ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume 68 22 Number 1, 2020

INTERNATIONALIZATION, THE HIGHLY QUALIFIED AND THE INNOVATION OUTPUT

Zuzana Potužáková[1], Jan Öhm[2]

[1] Department of Marketing and Trade, Economic Faculty, Technical University of Liberec, Studentská 1402/2, 461 17 Liberec, Czech Republic

[2] Department of Economic Statistics, Economic Faculty, Technical University of Liberec, Studentská 1402/2, 461 17 Liberec, Czech Republic

Link to this article: https://doi.org/10.11118/actaun202068010219
Received: 29. 11. 2018, Accepted: 20. 11. 2019

To cite this article: POTUŽÁKOVÁ ZUZANA, ÖHM JAN. 2020. Internationalization, the Highly Qualified and the Innovation Output. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* 68(1): 219–228.

Abstract

The process of Internationalization strongly influences the developed economies, including the EU, whereas the large scale of international trade in goods is characterized by production with high value added. Based on this, the fabrication of such commodities requires a highly qualified workforce and is very often followed by international patent protection.

This paper focuses on the link between the fraction of highly educated with tertiary education and the innovation output, measured by the number of EPO patent applications per million inhabitants. Due to the rising mobility of a highly qualified workforce, we have also tested the correlation between the fraction of tertiary educated foreigners and the innovation output. The aim of the paper is to state whether the higher share of a highly qualified workforce and the fraction of highly qualified foreigners correlate with innovation activities within the EU Member States. Given the number of EU Member States, the EU macro-regions division based on the social models of Esping-Andersen (1990), Sapir (2005), as well as Dolwik and Martin (2014) will be applied.

Keywords: EPO patents, internationalization, innovation, highly qualified, migration, EU, social models

INTRODUCTION

Internationalization or the process of international expansion started to be researched more intensively after 1990, when the scope of international activities of many enterprises grew significantly. Internationalization is defined by various authors. For example, Beamish (1990) describes it as a process in which companies enhance awareness of the impact of international transactions on their future. According to Welch and Loustarinen (1993) internationalization is a process of growing a company's participation in international operations. Internationalization could also be divided into the stages or paths that the enterprise undergoes (e.g. Andersen 1993; Contractor *et al.*, 2002; Curci *et al.*, 2013). There are several models demonstrating the internationalization process. Early on, the models were anchored especially by the well-known Uppsala model (Johanson and Wiedersheim-Paul, 1975) or the Stopford internationalization model (Stopford and Wells, 1973). Both of the models were developed during the origins of the international expansion of Western companies, when the national markets became too small for the growing appetite of companies searching for new outlets abroad. Several modern theories focused the internationalization process after the bipolar division taking into account the globalization influx, growing dynamics of international trade in goods and rising international competitiveness (e.g. Porter, 1990; Andersen, 1993; Dunning, 1993 or Kaplan and Norton, 1996).

When focusing on internationalization, there are, in general, four areas to consider. On the microeconomic level, they determine the enterprise's performance and on the macroeconomic level the economic growth. These areas are: product, process, finances and human resources (e.g. Porter, 1990; Andersen, 1993). Demel (2014) added a fifth area, innovation, which provides the production of high value added output. To measure the international innovation output, the indicator number of patent applications is frequently applied. It is considered the most appropriate indicator of the international competitiveness, research and development of the economy (OECD, 2003; European Commission, 2013). The nexus between international trade in goods and international patent protection (in other words, between internationalization of the product and innovation) is easily approvable. For example, in the Czech Republic in the recent decade, approximately 70% of the total patent protection was constituted by the international patents (UPV, 2016).

In this paper, we have decided to test the nexus between two of the above mentioned areas of internationalization, the innovation activities and human resources within the EU Member States. First of all, we will test the hypothesis that the fraction of the highly qualified (tertiary educated) correlates with the innovation output. In the second part of the paper, we will focus on the link between the highly educated foreign workforce and the innovation output. The aim is to state whether the above mentioned indicators of human resources correlate with the innovation activities within the EU Member States.

MATERIALS AND METHODS

The positive impact of the educated workforce on the economic growth has been confirmed by many authors starting from Schultz (1961), Becker (1964, 1993), Romer (1986) or Mincer (1991), who considered human capital an essential factor for the economic development of the developed economies. The importance of investment into human capital was approved by Krueger (1968), who measured labor inputs for differences in human capital in 28 countries worldwide in the 1950s. The positive link between the investments into human capital and a company's activities were further confirmed by Lucas (1990). More precisely, Barro (1991) calculated that the increase of school enrolment by 1% results in an annual GDP per capita growth of 1–3%. His conclusions were recently elaborated by Barro and Lee (2015) and by Lee and Lee (2016). They confirmed a 10% constant marginal rate of return on an additional year of schooling. Their results were based on the estimated school enrollment ratios from 1820 to 2010 and the estimated educational attainment for the total female and male populations from 1870 to 2010 Lee and Lee (2016). The data were available in 5-year intervals for 110 countries worldwide. These results, based on the long-term and large-scale research, confirm the generally accepted fact that investment into human capital and the need for a tertiary educated workforce is a necessity.

The nexus between intellectual protection (IP) as the output of innovation activities and economic growth started to be analyzed in the 1950s by Solow (1956) and Swan (1956) through so called new growth theories. They concluded that the economic growth is determined by endogenous factors, with government policy having a significant effect on long-term growth. The new growth theories are further divided into two groups. While the first group focuses on the concept and measurement of capital, the second includes research and development models (the so-called R&D Models). R&D models, e.g. Romer (1990) or Grossman and Helpman (1991), are based on microeconomic analysis and incentives for research and development. These theories try to answer questions about why companies invest in R&D or how innovations[1] in one company affect the company's background and competitors. Based on these theories, we can conclude that innovation, especially in the form of a patented product, service, etc., constitutes improvement of the company's output, which shall guarantee a temporarily monopolistic position on the market and stimulate the company's profits.

This link was later approved by many authors. For example, Thompson and Rushing (1999) analyzed this particular relation in more than fifty countries worldwide in the period of 1970–1985. Their conclusions show a positive influence of trade openness on patent protection. The study also confirmed that investment in infrastructure and the level of IP protection are connected. Similarly, Schneider (2005) researched the link between the years 1970 and 1990 in nearly fifty countries around the world. According to her conclusions, the level of IP protection positively influences the degree of innovation. Rodrigez-Pose and Crescenzi (2008) analyzed the relations between R&D investments and economic growth focused on the regional level. They verified the outcomes for the EU-25 at the regional level, where regional knowledge highly improves regional growth performance in the neighboring regions as well. Nevertheless, based on their calculations, the influx of knowledge and innovation, represented by investment in R&D, is geographically limited.

1 In the article, we apply the innovation definition according to OECD (2005) "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations".

On the corporate level, Greenhalgh and Rodgers (2006) focused on the rate of financial returns on patent protection investments in the patent activities of British companies between the years of 1989 and 2002. The study found a significantly higher rate of financial return when businesses patented with the European Patent Office, compared to patenting with Great Britain alone. Helmels and Rodgers (2010) also found that patent protection or trademarks in newly established British firms have become a significant factor influencing a company's future existence. Sandner and Block (2011) confirmed the positive impact of IP protection on the value of a company in financial markets.

Based on the theoretical framework we can conclude that both of the areas, highly qualified human resources and innovations have positive effects on a company's profits and generate the economic growth of the national economies. Surprisingly, the link between these areas is only rarely analyzed in the research papers; most of the papers' focus highly qualifies migration and its link to the innovation output.

Further, we will focus on the link between a highly educated workforce and innovation activities. The backbone of the research focuses on the nexus between highly qualified migration and its impact on the innovation output. This topic is currently abundantly discussed within the developed countries, who are trying to attract the highly skilled from the other (often less developed) countries. Traditionally, this subject has been analyzed in the United States, historically based on migration of the foreign workforce. According to Freeman (2005), the US retains a global comparative advantage in science and innovation which continuously attracts the highly skilled. Consequently, this type of migration boosts the innovation output of the US. Hunt and Gauthier-Loiselle (2010) concluded that migrants patent at double the native rate, due to their disproportionate holding of science and engineering degrees. Further, they approved on the panel data from the years 1940–2000 that a 1 percentage point increase in immigrant college graduates' population share increases patents per capita by 9–18 percent. The attractiveness of the US for the highly skilled migrants has also been confirmed by Stuen *et al*. (2012), who analyzed the enrolment of the international students in the doctoral programs. Thanks to large imports of foreign doctoral students in science and engineering, the US has sustained its primary position as developer of new knowledge. Mahroum (1999) concludes that about 50% of all (European) doctoral graduates stay in the USA when they have finished their studies, and many do not return home at all. According to Wadhwa *et al.* (2007), non-US citizens account for 24 percent of international patent applications from the United States. He also emphasized the fact that almost 80% of the immigrant-founded companies in the US were within just two industry fields: software and innovation/manufacturing-related services. Both of the fields require a highly-skilled workforce. These findings confirm the link between the highly skilled migration and innovation output in the United States.

When focusing on Europe, the papers validate very similar results. However, the topic has been emphasized relatively recently compared to the US. The nexus has been researched predominantly on the microeconomic level focusing especially on HR issues such as the work-team diversities (e.g. Horowitz and Horowitz, 2007) or top-management diversities (e.g. Pitcher and Smith, 2001). On the macroeconomic level, Niebuhr (2009) analyzed the topic of cultural diversity of the labor force, spreading from the migration, on patent applications in the German regions. According to her findings, there are positive effects of cultural diversity in the number of patents per capita that outweigh the costs of cultural diversity. Lee and Nathan (2010) analyzed the link between the cultural diversity and innovation output in London on the company level covering 2300 London firms. They found significant positive relationships between workforce and ownership diversity, and product and process innovation. Reaching the same conclusions, Parotta *et al.* (2012) analyzed the nexus between labor diversity and innovation in Danish companies. According to their findings, ethnic diversity is a crucial source of innovation. According to the most conservative estimates, a 10 percentage change in ethnic diversity increases the number of firms' patent applications by approximately 2.3 percent. Gagliardi (2015) confirmed the findings regarding skilled immigrants on the innovation activities of British companies on a sample of more than 22 thousand firms.

Also, the larger samples affirm these findings. Ozgen *et al.* (2011) analyzed the impact of migration innovation output of 170 NUTS II regions from 12 EU countries in the periods 1991–1995 and 2001–2005. Their calculations confirmed Niebuhr's result regarding the link between the diversity of the migrant community, skill level of the migrants and patent applications. On the contrary, the increasing share of the foreigners in the population alone does not affect patent application. Bosetti *et al.* (2015) analyzed the effects of highly-skilled migrants in 20 European countries in the years 1995–2008. Their findings show that a larger pool of highly skilled migrants is associated with higher levels of knowledge creation, especially in the case of PTC applications. Based on these facts, we can assume that there is a nexus between highly skilled migrants and innovation output in Europe. However, the link depends, according to the findings of the paper, more on cultural/ethnic diversity and its qualifications than on the share of the population.

Based on the above mentioned theoretical framework, we will test both hypotheses. First of all, we will test whether the fraction of the tertiary educated human resources in sciences and technology (HRST), defined also by ISCED 2011 classification as ISCED 5- ISCED 8, correlates with the innovation output. Both of the indicators are available for the national economies as well, which makes the calculations on the level of the EU Member States suitable. As the indicator of human resources, the human resource indicator with tertiary education per million inhabitants was chosen.

For innovation activities we choose the frequently used EPO patent applications per million inhabitants. According to OECD (2009), patent protection is one of the traditional and most important intellectual property protection institutes. As mentioned above, due to internationalization accompanied by intensified international commodity exchange, national patent protection is not a sufficient guarantee of financial return. Therefore, the importance of international patent protection is growing (OECD, 2016). The EPO patent authors have opted for further analysis on the grounds of the data availability within Eurostat across the EU, unlike the indicator regarding the number of PTC applications registered only for the OECD members. Both indicators are available from the Eurostat database. Given the number of EU Member States, the authors of this paper have decided to regard the countries as macro-regions based on the Esping-Andersen (1990), Sapir (2005) and Dolwik and Martin (2014) social model division[2]. The chosen delay between the indicators was two and three years because the development of products with high value added requires a relatively long period.

Later on in the paper, we will test the second hypothesis. It should verify whether the fraction of the tertiary educated foreigners (defined also by ISCED 2011 classification as ISCED 5-ISCED 8) positively correlates with the innovation output. The indicator tertiary educated HRST for foreign workforce was not available, so we have decided to apply the indicator foreigners with tertiary education per million inhabitants which covers, not exclusively, the science and technology branches. For innovation activities we choose again EPO patent applications per million inhabitants.

Several methods will be used to achieve the set goals. Firstly, a regression analysis, a regression line model in particular, is applied in individual years to the set of surveyed countries. Linear model parameters are estimated by the method of least squares (the so-called OLS) minimizing the sum of the squares of the differences between the observed dependent variable (values of the variable being predicted) in the given dataset and those predicted by the linear function. The suitability of the model is assessed on the basis of the standard F-test, which corresponds to the decomposition of variability of the dependent variable on the model and the residual ones. This ratio is denominated by degrees of freedom, concretely considered the number of model parameters (p - 1) and the number of observations (n - p). A small P-Value (less than 0.05 if operating at the 5% significance level) indicates that a significant relationship of the form specified exists between Y (dependent variable) and X (independent variable). Partial parameters are tested by the t-tests, in which case the relevance of the model slope is also considered to be a correlation coefficient significance test regarded as a guideline in determining the strength and direction of potential dependence. The t-statistic tests the null hypothesis that the corresponding model parameter equals 0, versus the alternative hypothesis that it does not equal 0. Small P-Values (less than 0.05 if operating at the 5% significance level) indicate that a model coefficient is significantly different from 0. As mentioned, the considered significance level for all analyses is 5%; in particular cases even stronger tests are mentioned. The considered materiality level for all analyses is 5%; in particular cases even stronger tests are mentioned. The additional Durbin-Watson test aimed at detecting possible autocorrelation of residues is not essential due to the time factor exclusion, however, in most analyses, the hypothesis on autocorrelation of residues is not rejected at a 5% materiality level (Anděl, 2007).

The second group of calculations is based on the analysis of the variance method (ANOVA). This

2 The Anglo-Saxon model (Great Britain, Ireland) is characterized by a low level of government interventions, the decisive role of the market and the concept of a minimal state. The Continental model (Austria, Germany, France, Belgium, Luxembourg, the Netherlands) is based on the basic idea that preventing social problems is more effective than addressing them. The objective of such a model is a high level of social protection and employment. The Scandinavian model (Finland, Sweden, and Denmark) is characterized by egalitarian tendencies and high redistribution of the national product. Social security concerns essentially all population groups, resulting in the cost of a system which can only be financed through high employment. The Southern European model (Spain, Italy, Greece, Portugal, Malta, Cyprus), also called the Mediterranean model, is defined by higher income inequality, and social systems do not reach the parameters prevalent in most of the original EU countries. The problem is strict legislation to protect workers' rights, creating rigidities in the labor market. The post-communist, or the so-called Central European model (the Czech Republic, Slovakia, Poland, Hungary, Slovenia) and Baltic model (Estonia, Lithuania, Latvia) take on the elements of the continental and liberal model with regard to its time of origin. The Central European model is closer to the continental model, while the Baltic model is predominantly liberal. The model of the Balkan states (Romania, Bulgaria, and Croatia) combines the liberal model as for the amount of money invested together with the Mediterranean in terms of distribution.

method, which consists in the decomposition of variability of the researched variables into, within and between groups, will allow the internal and external differences within and between the particular macro-regions (models) of the researched group to be revealed. In order to verify the assumption of normality, the Kolmogorov-Smirnov test will be performed, as the partial sets of data are of a small scale. Homoscedasticity of subsets will be verified by the Bartlett's test. The considered materiality level for all analyses is equal to 5%; nevertheless, in many cases the tests are much stronger and meet even the 1% of the type I error level, whereas the homoscedasticity test is of a higher materiality level, i.e. more than 5% (Anděl, 2007).

The data are achieved from a regular distribution; therefore, a parametric version of the ANOVA will be applied. Particular data sets (models in terms of typology of socio-economic characteristics) are of identical data scattering (Anděl, 2007).

To determine which sample means are significantly different from which of the others, the Multiple Range Test is performed. A graphical illustration of which means are significantly different from which of the others, based on the contrasts displayed in the second half of the table is used in Tab. IV. Each column of X's indicates a group of means within which there are no statistically significant differences.

RESULTS

Results obtained in the regression analysis indicate that there is a statistically significant dependence of patents on the employment of university graduates in the sector. This relation is direct and moderate. The value of the correlation coefficient oscillates around 0.5 in the period between 2005 and 2012. The regression model is rather limited by the insignificance of the constant member, which exceeds the type I error of 5% in all partial tests. At the same time, however, it is of real significance; therefore, it is retained in the model. For example, the regression line of the period 2014/2012 is in the form $Y = -26.028 + 0.7969 \times X$. This means the rate of EPO increase per highly qualified employee is approximately 0.7969.

The first table determines the results of the first hypothesis sets. Although there is dependence on the first pursued periods, the hypothesis of independence apparently proves to be verified to an increasingly higher level of significance with advancing progression. This may be a sign of a certain glut in the science and research sector, or, as the case may be, this may call attention to other potential difficulty. In any case, the number of patents ceases to be dependent on the number of highly qualified.

For the second hypothesis examined, the basic two-year difference is a one-year delay. Contrary to previous analyzes, the assumption is that highly qualified migration boosts the innovation output. However, this assumption does not confirm the results. As can be seen from the following table, this hypothesis has not been confirmed in any of the observed periods, and the first type of rejection error is between 35 and 96 percent, which represents a really high level of significance.

The above findings will be further analyzed at the macro-regional level. Decomposition to intergroup and intragroup variability reveals that there are statistically significant differences in both cases. These differences are lower for the highly qualified. Considering the lower size of the macro-regions that result from the necessity for simplification within a stipulated typology, the five percent error level is still respected. There is one big limitation of this analysis, which, however, also shows some interesting results. Among these macro-regions heteroscedasticity has been approved on the 5% significance level in the number of EPO applications. This is to the contrary with the number of HRST. The following table summarizes the results for both variables.

I: *Regression analysis of EPO/highly qualified dependence*

Two years delay			Three years delay		
Years	F-Ratio	P-Value	Years	F-Ratio	P-Value
2005/2003	8.17	0.0083	2006/2003	7.45	0.0112
2006/2004	10.42	0.0034	2007/2004	11.04	0.0027
2007/2005	10.26	0.0036	2008/2005	11.14	0.0026
2008/2006	8.45	0.0074	2009/2006	8.63	0.0068
2009/2007	6.99	0.0137	2010/2007	6.56	0.0166
2010/2008	5.97	0.0216	2011/2008	5.93	0.0221
2011/2009	6.02	0.0212	2012/2009	5.91	0.0223
2012/2010	4.78	0.0379	2013/2010	5.06	0.0332
2013/2011	4.19	0.0509	2014/2011	2.75	0.1108
2014/2012	2.45	0.1312			

Source: Own computations based on EUROSTAT (2018a)

II: *Regression analysis of EPO/foreigner dependence*

Years	F-Ratio	P-Value	Years	F-Ratio	P-Value
2006/2004	0.96	0.338	2005/2004	0.94	0.3451
2007/2005	0.00	0.9582	2006/2005	0.00	0.9569
2008/2006	0.00	0.9850	2007/2006	0.00	0.9553
2009/2007	0.18	0.6725	2008/2007	0.12	0.7325
2010/2008	0.18	0.6747	2009/2008	0.15	0.7009
2011/2009	0.88	0.3588	2010/2009	0.83	0.3711
2012/2010	0.70	0.4123	2011/2010	0.90	0.3520
2013/2011	0.42	0.5242	2012/2011	0.44	0.5118
2014/2012	0.21	0.6513	2013/2012	0.26	0.6160
			2014/2013	0.00	0.9485

Source: Own computations based on EUROSTAT (2018a)

III: *ANOVA of HRST and EPO*

HRST			EPO		
Year	F-Ratio	P-Value	Years	F-Ratio	P-Value
2005	4.17	0.0065	2005	34.87	0.0000
2006	3.62	0.0126	2006	32.72	0.0000
2007	3.11	0.0245	2007	30.56	0.0000
2008	3.28	0.0195	2008	34.66	0.0000
2009	3.57	0.0136	2009	29.77	0.0000
2010	3.48	0.0152	2010	32.92	0.0000
2011	3.17	0.0224	2011	34.11	0.0000
2012	3.24	0.0205	2012	33.21	0.0000
2013	3.30	0.0190	2013	33.69	0.0000
2014	N/A	N/A	2014	27.48	0.0000

Source: Own computations based on EUROSTAT (2018a)

Tab. III reveals that F-Ratio (different from the previous Regression F-Ratios) is again decreasing over time. The whole analysis may thus indicate that the factor of time should also be taken into consideration. Together with spatial factors, these results may possibly lead to the conclusion that the present Research and Development policies have reached their limits. Therefore, it is necessary to deepen the analyses accordingly to these results and presumptions.

The second set of data again shows different results. The ANOVA P-Value is different from year-to-year and oscillates around the initially set five percent error. Thus, another approach is selected and both datasets are compared in the multiple range test.

It is obvious that the ranking is different in both cases (see especially the ranking for Central European, Balkan and Baltic regions). Also, there is significant difference between and within particular groups.

The possible interpretation of the results is that with a higher level of a particular indicator there is also a higher level of competition provided by dispersion, that is to say, risk. In both cases, the Anglo-Saxon area has the highest central tendency. The most interesting difference is in the Central European area. The total range is absolutely different but relatively there is not a comparable difference. Detailed figures are discussed in the next chapter.

DISCUSSION

Based on our calculations we can confirm the nexus between the highly qualified workforce and the number of EPO patents. This hypothesis is in line with the generally accepted fact that investment into human capital is a necessity. Surprisingly, the same nexus was not confirmed for the foreign workforce. However, there can be several reasons for the fact that our finding does not correspond with the previously mentioned research papers.

IV: *Multiple Range Tests of HRST and foreigners*

HRST (2013)				Foreigners (2014)			
Type	Count	Mean	Homogeneous Groups	Type	Count	Mean	Homogeneous Groups
Balkan	3	111,253	X	Baltic	2	21,65	X
Central European	5	132,121	XX	Mediterranean	6	23,9	X
Mediterranean	6	142,711	XXX	Balkan	1	27,6	XX
Conservative	6	170,63	XXX	Conservative	6	32,5667	XX
Baltic	3	186,419	XX	Scandinavian	3	38,2667	XX
Scandinavian	3	191,829	XX	Central European	5	39,02	XX
Anglo-Saxon	2	208,952	X	Anglo-Saxon	2	49,75	X

Source: Own computations based on EUROSTAT (2018a)

First of all, as with every data sample, this one also has its limits. The Eurostat database does not distinguish between the EU citizens coming from the other Member States and non-EU foreigners. The definition of foreigner is based on the fact that the particular person's citizenship is different from that of the country (EU Member State) where he or she is currently living. The division between the EU and non-EU population would definitely help to differentiate between the intra-EU migration and the foreign workforce originating from the other source countries. Furthermore, it is necessary to mention that the first indicator also covers, due to its constructions, the highly-qualified foreign workforce in research and technology. However, the figures concerning HRST are not available. On the other hand, it is necessary to mention that the share of the total foreign population on the total population is about 6% within the entire EU; in most of the Member States it does not exceed 3–4% (Eurostat, 2018b), which implies that the fraction of foreign HRST would be relatively minor.

Moreover, for our purposes ISCO would be a more suitable classification than ISCED. The ISCO classification by its very nature focuses on occupation groupings of the employed (not the entire population). It would definitely better determine whether there is an appropriate allocation effect on the labor markets of the analyzed EU Member States. Unfortunately, the foreign labor force grouped according to the ISCO classification is not available in the Eurostat database.

Additionally, due to the problems with recognition of qualifications (or diplomas), under-qualification effects of the foreign labor force can occur (see e.g. Quintini, 2011). This allocation problem on particular EU labor markets is also concluded by Bosetti *et al.* (2015), Jonhston *et al.* (2015) or Ozgen (2011). These results can signify that the EU cannot efficiently use the foreign workforce and that the highly educated foreign population is employed in positions for which they are over-qualified. We consider this aspect to be the most essential. However, it would require more detailed analysis to state the under-qualification effects on the innovation output within the EU Member States.

Finally, there is also one methodological point which raises an important theoretical question. The regression analysis method used in our research is valid only in a limited range of explanatory variables (this is often forgotten by many researchers and the difference between impact and causality is not taken into consideration). This fact raises the question as to whether globalization has not reached its limit and, if so, rendered the conclusion of the scientists mentioned above obsolete.

CONCLUSION

Internationalization has brought many challenges to the EU business environment and EU Member States in recent decades. Among them belongs the rising necessity of international patenting due to the large export volume of products with high value added. Further, thanks to the accompanying globalization, migration has become easier world-wide, combined with competition of national economies for highly qualified foreign workforce. In the article we have tested two hypotheses focusing on the nexus between two areas of internationalization, human resources and innovation. The first one should verify whether the share of the tertiary educated (human resources in science and technology (HRST)) correlates with the innovation output, defined as the number of EPO patent applications per million inhabitants. The other hypothesis should verify the same nexus for the tertiary educated foreigners.

Based on our calculations we can confirm that the number of EPO applications within the surveyed EU Member States is positively influenced by the fraction of tertiary educated HRST. However, this influence is diminishing over time; moreover, its significance may even be assumed to have ceased.

In different circumstances, migration influences do not have a statistically significant effect on the quantity of patent applications. This hypothesis has not been demonstrated at more than a 30% materiality level. There are several reasons which can explain the differences in the results described in the Discussion section. In our opinion, the over-qualification and under-qualification effects play the most critical role. Nevertheless, this assumption requires more detailed analysis.

Considering more detailed decomposition, there are statistically significant differences between European macro-regions. These differences are apparent not only within the explanatory variable of the patent applications, but within the individual explanatory variable as well. The fraction of the tertiary educated is not as heterogeneous as can be quantified in a number of patent applications. Nevertheless, the 5% level of error indicates a significant difference between different groups of countries. Taking into account specific regions, the Baltic model proves itself to be different at higher level of university graduates; however, this model reaches the penultimate place in patent applications.

The number of the tertiary educated in science and technology drops from the Anglo-Saxon model (average 208,952) towards the Balkan model (average 111,253). Nevertheless, the homogeneity of the individual macro-regions does not rise in the same direction. The lowest homogeneity is demonstrated in the Anglo-Saxon model with a standard deviation of 16,074 university graduates per million, on the contrary, the Mediterranean sector shows a variation of 516,748 university graduates.

Finally, we can conclude that the nexus between the two areas of internationalization, human resources and innovation was confirmed within the EU Member States and macro-regions, however, only for the domestic highly-qualified. On the other hand, the difference between the tertiary educated foreigners share is generally not statistically significant among various macro-regions. The lowest share of 21.65% is in the Baltic model, the highest in the Anglo-Saxon model with 49.75%. This particular difference is significant, however, generally these difference are not significant even at a 17% error level. The homogeneity among macro-regions parallels the homogeneity within them.

Acknowledgements

This article was prepared with the institutional support of the long-term conceptual development of the Faculty of Economics, theTechnical University of Liberec, within the framework of the project Excellent Research Teams – Business in International Trade.

REFERENCES

ANDĚL, J. 2007. *Statistické metody* [in Czech: *Statistical Methods*]. Praha: Matfyzpress.

ANDERSEN, O. 1993. On the Internationalization Process of Firms: A Critical Analysis. *Journal of International Business Studies*, 24(2): 209–231.

BARRO, R. J. 1991. Economic Growth in a Cross Section of Countries. *Quarterly Journal of Economics*, 106(2): 407–444.

BARRO, R. J. and LEE, J. W. 2015. *Education Matters: Global Schooling Gains from the 19th to the 21st Century*. Oxford: Oxford University Press.

BEAMISH, P. W. 1990. The Internationalisation Process for Smaller Ontario Firms: A Research Agenda. In: RUGMAN, A. M. (Ed.). *Research in Global Strategic Management – International Business Research for the Twenty-First Century: Canada's New Research Agenda*. Greenwich: JAI Press Inc., pp. 77–92.

BECKER, G. S. 1964. *Human capital: A theoretical and empirical analysis, with special reference to education*. Chicago: University of Chicago Press.

BECKER, G. S. 1993. *Human capital: A theoretical and empirical analysis, with special reference to education*. 3rd Edition. Chicago: University of Chicago Press.

BOSETTI, V. 2015. Migration of skilled workers and innovation: European Perspective. *Journal of International Economics*, 96(3): 311–322.

CONTRACTOR, F. J., KUNDU, S. K. and HSU, C. C. 2003. A Three-Stage Theory of International Expansion: The Link between Multinationality and Performance in the Service Sector. *Journal of International Business Studies*, 34(1): 5–18.

CURCI, R., MACKOY, R. and YAGI, N. 2013. Stages and Paths of Firm Internationalization: Testing the Value Chain Internationalization Framework. *Journal of Comparative International Management*, 16(1): 3–22.

DUNNING, J. H. 1993. *Multinational enterprise and the global economy*. Reading: Addison-Wesley.

DEMEL, J. 2014. *Internationalization as a significant area of utilization of the company's potential* [in Czech: *Internacionalizace jako významná oblast využití potenciálu podniku*]. Liberec: Technical university of Liberec.

DOLVIK, J. E. and MARTIN, A. (Eds.). 2014. *European social models from crisis to crisis: employment and inequality in the era of monetary integration*. Oxford: Oxford University Press
EUROPEAN COMMISSION. 2013. *Innovation Union Scoreboard 2013*. Brussels: EC.
EUROSTAT.2018a *Eurostat database*. [Online]. Luxembourg: Eurostat. Available at: https://ec.europa.eu/eurostat/data/database [Accessed: 2018, August 8].
EUROSTAT. 2018b. Population by place of birth. *Eurostat*. [Online]. Luxembourg: Eurostat Available at: https://ec.europa.eu/eurostat/statisticsexplained/index.php?title=File:Population,_by_place_of_birth,_2016_(%25_share_of_total_population)_PITEU17.png [Accessed: 2018, August 8].
ESPING-ANDERSEN, G. 1990. *Three Worlds of Welfare Capitalism*. Cambridge: Blackwell Publishing.
FREEMAN, R. 2005. *Does globalization of the scientific/engineering workforce threaten US economic leadership?* NBER Working Papers 11457. National Bureau of Economic Research.
GAGLIGARDI, L. 2015. Does skilled migration foster innovative performance? Evidence from British local areas. *Papers in Regional Science*, (98)4: 773–794.
GREENHALGH, C. and RODGERS, M. 2006. The value of innovation, the interaction of competition, R&D and IP. *Research Policy*, 35(4): 562–580.
GROSMAN, G. M. and HELPMAN, E. 1991. *Innovation and growth in a global economy*. Cambridge: MIT Press.
HELMELS, C. and ROGERS, M. 2010. Innovation and the survival of the new firms in the UK. *Review of Industrial Organization*, 36(3): 227–248.
HOROWITZ, S. K. and HOROWITZ, I. B. 2007. The Effects of Team Diversity on Team Outcomes: A Meta-Analytic Review of Team Demography. *Journal of Management*, 33(6): 987–1015.
HUNT, J. and GAUTHIER-LOISELLE, M. 2010. How much does immogration boost innovation? *American Economic Journal: Macroeconomics,* 2(2): 31–56.
JOHANSON, J. and PAUL-WIEDERSHEIM, F. 1975. The Internationalisation of the Firm. Four Swedish Cases. *Journal of Management Studies*, 12(3): 305–322.
JOHNSTON, R. *et al*. 2015. East vs. West. Over-qualification and earnings among UK's European migrants. *Journal of Ethnic and Migration Studies*, 41(2): 196–218.
KAPLAN, R. S. and NORTON, D. P. 1996. *The Balanced Scorecard: Translating Strategy into Action*. 1st Edition. Boston: Harvard Business School Press.
KRUEGER, A. O. 1968. Factor Endowments and Per Capital Income Differences Among Countries. *The Economic Journal*, 78(3): 641–59.
LEE, J.-W. and LEE, H. 2016. Human Capital in the Long Run. *Journal of Development Economics*, 122(2): 147–169.
LEE, N. and M. NATHAN. 2010. Knowledge Workers, Cultural Diversity and Innovation. *International Journal of Knowledge-Based Development*, 1 (1/2): 53–78.
LUCAS, R. 1990. Why doesn't capital flow from rich to poor countries? *American Economic Review*, 80(1): 92–96.
MAHROUM, S. 1999. Skilled Labor (Competing for the Highly Skilled: Europe in Perspective). *Science and Public Policy*, 26(1): 17–25.
MINCER, J. 1991. *Education and Unemployment*. NBER Working Paper 3838. National Bureau of Economic Research.
NIEBUHR, A-K. 2009. Migration and innovation. Does cultural diversity matter for regional R&D activity? *Papers in Regional Science*, 89(3): 563–586.
OECD. 2003. *Oslo Manual*. Paris: OECD Publishing.
OECD. 2009. *Patent Statistics Manual*. Paris: OECD Publishing.
OECD. 2016. *OECD Science, Technology and Innovation Outlook*. Paris: OECD Publishing.
OZGEN, C. *et al*. 2011. *Immigration and innovation in European regions*. IZA Discussion Papers No. 5676. Bonn: IZA.
PAROTTA, P. 2012. *The nexus between labor's diversity and firm's innovations*. IZA Discussion Papers No. 6972. Bonn: IZA.
PITCHER, P. and SMITH, A. D. 2001. Top Management Team Heterogeneity: Personality, Power, and Proxies. *Organization Science*, 12(1): 1–18.
PORTER, M. E. 1990. *The Competitive Advantage of Nations*. New York: The Free Press.
QUINTINI, G. 2011. *Over-qualified or under-skilled. A Review of Existing Literature*. OECD Social, Employment and Migration Working Papers, No. 121. Paris: OECD Publishing.
RODRÍGEZ-POSE, A. and CRESCENZI, R. 2008. Research and Development, Spillovers, Innovation System and the Genesis of the Regional growth in Europe. *Regional Studies*, 42(1): 51–67.
ROMER, P. M. 1986. Increasing Returns and Long-Run Growth. *Journal of Political Economy*, 94(3): 1002–1037.
ROMER, P. 1990. Endogenous technological change. *Journal of Political Economy*, 80(5): 71–102.

SANDTNER, P. G. and BLOCK, J. 2011. The market value of R&D, patents, and trademarks. *Research Policy*, 40(7): 969–985.
SAPIR, A. 2005. *Globalization and the reform of the european social model.* Brussels: Bruegel
SCHULZ, T. W. 1961. Investment in Human Capital. *The American Economic Review*, 51(1): 1–17.
SCHNEIDER, P. H. 2005. International trade, economic growth and intellectual property rights: A panel data study from developed and developing countries. *Journal of Development Economics*, 78(5): 529–547.
SOLOW, R. 1956. A contribution to the theory of the economic growth. *The Quarterly Journal of Economics*, 70(1): 65–94.
STOPFORD, J. M. and WELLS, L. T., JR. 1972. *Managing the Multinational Enterprise: Organization of the Firm and Ownership of the Subsidiary*. New York: Basic Books.
STUEN, E. T. *et al*. 2012. Skilled immigration an innovation: Evidence from enrolement fluctuations in US doctoral programmes. *The Economic Journal*, 122(565): 1143–1176.
SWAN, T. W. 1956. Economic growth and capital accumulation. *Economic Record*, 32(2): 334–361.
THOMPSON, M. A. and RUSHING, F. W. 1996. An Empirical Analysis of the Impact of Patent Protection on Economic Growth. *Journal of Economic Development*, 21(2): 61–79.
UVP. 2016. Annual Report 2015. *Industrial Property Office.* [Online]. Prague: UPV. Available at: http://upv.cz/en/publications/annual-report/annual-report.html [Accessed: 2018, August 20].
WADHWA, V. *et al*. 2007. *America's New Immigrant Entrepreneurs*. Kauffman Foundation Report. Kauffman.

Contact information

Zuzana Potužáková: zuzana.penickova@tul.cz