DEPENDENCIES MODELS ON INNOVATION AND ECONOMY INDICATORS IN THE EUROPEAN UNION

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Abstract. *In the past decade the business field has encountered a shift towards knowledge economy and a change of principles in the direction of sustainability, wealth and innovation. Although the innovation level of a region overall is difficult to assess, indicators, such as patent applications or enterprises introducing an innovation with environmental benefits offer a measurement tool for this aspect. The present study estimates first a panel regression model with patent applications to the European patent office as dependent variable in connection to other economic and research and development factors between 2010-2014 for the selected European Union member states. The second part of the study focuses on a regression for 2014 having the enterprises that introduced an innovation with environmental benefits obtained within the enterprise as a dependent variable and economic independent variables also in the case of certain selected European Union countries. Therefore, the present paper inquires two types of dependent variables regarding innovation and proposes to offer dependencies models between innovation and economic indicators based on regression models. The results indicate a relationship with expenditures on research and development on regional level, as well as enterprises development for the selected countries of the European Union. While innovation is mostly treated as a separate independent factor in the economic system, a systematic approach of innovation is significant for it to be designed and created, in order to ensure the basis for further innovation stimulating policies. From a statistical point of view, a main current issue is represented by the selection of relevant indicators measuring innovation levels on a regional level, most indicators being more qualitative and subjective than quantitative. The relevance of the study lies in the fact that the subject is a novelty in terms of scientific literature, as these indicators have not been tested throughout other regression models before.*

Keywords: *innovation; research and development; patents, economy; environment*

Introduction

As the pressure towards knowledge economy and technology development increases, the issue of generating innovations in numerous sectors of activities has become. Generating innovation has become a main factor for the long-term efficiency and development of enterprises and organizations globally. If until two decades ago bringing small improvements to existing products or bringing new versions of products and services would have been competitive features of a company, today the need for essential innovations, especially in terms of sustainability, technology, organization and not only are imperatives in order to be able to maintain one's own position on the market and further grow.

Innovation and its measurement indicators have been studied by several authors and organizations, that have endeavored efforts in order to find optimal systems of indicating the innovation level, as well as the factors, that lead to innovative behavior. Innovation is frequently associated as a term with ''invention'' although the literature disputes often their use as synonyms, as innovation is considered by some as a new product or technology created using novelty and being marketable, or introduced into production, management and other activities, while invention refers to a progressive novelty new for the organizational systems (Manuylenko et al., 2015). Schumpeter (1982) was one of the first to define innovation as utilizing new combinations of existing productive forces to solve the problems of business (Kogabayev & Maziliauskas, 2017). According to OECD (2005) innovation means ''the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations". Innovation has been linked to value creation for stakeholders as more authors mention (Špaček & Vacik, 2016; Kanten & Yaşlioglu, 2012; Hsu & Fang, 2009).

Currently one main strategic issue referring to innovation is represented by finding appropriate measurement indicators to determine the degree and efficiency of innovation on organizations, countries', regional level and factors, that could influence these innovation indicators. Three of the most frequently used indicators in measuring innovations are patents, patent citations and patent applications, however several other factors can be measurement units for the degree and efficiency of innovations (Information Resources Management Association, 2018).

The main objective of the present study was to estimate an OLS panel regression model, that reveals a connection of a main innovation indicator, namely patent applications to the European patent office by priority year to four independent variables: national public funding to transnationally coordinated research and development (R&D) in Million Euros, business expenditure on research and development (R&D) in Million Euros, job-to-job mobility for ages 25-34 years in thousands, high-tech patent applications to the European patent office by priority years (total number) for the period 2010-2013. Furthermore, further tests are performed in order to determine the most efficient model, including the Durbin-Wu-Hausman test. The joint test and the Wald test are further implemented. The second part of the practical analysis referred to another OLS regression model having enterprise innovation with environmental benefits as a dependent variable in connection to the independent variables: transnationally coordinated research and development (R&D) in Million Euros, business expenditure on research and development (R&D) in Million Euros and high growth enterprises by 10% or more and related employment. The results of the study revealed that factors such as job-to-job mobility and national funding to transnationally coordinated research and development can have a significant impact on the indicators selected for innovation measurement.

Literature review

As a main key factor for economic growth innovation has become one of the main contemporary strategic issues of organizations, countries and regions globally. Simultaneously with the increased dynamics of competition and technology development, customer changing preferences and the development of innovative products on a high scale, the term of innovations itself has become a main strategic issue overall in the business field, as well as all the other sectors of activities, in order to maintain the possibility of expansion and development for the future. Several authors have inquired the subject of innovation and have provided several definitions.

The main definition of innovation was given however by Schumpeter (1982), who defined the term ''innovation'' as utilizing new combinations of existing productive forces to solve the problems of business as mentioned in the article of Kogabayev and Maziliauskas (2017). Other authors have confirmed practically in their studies this definition of innovation given by Schumpeter (1982). According to Cingula and Veselica (2010) innovation is the use of new knowledge to offer a new product or service that customers want and thus, not only the invention itself is essential in the case of innovations, but also their trading on the market. Brătianu (2011) defines the term innovation as ''to create a new entity and to bring it in its final market form''.

Regarding the types of innovation, Tanţău and Staiger (2018) mention the following main types:

a) product innovation or introducing new, redesigned or essentially improved products or services;
b) business model innovation, such as changes of the value proposition or other components of a business model, that ultimately create value for the organizations;
c)process innovation, referring to incremental process improvements, that could have as main objectives, time or costs decrease, improved financing or coordination (Davenport, 1993);
d)organizational innovations and marketing innovations, such as new marketing channels or new marketing concepts (Doyle and Bridgewater, 1998). Zawawi et al. (2016) describe another main type of classification of innovation as technological and administrative or managerial, as described in Figure 1, the combination of the two bringing significant contribution to the organization's competitiveness potential.

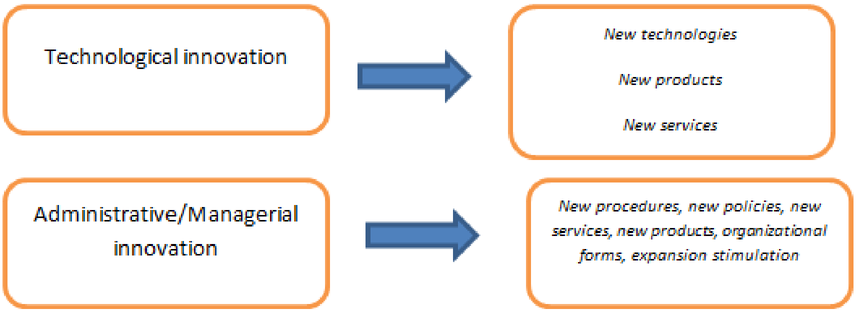

Figure 1. Dimensions and components of innovations (Afuah, 1998; Yang, 2009; Zawawi et al., 2016)

In order to be successfully implemented and accepted by the public innovations have to be economically reasonable and thus, their practicability on a micro-level is a key factor in their introduction in a market economy as mentioned by Bock and Hasenkamp (2013). Referring to the general approach of the innovation process, Tohidi and Jabbari (2012) offer structure of this process, as illustrated in Figure 2:

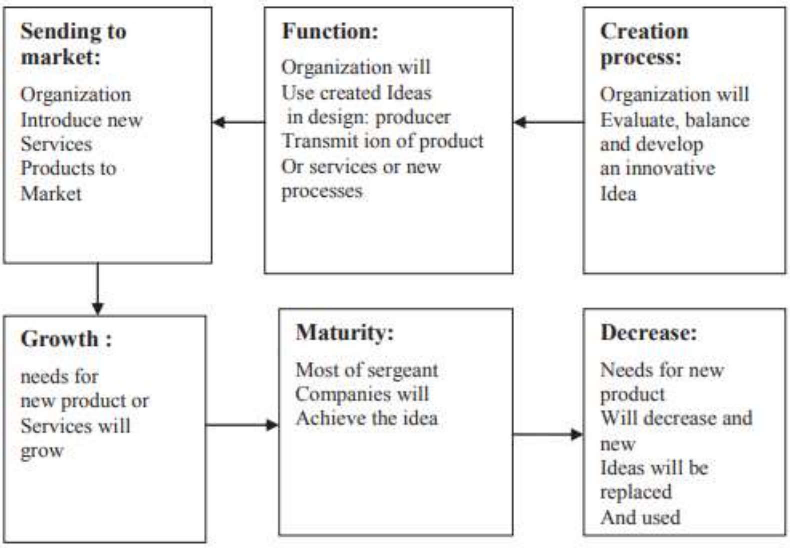

Figure 2. The innovation process (Source: Tohidi and Jabbari, 2012)

Dan et al. (2011) mention that innovation is linked to knowledge and may be described as '' also described as a part of a management process that may need to draw on other organizational resources that creativity does not''. A main issue regarding the innovation development is represented by the measurement of innovation. While many refer to innovations generated in several fields, the measurement of innovation and the selection of appropriate indicators for the measurement remains a challenge for the management of organizations, as well as on a regional level. The main general indicators, that measure development in terms of innovation are currently considered as: the patents (or patent applications) and patent citations, described as indicators measuring the investments output into new knowledge and technology (Information Resources Management Association, 2018), new products or services and process innovations. Although patents and patent citations are considered main indicators for innovation other types of indicators are also accepted for measuring innovation development, such as number of trademarks, increased customer loyalty levels, awards and honors for innovations, inventions suggestions, disclosures as to measuring rates of ideas generation within organizations, research and development expenditure, high-technology exports, researchers in research and development activities (Phen, 2013; Maradana et al., 2017).

As more types of innovations are emerging in time also measurement indicators are expected to expand and diversify.

The interconnection of innovation to economy and economic growth has been researched by more authors and has been confirmed through numerous studies. For example, Ulku (2004) proved through a panel model for 20 OECD countries and 10 non OECD countries for the period between 1981-1997, that innovation has a positive effect on GDP per capita, while research and development expenditures increased the level of innovation. The strong connection between innovation and economic growth has also been confirmed by the study of Peece et al. (2015) for the case of Poland, Czech Republic and Hungary between 2000-2013 through estimation of a regression model. Maradana et al. (2017) emphasize the bidirectional system of innovation causing economic growth, as well as economic growth leading through more innovation creating a circle of development and growth regarding both factors.

The present paper offers another perspective of influencing factors on innovation through the ordinary least squares regression models and testing in order to emphasize new independent variables in connection with the selected innovation indicators.

Methodology

In order to perform the empirical analysis of the present study, we selected one dependent variable, namely patent applications to the European Patent Office (EPO) by priority year, as well as four independent variables: business expenditure on research and development (R&D) in Million Euros, national public funding to transnationally coordinated research and development (R&D), high-tech patent applications to the European Patent Office (EPO) by priority year, job-to-job mobility age (between25-34 years old) in Thousand for the case of the following European Union countries: Belgium, Bulgaria, the Czech Republic, Denmark, Germany, Estonia, Greece, Spain, Croatia, Italy, Cyprus, Latvia, Lithuania, Hungary, Malta, the Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden, United Kingdom.

The patent applications to the European Patent Office refer to the requests for protection of an invention directed either directly to the European Patent Office (EPO) or filed under the Patent Cooperation Treaty and designating the EPO (Euro-PCT), while the indicators refer to the number of applications per country (Eurostat, 2018a). Business expenditure on research and development is expressed in million Euros.

National public funding to transnationally coordinated R&D (Mil. Euro) refers to the total budget financed by the government (state, federal, provincial), as measured by GBAORD directed to transnational public R&D performers and transnational public R&D programs according to Eurostat (2018b). High-tech patent applications to the EPO by priority year refer to patents in the high-tech sector. The term ''patents'' reflects a country's inventive activity, as well as the country's ability to exploit knowledge and transform this into economic gains as mentioned in Eurostat (2018c). Thus, patent statistics are broadly used to evaluate the inventive performance of regions. Contrary to general beliefs that patents generally refer to technology patents, the high-tech patents account for only a quarter of the total patents. For example, in 2012 high-technology patent applications to the European patent office accounted for approximately 23,9% of the patent applications made at the European patent office, while the rest of the patent applications were related to other fields (Eurostat, 2018d). Job-to-job mobility age (25-34 years old) in Thousand refers to the movement of individuals between one job and another from one year to the next (Eurostat, 2018e). Personnel fluctuation can have an impact on costs and innovation levels of the institutions and enterprises, as it can impact negatively the level of employee or team's creative initiatives and the overall level of innovative and financial progress of the organization.

The source of the statistics indicators is Eurostat, while we estimated a panel regression model for the analyzed period was 2010-2013. The Stata software was used for analysis of the econometric models described in the Findings and analysis section.

Based on the previously mentioned variables we first estimated a panel regression model, that determined the impact of the independent variables on the patent applications to the European patent office by priority year (PAE), namely:

$$PAEit = \alpha i + Xit \times \beta + \varepsilon it \quad i = 1 \dots N, t = 1 \dots T$$

where X refers to the the explanatory variables, the i refers to the country and t refers to the year or the time series perspective.

Secondly, we performed the random effects and fixed effects OLS panel regressions and then we tested with the Durbin-Wu-Hausman test which of these was more efficient in our case. Furthermore, the joint test, Waldman test were performed, as well as an OLS panel regression with lagged variables, implying the effect of the independent variables in the previous year on the current year dependent variable.

Another inquired OLS regression was done for 2014 for another selection of variables, namely: the dependent variable, enterprise innovation with environmental benefits and three independent variables: national public funding to transnationally coordinated R&D (Mil. Euro), business expenditure on research and development (R&D) and high growth enterprises by 10% or more and related employment. This was performed for the European Union states with the available data for 2014 from Eurostat. The statistics available on Eurostat referred only to this year. This OLS regression analysis was done, as enterprises innovation with environmental benefits is another significant innovation measurement indicator and refers to enterprises that introduced an innovation with environmental benefits obtained within the enterprise (Eurostat, 2018f). High-growth enterprises by 10% or more and related employment refer to enterprises with a turnover growth of over 10% and related employment as the growth is measured by turnover or number of employees (Eurostat, 2018g).

The present research offers a new approach on innovation, as previous studies have not inquired the relationship of these variables on this main indicator of measurement for innovation.

Findings and analysis

Innovation is a broad concept, that has always represented a challenge for measuring in the sense of its development and effects on different levels, such as on company level, regional, national, international level. Roos and O'Connor (2015, p.67) mention the recommendation of using multiple indicators to measure efficiently innovation, such as research and development expenditure, patent counts and citations, new products and other variables. For the panel regression model we have selected as mentioned in the Methodology a dependent variable for measuring innovation the patent applications to the European patent office by priority year, while the independent variables were: national public funding to transnationally coordinated research and development (R&D) in Million Euros, business expenditure on research and development (R&D) in Million Euros, job-to-job mobility for ages 25-34 years in thousands, high-tech patent applications to the European patent office by priority years (total number) for the period 2010-2013. The selected 25 countries from the European Union, for which data could be found on Eurostat (2018h).

Table 1. Ordinary least squares (OLS) panel regression with random effects 2010-2013 European Union (Authors' own research based on Eurostat data (2018h))

Dependent variable: Patent applications to the EPO by priority year (PAE)	Coef.	St.Err	t-value	p-value	Sig.
Independent variables: Business expenditure RD (Mil. Euro)	0.1835	0.0338	5.43	0.000	***
National public funding to transnationally coordinated R&D (Mil. Euro)	2.7196	1.5110	1.80	0.072	*
High-tech patent applications to the EPO by priority year	3.2067	0.2697	11.89	0.000	***
Job-to-job mobility age (25-34 years old) in Thousand	-5.1284	2.1210	-2.42	0.016	**
_cons	43.5568	240.1721	0.18	0.856	
Mean dependent var	1909.3900	SD dependent var	4467.1500		
Overall r-squared	0.9782	Number of obs	100		
Chi-square	405.2631	Prob > chi2	0.0000		
*** p<0.01, ** p<0.05, * p<0.1					

The results of the performed econometric analysis indicated that job-to-job mobility by age in the sector 25-34 years represents a significant determinant of patent application to the European patent office as shown in Table 1: an increase of 1000 in job-to-job mobility (25-34 years) will involve a decrease of the patent applications to the European patent office by 5.12, when all other variables are constant, so this factor will impact indirect proportionally the inquired dependent variable. The job-to-job mobility, implying the mobility of individuals from one job to another from one year to the next (Eurostat, 2018e) is a demotivating factor for innovation, as it implies costs, losses and less long-term involvement of employees in innovative processes within organizations.

High-tech patent applications to the European patent office also seemed to be influencing significantly and positively the patent applications to the European patent office (EPO) by priority year, namely an increase of one in the number of high-tech patent applications will lead to an increase of approximately 3.2 patent applications to the European patent office by priority year. This could be explained by the high-tech innovations, as having an important impact in the innovation levels overall. The other independent variables also involve an increase of the dependent variable, namely a 0.18 increase in patent applications at the European patent office at an increase of 1 million Euros of the business expenditure on research and development and a 2.71 increase of the dependent variable at an increase of 1 million Euros of national public funding to transnationally coordinated R&D.

The four selected independent variables explain in the amount of 97% the dependent variable of patent applications to the European patent office by priority year, as the overall R-squared is 097. We assume that country-specific effects are not correlated with the independent variables.

Furthermore, we estimated the fixed effects for the OLS panel regression for 2010-2013 for the same selection of European Union countries. We test for the effects which are not dependent on time, but on the country itself. The omitted variable bias is caused due to the country-specific effects with the independent variables. These country-specific effects are hidden. We estimate the fixed-effects in order to correct for the omitted variable bias. The OLS assumptions (constant variance) make it compulsory that the errors for each entity or country in our case are not correlated over time. This will be tested at a later point through the modified Wald test. The coefficients found in the fixed-effects differ because the effect for each country on the dependent variable has been removed from the coefficients and practically it is the same as adding an equivalent dummy variable for each country.

Table 2. OLS panel regression with fixed effects 2010-2013 for the European Union (Source: Authors' own calculations based on Eurostat data (2018h))

Patent applications to the EPO by priority year	Coef.	St.Err	t-value	p-value	Sig.
Business expenditure RD (Mil. Euro)	-0.1271	0.0305	-4.17	0.000	***
National public funding to transnationally coordinated R&D (Mil. Euro)	1.2374	1.0228	1.21	0.230	
High-tech patent applications to the EPO by priority year	1.0313	0.2219	4.65	0.000	***

Job-to-job mobility age (25-34 years old) in Thousand	0.0207	1.8030	0.01	0.991	
_cons	2117.0466	170.9396	12.38	0.000	***

Mean dependent var	1909.3900	SD dependent var	4467.1500
R-squared	0.5663	Number of obs	100
F-test	23.1802	Prob > F	0.0000
Akaike crit. (AIC)	1240.6891	Bayesian crit. (BIC)	1253.7149
*** p<0.01, ** p<0.05, * p<0.1			

In order to test which of the fixed-effects or random effects models will lead to a more relevant result we apply a Durbin-Wu-Hausmann test, where the null hypothesis is that the preferred model is the random effects versus the alternative fixed effects. In our case, as Prob>chi2=0.000, thus being below 0.05, we reject the null hypothesis that the unique errors are uncorrelated with the variables and thus, this is an indication that there is a strong fixed effects model.

Table 3. Durbin-Wu-Hausman test (Source: Authors' own calculations based on Eurostat data (2018h))

Patent applications to the EPO by priority year	Coefficients (b) Fixed	Coefficients (B) Random	(b-B) Difference	Sqrt(diag(V_b-V_B)) S.E.
Business expenditure R&D (Mil. Euro)	-0.1270818	0.1835434	-0.310625	0.0416872
National public funding to transnationally coordinated R&D (Mil. Euro)	1.237351	2.7196	-1.482249	0.9810698
High-tech patent applications to the EPO by priority year	1.031279	3.206712	-2.175433	0.2829068
Job-to-job mobility age (25-34 years old) in Thousand _cons	0.0206619	-5.128436	5.149098	2.363735

Whether time fixed effects have to be added we can test with a joint F test if the dummies for all years are jointly zero. The result of the F-test let us conclude that time fixed effects do not have to be included. Prob>F < 0.05 to reject the null hypothesis that time fixed effects should be included.

Table 4. JOINT TEST (Source: Authors' own calculations based on Eurostat data 2018h))

F test that all u_i=0; F(24, 68)=93.05 Prob>F=0.0000
Testparm_Iyear* (1) _Iyear_2011=0 (2) _Iyear_2012=0

(3) _Iyear_2013=0	
F(3,68)= 4.35 Prob>F=0.0073	

Finally, we perform a modified-Wald-test for panel data sets to test whether the errors have constant variance (homoscedasticity) which is a basic assumption of OLS holds for the fixed effects model. The null hypothesis can be rejected and to obtain efficient estimators an OLS panel regression with robust standard (also known as Huber White estimators) have to be estimated. The null hypothesis is sigma(i)^2= sigma^2 for all i. Sigma denotes the variance. Applying a chi2 distribution the test statistic is 4.7e+07, while the prob>chi2 = 0.000. The null hypothesis can be rejected by a 5% significance level.

Table 5 presents results of the OLS panel regression with robust standard errors. The variables Business Expenditure R&D and the number of high tech patents are significantly associated with the total number of patent applications respectively negatively and positively.

Table 5. OLS panel regression with fixed effects with robust standard error 2010-2013 for the European Union (Source: Authors' own calculations based on Eurostat data (2018))

Patent applications to the EPO by priority year	Coef.	St.Err	t-value	p-value	Sig.
Business expenditure R&D (Mil. Euro)	-0.1271	0.0610	-2.08	0.048	**
National public funding to transnationally coordinated R&D (Mil. Euro	1.2374	1.3310	0.93	0.362	
High-tech patent applications to the EPO by priority year	1.0313	0.3727	2.77	0.011	**
Job-to-job mobility age (25-34 years old) in Thousand	0.0207	2.9072	0.01	0.994	
_cons	2117.0466	286.7296	7.38	0.000	***
Mean dependent var	1909.3900	SD dependent var	4467.1500		
R-squared	0.5663	Number of obs	100		
F-test	4.1790	Prob > F	0.0163		
Akaike crit. (AIC)	1238.6891	Bayesian crit. (BIC)	1249.1097		
*** p<0.01, ** p<0.05, * p<0.1					

Table 6 illustrates the results of the OLS panel regression with lagged variables. Model 1 estimates a current dependent variable, patent applications to the EPO by priority year in connection to the selected independent variables from the current year as well, namely independent variables business expenditure, national public funding to transnationally coordinated R&D, high-tech patents and job-to-job mobility.

Table 6. OLS Panel regression with lagged variables for the European Union (2010-2013) (Source: Authors' own calculations based on Eurostat data (2018))

	(Model 1)	(Model 2)	(Model 3)
Dependent variable (Patent applications to the EPO by priority year)	T=0	T=-1	T=-2
business_expe~d	-0.127**	-0.170***	-0.092***
	(0.061)	(0.031)	(0.021)
national_publ~g	1.237	-0.206	-0.016
	(1.331)	(0.352)	(0.568)
high_tech_pat~s	1.031**	2.317***	1.284
	(0.373)	(0.256)	(0.754)
job_to_job_mo~y	0.021	3.096**	1.850***
	(2.907)	(1.364)	(0.596)
_cons	2117.047***	1848.976***	1823.836***
	(286.730)	(116.304)	(242.808)
Obs.	100	75	50
R-squared	0.566	0.797	0.672
Fixed Effects	Yes	Yes	Yes
Robust Std Err	Yes	Yes	Yes
Standard errors are in parenthesis			
*** p<0.01, ** p<0.05, * p<0.1			

Model 2 implies, that the job-to-job mobility from a previous year is positively associated with the amounts of patent application to the EPO by priority year in the current year. For example, in model 1 the regression model refers to patent applications to the EPO of 2012 for the European Union countries with independent variables business expenditure, national public funding to transnationally coordinated R&D, high-tech patents and job-to-job mobility in 2011 and the same principle applies for the other years taken into consideration for the study. The amount of high-tech patents in the previous year is significantly associated with patent applications to the EPO in the current year.

Model 3 is the estimation of the current value of the dependent variable patent applications to the EPO by priority year to the selected independent variables from two years ago. The results are that the job-to-job mobility from two years ago is positively associated with the amounts of patent applications to the EPO in the current year. Because coefficients of model 3 are lower, this means the effect of the independent variables of two years ago is less strong on the dependent variable from the current year than the effect of the independent variables one year ago on the dependent variable from the current year. Estimations are controlled for fixed effects and robust standard errors are applied.

Table 7. Ordinary least squares (OLS) regression for the period 2014 in the European Union (Source: Authors' own calculations based on Eurostat data (2018h))

Dependant variable Enterprise innovation with environmental benefits	**Coefficients**	**Std. Error**	**t**	**p>ItI**	
Independent variables					
National public funding to transnationally coordinated R&D (Mil. Euro)	19.06258	4.836198	3.94	0.001	No of observations=24 F (3,20)=253.46 R squared=0.9744 Prob>F=0.0000 Adj. R squared=0.9705
Business expenditure on R&D (Mil. Euro)	0.490576	0.0769413	6.38	0.000	
High growth enterprises by 10% or more and related employment	0.3693516	0.2117083	1.74	0.096	

For 2014 we also estimated a regression for enterprise innovation with environmental benefits as a dependent variable in connection to three independent variables: national public funding to transnationally coordinated research and development (R&D), business expenditure on research and development (R&D) and high growth enterprises by 10% or more and related employment, as shown in Table 7. The variable enterprise innovation with environmental benefits refers specifically to enterprises that introduced an innovation with environmental benefits obtained within the enterprise. We estimated the regression for 24 countries of the European Union, as for the rest this data was not available on Eurostat. The selected countries were: Bulgaria, the Czech Republic, Denmark, Germany, Estonia, Greece, Spain, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden, Serbia.

As one can observe in the table above the highest coefficient had a value of 19.06258, meaning that an increase of 1 Million Euro of national public funding to transnationally coordinated research and development can number of enterprises that introduced an innovation with environmental increase the benefits obtained within the enterprise by 19,06. This emphasizes the importance of funding to transnationally coordinated research and development programs for the increase of the number of innovations, as well as for stimulating enterprises to act in the sense of innovation.

The second coefficient of 0.490576 means that an increase of business expenditure on research and development of 1 Million Euro can lead to an increase of 0.49 in the number of enterprises that introduced an innovation with environmental benefits obtained within the enterprise, while an increase of one unit of High growth enterprises by 10% or more and related employment can lead to an increase of 0.3693516 in the number of enterprises that introduced an innovation with environmental benefits obtained within the enterprise. As the adjusted R-squared is 0.97 it means that these three independent variables explain in proportion of 97% the dependent variable. It implies the regression model has a strong explanatory meaning.

Conclusions

As a conclusion a main result of the study is that the job-to-job mobility by age in the sector 25-34 years is a significant determinant of patent application to the European patent office for the selected period 2010-2013 in the sense of a higher job-to-job mobility decreasing patent applications, as less effort and time is invested within an organization contributes to demotivating innovation levels. Secondly, national public funding to transnationally coordinated R&D (Mil. Euro) can contribute to increasing the number of enterprises that introduced an innovation with environmental increase the benefits obtained within the enterprise as mentioned in the case of the regression model for 2014 having enterprise innovation with environmental benefits as a dependent variable.

Innovation is a challenge nowadays for organizations worldwide, involving tremendous efforts from the side of the employees, as well as employers and for funding programs. While the expenditures in the research and development initiatives and the longer periods spent within organizations seem to positively influence the innovations in the sense of patent applications to the European patent office, emerging factors connected to market dynamics and technology development are expected to bring new indicators influencing innovation levels. A main future objective of research is to analyze patent applications and enterprise innovations with environmental benefits in connection to new external factors, that will be imposed by future economic and technological developments in the coming years.

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