

# Impact on Economic Growth of Technological Progress in the Turkey Economy: Empirical Analysis on Political and Financial Stability Channel

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Received: December 19, 2016

Accepted: January 20, 2017

Online Published: February 10, 2017

doi:10.5539/ibr.v10n3p80

URL: <http://dx.doi.org/10.5539/ibr.v10n3p80>

## Abstract

As an important dynamic of economic growth in the literature, technological progress is addressed in the study in the context of political and financial stability channels. In this context, the aim of the study is to determine the relationship between effects of technological progress on economic growth and political and financial stability concepts. The study for Turkish economy is based on data of 1984-2014 period and technological progress variable is considered as advanced technology export. As a result of the study, the obtained results of causality analysis showed that political and financial stability are important channels in technological progress and economic growth relation.

**Keywords:** technological progress, economic growth, political stability, financial stability

## 1. Introduction

This approach, supported by Lucas (1988), Romer (1989), Grossman and Helpman (1991), Aghion and Howit (1992), argues that investments in technological progress will increase economic growth and countries/firms that have technology will gain a significant competitive advantage in the post-1980 period. In his study, Romer (1990) considers technological progress as an internal element of growth and also explains technological progress as an important factor in this process.

Furthermore, he argues that the concept of information/technological innovation integrated in the production process will increase the effectiveness of the industry by creating positive externalities. Grossman and Helpman (1991), driven by Romer (1990) work, argue that the firms will attempt to create a continuous innovation in order to protect the monopoly power that they achieved through technological progress and by this means, the relationship between growth and technological innovation gains continuity.

International trade, at the core of the concept of globalization, is crucial for ensuring competition superiority in global markets and supporting fixed capital investments in developing countries where capital is insufficient. Posner (1961), who determined that technological progress and production of high-tech products would increase the country's exports, suggests that countries to increase their high-tech production, that means the speed of technological progress increases the potential for new product production and in this case the countries / firms that are producing the technology have comparative advantage in the market. In this process that is called technological gap, Posner (1961) suggests that costs are an important element in the innovative process and therefore the innovation realized is spreading in the learning process, the fact that the country has comparative advantage is heavily dependent on the factor it has. Time is needed for creation of scale economies and expansion of innovation.

In new patterns of growth, starting with the inclusion of the concept of innovation into the economic growth process, and developing by inclusion of innovation into patterns of growth as an output of human capital; the concept of innovation has become a concept that can also be supplied from outside the enterprise over time, going beyond a concept performed and spread inside the enterprise. This concept, called as open

innovation, was first described in the study by Chesbrough (2003). The concept of open innovation suggests that information that will reveal innovation can be supplied from inside or outside the enterprise. Chesbrough (2006) stated in his study that in the closed innovation model, company's research projects arise from its internal technology accumulation and develops, and go through production process and finally, some of them are put on market. Projects involve only the input and output phases of projects, that's why the system is called as closed. In the open innovation model, projects can arise from internal or external technology sources, and new technology can be integrated into the project at various stages. However projects can get into or come out market in many different ways.

Technological progress, which is placed on the basis of economic growth, is not only limited to the domestic market but also helps in that the country has an important advantage in international trade and supporting R&D activities by increasing total exports with advanced technology exports. On the other hand, the preservation of the technological innovations emerged as a result of R&D activities is another important point in the development of these activities. In this context, the functioning of legal regulations, such as the protection of intellectual property rights, supports technological innovations to emerge in the market. Because the number of patents in the country is an important factor on the country's technological progress and innovative image. In this case, the increase of the production of high technology in a country is related to R&D activities, therefore, to human capital accumulation. At the same time, the legal basis for the regulation of patents and trademarks of high technology products, emerged as a result of R&D activities carried out by human capital, must be sound. The investor, who benefits from the profit at the highest rate, is encouraged to make more production and develop technology with these rights protected in a sound legal basis.

The aim of this study is to determine the channels of the concept of technological progress that has an important place as a production factor for countries, which is affective in the said relation. This study is important at the point of determining the relation between the high technology exports, considered as a technological progress indicator that emerged as a result of R&D expenses, and political and financial stability of the country; evaluation of this relationship within the scope of economic growth and combining the concepts of stability and technological progress which are two important and prominent concepts in economic growth and achievement of international competitiveness. Because, as two different concepts in the country's economy, political and financial stability and technological progress are closely related to the important parameters, such as international trade, investment, capital movements, that determine the state of the countries in the world economy.

## **2. Literature Review**

In literature review that is made in the scope of the study, it is detected that number of studies that examines the relationship between political and financial stability and advanced technology exports / technological progress is very limited. The literature focuses more on relationship of financial and political stability between economic growth, on the other hand studies that are made place the concept of technological progress on the basis of economic growth. In this context, in this study it is accepted that technological progress is an important influence on economic growth and it takes the factors in which this relationship interacts into account in context of stability. Literature search, which has been made in this direction, includes technological progress / innovation / human capital and economic growth relationship and the relationship of these variables with stability and listed in table 1.

Table 1. Literature Review

Author(s)	Country	Period	Variable(s)	Result(s)
Ülkü (2004)	20 OECD member 10 OECD non-member country	1991-1997	R&D expenditure Innovation GDP per-capita	Innovation effects positive and statistical significant to GDP per capita
Almeida and Teixero (2007)	88 developed country	1996-2003	Political stability High-tech export R&D expenditure Number of patent Direct foreign capital investments	There is a positive correlation between political stability and innovation with the high-technology export.
Erdil etc. (2009)	131 developed and developing country	1995-2006	Information communication technology exports GDP	Information communication technology exports effects to GDP
Falk (2009)	22 OECD member country	1980-2004	R&D expenditure High-tech export Economic growth	There is a positive correlation between R&D expenditure high-tech export and economic growth
Wu (2010)	China	1998-2007	R&D expenditure Innovation rate Number of patent Stock of patent Economic Growth	Innovation effects to economic growth in the regions where a number of regional R & D activities
Yapraklı and Sağlam (2010)	Turkey	1980-2008	Labor force Human capital Telecommunication investment Produce price index Population GDP	Information communication technology positive effects to economic growth in the short and long term.
Yeo (2010)	USA	1988-2007	Innovation Economic performance	Innovation positive effects to economic performance.
Güloğlu and Tekin (2012)	High-income OECD countries	1991-2007	R&D expenditure Innovation Economic growth	R&D expenditure effects to innovation. Technological change effects to economic growth.
Kılavuz and A. Topçu (2012)	22 developing country	1998-2006	High - tech export and import Low - tech export and import Population Investment GDP	High-tech export, low-tech import and investment positive affects to economic growth.
Tüylüoğlu and Saraç (2012)	26 developed 18 developing country	1998-2007	R&D expenditure Human capital Intellectual property right Number of residents patent Direct foreign investment Trade openness	Protection of Intellectual property right negative effects to innovation in the developing country despite that positive effects in the developed country.
Zhang, Song and He (2012)	Pekin	1991-2010	Direct foreign investment Technology Number of patent Economic growth	There is relationship innovation and economic growth in the long term.
Amoghous and Ibourg (2013)	19 OECD member country	2001-2009	entrepreneurship Innovation Economic growth	Entrepreneurship and innovation positive effect to economic growth.
Göçer (2013)	Developing 11 Asia Country	1996-2012	R&D expenditure High-tech export Information communication Technologies export Economic growth	Increasing of R&D expenditure, High-tech export increases to information communication technologies export and economic growth
Işık (2014)	Turkey	1990-2010	Patent expenditure Economic growth	There is unidirectional causality relationship between patent expenditure and economic growth.
Erdem and Köseoğlu (2014)	Turkey	1970-2010	Number of patent competition power index	There is positivity relationship between technological change and competition power.
Dam and Yıldız (2016)	BRICS-TM countries	2000-2012	Public and private sector R&D expenditure Number of patent Economic growth	R&D positivity effects to economic growth and innovation.
Sungur, Aydın and Eren (2016)	Turkey	1990-2013	R&D expenditure Number of researchers Number of patent Export Economic growth	Innovation is support to R&D investment, export and economic growth
Malatyalı (2016)	Turkey	1989-2014	Technological developments Economic growth	economic growth is supported by technological developments.
Işık and Kılınc (2016)	Selected country group	1990-2011	R&D expenditure Electronic product export GDP	There is positive relationship between electronic product export and GDP with R&D expenditure

### 3. Econometric Analysis

The interrelationship between political stability, financial stability and high technology exports in Turkish economy are analyzed via the Vector OE Regression Model (VAR) model for the period 1984-2014. The interrelationship between these variables have been tried to be determined with Granger causality analysis, action and reaction functions, and variance separation methods. In the literature the high-tech export data used in the analysis is considered as the demonstration of technological progress which is one of the dynamics of economic growth, and its relationships with political stability and financial stability are expressed, as being the source of stable growth.

#### 3.1 Data Set

The political stability and financial stability data used in the analysis were obtained from the PRS Group International Risk Guide database, and advanced technology export data were obtained from the World Bank database. The variables used in the analysis, their sources, and symbols representing them are given in table 2.

Table 2. Variables Used in Analysis

Symbol	Variable Name	Reference
tec	High-Tech Export	World Bank
pr	Political Stability	ICRG PRS
fr	Financial Stability	ICRG PRS
gr	Economic Growth	World Bank

According to Table 1; tec represents advanced technology export, pr represents political stability, gr represents economic growth and fr represents financial stability. In addition to this, d indicates that subtraction is applied to the series.

#### 3.2 Method

In the study, the Vector Autoregressive Model (VAR) and Granger causality method were used in the determination of causality relations between variables. Moreover, the interrelationship between the variables were investigated by making use of the action and reaction functions and of the results of variance separation concerning model. The VAR model is used to determine the interrelationship between the series used at any moment in time. The VAR model, a dynamic model, considers the delayed values of all variables, and with this feature, it has a more flexible structure. Accordingly, bivariate VAR model is as follows (Mucuk and Alptekin 2008: 162).

$$yt = a_1 + \sum_{i=1}^p b_{1i} y_{t-i} + \sum_{i=1}^p b_{2i} x_{t-i} + v_{1t} \quad (1)$$

$$xt = c_1 + \sum_{i=1}^p d_{1i} y_{t-i} + \sum_{i=1}^p d_{2i} x_{t-i} + v_{2t} \quad (2)$$

In the model, p represents the length of the delays; v represents random error terms, of which means are zero, covariance with their delayed values are zero, variances are constant, with normal distribution.

In the VAR model it is possible to interpret variance separation and action and reaction functions. Variance separation and action and reaction functions allow to comment on the errors of the VAR model. A generalized action and reaction function not affected by the order of the variables included in the VAR model, is used in the action and reaction function revealing the direction and duration of the reaction given by the other variable for standard weekly shock occurring at a variable. In addition, variance separation denotes that to what extend the variances in the variables used are resulted from itself, and to what extend those are resulted from other variables (Bozdagli and Ozpinar, 2011: 52-56). Finally, Granger causality analysis equations used for the determination of causality relations between variables are as follows (Gujarati, 2001: 620-623).

$$X_t = \sum_{i=1}^n \alpha_i Y_{t-i} + \sum_{j=1}^n \beta_j X_{t-j} + u_{1t} \quad (3)$$

$$Y_t = \sum_{i=1}^m \gamma_i Y_{t-i} + \sum_{j=1}^m \delta_j X_{t-j} + u_{2t} \quad (4)$$

Here, if the predicted values of Y in the equation (3) are statistically significant and different from zero ( $\sum_{i=1}^n \alpha_i \neq 0$ ), and, if the predicted values of X in the equation (4) are statistically significant and not different from zero ( $\sum_{j=1}^m \delta_j \neq 0$ ), then, the direction of the causality is toward  $Y \rightarrow X$ . Conversely, in the equation (3), if  $\sum_{i=1}^n \alpha_i = 0$  ve  $\sum_{j=1}^m \delta_j \neq 0$ , then, the direction of the causality is toward  $X \rightarrow Y$ . In both equations, if the coefficients of Y and X are statistically significant and different from zero, there is a mutual causality

relationship between the variables. In both equations, if the coefficient sets of Y and X variables are statistically insignificant, there is no causality relation between variables.

If we use equation (1) to identify ADF unit root test which is used to investigate the stability of time series, provision of  $\gamma = 0$  equality in  $\gamma$  parameter in the equation shows that t Y contains unit root.

$$\Delta Y_t = \alpha + \gamma Y_{t-1} + u_t \tag{5}$$

Including additional differences of terms in the test equation leads to a decrease in degree of freedom in ADF test and loss of power in the test procedure.

$$H_0: \gamma = 0, : \text{Serial is contains unit root.}$$

$$H_1: \gamma < 0, : \text{Serial is not contains unit root.}$$

PP approach, which is an alternative test, considers the existence of unknown forms of autocorrelation and the conditional variable variance situation in the error term and uses non-parametric correction to solve the autocorrelation problem. For both tests, the fact that t statistic is larger than critical values leads to the rejection of null hypothesis which implies that the corresponding series contains unit root. Dickey-Fuller Test (DF) and Augmented Dickey-Fuller Test assume that error terms are statistically independent and have a constant variance. In their study, Phillips and Perron (1988) stated that it is necessary to make sure that there is no correlation between error terms and that they have a constant variance while DF and ADF procedure is being performed and expanded this assumption about error terms (Balan 2016:528).

### 3.3 Pre - Test Results

Unit root tests with Augmented Dickey Fuller and Phillips Perron unit root test models were conducted through three options which are stationary, trend stationary and trendless non-stationary. In both model all variables, except economic growth, include unit root at values for the level. In this case, there was subtraction applied to free the series from the unit root, and determined that in the first differences of all series no unit root included.

Table 3. Unit Roots Test Results

	ADF Unit Root Test			PP Unit Root Test		
	Intercept	Trend-Intercept	None	Intercept	Trend-Intercept	None
<b>pr</b>	-2.43	-2.04	-0.54	-1.83	-2.02	-054
<b>dpr</b>	-4.17*	-3.86**	-4.25*	-4.86*	-5.00*	-5.27*
<b>fr</b>	-1.88	-3.77**	-0.26	-1.92	-2.98	0.26
<b>dfr</b>	-4.04*	-3.97**	-5.44*	-5.38*	-5.30*	-5.44*
<b>tec</b>	-2.86	-2.85	-0.73	-2.31	-2.30	-0.65
<b>dtec</b>	-4.19*	-4.12*	-4.22*	-4.13*	-4.12**	-4.25*
<b>gr</b>	-6.10*	-6.01*	-3.54*	-7.83*	-7.68*	-3.58*
<b>dgr</b>	-9.28*	-9.11*	-9.45*	-24.76*	-24.10*	-25.12*

\*,0.01, \*\*,0.05 shows significance level.

Another precondition of VAR model is the definition of the lag length. Test results applied for this indicate that pursuant to Akaike Information Criterion the pertinent lag length in the model is 2.

Determination of whether or not forecasted VAR model dynamically stable is executed via autoregressive reverse root. In figure 1, all of the autoregressive reverse roots lying inside the unit circle indicates that the model is dynamically stable.

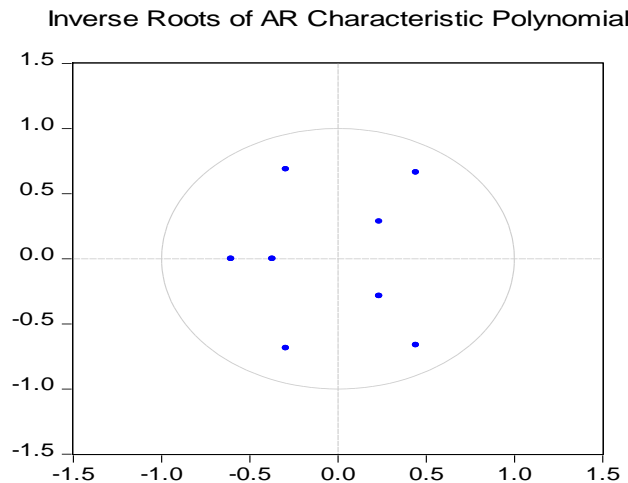


Figure 1. Dynamic Stability Graph

Two significant hypothesis of VAR model is the absence of the autocorrelation and heteroscedasticity issues in the error terms. Lastly, autocorrelation and heteroscedasticity test results of the model are shown in Table 4.

Table 4. Autocorrelation and Varying Variance Test Results

Autocorrelation Test (LM Test)		
Lag	LM Stat.	Prob. Value
1	16.05935	0.4488
2	8.975984	0.9144
3	16.96004	0.3882
Varying Variance Test (Joint Test)		
Che-Square	df	Prob. Value
163.0039	160	0.4191

LM test statistics where the existence of autocorrelation is examined and p value is bigger than 0.05 in Table 3 indicate that there is no autocorrelation issue. In addition to this, it is evident from the results of the joint test conducted to examine the heteroscedasticity issue in the model with chi-square probability value is bigger than 0.05 that there is no heteroscedasticity problem in the model.

### 3.3 Granger Causality Analysis Results

To determine causality relations between the variables of political stability, financial stability, export of advanced technology and economic growth that are used in the study Granger causality analysis method was used. Statistical data obtained as result of Granger causality analysis where the lag length (2) that determined in the framework of VAR model was used are shown in Table 5.

Table 5. Granger Causality Test Results

	dpr		dfr			dtec			gr			
	dfr	dtec	dgr	dpr	dtec	dgr	dpr	dfr	Dgr	dpr	dtec	dfr
<b>cq</b>	4.60	6.05	1.39	5.38	11.23	13.3	5.53	0.93	2.78	5.43	3.19	8.48
<b>s.d.</b>	2	2	2	2	2	2	2	2	2	2	2	2
<b>o.d</b>	0.09	0.04	0.49	0.06	0.00	0.00	0.06	0.62	0.24	0.06	0.20	0.01

According to Granger causality analysis results, in the model of political stability as an independent variable, a causality relationship from financial stability and export of advanced technology to political stability was detected. In the model where the export of advanced technology is an independent variable, a causality relation from political stability to advanced technology stability was determined. In the model of economic growth as an independent variable, there is a causality relation of political stability and financial stability to economic growth. All these relations are shown more clearly in Figure 2.

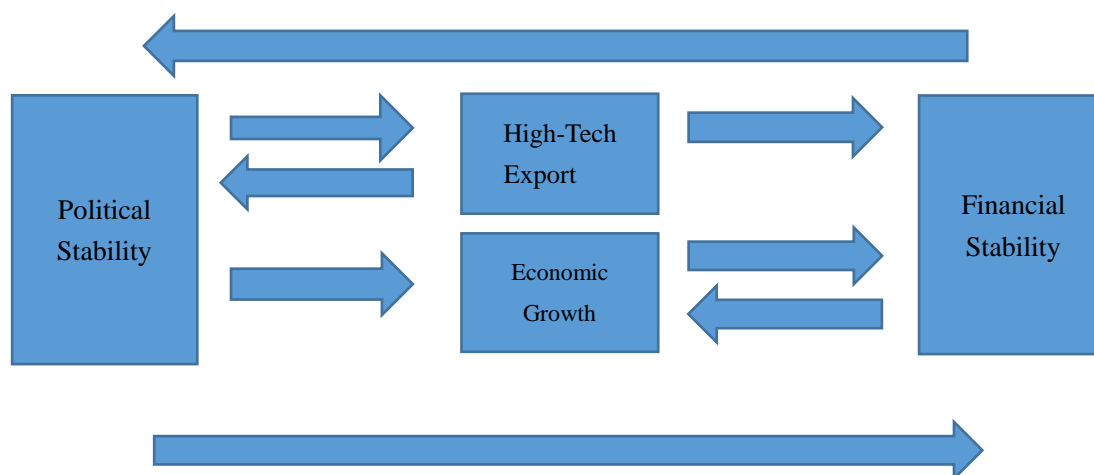


Figure 2. Relationship Granger Causality

The main purpose of the study is by determining the relation of political and financial stability with technological advancement based on the fact that technological advancement is a component that supports economic growth, to contribute to the development of this important factor of the economy. The results of causality analysis that conducted for the purpose indicate that the political stability in the country supports technology exports, and the export of advanced technology supports financial stability. With bi-directional causality relation between financial stability and economic growth added to these results, it is clearly seen that technological advancement supports economic growth through the financial stability. Additionally, investment in advanced technology of the country is an important variable to ensure political and financial stability. These circular results between stability-technological advancement and economic growth reveal the importance of the interaction of political and financial stability with technological advancement in ensuring economic growth as a final goal of country's economic policies. The political stability provided in the country, protection of property rights, governance stability, corruption, domestic and foreign unrest ensure that technological advancement and human capital remain in the country. Technological advancement that lies in the basis of economic growth brings financial stability providing a competitive advantage and investment increase and stable financial and political order ensures economic growth. Especially the causality relation from technological advancement to financial stability reveals influential channel of human capital on economic growth. On the other hand, mutual causality between technological advancement and political stability indicates that stability on the legal grounds is an important element that had the effect on the notion of human capital, at the same time, technological advancement is an important element that has the effect in creating the legal ground. Additionally, the relation of political stability with economic growth indicates that technological advancement is another channel between economic growth and political stability.

The impulse response of other variables to one standard error shock in the export of advanced technology and impulse responses of technology export to one standard error shock in other variables are shown in Figure 3 function graphics on action and reaction.

Here, the sequence of variables that are in causality relation obtained with VAR model is important. The action and reaction method which eliminates the sequencing problem was utilized and confidence intervals are used as  $+2$ . According to action and reaction function graphics, first, to one standard error shock in technology export the political stability and financial stability reacts negatively up to four terms and as of this period this action turns to positive. Economic growth at the beginning reacts negatively, and the reaction turns into positive and continues with fluctuations.

Secondly, to one standard error shock in political stability, the advanced technology export reacts positively up to four terms, and later on, this reaction turns into negative. The reaction of technology export to one unit shock is negative in general sense. Lastly, it reacts positively to a shock occurred in economic growth.

With the determination of causality relations, another analysis that was made within the context of variables of political and financial stability that determined as a channel influencing the technological advancement and economic growth is variance separation. Obtained variance separation results are shown in Table 5.

Response to Generalized One S.D. Innovations  $\pm 2$  S.E. Response to Generalized One S.D. Innovations  $\pm 2$  S.E.

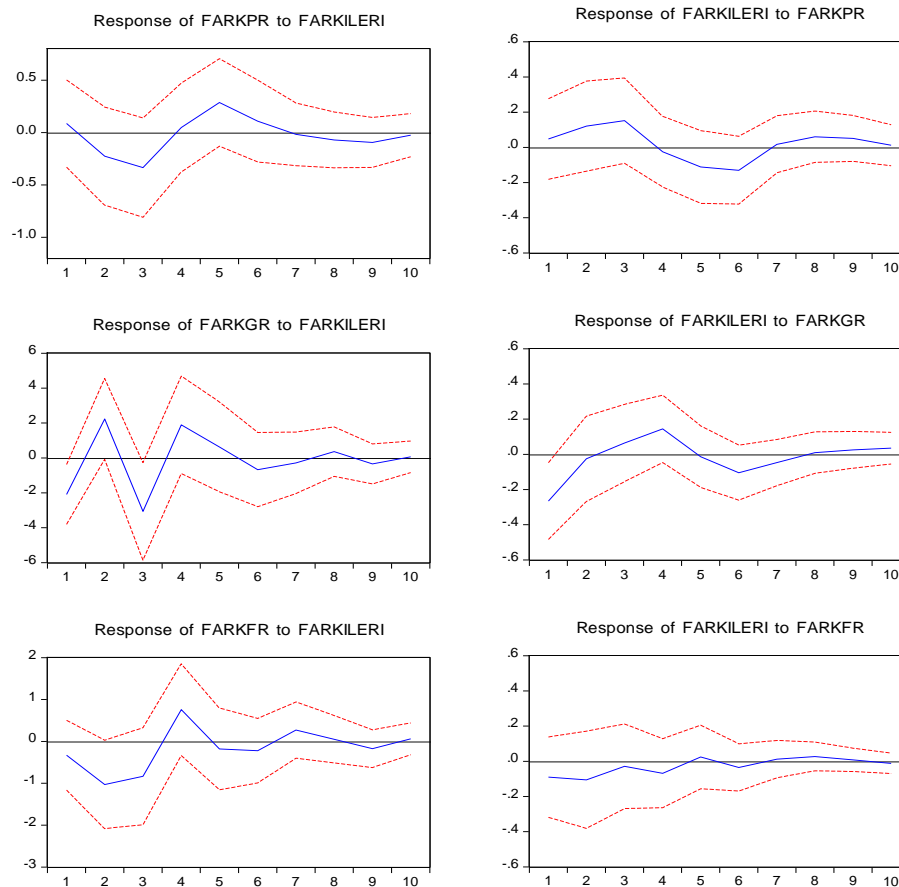


Figure 3. Impulse-Response Functions

Table 5. Variance Decomposition Results

Period	S.E.	dpr	dtec	Dtec dfr	gr
10	0.761781	13.17811	76.10155	6.532370	4.187970
Period	S.E.	dpr	dtec	Dpr dfr	dgr
10	1.424666	73.76699	14.11063	6.500953	5.621428
Period	S.E.	dpr	dtec	Dfr dfr	dgr
10	3.361505	9.115310	24.72620	47.55592	18.60258
Period	S.E.	dpr	dtec	Dgr dfr	dgr
10	8.325954	13.98702	34.80171	25.18792	26.02335

With the variance separation, according to the model where the export of advanced technology is an independent variable, at the end of 10 periods the changes in technological advancement were caused by political stability by 13.17%, by financial stability by 6.53%, by economic growth by 4.18%. On the other hand, 34.80% of economic growth was explained with technological advancement, 25.18% with financial stability, 13.98% political stability. This makes the acceptance of hypothesis stating that technological advancement is an important dynamic of economic growth, which was the starting point of the study accurate. On the other hand, at the point of answering the question of whether or not political and financial stability has effect on the explanatory power, which the study was built upon, it was found accurate that technological advancement has the highest explanatory power on financial stability with the rate of 24.72% and on political stability 24.72%. These results indicate that technological advancement is a significant factor in economic growth and the financial and political stability that provided in the process are effective channels.



#### 4. Conclusion

The concept of technological progress, one of the main determinants of economic growth, is closely related to economic growth as well as many economic indicators in today's economies. In the frame of its importance, in this study, at the point of technological progress to increase economic growth, the parameters with which it has interacted has been examined in terms of stability and the ways of ensuring a more sound technological progress and a stable economic growth by determining stability elements that support technological progress and also the growth have been questioned.

According to the results of the causality analysis conducted within the scope of the study, it is understood that the technological progress which is detected to be in a reciprocal interaction with political stability contributes to economic growth through this factor (also, according to the causality relation with economic growth). At the same time, the results of variance research support the results achieved by the causality analysis with the fact that the changes in the exports of high technology are explained by the political stability to the greatest extent and correspondingly, the changes in the political stability are explained by high technology exports to the greatest extent. In addition, the fact that the changes in economic growth are explained by high-technology exports to the greatest extent and the political stability has a high share of 13.98% suggests that the channel of political stability is effective in the relationship between technological progress and economic growth.

Another result of causality analysis is the relationship detected between high technology exports and financial stability. At the same time, the relation of causality from financial stability to economic growth supports the acceptance of financial stability as a channel between technological progress and economic growth. In addition, the results of the variance research show that the changes in financial stability are explained by high-technology exports at the highest rate after itself, and the changes in economic growth are explained by financial stability at the highest rate after itself. In this case, the finding that financial stability is a channel between economic growth and technological progress gains accuracy.

In the context of the conclusions, strengthening the legal basis to achieve / increase technological progress as an important factor on economic growth of the country is closely related to the achievement of political stability. Moreover, the technological progress is important in ensuring political stability. Thus, ensuring technological progress and its effective use in economic growth are closely related to the political stability of the country. In this context, improvement of the government stability, evaluated within the scope of data content of the political stability used in the analysis, socioeconomic conditions, investment opportunities, internal threats, external threats, corruption, military policies, regional policies, rule of law and ethnic tension factors will strengthen the relationship between technological progress and economic growth in the country, thus this will affect these parameters positively. On the other hand, the financial stability, provided by technological progress, will ensure the support for the economic growth. Achieving stability in total external debt as a percentage of GNP, evaluated within the scope of the financial stability data, total external debt service as a percentage of total exports, current accounts as a percentage of total exports, accurate international liquidity on a monthly basis of at the time of imports, exchange rate stability factors as percentage change will be beneficial in economic growth process.

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