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Determination of Country-Specific Effects of Technological Gap

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Teknolojik Açığın Ülke-Spesifik Etkilerinin Belirlenmesi

Öz

Bu çalışma, Avrupa Birliği'nde teknoloji açığının ülkeye özgü etkilerinin belirlenmesini analiz etmeyi amaçlamaktadır. Bu nedenle bu çalışma, teknoloji açığı modelini kullanmaktadır ve 1998-2016 dönemi için Avrupa Birliği ülkeleri için teknoloji açığının belirleyicilerini göstermektedir. Analizde dengeli panel veri metodu kullanılmıştır. 22 Avrupa Birliği ülkesi için teorinin ampirik testleri sunulmaktadır. Patent başvurusundaki büyüme oranının ve kişi başına Gayri Safi Yurtiçi Hasıla'nın büyüme oranının teknoloji açığını etkilediği bulunmuştur. Ortak İlişkili Etki Modeli sayesinde, her ülke için bu etkileri görebilmekteyiz. Bu, ülkeye özgü ekonomi politikasını geliştirme fırsatı vermektedir. Bu sayede ekonomi politikası uygulayıcıları bir ekonomik entegrasyona dahil bile olsa ülkeler, daha etkin politikalar geliştirebilirler.

Anahtar Kelimeler: Teknolojik açık, Yenilik, Panel Koentegrasyon, Avrupa Birliği, Büyüme

Determination of Country-Specific Effects of Technological Gap

Abstract

This study aims to analyze the determination of country-specific effects of technology gap in the European Union. For this reason, this study employs technology gap model and shows that the determinants of technology gap for the European Union countries for the period 1998-2016. Balanced panel data method was used in the analysis. It is presented empirical tests of the theory for 22 European Union countries. It is found that patent application growth rate and Gross Domestic Product per person employed growth rate effect technology gap. Owing to the Common Correlated Effect Model we are able to see these effects for each country. This gives the opportunity to develop country-specific economic policy. In this way, economic policy practitioners can develop more effective policies for countries, even if they are involved in an economic integration.

Keywords: Technological Gap, Innovation, Panel Cointegration, European Union, Growth

Introduction

Technological changes are important for the long term economic growth. Starting with Solow (1957), technology was accepted a new production factor. On the other hand, technology gap firstly developed by the Posner (1961). He emphasis that there is a strong relation between economic growth and country's technology level, and sometimes countries face with technological gap between innovation frontier. Technological differences create countries' Gross Domestic Product (GDP) per capita differences. In the literature, it is seen that GDP per capita can be to reflect the degree of technological sophistication of the country. Similarly, researchers included the investment-ratio and labor force as conditional variables, though the latter was often found to be of little significance and therefore omitted from the analysis (Fagerberg, 1994: 1164). Schumpeter (1947) says innovation causes to increase technological gap, and innovation decreases the technological gap.

There are two main approaches to measure technological capacity of a country: indicator and modeling approaches. Indicator approach uses statistics related with the innovation and modeling approaches based on endogenous growth and emphasis on the technological capability and it is measured by total factor productivity (Castellacci, 2011: 6). Williams (1968) found negative correlation between R&D and output growth. Fagerberg (1987) tested the technology gap hypothesis for the industrial countries for the period 1960-1983. It is found that there is a positive relation between economic development and technological changes.

Heitger (1993) assumed that the follower country grows faster and catches up. According to Encaoua (2007), European technology gap is seen in high-tech and specialized sectors. such as information and communication technology goods. Technology gap enlarges from the lack of labor productivity and innovation activities. Increases in GDP per person employed growth rate as an indicator of labor productivity reduce the technology gap. Fagerberg and Verspagen (2002) used two indicators, external patents and total R&D expenditures, to estimate the technology's effect for 29 countries. They found positive relation between economic and technological development level.

This study aims to overcome the studies by presenting a solid theory and empirical test of it. Lack of the data restricts empirical studies on technological gap. This study employs technology gap model and shows that the determinants of technology gap are innovation activities and labor productivities in the EU countries. In order to get these results for each country with using Common Correlated Effect Model of Pesaran.

1.Empirical Evidence

Empirical tests of the theory for 22 European Union countries are presented. 6 countries were omitted from the analysis because of their missing data. These countries are Luxemburg, Cyprus, Malta, Italy, Greece and Croatia. Before

implementing the panel cointegration tests heterogeneity and cross sectional dependence should be checked. It is found that these series are homogenous and have cross sectional dependence, and therefore second generation panel unit root and panel cointegration tests are usedd. In order to identify each country's position in our results, Common Correlated Effect Model of Pesaran (2006) is employed.

Data at issue are collected from World Bank Development Indicators and Eurostat for the period 1998-2016. Dependent variable is technology gap Blomstrom (1989):

$$TGAP_{i,t} = (y_{max,t} - y_{i,t})/y_{i,t} \quad (1)$$

to calculate this GDP (2000 constant prices, USD) is used, and independent variables are GDP per person employed growth rate (constant 1990 PPP, USD) as an indicator of labor productivity (L) and patent application growth rate (nonresidents) (P) as an indicator of innovation activities.

$$TGAP_{i,t} = \alpha_0 + \alpha_1 L + \alpha_2 P \quad (2)$$

2.Empirical Results

Luxemburg, Cyprus, Malta, Italy and Greece are omitted because of the missing data only 22 European Union countries' data are used for the analysis. For this reason, the heterogeneity and cross-sectional dependence should be tested, and it is found that there is a cross sectional dependence at the variables. Hence, second generation panel cointegration tests are used.

Long-run determinants of technology gap are tested. Firstly, heterogeneity between cross section units is tested by Pesaran and Yamagata (2008) test.

Table 1: Delta Test Results

TTest	Test Statistics
$\tilde{\Delta}$	0.737 (0.123)
$\tilde{\Delta}_{adj}$	0.749(0.128)

Note: Values in parenthesis show probabilities.

As H_0 is not rejected, series are homogeneous. Then CD_{LM} test of Pesaran (2004) is used to determine the cross-sectional dependence.

Table 2: Cross Sectional Dependence Test (CD_{LM} Test)

Variable	Test Statistics
TGAP	15.137***
L	7.102***
P	6.295***

Note: *** indicates that the coefficient is significant at 1%.

There is cross sectional dependence for all series. Because of the series homogenous, Cross-sectionally augmented Im, Pesaran, Shin (CIPS) Test should be used.

Table 3: CIPS Test Results

Variable	Test Statistics
TGAP	-1.824
L	-2.247
P	-2.728

According to Table, null hypothesis of non-stationary is not rejected at 1%, 5% or 10% level of significance that shows there is unit root problem. Westerlund (2008) developed the Durbin–H panel cointegration test, and cointegration is found. Table below represents test results.

Table 4: Durbin-H (2008) Panel Cointegration Test Results

	Test Statistics
Durbin-H Group	58.211***
Durbin-H Panel	2.194***

Note: *** indicates that the coefficient is significant at 1%.

The results show that there is a cointegration relationship. Therefore, long-run model can be estimated. Common Correlated Effect Model is used to estimate this.

Table 5: CCE Estimation Results

Country	*L*	*P*
AUT	1.057*	-0.011**
BEL	0.024	0.006
BGR	3.321	0.18*
CZE	-1.238**	-0.011
DNK	0.841*	0.014
EST	-0.316	-0.074*
FIN	1.329*	0.02**
FRA	2.706*	-0.024**

DEU	0.296	0.056
HUN	-3.347*	0.031***
IRL	-1.071	0.015
LVA	-1.188	0.128*
LTU	-0.175	-0.223*
NLD	0.614**	0.024***
POL	-4.6**	-0.047*
PRT	0.54	0.009
ROM	1.546	-0.084**
SVK	-5.232*	0.112*
SVN	0.439	0.012
ESP	1.579	0.094
SWE	0.142	-0.019**
GBR	-0.937	-0.042

Note: ***, **, * indicate that the coefficient is significant at 1%, 5% and 10% respectively.

Variable L shows GDP per person employed growth rate. P shows patent application growth rate. It is expected that coefficients of these variables are negative. At the table it is seen that Czech Republic, Hungary, Poland, Slovakia, L has negative and statistically significant coefficient as theory points out. (Estonia, Ireland, Latvia, Lithuania and United Kingdom have negative coefficients but not statistically significant). For the P series, Austria, Bulgaria, Estonia, France, Lithuania, Poland, Romania and Sweden have negative and statistically significant coefficient. (Czech Republic and United Kingdom have negative coefficients but not statistically significant).

Conclusion

This study aims to analyze the determinants of the technology gap in the European Union, and shows that the determinants of technology gap are innovation activities and labor productivities. Patent application growth rate and Gross Domestic Product per person employed growth rate are the determinants of the technology gap between countries. Besides, the patent application growth rate as an indicator of innovation activities determines technology gap more than GDP per person employed growth rate series which is an indicator of labor productivity.

To increase a country's economic growth and competitiveness, technology policy of the country is of great importance. Technology gap model can explain differences in growth between EU countries. But this model is not sufficient to explain the magnitude of technological deficits and how to eliminate them. This aspect has been criticized.

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