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Knowledge, Migration and Countries of Muslim World – Spatial Impacts and Prospects

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The article presents an empirical examination of the spatial dependence of emigrants and immigrants on the indicators of a knowledge based economy. The article is motivated by a knowledge gap among countries of the Muslim world, worsening demographic conditions, the growing importance of knowledge in the world economy and geographical proximity. The existence of spatial distribution and autocorrelation among migrants is examined through the spatial lag and the spatial error models. Although one can assume that the presence of both – the number of emigrants and the number of immigrants have similar preconditions, with slight variables - emigrants tend to indicate the dependence on the nearest neighbours. Therefore studying of emigrants among the countries of Muslim world is done better through spatial models and is more appropriate than the estimate regression coefficients through ordinary least square regression. When looking at the knowledge economy, findings also suggest that the number of internet users and the number of journal articles influence the number of emigrants (and also number of immigrants). The human desire to leave a country is also driven by other factors, for example tariff and nontariff barriers, average years of schooling, industrial production growth rate and the number of computers in each country.

1. Introduction

The relative importance of national prosperity such as physical resources, population growth, globalization, environment, amongst other things, has shifted over the time (López-Claros, 2011) and attention is more focused on knowledge and the knowledge based economy, leading to innovation and technical change. Intangible assets in the form of knowledge can be considered as indicators of long- term economic

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growth as well as an ultimate precondition of "Knowledge Based Economy" (OECD, 1996). Diffusion of this knowledge lies on the cooperative learning process which is achieved through the geographical (agglomeration economy) and cognitive proximity (shared values, culture and trust) (Camagni, Capello, 2009) of countries and here opens the way to study knowledge indicators through the spatial dependence. In addition, knowledge is associated with human capital therefore the knowledge based economy leans on the quality of human resources. Seen in this light, economy could reap the benefits from inward migration which allows for the movement of specialized skilled people (Porter, 1990). It might seem to be more appropriate to include into the observation only migrated skilled people. However as Daly (2006) suggests, new globalization framework demonstrating free mobility of people, goods and services operates under "free migration", where "free" does not mean only skilled but deregulated, uncontrolled and unlimited and in many cases, immigrants are frequently disadvantaged people. This fact leads to the premise that a country with high net migration flow (immigrants minus emigrants) gains not only positive but also negative repercussions from migration. When considering the perspective of economies moving towards a growth based on knowledge, the important question is - which knowledge factors encourage the human propensity to migrate?

As was mentioned above, the role of location should not be overlooked in generating, diffusing and absorbing of new knowledge on the international, national, regional or local level and this fact highlights spatial impacts on knowledge indicators. The importance of space moves the studying of the variable´s dependence away from the classic ordinary least square regression (or its modifications) towards spatial models which include spatial dependence and distribution within the explained and explanatory variables. The main goal of this article is to study the spatial influences of knowledge indicators and other independent variables, on the human propensity to migrate (seeking resources among countries in the form of knowledge and gaining a competitive advantage) across the 21 countries of Muslim World. Although a lot these countries "lie" on the poverty line, it can be assumed that in this era of information technology, these countries are also shifting toward knowledge-based economies and the resources of a knowledge based economy can influence on the number of immigrants and emigrants. Here, the paper analyses the human desire to migrate and

assumes that migrant people are seeking resources in the form of knowledge indicators from local countries (patches - areas) which have an influence on each other. Firstly, it is helpful to define migration through spatially depended movement of people who are seeking resources and trying to gain a competitive advantage. The next parts of paper are focuses on the resources which people are looking for in a knowledge based economy. Finally regression models are used to confirm or refute claims that migration depends on a) who your "nearest neighbours" are, and b) the significance of knowledge indicators.

2. Migration phenomenon and a human propensity to migrate

Migration can be planned and unplanned (Zhang et al., 2006) but generally, migration is the residential change of any type, from one domestic area to another (Goldscheider, 1971). This change of area depends on the decision making of the individual (personal values) and the population as a whole (common values) (Auger, Poggiale, Charles, 2000). One can assumes that individuals make decisions about movements due to the existing conditions in each area. Assuming you are living in a knowledge-based economy, these conditions can be determined by the gaining of knowledge and how easy it is to do so. If land is a set of areas (patches) colonised by individuals, then the population can grow or disappear in the patches (Levins, 1969). These patches are also defined by the existence of a knowledge economy. This situation is shown later on Figure 3 in analytical part of paper. We may define the countries as patches characterized through indicators of knowledge based economy and individuals who are seeking resources and make decisions about changing their areas depending on this (Auger, Poggiale, Charles, 2000). The human propensity to migrate is usually based on the cost-benefit trade-off model - trade-off between migration cost and income benefits related to relocation (Sjaastad, 1962) and it is interrelated with the decision to travel a given distance. The acceptance of the costs can depends on geographical factors such as high unemployment rate, low amenities, low social security, or other social barriers (Lemistre, Magrini, 2013). The usage of spatial models in this paper assumes that this propensity to migrate is partially influenced by migration in neighbouring countries. Spatial distribution of migration should also include the human decision to travel and to bear the distance/cost involved. In addition, spatial factors have strong effects especially on the migration of young people, because almost half of the

young population change their residence e.g. for the locations of their education (Magrini, Lemistre, 2013).

3. Essential triads towards the knowledge based economy

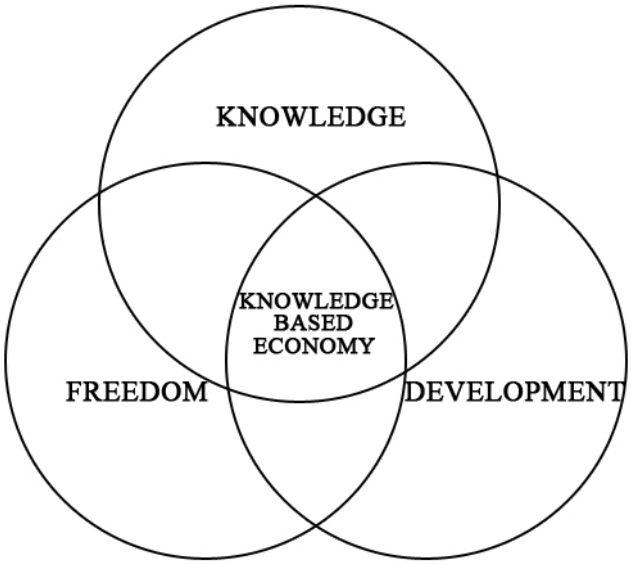
To define knowledge indicators which can have impact on the human propensity to reallocate to different areas means we should look at some assumptions we make about knowledge based economy. The economy has always been driven by knowledge (Karahan, 2012), however the concept of an economy based on knowledge as a core of long-term sustainable development has become increasingly important over the last few decades. According to the evolutionary theory, long-term growth is a result of co-evolution of knowledge, which is known by or used, supported and controlled by institutions. The process of technological learning itself is an essence of evolutionary approach in the sense of economic development (Nelson, 2007). From the view of knowledge systems, holders of knowledge (human capital) are the ones able to discover new technologies or processes (Dosi, Winter, 2000) and it basically means that knowledge can be considered as unlimited source leading to development.

Building a new generation of qualified human capital able to move processes and build the knowledge based economy, is generally considered to require expanding freedom, strengthening the foundations of education and realising comprehensive development (Mohammed bin Rashid Al Maktoum Foundation, 2011). This situation can be shown as follows:

The creative using of knowledge leads to innovations which allow individuals, corporations and nation-states, as Friedman (1999) suggests, going “farther, faster, deeper and cheaper” under the globalization. There are mainly two cultures, which played a leading role in scientific discovery and innovation in the past: the Muslim and Chinese cultures. Unfortunately several thousand years later, many Arab countries are showing a knowledge gap and low levels of cognitive performance in knowledge-related arenas (Mohammed bin Rashid Al Maktoum Foundation, 2011). Looking back at the migration issue, these patches (areas) lose their competitive advantage in a knowledge economy. As highlighted in the Arab Knowledge Report, Arab countries (a large part of the Muslim world) are still incapable of satisfying the appropriate

conditions for new generations to move towards a knowledge society. Most Arab countries have similarities with respect to the principles, values, social and political problems (Mohammed bin Rashid Al Maktoum Foundation, 2011).

Figure 1: Knowledge-freedom-development triad



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Muslim countries are similar only at first glance. For example, Turkey is the 20th largest economy in the world with a relatively young population. It also has the highest population growth among OECD countries, an urbanised population and a long tradition in science and technology (Elçi, 2011). Conversely, the region of Sub-Saharan Africa is characterized by a growing number of people living below the poverty line, partially due to the natural disasters and worsening climate change. Despite to the fact that the African Union adopted Africa´s Science and Technology Consolidated Plan of Action in 2007, low investments in science and technology has led to weak infrastructure development, low numbers of researchers and to minimum scientific outputs (Urama et. all, 2011). Many countries of the Muslim World are dependent on oil and oil production, especially the Arab region, but the volatility of oil price has driven many countries to diversify the economy and to revive science, technology and higher education. In addition, international portfolio investors benefit from diversifying their portfolio among the

Middle Eastern quality markets (Zonouzi, Mansourfar, Azar, 2014). The Arab region can be divided to three main categories: The first category is based on oil production (Oman, Saudi Arabia or United Arab Emirates), The second category have smaller oil resources but have a relatively developed higher education infrastructure (Algeria, Egypt, Lebanon, Palestina, Tunisia or Syria) and the third category have limited and underdeveloped natural resources and underdeveloped higher education infrastructure (Sudan, Yemen, etc.). Many Arab countries have considerable science and technology potential (successfully implemented IT, widespread ICT and university technologies), however this potential is diffused only through a few specialized knowledge workers, universities and public research centres (Badran, Zou´bi, 2011). Many countries in Central Asia have not adapted market economies and the research and development is inherited from the times of the former Soviet Union, their innovation performance is still declining (Mukhammadiev, 2011). So, the Muslim countries have strong interregional and also intraregional differences which can influence the knowledge gap in this part of the world.

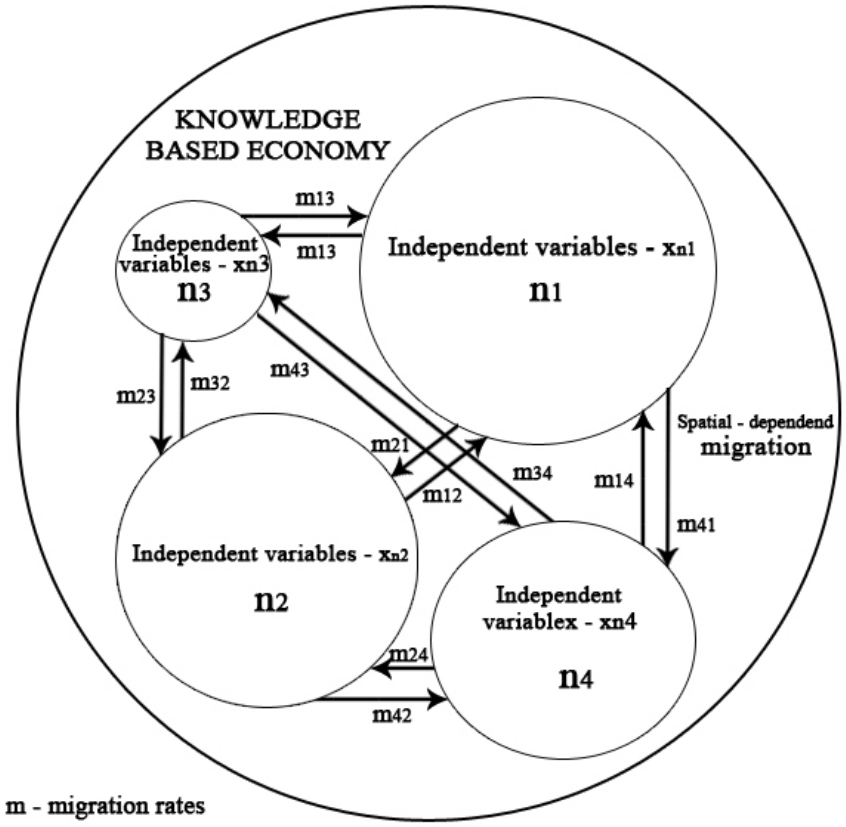
According to the OECD analysis, the knowledge society is based on the "*information society*" (knowledge-flow through communications and computer networks), "*learning economy*" (skill workers) and "*national innovation systems*" (OECD, 1996). The knowledge indicators usually result from the definition of knowledge society by OECD. Due to the fact that a lot of these factors are related to the innovative efforts, they can be divided into two groups – input and output indicators. R&D expenditures and R&D labor force (researchers, scientists or technical workers) are primarily used as input indicators [see Hagedoorn and Cloodt (2003), Furman et al. (2002), Greenhalgh and Rogers (2006)] patents and papers are, in some studies, also on the input side (Hagedoorn and Cloodt, 2003).In other papers these patents and papers are thought to be part of on the output model [see Guan, Chen (2012), Wu and Shanley (2009)]. However as Furman et. all (2012) suggests, a countries´ innovation activity can be influenced by common regional infrastructure, resource commitments and policy choices which can produce common linkages an a knowledge cluster environment. Endeavoring to take into account all possible factors, has leads to the creation of indexes such as "Knowledge Economy Index" (World Bank – 12 knowledge determinants), "Knowledge Economy Indicators"

(OECD – 32 knowledge determinants) or "Summary Innovation Index" (European Commission – 31 knowledge determinants).

4. General analysis

Looking at the knowledge-based economy, the main research question is: which variables influence the spatial number of migrants in the Muslim countries? The model situation can be expressed as follows:

Figure 2: Meta-population model under knowledge based economy



Source: Self-processed

The data examined in this paper refers to the 21 countries of the Muslim World, specifically in Sub-Saharan Africa, Central Asia, South Asia, South-East Asia and Oceania and South-East Europe. Countries have

been chosen, according to the data available, some countries were excluded because of missing data may have made an impact on the regression analysis. The dependent variables are number of emigrants (*E*) and number of immigrants (*I*) constructed using data from World Bank as independent variables. To include Knowledge-freedom-development triad factors, the empirical study uses variables from the Knowledge Economy Index[2], additional knowledge variables and one control variable. As a result, there are patches (countries) characterized by number of emigrants and immigrants on one side (dependent variables) and variables of knowledge based economy (independent variables) on the other side. All parts of the triad can be linked with pillars of the Knowledge economy index:

- Knowledge (first part of triad) can be connected with variables of "*Education*":
  - Gross secondary enrolment rate(% gross),
  - Gross tertiary enrolment rate(% gross),
  - Average years of schooling.
- Development (second part of triad) can be connected with variables of two pillars – "*Innovation*" and "*Information and communication technology*":
  - Royalty and license fees payments and receipts ((US$ mil.) per population,
  - Scientific and technical journal articles per million inhabitants – weighted by million population using sources such as Thomson Reuters, SCI and SSCI,
  - Patent applications granted by the UPSTO per million inhabitants – weighted by million populations,
  - Telephone mainlines and mobile phones per thousand inhabitants,
  - Personal computers per thousand inhabitants,
  - Internet users per thousand inhabitants.

[2] Variables included in the Knowledge Economy Index are used in their actual value to avoid distortion of data.

- Freedom (third part of triad) can be connected with variables of "*Economic Incentive and Institutional Regime*":

  − Tariff and nontariff barriers – especially tariff and non-tariff barriers of each country to trade (import bans and quotas, strict labeling, licensing requirements). The World Bank calculates this score on the basis of the Heritage Foundation´s Trade Freedom score,

  − Rule of law (perceptions of the incidence of violent and non-violent crime, the effectiveness and predictability of the judiciary and the enforceability of contracts),

  − Regulatory quality (price controls, inadequate bank supervision and other incidences of market-unfriendly policies).

Explanatory variables are the primary variables of interest in the initial analysis. Lot of countries in the Middle East are rich in oil resources and the categorization is needed via dummy variable "oil production" (1 – significant oil producer, 0 – insignificant oil producer). The global gender gap index published annually by the World Economic Forum represents factor of gender-gap disparities focusing on four fundamental categories (economy, politics, education and health). Despite the still existing gender-gap in Muslim World, findings of Genc et. all (2012) show that woman´s education plays a crucial role in economy. The next variable to measure knowledge based economy is annual percentage increase in industrial production. A control variable GDP per capita is used which impacts on the number of emigrants and immigrants. It is no doubt that GDP and employment rates in the destination country are variables which have impact on migration flows (Strielkowski, Glazar, Ducháč, 2014). Data come from the years 2009- 2011.

Table 1 provides descriptive statistics – mean (μ), standard deviation (δ), minimum and maximum values (*min*, *max*) and net flow of migrants (immigrants – emigrants) in each country (*net*).

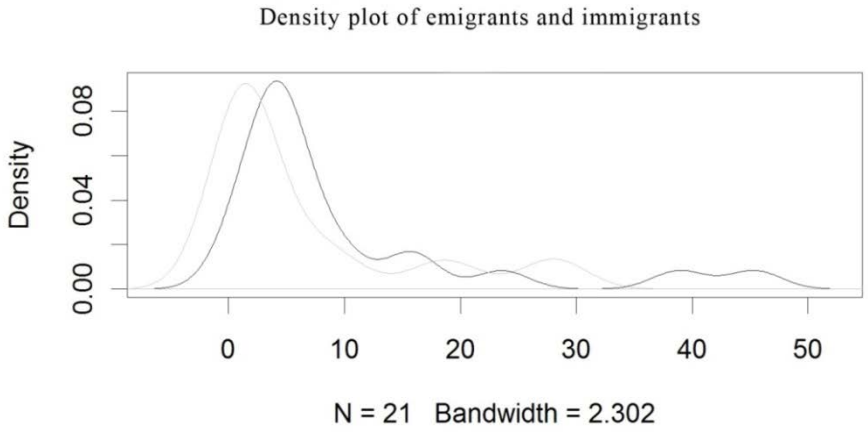
Table 1: Descriptive statistics for base case analysis

	Emigrants	*Immigrants*	*GDP per capita*	*Gross secondary enrolment rate*	*Gross tertiary enrolment rate*	*Average years of schooling*	*Royalty and license fees payments and receipts*	*Scientific and technical journal articles*	*Patent Applications*	*Telephone mainlines and mobile phones*	*Personal computers*	*Internet users*	*Tariff and nontariff barriers*	*Rule of law*	*Regulatory quality*	*The global gender gap index*	*Industrial production growth rate*	*Oil production*
μ	4,90	2,00	6,60	72,36	26,44	6,41	1,46	11,28	0,07	900,0	80,00	31,00	76,65	-0,47	-0,14	0,61	4,60	1,00
δ	12,10	9,01	7,06	26,34	14,20	2,05	10,86	29,92	1,22	472,2	143,2	19,27	8,87	0,54	0,51	0,05	2,20	0,46
mi	0,50	0,20	0,90	19,77	2,12	3,28	0,00	0,49	0,00	210,0	0,00	2,40	53,50	-1,34	-1,25	0,46	0,00	0,00
max	45,40	28,40	25,60	99,36	52,52	10,41	50,93	118,4	5,63	1930,	690,0	62,00	86,00	0,68	0,66	0,71	9,00	1,00
net (immigrants – emigrants)																		
Countries	*Albania*		-42,6	*Bosnia*		-38,2	*Iraq*		2,2	*Pakistan*		-0,2	*Sudan*		-2,8	*Yemen*		-2,6
	Azerbaijan		-14	*Algeria*		-2,7	*Morocco*		-9,1	*Saudi Arabia*		27,1	*Syria*		5,6			
	Burkina Faso		-3,3	*Egypt*		-4,1	*Malaysia*		3,1	*Sierra Leon*		-0,5	*Tunisia*		-6			
	Bangladesh		-2,6	*Kazakhstan*		-4,1	*Oman*		27,9	*Senegal*		-3,3	*Turkey*		-3,7			

Source: Self-calculated

Almost all countries have a negative migration flow with the exception of Iraq, Malaysia, Saudi Arabia and Syria. Malaysia is a leader in patent applications with positive net flow of migrants. The situation is unfavorable mainly in Albania and Bosnia Herzegovina with relative high negative migration flow. Density plot shows that the dependent variables (numbers of emigrants and numbers of immigrants) are not distributed normally. There is cluster of positive values around 5, 15 and around 30 in both cases. Residuals suggest that the use of ordinary least square regression model does not capture the studied relationship very well, probably in part as a result of dependencies among the data.

Figure 3: Density plots of dependent variables



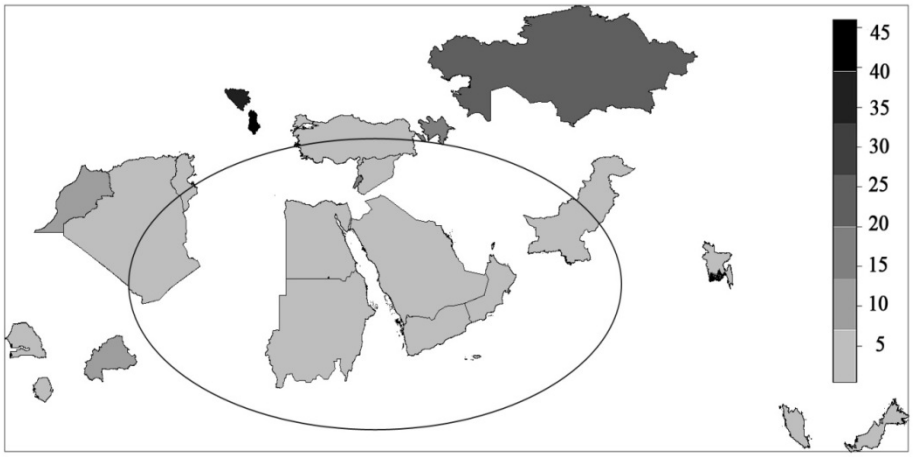
Source: Self-processed

4.1 Maps as Visual Displays of Data

Graphical displays can be considered as a method which allows patterns to be discovered visually and quickly. There can be observed results among evaluated countries that can influence their conditions (Ward, Gledisch, 2007). Countries on the following maps are shaded in increasing levels of grey for higher levels of emigrants or immigrants. The maps illustrate geographical clusters of emigrants and immigrants. There are significant disparities in the numbers of emigrants (Figure 5) and the numbers of immigrants (Figure 6) within the studied countries. Although there are some exceptions, the greatest level of emigrants tend to be registered by the countries situated in the periphery of the area (especially north) and the greatest level of immigrants tend to be

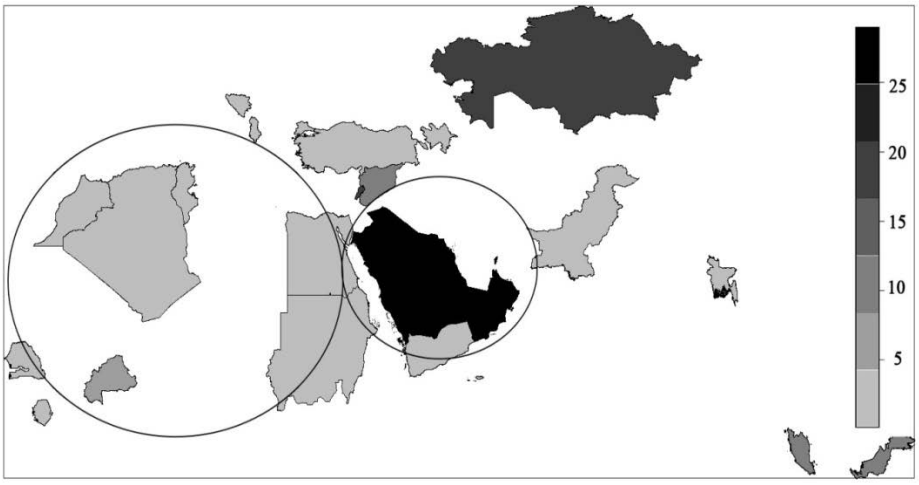
registered by countries situated at the Arabian peninsula and in Kazakhstan. There seems to be a positive spatial relationship between neighbouring areas. However, the information supplied in Figure 4 and Figure 5 is only a formal analysis of the possible presence of spatial autocorrelation in the studied sample.

Figure 4: Distribution of emigrants in countries of Muslim World



Source: Self-processed

Figure 5: Distribution of immigrants in countries of Muslim world



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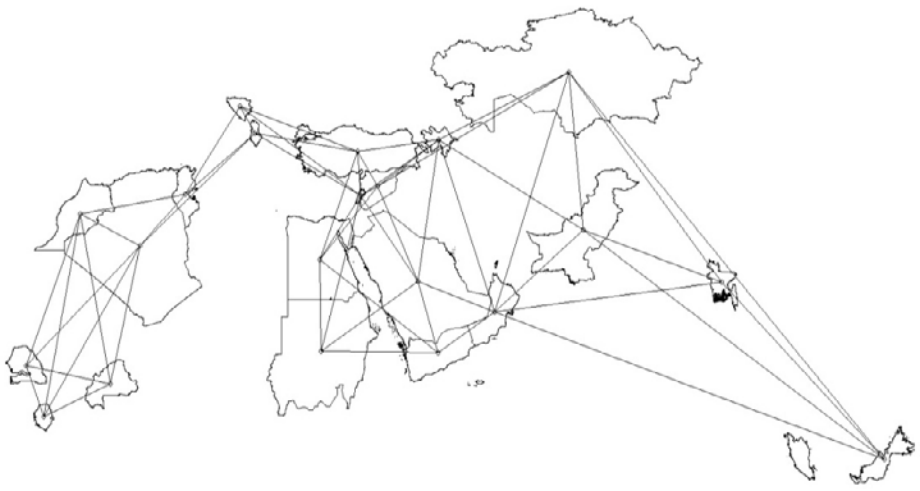
4.2 Measuring Spatial Association and Correlation between numbers of emigrants and immigrants among neighbouring countries

Patterns observed in plotted maps indicate relations between the neighbouring countries. Gledisch and Ward (2001) use to establishment linkages among neighbouring countries, the rule of the minimum distance of 200 or fewer kilometres between them. In the case of the countries studied in this paper, some of them were excluded from observation due to the lack of data and this is one reason for the poor connectivity matrix (low number of ones in matrix). Another way to observe relations between countries is using of k-nearest neighbours rule. The paper applies 4 neighbours rule because there are a lot of "islands" in the observation (however the literature suggests 6 as optimal solution). Connections between 4-nearest neighbouring observed countries are shown on the following figure:

Figure 6: Plot of 4-nearest neighbours in observed countries



Source: Self-processed

The linear association between variable and weighted average of its neighbour's variable (correlation between y_i and y_j) can be determined by local Moran´s I statistic. The local Moran´s I statistic is often used as a test of spatial correlation by constructing a Z-score with the mean and variance components. Local Moran´s I statistic is illustrated in Table 2.

Table 2: Local Moran´s I statistics

Variable	*Moran´s I*	*p-values*
Stock of emigrants	**0,1612**	**0,0298**
Stock of immigrants	**0,1651**	**0,0355**
GDP per capita	0,12466	0,0701
Industrial production growth rate	0,1016	0,1106
Global gender gap index	0,0387	0,2178
Oil production	**0,3**	**0,0028**
Tariff and nontariff barriers	-0,0201	0,4059
Regulatory Quality	-0,1227	0,7181
Rule of law	-0,1824	0,8523
Royalty payments and receipts	0,073	0,1498
Journal Articles	0,0061	0,3276
Average years of school	-0,008	0,3634
Gross secondary enrollment rate	0,0871	0,1395
Gross tertiary enrollment rate	**0,2882**	**0,0035**
Total telephones	0,0044	0,3295
Computers	0,0691	0,1579
Internet Users	0,0508	0,2148
Index of economy freedom	-0,1202	0,7143

Source: Self-calculated

The Moran scatter plot indicates standardized values of the variable numbers of emigrants and immigrants) which are plotted on the horizontal axis and the standardized spatial lag of this variable on the vertical axis. It consists of four quadrants corresponding to different types of spatial association. Most of the countries are located in the quadrants II and III (Figures 8 and 9) and present spatial clusters of countries with similar numbers of emigrants/immigrants in the Muslim world. The intensity of emigrant´s and immigrant´s numbers in the countries follows specific spatial patterns highlighting the importance of the geographical proximity of the sample countries. Local Moran´s I statistics confirm the presence of patterns only for several independent variables (this fact should not be overlooked in the construction of regression analysis). The analysis shows existence of the disparities in the level of emigrant´s/immigrant´s numbers experienced by the observed countries, but it is investigated more deeply using the regression analysis.

Figure 7: Moran scatter plot for stock of emigrants in observed countries

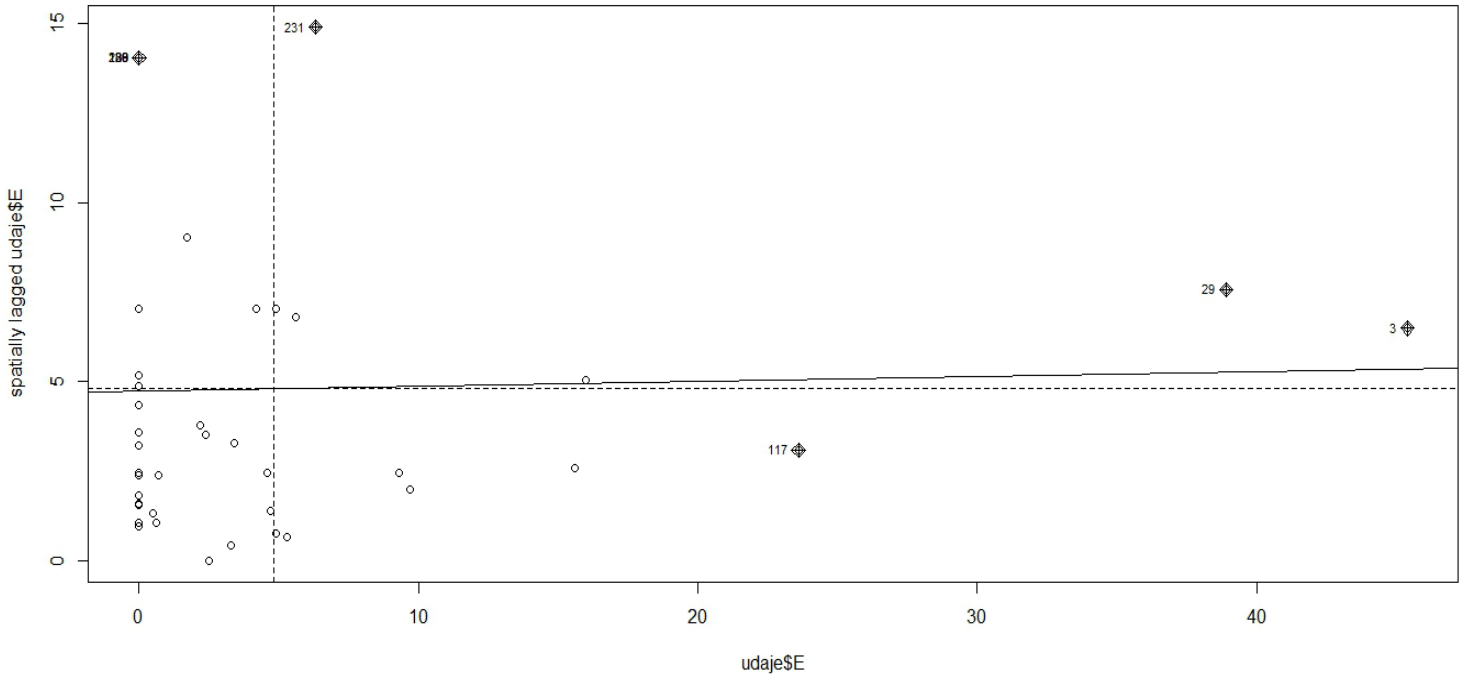


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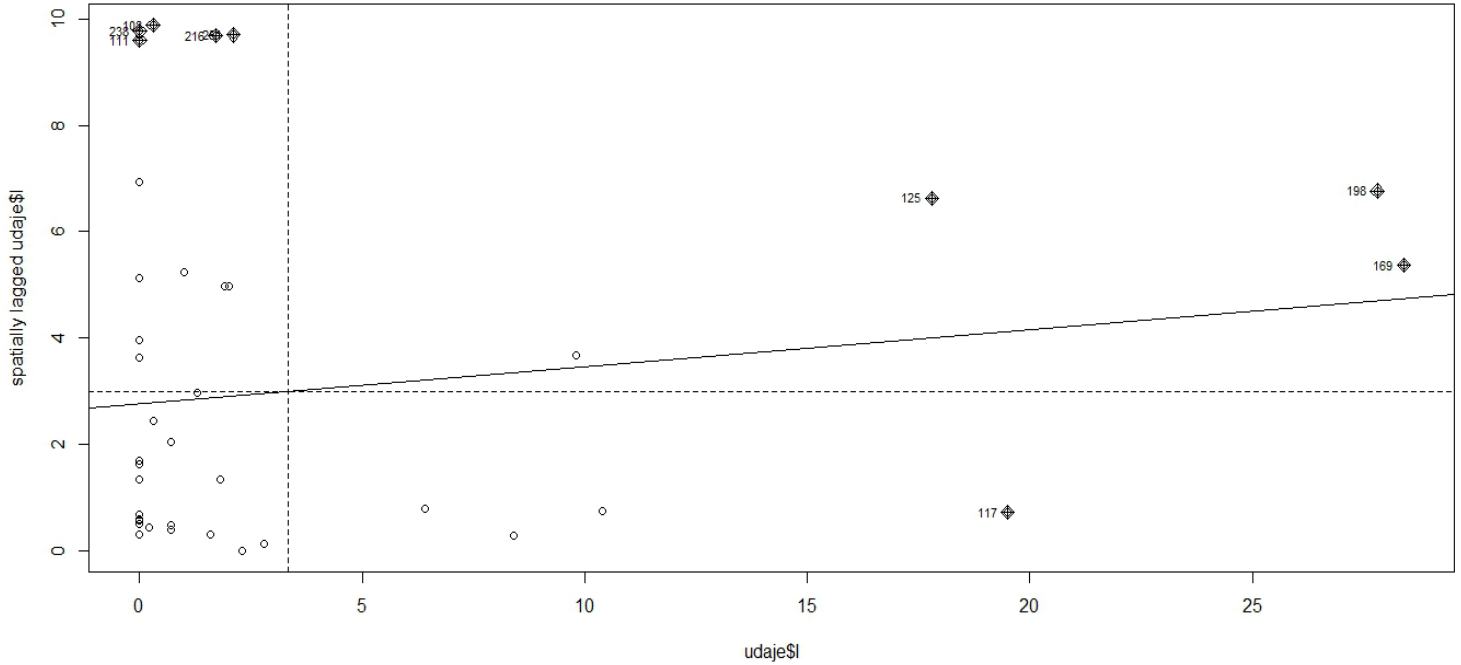
Figure 8: Moran scatter plot for stock of immigrants in observed countries



Source: Self-processed

5. Analysis of spatial dependence of migration

Spatial econometrics enlarges traditional regression models considering also interactions between countries, regions or cities. The main features of spatial models are spatial effects, especially spatial dependence and spatial diversity. The spatial dependence indicates situation when values of variables of a region depend on the values of the nearest region. The model for two neighbours *i* and *j* can be written according to LeSage and Pace (2009) as follows:

$$y_i = \alpha_i y_j + X_i\beta + \varepsilon_i, \quad (1)$$

$$y_i = \alpha_j y_i + X_j\beta + \varepsilon_i, \quad (2)$$

$$\varepsilon_i \sim N(0,\sigma^2) \;\; i = 1, \quad (3)$$

$$\varepsilon_i \sim N(0,\sigma^2) \;\; i = 1. \quad (4)$$

Due to the spatial structure of data, the spatial autocorrelation is usually presented together with the heterogeneity and the ordinary least square regression is insufficient to estimate regression coefficients (Anselin, 1999). The spatial diversity means, that the vector β_i is different for each observation *i* and this situation can be showed through following equation:

$$y_i = X_i\beta_i + \varepsilon_i, i = 1, \dots, n. \quad (5)$$

The above mentioned effects can lead to the structural instability of modelled relation and localization of the observation is important which can reveal the instability form (Anselin, 1999).There are two main possibilities how to examine the spatial dependence in a statistical model: spatial lag model and spatial error model. The main feature of spatial lag model is the presence of a spatially lagged dependent variable among the covariates. In other words, the values of *y* in one unit *i* are directly influenced by the values of *y* found in its neighbouring units $(y_i \sim y_j)$ (Warld, Gledisch, 2007). LeSage and Pace (2009) define the spatial lag model as follows:

$$y = \rho W y + X\beta + \varepsilon. \quad (6)$$

W is a spatial weights matrix, ρ is an added spatial autoregressive coefficient, *X* is a matrix of explanatory variables, *y* is dependent variable, *ß* is a vector of coefficient and ε is an random error. If there is some spatially clustered pattern having an impact on the value of *y* for *i* and its neighbours, but *y* is not influenced directly by the value of *y* of its neighbours, spatial error model is more appropriate. Spatial error model is an alternative to ordinary least square regression with spatially correlated errors (Warld, Gledisch, 2007). LeSage and Pace (2009) define the spatial error model as follows:

$$y = X\beta + \varepsilon + \lambda W\xi. \quad (7)$$

Overall error is split into two components - ε as a spatially uncorrelated error term as in the case of normal regression assumption and ξ as a spatial component of error term. The parameter λ defines the correlation between errors ξ of the nearest observations due to the connectivity´s vector *W*.

Spatial lag model in comparison to spatial error model explains spatial dependence through adding a spatially lagged dependent variable *y* on the right hand side of the regression equation. In the spatial error model errors cannot be considered as another independent variable and the information about spatial clustering is included in the structure of the error process. The advantage of a spatial concept is that it supposes dependency among observations. Specific forms of spatial autocorrelation (spatial dependency among observations) can be tested through Lagrange Multiplier tests (Warld, Gledisch, 2007).

In order to reduce any potential problem of multicollinearity (VIF>5) between independent variables, some of them were excluded from observation (regulatory quality, rule of law, gross secondary enrolment rate, total telephones and index of economy freedom). GDP per capita is considered as a control variable.

5.1 Spatial dependence of emigrants numbers

Lagrange Multiplier tests of spatial autocorrelation presence.

LMlag = 0.9498, df = 1, p-value = 0.3298

LMerr = 0.5345, df = 1, p-value = 0.4647

Lagrange Multiplier test shows that the model could mirror existence of spatially lagged dependent variable as spatially correlated errors; however the p-value is still high. Local Moran´s I statistic and density plot with clusters indicate correlation of the dependent variable in the space in both cases (numbers of emigrants and numbers of immigrants). Basic characteristics of ordinary least square regression, spatial lag model and spatial error model are presented in the next table:

Table 3: Basic characteristic of compared models – dependence of emigrants

Characteristics	OLS regression	spatial lag model	spatial error model
Multiple R-squared	0,8531	-	-
Rho	-	-0,37163	-
p-value:	0,01335	0,34477	< 2.22e-16
AIC	148,99	149,68	130,94
Log-likelihood:	-61,49749	-60,8411	-51,47093

Source: Self-calculated

The Akaike information criterion (AIC) and log-likelihood rule indicate that the more appropriate should be the usage of spatial lag model but according to F-statistics of models (p-value<0,05), the spatial error can be considered as model that can best estimate dependence of emigrants stocks. In the spatial error model, dependence is explained only through the error terms and estimated coefficients can be implemented directly. Independent variables in observation *i* do not have impact on the outcomes in observation which are in relation with *i* and spatial error model does not need to define impacts of variables as in spatial lag models.

5.2 MLE Estimation of Models

Table 4: Models summary – dependence of emigrants

Variables	OLS			SLDV			SEM		
	β	SE β	Pr(>|t|)	β	SE β	Pr(>|z|)	β	SE β	Pr(>|z|)
Intercept	-30,03	36,05	0,43	-16,61	25,47	0,51	-27,54	18,16	0,13
GDP per capita (control)	-0,9	0,53	0,12	-1,04	0,35	0	-0,69	0,27	0
Industrial production growth rate	-2,1	1,13	0,1	-2,21	0,71	0	-3,14	0,74	0
Global gender gap index	-20,15	48,07	0,69	-30,5	31,22	0,33	-52,8	15,88	0
Oil production (dummy)	-0,69	4,86	0,89	-1,01	3,16	0,75	6,93	2,9	0,02
Tariff and nontariff barriers	0,54	0,27	0,07	0,46	0,18	0,01	0,81	0,23	0
Royalty payments and receipts	-0,36	0,21	0,13	-0,42	0,14	0	-0,11	0,09	0,22
Journal articles	-0,14	0,08	0,11	-0,12	0,05	0,01	-0,18	0,05	0
Average years of school	4	1,43	0,02	4,36	0,95	0	3,71	0,68	0
Gross tertiary enrolment rate	0,11	0,17	0,53	0,16	0,11	0,15	0,03	0,09	0,77
Computers	-0,03	0,02	0,1	-0,03	0,01	0	-0,06	0	0
Internet users	0,04	0,02	0,1	0,04	0,01	0	0,04	0,01	0
Rho				-0,37					
λ							-3,03		
N	21			21			21		
df	13			14			14		
Log likelihood	-61,5			-60,84			-51,47		

Source: Self-calculated

As it can be seen in Table 4, the coefficients estimates for the impact of variables are in the most cases considerably larger in the spatial error model than in the spatial lag model and ordinary least square regression. OLS model and spatial lag model probably overestimate their direct impact and OLS does not take into account supposed spatial clustering among neighbouring countries. In all models, the influence of royalty

payment and receipts and gross tertiary enrolment rate on the stock of emigrants cannot be confirmed because of low statistical significance. The spatial error model corrects for the negative correlation of most variables and emigrants numbers. The global gender gap index has the highest impact on the emigrants numbers (one unit of improving conditions for women decreases numbers of emigrants by approximately 58 people) but its significance is proved only in the spatial error model. The main difference among models can be found in Oil production that is considered as a dummy variable – 1 for substantial oil producers and 0 for others. As it can be seen in spatial error model, the impact of this variable is positive and it means that if the country is "important oil producer" then the number of emigrants rises, but on the other hand as classic regression shows, this situation is opposite – if the country is not so "important oil producer" then the number of emigrants still rises. One can assume that the existence of oil in the country brings a competitive advantage, but this advantage can lead to different conflicts and to instability in the country. From the view of a knowledge based economy, there are two opposite situations: if the number of computers is increases the emigrants' numbers decrease but if the number of internet users increases the emigrants' numbers are also increases. The impact of these estimated variables is very low and the internet coverage seems to be sufficient in most countries, with exception of the Sub-Saharan Africa. There is more interesting and influential factors on a knowledge based economy, which is significant in all models – the average years of schooling. The more skilled people are able to reach a competitive advantage and they are suitable for the international labour market and it leads to a desire for cross-countries migration. With respect to the control variable (GDP per capita), Table 4 indicates that it is statistically significant.

5.3 Spatial dependence of immigrants stock

Lagrange Multiplier tests of spatial autocorrelation presence.

LMerr = 0.9505, df = 1, p-value = 0.3296

LMlag = 0.0733, df = 1, p-value = 0.7866

Lagrange Multiplier test shows that the model could mirror rather existence of spatially correlated errors like spatially lagged dependent

variable; however the p-value is still high. Basic characteristics of ordinary least square regression, spatial lag model and spatial error model are presented in the next table:

Table 5: Basic characteristic of compared models – dependence of immigrants

Characteristics	OLS regression	spatial lag model	spatial error model
Multiple R-squared	0.9164	-	-
Rho	-	0,09!6918	-
p-value:	0,001359	0,60197	0,090377
AIC	124.77	126.5	123.90
Log-likelihood:	-49.38505	-49.24904	-47.95123

Source: Self-calculated

Although the Akaike information criterion (AIC) shows that it should be more appropriate to use spatial error model, the log-likelihood rule and F-statistics of models (p-value<0.05) indicate that the choice of classical ordinary least square regression should be better and OLS regression can be considered as a model that can best estimate dependence of immigrants stocks in observed countries. In other words, in the case of stock of immigrants there are not spatial errors or spatial lag variables which can influence the model as a whole.

5.4 MLE Estimation of Models

Table 6 offers summary of three models before the modification of second order (this modification is applied mainly in OLS when insignificant variables are phased out). Although, compared to the emigrant´s dependence and despite to the local Moran´s I score for immigrants and Moran scatter plot, it seems that spatial clustering cannot be confirmed through spatial models and observations are without spatial clustering among neighbouring countries. In order to avoid possible underestimation or overestimation of the estimated coefficients and according to the MLE and AIC criterion, the OLS regression is probably a more appropriate method to explain the dependence on immigrants in the Muslim world. In addition, it can be a result of negative net migration flow in most countries (stock of immigrants is lower than stock of emigrants). All models (with or without spatial dependence) indicate significance of four variables – GDP per capita (as a control variable), oil production, journal articles

and internet users. Numbers of immigrants depends on the fewer factors like numbers of emigrants, but the influence of these variables is very low with exception of the global gender gap index and average years of schooling. In short, the existing gap between men and women has an impact on the people leaving but not on their arriving to the country. The situation is similar in terms of the average years of schooling. Table 7 shows resulting estimators and statistical significance of variables after the modification of second order. The classic linear model (OLS regression) corrects for the negative correlation of most variables and immigrants numbers with exception of GDP per capita. It means that if GDP per capita will rise then the number of immigrants to the country will also rise (1.78 units). The impact of Oil production is the highest and negative (in the case of numbers of emigrants is this impact positive), but it means that if the country is an "important oil producer" then the number of immigrants decreases. This result leads to the question why people don´t arrive in the countries with economy advantages? The situation is similar in the case of two remaining variables of knowledge based economy, although their influence is relative small.

Table 6: Models summary – dependence of immigrants

Variables	OLS			SLDV			SEM		
	β	SE β	Pr(>|t|)	β	SE β	Pr(>|z|)	β	SE β	Pr(>|z|)
Intercept	3,31	20,2	0,87	4,6	13,23	0,72	-3,78	13,5	0,78
GDP per capita (control)	1,89	0,33	0	1,87	0,22	0	1,86	0,23	0
Industrial production growth rate	1	0,6	0,13	0,95	0,41	0,02	0,84	0,46	0,07
Global gender gap index	7,29	27,36	0,8	5,78	17,97	0,75	12,26	17,18	0,48
Oil production (dummy)	-6,66	2,63	0,03	-7,34	2	0	-3,9	1,93	0,04
Tariff and nontariff barriers	-0,1	0,14	0,5	-0,12	0,1	0,23	-0,04	0,12	0,74
Royalty payments and receipts	-0,09	0,11	0,42	-0,1	0,07	0,17	-0,09	0,07	0,18
Journal articles	-0,11	0,04	0,04	-0,1	0,03	0	-0,09	0,03	0
Average years of school	-0,35	0,78	0,67	-0,22	0,55	0,69	-0,63	0,49	0,2
Gross tertiary enrolment rate	0,1	0,1	0,32	0,1	0,06	0,11	0,11	0,07	0,14
Computers	0	0,01	0,76	-0,03	0	0,63	-0,02	0	0,73
Internet users	-0,2	0,09	0,06	-0,21	0,06	0	-0,21	0,07	0
Rho				0,1					
λ							-1,7		
N	21			21			21		

df	13			14			14		
Log likelihood	-49,39			-49,25			-47,95		

Source: Self-calculated

Table 7: OLS regression for immigrants – model´s summary after the modification of second order

Variables	OLS			
	β	SE β	t value	Pr(>|t|)
Intercept	3,63434	1,90422	1,909	0,07442.
GDP per capita (control)	1,78024	0,18702	9,519	5,43e-08 ***
Oil production (dummy)	-4,55477	1,87247	-2,432	0,02711 *
Journal articles	-0,08353	0,03105	-2,69	0,01611 *
Internet users	-0,23136	0,06449	-3,587	0,00246 **
Multiple R-squared	*0,8753*			
Adjusted R-squared	*0,8441*			
p-value	*4,69E-07*			
Significant codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1				

Source: Self-calculated

6. Conclusion

This article has examined spatial depended migration among countries of Muslim world which is partially influenced by knowledge-based economy indicators. Decision making of individuals about movement between different colonised areas (patches - countries) seems to be related to new national propensity drivers – knowledge. It means that there is a trade of between migration costs and income benefits which are reached also through knowledge indicators. The visual displays of data present the existence of geographical clusters of emigrants and immigrants numbers – there is a likely positive spatial relationship between neighbouring areas. Although, we can found the spatial pattern of emigrant´s numbers among countries which are situated in the periphery of the area (north) and the spatial pattern of immigrant´s numbers among countries which are situated at the Arabian Peninsula and in the Kazakhstan, the quantitative research confirms spatial autocorrelation only in the case of emigrants. The intensity of spatial dependence highlights the importance of the geographical proximity of

the sampled countries. Due to the spatial structure of data, this paper presents the spatial dependence and spatial diversity through the spatial models because the ordinary least square regression can overestimate or underestimate the regression coefficients. Findings also suggest that the significant explanatory variables coverage the essential triad towards the knowledge based economy: average years of schooling (knowledge), tariff and nontariff barriers (freedom), journal articles, number of computers and internet users (development). The presence of multicollinearity caused the exclusion variables such as regulatory quality, rule of law, gross secondary enrolment rate, total telephones and index of economy freedom from the observation. Models show that the highest impacts on the emigrant´s stock have variables average years of schooling and the global gender gap index. The importance of average years of schooling indicates that the more skilled people are able to reach a competitive advantage and they can migrate through the international labour market. Although, results show the significance of knowledge indicators in the case of both – leaving and arriving people, their estimated regression coefficients are relative small and one can assumes that there are other "stronger" determinants which has impact on the human desire to migrate.

Several policy recommendations can be drawn from this study. Firstly, the negative migration flow in the most countries of the Muslim Word can lead to worsening demographic situation. There is a need to reduce the number of emigrants and use significant variables of knowledge based economy to raise the number of skilled immigrants (wide spreading of information and telecommunication technologies). Secondly, there is need to decrease tariff and nontariff barriers which are part of "freedom" presented in triad towards knowledge based economy. Thirdly, the findings of the study also suggest that the number of emigrants depends on the number of emigrants in neighbouring countries and it means that the improvement of indicators of knowledge based economy in the nearest neighbours can reduce the number of emigrants in each country of selected area.

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