innovation, which is a Latin-based term, is derived from the word 'innovatus'. The dictionary meaning of innovation is starting to use new methods in economic, social, cultural and administrative matters. In accordance with this definition, innovation symbolize not only a process but also a result. In this context, the term is used for the innovations that have economical value. Hence, formations that have the innovation characteristics for society and the economy should be in a commercial nature, contributing to an increase in prosperity.

Innovation; while you are creating a foundation of economic growth, on the other hand the term chord structure is an important variable in firms and regions competitive in the international market. The varible examined in the study of innovation and enhanced economic growth in a comprehensive manner in addition to decreasing differences between regions facilitates the distribution of information and sectors. In this context, increasing coordination between sectors in region with innovation and solidarity. Hence, the regions of the competition which is one of the driving forces of the innovation will contributes to increase the R&D activities focused on innovation. Also innovation contributes to the growth and development of the less developed regions. In this case, innovation changes for social, cultural, economic and political improving competitiveness and profit maximization of firms.

Regarding this definition, first of all, it is necessary to solve the contradiction in the terms of invention and innovation. Schumpeter has pointed out the difference between innovation and inventions. According to Schumpeter, developing the ideas of a product or manufacturing process for the first time is invention, whereas the innovation is the transformation of a new idea into an economic value for the first time. At the same time innovation is a result of knowledge accumulation, while the inventions, are a product of scientific activities, which do not always result in innovation. Hence, inventions do not have economic effects by themselves. The transformation of inventions into innovation, in other words, their commercialization, is related to personal talent, i.e. the entrepreneur. According to Schumpeter, everything that brings profits to the entrepreneur as a result of technological advances is defined as innovation. In this scope, the activities of innovation consist of creating a new market and production method, inventing a product and establishing production factors in order to provide raw material input. In this context, innovation is the discovery of a new form of production on a scientific standpoint, the discovery of a new product that has not been found out by producers and consumers before.

Another important factor in innovation is the positive relationship between regionalization, institutional infrastructure and economic growth. In order for this positive relationship to be formed, technological products and the information should be produced, marketed, organized and presented in different forms, and commercialized. In this case, innovation systems make a very important contribution to economic growth by increasing competitive capacity of the nations and regions. In this direction, institutions-organizations such as university-industry collaborations, R&D institutes, technoparks-technocities, development agencies and research centers play an important role both in national and regional sense in economic growth process. In addition, innovation systems are processes that lead to drastic changes in the economic, political and social structures of the regions. Therefore, the factors such as intensity of innovation activities, incentives for R&D expenditures, accessibility of institutions that have undertaken the task of supporting the entrepreneurship are very important in terms of the development of regions.

The questions that have been addressed regarding the purpose of the work are:

i. What is the innovation performance measurement capacity of the Eastern Marmara Of The Region?
ii. Is the region productive in terms of innovation?

iii. What are the factors that influence the region that is related to innovation?

It is expected to contribute to the literature within the scope of the answers to these questions.

**2. Literature Review**

There are many empirical studies on innovations in the literature. These studies have been searching for the answers of the questions such as: "What are the determinants for the innovations at company, region and country level?", "How is the level of innovation performance measured?", and "Is innovation a process that enhances competition?". For this reason, in addition to the studies examining the effects of the components of innovation performance measurement and index values on innovation outputs, the innovation subject is included in empirical studies in the context of economic growth and regional competition. Some of these studies are as follows.

Jaffe (1989) examined the effects of university researches and private sector R&D expenditures on innovation in the US between the years of 1972 and 1981. Analyzes have been separated into three groups as medicine, chemistry and electricity sectors. At the end of the study; it was stated that, while there was a positive relationship between university researches and private sector R&D expenditures, the strongest relation belonged to the pharmaceutical sector. This relationship leads to an increase in innovation as a result of the increase in university researches and private sector R&D expenditures.

Popp (1998) analyzed the relationship between innovation and energy prices in the US economy between the years of 1970 and 1994. In the study, the number of patents was included as a dependent variable, and the Energy prices, public sector spending on R&D and information stocks were independent variables. The analysis has resulted in a positive and strong relationship between the variables. It was stated that the increase in the number of patents and the increase in energy prices were in the same direction.

Porter and Stern (2001) conducted a study covering 75 countries to show the innovation index capacity at national level. The study also included the main activities, including countries' patents, innovation policy, clustering and innovation connections, and different sub-variables. Index values were calculated by using standardization method in the model where 24 variables such as public-private sector R&D

investments, population structure, suppliers, university-industry cooperation, and number of scientists were used. After the index values were calculated, the innovation capacity index was established by taking the non-weighted averages of the 4 main sub-indexes. These variables in the study were subjected to regression analysis. 23 of the 24 variables were statistically significant. In the study Turkey is ranked as 44th with 17.8 points in the innovation capacity index.

Porter, Stern, and Furman (2002) also conducted a study on innovation determinants. They have defined the innovation determinants based on the knowledge-based internal growth model, the national innovation system, and Porter's theory of competition. It was emphasized that, although these models have many common aspects, they differ in terms of the factors. In the study; the information stock in economy and the number of employees working in R&D was analyzed with the theory of internal growth, the innovation's micro-economical aspects were analyzed with the theory of competition, and the national innovation system was used to analyze the roles of institutions in the countries, the national politics, and higher education systems.

Huggins (2003) carried out an index study on the regions in UK between 1993 and 1999. In the study, four variables were analyzed: regional economic growth, innovation activities, competition development and the number of knowledge-based firms. As a result of the analysis, it was found that there was a strong correlation between the variables.

Martin (2004), reviewed the factors affecting economic growth in 207 regions of Europe. In this context, the effects on economic growth within the components were estimated with Barro type convergence approach between 1980 and 2001. These components include; per capita national income, R&D expenditures, physical capital, share of high technology sectors in total employment, proportion of higher education students and external economies. Regionally, the effect of these expenditures on per capita national income and R&D expenditures are concluded to be significant.

Hu and Mathews (2005) studied the determinants of the innovation capacity of the countries of Taiwan, China, Korea, Singapore and Hong-Kong between 1970 and 2000. In this study; they used the population, national income per capita, number of scientists, expenditure on research and development, risk capital market power, number of academic publications in magazines, capacity to protect the intellectual property, openness to international investment and trade, the frequency of the antitrust policies,

and the GDP share of high education expenditures as independent variables. As a result of the analysis; it was found that the protection of intellectual property rights negatively affects innovation. They concluded that there was a positive relationship between the other variables and the innovation capacity.

Lenger (2008) conducted a survey on Level 1 regions of Nomenclature of Territorial Units for Statistics (NUTS) of Turkey covering the years between 1998 and 2005. Lenger analyzed the effects of patent applications, which is the determinant of innovation performance, on the utility model, the cooperation of the state universities in the regions with the industry, and the number of publications in the universities. In addition, the data of the research variables were analyzed with the Generalized Moments Method (GMM). As a result of the analysis, it was found that there was a positive and strong effect between the patent and the other variables.

Wonglimpiyarat (2010) tried to find the index of innovation capacity with components related to organization, process, service, and product and marketing innovation throughout Thailand. Under the main headings of "human capital", "infrastructure" and "innovation climate" in the study, the data regarding the variables were collected with the help of a questionnaire. The survey results were adapted to the index values between 0 and 4 points. As a result of the survey, the general index value of 2.3 points has been obtained and it has been found that Thailand has a moderate level of innovation capacity.

Annoni and Kozovska (2010) calculated the European regional competition index. In their calculations, they used the normalization method in the "matlab" program. They sought answers to the question of "Why it is so important to measure regional competitiveness in EU regional competitiveness index calculations?". Index calculations have been made up of three variables. These are; education, macro-economic stability and infrastructure. These variables consist of 69 components. In the analyzes, it was concluded that, macroeconomic stability is the most important factor affecting the regional competition index.

Fritsch and Slavtchev (2011) examined the information production function in 93 regions in East and West Germany within the regional innovation system. They analyzed the relationship of regional patent applications, which were considered as outputs, with the variables such as research institutes, population density, funds

allocated to university academic staff, employment in the sectors of service-transportation-electricity-chemistry, average employment and number of private sector R&D professionals, in the study covering 1995-2000 period. In the results of this study; the effects of average employment per institution and service sector employment variables on patent applications were significant and negative, while the effects of other variables on patent applications were positive and significant.

Slaper et al. (2011) examined the relationship between regional innovation performance and economic growth. This work, which was based on 3110 residential areas in the USA, consisted of two parts. In the first part, to determine the regional innovation performance and capacity, regional innovation index was created by using the variables of the number of SMEs (small and medium sized enterprises), patents, private sector R&D expenditures, the ratio of the number of the license/associate's degree graduates to the population, the ratio of the risk capital to the investment, the infrastructure, employment structure in the high-tech industries belonging to the years between 1997 and 2006. The first part forms the input variable of the second part at the same time. In the second part of the study, the innovation outputs of the regions and the possible effects of their performances on the economic growth were analyzed by econometric method. As a result of analysis; it has been found that there are positive and significant effects between the number of SMEs, private sector expenditures, number of patents, infrastructure, and economic growth in advanced technology industries.

Gömleksiz (2012), calculated the innovation index of NUTS Level 2 regions in Turkey. In the study carried out by minimum-maximum normalization method considering global index sub-variables, the innovation inputs consisted of human capital-education, infrastructure-culture, market development and business environment. Innovation outputs were consisted of prosperity, and the creative and scientific outputs. All these sub-variables were examined within 45 components.

Asheim et al. (2013) investigated the effects of public policy on regional innovation. In this research, they pointed out that it has important effects on the regional innovation system in the culture variable, like industrial information intensive products. However, they argued that these influences were hindered by public policy intervention in terms of scientific framework. In their study, they pointed out that a new regional innovation system approach will create a policy for regional advantages.

## 3. Methodology

The regional innovation index consists of inputs and outputs. In this context innovation inputs consist of main variables such as; possible sword, infrastructure-culture and entrepreneurship-trade. Sub-variables forming these main variables are; human resources, research systems, investments-loans-supports, population, energy, information communication technologies, health, transportation, culture, entrepreneurship, trade and financial intermediaries. Innovation outputs are listed as 4 sub-variables such as; innovations, scientific outputs, economical outputs and social welfare.

The Turkish averages and the variables belonging to the TR4 region are divided into two groups as basic and sub-variables. The basic variables are the outputs of: enablers, infrastructure- culture, entrepreneurship-trade and innovation. The sub-variables are: human resources, research systems, investments-loans-support, population, energy, information communication technologies, health, transportation, culture, entrepreneurship, trade and financial intermediary institutions, innovations, scientific outputs, economic outputs, and social prosperity. The data for all these variables will be examined below, using the minimum and maximum normalization method.

In the creation of regional innovation indexes in Turkey, the European innovation scoreboard and the method of normalization, which is a measure of regional innovation, have been used. The factors affecting the formation of regional innovation indexes and the effects of these factors on the regions have been examined. In this context, the factors affecting the regions are analyzed by normalization method (minimum-maximum). Additionally, this method is preferred, due to the reason that the regions will be able to be compared with each other. The index values for each given region, and innovation input and output variables are calculated by the normalization method, which is a standardization process.

Market actors have to analyze the dynamic market structure in their decision-making processes. Within this structure, many alternatives should be examined and comparisons should be made by evaluating these alternatives. This leads to the development of very different decision making methods within the dynamic structure. The normalization techniques are utilized in the analysis of the components with

different variables. When the studies done with this method are examined, it is seen that the normalization methods are preferred (Wang et al., 2009: 2272).

Minimum-maximum normalization method is a generalized standardization process that is used to construct regional innovation indexes. Each component of the examined variables is used to generate the index values of the regions. These index values are in the range of 0 to 1 point interval according to minimum-maximum normalization method within the components (Aydın, 2012: 4-22). These regions that are mentioned are ranked according to their averages of general index score. The equation for the minimum-maximum normalization method is shown below.

In the equation; $Endeks_{xi} = \frac{x_i - x_{min.}}{x_{mak.} - x_{min.}}$

$x_i$ ; is the numerical value of the regions within the group where the index value will be calculated

$x_{min.}$ ; is the minimum value in each group

$x_{max}$; refers to the maximum value in each group.

Regional Innovation Efficiency = Innovation Output Average/Innovation Input Average

Index values for each region are calculated by dividing the difference between the group value belonging to the region and the minimum value in the group by the difference between the maximum value and the minimum value in the group. Regions with high innovation performance have the value of 1 and values close to 1; while those with low innovation performance have the value of 0 and values close to 0 (Çakır, 2012: 10-11). Additionally, the indexes of innovation and productivity of the regions are presented in the findings.

## 4. Findings

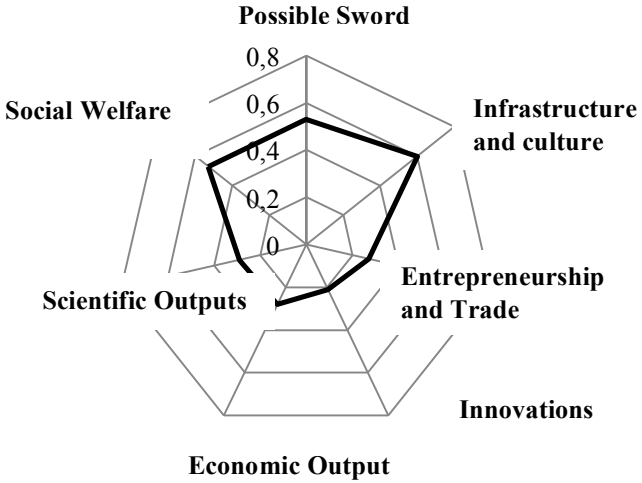
In the Table, regional innovation indexes and productivity scores are presented according to the minimum-maximum method. The ranking in the Table is based on the overall score averages. According to the calculations, TR4 region's average index score and productivity score rankings are considerably higher than the average of Turkey.

**Tablo 1: The Data Of TR4 Minimum - Maximum Normalization Method**

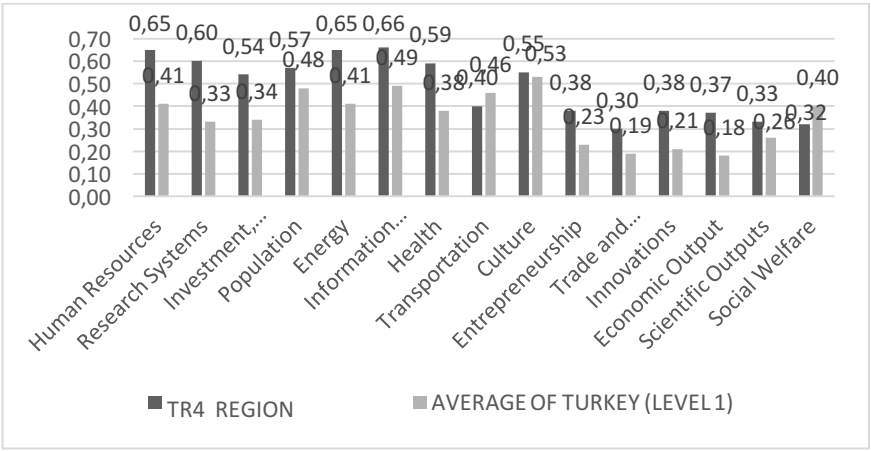
| VARİABLES (LEVEL 1) | TR4 REGION | AVERAGE OF TURKEY |
|---|---|---|
| **1.Possible Sword** | **0.59** | **0.3725** |
| 1.1. Human Resources | 0.65 | 0.41 |
| 1.2.Research Systems | 0.60 | 0.33 |
| 1.3. Investment, Credit and Supports | 0.54 | 0.34 |
| 1.4. Population | 0.57 | 0.48 |
| **2. Infrastructure and culture** | **0.57** | **0.454** |
| 2.1. Energy | 0.65 | 0.41 |
| 2.2.Information Communication Technology | 0.66 | 0.49 |
| 2.3. Health | 0.59 | 0.38 |
| 2.4. Transportation | 0.40 | 0.46 |
| 2.5. Culture | 0.55 | 0.53 |
| **3. Entrepreneurship and Trade:** | **0.34** | **0.21** |
| 3.1. Entrepreneurship | 0.38 | 0.23 |
| 3.2. Trade and Financial İntermediary Institutions | 0.30 | 0.19 |
| **4.Innovation Outputs:** | **0.35** | **0.2625** |
| 4.1. Innovations | 0.38 | 0.21 |
| 4.2 Economic Output | 0.37 | 0.18 |
| 4.3. Scientific Outputs | 0.33 | 0.26 |
| 4.4. Social Welfare | 0.32 | 0.4 |
| **Regional Innovation Efficiency** | **0.71** | **0.65** |

In the table, an average of Turkey Level 1 and The Eastern of Marmara Region illustrate the data that belongs to basic and the sub-variables Minimum-Maximum normalization method. All bases in the Eastern Marmara Region of sub-variables are valued above the average of Level 1. It is possible to explain this situation to the level of development of the region. According to estimates, an average of index points are above in the Eastern Marmara region of Turkey in the ranking of productivity the average. This situation outlines the following way.

**Şekil 2: TR4 Region Belong to That Comparison Of Variables**




Sub-Variables Of Comparison



The Eastern Marmara of Region is on the top when ranked with minimum-maximum normalization method in Level 1 in terms of general, productivity and many other sub-variable indexes. The TR4 region needs to be developed in the infrastructure-culture input variable, from the innovation input variables, while it is in the forefront especially in the variables of enablers and entrepreneurship-trade. Moreover, it is above Turkey's average in the sub-variables of input, especially in human resources, research systems, investments-loans-supports, population, information communication technologies, health, entrepreneurship and trade-financial intermediaries. In the context of innovation outputs, the TR4 region is the leader in; innovations (In the entrepreneurships where the, technological, product-process, organizational-marketing innovations and innovation activities continue in terms of total economic activities), economic outputs (utility models, patents, designs and number of brands according to total registration numbers), scientific outputs (Number of publications per million people, articles, citations, scientific documents, doctoral students and in the average academic point averages of the universities), social prosperity (the general purchasing power parity according to expenditure groups, the value added production per labor and the level of prosperity of the whole family), and in all of the other sub-component outputs. In this direction, it is in the higher class in terms of innovation. It is necessary to determine policies for energy, culture and transportation from infrastructure-culture input variables. Development of sub-variables in the middle ranks is important for the region, depending on investment, trade and entrepreneurship activities. Especially, it can be said that the presence of neighboring regions with heavy industrial density is effective in the energy sub-variable. In this context, the efficient use of energy resources and energy savings are important in terms of costs in the production phases for the region.

In order for economic growth in Turkey to have a stable structure, the improvement of especially entrepreneurship, trade, innovation, economic and scientific outputs, from the sub-variables, will contribute to making the Turkish economy more dynamic. Particularly regional or national policies to be implemented for the development of skilled labor can be increased by Turkey's keeping its economic growth and international competitiveness continuous. In addition, the investments to be made in research centers with the university-industry cooperation within the regions are very

important. Supporting entrepreneurship and commercial sectors in the context of R&D activities can provide a solid boost to regional innovation performance, because the entrepreneurial factor plays a key role in the innovation process. In other words, entrepreneurship will have a direct impact on enhancing regional innovation performance. In this case, goods and services with high added values can be produced and branding can be provided within economic sectors. Additionally, the reason for the culture, from the sub-variables, to be higher is the components. In this context, healthier results can be obtained in the calculation of innovation index if different components of culture sub-variable can be created (i.e. social capital and confidence index).

## 5. Conclusion

In the era of the information economy, countries and regions have adopted the innovation approach for the economic growth. This approach is based on the production processes that are differentiated within the capitalist economic system, the infinite needs of consumer societies, and the needs of innovation in production processes. In this context, it is important to evaluate the relations among many economic, social and humanitarian structural factors, which operate within the innovation approach.

The prerequisite for Turkey's achieving sustainable economic growth is the development of regional innovation policies. In this study, 15 sub-variables in the regional innovation system and a total of 68 components belonging to these variables were analyzed in the context of Turkish NUTS Level 1 with a certain innovation input-output table. In this framework, this input-output model, which influenced regional innovation and economic growth, was examined by using normalization method. In this case, institutions and organizations need to prepare plans according to their regional characteristics in order to produce high value added goods and services in economic sectors and to provide branding. In this direction, measurement of performance between sub-variables of human resources, research systems, investments-loans-supports, population, energy, information communication technologies, health, transportation, culture, entrepreneurship, trade-financial intermediaries, innovations, economic and scientific outputs and social prosperity in the regional innovation system carries importance for the regions. This is because of the fact that the sub-variables are important competition factors in both economic growth and the innovation system. These factors, which affect the national and regional competitive superiority, also affect

the economic growth in a positive way with the rapid development of the technology. In addition, when the population living in the regions believes that innovation is an indispensable element in terms of economic growth and turning it into a culture will positively affect the regional innovation.

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