Economic Insights – Trends and Challenges	Vol.VI(LXIX) No. 4/2017	5 - 12

The Correlation between Innovative Capabilities and Economic Development

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Abstract

The purpose of this paper is to emphasize the correlation between innovative capabilities and economic development, starting from the theories in the field. In this respect, we analysed Gross Domestic Product per capita in current US$ (GDP/capita), as dependent variable, and Global Innovation Index (GII), as independent one. Using the IBM® SPSS® Statistics Version 21 software, we empirically tested different types of models. The results showed a significant correlation between GDP/capita and GII, which is best described by the power model, as 72.5% of the variation in the GDP/capita was due to the variation of GII. Therefore, we consider that Global Innovation Index as a measure of innovative capabilities of a country is representative when testing the correlation with GDP/capita.

Keywords: *correlation; innovative capabilities; economic development; regression equation.*

JEL Classification: *O11; C29; B23.*

Introduction

Due to the effects of the global economic crisis, integrating the advanced IT techniques in the production process as well as making significant investments in research and development (R&D) activities, hold a significant role in productivity performance improvement and, as a consequence, in rising the living standards.

But, as the Organisation for Economic Co-Operation and Development (OECD) emphasize, the spillovers of scientific and technological transfer mostly depend by regulatory environment and market structures. New innovative capabilities lead to economic growth only if regulatory and economic environment enable the creation and delivery of innovative products, services and processes. In this respect, according to OECD figures, despite the opportunities offered by globalization and advanced technologies, many OECD countries have difficulties in strengthening their innovative capabilities and improve their productivity performance.

The purpose of this study is to highlight the relationship between innovative capabilities and economic development, based on the theories in the field.

Literature Review

The impact of innovation on economic growth had been emphasized since as early as classical economists. Adam Smith (1776) did recognize the great importance of research activities on productivity growth. Also, List (1841) saw that industry should be linked to the formal institutions of science and of education, recognizing the interdependence of tangible and intangible investment as well as of domestic and imported technology.

Although the well-known scholars underlined a theoretical link, Robert Solow (1957) was the first researcher who introduced innovation into formal economic growth models. Starting from the theory which underlines that capital accumulation was the primary determinant of growth, he measured the fraction of growth[1] that was attributable to increases in capital, as for instance investments in machinery and related equipment. Capital accumulation accounted for less than a quarter of the measured growth. In Solow's study, innovation was placed "in the centre of economic growth squarely", where it has remained until now.

Following Solow's contributions, some scholars developed more sophisticated models in order to better underline the impact of innovation on economic growth. Lucas (1988) modeled human capital with constant rather than diminishing returns, showing the importance of a highly skilled workforce for long-term growth. Consequently, this model underlined the major role of investments in training and education for long-term economic growth. Conversely, Romer (1986, 1990) endogenized innovation in the growth model by introducing knowledge spillovers (defined as firm's unintentional contribution to the increase of knowledge stock). Thus, compared with Lucas, Romer underlined the critical role of investments in R&D as well as human capital for economic growth.

The theory[2] according to which intangible investment in knowledge accumulation is decisive for economic growth rather than physical capital investment has also been sustained by the World Bank (1991) and other economists (Grossman and Helpman, 1991; Rebelo, 1991; Aghion and Howitt, 1992).

Showing the importance of innovative capabilities and R&D activities for nations' competitiveness, J. Dunning (1992) and M. Porter (1992) have emphasized the fact that in order to progress towards a higher level of development a country has to supports and stimulates the creation and development of "competitive advantages based on innovation and knowledge" (Iacovoiu, 2009). Thus, in advanced stages of development the high level of competitiveness is related to the ability of local companies to support innovation in the organizational, managerial and technological field (*the stage of competitive advantage arising from innovation*, the third stage) as well as the unprecedented intensification of relations between firms, based on the development of informational processes (the fourth stage, *the information stage*). Given the ability of transnational corporations to relocate the added value activities, the governments of host countries must influence significantly the quantity, quality and cost of inputs factors and ensure the improvement of issues like education, fiscal, environmental protection or the network transport. (Matei, 2004; Voica et al, 2015)

So, from a certain point of economic development, maintaining and increasing competitiveness requires to develop the own innovative capabilities (Akçomak and Bas, 2008). Therefore, innovation is "the only self sustaining driver of economic growth" (Romer, 1987) for the countries that have reached a high level of economic development.

[1] It was defined by R. Solow as "the increase in GDP per hour of labour per unit time".
[2] This theory is known as "New Growth Theory".

Data and Methodology

In order to verify the correlation between innovative capabilities and economic development we analysed Gross Domestic Product per capita in current US$ (GDP/capita) and Global Innovation Index (GII). The two indicators' value for the year 2013 is presented in Appendix.

The overall *GII* score is calculated as "the simple arithmetic average of the two Sub-Indices. The Innovation Input Sub-Index takes into account those elements of the national economy that enables innovative activities, respectively: Human capital and research; Institutions; Infrastructure; Market sophistication; Business sophistication. The Innovation Output Sub-Index is built around two output pillars namely Knowledge and technology outputs and Creative outputs" (Dutta and Lanvin, 2013).

Starting from the theoretical relationship between the analysed indicators, we considered the GDP per capita as depending variable and the innovation parameter (GII) as independent one.

$$\mathbf{GDP/capita = f\ (GII)} \quad (1)$$

The followings stapes were performed by using the IBM® SPSS® Statistics Version 21 software: (1) Creating the scatter plots; (2) Graphing the fitting line for different types of models, respectively the Linear, Logarithmic, Inverse, Quadratic, Cubic, Power, Compound, S-curve, Logistic, Growth, and Exponential models; (3) Calculating the F and R square indicators; (4) Determining the regression equation.

We considered only models for which the value of significance probability (Sig.) is lower than .05 (5%). The model that best describes the correlation between variables is the one with the higher coefficient of determination value (R Square).

Results and Discussions

The values of F and R Square and of the parameters of the regression equations are presented in the table below (tab.1).

Table no 1. Values of F and R Square and of the parameters of the regression equation (Dependent Variable: GDP_capita; Independent variable: GII)

Equation	Model Summary					Parameter Estimates			
	R Square	F	df1	df2	Sig.	Constant	b1	b2	b3
Linear	.630	237.041	1	139	.000	-41791.828	1555.921		
Logarithmic	.571	185.049	1	139	.000	-188742.578	57296.655		
Inverse	.489	133.127	1	139	.000	71213.801	-1890488.051		
Quadratic	.670	140.125	2	138	.000	12379.468	-1293.136	34.472	
Cubic	.671	92.973	3	137	.000	33384.605	-2988.635	77.690	-.348
Power	.725	366.467	1	139	.000	.001	4.351		
Compound	.708	337.018	1	139	.000	105.578	1.118		
S-curve	.703	329.161	1	139	.000	13.244	-152.753		
Logistic	.708	337.018	1	139	.000	.009	.895		
Growth	.708	337.018	1	139	.000	4.659	.111		
Exponential	.708	337.018	1	139	.000	105.578	.111		

Source: Author own calculation based on data in Appendix

As underlined above, the power model is the one that best describes the association between the GDP/capita and Innovation Index (GII) because 72.5% of the variation in the GDP/capita is explained by GII.

The power regression equation is:

$$\mathbf{GDP/capita = 0.001 \times (GII)^{4.351}} \quad .. \qquad (2)$$

The position of the fitting line against the distribution of the data points for the power model is shown in figure 1.

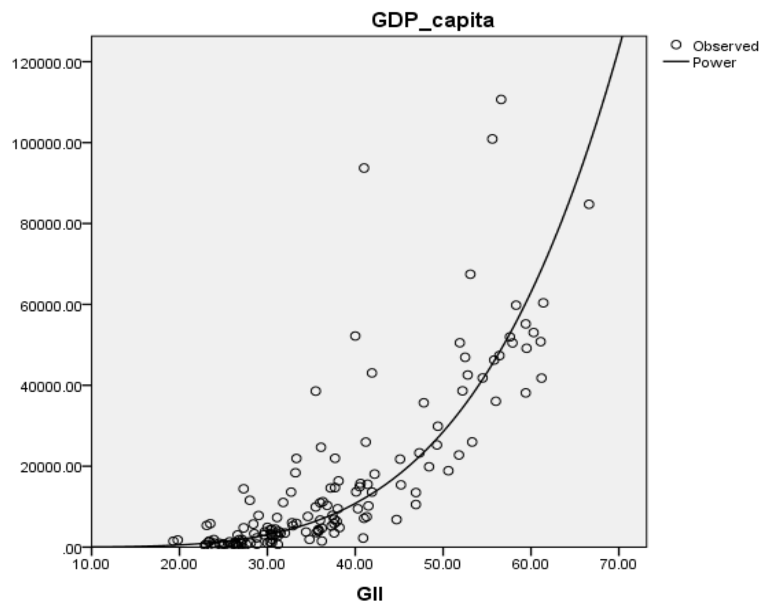

Fig. no 1. The Power Model

Source: Author own calculation based on data in Table 3

Conclusions

According to our analyses, there is a significant correlation between innovative capabilities and economic development. This correlation is best described by the power model, using Gross Domestic Product per capita as dependant variable, and Global Innovation Index as independent one. The power model presented a value of significance probability lower than .05 (5%) and the coefficient of determination (R Square) value was .725, showing that 72.5% of the variation in the GDP/capita is given by GII.

Therefore, using Global Innovation Index as a measure of innovation performance in order to verify the correlation with economic development given by Gross Domestic Product per capita seems to be representative.

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APPENDIX

GDP/capita and GII score (2013)

Crt. No.	COUNTRY	GDP/capita[1] (current US$)	GII Score[2]
1	Luxembourg	110,664.80	56.6
2	Norway	100,898.40	55.6
3	Qatar	93,714.10	41
4	Switzerland	84,748.40	66.6
5	Australia	67,463.00	53.1
6	Sweden	60,380.90	61.4
7	Denmark	59,818.60	58.3
8	Singapore	55,182.50	59.4
9	United States of America	53,042.00	60.3
10	Kuwait	52,197.30	40
11	Canada	51,964.30	57.6
12	Netherlands	50,792.50	61.1
13	Austria	50,510.70	51.9
14	Ireland	50,478.40	57.9
15	Finland	49,150.60	59.5

Appendix (cont.)

16	Iceland	47,349.50	56.4
17	Belgium	46,929.60	52.5
18	Germany	46,251.40	55.8
19	United Arab Emirates	43,048.90	41.9
20	France	42,560.40	52.8
21	New Zealand	41,824.30	54.5
22	United Kingdom	41,781.10	61.2
23	Japan	38,633.70	52.2
24	Brunei Darussalam	38,563.30	35.5
25	Hong Kong (China)	38,123.50	59.4
26	Israel	36,050.70	56
27	Italy	35,685.60	47.8
28	Spain	29,882.10	49.4
29	Korea, Republic of	25,977.00	53.3
30	Saudi Arabia	25,961.80	41.2
31	Cyprus	25,249.00	49.3
32	Bahrain	24,689.10	36.1
33	Slovenia	23,295.30	47.3
34	Malta	22,775.00	51.8
35	Greece	21,965.90	37.7
36	Oman	21,929.00	33.3
37	Portugal	21,738.30	45.1
38	Czech Republic	19,858.30	48.4
39	Estonia	18,877.30	50.6
40	Trinidad and Tobago	18,372.90	33.2
41	Slovakia	18,049.20	42.2
42	Uruguay	16,350.70	38.1
43	Chile	15,732.30	40.6
44	Lithuania	15,529.70	41.4
45	Latvia	15,381.10	45.2
46	Barbados	14,917.10	40.5
47	Argentina	14,715.20	37.7
48	Russian Federation	14,611.70	37.2
49	Venezuela, Bolivarian Republic of	14,414.80	27.3
50	Poland	13,653.70	40.1
51	Kazakhstan	13,611.50	32.7
52	Croatia	13,597.90	41.9
53	Hungary	13,485.50	46.9
54	Gabon	11,571.10	28
55	Brazil	11,208.10	36.3
56	Panama	11,036.80	31.8
57	Turkey	10,971.70	36
58	Malaysia	10,538.10	46.9
59	Mexico	10,307.30	36.8
60	Costa Rica	10,184.60	41.5
61	Lebanon	9,928.00	35.5
62	Romania	9,490.80	40.3
63	Mauritius	9,477.80	38
64	Colombia	7,831.20	37.4
65	Azerbaijan	7,811.60	29
66	Belarus	7,575.50	34.6
67	Bulgaria	7,498.80	41.3
68	Botswana	7,315.00	31.1
69	Montenegro	7,106.90	41

Appendix (cont.)

70	South Africa	6,886.30	37.6
71	China	6,807.40	44.7
72	Peru	6,661.60	36
73	Serbia	6,353.80	37.9
74	Ecuador	6,002.90	32.8
75	Dominican Republic	5,879.00	33.3
76	Angola	5,783.40	23.5
77	Thailand	5,779.00	37.6
78	Namibia	5,693.10	28.4
79	Algeria	5,360.70	23.1
80	Jamaica	5,290.50	32.9
81	Jordan	5,213.40	37.3
82	Belize	4,893.90	30
83	TFYR of Macedonia	4,838.50	38.2
84	Iran, Islamic Republic of	4,763.30	27.3
85	Bosnia and Herzegovina	4,661.80	36.2
86	Albania	4,460.30	30.9
87	Fiji	4,375.40	30.5
88	Tunisia	4,316.70	35.8
89	Paraguay	4,264.70	30.3
90	Mongolia	4,056.40	35.8
91	Ukraine	3,900.50	35.8
92	El Salvador	3,826.10	31.3
93	Cabo Verde	3,767.10	29.7
94	Guyana	3,739.50	34.4
95	Georgia	3,596.90	35.6
96	Armenia	3,504.80	37.6
97	Guatemala	3,477.90	31.5
98	Indonesia	3,475.30	32
99	Egypt	3,314.50	28.5
100	Sri Lanka	3,279.90	30.4
101	Morocco	3,092.60	30.9
102	Swaziland	3,034.20	29.6
103	Nigeria	3,005.50	26.6
104	Bolivia, Plurinational State of	2,867.60	30.5
105	Philippines	2,765.10	31.2
106	Honduras	2,290.80	28.8
107	Moldova, Republic of	2,239.60	40.9
108	Viet Nam	1,910.50	34.8
109	Uzbekistan	1,878.00	23.9
110	Ghana	1,858.20	30.6
111	Nicaragua	1,851.10	27.1
112	Zambia	1,844.80	26.8
113	Sudan	1,753.40	19.8
114	Côte d'Ivoire	1,528.90	23.4
115	India	1,497.50	36.2
116	Yemen	1,473.10	19.3
117	Cameroon	1,328.60	25.7
118	Pakistan	1,275.30	23.3
119	Kyrgyzstan	1,263.40	27
120	Kenya	1,245.50	30.3
121	Lesotho	1,125.60	26.3
122	Senegal	1,046.60	30.5
123	Tajikistan	1,036.60	30

Appendix (cont.)

124	Cambodia	1,006.80	28.1
125	Bangladesh	957.8	24.5
126	Zimbabwe	953.4	24
127	Tanzania, United Republic of	912.7	26.4
128	Benin	804.7	25.1
129	Burkina Faso	760.9	27
130	Mali	715.1	28.8
131	Nepal	694.1	25
132	Uganda	657.4	31.2
133	Rwanda	638.7	27.6
134	Togo	636.4	23
135	Mozambique	605	26.5
136	Guinea	523.1	25.7
137	Ethiopia	505	24.8
138	Gambia	488.6	26.4
139	Madagascar	463	22.9
140	Niger	415.4	24
141	Malawi	226.5	26.7

Source: 1) The World Bank, Data, http://data.worldbank.org/indicator/NY.GDP.PCAP.CD, on-line, [Accessed on July 16, 2015]; 2) Dutta, S. and Lanvin B., 2013. *The Global Innovation Index 2013: The Local Dynamics of Innovation*, p.10-11.