THE USV ANNALS OF ECONOMICS AND PUBLIC ADMINISTRATION | VOLUME 15, ISSUE 2(22), 2015

AN ECONOMETRICAL APPROACH OF THE RELATIONSHIP BETWEEN INNOVATION AND NET OUTWARD INVESTMENT POSITION

Associate professor Ph.D. **Viorela IACOVOIU**
Petroleum-Gas University of Ploieşti, Romania
vioiacovoiu@yahoo.com

Associate professor Ph.D. **Adrian STANCU**
Petroleum-Gas University of Ploieşti, Romania
astancu@upg-ploiesti.ro

Abstract:
Starting from the theory of the Investment Development Path (IDP) and competitive advantages, this study presents an econometrical approach of the relationship between net outward investment position, given by the net outward investment per capita (NOI), and innovation capabilities, reflected by the global innovation index (GII). The results of the analysis carried out for the worldwide economies, in the year 2013, using five models demonstrate that there is no significant correlation between NOI, as dependent variable, and GII as independent one. Thus, the highest coefficient of determination value was .201 (cubic model), reflecting the fact that only 20.1% of the variation in the NOI is explained by GII. Therefore, the level of country's innovation capacities is not one of the main forces that determine its NOI position.

Key words: net outward investment position, innovation, Investment Development Path, competitive advantages, regression equation, Foreign Direct Investment.

JEL classification: F21, F23, O52

1. INTRODUCTION

Specialists agree that technological innovation is essential, in order to increase competitiveness and maintain a solid economy in a global and dynamic system, as knowledge and creativity represent the life-force of the economy (Iacovoiu and Panait, 2014). Moreover, due to the effects of the global economic crisis, technological innovation and the transition from the "industrial approach" of the economy to the "informational approach" becomes imperative (Smick, 2009).

During this process, transnational corporations, that control the supply and use of the major part of the high-tech advanced technologies engendered within the private sector (Dunning, 2006), making significant investments in research and development activities, at the same time with the integration of advanced IT techniques and communication in the production process, hold a significant role. The empiric evidence shows that over 50% of the research development - related expenses spent at a global level are focused inside the transnational companies mainly in areas such as car industry, IT equipment industry and pharmaceutical industry.

In order to capitalize in a more cost-effective manner their ownership advantages given by the possession of intangible assets (information, technology, managerial knowledge, organizational knowledge), transnational corporations carry out international investment, generating significant flows of foreign direct investment (FDI). As such, at a high level of development, when the economies competitive advantages are based on the ability of local companies to support innovation in the organizational, managerial and technological field and to coordinate the resources available in a regional or global manner, outward FDI may surpass inward FDI flows (Porter, 1992; Dunning, 1992).

Given the theories in the field (Dunning, 1993; Buckley and Castro, 1998; Durán and Ubeda, 2001), in advanced stages of investment development path, respectively stage 4, characteristic of developed countries, and stage 5, specific of the most developed countries, the high

level of competitiveness is based on innovation and knowledge. Thus, in stage four, outward FDI (OFDI) stock becomes higher than inward FDI (IFDI) stock based on increasingly foreign direct investment outflows and net outward investment (NOI) position turns from negative to positive. At stage five, negative values alternate with positive ones, depending on the evolution of exchange rates and the business cycle phases (Dunning and Narula, 1996; Narula and Dunning, 2010).

Therefore, the theories of Investment Development Path and the competitive advantages highlight the existence of a close connection between innovative capabilities and net outward investment position, through the level of competitiveness (Table no.1).

Table no.1. Relation between innovative capabilities, competitive advantages and NOI position

NOI position	IDP stages	Competitive advantages stages	Innovative capabilities
Negative values	Stage 1	Competitive advantages based on the endowment with factors of production, mainly natural resources (stage 1).	Very low
	Stage 2	Competitive advantages based on the endowment with factors of production, including those created (stage 1).	Low
	Stage 3	The competitive advantage is generated by means of investments regarding the improvement of the quality of the existing production factors (stage 2).	Medium
Positive values	Stage 4	Competitive advantage arising from the capacity of the local companies to sustain technological, managerial and organizational innovation (stage 3).	High
Alternate values (unstable equilibrium)	Stage 5	Competitive advantage is based on the innovation and development of informational processes (stage 4).	Very high

Source: Authors' own elaboration based on the theories of Investment Development Path (Dunning, 1993; Buckley and Castro, 1998; Durán and Ubeda, 2001)

As presented above, the level of country's innovation capabilities seems to be one of the main forces that determine the turning points of its net outward investment position. Consequently, is there any reason to assume that a correlation between innovation and NOI position, really exist? The purpose of this study is to verify the relationship between these two parameters and to underline the regression equation which best describes the association between them.

2. DATA AND METHODOLOGY

DATA

To verify the correlation between innovative capabilities and net outward investment position we analyze in static manner specific indicators worldwide for the year 2013, respectively net outward investment per capita (NOI) and global innovation index (GII) as presented in Appendix 1.

Net outward investment per capita (NOI) was calculated using the following formula:

$$NOI = \frac{OFDIS - IFDIS}{TP} \quad (1)$$

where:
OFDIS – outward FDI stock;
IFDIS – inward FDI stock;
TP – total population.

The overall *Global Innovation Index (GII)* score is calculated as the simple arithmetic average of the Input and Output Sub-Indices. The Innovation Input Sub-Index is based on five input pillars as follows: (1) Institutions, (2) Human capital and research, (3) Infrastructure, (4) Market sophistication, and (5) Business sophistication. The Innovation Output Sub-Index Innovation is built around two output pillars: (6) Knowledge and technology outputs and (7) Creative outputs (Dutta and Lanvin, 2013).

METHODOLOGY

From the above theories (Table no.1), according to which in the upper stages of the investment development path (stage 4 and 5) competitive advantages derive mainly from the ability of local companies to sustain innovation, while in the initial stages the innovation capabilities are low, we grouped the world countries (Appendix 1) depending on the level of GII. Thus, we associated values greater than 51 with a high level of innovation, values ranging between 35 and 51 correspond to a medium level of innovation, and values lower than 35 equals a low level of innovation (Table no.2).

Table no.2. GII values and corresponding levels

GII values	GII levels
GII $\geq$ 51.01	High
GII $\in$ [35.00, 51.00]	Medium
GII $\leq$ 34.99	Low

Source: Authors' own elaboration

The level of NOI variable, positive or negative values, established according to the distribution of countries analyzed by GII levels is presented in the Table no.3.

Table no.3. GII and NOI Cross-tabulation

			NOI		Total
			Negative values	Positive values	
GII	Low level	Count	66	1	67
		% within GII	98.5%	1.5%	100.0%
		% within NOI	55.0%	4.5%	47.2%
		% of Total	46.5%	0.7%	47.2%
	Medium level	Count	48	3	51
		% within GII	94.1%	5.9%	100.0%
		% within NOI	40.0%	13.6%	35.9%
		% of Total	33.8%	2.1%	35.9%
	High level	Count	6	18	24
		% within GII	25.0%	75.0%	100.0%
		% within NOI	5.0%	81.8%	16.9%
		% of Total	4.2%	12.7%	16.9%
Total		Count	120	22	142
		% within GII	84.5%	15.5%	100.0%
		% within NOI	100.0%	100.0%	100.0%
		% of Total	84.5%	15.5%	100.0%

Source: Authors' own elaboration based on data in Appendix 1

We note that 66 (98.5%) of the 67 states that recorded a low level of GII were inward investors (negative values of NOI), while 18 (75%) of the 24 economies that recorded a high level of GII registered positive values of NOI.

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

$$NOI = f(GII) \quad (2)$$

Furthermore, in order to underline the regression equation which best describes the association between NOI and GII, the followings stapes were performed by using the IBM® SPSS® Statistics Version 21 software:

- Creating the scatter plots;
- Graphing the fitting line for different types of models;
- Calculating the F and R square indicators;
- Determining the regression equation.

Due to the fact that NOI has negative values, the Compound, Power, S-curve, Growth, Exponential, and Logistic models cannot be applied. Therefore, only five models can be analyzed, respectively the Linear, Logarithmic, Inverse, Quadratic and Cubic models.

Concerning the choosing of the best model that describes the association between NOI and GII the criteria such as the value of significance probability and the value of coefficient of determination were used. Firstly, the value of significance probability must be lower than .05 (5%) to take into account the coefficient of determination value. Secondly, the model which has the higher coefficient of determination value is the one that better describes the type of relationship between variables.

3. RESULTS AND DISCUSSIONS

a) The Linear Model

Figure no.1 shows the position of the fitting line against the scatter of the data points.

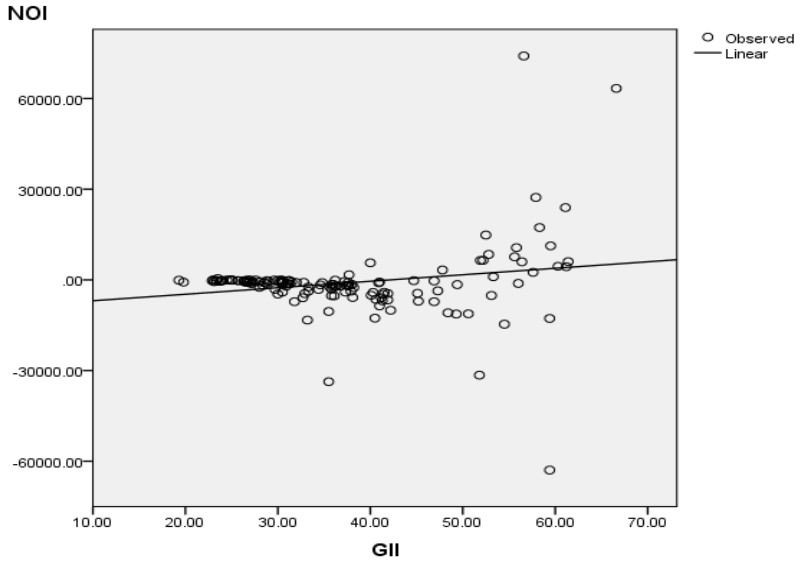

Figure no.1. The Linear Model

Source: Authors' own elaboration based on data in Appendix 1

Table no.4 shows the values of F and R Square and of the parameters of the regression equation for the linear model.

Table no.4. Values of F and R Square and of the parameters of the regression equation for the linear model

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.040	5.807	1	140	.017	-9058.034	214.884

Source: Authors' own elaboration based on data in Appendix 1

According to the information in Table no.4, the coefficient of determination (R Square) is .04 and the significance probability is 1.7%. Thus, about 4% of the variation in the NOI is explained by GII. This is a low value which means that there are other important factors that determine the variation of NOI.

b) The Logarithmic Model

The fitting line for the logarithmic model is shown in Figure no.2.

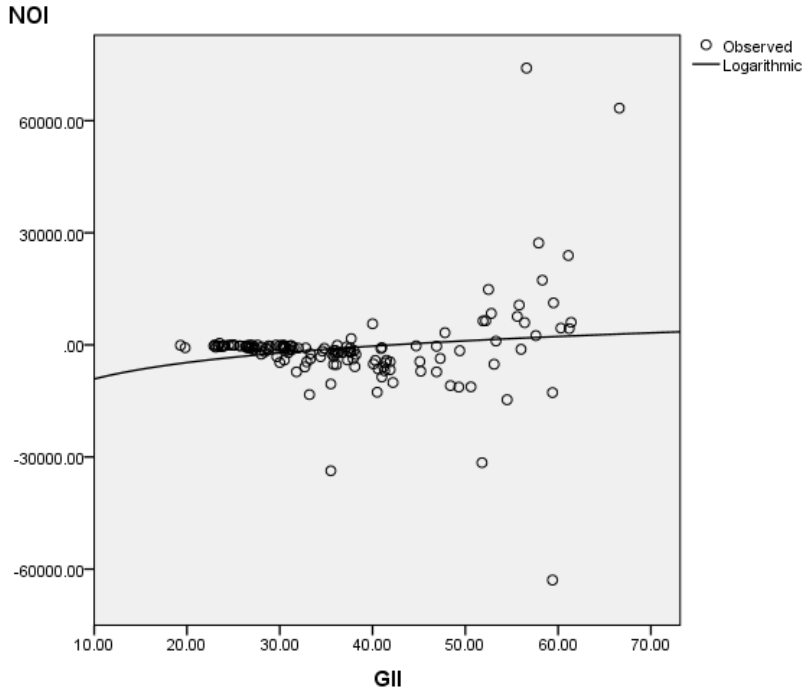

Figure no.2. The Logarithmic Model

Source: Authors' own elaboration based on data in Appendix 1

The values of F and R Square and of the parameters of the regression equation for the logarithmic model are displayed in Table no.5.

Table no.5. Values of F and R Square and of the parameters of the regression equation for the logarithmic model

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Logarithmic	.023	3.332	1	140	.070	-23716.054	6339.312

Source: Authors' own elaboration based on data in Appendix 1

The coefficient of determination is .023 and the significance probability is 7%. Therefore, about 2.3% of the variation in the NOI is explained by GII, which is a lower value than the one obtained in the linear model.

c) The Inverse Model

Figure no.3 shows the position of the fitting line against the distribution of the data points.

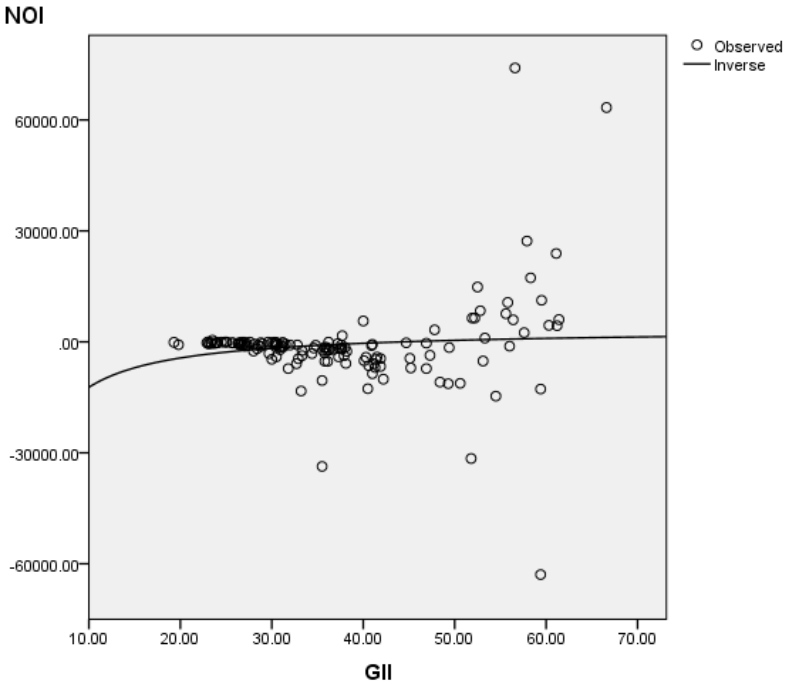

Figure no.3. The Inverse Model
Source: Authors' own elaboration based on data in Appendix 1

Table no.6 shows the values of F and R Square and of the parameters of the regression equation for the inverse model.

Table no.6. Values of F and R Square and of the parameters of the regression equation for the inverse model

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Inverse	.012	1.633	1	140	.203	3585.403	-158783.040

Source: Authors' own elaboration based on data in Appendix 1

The coefficient of determination is .012 and the significance probability is 20.3%. Therefore, about 1.2% of the variation in the NOI is explained by GII, which is the lowest value up to now.

d) The Quadratic Model

The fitting line for the quadratic model is displayed in figure no.4.

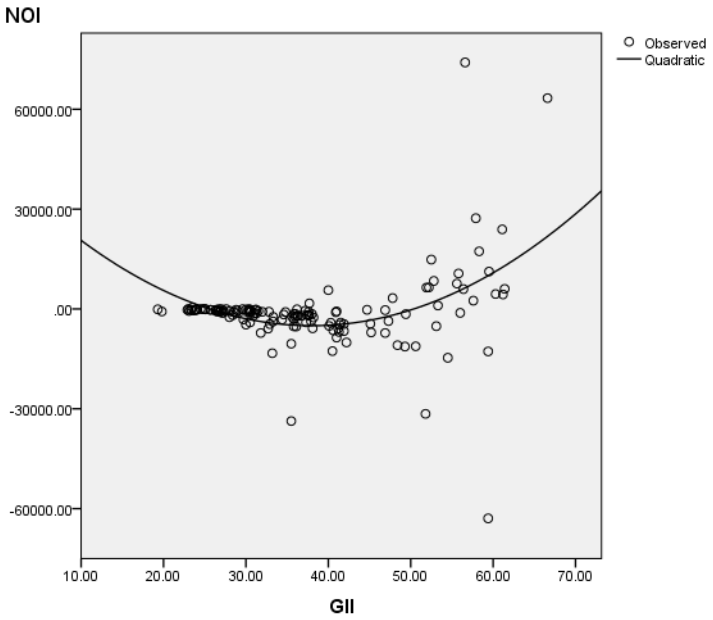

Figure no.4. The Quadratic Model
Source: Authors' own elaboration based on data in Appendix 1

The values of F and R Square and of the parameters of the regression equation for the logarithmic model are shown in Table no.7.

Table no.7. Values of F and R Square and of the parameters of the regression equation for the quadratic model

Equation	Model Summary					Parameter Estimates		
	R Square	F	df1	df2	Sig.	Constant	b1	b2
Quadratic	.159	13.117	2	139	.000	42191.372	-2486.983	32.746

Source: Authors' own elaboration based on data in Appendix 1

The coefficient of determination is .159 and the significance probability is 0.000%. Therefore, about 15.9% of the variation in the NOI is explained by GII, which is a higher value than the ones obtained in the previous models.

e) The Cubic Model

Figure no.5 shows the position of the fitting line against the distribution of the data points.

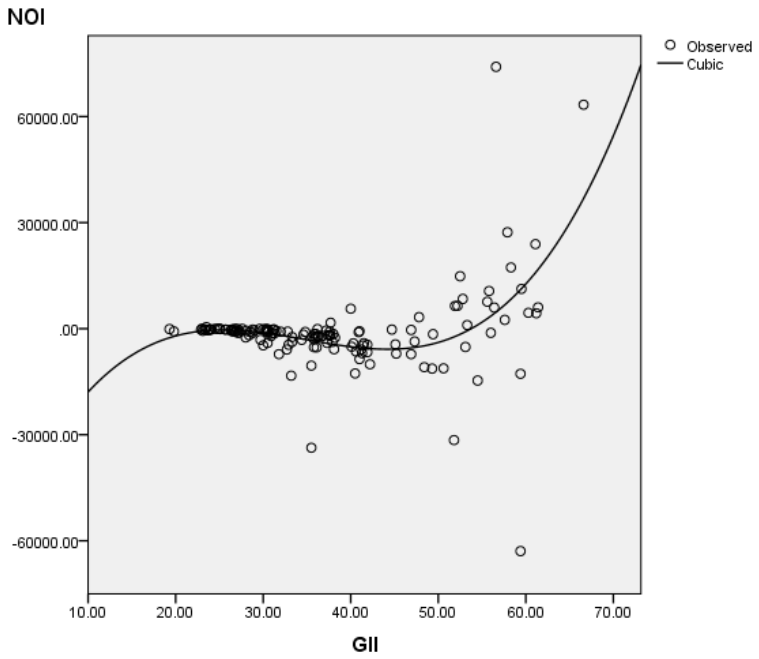

Figure no.5. The Cubic Model for the association between NOI and GII
Source: Authors' own elaboration based on data in Appendix 1

Table no.8 shows the values of F and R Square and of the parameters of the regression equation for the cubic model.

Table no.8. Values of F and R Square and of the parameters of the regression equation for the cubic model

Equation	Model Summary					Parameter Estimates			
	R Square	F	df1	df2	Sig.	Constant	b1	b2	b3
Cubic	.201	11.592	3	138	.000	-58818.562	5678.655	-175.628	1.681

Source: Authors' own elaboration based on data in Appendix 1

The coefficient of determination is .201 and the significance probability is 0.000%. Thus, about 20.1% of the variation in the NOI is explained by GII, which is the highest value from the analyzed models. Consequently, the cubic model is the one that best describes the association between NOI and GII.

The cubic regression equation is:

$$NOI = -58818.562 + 5678.655(GII) - 175.628(GII)^2 + 1.681(GII)^3 \quad (3)$$

4. CONCLUSIONS

In order to verify the correlation between innovative capabilities and net outward investment position we analyzed in a static manner two representative indicators, namely net outward investment per capita and global innovation index, for 142 worldwide economies, in the year 2013. The results of the analyses carried out, using the Linear, Logarithmic, Inverse, Quadratic and Cubic models, demonstrate that there is no significant correlation between NOI, as dependent variable, and GII, as independent one.

Firstly, only linear, quadratic and cubic models presented a value of significance probability lower than .05 (5%). Secondly, the highest coefficient of determination value was .201, showing that 20.1% of the variation in the NOI is explained by GII, in the case of cubic model. Therefore, the cubic regression equation is the one that better describes the relationship between net outward investment per capita and global innovation index.

Consequently, there are other forces, besides the level of country's innovation capacities that determine the turning points of its NOI position, as for example economic and political structure, natural resource endowments, and so forth.

REFERENCES

[1] Boudier-Bensebaa, F. (2008). „FDI-assisted development in the light of the investment development path paradigm: Evidence from Central and Eastern European countries", *Transnational Corporations*, Vol. 17, No. 1, 37-67.
[2] Buckley, P.J., Castro, F.B (1998). „The investment development path: the case of Portugal", *Transnational Corporations*, Vol. 7, No. 1, 1-15.
[3] Durán, J., Ubeda, F. (2001). „The investment development path: a new empirical approach", *Transnational Corporations*, Vol. 10, No. 2, 1-34.
[4] Dunning, J.H. (1992). „The competitive advantage of countries and the activities of transnational corporations", *Transnational Corporations*, Vol. 1, No. 1, 135-168.
[5] Dunning, J. (2000). „The eclectic paradigm as an envelope for economic and business theories of TNC activity", *International Business Review*, Vol.9, No.2, 163-190.
[6] Dunning, J. (2006). „Towards a new paradigm of development: implications for the determinants of international business", *Transnational Corporations*, Vol. 15, No. 1, 173-227.
[7] Dunning, J.H., Narula, R. (1996) (eds.), „Foreign Direct Investment and Governments: Catalysts for Economic Restructuring", Routledge, London.
[8] Dutta, S. and Lanvin B. (2013), "The Global Innovation Index 2013: The Local Dynamics of Innovation", Cornell University, INSEAD, and WIPO, Geneva, Ithaca, and Fontainebleau
[9] Iacovoiu, V.B., Matei, M. (2014), „The Limitation of Investment Development Path Theory. European Union Case", *Economic Insights – Trends and Challenges*, Vol.III (LXVI), No.4, 33-40.
[10] Lundvall, B.A., Borras, S. (2005). „Science, technology, innovation and knowledge policy", *The Oxford Handbook of Innovation*, Oxford University Press, Norfolk.
[11] Narula, R. (2003). „Globalisation and Technology: Interdependence, Innovation Systems and Industrial Policy", Polity Press, Cambridge.
[12] Narula, R., Dunning, J.H. (2010). „Multinational enterprises, development and globalisation: Some clarifications and a research agenda", *Oxford Development Studies*, Vol. 38, No. 3, 263-287.
[13] Narula, R., Guimón, J. (2010). „The investment development path in a globalised world: implications for Eastern Europe", *Eastern Journal of European Studies*, Volume 1, Issue 2, 5-19.
[14] Scutariu, A.L and Năstase, C (2009). "Aspects regarding the evolution of the foreign direct investments in Romania between 1990-2007", *The Annals of the "Ştefan cel Mare" University Suceava. Fascicle of The Faculty of Economics and Public Administration*, Vol.9, No.1, 117-123.
[15] Porter, M. (1992), „The Competitive Advantage of Nations", The Mac Millan Press.Ltd., London
[16] Smick, D.M. (2009). „The World is Curved. Hidden Dangers to the Global Economy", Publica Publishing House, Bucharest
[17] UNCTAD, "World Investment Report (2006), FDI from developing and transition economies: Implication for development", New York and Geneva
[18] UNCTAD, "World Investment Report (2014), Investing in the SDGs: An action plan", New York and Geneva
[19] Zaharia. P, (2013). "Decentralization, eligibility of authorities and consultation of citizens - evidence of the occurrence of autonomy in local public administration management", *Annals of the „Constantin Brancusi" University of Targu Jiu, Economy Series, Issue*, No.2/2013, 323-328.

APPENDIX 1

Crt. No.	COUNTRY	NOI[1] (USD)	GII SCORE[2]
1	Switzerland	63358	66.6
2	Sweden	6033	61.4
3	United Kingdom	4358	61.2
4	Netherlands	23911	61.1
5	United States of America	4474	60.3
6	Finland	11244	59.5
7	Hong Kong (China)	-12757	59.4
8	Singapore	-62921	59.4
9	Denmark	17313	58.3
10	Ireland	27273	57.9
11	Canada	2487	57.6
12	Luxembourg	74081	56.6
13	Iceland	5966	56.4
14	Israel	-1176	56
15	Germany	10652	55.8
16	Norway	7618	55.6
17	New Zealand	-14667	54.5
18	Korea, Republic of	1029	53.3
19	Australia	-5178	53.1
20	France	8415	52.8
21	Belgium	14833	52.5
22	Japan	6455	52.2
23	Austria	6432	51.9
24	Malta	-31532	51.8
25	Estonia	-11213	50.6
26	Spain	-1560	49.4
27	Cyprus	-11300	49.3
28	Czech Republic	-10893	48.4
29	Italy	3253	47.8
30	Slovenia	-3639	47.3
31	Hungary	-7219	46.9
32	Malaysia	-360	46.9
33	Latvia	-7059	45.2
34	Portugal	-4455	45.1
35	China	-253	44.7
36	Slovakia	-10081	42.2
37	Croatia	-6617	41.9
38	United Arab Emirates	-4526	41.9
39	Costa Rica	-4101	41.5
40	Lithuania	-4796	41.4
41	Bulgaria	-6934	41.3
42	Saudi Arabia	-5863	41.2
43	Qatar	-705	41
44	Montenegro	-8608	41
45	Moldova, Republic of	-992	40.9
46	Chile	-6443	40.6
47	Barbados	-12667	40.5
48	Romania	-4165	40.3
49	Poland	-5115	40.1
50	Kuwait	5639	40
51	Macedonia	-2574	38.2
52	Uruguay	-5840	38.1
53	Mauritius	-1516	38

54	Serbia	-3731	37.9
55	Greece	1687	37.7
56	Argentina	-1888	37.7
57	Thailand	-1893	37.6
58	South Africa	-817	37.6
59	Armenia	-1766	37.6
60	Colombia	-1840	37.4
61	Jordan	-4047	37.3
62	Russian Federation	-519	37.2
63	Mexico	-2005	36.8
64	Brazil	-2153	36.3
65	Bosnia and Herzegovina	-2055	36.2
66	India	-85	36.2
67	Bahrain	-5311	36.1
68	Turkey	-1504	36
69	Peru	-2288	36
70	Tunisia	-3054	35.8
71	Ukraine	-1472	35.8
72	Mongolia	-5253	35.8
73	Georgia	-2302	35.6
74	Brunei Darussalam	-33679	35.5
75	Lebanon	-10460	35.5
76	Viet Nam	-911	34.8
77	Belarus	-1695	34.6
78	Guyana	-3181	34.4
79	Dominican Republic	-2355	33.3
80	Oman	-3741	33.3
81	Trinidad and Tobago	-13298	33.2
82	Jamaica	-4549	32.9
83	Ecuador	-832	32.8
84	Kazakhstan	-5894	32.7
85	Indonesia	-858	32
86	Panama	-7217	31.8
87	Guatemala	-632	31.5
88	El Salvador	-1297	31.3
89	Uganda	-235	31.2
90	Philippines	-197	31.2
91	Botswana	-1281	31.1
92	Morocco	-1446	30.9
93	Albania	-2116	30.9
94	Ghana	-762	30.6
95	Bolivia	-989	30.5
96	Senegal	-162	30.5
97	Fiji	-4045	30.5
98	Sri Lanka	-355	30.4
99	Kenya	-69	30.3
100	Paraguay	-684	30.3
101	Tajikistan	-198	30
102	Belize	-4723	30
103	Cabo Verde	-3158	29.7
104	Swaziland	-61	29.6
105	Azerbaijan	-504	29
106	Mali	-221	28.8
107	Honduras	-1201	28.8
108	Egypt	-956	28.5
109	Namibia	-1846	28.4
110	Cambodia	-590	28.1
111	Gabon	-2514	28
112	Rwanda	-71	27.6
113	Iran	-481	27.3

114	Venezuela	-1081	27.3
115	Nicaragua	-1166	27.1
116	Burkina Faso	-68	27
117	Kyrgyzstan	-607	27
118	Zambia	-871	26.8
119	Malawi	-71	26.7
120	Nigeria	-422	26.6
121	Mozambique	-811	26.5
122	Gambia	-408	26.4
123	Tanzania, United Republic of	-258	26.4
124	Lesotho	-499	26.3
125	Cameroon	-248	25.7
126	Guinea	-269	25.7
127	Benin	-117	25.1
128	Nepal	-18	25
129	Ethiopia	-64	24.8
130	Bangladesh	-54	24.5
131	Niger	-276	24
132	Zimbabwe	-188	24
133	Uzbekistan	-281	23.9
134	Syrian Arab Republic	-452	23.7
135	Angola	448	23.5
136	Côte d'Ivoire	-396	23.4
137	Pakistan	-142	23.3
138	Algeria	-601	23.1
139	Togo	-5	23
140	Madagascar	-283	22.9
141	Sudan	-768	19.8
142	Yemen	-121	19.3

Source: [1] Authors' own calculations based on data available at UNCTAD, WIR 2014, pp.209-214 (OFDI stock and IFDI stock) and World Bank, www.worldbank.org (total population);
[2] Dutta, S. and Lanvin B. (2013), The Global Innovation Index 2013: The Local Dynamics of Innovation, pp.10-11.