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The Relationship between R-D Expenditures and Economic Growth: A Case of the Central Asian Republics and Turkey[1]

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Abstract

Research and Development (R-D), which means of new technology, new information, new production technics and new product is one of the most important resources of human capital. In endogenously growth theories, the relationship between R-D expenditure and economic growth that was developed by Romer, Grossman-Helpman and Aghion-Howitt, has directed a lot of studies nowadays. Enterprises have to seeking innovation to obtain. This seeking innovation, will raise efficiency and contribute the economic growth. Multiple countries which provide competitive power in science and technology and product technology and information based products, are inside the developed countries today. In this study, the relationship between R-D expenditures and economic growth was tested with panel data analysis for the four Central Asian Republic (Kazakhstan, Kyrgyzstan, Tajikistan and Azerbaijan) and for Turkey. General theory shows that there is a positive relationship between R-D and economic growth. This relationship will analyzed for the this five country. In this context, to test the data's stability, we made Levin-Lin and Chu (LLC) Panel Unit Root Test. After that, we made Pedroni Cointegration and Panel Granger Causality tests. In the conclusion of the analysis it has been reached that there is a one-sided causal relation from economic growth to R-D expenditures. On the other hand there is no causal relation from R-D expenditures to economic growth.

Keywords: R-D Expenditures, economic growth, panel data.

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Introduction

Many studies have been carried out about the resources of economic development. Technologic innovation is the essential factor for providing sustainable development. Technologic innovation will increase productivity and increase effective usage. Research and development is the source of technological innovation and productivity. Research and development which means new Technology, new information, new production techniques and new products is inevitable for sustainable development. Main purpose of this study is to reveal relation between Research and development expenditures and economic development of four central Asia Republics and Turkey (Kazakhstan, Kyrgyzstan, Tajikistan and Azerbaijan). Within this scope firstly theoretical information was given about the subject and Research and development expenditures and size of of Turkey and other four central Asia countries were determined than other studies were allowed for. Research and Development Expenditures of 5 countries between 1996 and 2014 period and economic development relation was analyzed by Pedroni cointegration test and panel Granger causality test. Examined countries were different of previously examined countries and studies; it is thought this study will contribute to literature positively.

Conceptual Framework and Literature Search

New technologies have an important place in growth theories which were suggested before starting from classic economists up to our day. As the famous saying of Schumpeter a growth theory which hasn't got innovations (new technology) is such a hamlet where Danish Prince is missing (Gülmez and Yardımcıoğlu, 2012,336). Opinions of Schumpeter mention that entrepreneur and technological development is same things. So innovations are the internal variables of growth. Even innovations and technological development could be accepted as the engine of growth. But we can't say that established a growth theory.

According to Neoclassical growth model led by Solow, long term growth depends on technological development which is completely exogenous factor. But do to technology is not explained inside the model, Neoclassical model was unsuccessful about explaining wage gaps in countries (Deliktaş,2001:7; Tuncel,2009:3). Even Solow mentioned that growth originates technological change rather than labor and capital in his study about USA economy, did not included technological change as an internal factor to the model. Neoclassical growth model stipulates temporary growth due to the lack of technological development and can't explain long term growth. Although the reasons which provides growth is known as technological development but not explained to model, caused internal development theories as a reaction to Neoclassical model.

Technology was handled as internal variable in internal growth theories which were carried out by Romer and Lucas. Internal growth theory, stipulates economic potentials which freely operate in non-central market structure determined as internally instead of external technological development which is not under control of market mechanism (Romer, 1994:3). Research and Development models approach which is the driving power of internal growth was firstly suggested by Romer and it was developed by Lucas and Riviera-Batiz and Aghion-Howitt. Research and Development models are models which explain development period of countries and handle technology as a separate production activity.

Rivera-Batiz and Romer interiorized information and technology and examined relation between internal growth theory and economic integration in study made in 1991. In this

model it was emphasized that economic development between two developed countries will permanently increase the development ratio of world. In the study research and development activities which are determined as source of growth were handled in two phases such as Knowledge driven model and lab equipment model. While there is no effect of trade gap in knowledge driven model on economic growth; in lad equipment model in case of complete economic integration model there is a permanent effect of material trade on economic growth and it increases (Rivera-Batiz and Romer, 1990:1-30).

Grossman and Helpman explained relation between investment ratio and growth to technology production in research and development sector and mentioned spread in technology would affect growth positively (Ateş, 1998:7). Grossman and Helpman defined three main production activities such as traditional product, industry product and research and development studies within the frame of multi countries dynamic general balanced model. in this sense, international capital flows are included in research and development sector and constitute the driving power of growth (Grossman and Helpman, 1988:1). Expanding to foreign trade provides to encourage local research and development activities. That causes constitution of positive exteriority (Grossman and Helpman, 2003:196). Exteriorities increase the growth and country wealth.

Aghion and Howitt accepted each innovation invalidates old technology and evaluated this situation as creative destruction. Value of innovation is determined by profitability of monopoly companies which use innovations as input in this sector not by companies which carry out research and development activities. According to the model which they established, while technology increase was seen toward to the countries where innovations are performed, countries which don't perform innovations are remained under technology borders (Aghion and Howitt, 1992:323-351). Essential element of Aghion and Howitt model are the technological innovations which develops the qualification of products. For that reason research and development activities maximizes social welfare. Shortly internal growth models handled technology with internal factors and strongly interrelated research and development activities and economic growth. For that reason flashed several future studies.

Several studies have been carried out between research and development expenditures and economic development. Most of these studies is involves OECD countries and developed countries and positive direction relation is shown in most of these studies between research and development expenditures and economic growth. Goel and Ram (1994) tested relation between research and development expenditures and economic growth in their studies between 1960 and 1985 periods for 52 countries (18 developing, 34 less developed country). In consequence of study, it was determined research and development expenditures increased economic development in high income countries only. But causal relationship was not determined between research and development expenditures and economic growth.

Coe and Helpman (1995) tested relation between research and development expenditures and economic growth between 1971 and 1990 period for 22 countries in their study. In consequence of study international research and development expenditures of countries which are especially outward oriented effected their economic growth.

Freire-Serén (2001) examined relationship between economic growth and research and development expenditures between 1965 and 1990 period for 21 OECD countries. According to findings, it was determined that 1 % increase in research and development expenditures increases reel gdp (gross domestic product) 0.08 %.

Sylwester (2001) tested relation between research and development expenditures and economic growth between 1981 and 1996 period for 20 OECD countries in his study. In consequence of study while research and development expenditures were seen to increase economic growth in G7 countries, no relationship was determined between research and development expenditures and economic growth in 20 OECD countries.

Falk (2007) examined effect of research and development expenditures on long term growth with dynamic panel data analysis in 1970-2004 periods in OECD countries. In consequence of study, as long as research and development investments shares in gdp (gross domestic product) of advanced technology sectors increases; gross national product per capita will increase too.

Wu and Zhou (2007) tested relation between research and development expenditures and economic growth between 1953 and 2004 period for China countries in their study with co-integration and causality analysis. In consequence of study long term co-integration relationship and dual causal relation between research and development and gdp (gross domestic product) was determined.

Samimi and Alerasoul (2009) analyzed relation between research and development expenditures and economic growth between 2000 and 2006 period for 30 developing countries with panel regression method in their study. According to their findings, there was no significant relationship between two variables.

Yaylalı et.al (2010) tested relationship between research and development expenditures and economic growth for 1990-2009 periods in Turkey in their studies with co-integration and causality analysis. in consequence of study one-way causal relationship was determined from research and development expenditures towards to economic growth.

Gülmez and Yardımcıoğlu (2012) examined long term relation between research and development expenditures and economic growth between 1990 and 2010 period for 21 OECD countries with panel data analyze. According to findings, 1% increase in research and development expenditures causes 0.77 % increase on economic growth in long term approximately. Also it was determined that there is a significant mutual relationship between research and development expenditures in long term and economic growth.

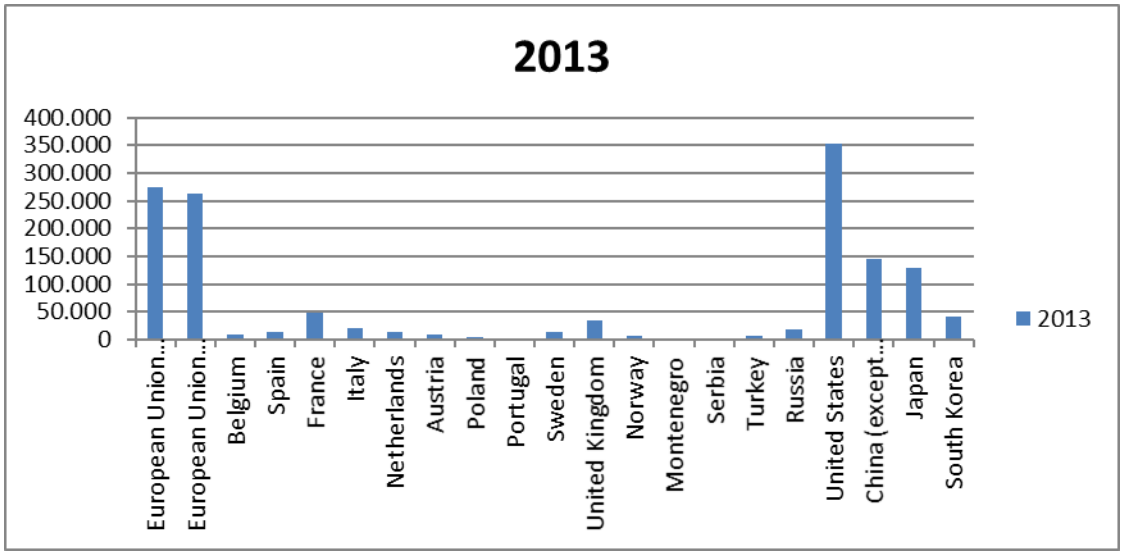
Wang et. al (2013) examined effects of research and development expenditures to economic growth in advanced technological sectors for 23 OECD countries and Taiwan between 1991 – 2006 period. In consequence of study, it was determined that high industrial Research and development expenditures have strong and positive effect on reel income per capita.

Altıntaş and Mercan (2015) examined effects of research and development expenditures on economic growth for 21 OECD countries between 1996-2011 periods in their study with production function. In consequence of analyzes it was determined that increase on research and development expenditures effected strongly economic growth this effect is higher than constant capital formation and labor increase ratio and 1 unit increase in research and development expenditures increases economic development 3,4 units.

Course of Research and Development Expenditures in Turkey and Central Asia Republics

Research and development expenditures in Turkey are too low comparing to OECD countries. In spite of this it is too higher comparing to central Asia republics. Course of Research and development expenditures for 2013 was given in figure 1.

Figure 1. Viewing the world of R & D Expenditure (Billion €)



Source: http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

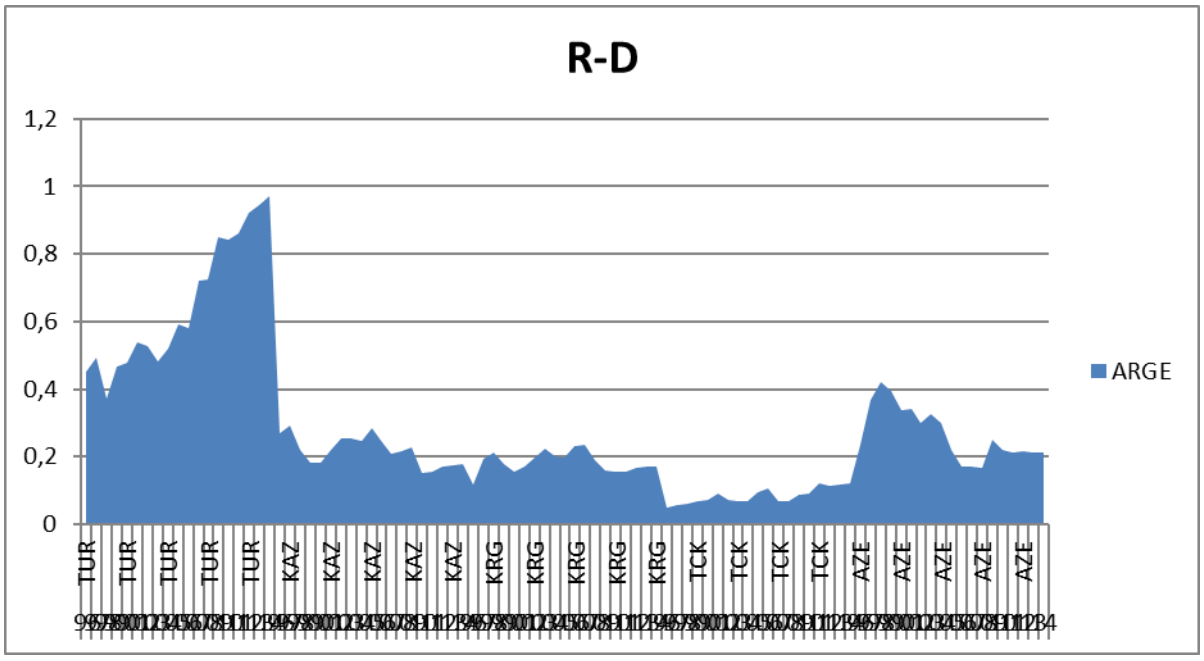
According to figure 1 USA ranks first for Research and development expenditures with 353 billion euros. Research and development expenditures of EU15 are 263 billion Euros. Research and development expenditures of EU28 is 274 billion euros. Namely Research and development expenditures of last 13 countries which participated to EU are 1 Billion euros. In spite of that, Research and development expenditures of china are 145 billion euros and Research and development expenditures of Japan are 128 billion euros. Turkey is included first 20 of the list with 5.8 billion euros. When the list is considered it is seen, the most Research and development expenditures are made in developed countries.

Batelle made evaluations about Research and development expenditures for current situation and future situation in study named "Global R-D Funding Forecast": USA, China, Japan and European countries have 78 % share total with 1,6 Trillion dollars Research and development expenditures in 2014. Research and development expenditures in western countries continues in a wide field such as robots, high performance computer, social media, software, energy sources which provide expenditure effectiveness and nanotechnology. While increase in Research and development expenditures on southeastern Asia countries provide rapid growing, low Research and development expenditures in Israel, Qatar and other Middle East countries limits rapid growing. Even Africa, South America and Middle East countries have rapid growing it seems difficult to realize a lasting rapid growing without concentrating on Research and development expenditures (Altıntaş ve Mercan, 2015:350).

While share of Research and development expenditures in gross domestic product was 4-5 % for developed countries. This ratio in Turkey did not reached 1 % even it increased. Share of

Research and development expenditures to gross domestic prodcut of central Asian countries which are the subject of this research was even lower than 0,4% . Research and development expenditures of central Asian countries in Gross domestic product which are the subject of this research were shown in Figure 2.

Figure 2. Share of R & D expenditure in GDP (%)



Source: databank.worldbank

As shown in figure 2 Research and development expenditures share to gross domestic product for countries which are subject of this research, Turkey ranks first with 0,97 % share and Azerbaijan ranks second with 0.21 %. Condition of providing stable growth in these countries is to increase research and development expenditures.

Data, Econometric Methods and Results

Data and Econometric Methods

Data between 1996-2014 years for Turkey and 4 Central Asian countries were tested by panel data analysis. Research and development indicator which was used in study shows research and development share in Gross domestic product and included as research and development in analysis. Growth data which was used in the study gives the annual increases within the scope of gross domestic product and named as GDP in analysis. data belonging to study were obtained from "databank.worldbank" address of database of World Bank.

Predicted model in this study was shown with (1) numbered equity.

$$GDP_{it} = \alpha + \boldsymbol{\beta}1\ RD_{it} + \varepsilon_{it} \qquad (1)$$

In the model, independent variable is growth and shown as "GDP" in the model. independent variable of model is research and development expenditures and they are shown as "RD"(research and development) in the model.

Econometric Methods and Empirical Findings

Usage of panel data unit root tests was developed in order to increase the power of unit root tests depending on single time serial (Maddala ve Wu, 1999:631). In studies where time serial data are used, it should be tested whether used data have stable structure or not. Because in case of usage of non- stable time serials, spurious regression problem occurs and in this case results obtained by regression analysis don't reflect real relationship (Granger and Newbold, 1974:111). Before determining relations between research and development and economic growth of Turkey and other Central Asia republics with co –integration and causality analysis, Levin-Lin and Chu (LLC) Panel unit root test was performed in order to determine whether variables include unit root or not and to determine the stability of variables. Unit root tests are applied to determine stability in serials. If serial includes unit root it is not stable. For that reason, the thing to be done is transform serials as stable position. Panel unit root tests are included for stability determination between Panel serials. In panel unit root tests, equality to Zero of β coefficient is tested for stability analyze. LLC Panel unit root test results were given in Table 1.

Table 1. LLC Panel unit root test results

LLC			
		t-statistics	**p-value**
GDP	**level**	-1.38858	0.0825
	1.difference	-5.52258	0.0000
R-D	**level**	-0.13159	0.4477
	1.difference	-4.37350	0.0000

According to findings in Table 1 it is not stable on Economic growth in 5 % significance level and research and development serials. In order to perform Pedroni Co-integration test which gives long term relationship between serials; serials have been transformed in to stable position.

Existence of long term relationship between serials is measured by pedroni co-integration test. Pedroni co-integration test results were given in Table 2.

Table 2. Pedroni co-integration test results

		test statistics	**p-value**
GDP & R-D	Panel v-statistics	0.006631	0.4974
	Panel rho- statistics	-5.271332	0.0000
	Panel PP- statistics	-8.505231	0.0000
	Panel ADF statistics	-6.425851	0.0000
	Group rho statistics	-2.789714	0.0026
	Group PP-statistics	-9.644203	0.0000
	Group ADF-statistics	-7.176735	0.0000

Co –integration relation between growth and research and development was tested in Table 2. According to Pedroni co-integration Test results it is seen that 6 of 7 tests (5 of them 1 %) between growth and research and development are in significance level. Accordingly it was determined there are long term relation between serials and they are co-integrated.

After co-integration test, Granger causality test is implemented in order to test whether there is a relationship between variables and direction of that relation if available. Granger causality test is used to test whether there is a relation between variables and to determine the direction if available. Simple causality model established by Granger is like this:

$$Y_t = \sum_{j=1}^{m} c_i X_{t-j} + \sum_{j=1}^{m} d_j Y_{t-j} + \eta_t \qquad \textbf{(2)}$$

If X variable is reason of Y variable according to model, variations in X comes first than variations in Y. Variables were first stabilized previously due to causality inference is carried out more than prediction in Granger Test (Granger, 1969:431).

Developed condition of Granger causality is Holz-Eakin, Newey and Rosen model. Panel which was developed by Holtz-Eakin et.al (1988) depends on ordinary least squares. Holtz-Eakin et.al suggested usage of instrument variable set which includes differences or levels of variables adopted for causality test by taking the difference of variables in order to purify from fixed effects (Öztürk et.al, 2011:63).

Holtz-Eakin et.al model is defined as below.

$$y_{it} = \alpha_{0t} + \sum_{l=1}^{m} \alpha_{lt} y_{it-l} + \sum_{l=1}^{m} \delta_{lt} x_{it-l} + \psi_t f_i + u_{it} \qquad \textbf{(3)}$$

f_i shows fixed effects, u_{it} shows error term in equity. Error term uit in this definition is correlated with yit in equity. (Holtz-Eakin et.al, 1988:1376).

Table 3. Granger Causality Test Results

	Lags	Obs	F-statistics	Probably
R-D → Growth	5	65	0.36479	0.8704
Growth → R-D	5	65	2.07063	0.0833

According to results of Granger Causality Test in Table 4 while there is a causal relation from economic growth towards Research and development, causal relationship was not determined from research and development to economic growth. Accordingly single side causality was founded between research and development and economic growth.

It was seen relation between research and development and economic growth which exists in long term is not valid for short period. Possible reason of that research and development expenditures of handled countries have small share in gross domestic product. As long as economic growth of these countries are provided their share for research and development increases even in small ratios too. Accordingly increases in gross domestic product will provide to transfer more sources to research and development and this will increase economic growth.

Result and Recommendations

In this study; relation between Research and development expenditures and economic development of four central Asia Republics and Turkey (Kazakhstan, Kyrgyzstan, Tajikistan and Azerbaijan) for 1996 – 2014 periods were mutually researched. It was seen serials in panel unit root test are stable in 1st difference. After unit root problem was removed in serials and transforming serials stable condition, co-integration test which was the second phase and give long term relations between serials was performed. In this context, long term relationship was seen between research and development and economic growth. Granger causality test which was performed finally one-way causality was determined from research and development expenditures towards economic growth. Accordingly; while research and development is a reason for economic growth, economic growth is not a reason for research and development.

Consequently, positive relation was seen between research and development expenditures and economic growth. But due to countries which were handled have small research and development shares in respect to gross domestic product this relation is not strong. As long as the economic growth of these countries are provided their research and development share increases too. Accordingly, increases in gross domestic product will provide to transfer more sources to research and development. In this context research and development studies and expenditures should be increased in order to provide sustainable economic growth.

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