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IMPACT OF TECHNOLOGICAL INNOVATION ON COMPETITIVENESS OF TRANSITION COUNTRIES

In this paper we analyze the impact of technological innovation on the competitiveness of the countries which started the process of transition in 1990. Transition countries are dividied into two groups: those which have not completed the process of transition, and those which have successfully completed the transformation of their economies. We used the concept of Global Competitiveness Index (GCI), developed by the World Economic Forum (WEF), to measure competitiveness. The analysis starts by formulating two hypotheses, involving technological readinness and innovation. T-test was used for confirming the first hypothesis, Pearson's correlation coefficient and Spearman's rank correlation coefficient were used in the case of the other.

Keywords: *Global Competitiveness Index; technological readiness; innovation; GDP per capita.*

JEL Classification: F4; O30.

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ВПЛИВ ТЕХНОЛОГІЧНИХ ІННОВАЦІЙ НА КОНКУРЕНТОСПРОМОЖНІСТЬ КРАЇН ІЗ ПЕРЕХІДНОЮ ЕКОНОМІКОЮ

У статті проаналізовано вплив технологічних інновацій на конкурентоспроможність країн, які ввійшли у перехідний період у 1990 році. Країни з перехідною економікою поділено на дві групи: ті, в яких процес ще не завершився, і ті, які успішно закінчили транформацію економіки. Для вимірювання конкурентоспроможності використано концепцію індексу глобальної конкурентоспроможності, розроблену Світовим економічним форумом. Аналіз передбачає формулювання двох гіпотез стосовно технологічного розвитку та інновацій. Для підтвердження першої з них використано Т-тест, для другої використано коефіцієнт кореляції Пірсона та коефіцієнт рангової кореляції Спірмена.

Ключові слова: *індекс глобальної конкурентоспроможності; технологічний розвиток; інновації; ВВП на душу населення.*

Рис. 2. Табл. 5. Літ. 19.

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ВЛИЯНИЕ ТЕХНОЛОГИЧЕСКИХ ИННОВАЦИЙ НА КОНКУРЕНТОСПОСОБНОСТЬ СТРАН С ПЕРЕХОДНОЙ ЭКОНОМИКОЙ

В статье проанализировано влияние технологических инноваций на конкурентоспособность стран, которые вошли в переходный период в 1990 году. Страны с переходной экономикой разделены на две группы: те, в которых процесс еще не завершился, и те, которые успешно закончили транформацию экономики. Для измерения конкурентоспособности использована концепция индекса глобальной конкурентоспособности, разработанная Мировым экономическим форумом. Анализ предусматривает

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формулировку двух гипотез относительно технологического развития и инноваций. Для подтверждения первой из них использован Т-тест, для второй использован коэффициент корреляции Пирсона и коэффициент ранговой корреляции Спирмена.

Ключевые слова: *индекс глобальной конкурентоспособности; технологическое развитие; инновации; ВВП на душу населения.*

1. Introduction. During historical development of economic thought, numerous economists conducted the competetiveness analysis. Ricardo pointed out the importance of competitive advantage (in relative prices and cost factors) for expansion of international commerce of a country. Schumpeter's (Hegedoorn, 1996) competitiveness analysis is based on the key role of entrepreneurs and innovations. He pointed two important aspects of innovations: the first one emphasises that technological advancement results from the firms' competitiveness in research and development (R&D) and organizational design; the second aspect states that innovation enables a company to gain a monopolistic profit. However, the Schumpeterian world is competitive. Over time, technological innovations start resembling those of the competitors so that monopolistic profits of innovators fade away resulting in new incentives for research and innovation. Changes in comparative advantages occur due to the repetition of these processes: from production with a large share of labour, through production with a large share of capital, towards the production based on a large share of research and development. Robert Solow (1994) and Whelan (2005) analyzed the growth factors and pointed out the importance of technological innovations and the increase in the "know-how" in economy. Kogut (1991) and Kogut and Zander (2003) emphasized the importance of knowledge in a competitiveness game. They stated that a country's competitiveness might explain differences in the country's capabilities in terms of technology and organization principles whereas Porter (1990) takes the approach which illustrates a systemic relationship between competitiveness factors: the strength of factor endowments; demand conditions; the competitiveness of firm strategies, structures, and rivalries in major industries; and the strength and diversity of related supporting industries. He observes that national competitiveness is measured by two sets of indicators: the presence of substantial and sustained exports to a wide array of other nations; and/or significant outbound foreign investment based on skills and assets created in a home country (Porter, 1990). Dunning (1993) introduces foreign direct investments and cross-border activities of multinational companies (MNC) which affect a country's competitiveness into Porter's matrix. Dunning (1994) points out technological fusions and alliances among MNCs. The reasons to support this strategy may be found in high costs of R&D and a shorter life cycle of new products, which bring about a considerable increase in production costs in high-technology industries. Technological fusions of MNCs enable them to gain huge profits from economy of scale and economy of scope at the global market. Such claim remains in line with empirical analyses (Lall, 2003) confirming that countries' competitiveness in terms of exports of highly technological products results from innovations taken by exporting countries or from capacity reallocation on behalf of transnational corporations (TNCs) coming from the countries which introduce innovations.

Some economists emphasize that we live in the times of highly technological neomercantilism in which science, technology, and innovations are observed as a

means of achieving international competitiveness. It implies that countries may achieve successful economic growth and be competitive at the world market if they manage to establish the institutions adjusted to current development of society, techniques and technology (Maksimovic, 2010).

2. Defining and measuring competitiveness. Competitiveness means different things to different economists. They have viewed competitiveness from at least two different perspectives: the micro (firm) perspective and the macro (nation) perspective. Fetridge (1995) described competitiveness at 3 different levels of aggregation: a firm, an industry or groups of industries and a nation. At each level of aggregation there are diferent measures of competitiveness.

The official definition of competitiveness provided by the OECD is as follows: competitiveness is the degree to which a nation can, under free and fair market conditions, produce goods and services that meet the test of international markets while simultaneously maintaining or expanding the real incomes of its citizens (Scoot and Lodge, 1985). It stresses that the ultimate goal of competitiveness is increasing the real income of citizens. Markusen (1992) noted that a country is competitive if it maintains a growth rate of real income equal to that of its trading partners in an environment of free and (long run) balanced trade. Nurbel (2007) emphasizes the national structure (national innovation system and "national diamond") as a factor of nation's competitiveness. This national structure constitutes the ground where interactions generate the forces which may influence the competitiveness of a nation.

Economists suggested numerous indicators of national competitiveness. All of them can be grouped into two groups. The first group comprises those measuring the growth of income per capita or the growth of productivity, whereas the second group incorporates all those who measure trade performance. Some measures of national trade performance are: a shift in export composition toward higher value added or high-tech products; constant or increasing world market shares; and a current account surplus (McFetridge, 1995).

The literature offers various indices of competitiveness utilized by various organizations: International Institute of Management Development (IIMD) and World Economic Forum (WEF). World Competitiveness Yearbook index values scores, provided by IMD, analyzes and ranks the ability of nations to create and maintain an environment that sustains the competitiveness (McCauley, 2008), and Global Competitiveness Index, provided by the WEF, represents summative values encompassing numerous aspects of economic and social prosperity.

For more than 30 years (since 1979), WEF has been researching and measuring complex phenomena of competitiveness, by applying the recommendations of growth and development theory, contemporary institutional economics, and applied business economics. In assessment of competitiveness WEF utilizes the concept and methodology of Global Competitiveness Index (GCI), developed and made explicit by Porter and his associates (Sala-i-Martin et al., 2008). GCI is an integrated composite index, which concentrates on productivity level determinants as a key factor of national prosperity. This is in line with Porter's opinion (1990) that the key to per capita income growth is productivity growth; the key to productivity growth is innovation; and the key to innovation is a properly functioning "diamond" or cluster (innovation system). Porter was the first to make theoretical and practical links

between strategic aspects of business competitiveness at the level of a enterprise with the environment at the level of a sector or the level of the entire economy. Competitiveness is systematically followed by 108 indicators throughout 12 fields of competitiveness grouped as basic requirements, efficiency enhancers and innovation and sophistication factors.

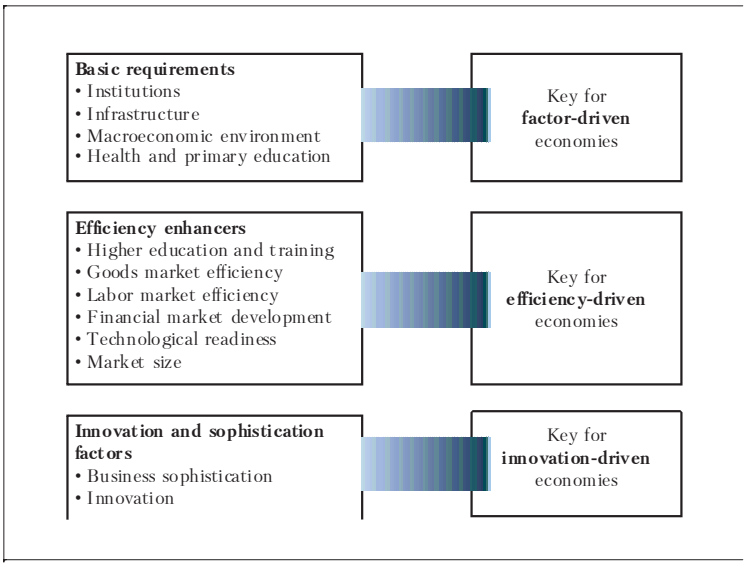

Figure 1. **12 pillars of competitiveness**

Source: The Global Competitiveness Report 2007-2008. World Economic Forum, Geneva, Switzerland, 2008., p. 7.

Growth phase concept emerged together with development of composite GCI. At the first (factor-driven) stage GDP per capita is lower than $2000, and the economic growth primarily depends on the quality and quantity of primary production factors and basic requirements for entrepreneurship (Figure 1.). At this stage, the most important role and the largest ponder (50%) are assigned to the first group (basic requirements).

At the second stage of development (efficiency-driven stage), GDP per capita is between $3000 and $9000, where efficiency enhancers influence the growth, with their ponder amounting to 50%. At the third stage of development (innovation-driven), GDP per capita is above $17000, with the ponder innovation and sophistication factors amounting to 30%.

3. Research methodology. The starting point in the analysis represents the concept and GCI model taken from the WEF's report (2011). The influence of all pillars of competitiveness on the competitiveness of two groups of transitional economies is analyzed, as measured by GCI.

The first group comprises 15 countries which are still undergoing the process of transition (Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Montenegro, Croatia, Kazakhstan, Kyrgyz Republic, Macedonia, Moldova, Russian Federation,

Serbia, Tajikistan, Ukraine and Georgia). The second group comprises 10 countries which have completed the process of transition (Hungary, Czech Republic, Slovenia, Poland, Bulgaria, Romania, Slovak Republic, Estonia, Latvia and Lithuania). There are two methodological procedures used. The first one is the t-test (one-sample mean test) used with the purpose of determining the importance of individual pillars in generating GCI. For this purpose the arithmetic mean of indices for every pillar of competitiveness was calculated for both groups of transition countries. What follows is the assessment of statistically important deviation of these values as compared with the test values. Given that, according to the WEF methodology, the values of all pillars indices are in the range between 1 and 7, we selected the test value 4. In accordance with that, we formulated the following statistical hypotheses:

Ho: $\mu \leq 4$ (the value of arithmetic mean of the pillar is lower than the test value 4).

H1: $\mu > 4$ (the value of the arithmetic mean of the pillar is higher than the test value 4).

The other procedure for calculating the degree of correlation between the values of competitiveness index (both global and the index of each of the respective pillars) and the value of GDP per capita, for each group of countries respectively, implies using Pearson's and Spearmen's coefficients.

The following research hypotheses have been formulated for the purpose of this analysis:

H1: GCI is positively correlated with GDP p/c.

H2: Institutions (the first GCI pillar) are positively correlated with GDP p/c.

H3: Infrastructure (the second GCI pillar) is positively correlated with GDP p/c.

H4: Macroeconomic environment (the third GCI pillar) is positively correlated with GDP p/c.

H5: Health and primary education (the fourth GCI pillar) is positively correlated with GDP p/c.

H6: Higher education and training (the fifth GCI pillar) is positively correlated with GDP p/c.

H7: Goods market efficiency (the sixth GCI pillar) is positively correlated with GDP p/c.

H8: Labour market efficiency (the seventh GCI pillar) is positively correlated with GDP p/c.

H9: Financial market development (the eighth GCI pillar) is positively correlated with GDP p/c.

H10: Technological readiness (the ninth GCI pillar) is positively correlated with GDP p/c.

H11: Market size (the tenth GCI pillar) is positively correlated with GDP p/c.

H12: Business sophistication (the eleventh GCI pillar) is positively correlated with GDP p/c.

H13: Innovation (the twelfth GCI pillar) is positively correlated with GDP p/c.

4. Research results. The results obtained by applying the aforementioned methodology are shown in Tables 1 to 5.

Table 1. **One sample t-test for Group I countries**

Factors	Mean	Std. Deviation	Std. Error Mean	t	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Evaluation
							Lower	Upper	
1. Institutions	3,5567	,41208	,10640	-4,167	,001	-,44333	-,6715	-,2151	Low
2. Infrastructure	3,5320	,57144	,14755	-3,172	,007	-,46800	-,7845	-,1515	Low
3. Macroeconomic environment	4,3233	,75069	,19383	1,668	,117	,32333	-,0924	,7391	Medium
4. Health and primary education	5,6513	,28610	,07387	22,354	,000	1,65133	1,4929	1,8098	High
5. High education and training	4,0320	,34923	,09017	,355	,728	,03200	-,1614	,2254	Medium
6. Goods market efficiency	3,8393	,29487	,07614	-2,110	,053	-,16067	-,3240	,0026	Medium
7. Labor market efficiency	4,4640	,27155	,07011	6,618	,000	,46400	,3136	,6144	High
8. Financial market development	3,6827	,39834	,10285	-3,085	,008	-,31733	-,5379	-,0967	Low
9. Technological readiness	3,4380	,43888	,11332	-4,959	,000	-,56200	-,8050	-,3190	Low
10. Market size	3,2320	,98522	,25438	-3,019	,009	-,76800	-1,3136	-,2224	Low
11. Business sophistication	3,4207	,23984	,06193	-9,355	,000	-,57933	-,7121	-,4465	Low
12. Innovation	2,8267	,35359	,09130	-12,852	,000	-1,17333	-1,3691	-,9775	Low
a) Basic Requirement	4,2667	,37435	,09666	2,759	,015	,26667	,0594	,4740	High
b) Efficiency Enhancers	3,7747	,26422	,06822	-3,303	,005	-,22533	-,3717	-,0790	Low
c) Innovation	3,1240	,27581	,07121	-12,301	,000	-,87600	-1,0287	-,7233	Low

Table 1 shows that the following pillars are not relevant for Group I: macroeconomic environment; high education and training; and goods market efficiency. For these pillars, p-value exceeds 0.05 (the hypothesis H1 is rejected), which means they exert no significant influence on the global competitiveness index.

Table 2. **Correlation between GCI pillars and GDP per capita for Group I countries**

	Pearson's correlation coefficient		Spearman's rank correlation coefficient	
Hypothesis	*R*	*p value*	R_S	*p value*
H1	0,622 *	0,013	0,756**	0,001
H2	0,183	0,513	0,157	0,576
H3	0,810**	0,000	0,674**	0,006
H4	0,568*	0,027	0,721**	0,002
H5	0,690**	0,004	0,695**	0,004
H6	0,612*	0,015	0,682**	0,005
H7	0,132	0,638	0,300	0,277
H8	-0,326	0,236	0,014	0,960
H9	0,332	0,227	0,386	0,156
H10	0,780**	0,001	0,829**	0,000
H11	0,461	0,084	0,527*	0,043
H12	0,485	0,067	0,593*	0,020
H13	0,618*	0,016	0,729**	0,002

Note: * – statistically significant results at the 0.05 significance level (two-tailed test); ** – statistically significant results at the 0.01 significance level (two-tailed test).

As Table 2 shows, the results of Pearson's correlation coefficient application suggest that the pillars of infrastructure, technological readiness and health and primary education correlate most with the value of GDP per capita in the Group I. Spearman's coefficient shows that the pillars of technological readiness, innovation and macroeconomic environment mainly correlate with the value of GDP per capita.

Table 3. **One sample t-test for Group II countries**

Factors	Mean	Std. Deviation	Std. Error Mean	t	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		Evaluation
							Lower	Upper	
1. Institutions	3,9490	,45025	,14238	-,358	,728	-,05100	-,3731	,2711	Medium
2. Infrastructure	4,2690	,53336	,16866	1,595	,145	,26900	-,1125	,6505	Medium
3. Macroeconomic environment	4,8510	,33445	,10576	8,046	,000	,85100	,6118	1,0902	High
4. Health and primary education	6,0210	,18651	,05898	34,265	,000	2,02100	1,8876	2,1544	High
5. High education and training	4,8340	,36455	,11528	7,235	,000	,83400	,5732	1,0948	High
6. Goods market efficiency	4,3020	,24087	,07617	3,965	,003	,30200	,1297	,4743	High
7. Labor market efficiency	4,5640	,19202	,06072	9,288	,000	,56400	,4266	,7014	High
8. Financial market development	4,2330	,29560	,09348	2,493	,034	,23300	,0215	,4445	High
9. Technological readiness	4,3150	,34792	,11002	2,863	,019	,31500	,0661	,5639	High
10. Market size	3,8820	,69063	,21840	-,540	,602	-,11800	-,6120	,3760	Medium
11. Business sophistication	4,0220	,33839	,10701	,206	,842	,02200	-,2201	,2641	Medium
12. Innovation	3,3390	,37269	,11786	-5,609	,000	-,66100	-,9276	-,3944	Low
a) Basic Requirement	4,7740	,31500	,09961	7,770	,000	,77400	,5487	,9993	High
b) Efficiency Enhancers	4,3550	,20829	,06587	5,390	,000	,35500	,2060	,5040	High
c) Innovation	3,6800	,33480	,10587	-3,023	,014	-,32000	-,5595	-,0805	Low

According to the results in Table 3, the following pillars prove to be statistically irrelevant to the Group II: institutions, infrastructure, market size and business sophistication. Other pillars show a statistically relevant influence on the value of GDP.

The results in Table 4 show that, according to the value of Pearson's correlation coefficient, the following pillars largely correlate with the value of GDP per capita: business sophistication, health and primary education and infrastructure. On the other hand, the values obtained through the application of Spearman's coefficient show that the value of GDP per capita mainly correlates with the following pillars: goods market efficiency, innovation and health and primary education.

Table 4. **Correlation between GCI pillars and GDP per capita for Group II countries**

	Pearson's correlation coefficient		Spearman's rank correlation coefficient	
Hypothesis	*R*	*p value*	R_S	*p value*
H1	0,528	0,117	0,576	0,082
H2	0,452	0,190	0,442	0,200
H3	0,760*	0,011	0,721*	0,019
H4	0,513	0,129	0,515	0,128

The End of *Table 4*

Hypothesis	Pearson's correlation coefficient		Spearman's rank correlation coefficient	
	R	*p value*	R_S	*p value*
H5	0,795**	0,006	0,733*	0,016
H6	0,676*	0,032	0,681*	0,030
H7	0,725*	0,018	0,830**	0,003
H8	-0,012	0,973	0,231	0,531
H9	0,272	0,448	0,529	0,116
H10	0,574	0,083	0,600	0,067
H11	-0,151	0,677	-0,097	0,789
H12	0,816**	0,004	0,673*	0.033
H13	0,690*	0,027	0,758*	0,011

Note: * – statistically significant results at the 0.05 significance level (two-tailed test); ** – statistically significant results at the 0.01 significance level (two-tailed test).

Table 5. **t-test, Pearson and Spearman coefficients values for two groups of countries for two pillars of competitiveness (Technological readiness and Innovation)**

Pillars	Group I countries (15)			Group II countries (10)		
	t-test	Pearson	Spearman	t-test	Pearson	Spearman
Technological readiness: • availability of latest technologies • firm-level technology absorption • FDI and technology transfer • Internet users • broadband Internet subscriptions • Internet bandwidth	0,000	0,780**	0,829**	0,019	0,574	0,600
Innovation: • capacity for innovation • quality of scientific research institutions • company spending on R&D • university-industry collaboration in R&D • government procurement of advanced tech products • availability of scientists and engineers • utility patents per million population	0,000	0,618*	0,729**	0,000	0,690*	0,758*

Note: * – statistically significant results at the 0.05 significance level (two-tailed test); ** – statistically significant results at the 0.01 significance level (two-tailed test).

In Table 5 we compare the results of the analysis for two pillars of competitiveness: technological readiness and innovation for both groups of countries. The results enable us to make the following conclusions: first, technological readiness and inno-

vation exert a significant influence on GCI, in the case of both groups of countries; second, the correlation between technological readiness and GDP p/c is relevant to Group I, whereas the correlation between innovation and GDP p/c is relevant to Group II. Such result helps us to draw the conclusion that the countries in Group II (10) have established a stronger technological basis (largely due to the FDI inflows), and that they have preserved and enlarged the innovation capacity to a larger extent than the countries in Group I (15).

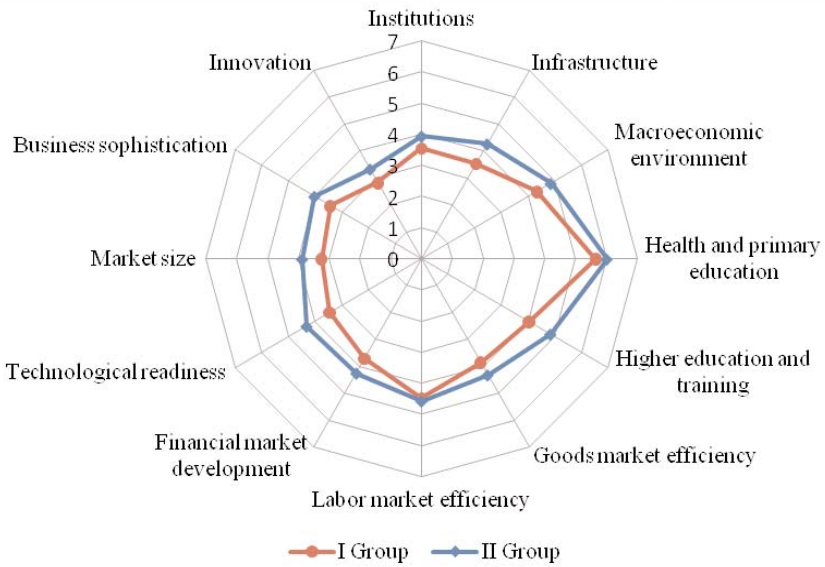

Figure 2. **Comparison between two groups of the countries according to GCI pillars**

Source: Authors' calculations based on Global Competitiveness Report 2011.

The comparison of mean values of competitiveness pillars between two groups of countries shows there is a noticable advancement characterizing developed (transitional) economies in all the factors listed in respective pillars.

Limitations of this analysis may be found in the way countries were classified. This classification was performed following the UNCTAD's classification of post-socialist countries which distinguishes between transitional (15) and developed (10) countries (UNCTAD stat 2011), failing to classify them according to their respective stages of development. For this reason, countries at a different stage of development may be found within the same group.

5. Conclusion. Competitiveness is a very complex phenomenon, which may be observed at the level of a company, industry, and an economy. There are numerous factors of social and economic environments affecting competitiveness. A combination of these factors determines a country's competitiveness at the global market.

Technological changes are very dynamic nowadays, and for this reason all countries should develop their own technological and innovation capacities in order to be able to implement (or develop by themselves) the latest technological achievements.

Countries will enhance their own competitiveness if they are capable to change their exports structure from resource intensive and labor intensive industries to human capital and technology intensive industries. The enhancement of the structure and quality of exports is possible only if technological and innovation capacities are updated and improved, as well as by improvement of all the other factors contained within competitiveness pillars.

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