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The analysis of innovation in Western Balkan countries in 2012

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The positive correlation between innovativeness and economic growth has been confirmed in plenty of empirical and theoretical research. Issues related to the conditions contributing to the promotion of innovation have a leading role in the development of methods for the stimulation of economic growth in the contemporary economic environment. Complex and multiple correlations between innovation and economic growth have an impact on the key economic factors, not only in economically developed and generally highly innovative countries, but also in less developed countries, such as the Western Balkan countries. This article first gives retrospective views on the importance of innovation and the applicable national innovation systems for the economic development of countries. Further, the article provides a brief insight into the metrics of the global innovation index (GII) and the global competitiveness index (GCI). The focus of analysis has been the relationship between innovation outputs and innovation inputs, as well as the relationship between the GII and the GCI of six Western Balkan countries (Albania, Bosnia and Herzegovina, Macedonia, Serbia, Croatia, and Montenegro), and a group of six selected European Union (EU) countries, five of which border this region (Bulgaria, Greece, Hungary, Romania, and Slovenia), whereas Austria, as a highly developed and highly innovative country, is geographically located very close to the Western Balkans.

Keywords: innovations; innovativeness; innovation capacity of the economy; national innovation systems; economic development; macro competitiveness

JEL classification: O310, 0520.

1. Introduction

A higher share of new products, services, and processes stands for one of the central assumptions underlying the process of generating economic growth and improving competitiveness of a country, irrespective of its level of economic development (Hasan & Tucci, 2010; LeBel, 2008; Zhu et al., 2011). What is more, for the Western Balkan countries, as the least developed part of Europe from an economic point of view, improvement of innovativeness is much more than a mandatory prerequisite for their economic recovery. To put it briefly, the growth of the innovation capacity of the economy, on one hand, and the improvement of competitiveness on the other is a long term prerequisite for their economic and social survival (Balkyte & Tvaronaviciene, 2010; Kilijoniene, Simanaviciene, & Simanavicius, 2010).

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Evaluation of the achieved level of innovativeness and competitiveness of the Western Balkan countries and subsequent evaluation of the quality of their national innovation systems is possible on the basis of a number of measures. This study relied on the data from the Global Innovation Index Report (2012) and the Global Competitiveness Index Report 2012–2013. Data on innovation and the competitive performance of these countries is compared to the data on innovativeness and competitiveness of the six European Union (EU) countries, whose EU status is a goal of the Western Balkan countries (Croatia joined the EU in 2013). In our opinion, it stands to reason to compare the values of the global competitiveness index (GII) innovation input, innovation output, and the global competitiveness index (GCI) of the Western Balkans and a selected group of EU countries, especially since these countries are similar in respect to the number of inhabitants and the size of the territory that they occupy (with the exception of Romania). If the results of the comparative analysis of the key parameters of innovativeness show a big gap between the Western Balkan countries and the selected EU countries, it can be concluded that low innovativeness *ceteris paribus* stands for the limiting factor of improvement of their competitiveness. However, low competitiveness means a further developmental gap between the Western Balkan countries and the other European economies. It can be an important message to the development policymakers in the Western Balkans for the future.

2. The importance of innovativeness and the construction of a national innovation system for economic development

The last 20 years have brought a sudden increase in economists' interest in the study of the phenomenon of innovation and innovativeness at a global level (Freeman, 2002; Greenhalgh & Rogers, 2010). It is clear that innovations are by far the most important determinant of economic growth and improvement of competitiveness of countries (Cooke et al., 2000; Metcalfe & Ramlogan, 2008). On one hand the growth of innovativeness on all levels, as well as the progress of econometrics and the creation of a large number of different databases on the other, have created possibilities of more precise quantification of the factors of innovativeness of certain countries and more adequate analysis of the impact of innovation on economic growth and macro competitiveness.

The interest of economic theory in exploring the importance of innovations for the process of generating economic growth emerged in the 1960s with the promotion of the neoclassical growth model of Robert Solow, has continued until the present day. The fact that Solow incorporated the complex of innovation into the so-called residual factor, and his firm attitude on its decisive role in the economic progress of the US in the first half of the twentieth century (Solow, 1956, 1957), was also a powerful message to a number of researchers, pointing in the direction that their interest should take. In the years following the announcement of the results of Solow's research, analysts engaged considerable efforts to efficiently grasp the nature and significance of residual factor, whose value is dominantly determined by the complex of innovations (Barro & Sala-i-Martin, 1995). The view that differs in innovative capacity of economies is the central reason why the existence of profound differences in economic performance of national economies prevailed (Fagerberg, Srholec, & Verspagen, 2009; Link & Siegel, 2003). The emergence of new (endogenous) growth theory during the 1980s and 1990s contributed further to the expression of this view in economics (Romer, 1986, 1987, 1990).

The view underlying the new growth theory is that economic policymakers and the conduct of economic subjects have an impact on the dynamics of economic progress in the long run. Judging by the opinion of the advocates of endogenous theory, it is possible to affect the equilibrium growth to a large extent. As an endogenous variable, innovations are products of the economic system, so that the market evaluation of their effects often highlights market failure. Specifically, much of the knowledge standing for the key generator of innovations has qualities of public goods, which makes it hard to get. However, the possibilities of cheap reproductions remain. Due to the fact that the private economic agents cannot make use of all the benefits of knowledge accumulation and technological solutions, the economic growth rate is inevitably at a lower level, when compared to the socially possible rate of appreciation of national production. Therefore, innovators must be guaranteed adequate incentives for the investment of financial and human resources in activities that are characterised by pronounced capital intensity and high risk investments. Therefore, the process of generating innovation must be tied to the needs of researchers and innovators to use commercial evaluation of new ideas to make profit (Romer, 1987).

3. Creation and promotion of the concept of the national innovation system

The positive correlation between innovation and economic development has been confirmed in plenty of empirical and theoretical research (Cimoli & Dosi, 1995, p. 243). Generally speaking, the issues related to the conditions contributing to the promotion of innovation have a key role in the investigation of alternative methods of stimulating economic growth (see, for example, Sharif, 2006). Innovations are primarily grounded on the results of fundamental and applied research in the developed world, which is, in theoretical terms, in direct relation to the development and affirmation of the concept of national innovation systems (Peters, 2006, p. 2).

The development of the concept of the national innovation system is primarily the result of increased awareness of the importance of innovation for economic growth. Over a relatively short period of time, this concept exerted a strong influence on the shape and practical realisation of innovation policy as an increasingly important factor of development management not just of the leading markets, but also of fast developing countries in the world (for example, Alkemade et al., 2011; Archibugi et al., 1999; Kuhlmann & Edler, 2003; Smits & Kuhlmann, 2004).

The emergence of this concept is linked to a British economist Christopher Freeman (1987). The concept of a national innovation system got its theoretical background in the works of Lundvall (1992) and Nelson (1993). Since then, the concept of a national innovation system has attracted the attention of economic development policymakers in a great number of countries, expressing at the same time its undeniable practical relevance (see Johnson & Lundvall, 2000).

In respect to their basic structure, national innovation systems consist of components, the connection between them, and the corresponding attributes. The system components include different stakeholders (individuals, companies, banks, universities, research institutions, government agencies, and others), available physical capital (machinery, equipment, and buildings), available technological solutions, as well as numerous formal and informal institutional factors (the laws, traditions, social norms). The connections between the system components can have market and non-market character. The dynamics of national innovation systems is determined by their intensity and quality. The attributes of the system are related to the characteristics of the components and the connections between them that are determined by the system capacities. Given that the purpose of national innovation systems is the creation, generation, and diffusion of technology, their key qualities lie in the ability of actors to make use of these activities and use technologies that lead to the creation of largest economic values (Carlsson et al., 2002, pp. 234–235).

Some believe the state to be the most influential factor in the majority of the national innovation systems, since it finances and implements the major part of the basic research and development activities in the country (Niosi, 2002, p. 212). However, there are some noteworthy positions, based on which the efficiency of national innovation systems largely depends on the success of the company in developing new technologies and market implementation of product and service innovation (see, for example, Freeman, 2004).

One of the modalities of the national innovation system is found in the concept of Porter's 'Diamond' (Porter, 1990). The key message of Porter's model of competitive advantage is that the companies, as the carriers of economic activity of a country, realise competitive advantage through innovations. Porter believes that the competitiveness of a country is a function of economic potential to innovate and realise continuous improvement in all business areas. In a nutshell, according to Porter, innovations generate and maintain competition, i.e. the country's competitiveness depends on the ability of its economy to innovate and improve economic growth. Approach to innovation involves the conquest and use of new technologies, new products and new ways of doing business. Innovations offer a new basis of competing on the market to individual companies, as well as new ways to compete on the basis of old principles. They may include new product design, new production process, a new approach to the market or a new way of training, but they always involve investment in upgrading the skills and knowledge, as well as investment in physical assets and brand reputation (Porter, 1990).

Porter placed special emphasis in the process of generating innovations on the phenomenon of industrial clusters. Cluster-based economy determines the quality of the business environment and stands for an important factor of competitiveness improvement. Cluster organisation is determined by the following attributes: quality of inputs, the context of strategic behaviour, local competition, sophisticated local demand, and the existence of related and supporting industries. Special emphasis is placed on the importance of the quality of relations between the clusters and the scientific community, which affects the degree of utilisation of innovation capacity of the economy (Porter & Stern, 2002, p. 6).

The concept of national innovation systems has become an unavoidable concept of international organisations such as OECD, UNCTAD, and many bodies of the EU (Peters, 2006, p. 15). The increasing interest in this concept was particularly present in fast developing countries of Asia, as well as in a number of countries of Latin America (Lundvall, Dalum, Johnson, & Sloth Andersen, 2002, p. 214). This is a logical consequence of the fact that the efficiency of the national innovation system significantly determines the innovation capacity of the economy, in terms of the ability of the national economy to create and use new knowledge in the process of creating the economic values.

The core of the concept of the national innovation system undoubtedly lies in Schumpeter's views on the importance of innovations and entrepreneurship in the shaping of key macroeconomic performance. Schumpeter claims that the central content of entrepreneurial activities is reflected in the creation and diffusion of innovations, since the entrepreneur's personality does not accept the world of routines, established technologies and 'unchanging institutional settings' (Schumpeter, 1961). Entrepreneurs introduce innovations in life by overcoming resistance to changes, at the same time disturbing the economic balance and starting the development process.

Recognising innovation as a kind of unique development resource, most economists today believe that the management of this complex is becoming one of the key aspects of the efficient functioning of certain economies. The increasing importance of innovation in business calls for a serious approach to the issue of management of innovation activities at all levels, starting from the top, the macro-level, to the level of individual companies.

4. The Global Innovation Index as the illustration of innovativeness of economy

Seeing the importance of innovation for the economic development of countries, i.e. seeing the importance of the innovation capacity of the economy for the economic progress of the state, the Confederation of Indian Industry, together with INSEAD (The Business School for the World) and Canon India, developed the GII, aimed at pointing to the level of innovativeness of individual countries. Furthermore, the objective of this report is the identification of the obstacles that block the effects arising from the use of innovation in companies and the economy as a whole.

The GII relies on two sub-indices, the Innovation Input Index (III) and the Innovation Output Index (IOI), each composed of the following pillars. Innovation inputs are composed of five pillars focusing on elements, i.e. innovative potentials of the national economy: (1) Institutions; (2) Human capital and research; (3) Infrastructure; (4) Market sophistication; and (5) Business sophistication. Innovation outputs include two pillars that point to the actual results of innovation: (6) Scientific outputs; and (7) Creative outputs.

Each pillar is divided into sub-pillars, representing aggregates of a number of indicators. Incentive or input parameters define the capacity of the environment to stimulate the creation and application of innovation in the economy. Outputs are the proof of the results of innovation inputs, such as, for example, patents, trademarks, copyrights, creative products, workers in the areas of knowledge-based services, the share of exports of high-tech products in total exports, and so on.

5. Innovations as the factor of global competitiveness

Economic theory uses different methods to explain the essence of competitiveness of countries on the world market (see, for example, Castellacci, 2008; Gibson & Naquin, 2011; Guan et al., 2006; Lall, 2001; Pudelko & Mendenhall, 2009; Sener & Saridogan, 2011). In broad terms, a country's competitiveness is based on the measurement of the key macroeconomic indicators and the living standard, with the focus on productivity. In narrow terms, however, this concept is defined as a country's ability to export its products to the world market.

There is no generally accepted methodology for quantifying macro-economic competitiveness (Snieška & Bruneckienė, 2009, p. 55). Practice offers several approaches to its measurement, among which the GCI, developed by the World Economic Forum, is the most significant. The model is based on more than 150 variables, classified into 12 pillars.

The assumption underlying the GCI is that countries pass through three phases of development. In the first stage *(factor-driven stage)*, the basic factors of competitiveness that are important for growth and productivity are: well-functioning public and private institutions, well-developed infrastructure, stable macroeconomic environment, and a good, healthy, and literate labour (see, for example, Macerinskiene & Sakhanova, 2011). As they further develop, the countries enter the second stage *(efficiency-driven stage)*, where they carry out more efficient production processes, thus increasing product quality.

At this stage, the increased competitiveness is influenced by higher education and training, goods market efficiency, well-functioning labour markets, sophisticated financial market, large domestic and international market, and the use of existing technology. In the third stage *(innovation-driven stage)*, the growth of productivity and competitiveness is primarily made possible through innovations (Hall & Mairesse, 2006). Knowledge-based economy has become the dominant economy of the twenty-first century, while the development of the global economy becomes driven by innovation (see Hsu et al., 2008). Innovation and knowledge, in the broadest sense of the word, are becoming the factors of development and, therefore, the factors of competitiveness (Snieška & Drakšaitė, 2007).

The Global Competitiveness Report 2012–2013 contains data for 144 countries. Although the results of all 12 pillars are shown separately, it is important to know that they are not independent. Instead, they overlap, with weaknesses in one area having a negative impact on other areas. For example, it is difficult to achieve a satisfactory innovation capacity of the economy (pillar 12) without healthy, well-educated, and trained labour (pillars 4 and 5) that is ready to accept new technologies (pillar 9), and without an efficient goods market that allows the placement of innovation on the market (pillar 6). Although the pillars are summarised in one index, measures are presented for each of the 12 pillars separately, because it provides insight into specific areas that certain countries need to improve.

6. The results of an empirical study

Based on different statistical tools, we conducted an analysis of the correlation between innovation outputs and innovation inputs, as well as the correlation between the GII and GCI for six countries of the Western Balkans (Albania, Bosnia and Herzegovina, Macedonia, Serbia, Croatia, and Montenegro), and a group of six selected EU countries. Out of these six countries, five directly border this region (Bulgaria, Greece, Hungary, Romania, Slovenia), and the sixth country, Austria, is a highly developed, innovative country.

Judging by the available data related to the countries that are observed in the context of this study, the analysis of variables includes the following: (1) data visualisation; (2) correlation analysis between: (2a) innovation outputs and innovation inputs; and (2b) the GII and the GCI; (3) analysis based on the information derived from the box plot diagrams; and (4) cluster analysis.

6.1. Innovation performance across the selected countries

Based on the data on the values of GII, III, IOI, as well as their basic components in relation to the Western Balkan countries on one hand, and the selected EU members on the other hand, Figure 1 graphically illustrates the relationship between the analysed variables.

This graphic presentation gives only partial information on the innovativeness of the observed countries. It points to the gap between the Western Balkan countries and the group of six selected EU countries, in respect of all pillars of GII. The exception is the fourth pillar (Market sophistication) and the sixth sub-pillar of innovation inputs (Knowledge and Technology Outputs), in respect of which the Western Balkan countries are closer to the average of the observed EU countries.

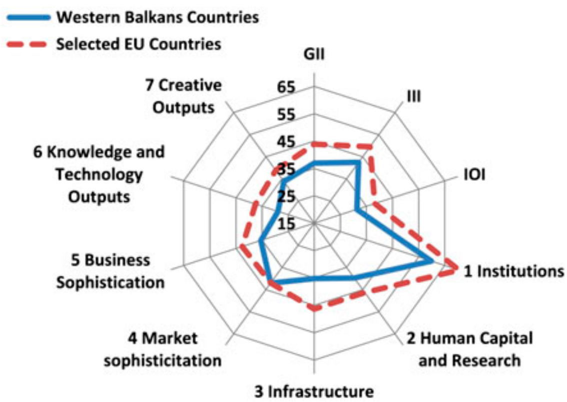

Figure 1. Graphical presentation of relations between the analysed variables.
Source: Authors' calculation based on Dutta (2012). The global innovation index 2012. Stronger Innovation Linkages for Global, INSEAD.

6.2. Component-wise analysis of the indexes of innovations and competitiveness

The standard way to show the connection (direction and degree of quantitative variation agreement) between the two variables is a scatter diagram, standing for the kind of a common spot diagram. Figure 2 shows a scatter diagram of the relationship between the variables III and IOI in the Western Balkan countries.

The graphic presentation of data pairs of variables III and the IOI for the six countries of the Western Balkan shows low interdependence between the variations of observed variables. Customising the linear form of interdependence and the analysis of the components of the specified model also point to the previously stated and visually perceived statement. In fact, linear regression function has the following form: y = −19.

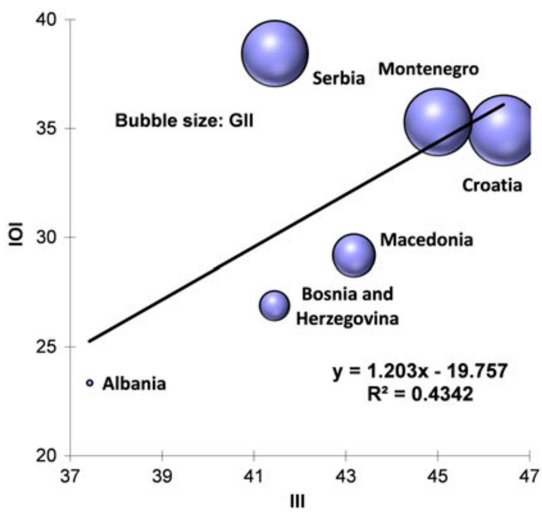

Figure 2. Scatter diagram for III and IOI for the Western Balkan countries.
Annotation: size of the bubble shows the relative ratio of the value of GII.
Source: Authors' calculation based on Dutta (2012). The global innovation index 2012. Stronger Innovation Linkages for Global, INSEAD.

75 + 1. 203 * X, with statistics of $R^2 = 0.434$ and R = 0.659. The value of the coefficient of determination points to the fact that only 43.4% of the variation of the variable IOI is explained by the variations of the variable III, while the remaining 56.6% is the result of the impact of other factors not included in this model. Weak correlation is confirmed by the correlation coefficient of 0.659. Its value points to the existence of weak direct (straight line extending from the lower left to the upper right corner of the graph) linear correlation between the observed variables in the countries included in the sample. The slope of the line ($b_1 = 1.203$) points to the fact that an increase of III by one unit leads to an increase of IOI by 1.203 (corresponding to the units of measurement used to express the variable IOI). Testing the hypothesis of linear interdependence of variables through appropriate regression coefficient gives the value of the test statistics of 1.752. With the probability of the significance level of the test at a 0.05 and 2.7764 test threshold, it can also be concluded that there is no statistically significant linear correlation between the variables III and IOI.

The graphic presentation of data pairs of variables III and the IOI for the six EU countries (Figure 3) points to a very strong correlation between the variations of the observed variables. Customising the linear form of interdependence and analysis of the components of the specified model also point to the previously stated, visually perceived statement. In fact, the linear regression function has the following form: $y = -21.68 + 1.208 * X$, with statistics of $R^2 = 0.819$ and R = 0.905. The value of the coefficient of determination points to the fact that 81.9% of the variation of IOI variable is explained by the variation of the variable III, while the remaining 8.1% is primarily the result of the impact of other factors not included in this model. A very strong correlation is confirmed by the correlation coefficient of 0.905. Its value points to the existence of a very strong, direct (straight line extending from the lower left to the upper right corner of the graph) linear correlation between the observed variables in the countries included in the sample. The slope of the line ($b_1 = 1.208$) indicates that an increase of III by one unit leads to an increase of IOI by 1.208. Testing the hypothesis of linear

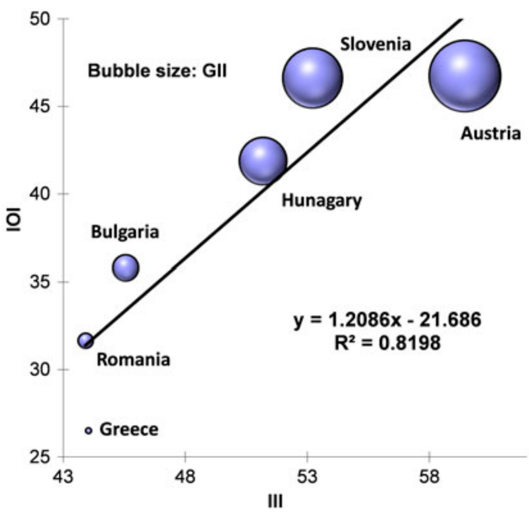

Figure 3. Scatter diagram for III and IOI for the selected group of EU countries.
Source: Authors' calculation based on Dutta (2012). The global innovation index 2012. Stronger Innovation Linkages for Global, INSEAD.

interdependence of variables through appropriate regression coefficient gives the value of the test statistics at 4.266. With the probability of significance level of the test at 0.05 and 2.7764 test threshold, it can also be concluded that there is a statistically significant linear correlation between the variables III and IOI.

Analysis of the relationship between III and IOI for the Western Balkan countries (Figure 4) has shown that there is no statistically significant impact of III on IOI. Conversely, in considering the relationship of these variables at the level of the selected EU countries, the existence of a statistically significant impact (linear interdependence) of III on IOI is confirmed.

The graphic presentation of data pairs of variables GII and GCI for the selected countries shows a very weak correlation between the variations of the observed variables. Customising the linear form of interdependence and analysis of components of the specified model also points to the previously stated, visually perceived statement. In fact, the linear regression function has the following form: y = 3.558 + 0. 011*X, with statistics of $R^2 = 0.217$ and R = 0.466. The value of the coefficient of determination points to the fact that only 21.7% of the variation of the variable GCI is explained by the variations in GII, while the remaining 78.3% is the result of the impact of other factors not included in this model. Weak correlation is confirmed by the correlation coefficient of 0.466. Its value points to the existence of weak, direct (straight line extending from the lower left to the upper right corner of the graph) linear correlation between the observed variables in the countries included in the sample. The slope of the line ($b_1 = 0.011$) shows that an increase of GII by one unit leads to an increase of GCI by 0.011. Testing the hypothesis of linear interdependence of variables over the corresponding regression coefficient gives the value of the test statistics at 1.0309. With the probability of significance level of the test at 0.05 and 2.7764 test threshold, it can also be

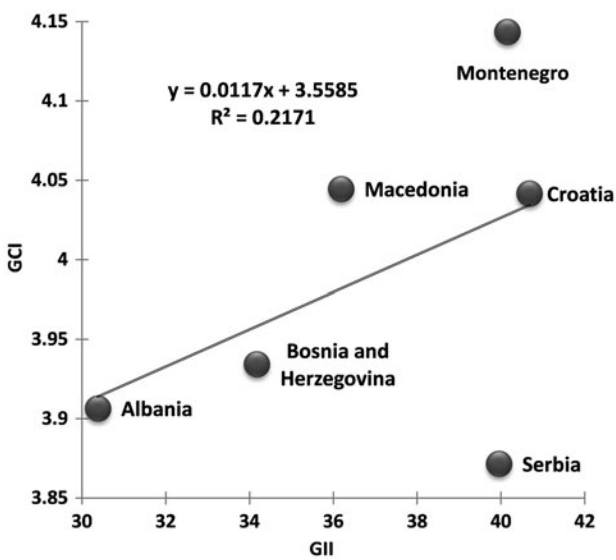

Figure 4. Scatter diagram for the GII and the GCI for the Western Balkan countries.
Source: Authors' calculation based on Dutta (2012). The global innovation index 2012. Stronger Innovation Linkages for Global, INSEAD and Global Competitiveness Report 2012–2013, World Economic Forum.

concluded that there is no statistically significant linear correlation between the variables GII and GCI.

The graphic presentation of data pairs of variables GII and GCI for the selected EU countries (Figure 5) shows a strong correlation between the variations of the observed variables. Customising the linear form of interdependence and analysis of components of the specified model also point to the previously stated, visually perceived statement. In fact, linear regression function has the following form: y = 1.887 + 0.056*X, with statistics of $R^2 = 0.722$ and R = 0.849. The value of the coefficient of determination points to the fact that 72.2% of the variation of the variable GCI is explained by the variations in GII, while the remaining 27.8% is a result of the impact of other factors not included in this model. A strong correlation is confirmed by the correlation coefficient of 0.849. Its value points to the existence of a strong, direct (straight line extending from the lower left to the upper right corner of the graph) linear correlation between the observed variables in the countries included in the sample. The slope of the line ($b_1 = 0.056$) points to the fact that an increase of GII by one unit leads to an increase of GCI by 0.056. Testing the hypothesis of linear interdependence of variables through appropriate regression coefficient gives the value of the test statistics at 3.237. With the probability level of significance of the test 0.05, and 2.7764 test threshold, it can be concluded that there is statistically significant linear correlation between the variables GII and GCI.

Analysis of the relationship between the GII and the GCI at the level of the Western Balkans has shown that there is no statistically significant effect of the GII on the GCI. At the same time, in considering the relationship of these variables at the level of the selected EU countries, the existence of a strong, direct linear correlation, as well as the statistically significant impact (linear interdependence) of the GII on the GCI is confirmed.

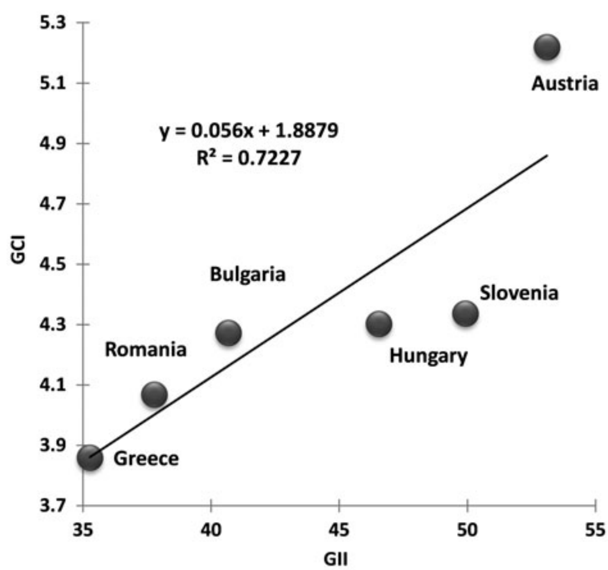

Figure 5. Scatter diagram for the GII and the GCI for the selected EU countries.
Source: Authors' calculation based on Dutta (2012). The global innovation index 2012. Stronger Innovation Linkages for Global, INSEAD and Global Competitiveness Report 2012–2013, World Economic Forum.

6.3. Identifying outliers

In descriptive statistics, a *box plot* is a convenient way of graphic presentation of numerical data summary on the basis of five parameters: minimum value of a numeric set of data, the bottom quartile (Q_1), median (Q_2), the top quartile (Q_3), and the maximum value of a numeric set of data. A *Box plot* also indicates the presence of outliers.

A *Box plot* points to the differences between populations, without giving any assumptions that are based on the analysis of statistical distribution: it is a non-parameter display. The distance between the different parts of the display points to the degree of dispersion (scattering) and asymmetry of data, as well as to the identification of gross errors in terms of individuals not belonging to the set. A Box plot can be displayed horizontally or vertically.

The maximum values of the variables *GII, III*, and *IOI* for the group of six analysed Western Balkan countries (Figure 6) equal 40.68 (Croatia), 46.43 (Croatia), and 38.45 (Serbia), while the minimum values are 30.38 (Albania), 37.42 (Albania), and 23.35 (Albania). The presence of outliers was not identified among the observed data. The average values of the observed variables for all the countries included in the analysis are 36.92, 42.49, and 31.35. From the aspect of the median value, which is (for the variable GII) 38.065, it can be noted that 50% of the countries included in the analysis have a value of the variable GII lower than 38.065 (median values), while the other 50% of the countries have a value greater than 38.065. In the case of the variable III, the median value is 42.31, which indicates that 50% of the countries included in the analysis have a value of the variable III lower than 42.31 (median values), while the other 50% of the countries have a value greater than 42.31. The median value for the variable IOI is 32.055, which points to the fact that 50% of the countries included in the analysis have a value of IOI lower than 32.055 (median values), while the other 50% of the countries have a value greater than 32.055. The first quartile (for the variable *GII*) amounts to 33.22, which indicates that 25% of countries have the value of the observed variable GII lower than 33.22%, while 75% of the surveyed countries have a value greater than the value of the first quartile. On the other hand, 25% of countries have a value of the GII larger than 40.282 (third quartile), while the remaining 75% of the countries have a value that is less than the third quartile. The first quartile (the III variable) is 40.435, which indicates that 25% of countries have a value of the observed variable III less than

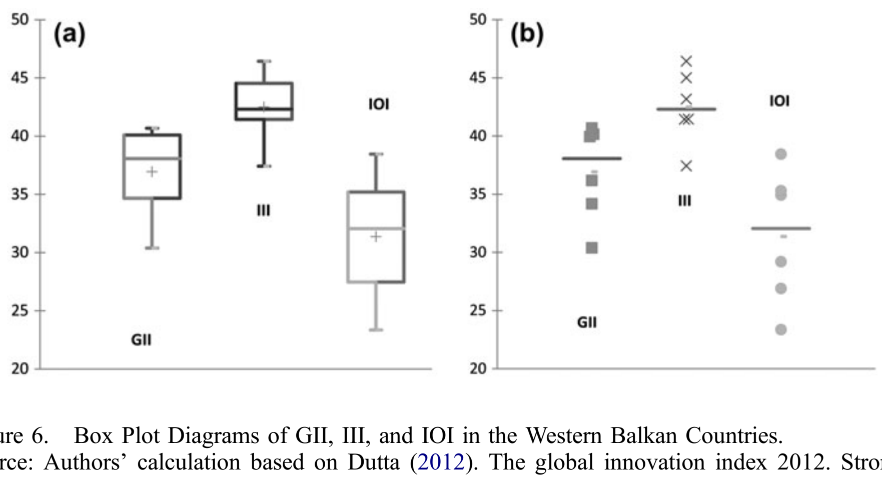

Figure 6. Box Plot Diagrams of GII, III, and IOI in the Western Balkan Countries.
Source: Authors' calculation based on Dutta (2012). The global innovation index 2012. Stronger Innovation Linkages for Global, INSEAD.

40.435, while the remaining 75% of the surveyed countries have a value greater than the value of the first quartile. On the other hand, 25% of the countries have a value larger than 45.358 (third quartile) in respect of the variable III, while the remaining 75% of the countries have the value that is less than the third quartile. The first quartile (for the variable IOI) is 26.012, which points to the fact that 25% of the countries have a value of the observed variable IOI less than 26.012%, while the 75% of the countries surveyed have a value greater than the value of the first quartile. On the other hand, 25% of the countries have a value larger than 36.088 (third quartile) for the variable IOI, while the remaining 75% of the countries have a value that is less than the third quartile.

Based on the values of the asymmetry coefficient (variable GII), $\alpha_3 = -0.801$, it can be concluded that this is a significantly negative asymmetrical pattern. In addition, it is a distribution that is more flattened compared to the distribution with normal height, since the curvature coefficient $\alpha_4 = -0.683$. In respect of the value of the variable GII, the observed group of countries is in terms of variability relatively homogeneous (coefficient of variation is 11.14%). In respect of the asymmetry coefficient (variable III), $\alpha_3 = -0.515$, it can be concluded that this is a significantly negative asymmetrical pattern. What is more, it is a distribution that is more elongated (less flattened), as compared to the distribution of normal height, since the curvature coefficient is $\alpha_4 = 0.304$. As for the value of the variable III, the observed group of countries is in terms of variability relatively homogeneous (coefficient of variation is 7.46%). When the variable IOI is taken into consideration, since the value of the coefficient of asymmetry is $\alpha_3 = -0.226$, it can be concluded that this is a moderately negative asymmetrical pattern. What is more, it is a distribution that is more flattened as compared to the distribution of normal height, since the curvature coefficient $\alpha_4 = -1.583$. In terms of the value of the variable IOI, the observed group of countries is in terms of variability relatively homogeneous (coefficient of variation is 18.44%).

Figure 7 shows the box plot diagram that refers to the GII, III and IOI for the selected EU countries.

The maximum values of the variables GII, III, and IOI for the observed group of EU countries are 53.10 (Austria), 59.45 (Austria), and 46.75 (Austria), while the minimum values are 35.27 (Greece), 43.91 (Romania), and 26.52 (Greece). The existence of outliers was not identified among the analysed data. The average values of the observed variables for all countries included in the analysis are 43.88, 49.56, and 38.21. In

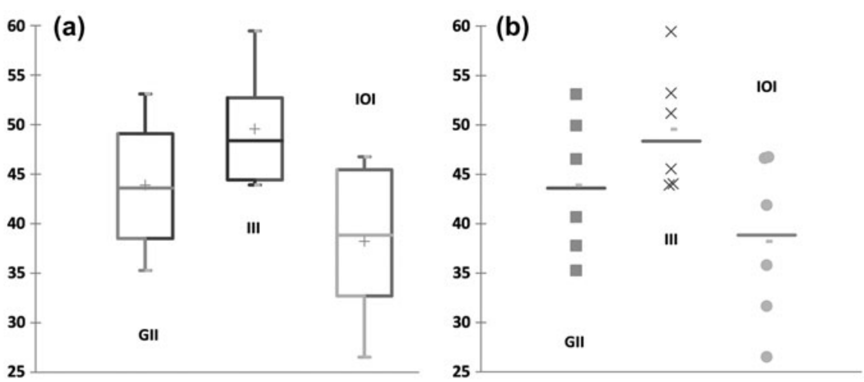

Figure 7. Box Plot Diagrams of GII, III and IOI for the selected EU countries.
Source: Authors' calculation based on Dutta (2012). The global innovation index 2012. Stronger Innovation Linkages for Global, INSEAD.

respect of the median value, which is (for the variable GII) 43.605, it can be concluded that 50% of the countries included in the analysis have a value of the variable GII less than 43.605 (median values), while the other 50% of the countries have a value greater than 43.605. In the case of the variable III, the median is 48.365, which indicates that 50% of the countries included in the analysis have a value of the variable III less than 48.365 (median values), whereas the other 50% of the countries have a value greater than 48.365. The median value amounts to 38.845 for the variable IOI, and suggests that 50% of the countries included in the analysis have a value of IOI less than 38.845 (median values), whereas the other 50% of the countries have a value greater than 38.845. The first quartile (for the variable GII) is 37.152, which suggests that 25% of the countries have a value of the observed variable GII less than 37.152, while the remaining 75% of the observed countries have a value greater than the value of the first quartile. At the same time, 25% of countries have a value of the variable GII larger than 50.715 (third quartile), while the remaining 75% of the countries have a value that is lower than the third quartile. The first quartile (the variable III) is 44, which suggests that 25% of the countries have a value of the observed variable III less than 44, while the remaining 75% of the analysed countries have a value greater than the value of the first quartile. At the same time, 25% of the countries have the value of the variable III greater than 54.77 (third quartile), while the remaining 75% of the countries have the value that is less than the third quartile. The first quartile (for the variable IOI) is 30.375 which indicates that 25% of the countries have the value of the observed variable IOI 30.375, while the remaining 75% of the observed countries have a value greater than the value of the first quartile. On the other hand, 25% of the countries have a value larger than 46.66 (third quartile) in respect of the variable IOI, while the remaining 75% of the countries have the value that is less than the third quartile.

Based on the asymmetry coefficient (the variable *GII*), $\alpha_3 = 0.\ 106$, it can be concluded that it is a moderately positive asymmetrical distribution. In addition, it is a distribution that is more flattened as compared to the distribution of normal height, since the curvature coefficient is $\alpha_4 = -1.891$. In respect of the value of the variable GII, the observed group of countries is in terms of variability relatively homogeneous (coefficient of variation is 16.12%). In respect of asymmetry coefficient (the variable III), $\alpha_3 = 0.766$, it can be concluded that this is a significantly positive asymmetrical distribution. What is more, it is a distribution that is more flattened as compared to the distribution of normal height, since the curvature coefficient is $\alpha_4 = -0.585$. In respect of the value of the variable III, the observed group of countries is in terms of variability relatively homogeneous (coefficient of variation is 12.51%). When it comes to the variable IOI, since the value of the coefficient of asymmetry is $\alpha_3 = -0.328$, it can be concluded that this is a moderately negative asymmetrical pattern. Moreover, it is a distribution that is more flattened as compared to the distribution of normal height, since the curvature coefficient is $\alpha_4 = -1.621$. As for the value of the variable IOI, the observed group of countries is in terms of variability relatively homogeneous (coefficient of variation is 21.67%).

6.4. Identifying development paths

Based on the cluster analysis, the analysed set of elements is divided into subsets, so that the same cluster contains the elements that are similar in some respect. In this case, the method agglomerative hierarchical clustering was used.

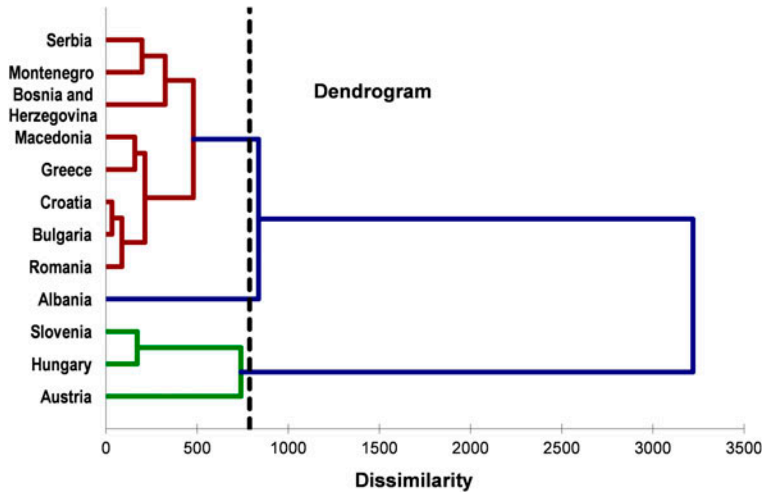

Figure 8. Dendrogram for the Western Balkan countries and the selected EU countries.
Source: Authors' calculation based on Dutta (2012). The global innovation index 2012. Stronger Innovation Linkages for Global, INSEAD and Global Competitiveness Report 2012–2013, World Economic Forum.

Figure 8 presents the dendrogram of the conducted cluster analysis, based on the data from the table given in the appendix for the GII, regarding the 11th *(Business sophistication)* and 12th *(Innovation)* GCI pillar for the Western Balkan countries and six selected EU countries. The x-axis shows the degree of dissimilarity between the observed countries.

In the process of grouping the selected countries, we relied on the bottom-up agglomerative hierarchical clustering method. In the initial stage, each country is treated as a separate cluster. Their merging in pairs of clusters, performed on the basis of the similarity in terms of the values of the observed variables, is the result of all subsequent clustering iteration until all observed entities are grouped within one cluster. If the possible cross-section of dendogram is at a level of dissimilarity of 500, four clusters of the observed countries are clearly identified. The largest group consists of eight countries (Romania, Bulgaria, Croatia, Greece, Macedonia, Bosnia and Herzegovina, Montenegro, and Serbia), which makes 66.7% of the total number of observed countries. The second group involves Slovenia and Hungary, while the third and the fourth 'group' include Albania and Austria, which are distinguished as separate clusters. The striking feature of the first cluster is that its elements of two sub-clusters are created at a higher level of dissimilarity as compared to the countries that belong to another cluster, which suggests that the countries comprising the cluster have significantly larger variations in respect of the observed variables in relation to other countries within the cluster. Merging of the clusters is performed at a higher level of dissimilarity (less than 1000), which implies that Albania joins the countries in the first cluster, whereas Austria joins members of the other cluster.

7. Conclusion

On the basis of the above presented analysis, it is possible to formulate the following conclusions:

First, in the process of analysing the correlation between the III and the IOI at the level of the Western Balkan countries, we found no statistically significant effect (linear correlation) of the III on the IOI. At the same time, in analysing the correlation of these variables and the reference level of the European countries, we found a very strong direct linear correlation, and statistically significant impact (linear correlation) of the III on the IOI.

Second, in the process of analysing the correlation between the GII and the GCI at the Western Balkans, we found no statistically significant effect (linear correlation) of the GII on the GCI. At the same time, in considering the correlation between these variables at the level of the EU countries that border the Western Balkan region, we established a strong direct linear correlation, and statistically significant impact (linear correlation) of the GII on the GCI.

Third, in the course of analysing the variables GII, III, and IOI for a group of six Western Balkan countries (via box plot diagrams), we found the maximum values of 53.10 (Austria), 59.45 (Austria), and 46.75 (Austria), as well as the minimum values of 35.27 (Greece), 43.91 (Romania), and 26.52 (Greece). It is characteristic that in respect of the values of these variables, the observed group of countries is relatively homogenous, so that there are no significant deviations or outliers. In respect of the Western Balkan countries, the analysis of these variables showed that the maximum values of these variables are at a lower level as compared to the group of the selected EU countries, i.e. that they amount to 40.68 (Croatia), 46.43 (Croatia), and 38.45 (Serbia). At the same time, the minimum values are also at the lower level in relation to the selected EU countries, i.e. they amount to 30.38 (Albania), 37.42 (Albania), and 23.35 (Albania). The existence of outliers was not identified among the observed data. This group of countries is also relatively homogeneous.

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