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The relationship between innovation and economic growth in emerging economies

130 - Organizational Response To Globally Driven Institutional Changes

Abstract

This paper will investigate the influence of innovation activities on economic growth in emerging markets during the period of 1991 to 2013. For this purpose a multiple regression model is used, which ultimately showed that there is no statistically significant relationship between innovation and economic growth. On the other hand, analysis showed that, with the clause ceteris paribus, an increase of 1 billion of foreign direct investment decreases the total number of patents per million citizens for 7.66 patents per million citizens. The final result is a developed econometric model which is applied for selected emerging markets in the observed period.

Keywords:

Innovation, economic growth, foreign direct investments, patents.

1. Introduction

Innovation is the basis for the development of knowledge-based economies and plays an important role in economic growth. According to Oslo Manual, innovation is defined as „“the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations” (OECD/ EUROSTAT, 2005). Knowledge-based economies are characterized by creation, dissemination and application of knowledge and innovation. The process of creation, exchange and successful commercialization through innovation activities is a prerequisite for bolstering economic growth and employment. The innovation activities boost the competitiveness of an economy and lead to prosperity in society. Significant attention was given to innovation in economic literature, as these activities notably determine the level of economic development.

In recent decades, there has been a lot of discussion about emerging economies. In economic literature, emerging economies are defined in different ways. Emerging economies as compared to developed economies are characterized as having a higher growth rate, a rising middle class, technological development, a process of urbanization, and a research basis (Pacek & Thorniley, 2007).

This paper aims to analyze the question of whether any significant statistical relationship can be detected between innovation and economic growth in emerging markets. Innovation is observed

regarding the total number of patents per million citizens, while economic growth is measured by the GDP growth rate. The control variables are foreign direct investment and research and development expenditures. The null hypothesis tests the following model: there is no relationship between the total number of patents per million citizens and economic growth in emerging markets controlling for the R&D expenditures and foreign direct investments. An auxiliary hypothesis is there is a relationship between the total number of patents per million citizens and foreign direct investments in emerging markets controlling for the R&D expenditures. The multiple regression coefficients have a "ceteris paribus" interpretation.

2. Review of Theoretical Research

In contemporary societies, innovation is one of the most significant factors for a company`s business and economic development as a whole. Innovation enables faster and better adaptation to dynamic changes in the environment, better satisfaction of existing needs and the creation of new needs. Its existence had an influence on changing the way of production and performance of companies, economic development and the knowledge-based economy. A lack of innovation, however, leads to lagging behind in economic development of country (OECD & EUROSTAT, 2005).

The basic definition of innovation and the theory of innovation were assigned by Joseph Schumpeter in the 1940s. He stressed that economic development is largely determined by non-economic factors. These factors are related to the institutional structure of society. The main role in it belongs to the entrepreneur, who is not only the manager, but the unique and specific person who accepts the risk attached to introducing new products and technologies. In this way, the entrepreneur fulfills the innovation process, which is crucial for economic development. The basic inputs that move forward capitalism economy are new consumer goods, the new methods of production or transportation, the new markets, the new forms of industry organization that capitalist enterprises creates (Schumpeter, 1912, 1942).

The most significant determinant of economic growth is knowledge, particularly observed in new growth theory. The two most important courses of new growth theory are focused on endogenous growth models and an evolutionary approach to presenting the complexity of technological change as a source of economic growth. At the present time, developed countries largely base their economic growth on the creation and use of knowledge. Knowledge, objectified in technological changes, has become a fundamental creator of competitive advantage among companies and countries on the world market (Lucas, 1988, 1993).

3. Quantitative Analysis

3.1. Data and Methodology

In this paper, quantitative methods are used to identify linkages between economic growth and innovation activities in emerging markets. Some authors have used statistical data on patents as an

indicator of innovation economy. Such an approach is justified by the fact that data on patents are widely available. Patents represent the output of R&D activities. They can be used for both qualitative and quantitative analysis (Griliches, 1990). It is important to take in consideration that not all innovation is patented, so patents are not only one indicator of innovation.

Depended variable in this paper is the total number of patents per million citizens. The total number of patents includes the sum of resident and non-resident patent applications. *Independent variables* are GDP growth rate, net amount of foreign direct investment (FDI) in US dollars and R&D expenditures as percent of GDP. Control variables are FDI net and R&D expenditures. The data are taken from World Bank Database (*World Development Indicators*, 2015). These data are used as panel data. A panel data set is one that follows a given sample of individuals over time, and thus provides multiple observation points on each individual in the sample (Hsiao, 2003).

The sample of emerging markets is focused on the top seven economies from Standard & Poor's (S&P) that have undergone rapid economic growth in recent decades. These economies are China, India, Brazil, Russian Federation, Indonesia, Mexico and Turkey.

3.2. Statistical Approach

In this paper, the Random effect model is used. In the random effect model, the individual-specific effect is a random variable that is uncorrelated with the explanatory variables.

Unrelated effect is: $E(u_i \mid X_i) = 0$, where u = residual with included specify of the country and X = independent variables.

This assumption says that the individual-specific effect is a random variable that is uncorrelated with the explanatory variables of all past, current and future time periods of the same individual. This is a very strong assumption that economists usually do not favor.

The random effect model is used because of the fact that emerging markets have common characteristics, like rapid growth rate, a void of institutions, a high percentage of the population between the ages of 0 to 14, an increasing population of highly educated persons, a low level of research capacities and low-ranked innovation competitiveness. These characteristics are presented for all the selected and analyzed countries.

3.3. Regression, Tests and Results

The analysis starts with a summary of descriptive statistics, which is presented in the following Table.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Patents per million citizens	168	87.99756	99.59668	0	607.8887
GDP growth rate (%)	168	4.611865	4.819657	-14.53107	14.27646
R&D expenditures (as % GDP)	105	0.8255872	0.398106	0.4756	2.01466

FDI net	69	- 3.18e+10	5.10e+10	-2.32e+11	3.35e+10

Table 1. Descriptive statistics and variables (Source: Author)

The mean of total patents per million citizens is 87.99 and the standard deviation is on the normal distribution and the empirical rule. The same case is with the GDP growth rate. The standard deviation observed on R&D expenditures is two times less than the mean, while for FDI, the net is greater.

The following Table represents the correlation matrix between independent variable and predictors.

Variable	Patents per million citizens	GDP growth rate	FDI net	R&D expenditures (as % GDP)
Patents per million citizens	1.0000			
GDP growth rate	0.0635	1.0000		
FDI net	-0.5683	-0.4379	1.0000	
R&D expenditures (as % GDP)	0.7086	0.3283	-0.7123	1.0000

Table 2. Correlation matrix between independent variable and predictors (Source: Author)

The simple correlation with the total number of patents per million citizens and other predictors are on the limit of 0.71 and could be used for multiple regression models.

Regression analysis that was performed at the beginning showed the following results:

Patents per million citizens	Coef.	Std. Err.	z	P > |z|	[95% Conf.	Interval]
GDP growth rate	-0.0951912	1.729544	-0.06	0.956	-3.485034	3.294652
FDI net	-7.68e-10	2.66e-10	-2.89	0.004	-1.29e-09	-2.47e-10
R&D expenditures (as % GDP)	314.758	49.91362	6.31	0.000	216.9291	412.5869
_cons	-160.081	57.51327	-2.78	0.005	-272.8049	-47.35706
sigma_u	95.035983		Number of obs.			53
sigma_e	35.871209		Number of groups:			7
rho	0.8752984					
R-sq	within= 0.7421,	between=0.5594,	overall=0.5096			

Table 1. Multiple regressions using random effects model (Source: Author)

The regression analysis shows that there is a statistically significant correlation between GDP growth and patents per million citizens, but the main problem lies in the probability of this model. Actually, the model is not relevant anyway, because it is applicable in less than 5% of the cases. In this way, the null hypothesis has proven that there is no relationship between innovation and economic growth in emerging markets.

Further analysis focused on foreign direct investment and innovation in emerging markets. The United Nation report about investments identified these emerging markets as the most attractive countries for FDI (UNCTAD, 2015). To test the auxiliary hypothesis, the same model was applied, but excluded the data for GDP growth rate. The output of multiple regression models with a random effect is presented in the following Table.

Patents per million citizens	Coef.	Std. Err.	z	P > |z|	[95% Conf.	Interval]
FDI net	-7.66e-10	2.61e-10	-2.94	0.003	-1.28e-09	-2.55e-10
R&D expenditures (as % GDP)	314.7814	46.6997	6.74	0.000	223.2517	406.3111
_cons	-160.5859	52.34438	-3.07	0.002	-2631791	-57.99284
sigma_u	93.668666		Number of obs:		53	
sigma_e	35.706264		Number of groups:		7	
rho	.087312487					
R-sq:	within= 0.7426,	between=0.5590,	overall=0.5089			

Table 2. Multiple regressions using random effects model (Source: Author)

The result shows that all predictors are statistically significant. The number of R-squared which is 74.26 % of the variance of the dependent variable total number of patents per million citizens is explained in the regression model. The number of probability (P) is close to zero value, which indicates that the model is applied in 99.99% of the cases.

The result of regression analysis was tested with the Breusch and Pagan Lagrangian multiplier test for random effects (LM test). The LM test helps to decide which analysis to perform between random effects regression and a simple OLS regression. The result of the test is presented in the following Table.

Patents per million citizens [Country, t] = X_b + u [Country, t] + e [Country, t]			
Estimated results:		Var.	sd = sqrt (Var)
Patents per million citizens		16043.3	126.6621
e		1274.937	35.70626
u		8773.819	93.66867
Test:	**Var (u) = 0**	chibar2 (01 =	102.92
		Prob > chibar2 .	0.0000

Table 3. Breusch and Pagan Lagrangian multiplier test for random effects (Source: Author)

The null hypothesis in the LM test is that variances across entities are zero. This is no significant difference across units (i.e. no panel effect). The test showed zero value for the indicator Prob > chibar2, which confirms the validity of the regression model.

The final result of regression performed for the selected emerging markets could be explained with the following model:

$$\textbf{(Number of patents per million citizens)}_{it} = -0.000000000766(\text{FDI net})_{it} + 314.78\ (\text{R\&D expenditures as \% of GDP})_{it} - 160.56 + u_{it},$$

where *i* - country, *t* –year and u_{it} is residual.

The previous equation allows us to conclude that foreign direct investment has negative effects on increasing the number of patents in emerging markets, while increasing R&D expenditures stimulates innovation activities related to patent applications.

More precisely, an increase of 1 billion of FDI decreases the number of patents per million citizens for 7.66 patents per million citizens. On the other hand, increasing 1% of R&D expenditures brings patents up to 314.78 per million citizens.

The multiple regression coefficients have a "ceteris paribus" interpretation. In this way, the null hypothesis has proven that there is a statistically significant relationship between foreign direct investment and innovation measured by the number of patents. This relationship is also inverse in character, where increasing FDI reduces patents per million citizens, while increasing R&D has enhanced patents per million citizens.

4. Conclusion

The obvious conclusion to be drawn is that there are no statistical relationship between economic growth, measured with GDP growth rate and innovation, measured with the number of patents per million citizens in the period from 1991 to 2013. Based on further performed quantitative research for emerging markets, the final conclusion could be that foreign direct investment has negative effects on innovation activities, regarding the number of patent applications. The econometric model obtained shows that FDI decreases the total number of patents per million citizens in emerging economies, while increasing R&D expenditures has stimulating effects on patent application. Multinational companies, as the main driver of foreign direct investments, transfer the final technical solution in emerging markets. Because of this fact, the total number of patents will go down. On the other hand, increasing R&D expenditures and investment in R&D activities has stronger effects on increasing patent applications. The econometric model is applied to selected emerging markets in the period from 1991 to 2013.

Therefore, the prospects for the future in emerging markets will be focused on more investment in R&D activities. Increasing investment will have positive effects on innovation activities, economic growth based on innovation and a better rank on the global innovation map.

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