

***TYPOLOGY OF COUNTRIES ON THE KNOWLEDGE ECONOMY
DEVELOPMENT***

The purpose of this article is countries typology on the knowledge economy development. The method of cluster analysis is the core of this research. In particular, the method k-means clustering was used for the typology. Knowledge assessment methodology developed by the World Bank, is a comparative tool formed by the four knowledge economy pillars. The clusters are analyzed by the 4 Knowledge Economy pillars: Economic Incentive and Institutional Regime, Education, Innovation, Information and Communications Technologies. Based on the twelve main indicators of knowledge economy it has been selected 6 cluster groups with different levels of knowledge economy. Particular attention should be paid to the sixth cluster with the highest level of knowledge economy. Based on their national policies and strategies the countries of other clusters, especially the fifth cluster with the lowest level of knowledge economy, should make significant changes to achieve the appropriate level. Ukraine some other post-socialist countries form the fourth cluster with highly education level and extremely low level of Economic Incentive and Institutional Regime. Countries typology on the knowledge economy development has not been conducted in a scientific field yet. The main result of this research is indentation the group with the similar features of the knowledge economy development. The research helps to identify the strengths and weaknesses in the knowledge economy development of individual countries which further leads to right policy regarding the knowledge economy.

Keywords: typology, Knowledge economy, KAM, cluster

Introduction. Socio-economic development of country is increasingly linked to a nation's ability to acquire and apply knowledge and information. Comparative advantages come less from abundant natural resources or cheaper labor, and more from technical innovations and the competitive education system. Most of world's countries are transforming to knowledge economy: some of them have achieved the significant results in this area; others are only on the first stage of the knowledge economy building. In the knowledge economy, there is no tradition of classifying countries into one of a small number of categories based on their economic institutions and policies, ICT infrastructure, education and innovation system. The aim of this paper is to identify the various knowledge economy stages of the national economies. Knowledge economy typology provides for comparative analysis and defining the strengths and weaknesses of every country.

Methodology. In 1999 the World Bank Institute (WBI) has developed the Knowledge Assessment Methodology (KAM) as a Knowledge-Based Economy framework for its member states in order to specify their level of knowledge-based economic development. WBI stated in their framework that a knowledge economy is one that utilizes knowledge as the key engine of economic growth. It is an economy where knowledge is acquired, created,

disseminated and used effectively to enhance economic development [1].

The KAM is an interactive benchmarking tool created by the Knowledge for Development Program to help countries identify the challenges and opportunities they face in making the transition to the knowledge economy. The KAM consists of 148 structural and qualitative variables for 146 countries. Variables are normalized on a scale of 0 to 10 relative to other countries in the comparison group. Based on the four pillars Knowledge Index (KI) and Knowledge Economy Index (KEI) are calculated. Knowledge Index measures a country's ability to generate, adopt and diffuse knowledge. This is an indication of overall potential of knowledge development in a given country. The Knowledge Economy Index takes into account whether the environment is conducive for knowledge to be used effectively for economic development. It is an aggregate index that represents the overall level of development of a country or region towards the Knowledge Economy [2]. Figure 1 presents the Knowledge Economy Index and Knowledge Index structures.

Cluster Analysis. The typology of countries was constructed by means of a cluster analysis, which is a multivariate method that aims to classify a sample of subjects (in our case - countries) on the basis of a set of measured variables into a number of different groups such that similar subjects are placed in the same group [3].

In this investigation, the k-means (non-hierarchical) clustering method was used. Non-hierarchical cluster analysis tends to be used when large data sets are involved. It is sometimes preferred because it allows subjects to move from one cluster to another (this is not possible in hierarchical cluster analysis where a subject, once assigned, cannot move to a different cluster).

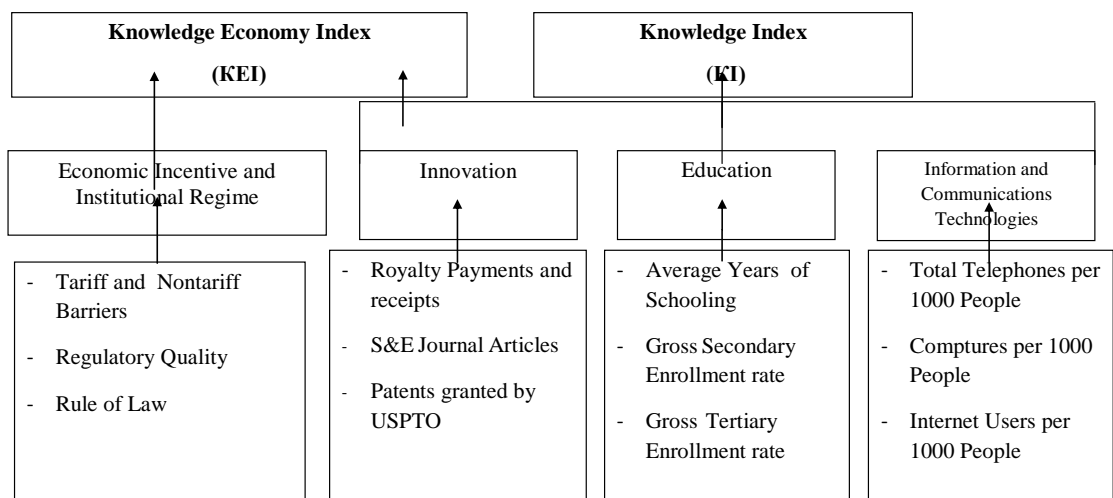


Figure 1. Knowledge Index and Knowledge Economy Index

Before starting the clustering, the information of the 146 world's countries participating in the project on 148 indicators was meticulously analyzed. The

final indicators set for the typology was selected due to data availability and methodological considerations of the cluster analysis carried out to construct the typology. The data set of 12 indicators on 144 countries was defined to be included in the cluster analysis. The variables considered in the analysis are [2]:

- *Tariff and Nontariff Barriers*: this is a score assigned to each country based on the analysis of its tariff and non-tariff barriers to trade, such as import bans and quotas as well as strict labeling and licensing requirements. The score is based on the Heritage Foundation's Trade Freedom Score.
- *Regulatory Quality*: this indicator measures the incidence of market-unfriendly policies or inadequate bank supervision, as well as perceptions of the burdens imposed by excessive regulation in areas such as foreign trade and business development.
- *Rule of Law*: this indicator includes several indicators, which measure the extent to which agents have confidence in and abide by the rules of society. These include perceptions of the incidence of both violent and non-violent crime, the effectiveness and predictability of the judiciary, and the enforceability of contracts.
- *Royalty Payments and receipts*: Royalty and Licenses Fees Payments (per pop.) + Royalty and Licenses Fees Receipts (per pop.)
- *S&E Journal Articles/mil. people*: this is the variable S&E Journal Articles, weighted by million population.
- *Patents granted by USPTO/ mil. people*: this is variable "Patents granted by USPTO" weighted by million population.
- *Average Years of Schooling*: this variable is used as an aggregate measure of the educational stock in a country.
- *Gross Secondary Enrollment rate*: the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown.
- *Gross Tertiary Enrollment rate*: the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown.
- *Total Telephones per 1000 People*: telephone mainlines + mobile phones
- *Comptures per 1000 People*: personal computers are self-contained computers designed to be used by a single individual.
- *Internet Users per 1000 People*: the indicator relies on nationally reported data. In some cases, it is based on national surveys (they differ across countries in the age and frequency of use they cover), in others it is derived from reported Internet Service Provider subscriber counts.

Typology. In this method the desired number of clusters was specified in advance and the 'best' solution was chosen. Based on the abovementioned variables countries were clustered into six clusters that have similar Knowledge Economy patterns. Figure 2 presents the average KEI variables for six clusters. The sixth cluster occupies the best position on all indicators except Gross

Tertiary Enrollment Rate. Cluster 4 takes the first-place position in Gross Tertiary Enrollment Rate (9,1). The weak performance of all three Economic Incentive and Institutional Regime variables reflects the cluster's generally injurious effect of institutional environment for success in the knowledge economy. Because of its weak showing in all four KE pillars Cluster №5 unfortunately ranks as the weakest Knowledge Economy.

Cluster 1 is formed by 29 countries. They are mostly Arab states of the Persian Gulf, the Balkans and Latin America countries with high income or upper middle income. The complete list of the first cluster is given below: Africa: two countries with upper middle income (South Africa and Mauritius); Middle East and N. Africa: six countries with high income (United Arab Emirates, Bahrain, Oman, Saudi Arabia, Qatar, Kuwait) and one country with upper middle income (Jordan); Europe and Central Asia: six with upper middle income (Romania, Bulgaria, Serbia, Macedonia, Turkey, Bosnia and Herzegovina) and lower middle income Georgia;

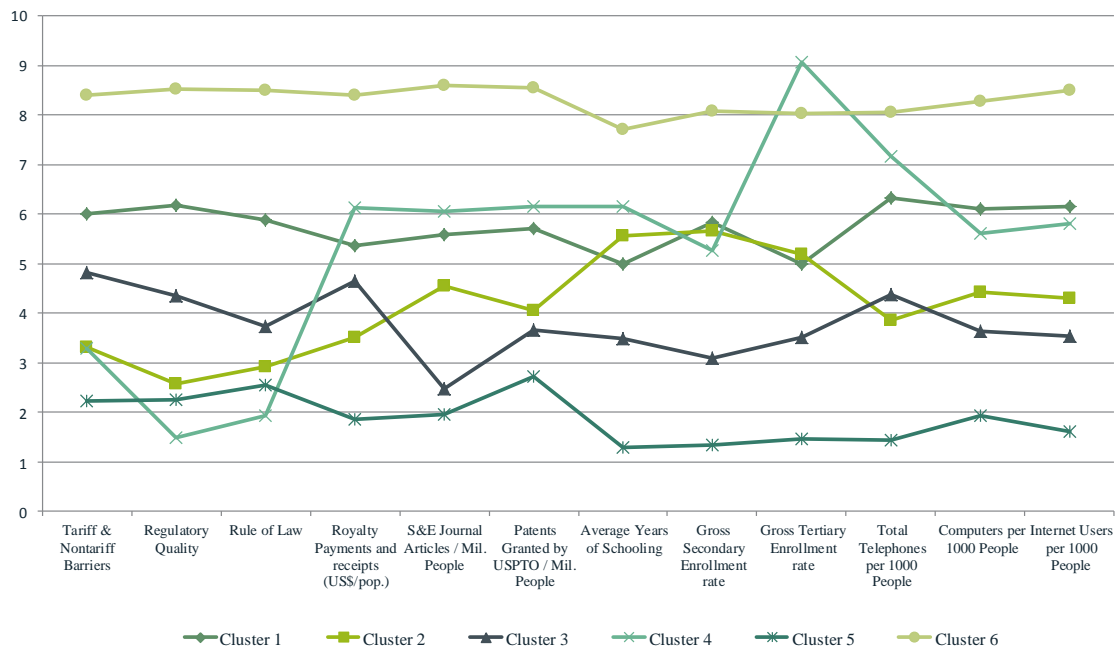


Figure 2. Cluster's KEI variables, 2012 p.

Latin America: two countries with high income (Aruba and Trinidad and Tobago) and nine with upper middle income (Uruguay, Costa Rica, Jamaica, Brazil, Dominica, Panama, Mexico, Peru, Colombia); East Asia and the Pacific: Malaysia and Thailand with upper middle income.

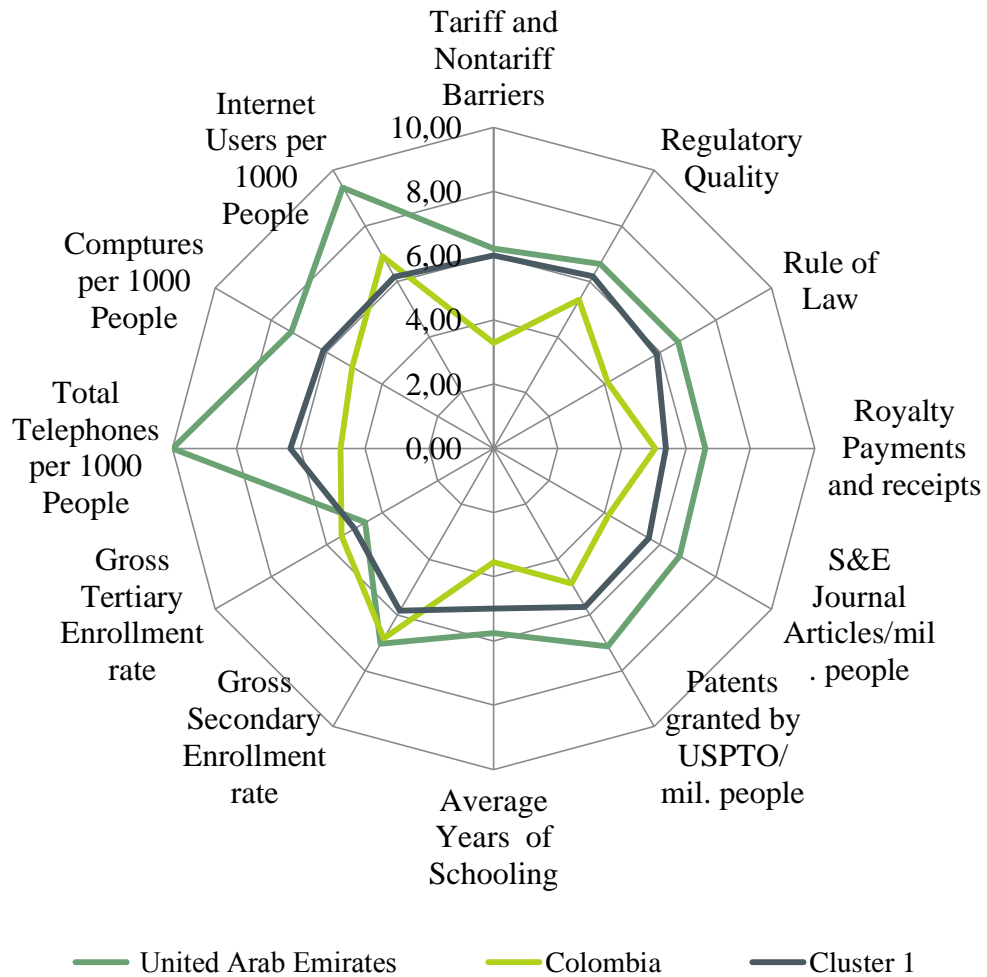


Figure 3. Cross-country Comparison, Cluster 1

Figure 3 presents the average variables for cluster 1, variables for the countries with the highest (United Arab Emirates - 42) and lowest KEI (Colombia - 76). Cluster 1 shows good performance in all variables (5.00-7.00). It is specifically strong in the next two pillars: Economic Incentive and Institutional Regime and ICT, ranking second for both. The weak level is in the education pillar, especially through the lower variables average years of schooling and gross tertiary enrollment rate.

The next 19 countries form the cluster №2, which includes four countries with upper middle income of region Middle East and N. Africa (Algeria, Tunisia, Lebanon and Islamic Rep. Iran), seven countries of Europe and Central Asia (two countries with upper middle income – Azerbaijan and Kazakhstan, three with lower middle income – Armenia, Moldova, Uzbekistan and other two with low income – Kyrgyz Rep. and Tajikistan), four countries of Latin America

(Cuba and Ecuador with upper middle income, Bolivia and Guyana with lower middle income), three of East Asia and the Pacific (upper middle income China and two countries with lower middle income – Mongolia and Fiji) and Sri Lanka (lower middle income country of South Asia).

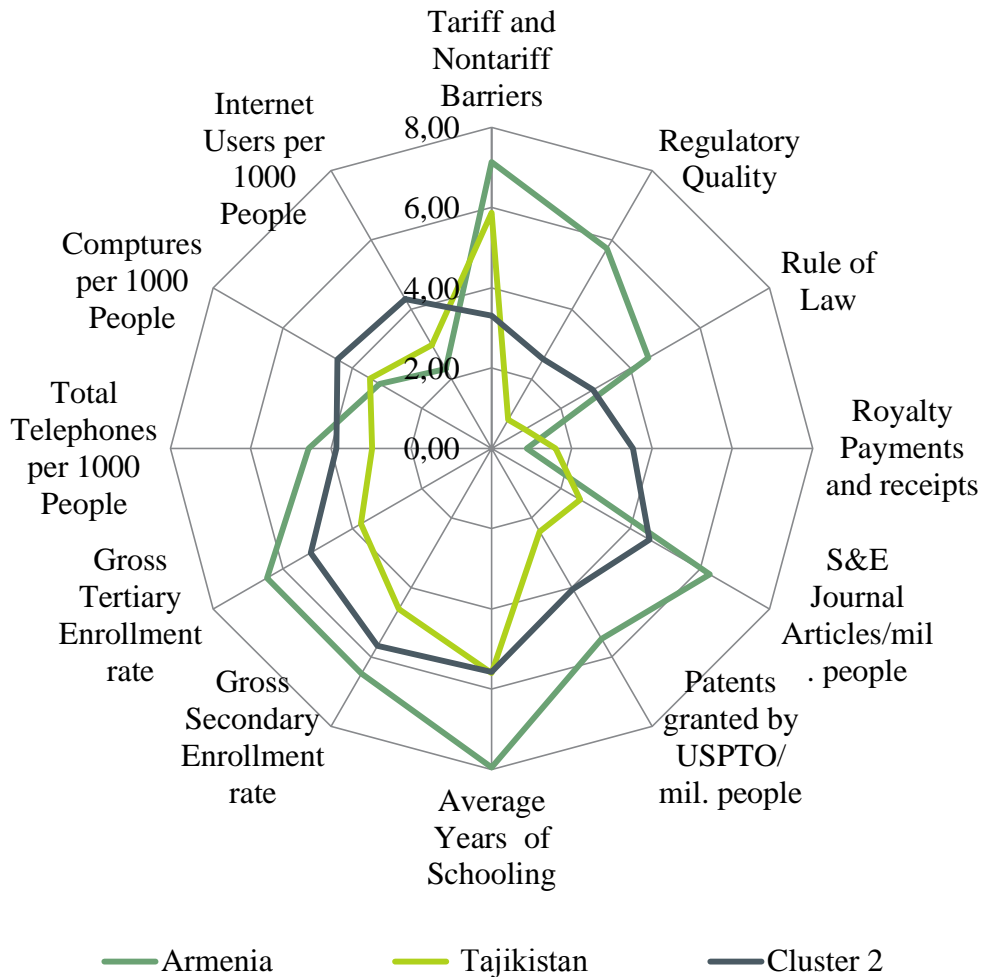


Figure 4. Cross-country Comparison, Cluster 2

Low variables of Economic Incentive and Institutional Regime indicate the unfavorable conditions of developing economies, emerging economic and legal environment, poor quality control, low business development and private initiative. Among the four pillars only education variables for this cluster group are under the line of 5,00. Armenia has the highest KEI rank (71), Tajikistan is ranked 105 position.

The third cluster is composed by the next 14 countries: Africa: two countries with upper middle income (Botswana, Namibia) and lower middle income Swaziland; Middle East and N. Africa: Arab Rep. Egypt and Morocco with lower middle income; Europe and Central Asia: Albania – upper middle income country; Latin America: four countries with lower middle income (El Salvador, Paraguay, Guatemala, Honduras) and Dominican Republic with upper middle

income; East Asia and the Pacific: three countries with lower middle income: Vietnam, Philippines and Indonesia.

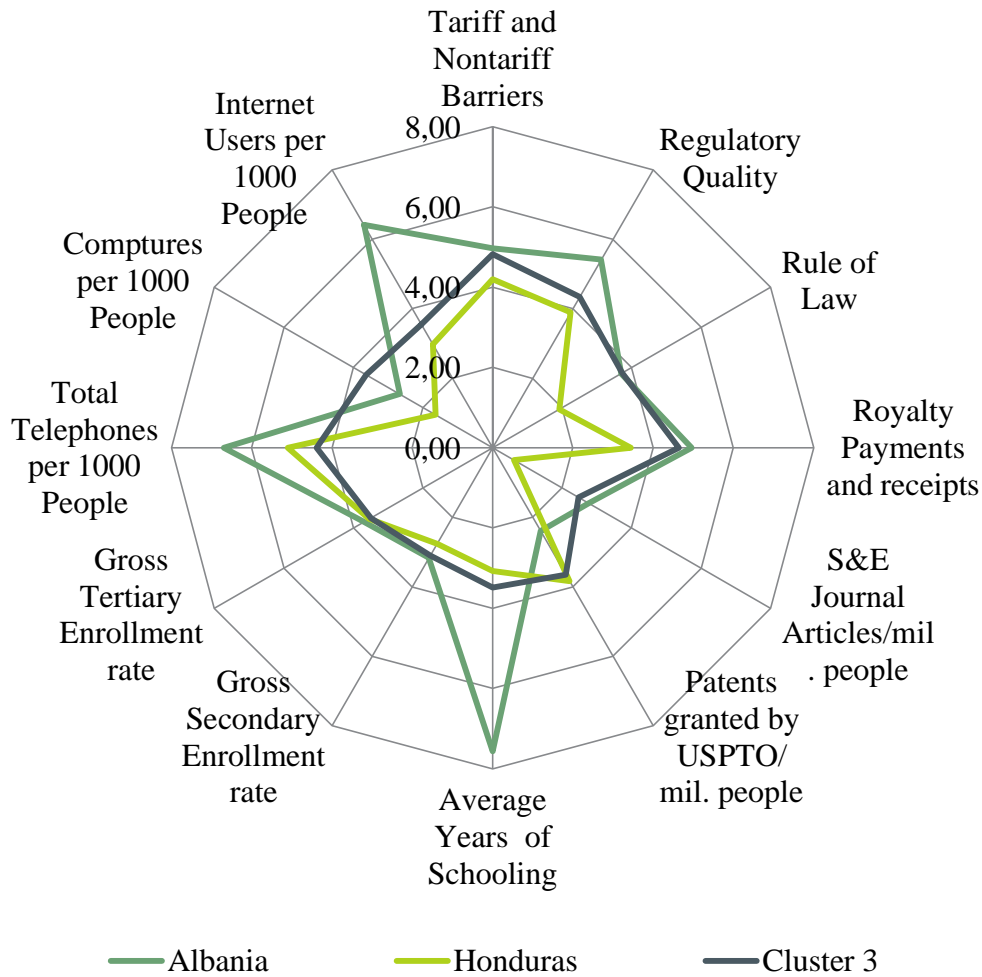


Figure 5. Cross-country Comparison, Cluster 3

The 12 main variables for this cluster are less than 5,00, especially the lower indicators present the Innovation and Education pillars. The weakest zone is the indicator describing the S&E Journal Articles. Normalized variable is 2,50. Contrary to the Cluster 2, Cluster 3 need the improvement in the educational structure of the population. Figure 5 shows the internal imbalances in the third cluster.

Three post-Soviet countries (Russian Federation, Ukraine and Belarus) and two countries of region Latin America with the strong centralized authority (Argentina, Venezuela) form the fourth cluster. This cluster includes four countries with upper middle income and one country with lower middle income (Ukraine).

Ranked in 55st position for the KEI, Russia's overall performance was hampered primarily by weaknesses in its EIR pillar, which, with a value of only 2.23, puts it in 117 th place. The weak performance of all three EIR variables reflects the country's generally uncondusive institutional environment for success in the knowledge economy. In the education pillar, lower

scores in average years of schooling and secondary enrollment rates have led to a 17-spots drop down to 44 th place. Its ICT pillar has registered a sizable improvement, moving up 19 spots, mainly because of an increase in the number of telephone users. Contrary to Russia Venezuela has the weakest position in this group of countries – 86[4].

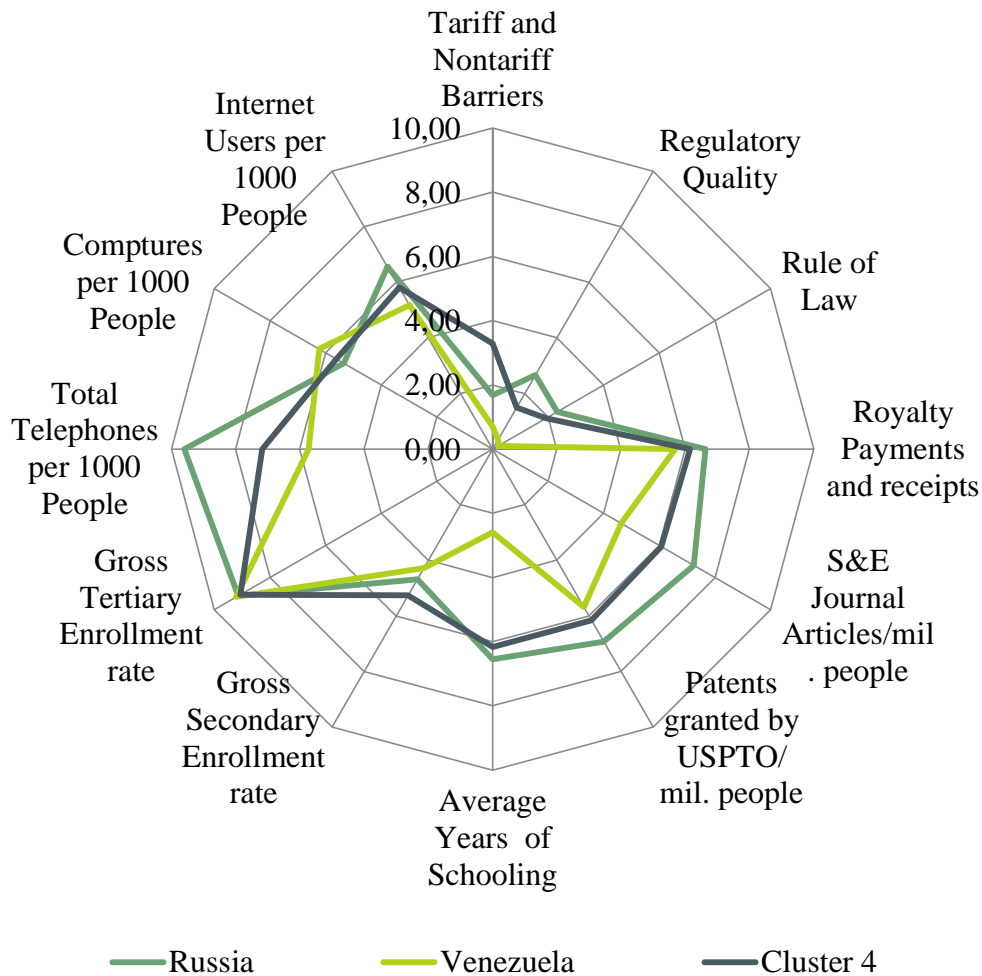


Figure 6. Cross-country Comparison, Cluster 4

Cluster 4 presents a low rate of all normalized variables of Economic Incentive and Institutional Regime. On the other hand, Cluster 4 has high competitiveness in the Education pillar. The ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the Secondary education are higher than 80% in all 5 countries. The same variable of tertiary education is more than 75,00% in all countries, except Argentine: it has 69,38% of Gross Tertiary Enrollment rate.

The fourth cluster is also strong in all the innovation indicators: royalty payments and receipts, science and engineering (S&E) journal articles and patents. Technical progress is at the heart of economic growth and development.

New or improved technology can be achieved through own research and innovations or through the absorption and adaptation of foreign technologies. To facilitate such technical progress requires a complex system of supporting institutions and good economic policies.

The cluster №5 is composed by 36 developing countries with low/lower middle income which belong to the next world's region: Africa (Ghana, Senegal, Zambia, Nigeria, Lesotho, Cameroon, Mauritania, Cote d'Ivoire, Sudan, Angola, Kenya, Uganda, Zimbabwe, Malawi, Burkina Faso, Benin, Mali, Rwanda, Tanzania, Madagascar, Mozambique, Ethiopia, Guinea, Eritrea, Sierra Leone), Middle East and N. Africa (Syrian Arab Republic, Yemen, Djibouti), Latin America (Nicaragua), South Asia (Bangladesh, Nepal, Pakistan, India) and East Asia and the Pacific (Myanmar, Lao PDR ta Cambodia).

India show the best result of these countries. India's KEI fell 6 spots to 109 th in the 2012 KEI rankings. Mainly because of growth in USPTO patents, India's innovation pillar has leaped up 20 places to rank 76th. India's EIR and ICT pillars have registered slight declines, falling 4 and 8 spots respectively. Myanmar unfortunately ranks the lowest position in World KE Rankings with KEI of 0,96[4].

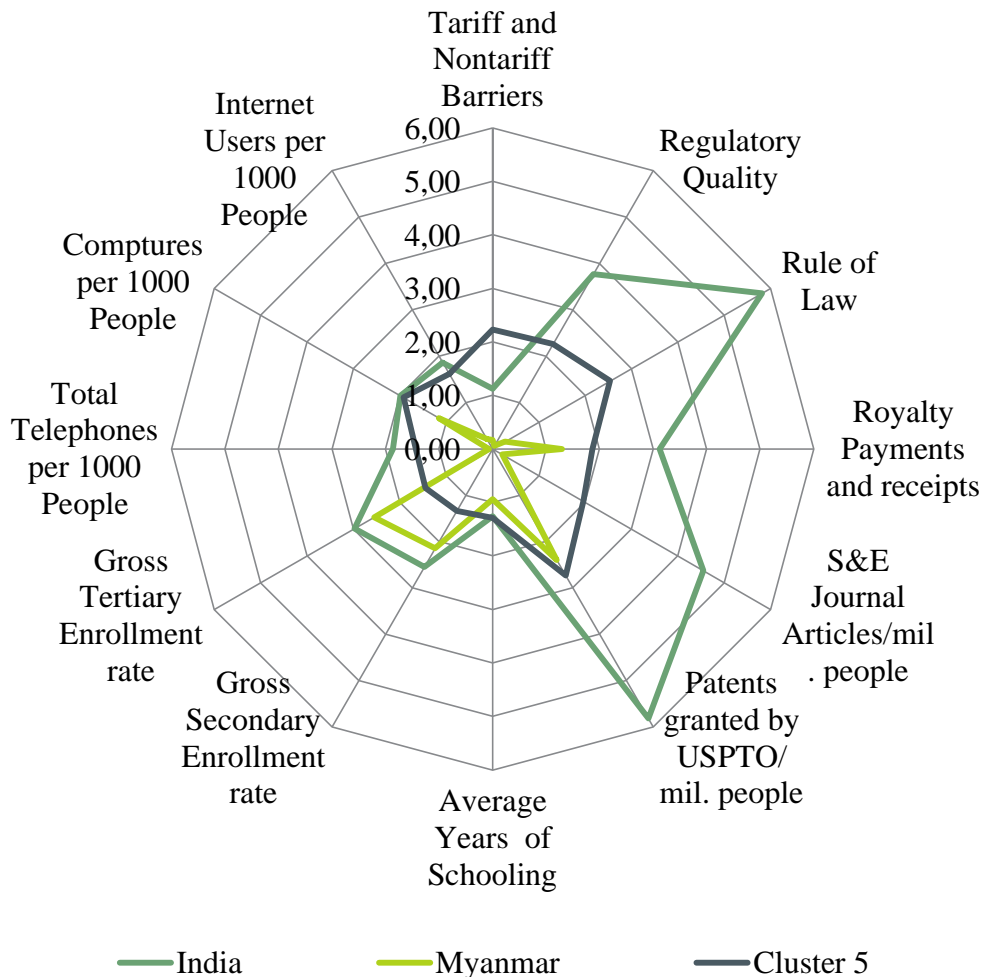


Figure 7. Cross-country Comparison, Cluster 5

Because of its weak showing in all 12 variables pillars, the fifth cluster ranks as the weakest knowledge economy. Especially no normalized variables of Education and ICT pillars exceeded 2.00.

These countries should pay attention for creation and development their KE strategies on the national and local levels. The priorities for this countries are:

- Improvement of Law and Institutions. The indicators of tariff and nontariff barriers, regulatory quality and rule of law are less than 3.00.
- More intensive application of ICT, especially by increasing telephone mainlines, and the number of computers and internet users in the population. In 2012 the number of computers per 1000 people in some country were less than 10 (Angola, Benin, Ghana, Burkina Faso, Eritrea, Ethiopia, Myanmar, Madagascar, Malawi, Mali, Mozambique, Nepal, Tanzania);
- Quantitative improvement of education by increasing secondary and tertiary enrollment rates. For example, in Eritrea, Malawi, Tanzania and Mozambique the Gross Tertiary Enrollment rate is less than 2.00%.

Developed countries with high/upper middle income compose the sixth cluster (41 countries):

- North America: USA and Canada;
- Europe and Central Asia: Sweden, Netherlands, Norway, Switzerland, United Kingdom, Luxembourg, Spain, Slovenia, Italy, Slovak Republic, Portugal, Poland, Finland, Denmark, Germany, Ireland, Belgium, Iceland, Estonia, France, Czech Republic, Hungary, Cyprus, Greece, Croatia, Austria, Lithuania and Latvia;
- Middle East and N. Africa: Israel, Malta;
- East Asia and the Pacific: New Zealand, Australia, Japan, Singapore, Taiwan, Rep. Korea and Hong Kong.
- Latin America: Barbados and Chile.

Contrary to the developing Cluster 5, the developed Cluster 6 presents the top position of all variables which reflects strong performance on the EIR, innovation, ICT and education pillars (Figure 2).

Sweden retains its first-place position as the world's most advanced knowledge economy, with a 2012 KEI of 9.43. Sweden is especially strong in innovation and ICT, ranking second for both pillars. In the education pillar, however, it fell to 6th place from 3rd place in 2000. Sweden's competitiveness in the ICT pillar is largely attributable to an increase in Internet users. Sweden is also remarkably strong in all the innovation indicators: royalty payments and receipts, science and engineering (S&E) journal articles, and patents. The slight decline in its education performance is mainly due to a drop in secondary and

tertiary enrollment rates. The gross secondary enrollment rate declined from 152 percent in 2000 to 103 percent most recently. The tertiary enrollment rate has risen over time, but not as fast as other countries, so its normalized score declined from 9.72 in 2000 to 8.72 in the most recent year[4].

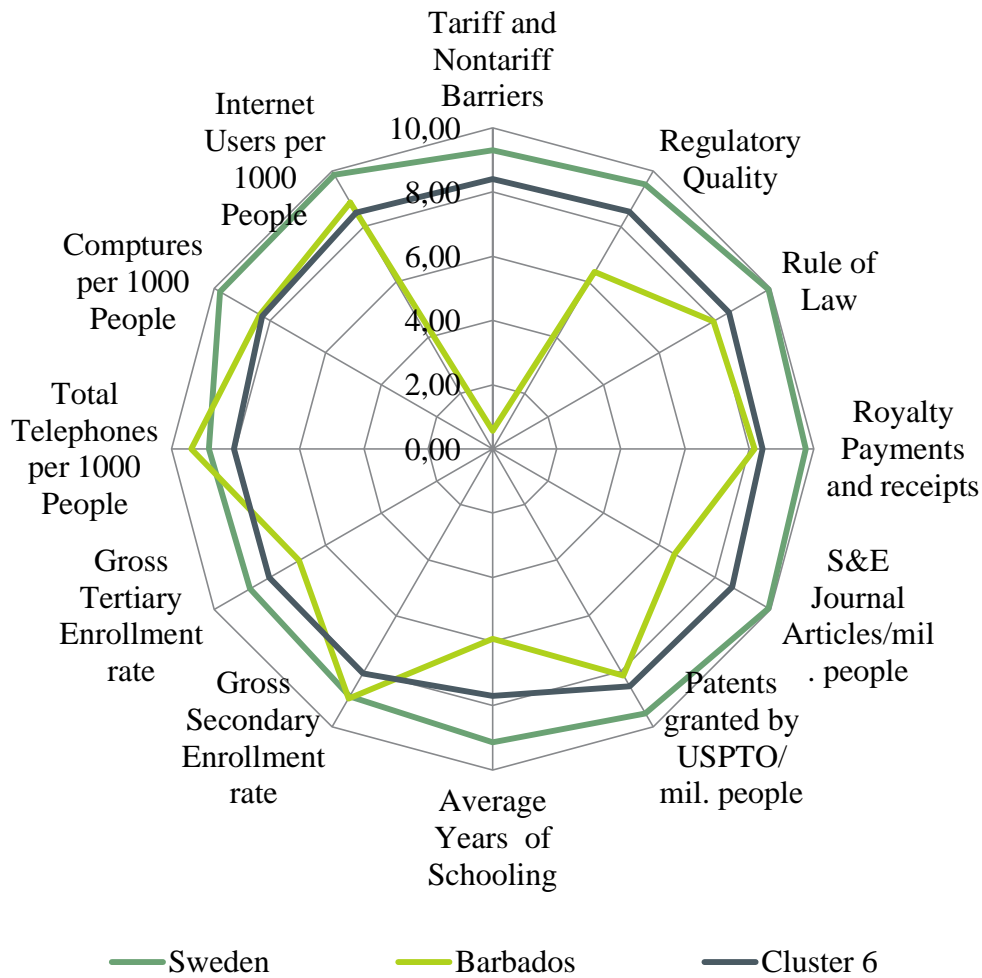


Figure 8. Cross-country Comparison, Cluster 6

The countries formed the sixth cluster provide good economic policies and institutions that permit efficient mobilization and allocation of resources and stimulate creativity and incentives for the efficient creation, dissemination and use of existing knowledge. Educated and skilled workers of national economy continuously upgrade and adapt their skills to efficiently create and use knowledge. The high variables of ICT is the clear evidence of a modern and adequate information infrastructure that can facilitate the effective communication, dissemination and processing of information and knowledge.

Conclusion. Building a knowledge economy is a long process involving radical and far-reaching changes. The transformations that a particular country should make depend primarily on its achieved level of economic development. Scenarios for building a knowledge economy cannot be common to all

countries. This analysis could help to assist national, regional and local decision makers in developing their knowledge economy, through a better understanding of the important of all Knowledge Economy pillars. Also developing the successful strategy for each country depends on the ability to pinpoint areas where policy attention or investment may be required.

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