THE IMPACT OF R&D INTENSITY ON HIGH-TECH EXPORTS: CASE OF TURKEY AND EU-27 COUNTRIES

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Abstract

In the literature, there is no study showing the effect of Research & Development (R&D) intensity on high-tech export statistically for EU 27 countries[4] and Turkey. Thus we have chosen the subject matter to fulfill this inadequacy in the literature. In this context, the main objective of the study is to test the "R&D led High-Tech Export" hypothesis for the case of EU 27 countries and Turkey. To achieve this objective, the statistics that were published by Eurostat about R&D intensity and the ratio of high-tech export to the total export were used. In this end, after reviewing the R&D intensity and high-tech export concepts, the fixed effect model is formed with least squares regression method using a panel data for the period 1999-2007 and EU 27 countries and Turkey. As a result of this panel data analysis, it is found that R&D intensity has a meaningful effect on high-tech export of EU 27 countries and Turkey.

Keywords: R&D intensity, high technology export, EU27 countries, panel data.

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[4] European Union (EU27) includes the following countries; Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Spain, Slovakia, Slovenia, Sweden and the United Kingdom.

1. Introduction

R&D is known as the key of getting over a crisis and also defined as the transformation of money to knowledge (Yetiş, 2009: 28-34). Thus, R&D and crisis relationship has a paradoxical structure. Since it is not possible to make R&D activities without having financial resources, it will not be possible to produce high-tech. But in the crisis periods due to the difficulties to find a financial resource, the R&D and respectively technology development activities generally decrease. By interrupting R&D activities on the other hand, the organizations lose their chance to use R&D and high-tech export as a tool to get over the crisis. To provide a statistical point of view to this complicated structure, in this study, we have examined whether there is a relationship between the "R&D intensity" and "high-tech export" using the data published by Eurostat, whose mission is to provide high quality statistical data to the European Union. The data includes the period before the crisis between the years 1999-2007.

1.1. R&D Concept

Research and Development (R&D), "comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications" (Frascati, 2002: 30).

The importance of R&D has been increasing for the companies, who realized the positive effects of the innovative solutions which are the results of this creative work in the scope of these R&D activities on competitiveness. The main reasons for the importance of R&D for the companies are as follows (Mucuk, 2005: 368-371):

- Reasons related to the market; the necessity of developing new products to have competitive advantage,
- Organizational reasons; to become the leader in the market and being known as an innovative company,
- Social reasons; to satisfy the customer needs with different products and prove its social utility,
- Reasons related to the personnel; to attract, keep and motivate capable, creative, ambitious personnel in the company.

Due to this importance of R&D, EU countries defined their 2010 R&D objective as to increase the ratio of their R&D expenditures to the Gross Domestic Product (GDP) to at least

3 % (Eurostat, 2008:9).

Since R&D is the process of transformation of money to knowledge, high financial source is needed. Thus, R&D expenditure is one of the main variables that is used to define the capability of producing technology of a country or a company (Avcı, 2007: 120). R&D expenditures includes; R&D personnel's labor, social security and retirement costs, materials, consumables, equipments, software needed for R&D, taxes, rents paid for research facilities, …etc. (Gök, http://www.tubitak.gov.tr/tubitak_content_files/BTYPD/kilavuzlar/Frascati_Presentation.pdf, 2010).

In this context, R&D expenditure is the indicator of efforts of public and private sectors to gain competitive advantage (OECD Factbook 2009:164); because in today's world to find a place in the current and new markets, to be successful in these markets and to sustain this success is closely related to what extend the technology is used effectively (Demirci et.al., 2006) and technology can be produced by R&D activities. In macro level, as an indicator of R&D, the ratio of R&D expenditures of a country to the GDP of that country, which is defined as R&D intensity, is used (Wang, 2010: 103-116). In this study, the R&D intensity statistics, which were published by Eurostat will be used to measure the R&D performances of the countries.

1.2. High-Tech Export

The knowledge produced by human changes the living environment and controls that environment. This produced knowledge is technology, which gives rise to the products for production and consumption purposes (Gürak, 2006: 9). Today, new economic system, gain its power especially from high-tech sectors and these sectors have been developing gradually. Knowledge society and the revolution of informatics; play an important role on increasing the efficiency, decreasing the inflation, and unemployment ratio and so increasing the social welfare (The Economist, 1999: 15).

This new economical system is named as "knowledge-based economy", "digital economy", "high-tech economy", "network economy", or "information technology economy" (Tapscott, 1998: 40). In this new system, especially in the last quarter of this century, the intensity of the competition is more than ever. Thus, some researchers in the traditional economics literature, added the concept "hyper competition" besides the concepts; "excessive competition", "destructive competition", and "cutthroat competition" to explain the intensity and harshness of the competition (Brahm, 1995: 73). Thus, including J. Schumpeter, many economists insisted on the role of technological innovation on increasing production, development of economy and accordingly the level of competitiveness (Kök et.al., 2007). As a result of such researches about the importance of technology, it is found that R&D activities towards high-tech sector have a positive effect on GDP (Falk, 2007: 140-147).

In point of countries view, high-tech industry and its export has a large coverage area starting from macro level analysis of global trends, the related industry-sector dynamics emerging from the country's science-industry-commerce-policy; to micro level like the organizational structure of enterprises and working individuals. The developed and developing countries that realize this process, produce this technology which is the outcome of the R&D activities not only for the internal market, but also for the export purposes. Since by the help of export activities countries/companies have a larger market than the internal market, the unit costs of R&D investments decrease and this become a motive for such activities (Özer and Çiftçi, 2009: 39-49).

In the literature, the ratio of high-tech export to the total export is commonly used as an indicator of high-tech export performances of countries. In this study, the ratios that were published by Eurostat are used.

2. Model and Methodology

Here the objective is to determine the long-run relationship between R&D expenditures and Higher Technology Exports for the case of European Union. In a panel data context other variables affecting the Higher Technology Exports can easily be absorbed into the cross-section and periodic effects. Specifically, we are testing the R&D led Higher Technology Exports hypothesis in terms of EU countries. The 27 EU-member countries plus Turkey involved in this study are all open economies. The basic type of model can be defined in terms of panel or pooled data econometrics is as follows:

$$Y_{it} = \alpha + \mathbf{X}'_{\mathbf{it}}\boldsymbol{\beta} + \gamma_i + \delta_t + \varepsilon_{it} \quad (1)$$

where Y_{it} is the dependent variable, and $\mathbf{X}_{it}$ is a vector of k-regressors, and are ε_{it} the unobserved error terms for the cross-sectional units $i = 1, 2, \ldots, N$ over the given time periods

$t = 1, 2, \ldots, T$. The α and $\boldsymbol{\beta}$ parameters represent the overall constant and slope (vector) in the model, while the γ_i and δ_t represent cross-section or period specific effects (fixed and random respectively).

2.1 Panel Unit Root Tests

Recent literature approves that panel-based unit root tests have higher power than unit root tests based on individual time series. Panel unit root tests are similar, but not identical, to unit root tests carried out on a single series. Here, we briefly describe a general panel unit root test. Consider a following AR(1) process for panel data:

$$Y_{it} = \rho_i Y_{it-1} + X_{it}\delta_i + \varepsilon_{it} \qquad (2)$$

Here X_{it} represent the exogenous variables in the model, including any fixed effects or individual trends, ρ_i are the autoregressive coefficients, and the errors ε_{it} are assumed to be mutually independent idiosyncratic disturbance. If $|\rho_i| < 1$, Y_{it} is said to be weakly (trend-) stationary. On the other hand, if $|\rho_i| = 1$ then Y_{it} contains a unit root.

For testing purposes, there are two natural assumptions that can be made about the ρ_i. First, one can assume that the persistence parameters are common across cross-sections so that $\rho_i = \rho$ for all i. The Levin, Lin, and Chu (LLC) (2002), Breitung, and Hadri (2000) tests all employ this assumption. Alternatively, one can allow ρ_i to vary freely across cross-sections. The Im, Pesaran, and Shin (IPS) (2003), and Fisher-ADF and Fisher-PP tests are of this form.

2.2 Panel Cointegration Tests

The Pedroni (1999) and Kao (1999) tests are based on Engle-Granger (1987) two-step (residual-based) cointegration tests. The Fisher test is a combined Johansen test. Here we give a brief summary of Pedroni (Engle-Granger based) Cointegration Tests. Pedroni (2004) proposes several tests for cointegration that allow for heterogeneous intercepts and trend coefficients across cross-sections. Consider the following regression

$$Y_{it} = \alpha_i + \delta_i t + \beta_{1i} X_{1it} + \ldots + \beta_{Mi} X_{Mit} + \varepsilon_{it} \qquad (3)$$

for $m = 1, 2, \ldots, M$; where Y and X are assumed to be integrated of order one, e.g. I(1). The parameters α_i and δ_i are individual and trend effects which can be set to zero if desired. Under the null hypothesis of no cointegration, the residuals will be I(1). The general approach is to obtain residuals from (3) and then to test whether residuals are I(1) for each cross-section by running the auxiliary regressions,

$$e_{it} = \rho_i e_{it-1} + u_{it} \tag{4}$$

or

$$e_{it} = \rho_i e_{it-1} + \sum_{j=1}^{p_i} \varphi_{ij} \Delta e_{it-j} + \upsilon_{it} \tag{5}$$

Pedroni describes various methods of constructing test statistics for null hypothesis of no cointegration ($|\rho_i| = 1$). There are two alternative hypotheses: the homogenous alternative $(\rho_i = \rho) < 1$ for all i and the heterogeneous alternative, $\rho_i < 1$ for all i. The Pedroni panel cointegration statistic is constructed from the residuals of auxiliary regression and the standardized statistic is asymptotically normally distributed.

3. Data and Empirical Results

We have made use of a panel data comprising Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Spain, Slovakia, Slovenia, Sweden, Turkey and the United Kingdom for the period 1999-2007. The variables included in the study were Higher Technology Exports percentage (HTEP) in the whole exports of related country, and the percentage of R&D expenditures in the whole number of GNP of related country (RDEP). The major data source is EUROSTAT. Throughout this study we have used Eviews 6 version for empirical evaluations. For the panel data of two variables HTEP and RDEP we have conducted panel unit root tests available in the software. The results are reported in Table 1 below.

Table 1. Panel Unit Root Test Results.

Series	Levin, Lin and Chu t*	Im, Pesaran and Shin W-stat	ADF - Fisher Chi-square	PP - Fisher Chi-square
HTEP	-8.25078	0.47421	62.3948	44.7278
	0.0000	0.6823	0.2594	0.8604
RDEP	1.61009	2.29310	47.1237	115.846
	0.9463	0.9891	0.7950	0.0000

NOTES: (1) For the first two test The Null: Unit root (assumes common unit root process) (2) For the last two test The Null: Unit root (assumes individual unit root process). (3) Exogenous variables: Individual effects, individual linear trends, (4) Newey-West bandwidth selection using Bartlett kernel. (5) First lines are test statistics and second lines are related probabilities.

Panel unit root test statistics generally have the implication first order unit root. Panel unit root tests in the first differences not reported here have shown no unit roots. Therefore we conclude that these series are all have stochastic trends. That is, all the series at hand are homogenous of order one. The next step in the panel time series analysis is to carry out a cointegration test which is presented at Table 2 below.

Table 2. Pedroni Residual Cointegration Test for the series HTEP and RDEP

Alternative hypothesis: common AR coefs. (within-dimension)				
	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-0.438530	0.3624	-0.340694	0.3764
Panel rho-Statistic	0.154820	0.3942	-0.414025	0.3662
Panel PP-Statistic	-2.739073	0.0094	-2.826961	0.0073
Panel ADF-Statistic	-5.134634	0.0000	-3.853797	0.0002
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	Prob.		
Group rho-Statistic	2.057519	0.0480		
Group PP-Statistic	-2.419479	0.0214		
Group ADF-Statistic	-3.278389	0.0018		

NOTES: (1) Null Hypothesis: No cointegration, (2) Trend assumption: No deterministic trend (3) Newey-West bandwidth selection with Bartlett kernel.

As it is well known, the existence of stochastic trend does not hinder the long run relationship between variables. Cointegration tests in general reject the null hypothesis of no cointegration. Therefore we conclude that there is at least one long run relationship between these variables.

The third problem with this analysis is to detect the direction of causality between these two variables. The answer is provided with the Table 3 below. We have performed panel data Granger causality analysis for both directions. As it can be followed from the last column, the causality from R&D to High Tech Exports is meaningful, while the reverse is insignificant. This result is a confirmation of “R&D led High Tech Exports” hypothesis, in the case of EU and Turkey.

Table 3. Panel Granger Causality Test Results.

Null Hypothesis	F-Statistic	Prob.
RDEP does not Granger Cause HTEP	2.43676	0.0902
HTEP does not Granger Cause RDEP	0.79846	0.4515

NOTES: (1) Lags: 2 (3) Cross-Sections Included: 28 (4) Total Panel (Balanced) Observations: 196.

As we have determined the type of causality, there remains only one problem that to estimate the long run relationship from R&D expenditures to economic High-Tech Exports. We have several alternatives. The significant models are reported in the Table 4 below.

Table 4. Long-run Relationships between HTEP and RDEP.

Model	Variables	Coefficient	Std. Error	t-Statistic	Prob.
Panel Least Squares	CONSTANT	9.270993	2.208904	4.197100	0.0000
	RDEP	3.138717	1.661469	1.889122	0.0602
Cross-section Fixed effects	CONSTANT	10.11821	1.338159	7.561291	0.0000
	RDEP	2.498523	0.832905	2.999770	0.0030
Period fixed effects	CONSTANT	10.50908	2.007432	5.235085	0.0000
	RDEP	2.203163	1.508281	1.460711	0.1455
Cross-section and period effects	CONSTANT	10.14411	1.317122	7.701725	0.0000
	RDEP	2.478950	0.819198	3.026068	0.0027

NOTES: (1) Method: Panel Least Squares, (2) Periods Included: 9, (3) Cross-Sections Included: 6 (4) Total Panel (Balanced) Observations: 54.

All the models, except the period fixed effects model, have significant coefficients estimates both for constant term and slope parameter.

4. Conclusion

The nature of the relations between R&D expenditures and High-Tech Exports is of interest to examine. Here the objective was to determine the long-run relationship between R&D expenditures and High-Tech Exports for the case of EU countries. We have employed panel causality analysis to examine relationship between R&D expenditures and High-Tech Exports in the EU and Turkey using annual time series of major EU countries. We have made use of a panel data comprising 27 EU countries and Turkey for the period 1999-2007. The variables included in the study were the percentage of R&D expenditures in Gross domestic product (RDEP) and the percentage of high tech exports in the total amount of exports (HTEP).

Panel unit root test statistics generally have the implication of first order unit root. Cointegration tests in general reject the null hypothesis of no cointegration. Therefore we conclude that there is at least one long run relationship between these variables. The panel data analysis results show that higher R&D expenditures have an influence on gross domestic product in the case of EU. This result is a confirmation of “R&D expenditures led High-Tech Exports” hypothesis, in the case of Turkey and EU countries.

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