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THE NEXUS BETWEEN MIGRATION, INNOVATION AND ECONOMIC DEVELOPMENT IN EU-28

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Abstract: *In an increasingly interconnected world, international migration became a topic of great interest from economic, social, cultural and political point of view, with complex effects on both origin and destination country. The international labour force mobility generates both opportunities and challenges that any nation should take into consideration, in order to obtain maximum of benefits, as well as mitigating the negative effects that can arise from the migration movements. Therefore, migration is a process that needs to be managed and not a problem that needs to be solved. Highly qualified immigrants boost innovation output, their cultural diversity may produce positive spill-overs, especially in host countries and represent an important channel for transferring technology from destination countries back to origin countries. This research investigates the extent to which immigration along with financial support in R&D and investments in higher education influence innovation and eventually, economic development, for 104 NUTS 1 macro-regions in the EU, over the period 2003 to 2012. The study is based on the development of econometric models on panel data, using a set of indicators specific to the process of immigration, innovation and economic development. The research uses classical models with fixed effects (non-spatial models), measures the global and local spatial autocorrelation of the data set and at last spatial autocorrelation models are generated. The econometric estimations of the international migration impact on intellectual assets (measured by the number of patents) highlight a positive nexus, strengthened when taking into account different factorial combinations related to the economic dimension, such as: financial support in research and development (especially in the business sector and in the whole sector), investment in tertiary education, personnel employed in knowledge intensive sectors, as well as the share of scientists and engineers in population. In order to boost knowledge creation and per capita GDP, EU should not only attract scientists and engineers migrants, but also provide further financial support in research and development.*

Keywords: *international migration; innovation; economic development; EU-28.*

JEL Classification: *F22; O31; O11.*

1. Introduction

In the current framework of globalization era, migration represents a topic of great interest from economic, social, cultural and political point of view, requiring in-depth and continuously research at regional, national and global level. Migration is not a new phenomenon it has existed since ancient times, undergoing various changes and taking different forms. International labour mobility influences the innovation and the development of an economy, generating both opportunities and challenges that any nation should take into consideration, in order to obtain maximum of benefits, as well as mitigating the negative effects that can arise from the migration movements. In the new age dominated by mass migration, with plenty of highly qualified individuals, the migration-innovation nexus has become a topical issue in several related disciplines and fields (Lissoni, 2016). Over the years, lots of researchers studied and gauged the impact of migration movements on innovation output, both in origin and destination country. In today's increasingly interconnected world, modern transport offers the opportunity for people to move faster, quicker and cheaper to different parts of the world, in search for work places, opportunities, higher education and a better quality of life. Also, wars, poverty and hard conditions of living force people to abandon their homes, their countries, seeking abroad a better future. When international migration is sustained by appropriate policies, it can lead to inclusive and sustainable economic growth and development, both in origin and host countries (United Nations, 2017).

2. Literature Review

2.1. Effects on destination countries

In an empirical research, Niebuhr (2010) highlights that the diversity of knowledge and capabilities of labour force from different cultural backgrounds boost regional innovation (generate new ideas, processes and products). The downsides of diversity, such as costs caused, for instance, by communication barriers are outweighed by the benefits induced in regional R&D sectors.

In a similar way, Bove and Elia (2017) emphasise that cultural heterogeneity have a more consistent impact on GDP per capita in developing countries, in comparison with the developed ones.

Ozgen, Nijkamp & Poot (2011) found that the diversity of migrants intensify knowledge formation, spill-overs, improves entrepreneurship and leads to economic growth. Although an increasing share of foreigners in the population of a region does not guarantee a higher level of innovativeness, immigrants from different cultural backgrounds and with higher education record a larger number of patent applications.

Ferrucci and Lissoni (2019) reveal that more diverse teams spur creativity and produce patents of higher quality. Their research also suggests that mixed local-foreign inventors teams with different nationalities always outperform both local ones and same-nation foreign teams.

Hunt and Gauthier-Loiselle (2009) gauge the impact of highly qualified immigrants on patenting per capita. A college graduate immigrant contributes at least twice as much to patenting, in comparison with a native counterpart. Also, some immigrants may indirectly enhance innovation by providing complementary skills and knowledge to native workers (e.g. positive spill-overs on fellow researchers).

In U.S. skilled immigration may support rising aggregate real incomes in the long run and have a significant and positive influence on patenting, but smaller in comparison

to foreign graduate students. Also, the skills of foreign workers could be complementary to natives (Chellaraj, Maskus, and Mattoo, 2008).
In European recipient countries, highly-skilled foreigners contribute to knowledge creation, measured by the number of patents and by the number of citations to published articles (Bosetti, Cattaneo and Verdolini, 2015).
Fassio, Montobbio and Venturini (2019) emphasises the positive impact of skilled migration on innovation, in 16 European industries. The intensity is stronger in industries with low levels of over-education, high levels of FDIs and openness to trade and also, in industries with ethnic diversity. The diversity of skilled immigrants (at firm level) provides complementary skills to natives and boosts the knowledge spill-overs, and thus enhances innovation.
When it comes to regional competitiveness, especially on innovation, entrepreneurship and productivity, Poot (2007) agrees that immigration and population ageing have a substantial impact. Empirical evidence emphasises that population ageing reduces regional competitiveness, in contrast to highly skilled immigration, which foster innovation. Immigrants may be more creative, generate new ideas, set up new businesses and may be less risk averse in comparison to indigenous peers. Due to the fact that migrants are younger, on average, they adjust easily to economic changes. On the other hand, diversity can create a less cohesive society, which may mitigate trustworthiness and competitiveness.

2.2. Effects on origin countries
If for host countries the immigration of highly-skilled labour force represent ”brain gain”, for the origin countries the emigration of high-skilled individuals represents a loss of the most talented workers. However, it cannot be denied that migrants are an important channel for transferring technology from destination countries back to origin countries. This can be through knowledge they impart directly, the significant remittances they send home (financial support) and investments they make in origin countries, like setting up new enterprises (Gelb and Krishnan, 2018).
Also, the knowledge acquired abroad by immigrants can be transferred back to the origin country and be exploited under sound Intellectual Property Rights institutions and thus domestic innovation can be enhanced (Naghavi and Strozzi, 2015).

3. Research Methodology

3.1. Objectives and research stages
The general purpose of the research is to evaluate the relationship between migration, innovation and regional economic development for 104 macro regions (NUTS 1 level) in the EU-28, between 2003 and 2012. The study focuses on how immigration along with financial support in R&D and investments in education influence the innovation output in different regions of a country. The study is based on the development of econometric models on panel data, using a set of indicators specific to the process of immigration, innovation and economic development.
In the first place, the research uses classical models with fixed effects (non-spatial models), with the dependent variable = the number of patents. The next step is to measures the global and local spatial autocorrelation of the data set, by applying

Moran's I Index and Geary's C Index. If the spatial dependence is validated, the last step is to generate models that include spatial elements, with the dependent variable (innovation) and different combinations of the independent variables.
The set of indicators emphasize the economic dimension, investment in human and fix capital, demographic dimension, investment in R&D, labour market dimension, innovation output and migration stocks for the 104 EU macro-regions.
The data source is represented by Eurostat - European Commission and OECD Statistics - Organization for Economic Co-operation and Development and data processing is computed using STATA 14 econometric package.

3.2. Regression model, endogenous and exogenous variables

For a more accurate estimation of the parameters, the general form of the regression model specification uses the natural logarithm of the variables. It takes the form of a double-logarithmic model and has the following general form:

$$ln(Nr\_patents) = \beta 0 + \beta 1 * ln(GDP\_cap) + \beta 2 * ln(Edu\_tert) + \beta 3 * ln(Edu\_sec) + \beta 4 * ln(Pop\_dens) + \beta 5 * ln(GERD) + \beta 6 * ln(Empl\_tech) + \beta 7 * ln(Immigr) + \varepsilon$$

The endogenous variable is the number of patents and the exogenous variables are GDP per capita (pps), tertiary and secondary education (%), population density (inhabitant/km^2), intramural R&D expenditure in total sectors (%GDP), employment in technology and knowledge intensive sectors (%) and immigration (stock).

3.3. Descriptive statistics and the correlation matrix

Descriptive statistics in table 1 is a summary statistics of some of the indicators used to evaluate the immigration-innovation nexus. It presents the average value, the standard deviation, the minimum and maximum value of variables analysed.

Table 1: Descriptive statistics, 2003-2012

Variable	Mean	Std. Dev.	Min	Max
patents_epo	529.0979	971.9792	0.1	6334.67
inov_intens	92.84096	108.0418	0.18	589.89
immigr	35985.25	36533.92	190.45	346422.3
gdp_eur_inhab	23727.05	12281.66	1900	63100
gdp_pps_inhab	23697.19	10224.38	3385.4	69300
gfkf	21.72029	5.686458	2.39	50.94
edu_tert	24.57353	7.982733	6.1	52.7
edu_sec	47.01163	15.03995	6.9	76.9
pop_dens	378.7491	903.8705	5.9	7194.2
gerd_gdp	1.441606	0.9464839	0.11	4.96
berd_gdp	0.9170288	0.8362437	0.01	4.36
empl	64.10067	7.129177	43.2	82.5
unempl	9.185769	4.785592	2.9	33.3
rd_pers_tot	33800.75	30304.64	32	175429

Source: personal processing in STATA 14

Among the 104 macro-regions are major developmental differences. Therefore, the maximum value of the number of patents is registered in a region from Germany (6334.67) and the minimum value in Malta (0.1). The average value of the number

of patents is 529.0979 and the standard deviation is 971.9792. In terms of immigration stocks, the maximum value of the number of immigrants is registered in a region from UK (346422.3) and the minimum value in Malta (190.45). GDP per capita measured in euros has a maximum value of 63100 in Luxemburg and a minimum value of 1900 in a region from Bulgaria, with an average value of 23727.05 and a standard deviation of 12281.66.
Table 2 presents the correlation matrix, respectively the correlation coefficients between the set of variables took into account. Each variable is correlated with all other variables in the table. This type of matrix uses Pearson's Correlation (r) and examines the strength and the direction of the linear relationship between two continuous variables.

Table 2: The correlation matrix

	gdp_eur	gdp_pps	gfkf	edu_tert	edu_sec	pop_dens	gerd	berd	empl	unempl	rd_pers	innov_int	patents	immigr
gdp_eur_loc	1.0000													
gdp_pps_loc	0.7823*	1.0000												
	0.0000													
gfkf	-0.0838*	-0.0199	1.0000											
	0.0068	0.5218												
edu_tert	0.5486*	0.5206*	-0.0910*	1.0000										
	0.0000	0.0000	0.0033											
edu_sec	-0.2401*	-0.2736*	-0.1993*	-0.1914*	1.0000									
	0.0000	0.0000	0.0000	0.0000										
pop_dens	0.4614*	0.4792*	-0.2070*	0.3446*	-0.1680*	1.0000								
	0.0000	0.0000	0.0000	0.0000	0.0000									
gerd_gdp	0.4604*	0.4999*	-0.0561	0.4657*	0.0786*	0.0955*	1.0000							
	0.0000	0.0000	0.0706	0.0000	0.0112	0.0020								
berd_gdp	0.3952*	0.4229*	-0.0394	0.3428*	0.0295	-0.0095	0.8834*	1.0000						
	0.0000	0.0000	0.2041	0.0000	0.3424	0.7595	0.0000							
empl	0.4350*	0.4831*	0.0924*	0.4303*	0.0664*	-0.0385	0.5303*	0.4673*	1.0000					
	0.0000	0.0000	0.0028	0.0000	0.0323	0.2151	0.0000	0.0000						
unempl	-0.2144*	-0.2837*	-0.1507*	0.0254	-0.0396	0.1080*	-0.2434*	-0.2977*	-0.6631*	1.0000				
	0.0000	0.0000	0.0000	0.4141	0.2015	0.0005	0.0000	0.0000	0.0000					
rd_pers_tot	0.4188*	0.3794*	-0.0981*	0.2812*	-0.0839*	0.0711*	0.5704*	0.5278*	0.3454*	-0.1973*	1.0000			
	0.0000	0.0000	0.0015	0.0000	0.0068	0.0219	0.0000	0.0000	0.0000	0.0000				
innov_int	0.4997*	0.5539*	-0.0731*	0.2967*	0.1120*	0.1015*	0.7677*	0.7140*	0.5434*	-0.3311*	0.5518*	1.0000		
	0.0000	0.0000	0.0184	0.0000	0.0003	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000			
patents_epo	0.3738*	0.3608*	-0.0701*	0.1658*	0.0652*	0.0213	0.5755*	0.5491*	0.3587*	-0.2542*	0.7913*	0.7960*	1.0000	
	0.0000	0.0000	0.0238	0.0000	0.0355	0.4929	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
immigr	0.2430*	0.2560*	0.0939*	0.1529*	-0.2390*	0.0154	0.2386*	0.2318*	0.1861*	-0.1592*	0.6613*	0.2301*	0.4517*	1.0000
	0.0000	0.0000	0.0024	0.0000	0.0000	0.6201	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

Source: personal processing in STATA 14

The value of the correlation coefficient can range between -1 and +1. A value of 1 indicates a perfect linear relationship between the variables, while a value of 0 shows no (linear) correlation. A value of the correlation coefficient between 0.6 and 0.8 indicates a strong linear relationship, a value between 0.4 and 0.6 shows a moderate correlation, while values between 0.2 and 0.4 highlight a weak relationship between the variables. The sign of the correlation coefficient (- or +) points out the direction of the relationship. If the sign of the coefficient is positive, then both variables increase or decrease together. If the sign of the coefficient is negative, then one variable increases and the other one decreases.
Therefore, the innovation intensity = (nr. of patents/population of the region)* 1 million, records a strong proportional linear correlation with expenditure on R&D (GERD and BERD), a moderate positive correlation with GDP per capita, employment and total R&D personnel and researchers, and a weak positive correlation with tertiary education and the number of immigrants. Between innovation intensity and unemployment exist a weak inverse proportional relationship. The variable number of patents has a strong proportional relationship with total R&D personnel and researchers, a moderate positive correlation with GDP per capita,

expenditure on R&D and the number of immigrants, and a weak proportional relationship with tertiary education and employment. It can be observed a moderate positive linear relationship between GDP per capita (Euro and PPS) and the expenditure on R&D, tertiary education, employment, population density, innovation intensity and total R&D personnel and researchers. An expected inverse proportional relationship between unemployment rate and GDP per capita is highlighted.

4. Results and discussion

4.1. Non spatial models with fixed effects

In order to identify which model is better, with fixed effects or with random effects, it is used Hausman Test. After computing, it generated a Prob>chi2 = 0.0000 which results that the optimal model is the one with fixed effects. Therefore, 8 non spatial models with the endogenous variable = innovation output were generated (4 models with the number of patents and 4 models with innovation intensity).

Table 3: Non spatial fixed effects models (dependent variable = innovation output)

	(1) Patents	(2) Patents	(3) Patents	(4) Patents	(5) Innov_int	(6) Innov_int	(7) Innov_int	(8) Innov_int
gdp_eur_cap	0.331***	0.330***	0.314***	0.345***	0.318***	0.343***	0.341***	0.315***
	(6.05)	(6.14)	(5.87)	(6.39)	(5.65)	(6.26)	(6.40)	(5.83)
edu_tert	0.394***	0.430***	0.512***	0.505***	0.501***	0.862***	0.341**	0.415**
	(3.63)	(3.34)	(3.91)	(4.28)	(4.29)	(3.51)	(2.70)	(3.16)
educ_sec	0.00802*			0.00763*			0.00751*	0.00695*
	(2.35)			(2.43)			(2.06)	(2.10)
pop_dens			1.022		2.171*			2.051*
			(1.01)		(2.14)			(2.06)
gerd_%gdp		0.643***	0.778***				0.895***	0.618***
		(6.57)	(7.60)				(8.60)	(6.78)
berd_%gdp	0.237***			0.241***	0.182***	0.192***		
	(5.51)			(5.62)	(4.42)	(4.60)		
herd_%gdp				0.0698		0.00876		
				(1.81)		(0.24)		
empl_tech	0.355***				0.312***			
	(4.72)				(5.27)			
hrst						0.742**		
						(3.12)		
rd_pers_buss		0.115**						
		(2.93)						
rd_pers_edu		0.365***		0.333***				0.314***
		(4.60)		(3.92)				(3.95)
rd_pers_tot			0.677***				0.736***	
			(5.42)				(5.93)	
immigr	0.127***	0.0974***	0.0736**	0.104***	0.132***	0.137***	0.0665*	0.0804**
	(4.81)	(3.73)	(2.76)	(3.97)	(4.95)	(5.21)	(2.47)	(3.04)
_cons	3.400	3.520***	11.19***	2.899**	11.27***	-1.347*	6.489***	12.26***
	(1.88)	(3.94)	(4.25)	(3.29)	(4.12)	(-2.17)	(5.18)	(4.77)
N	1040	1040	1040	1040	1040	1040	1040	1040

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Source: personal processing in STATA 14

Interpretation for model no. 4: The results show that a 1% increase in GDP per capita would generate a 0.345% increase in the number of patents. Also, when R&D expenditures in the business sector increase by 1%, the number of patents increases by 0.241%. A 1% increase in people with tertiary education may result in an increase of the number of patents by 0.505%. When the number of educated immigrants increases by 1%, the number of patents increases by 0.104%. N represents the number of observations (1040).

To conclude, in all models innovation from a region is positively influenced by the economic conditions, by the financial support on R&D, by the people employed in technology and knowledge intensive sectors and by the R&D personnel. Investment in human capital is a determining factor in the development of a region, as well as highly qualified immigrants, which contribute positively to innovation performances.

4.2. Identification of spatial autocorrelation (Moran's I and Geary's C Index)

In order to test the presence of spatial dependence, Moran's I and Geary's C Index will be applied. Moran index takes into consideration both the value of the variables and the geographical coordinates of the macro-regions in which they are recorded. The value of I range between -1 (showing a negative spatial autocorrelation among variables) and 1 (positive spatial autocorrelation). Geary index is inversely proportional to Moran index, but is not identical. While Moran's I is a measure of global spatial autocorrelation, Geary's C is a measure of local spatial autocorrelation (table 4 and 5). The value of C range between 0 and 1.

Table 4: *Moran's I*, a measure of global spatial autocorrelation, EU 28, year 2012

Variables	I	E(I)	sd(I)	z	p-value*
gdp_eur_cap	0.541	-0.010	0.056	9.746	0.000
gdp_pps_cap	0.569	-0.010	0.056	10.304	0.000
edu_tert	0.463	-0.010	0.056	8.374	0.000
edu_sec	0.784	-0.010	0.056	14.155	0.000
patents_epo	0.456	-0.010	0.057	8.238	0.000
innov_int	0.648	-0.010	0.057	11.613	0.000
gerd_gdp	0.472	-0.010	0.056	8.560	0.000
berd_gdp	0.469	-0.010	0.056	8.494	0.000
immigr	0.147	-0.010	0.055	2.857	0.004

Source: personal processing in STATA 14

Table 5: *Geary's C*, a measure of local spatial autocorrelation, EU 28, year 2012

Variables	c	E(c)	sd(c)	z	p-value*
gdp_eur_cap	0.431	1.000	0.061	-9.366	0.000
gdp_pps_cap	0.442	1.000	0.063	-8.839	0.000
edu_tert	0.469	1.000	0.061	-8.718	0.000
edu_sec	0.194	1.000	0.064	-12.594	0.000
patents_epo	0.465	1.000	0.060	-8.859	0.000
innovation_int	0.304	1.000	0.059	-11.712	0.000
gerd_gdp	0.508	1.000	0.062	-7.947	0.000
berd_gdp	0.453	1.000	0.061	-8.938	0.000
immigr	0.805	1.000	0.072	-2.707	0.007

Source: personal processing in STATA 14

After computing the proximity matrix with five neighbours, both Moran's I value and Geary's C value prove the existence of a positive spatial autocorrelation with respect to the dependent variables took into consideration: GDP per capita, tertiary and secondary education, the number of patents, innovation intensity, intramural R&D expenditures and immigration stock.

As it can be observed at Moran's I test, the value of I is greater than the value of E(I) in all cases, which evidences a positive spatial autocorrelation and that close macro-regions have similar values for the variables of interest. The greater Moran's I is, the more intense the spatial dependence is. The highest positive spatial autocorrelation is recorded at secondary education (I=0.784). Z value is above 1.96 (table value) and p-value is under 0.05, which justifies the spatial correlation test.
At Geary's C test the value of z coefficient is lower than -1.96 (table value) and p-value is below 0.05, which is a good result.
Figure 1 presents the Moran scatter plot for the variables: innovation intensity and the number of immigrants. They are emphasized on the horizontal axis, while their spatially lagged counterparts are on the vertical axis. Moran Scatterplot shows the relationship between the values of a variable from a location and the average value of the same variable at neighbouring locations.

Innovation intensity | Number of immigrants

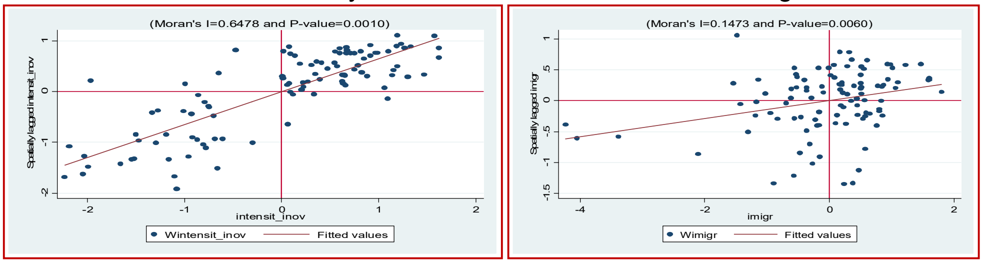

Figure 1: Moran scatter plot
Source: personal processing in STATA 14

As it can be observed, in case of innovation intensity scatterplot, there are lots of dots in the first and third quadrant (hotspots). This highlights a positive spatial autocorrelation and a cluster of similar values. This means that the values that are above the mean in a location are surrounded by neighbouring locations with average values that are above the mean (first quadrant) and values that are below the mean in a location are surrounded by neighbouring locations with average values that are below the mean (third quadrant). In case of the number of immigrants, it can be observed an agglomeration of dots especially in the first quadrant, but also in all other quadrants. This means that some locations are similar to the neighbours, while others are different, in terms of the number of immigrants.

4.3. Spatial models with endogenous variable = innovation intensity

Due to the fact that the spatial dependence is validated, it is justified to compute spatial models. Therefore, in table 6 four spatial models were generated (Spatial Autoregressive Model, Spatial Error Model, Spatial Durbin Model and Spatial Autocorrelation Model), after which the best model was chosen.
The optimal model is considered to be the one which has the lowest value of the AIC and BIC tests, and the highest value of the LL function and R-square. Therefore, the best model for this set of data panel is Spatial Durbin Model (SDM). In table 7 are

generated eleven Spatial Durbin Models, with the dependent variable= innovation intensity.

Table 6: Diagnostic tests for the selection of the optimal spatial model

Model	R^2 (within)	Log Likelihood Function (LL)	Akaike Information Criterion Test (AIC)	Schwarz Criterion Test (BIC)
M1 SAR	0.1537	-302.7244	621.4488	661.0247
M1 SEM	0.1566	-299.1173	614.2347	**653.8105**
M1 SDM	**0.1907**	**-283.5451**	**595.0902**	664.3479
M1 SAC	0.1586	-298.2001	614.4002	658.923
M2 SAR	0.1690	-294.0724	604.1447	643.7205
M2 SEM	0.1717	-291.0358	598.0715	**637.647**
M2 SDM	**0.1967**	**-275.8679**	**579.7359**	648.9935
M2 SAC	0.1736	-283.6632	585.3265	629.8493
M3 SAR	0.1802	-286.7866	589.5731	629.149
M3 SEM	0.1828	-284.351	584.702	**624.2778**
M3 SDM	**0.2016**	**-275.8679**	**579.7359**	648.9935
M3 SAC	0.1839	-283.6632	585.3265	629.8493

Source: personal processing in STATA 14

Table 7: Spatial Durbin Model with endogenous variable = innovation intensity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
gdp_eur_cap	0.335***	0.334***	0.299***	0.316***	0.343***	0.331***	0.329***	0.302***	0.303***	0.297***	0.290***
	(6.28)	(6.27)	(5.45)	(5.91)	(6.42)	(6.26)	(6.26)	(5.55)	(5.75)	(5.44)	(5.38)
immigr	0.108***	0.103***	0.118***	0.105***	0.0914***	0.0915***	0.117***	0.101***	0.102***	0.0986***	0.0744**
	(4.33)	(4.12)	(4.60)	(4.19)	(3.68)	(3.68)	(4.67)	(3.87)	(4.07)	(3.83)	(2.87)
berd_%gdp	0.264***	0.256***	0.199***	0.250***	0.309***	0.310***	0.255***	0.263***	0.263***	0.259***	
	(5.84)	(5.65)	(4.99)	(5.90)	(6.62)	(6.65)	(6.19)	(6.28)	(6.31)	(6.20)	
gerd_%gdp											0.717***
											(7.73)
edu_tert	0.899***	0.856***	0.659***	0.744***	0.869***	0.884***	0.714***	0.685***	0.664***	0.663***	0.554***
	(5.86)	(5.50)	(4.34)	(4.85)	(5.66)	(5.78)	(4.88)	(4.59)	(4.41)	(4.38)	(3.75)
herd_%gdp		0.0675	0.0105	0.0268					0.0177	0.0164	
		(1.80)	(0.30)	(0.77)					(0.51)	(0.48)	
empl			0.125							0.158	0.0776
			(0.41)							(0.52)	(0.26)
unempl								-0.00770			
								(-0.17)			
educ_sec					0.00749*	0.00751*	0.00768*	0.00846*	0.00853*	0.00832*	0.00818*
					(2.17)	(2.01)	(2.18)	(2.16)	(2.21)	(2.08)	(2.13)
empl_techno							0.980***				
							(4.74)				
rd_pers_buss	0.123*	0.112*			0.110*	0.111*					
	(2.43)	(2.26)			(2.24)	(2.26)					
rd_pers_edu	0.342***	0.397***			0.314***	0.317***					
	(4.50)	(4.85)			(4.14)	(4.18)					
rd_pers_tot				0.445***							
				(5.74)							
Rho	0.494**	0.492**	0.467*	0.442*	0.389	0.409*	0.398*	0.408*	0.419*	0.410*	0.451*
	(2.62)	(2.60)	(2.47)	(2.20)	(1.93)	(2.05)	(2.07)	(2.10)	(2.17)	(2.12)	(2.41)

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Source: personal processing in STATA 14.

As a general conclusion, a very important factor in the increase of innovation output is economic dimension along with highly skilled migrants and investments in R&D. Furthermore, human capital plays a major role, especially people with tertiary education and/or employed in science and technology sectors, that can enhance innovation, which is a measure of technological progress, which is a driver of productivity growth and at last a driver of economic growth.
The ρ (rho) parameters have all positive signs and are statistically significant, indicating a pure spatial effect on the dependent variable. This emphasises that the

innovation intensity from a region influences the innovation intensity from neighboring regions. Therefore, in terms of innovation it can be observed the existence of a spillover effect from a region to another close region.

5. Conclusion

This research has examined the extent to which skilled immigrants along with investments in R&D sectors and in higher education enhance innovation output and contribute to economic growth, on a date panel of 104 macro-regions from EU, between 2003 and 2012. The study is based on the development of econometric models on panel data, using a set of indicators specific to the process of immigration, innovation and economic development. Therefore, the research uses both classical models with fixed effects (non-spatial models) and spatial autocorrelation models. The results indicate a positive nexus between skilled migrants and innovativeness of the regions, strengthened when taking into account different factorial combinations related to the economic dimension, such as: financial support in research and development, investment in tertiary education, personnel employed in technology and knowledge intensive sectors, as well as the share of scientists and engineers in population. Another finding of this study is that the innovation intensity from a region influences the innovation intensity from neighboring regions (highlighting the existence of a pure spatial effect).
It is also very important that in order to boost knowledge creation and per capita GDP, EU should not only attract scientists and engineers migrants, but also provide further financial support in research and development. To sum up, migration is a process that needs to be managed and not a problem that needs to be solved (GD No. 780, 2015).
The main limit of this research is the lack of data available regarding the number of patents for all the 104 macro-regions (NUTS 1 level) in the UE more recent than year 2012. Therefore the period of the study was chosen 2003-2012 because after year 2012 data for the number of patents at NUTS 1 level is not available.

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