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Article

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Amfiteatru Economic Journal

Provided in Cooperation with:

The Bucharest University of Economic Studies

Suggested Citation: Otoiu, Adrian; Bere, Ramona; Silvestru, Cătălin (2017) : An Assessment of the First Round Impact of Innovation Industries on Europe's Regional Economies, Amfiteatru Economic Journal, ISSN 2247-9104, The Bucharest University of Economic Studies, Bucharest, Vol. 19, Iss. 44, pp. 289-301

This Version is available at:

<https://hdl.handle.net/10419/169070>

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AN ASSESSMENT OF THE FIRST ROUND IMPACT OF INNOVATION INDUSTRIES ON EUROPE'S REGIONAL ECONOMIES

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Please cite this article as:

Oțoiu, A., Bere, R. and Silvestru, C., 2017. An Assessment of the First Round Impact of Innovation Industries on Europe's Regional Economies. *Amfiteatru Economic*, 19(44), pp. 289-301

Article History

Received: 26 September 2016

Revised: 12 November 2016

Accepted: 22 December 2016

Abstract

This paper attempts to give an economic perspective of the impact of the innovation industries. The estimation method used is that of panel data modelling, based on data from regions from European countries, including countries from Central and Eastern Europe, for which exploratory analysis was conducted on the effects of employment counts, number of companies, and wages per capita, in computer and related activities and research and development industries.

Higher employment in both industries have positive effects on total employment and GDP/Capita. No sizable displaced workers effects can be seen, as higher employment and wages/capita in innovation industries are accompanied by higher employment and lower unemployment at regional level. Positive effects can be observed for both young and mature workers, and are stronger for the latter, pointing out to strong potential spillover effects. Number of local companies is not a relevant indicator for assessing the influence of research and development activities. All these effects point to the sustainability of innovation industries, which not only lead to increase of GDP per capita, but also show positive spillover effects, increase employment and reduce unemployment.

The results for countries from Central and Eastern Europe (CEE) have been to some extent less significant, due to several objective factors. The results should also be viewed in the framework of the transition and catch-up period that characterizes the evolution of the CEE economies. The positive effects of strong growth are primarily reflected in GDP growth, and it may be that it takes a while for these effects to propagate in the rest of the economy in terms of job creation and sizable reduction of unemployment.

While the current analysis revealed some of the first-round impacts of the innovation industries, much work remains to be done in matching these effects with other determinants of employment and unemployment, which can improve existing models with relevant empirical elements.

Keywords: regional growth, innovation, research and development, computer and related industries, labour market, employment, unemployment

JEL Classification: R11, R23, O32, L86

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Introduction

The question as to what are the drivers of economic growth is more and more relevant since most EU (European Union) countries experience only modest GDP/capita growth. While the latest EC (European Commission) forecast signals an acceleration of growth due to positive factors, it acknowledges the fact that structural factors and crisis-related economic weakness still weigh upon its medium-term performance (European Commission, 2015a). This is also true for the global economy, which will see moderate acceleration of growth (European Commission, 2015a).

Another major issue affecting many economies is the proper functioning of the labour markets. Mass unemployment is affecting many economies, and especially the youth, for which economies cannot create proper opportunities that will enable them to enter the labour market. Apart from the historical perspective, while unemployment has been persistently high since the 70s until 2000 (Blanchard, 2006), more recent evidence shows that unemployment in Europe has fallen since the 2010-2011 peaks, but it is still close to historically high levels, with long unemployment spells and worse terms of employment for youths and prime-aged individuals (European Commission, 2015b).

These major issues have drawn the attention of the EU, which has addressed them in its policies. Through public policies, which represent one of the key means for protecting the values of a country (Lefter, 2015), policy makers should focus on overcoming these issues. The Europe 2020 sustainable growth strategy has among its key targets an increase in R&D spending to 3% by 2020, achieving a 75% employment rate for workers aged 20-64, at least 40% of 30-34-year-olds completing third level education, and 20 million fewer people in or at risk of poverty and social exclusion (European Commission, 2015c). Innovation and its digital agenda, are placed among its top 7 flagship initiatives (2012) as tools that will enable the achievement of these objectives. The potential of the digital economy, which grows seven times faster than the rest of the economy, should be exploited to deliver the economic and social benefits in a sustainable way (European Commission, 2014a). Also, innovation is seen as a main engine for generating growth and jobs, increase the competitiveness of the EU, solve challenges relating to population ageing (European Commission, 2014b).

The impact of innovation industries on labour markets has not been thoroughly explored from the classical point of view of job gains or losses, most likely because this is likely to be similar with the impact of technological change. There are two competing effects: innovation and ICT, by increasing productivity, can lead to job losses and displacement of workers in certain industries, whereas their expansion can create, directly or indirectly, new jobs, that need to be explored.

Considering the central roles that innovation and the digital economy play in the EU's future economic and social development, it was considered of utmost importance to inquire about their real impact on growth and jobs. Using a quantitative approach, the impact of two industries was examined, more specifically of computer and related activities, and research and development, on employment rates, unemployment rates and GDP/capita, at

regional level, which, according to the Nomenclature of territorial units for statistics (NUTS) used by Eurostat, corresponds to NUTS2 regions.

Our goal is not only to see to what extent these industries affect labour markets and GDP at regional level, but also to make a comprehensive analysis that examines most of the EU regions in both New and Old Member States (mostly defined as former Communist countries; to promote an empirical approach where the explanatory power of the basic economic indicators is fully explored, and see which of the explanatory variables (employment counts, wage levels, number of companies) are relevant. The last item is especially important, considering the fact that there is a significant conceptual ambiguity with respect to the dimensions of market-led innovation at local and regional level (Moulaertab and Sekiac, 2003).

1. Theoretical aspects regarding effects of innovation industries on economic growth

The literature review concerning the role of the innovation and the digital economy is vast and a comprehensive review is well beyond the scope of this paper. However, the intent is to pin down the key outcomes for the subsequent analysis of the impact of innovation and digital industries at regional level and thus create a perspective for the current analysis.

The labour market impact of jobs in innovation industries appears to be large. In a working paper, European Commission (2014b) states that while ICT represents 4.8% of the EU economy, it generated about half of productivity growth, and about 1/3rd of GDP growth. A review study (OECD 2004, cap 4 and cap 5) point out to multiple effects of ICT, that raise capital productivity, and effect lower transaction costs and more rapid innovation that boost economic growth. The same study (OECD, 2004) shows that ICT capital added between 0.3 and 0.8 percentage points of GDP and labour productivity growth in OECD over the 1995-2001 period.

In a meta-analysis of the effects of growth, Kokko, Tingvall and Videnord (2015) show the fact that most studies indicate a significant correlation between R&D spending and economic growth in both the EU and the US. The ICT industry effects economic growth not only through its own activity, but also to the spillover effects on other industries (Oulton, 2012). In his study, Oulton (2012) shows an average increase in annual long-term growth for 15 EU countries of 0.26 percentage points due to production of ICT goods, and 0.52 percentage points due to ICT use (spillover effects). If ICT intensity would reach the levels of USA or Sweden, there could be a further increase in long-term growth due to spillover effects by 0.21 percentage points, based on Oulton (2012). Overwhelming evidence on the ICT as a source of growth, based on an analysis of 102 countries for the period 1976-2005, is also presented by Vu (2011), which also shows the strategic role in improving ICT penetration, and enhancing its effects on growth through fostering innovation and exchange. In their analysis on a sample of 158 regions that form parts of 18 European countries over the 1998-2008 period, Moutinho, Oliveira and Coelho (2015) built a regional innovation system, in which R&D employment, technological capacity and knowledge intensity are shown to increase GDP and Gross Value Added, and decrease both total unemployment and youth unemployment in a significant way. García-Muñiz and Vicente (2014) show a more insightful perspective of the ICT role in the EU economy, by showing that 'ICT' sector has then the capacity to foster technological diffusion and the

generation of innovation in the European Union', but that low efficiency levels are recorded for those industries with the highest value creation.

The role of the technological change induced by the innovation industries can be ambiguous, with multiple effects that can act in opposite directions. Bartel and Sickerman (1993) show that in industries with high rates of technological change workers retire later, and that a sudden unexpected increase in technological change leads to early retirement. The same authors show that industries with high technological change command a higher wage premium (Bartel and Sickerman, 1999) after controlling for education and other personal characteristics of workers. In a review of three recent papers, it is argued that displacement of workers due to technological advances (The Economist, 2015) is often overrated, and that it does not automatically affect the low-skilled workers, unless their jobs can be easily automated. Autor (2015) cited by The Economist (2015) claims that the new jobs appearing from the use of technology sometimes more than compensate job losses due to substitution of workers with computers.

2. Methodology

The scope of the present analysis on the impact of innovation industries on the regional economies from Europe, was defined, based on the insights and findings from the literature review, with particular focus also on CEE countries.

Besides the effects of the innovation industries on economic growth, it was also considered important to incorporate effects on local labour markets. There is a major stream of research that shows that economic growth is not an end in itself, but one of the components of well-being and societal progress. Among other significant factors of socio-economic well-being is employment, as a means for providing households with their most important source of income (Oțoiu, Țițan and Dumitrescu, 2014).

Unemployment rates are also important from a sustainability point of view, as the adverse effects of persistent employment, in particular youth employment, are not to be neglected. Layard, Nickell and Jackman (2005) showed that unemployment is associated with loss of income and increased social inequality, and increase psychological and social problems. This is especially important in the context of massive retirements of the baby boomers, which will exit the labour market and may not be so easily replaced by youths with little or no relevant work experience.

All these outcome variables are important in the context of regional development. Lengyel and Rechnitzer (2013) show that unemployment rates play a major role in defining regional competitiveness, which is defined as a principal component of employment rates, available incomes, and labour productivity. Regional competitiveness, in turn, is highly correlated with GDP/capita (Lengyel and Rechnitzer, 2013), hence the role of these variables as drivers of regional growth in Central and Eastern Europe.

Thus, data used to conduct the analysis are from Eurostat, with taking into consideration European Union countries. The analysis targeting in particular Central and Eastern Europe (CEE) countries took into account the following countries: Bulgaria, Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Romania, Slovakia and Slovenia. Data was used at regional level, which according to the Nomenclature of territorial units for statistics (NUTS) corresponds to NUTS2 level. The 2008-2011 period was selected for conducting

the analysis, this period was chosen with taking into account data availability, and the definition of industries. Thus, since 2008, there is a better definition of the innovation industries, which makes the focus of the current exploratory analysis. For the current analysis, two sections, which can be considered as innovative industries, were selected: J and M sections. Section J groups 'production and distribution of information and cultural products, provision of the means to transmit or distribute these products, as well as data or communications, information technology activities and the processing of data and other information service activities' (Eurostat, 2008) which were previously scattered under broader sections. Section M groups scientific research and development, with professional, scientific and technical activities being separated from other activities.

Expanding the series with data from the corresponding industries, classified using NACE Revision 1 would have caused a significant break in series that would make estimation unreliable, as the innovation industries were regrouped into new sections that are not comparable, as acknowledged by Eurostat (2008).

The analysis variables are:

Dependent variables (DV):

- GDP/capita expressed in both purchasing-power parity (PPP) and Euros, to account for disparities between the New and Old Member States.
- Employment rates: for workers 15-25 (youths entering labour market) and workers aged 25 and over.
- Unemployment rates: for workers 15-25 (youths entering labour market) and workers aged 25 and over.

Independent Variables (IV) for a) scientific research and development and b) computer programming, consultancy and related activities industries:

- Number of local units;
- Wages and salaries per capita;
- Number of employees.

Data for industry-specific indicators is not complete due to the relatively small dimension of these industries. For the industries chosen, scientific research and development (NACE Revision 2 code M72) and computer programming, consultancy and related activities (NACE Revision 2 code J62) there is no data available on their share in manufacturing employment. Data is scarce and covers only some countries for the following indicators investment per person employed, and gross investment in tangible goods.

Based on a synthesis of the influences that innovation industries will have on growth and jobs, the scope of the current analysis is presented in table no. 1. These indicators are not, by any means, intended to be an exhaustive list of the items that define and quantify the impact of an industry on economic development.

Table no. 1: Innovation industry specific indicators and their hypothesized influence on economic indicators of sustainable regional development

Economic indicators of sustainable regional development (DV)	Innovation Indicators at industry level (IV)		
	Number of Local Units	Wages and salaries per capita	Number of Employees
GDP/Capita	+	?	+
Employment rate	+	?	+
Unemployment rate	-	?	-

Note: "+" positive influence; "-" negative influence; "?" influence that could not be presumed at the beginning of the analysis

The estimation method used is random-effects panel data models, estimated with the plm R package (Croissant and Millo, 2008). Effects represent the NUTS regions for which data is available. The choice of random effects was considered appropriate since the results will have a higher degree of generalization given the large number of regions, as opposed to a limited number of fixed effects with distinct characteristics.

The unbalanced nature of the panels, which did not allow estimation to be done on both individual and time effects, was overcome by using time dummy variables (represented by the factor variable time).

The general equation for the analyses performed is the following:

$$DV_{it} = \sum_k \beta_k IV_{ikt} + \sum_{t-1} year + \alpha_i + \delta_t + u_{it} \quad (1)$$

with DV is one of the dependent variables, IV the pair of the independent variables for the two industries, k is the index of the industries, i the index of individual fixed effects, t is the time index, β represents the coefficients of the regression parameters, α_i is the country constant, δ_t is the time constant (corresponding to base level year 2008) and u_{it} is the random error.

The use of the word model was explicitly avoided when defining the analysis approach, as the intent was to analyse the effects of these industries alone on the major indicators on key regional economic indicators. A model that will include all relevant variables stemming from standard economic theory and accommodate the indicators relevant for these industries would require work way beyond the scope and length of the current paper.

3. Results of analysis and discussions

The econometric analyses have revealed that, in most cases innovation industries have a sizeable impact on the dependent variables, as shown by coefficients of determination of over 20% that in most cases are even above 33%. This is in line with the exploratory nature of the analysis and confirms the fact that the activity in innovation industries is not the sole driver behind the evolution of the DVs, but that they should be taken into account when modelling changes in GDP, employment and unemployment.

The employment counts in the scientific research and development (R&D) (table no. 2) appear to have a positive effect on the GDP/Capita expressed in PPP and on employment counts for both youths and mature workers, and a negative effect on unemployment rates. This is in line with expectations, and shows the sizeable positive effect of this industry on Europe's regional economies. However, a closer examination gives more insights about its effects.

Table no. 2: Impact of employee counts on regional economic indicators

Dependent variable	Scientific research and development (M72)	Computer and related activities (J62)	R ²
Employment age 15-25 (000)	1.7657e-03*	1.4662e-03***	0.32
Employment age 25+ (000)	9.6286e-03***	4.0870e-03***	0.14
Unemployment rate age 15-25 (%)	-7.4985e-04***	1.4554e-05	0.36
Unemployment rate age 25+ (%)	-2.2028e-04**	3.0739e-06	0.28
GDP/Capita, expressed in purchasing power parity (PPP)	2.2025e-01**	1.4924e-01***	0.39
GDP/Capita, EUR	1.5716e-01	1.7872e-01***	0.34

*Note: Levels of significance based on calculated p-values: '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

First of all, results indicate that high disparities in the GDP/capita across the EU render estimation of impact of R&D useless, and that an analysis done on comparable data can help show the actual impact of this industry. The impact of having 100 more employees in R&D is 22 EUR/Capita GDP growth expressed in PPP.

While effects on both employment and unemployment are significant and confirm the working hypotheses, it can be seen their huge difference with respect to young versus mature workers. The decrease in unemployment rates triggered by increased employment in R&D is more than three-fold for youths (0.75 percentage points decrease for an increase of 1000 employees in this sector) as for mature workers (0.22 percentage points only). An increase in employment of 1000 R&D workers effects an increase of approximately 9630 mature workers in a region, and only 1766 young workers in a region. It is very likely that spillover effects can account for this difference.

From the perspective of employment counts, direct effects for computer and related industries (CI) are similar. Comparable results were obtained for GDP/capita, albeit the impact of having 100 more workers in this industry adds 15-18 EUR to it.

These explanations may account for the CI employment counts influence on employment. Additional CI workers are associated with increased employment for both youths (1.5 additional workers for one CI hire) and mature workers (4 additional workers for one CI hire), but the increase for the latter are less than half than the one effected by R&D. Finally, there is no evidence that CI employment is a solution to decreasing unemployment from a first-round effect perspective.

The number of local companies is also significant when assessing the impact of these industries on regional economic indicators. Results of the analysis are shown in table no. 3.

Table no. 3: Impact of number of local firms on regional economic indicators

Dependent variable	Scientific research and development (M72)	Computer and related activities (J62)	R ²
Employment age 15-25 (000)	-1.3511e-02	6.8778e-03***	0.23
Employment age 25+ (000)	-0.0320846	0.0115280***	0.06
Unemployment rate age 15-25 (%)	0.00590400*	-0.00088440***	0.34
Unemployment rate age 25+ (%)	1.9050e-03*	-3.1559e-04***	0.27
GDP/Capita, PPP	1.6394e+00	5.2430e-01***	0.34
GDP/Capita, EUR	2.28464.	0.47876***	0.28

Note: Levels of significance based on calculated p-values: '****' 0.001 '***' 0.01 '**' 0.05 '.' 0.1 ' ' 1

It seems that only for CI results are within expectations, and that they match the results obtained for the number of workers. One more CI entity adds 0.5 EUR to the GDP/capita, a result in line with the one obtained for employment counts if one is to consider that the average local CI firm has 4.3 employees.

Strong estimates are obtained for employment and unemployment, where 1 extra CI firm generated 12 jobs for the mature workforce, and 7 jobs for the youth. Unemployment for mature workers decreases by 0.3 percentage points, and by 0.9 percentage points for youth, mostly in line with results obtained for employment counts.

For R&D, it seems that there are no immediate significant effects on GDP/Capita and employment, probably due to the less dynamic nature of company creation which cannot be related to economic opportunities. It seems that a higher number of companies is associated with increases in unemployment rates, which may indicate a job destruction effect. However, further analysis should be conducted on this, as these results are not consistent with the other results obtained for this industry, and there may be other effects at play that may explain them.

A third dimension used to assess the first-round effects of innovation industries on the economic indicators of regional economy is related to average wages and salaries. This investigation is potentially trickier because of the potential competing effects (positive spillovers vs. job destruction and mass unemployment) that can tip the balance in favour of one or the other.

The results (table no. 4) are consistent with results obtained for the influence of the number of employees. It appears that, indeed, higher wages incorporate a premium for higher productivity, and that there are no adverse effects triggered by higher wages in these industries.

Table no. 4: Impact of wages and salaries on regional economic indicators

Dependent variable	Scientific research and development (M72)	Computer and related activities (J62)	R ²
Employment age 15-25 (000)	4.3277e-05	1.8257e-04*	0.22
Employment age 25+ (000)	2.28464.	0.47876***	0.28
Unemployment rate age 15-25 (%)	-3.5410e-05*	-1.4951e-04***	0.37
Unemployment rate age 25+ (%)	-1.2529e-05*	-4.3403e-05***	0.28
GDP/Capita, EUR	2.6403e-02***	1.1527e-01 ***	0.37

Note: Levels of significance based on calculated p-values: '****' 0.001 '***' 0.01 '**' 0.05 '.' 0.1 ' ' 1

An increase of 1000 EUR in wages triggers increases in GDP/capita in both industries. However, increases in R&D salaries are much stronger than those in Computer and related activities by about 5 times for each GDP/capita measure, and ranges from 115 EUR for CI to 26 EUR for R&D.

The employment effects are significant for CI, and extremely strong for the mature workers, as an increase of 1 EUR is associated with an increase of about 500 extra workers. By comparison, a similar increase of 1000 EUR leads to an irrelevant increase of about 2 extra workers for youth. A much stronger effect is observed for R&D, where a 1 EUR increase is associated with 2285 extra mature workers, albeit the result is significant at a 10% level only.

Decreases in unemployment are markedly different in the two industries, especially for youths, where the decrease due to CI is about 43 times stronger than for R&D: 0.15 percentage points for a 1000 EUR decrease for the former vs 0.035 for the latter. For the mature workers, these decreases are much smaller, both below 0.043 percentage points.

An initial assessment of results on CEE countries shows that these industries had no significant impact on the unemployment rates and on employment of the core working age population (over 25 years). Therefore, results where these effects were not significant at all were not shown in the tables. Weak results were also obtained for youth employment, which, with one exception, show counterintuitive results that may be due to other developments not captured in this analysis that deserve future research. With one exception, the R&D sector had no significant impact on growth, which may be due to the embattled evolution of this sector in the CEE countries. However, computer and related industries (CI) variables all show strong positive effects on growth.

The impact of employee counts for CI industry on GDP (Table no. 5) are in line with those obtained for Europe as a whole. The impact on youth employment is very small with a low level of significance and impact, and may be due to other factors behind the dynamic of both variables that are not captured in the present analysis.

Table no. 5: Impact of employee counts on regional economic indicators – CEE countries

Dependent variable	Scientific research and development (M72)	Computer and related activities (J62)	R ²
Employment age 15-25 (000)	-0.0032381	-0.0013088.	0.51
GDP/Capita, PPP	4.1713e-03	4.0052e-01***	0.66
GDP/Capita, EUR	-5.5190e-02	2.0261e-01***	0.64

Note: Levels of significance based on calculated p-values: '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

The number of local R&D firms from CEE countries seems to increase local employment by a sizeable extent, however, the impact appears to be limited (table no. 6), as, for example, an extra 1000 firms would trigger an increase in youth of only 107. However, the difference between this result and the one obtained for Europe is an encouraging development. The negative relation with GDP/capita is counterintuitive and can best be explained by the much stronger dynamic of the latter. By contrast, CI firms have a significant positive influence on GDP, almost three times stronger than for Europe as a whole. While statistically significant, the result for youth employment has little impact as

an extra 1000 firms would presumably lead to an insignificant decrease of 9.6 young employees.

Table no. 6: Impact of number of local firms on regional economic indicators – CEE countries

Dependent variable	Scientific research and development (M72)	Computer and related activities (J62)	R ²
Employment age 15-25 (000)	0.1068871***	-0.0095639***	0.56
GDP/Capita, PPP	-10.59470***	1.45579***	0.68
GDP/Capita, EUR	-3.82524.	0.54311***	0.62

Note: Levels of significance based on calculated p-values: '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Wages and salaries from CEE countries in the M72 (R&D) sector show a weak negative impact on the employment counts of the youth (table no. 7). This may in fact express a disconnect between youth job creation and R&D wages, pointing out to dynamics that are completely different and unrelated e.g. youth employment may be affected by strong emigration while R&D may grow a little, or that youth employment is booming triggered by strong growth while R&D sector is growing much slowly. For CI industries there is a strong positive impact as a 1 EUR increase in wages leads to 7.6 EUR growth in GDP/Capita, which is much larger in PPP terms. However, CI wages not to affect employment of youths, showing that there are no strong negative labour substitution effects. (Table no. 7).

Table no. 7: Impact of wages and salaries on regional economic indicators – CEE countries

Dependent variable	Scientific research and development (M72)	Computer and related activities (J62)	R ²
Employment age 15-25 (000)	-0.386606.	-0.010945	0.52
GDP/Capita, EUR	-1.7128	7.6148***	0.64
GDP/Capita, PPP	18.5662	11.1276***	0.62

Note: Levels of significance based on calculated p-values: '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Conclusions

The effects of innovative industries of key economic indicators show that both R&D and computer and related industries have a significant positive influence on the GDP and the labour markets.

In most cases, one may see that more employees in these industries translate into higher GDP/Capita, especially for R&D. This is also consistent with significant increases in employment numbers for both youths and mature workers. However, the first-round effects are stronger for R&D; in the case of unemployment, CI employment numbers had no impact on it.

Number of local companies is a significant indicator only for CI industries. Results are, however, not much different than those obtained for employment counts, adjusted with an average of 4.3 employees per firm. By contrast, number of companies is an irrelevant

indicator for the R&D activities, with weak and counter-intuitive results. This indicates that a more thorough investigation on the nature of employment in this industry is needed, which may also improve the reliability of business statistics on it.

Wages and salaries per capita are also bringing another perspective on the effect of these industries on GDP/capita and labour market indicators. The findings are consistent with those for employment numbers, which confirms the wage premium for increased productivity pointed out in the literature. Another salient feature of this indicator is that it does a better job in evidencing short-term first-round effects in the case of CI. It seems that these effects, that are more immediate, are better matched with the evolution of wages, albeit there could be the case that CI industries have a more moderate wage growth than R&D. It may be that increases for relatively low wages that are not tightly related to market conditions of the latter are immediately visible, and that the risks associated with R&D activities are passed on to employees as their regular wages are lower than the productivity increases they normally effect.

All these effects point out to the sustainable nature of the innovation industries on growth. Not only do they trigger an increase in GDP/Capita, but they also point out to positive spillover effects that exceed their size, increase employment, and decrease unemployment. The same effects can be seen for the youth; while the magnitude is smaller than for the older workers it may be that some of the spillovers consist of helping young unexperienced workers getting their first job(s).

Results obtained for Eastern European (EE) countries were, to a certain extent, less significant and less reliable due to several objective factors. First, data was scarcer due to the fact that, in these developing economies, the two innovation sectors were, to a certain extent less represented, a fact that explains the relative scarcity of the data (less than 25% of the observations for the dataset for all European countries). The second factor is given by the final stages of the transition period, with significant macroeconomic imbalances that accompanied the journey towards a fully functional market economy, that, for most countries, were also affected by the Great Recession. Therefore, in many cases, estimations were made using fixed effects models in order to address data scarcity and reliability of results. The choice of fixed effects, as opposed to random effects, is justified by the fact that, given the issues mentioned above, they refer strictly to the countries and time periods analysed, thus enabling us to draw more reliable conclusions about the available data.

Results should be also viewed within the transition and catch-up period that characterizes the evolution of the CEE economies. The positive effects of strong growth are primarily reflected in GDP growth, and it may be that it takes a while for these effects to propagate in the rest of the economy in terms of job creation and sizable reduction of unemployment.

The current analysis concentrates merely on the first round effects of the variables for which data availability allows drawing a conclusion that refers to most NUTS2 regions. Thus, a higher level of activity in these industries is supposed to increase GDP/Capita and employment, and decrease unemployment. The effect of wage levels in these industries is to be determined; on one hand it is possible to have the same effects as for the other variables for GDP, as higher wages can reflect higher productivity. However, for labour markets, it is not clear that there will be substitution effects triggered by these industries which can decrease employment and increase unemployment, or whether there will be an increase in employment and a decrease in unemployment due to spillover effects.

While the current analysis has uncovered some of the first-round impacts of the innovation industries, much work remains to be done in matching these effects with other determinants of employment and unemployment, which can improve existing models with relevant empirical elements.

References

- Autor, D.H., 2015. Why Are There Still So Many Jobs? The History and Future of Workplace Automation. *Journal of Economic Perspectives*, 29(3), pp.3-30.
- Bartel, A.P. and Sicherman, N., 1993. Technological Change and Retirement Decisions of Older Workers. *Journal of Labor Economics*, 11(1), pp.162-83.
- Bartel, A.P. and Sicherman, N., 1999. Technological Change and Wages: An Interindustry Analysis. *Journal of Political Economy*, 107(2), pp.285-325.
- Blanchard, O., 2006. European unemployment: the evolution of facts and ideas. Economic Policy. *CEPR & CES & MSH*, 21(45), pp.5-59.
- Croissant, Y. and Millo, G., 2008. Panel Data Econometrics in R: The plm Package. *Journal of Statistical Software*, 27(2), pp.1-43.
- European Commission, 2015a. European Economic Forecast spring 2015, *European Economy*, 2, [online] Available at: <http://ec.europa.eu/economy_finance/publications/european_economy/2015/pdf/ee2_en.pdf> [Accessed 2 September 2015]
- European Commission, 2015b. Labour Market and Wage Developments in Europe 2015. [online] Available at: <<http://ec.europa.eu/social/BlobServlet?docId=14290&langId=en>> [Accessed 2 September 2015].
- European Commission, 2015c. *Europe 2020. In a Nutshell. Targets*. [online] Available at: <http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/targets/index_en.htm> [Accessed 1 September 2015].
- European Commission, 2014a. The EU explained: Digital agenda for Europe. [online] Available at: <http://europa.eu/pol/pdf/flipbook/en/digital_agenda_en.pdf> [Accessed 1 September 2015].
- European Commission, 2014b. *Working Paper: Digital Economy – Facts & Figures* [online] Available at: <https://ec.europa.eu/taxation_customs/sites/taxation/files/docs/body/2014-03-13_fact_figures.pdf> [Accessed 2 August 2015]
- European Commission, 2013. *Innovation Union – A pocket guide on a Europe 2020 initiative*. Luxembourg: Publications Office of the European Union.
- European Commission, 2012. *Europe 2020. Flagship Initiatives*. [online] Available at: <http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/flagship-initiatives/index_en.htm> [Accessed 1 September 2015].
- Eurostat, 2008. *NACE 2008 Rev. 2 Introductory Guidelines*. [online] Available at: <<http://ec.europa.eu/eurostat/documents/1965800/1978839/NACEREV.2INTRODUCTORYGUIDELINESEN.pdf/f48c8a50-feb1-4227-8fe0-935b58a0a332>> [Accessed 2 August 2015].

- García-Muñiz, A.S. and Vicente, M.R., 2014. ICT technologies in Europe: A study of technological diffusion and economic growth under network theory. *Telecommunications Policy*, 38(4), pp.360–370.
- Kokko, A., Tingvall, P.G. and Videnord, J., 2015. The Growth Effects of R & D Spending in the EU: A Meta-Analysis. *Economics: The Open-Access, Open-Assessment E-Journal*, 9(2015-40), pp.1–26
- Layard, R., Nickell, S. and Jackman, R., 2005. *Unemployment: Macroeconomic Performance and the Labour Market*. Oxford: Oxford University Press.
- Lefter, C., 2015. Are the rules of European Union public policy a reality?. *Juridical Tribune*, 5(2), pp.254-258.
- Lengyel, I. and Rechnitzer, J., 2013. Drivers of Regional Competitiveness in the Central European Countries. *Transition Studies Review*, 20(3), pp.421–435.
- Moulaertab, F. and Sekiac, F., 2003. Territorial Innovation Models: A Critical Survey, *Regional Studies*, 37(3), pp.289-302.
- Moutinho, R., Oliveira, A.M. and Coelho, A., 2015. Socio-Economic Planning Sciences Beyond the “Innovation’s Black-Box”: Translating R & D outlays into employment and economic growth. *Socio-Economic Planning Sciences*, 50(C), pp.45-58.
- OECD, 2004. *The Economic Impact of ICT: Measurement, Evidence and Implications*. Paris: OECD Publishing.
- Oțoiu, A., Țițan, E. and Dumitrescu, R., 2014. Are the variables used in building composite indicators of well-being relevant? Validating composite indexes of well-being. *Ecological Indicators*, 46, pp.575–585.
- Oulton, N., 2012. Long term implications of the ICT revolution: Applying the lessons of growth theory and growth accounting. *Economic Modelling*, 29(5), pp.1722–1736.
- The Economist, 2015. Automation angst. Three new papers examine fears that machines will put humans out of work. [online] Available at: <<https://www.economist.com>> [Accessed 13 August 2015].
- Vu, K.M., 2011. ICT as a source of economic growth in the information age: Empirical evidence from the 19962005 period. *Telecommunications Policy*, 35(4), pp. 357–372.