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ESTIMATION OF IMPACT OF INNOVATIONS ON THE QUALITY OF TERTIARY EDUCATION

Y.H. HASANLI[1], S.A. SHABANOV[1]

[1] Azerbaijan State University of Economics, Baku, Azerbaijan
e-mail: yadulla.hasanli@unec.edu.az, sardar.shabanov@unec.edu.az

In order to estimate the impact of innovations on the quality of education it is important to have the indicators that those ones are able to characterize these definitions. It is known that the indicators impacting to quality of education can be divided into two parts: measurable and immeasurable. For example, how to characterize the education system of any country? There is no doubt that international comparisons are necessary here [6,7]. On the other hand, the education itself consists of different stages. It is known that education has both quantitative and qualitative indicators. For example, quantitative indicators include the level of literacy of the country's population, the number of preschool educational institutions, the number of secondary schools, and the number of teachers and so on. However, besides these indicators, in recent years, special attention has been paid to the quality of education. For example, the student's average score (at the pupil level) in the math, average scores on mathematics and natural sciences in the international PISA competition, "good" teacher, national tradition, culture, etc. [2,5,6].

In this study, we will use only the criterion of the number of journal articles falling to highly indexed scientific bases that allow us to describe the quality of tertiary education in the country to a certain extent. This criterion was first used in the article [3] published in 2013. It should also be noted that the article must concern only the fields of basic science and engineering, but not in any other area. This is due to the fact that these studies show that just these fields have a higher impact on the quality of tertiary education from a statistical point of view. That is to say, the impact of these fields is stronger than the impact of economics and business. So, in order to characterize the quality of tertiary education in the country, we will use the indicators of the number of articles concerning the fields of basic science and engineering and indexed by Web of Science. The most important feature of this indicator is its accessibility and one-dimensionality.

Now let's pay attention to innovation. A number of innovation indicators are used in the World Bank database [4]. We can show the followings as examples:

(1) High-technology export (% of manufactured export);
(2) High-technology export (current US $);
(3) Number of technical staff working in Research and Development (per million people);
(4) Number of researchers in Research and Development (per million people);
(5) Trademark applications;
(6) Patent applications;
(7) Share of Research and Development expenses in GDP (%);
(8) Intellectual property export (US $);
(9) Intellectual property import (US $).

The analysis was conducted by constructing the econometric models of impact of innovations on the quality of tertiary education for Azerbaijan, Germany, Austria, Russia, Kazakhstan, Iran and Turkey based on relevant indicators covering 2000-2017. Econometric models [1] were implemented through the Eviews 9 program. We took the number of articles as a dependent variable and we set up various regression equations and run correlation and regression analysis. The impact of the innovation on the number of articles that we have investigated has been statistically significant for only two indicators: 1) Intellectual property export (US \$); 2) Intellectual property import (US \$). That's why we removed the remaining indicators besides the two ones from our research. Some information for Azerbaijan is shown in Table 1.

Table 1. Values for some indicators for Azerbaijan.

Year	2002	2003	2004	2005	**2006**	2007
ImportIP(US $)	2 050 000	144 000	N/A	46 000	***1 281 000***	4 697 000
SciTechArticles	216,6	245,6	327,5	329,8	***280***	408,6
Year	2008	2009	2010	2011	2012	2013
ImportIP(US $)	4 827 000	19 229 000	16 531 000	18 423 000	28 180 000	N/A
SciTechArticles	470,8	617	618,7	655,8	683,1	481,8

Source: http://api.worldbank.org/v2/en/indicator/IP.JRN.ARTC.SC?

The regression equation of the dependence of the number of articles on the import of intellectual property for Azerbaijan was found as follows:

$$\ln(SciTechArticles) = 1\ 252\ 816 - 1,118388\ \ln(ImportIP) + 0,045111\ (\ln ImportIP)^2 \quad (1)$$

Here, ln (SciTechArticles) – the natural logarithm of the number of articles concerning the fields of basic science and engineering and entered in influential base; $\ln(ImportIP)$ - the natural logarithm of intellectual property imports.

Table 2. The basic results obtained for Azerbaijan through Eviews.

Dependent variable	Constant	ln (*ImportIP*)	(ln (*ImportIP*))^2	Number of obs.	R^2_{adj}
ln (*SciTechArticles*)	12,52816	-1,118388	0,045111	9	0,933544
(s.e.)	(1,819457)	(0,265173)	(0,009433)		
t-stat	6,885657	-4,217583	4,782170		
Prob	0,0005	0,0056	0,0031		

Source: the authors' calculations through Eviews.

All the statistical characteristics of this equation are satisfactory. Thus, the standard errors of the parameters are much smaller than the value of the parameter and it shows that the values found by the least squares method are highly reliable (t-test). Being Durbin-Watson statistics close to 2 (DW = 2,1181) shows that there is no first difference autocorrelation of the residuals and this is desirable. The value of adjusted R^2 is close to one (R^2_{adj}) indicates that the model has high levels of approximation. In other words, the change in the number of articles can be explained by the 93.3% change in the volume of imported intellectual property. It is obvious from the equation that the form of dependency is a square parabola oriented upward. Before the value of his ordinate decreases then it increases.

The computation shows that theoretically the minimum value is obtained in the case that the imports of intellectual property is equivalent to \$ 241,822. That is to say after the import of intellectual property exceeds \$ 242,000, the number of articles concerning the fields of basic science and engineering and entered in influential base starts rising, otherwise the decline is observed.

If we compare this obtained result with the official statistics, we will see that although the value was not in the database, such value occurred in the case wherein the closest value was 280 in 2006, while the amount of imported intellectual property was \$ 1281,000. The value of average elasticity coefficient for Azerbaijan was computed as $\bar{E} = 0,385$.

This means that if the value of imported intellectual property in Azerbaijan increases by 1% compared to the average, then the number of articles concerning the fields of basic science and engineering and entered in influential base will increase by approximately 0.385% compared to the average.

The econometric modeling results for Germany, Austria, Russia, Kazakhstan, Iran and Turkey are as follows:

- 1% increase in intellectual property exports for Germany increases the number of articles by 0.26%, but increase in imports by 1%, increases the number of articles by 0.12%. The impact of intellectual property exports on the number of articles is about twice as much as imports. The change in explanatory variables explains 95.81% of the change in response variable.
- For Austria it was determined that neither export nor import of intellectual property had significant impact on the number of articles. The econometric equation is constructed on the share of research and development in GDP. It was found that if the share of research and development in GDP changes in Austria by 1% compared to the average, then the number of articles compared to the average will change by 1,332% too.
- The econometric equation determining the dependence of the number of articles on imported intellectual property was constructed for Russia. The average elasticity value was found as 0.124. This means that change in intellectual property imports by 1% will change the number of articles approximately 0.12%.
- It was found out that the number of articles for Kazakhstan does not depend on the intellectual property export. The elasticity coefficient of the dependence of the article number on import for Kazakhstan was calculated: $9,390 * 10^{-9}$, it is practically zero. That is to say the number of articles for Kazakhstan is not elastic in relation to the volume of intellectual property imports.
- Since there was no other information in appropriate source about the two other indicators that interested us except for the number of articles, it was impossible to establish a regression equation for the 2000-2016 periods for case of Iran. However, the dynamics of the article show that science has rapidly evolved over the same years and the average annual growth rate of articles was 24.18%.
- The econometric equation determining the dependence of the number of articles on imported intellectual property was constructed for Turkey and the appropriate average elasticity value was computed as $\bar{E} = 0,761$. This shows that 1% increase (decrease) in intellectual property imports compared to the average for Turkey will increase (decrease) the number of articles by 0.76%. Note that coefficients of regression equation for Turkey are statistically significant with 1% risk. That is also the same for other countries those we have explored. The computations show that the coefficients for Germany were statistically significant at 5% risk.

Finally, it should be noted that with considering the special role of the export and import of intellectual property for the development of science and the improvement of the quality of tertiary education, Azerbaijan either should pay particular attention to the fields of basic science and engineering or increase their efforts on both intellectual property exports and imports by developing the fields of knowledge-intensive processing industries.

Keywords: Education, quality, intellectual property, econometrics, elasticity.

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