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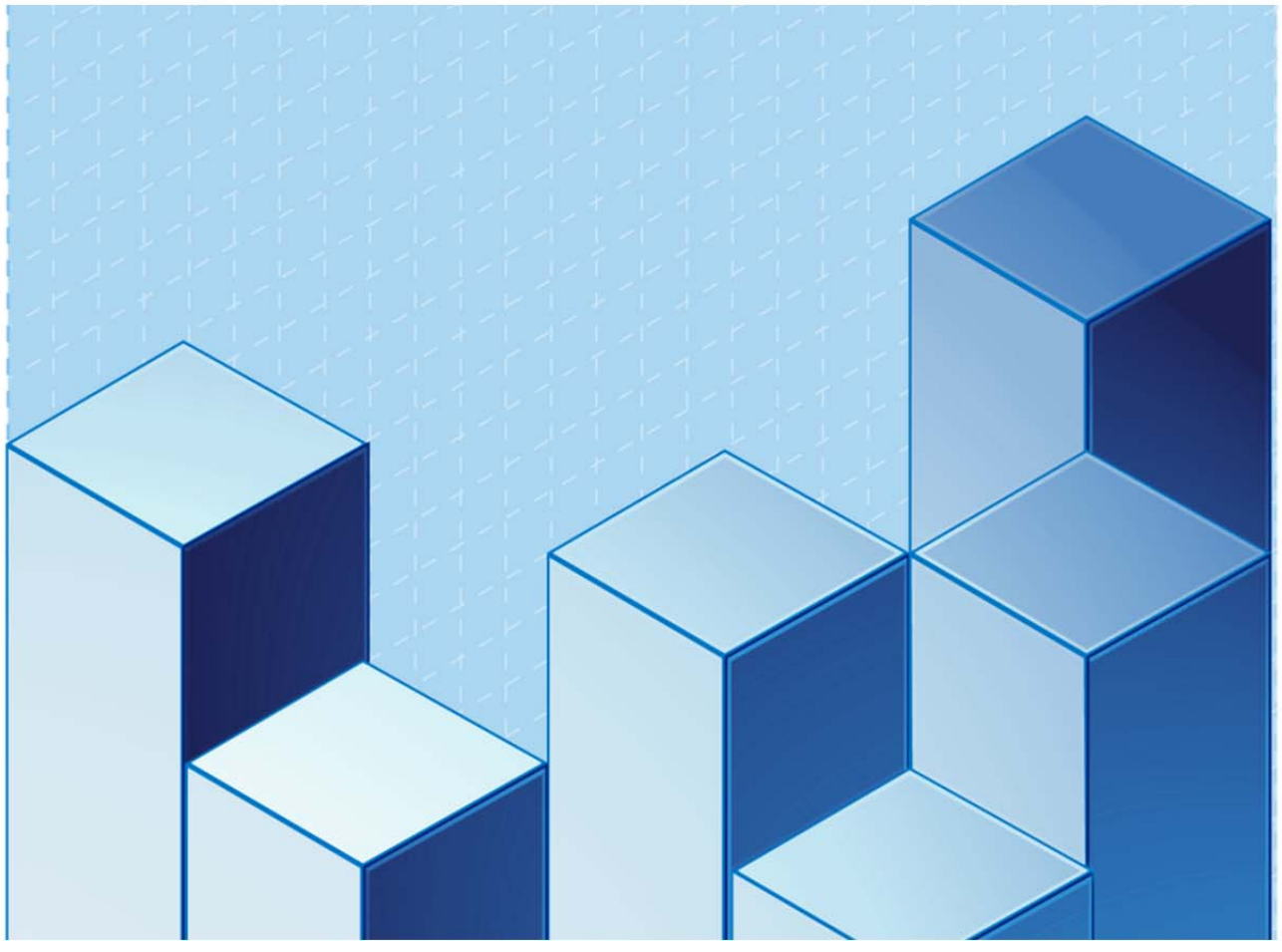

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A VALUATION OF THE LONG-TERM SOCIOECONOMIC CONTRIBUTIONS OF THE EUROPEAN HIGHER EDUCATION INSTITUTIONS*

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Abstract

This study analyses the contribution of Higher Education Institutions (HEIs) to the socio-economic development of the EU and each of its 28 members over the period 2000-2014. For this purpose, we examine the contributions of HEIs both through their educational and research activities. In the first case, we take into account the direct impact of higher education on the human capital of individuals, as well as the indirect impact on employment rates given the greater participation and employability, ceteris paribus, of people with higher education. In the second case, we study the contribution of the R&D of HEIs to technological capital. To carry out the analysis, counterfactual scenarios which assume that HEIs do not exist are estimated for each country. These counterfactual scenarios serve as a reference to estimate the impact of HEIs, applying techniques of growth accounting. The results obtained indicate that HEIs are a significant source of growth in EU countries, also contributing to mitigating the adverse effects of the periods of crisis. For the whole of the EU, the estimates show that GDP per capita would currently be more than one fifth higher than that corresponding to a scenario without HEIs. The results obtained also show the differences in GDP per capita between EU countries of up to 15% associated with the activity of HEIs.

Key words: HEIs, human capital, labour market, economic growth.

* This research has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no: 612774 (SPINTAN Project: Smart Public Intangibles).

** J.M. Pastor, L. Serrano and A. Soler: Universitat de València and Ivie.

1. Introduction

Globalization and the recent economic crisis have made it clear that there is a need not only to increase levels of company competitiveness but also to reorientate the productive specialization of economies towards activities which generate more value added. Knowledge is an indispensable factor nowadays in the development of innovation, the management of new technologies and the complex financial and commercial relations in our world today. Few doubt the role that higher education plays in this process since a high level of training on the part of individuals is required since the activities towards which the productive model is reorientated are the most knowledge intensive.

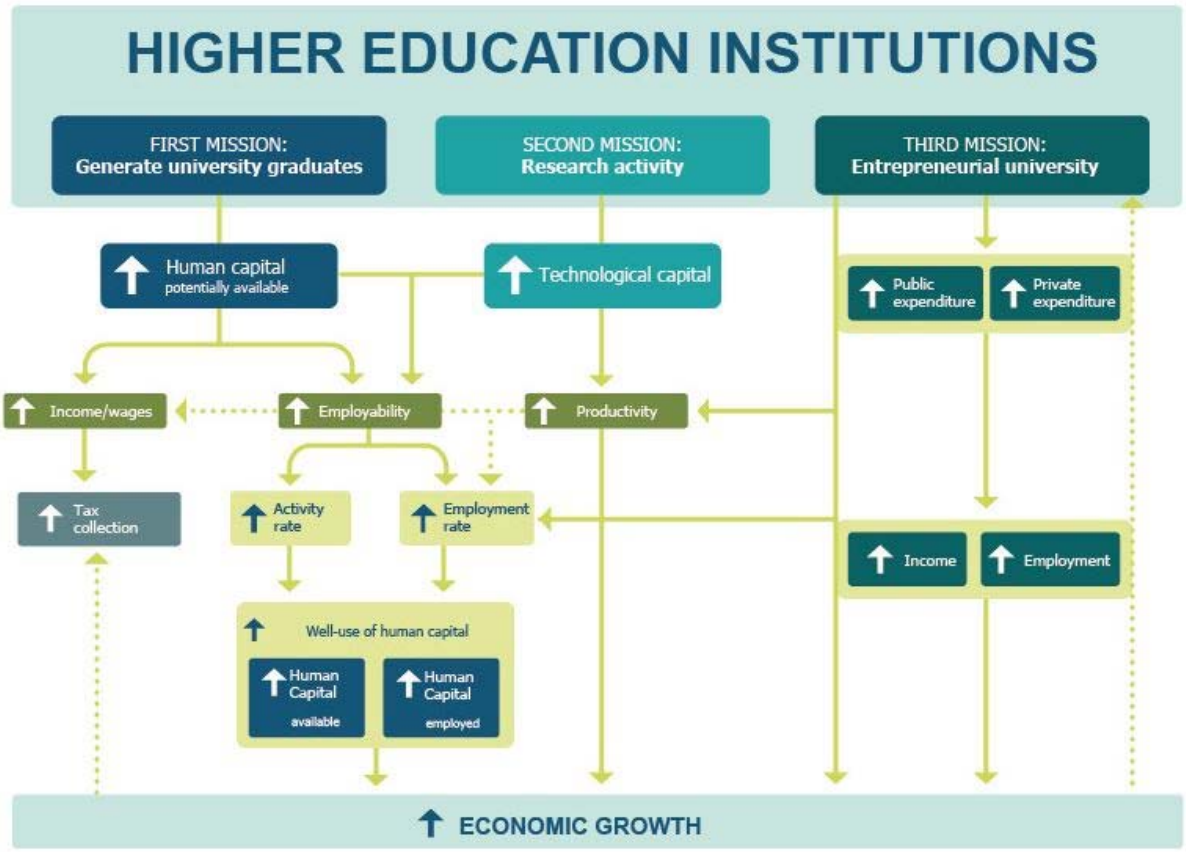
In such circumstances, the role of Higher Education Institutions (HEIs) is very important because the results of their three activities (teaching, research and transfer) are essential to contribute to this new stage of socioeconomic development in which advanced, knowledge-based societies are immersed.

This awareness of the significant contribution made by HEIs has led to studies where their contributions to economic and social development are measured. Most of these studies focus on quantifying the impacts in the short term by the demand side of university activity in employment and the demand in local companies through their own spending as well as the spending of other agents related to university activity. However, these studies do not take into account other university contributions by the supply side and in the long term which are produced by the increase in the human capital of their graduates or of the technological capital generated through their R&D activities (Pastor and Peraita 2016). Furthermore, the human capital generated by HEIs has positive effects on other variables related to the well-being and the development of a country such as respect for democratic values and the environment, life habits and the population's state of health, crime (McMahon 2009) or more recently, gender equality (Pastor, Peraita and Soler 2015).

In sum, it has been widely demonstrated by the specialized literature that human capital, research, and knowledge in general (the areas of HEIs' specialization) are crucial for the long-term development of societies today, characterized by their knowledge-intensive use. Aware of this fact, social, economic and political agents consider HEIs as an instrument for social and economic development at local, regional and national level, and thus studies on the economic impact of universities have evolved along with this awareness of the role that universities should play in the socioeconomic development of their areas of influence. The most recent studies have focused on studying the contribution of university activities to the supply of resources in the economy and their spillover effects on other variables such as economic growth or the per capita income of their environment, taking a broader time perspective.

Diagram 1 presents a summary of the relationship of HEIs with their immediate environment. As can be seen, these relationships are complex, multidirectional, direct and indirect and with very heterogenous maturation periods. This multiplicity of interrelations allows us to see how complex it is to estimate the socioeconomic contributions of a university.

Diagram 1. Long-term impact of HEIs on the supply side



Source: Pastor and Peraita (2012)

This paper analyses and quantifies the long-term impacts of HEIs in 28 EU countries. The exercises performed use the methodology developed by Pastor, Peraita and Pérez (2015), based on the design of counterfactual exercises. The work is organized as follows. Section 2 briefly describes the literature on the economic impact of university activity. Section 3 describes the models used to estimate the long-term economic impacts of HEIs in their territories and section 4 analyses the contribution to the generation of technological capital. Section 5 details the contribution to economic growth, while section 6 looks at the contribution to the increase in per capita income. Finally, section 7 presents the main conclusions.

2. The literature on the long-term effects of HEIs

Studies on the short-term effects of HEIs' spending by the demand side do not address the major contributions of universities: their direct contributions to the supply of human and technological capital and the spillover effects of the activity of these institutions. In the studies on the long-term contributions of HEIs, we can distinguish between two types of analyses:

1) **Studies on the direct impact of HEIs by the supply side:** In these studies, HEIs are considered as instruments of socioeconomic development in their respective regions. These studies

analyse the role of HEIs as incubators of technological innovation and quantify their contribution to the creation of human and technological capital through their teaching and research activities and their subsequent economic effects. Their contribution is established in terms of the increase in the level of studies, technological capital, wage returns, increases in activity and occupation rates or their contribution to economic growth.

2) **Studies on the economic and social spillover effects of HEIs:** These studies review the non-quantifiable private and social benefits directly associated with university activity (quality of life, health, respect for the environment, child rearing, citizen participation, social capital, reduction of discrimination, crime, etc.).

There are many studies that provide data on the activities developed by HEIs (student spending, graduates, doctorates, patents, research results, spin-offs, etc.) and show the relationship between these university activities and various socioeconomic variables at local and regional level. It is certainly difficult to determine a causal link between university activities and the economic outcomes in their environment (Drucker and Goldstein, 2007). However, the regularity observed confirms that universities have a role to play in local and regional development.

Undoubtedly, the variables which are most used in studies to highlight the contribution of HEIs to their environment are human capital and research. Twenty-five years ago Bluestone (1993) pointed out that by university students earning higher salaries than they would if they did not have university studies, they therefore pay higher income taxes, showing that university spending, in addition to other social and economic effects, is a fiscally profitable investment for governments[1]. Similarly, Goldstein and Renault (2004) analyse the research and technology activities for the first fifty universities in the United States[2] , suggesting that with the reorientation towards a knowledge-based economy, university activities have become increasingly important and, consequently, have more important dissemination impacts which can be internalized and generate economic growth in the regional environment. Similarly, Anselin et al. (1997) analysed the degree of "spatial diffusion" between university research and high technology innovations for the case of the United States. They used Griliches-Jaffe knowledge production function (Griliches, 1979 and Jaffe, 1989) both at state and metropolitan levels, to estimate the effects of spatial diffusion between different US states.

Other important contributions refer to the role of universities as entrepreneurial and knowledge transfer universities. In a study on university technology parks, Mian (1995) concludes that business incubators have a very positive impact on the creation and development of new technology-based companies. O'Shea et al. (2005) analyse the success of universities in generating technological spin-off companies based on a set of determinants. Bramwell and Wolfe (2005) analyse the impacts of the University of Waterloo in Ontario, Canada, including an excellent summary of the literature on the mechanisms of knowledge transmission from universities to the economy. Sudmant (2009) studies

[1] Brown and Heaney (1997) consider that the economic impact of universities is overestimated by not taking into account the potential effects of migration on the localization of human resources. In fact, since university graduates are more geographically mobile, if the environment is not favorable to employment and working conditions in general, they are less likely to reside in the community and, therefore, to contribute to the university environment.

[2] Specifically, the periods 1969-86 and 1986-98 are analyzed in a total of 312 metropolitan areas. Impacts are calculated based on the changes in the average income per employee and controlling for another set of factors traditionally used to explain economic growth.

the economic impact of the University of British Columbia (UBC) in Vancouver incorporating concepts adapted from the literature on the economics of education, innovations and economic growth. In this study we consider that the economic impact of universities is different from those of other institutions because, along with the "static impact" on the local regional economy, there is also a "dynamic impact", i.e., long term. This dynamic or long-term impact refers to the role of universities in the creation and transmission of knowledge, an impact on the supply side insofar as it increases the productive capacity of the regional economy. Four economic impacts are estimated in this study: direct expenditure, those induced by expenditures that are not specific to the university but would not take place if they did not exist, the impact on the level of education of the labour force and the impact of the new knowledge created or transmitted by universities. This study stresses the importance of this dynamic impact on the supply of resources and calculates the impact of the research activities of the UBC on the economy, the so-called dynamic multiplier effect, using total factor productivity (TFP).

For the European case, the consultancy BiGGAR Economics (2015) carried out a study to analyse the role of universities belonging to the League of European Research Universities (LERU) to assess the contribution of the 21 member universities of LERU in Europe. The study is very broad and analyses the economic contribution derived from the core activities of all LERU Universities, including those related to direct income and employment, purchase of goods and purchased services, staff expenses and capital expenditures; contributions associated with students, contribution of knowledge transfer, business and innovation associated with LERU Universities, contribution to tourism through visits to students and staff, and expenses in conferences and events organized in each university; the economic contribution derived from the increased income generated during the working life of the graduates as a result of having a university education and the estimated total economic contribution of the member universities of LERU across Europe. One of the virtues of this study is that it considers both short and long-term impacts. As noted in the study itself, "an important limitation of traditional approaches to economic assessment of value is that they do not take into account the long-term effects on the economy". Much of the activity undertaken by universities focuses on the long-term results that often take some time to manifest themselves.

In the Spanish case, the first work of this kind is the Valencian Institute of Economic Research report conducted by Pastor and Pérez (2008) for the University of the Basque Country. This study quantifies the impacts by the supply side of a university with a transparent methodology for the Spanish case. This line of research continued with studies on different universities and even with a study on the whole of the Spanish University System[3].

The contributions of HEIs quantified in the first type of studies tend to be limited to the economic sphere. However, apart from these quantifiable socioeconomic contributions, the activities of universities have significant positive economic and social externalities which are non-quantifiable, either because there is no data or because they are non-monetary variables. McMahon (2009) draws up a list of non-monetary benefits of universities that are rarely quantified: increased social capital, improved health, reduced delinquency, reduced gender inequality (Pastor and Peraita, 2015),

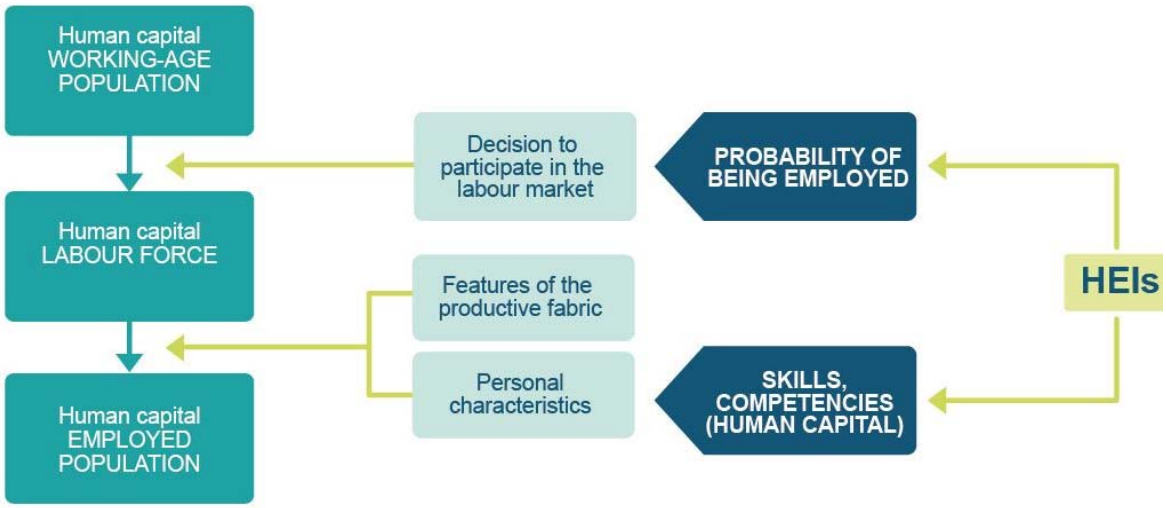
[3] See www.ivie.es

increased citizen participation, greater respect for the environment, greater equal opportunities, better conditions for the upbringing of children, etc.[4] All these impacts of university education represent social and private non-monetary benefits that no one doubts but which are difficult to quantify.

3. The contribution of HEIs through the generation of human capital

The generation of human capital through teaching is one of the most direct and visible contributions of HEIs. In addition to the intellectual enrichment of the graduates, their greater human capital increases their employability, their participation in the labour market (activity), their functional and geographical mobility and their productivity, having a positive impact on all society in specific areas such as an increase in the activity rate, a reduction in the unemployment rate, and regional economic growth. This section quantifies the contributions of HEIs in EU countries generated directly through the activity of teaching. Specifically, the contribution of HEIs to the increase in the population's human capital of each of the EU countries is estimated, as well as the indirect contribution of this increase in the rate of activity and employment that this human capital produces (see **diagram** 2).

Diagram 2. Human capital and the labour market



Source: Own elaboration

The quantitative estimation of the human capital of individuals, and by extension, of a society as a whole, is a complicated task in that human capital includes diverse aspects such as acquired knowledge, mental and physical capacity and work experience.

If it is accepted that the ultimate goal of education is to acquire knowledge and skills, it is reasonable to assume that human capital increases as students complete educational levels. This is why most of the human capital measures used in studies are based on formal and regulated education statistics. Thus, it is common practice to approximate human capital using the level of studies completed by

[4] Several reports point out that children with parents with university education will be better educated at home and are more likely to enter university and complete their studies.

individuals. Similarly, when we want to estimate the human capital of the population of a society, it is done through the percentages of population in each of the educational levels or through the synthetic indicator of the population's average years of study. The implicit assumption in these human capital indicators is that there is some proportionality between years of study and the level of human capital.

3.1. Direct contribution of HEIs to the generation of human capital

If the average years of study of a country's population is taken as an indicator of their human capital, the contribution of HEIs can be quantified by the increase of this indicator which is a direct consequence of the teaching activity of HEIs. In practical terms, the contribution of HEIs is calculated based on the difference between the average years of study of the population in each country and the average years of the *counterfactual* study: i.e., those that the population of each country would have in the case of HEIs not having formed any graduate.

We calculate the average years of study of the population in country r (AYSr) by computing the quotient between the years of study of the population as a whole and the number of individuals, according to the following expression:

$$\mathrm{AYS_r} = \frac{\sum_i \mathrm{YS^i POP_r^i}}{\sum_i \mathrm{POP_r^i}}$$

Where YS_i are the years of study required to complete the level of studies i and POP^i_r is the number of individuals of country r who have completed the level of studies i.

The series of years of the counterfactual study (those that the population of a country would have if their HEIs had not trained any graduates) are calculated considering that if HEIs did not exist, their graduates would have reached the level of studies before university (post-compulsory secondary studies).

Figure 1 shows the evolution of the actual years of study along with the counterfactual years of the working-age population in EU countries during the period 2000-15. In the last 15 years, the average years of study of the working age population in the EU have increased by 11.5%. In the last 15 years, the average years of study of the working age population in the EU have increased by 11.5%. In 2015, the value of this indicator for the EU's working age population was 11.2, compared to 10.0 years in 2000. In 2015, without the contribution of HEIs, the average years of study would have been 10.4 years, and therefore the human capital directly generated by HEIs represents 0.8 years per person of working age. That is, HEIs are responsible for 7.2% of the human capital endowments of the EU's working age population.

Figure 1. Higher education contribution to human capital. Mean years of schooling of population between 15 and 64. International comparison. 2000-2015

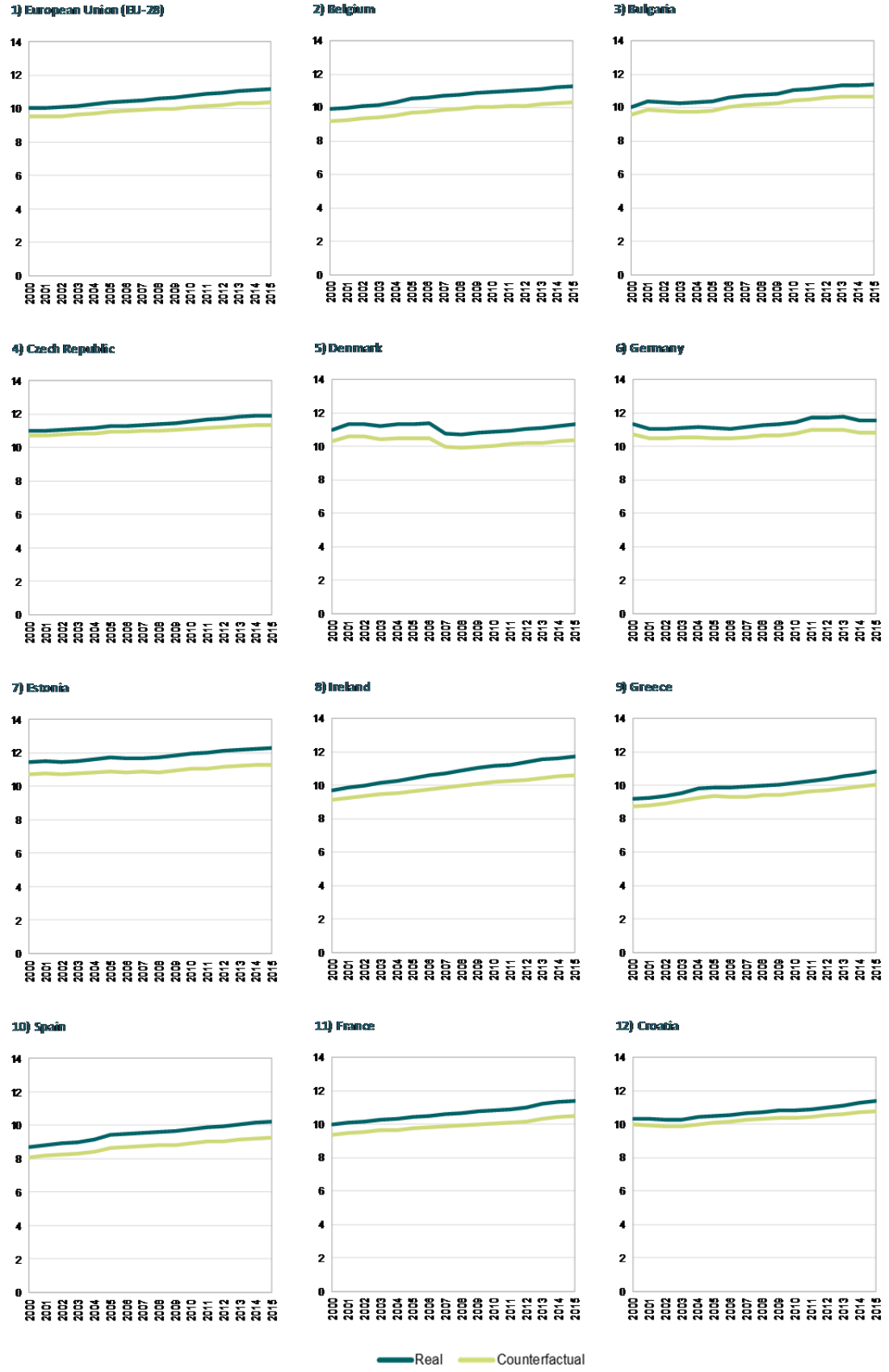


Figure 1. Higher education contribution to human capital. Mean years of schooling of population between 15 and 64. International comparison. 2000-2015 *(cont.)*

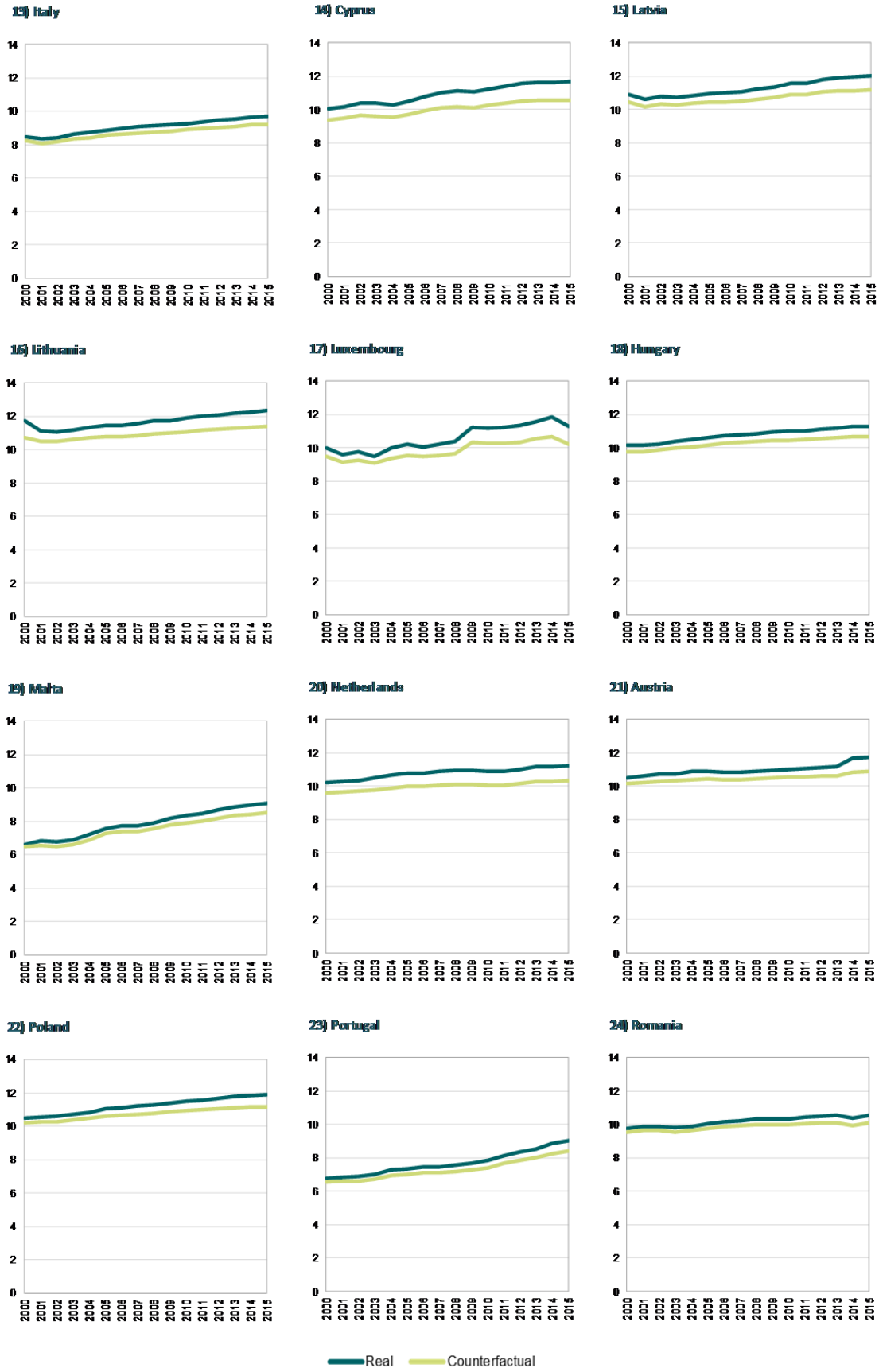
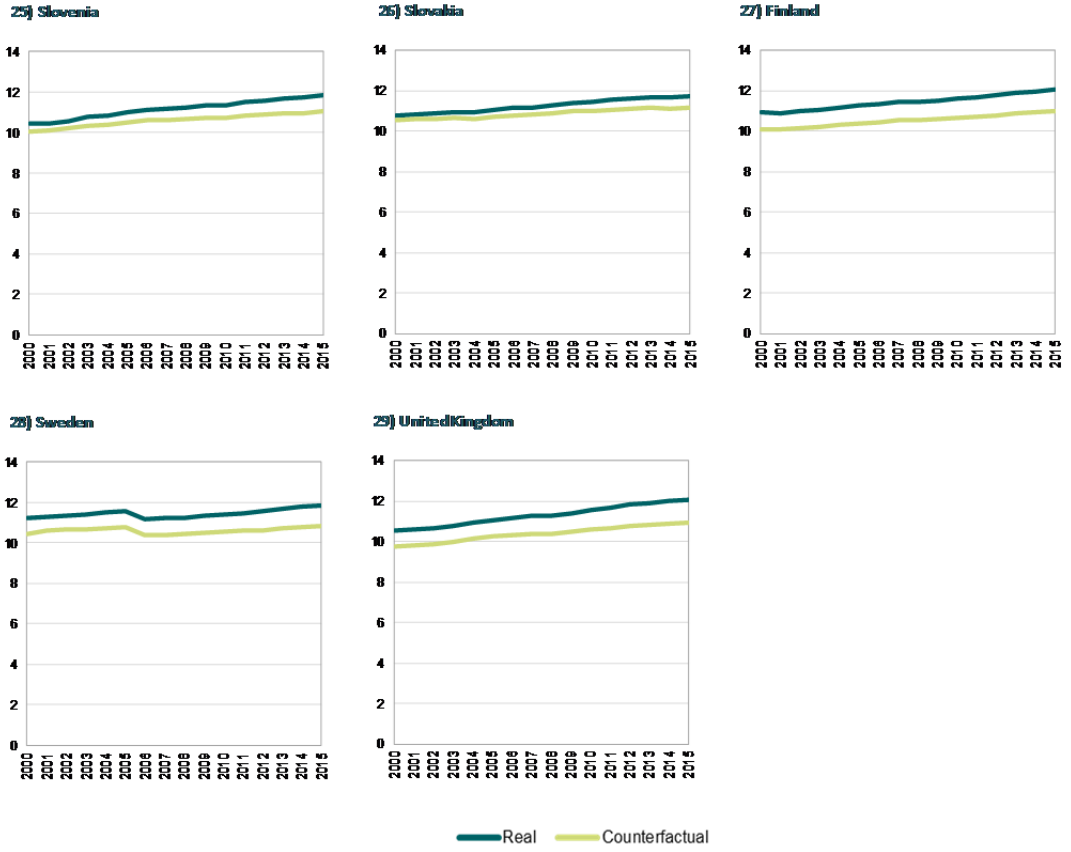


Figure 1. Higher education contribution to human capital. Mean years of schooling of population between 15 and 64. International comparison. 2000-2015 *(cont.)*



Source: Eurostat and own elaboration

The comparison by country shows that human capital experienced a considerable increase over the period in countries such as Malta (36.5% cumulative growth), Portugal (33.2%) and Ireland (21.4%). Regarding the contribution of HEIs, their greatest contribution to the generation of human capital is in Ireland, Spain, Luxembourg, Cyprus and the UK, where HEIs are responsible for increases of more than 9%. On the contrary, the lowest contributions are in Romania, Italy and Slovakia where they do not reach 5% of the total human capital.

Similarly, **figure 2** shows the evolution of the actual years of study and the counterfactual ones of the EU's labour force over the period 2000 2015. Since 2000 the average years of study of the labour force in EU countries have increased by 10.9%. The EU's working population had 11.9 average years of study in 2015, compared to 10.7 years in 2000. In 2015, without the contribution of HEIs, the active population would have had 10.9 years of study. This means that the human capital directly generated by HEIs amounts to 1 year per active person. In other words, HEIs are responsible for the human capital per capita in the European Union being 8.8% higher in the European Union.

Human capital has experienced a notable increase over the period in countries such as Portugal (37.5% cumulative growth), Malta (37.1%) and Ireland (20.6%). The most significant contributions of HEIs to human capital per capita are in Ireland, Spain, Luxembourg, Cyprus and the UK, where HEIs are responsible for increases of more than 11%. In contrast, the lowest contributions are in Romania, Czech Republic, Italy and Slovakia where they do not reach 6%.

Figure 2. Higher education contribution to human capital. Mean years of schooling of active population between 15 and 64. International comparison. 2000-2015

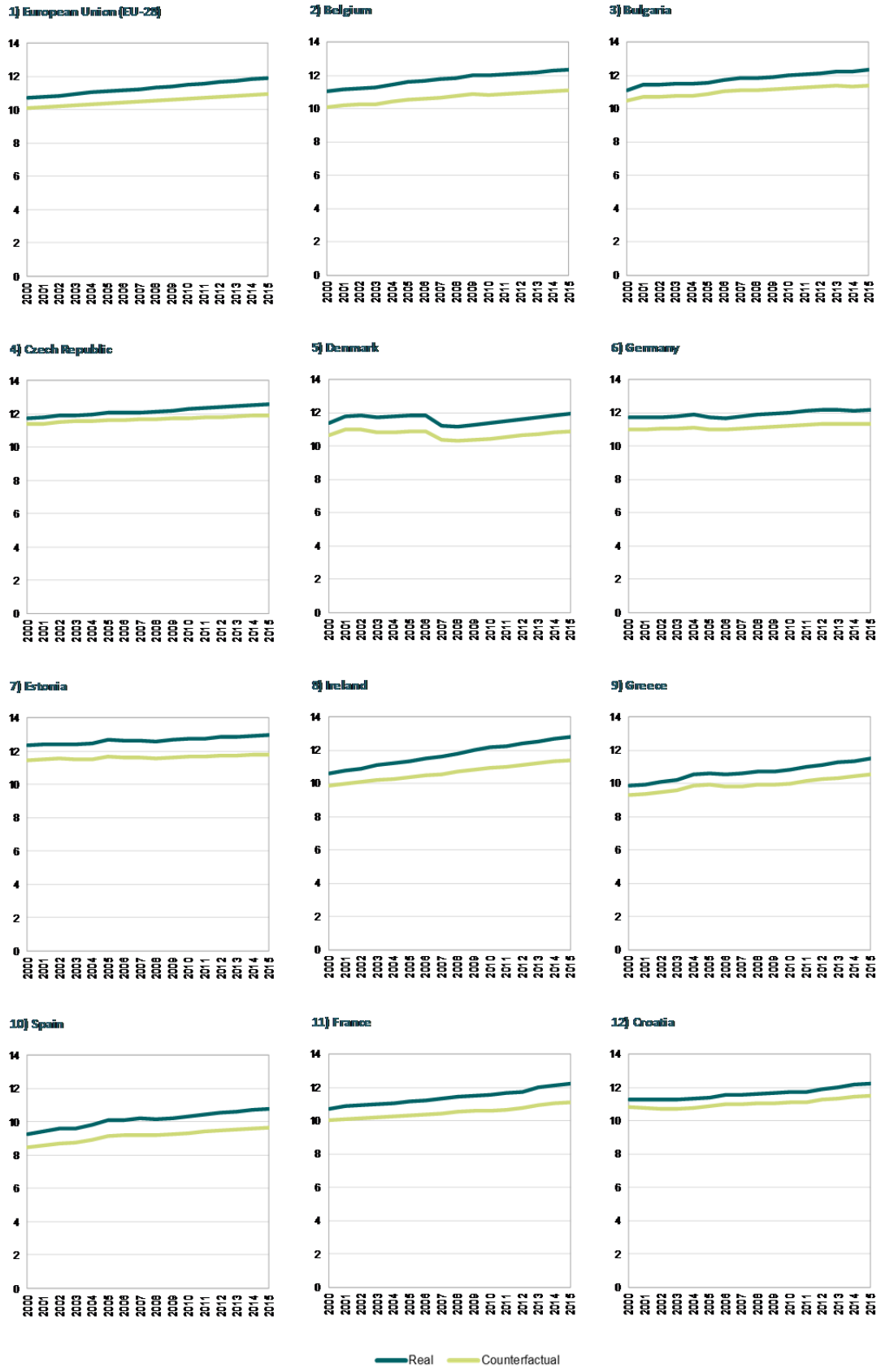


Figure 2. Higher education contribution to human capital. Mean years of schooling of active population between 15 and 64. International comparison. 2000-2015 *(cont.)*

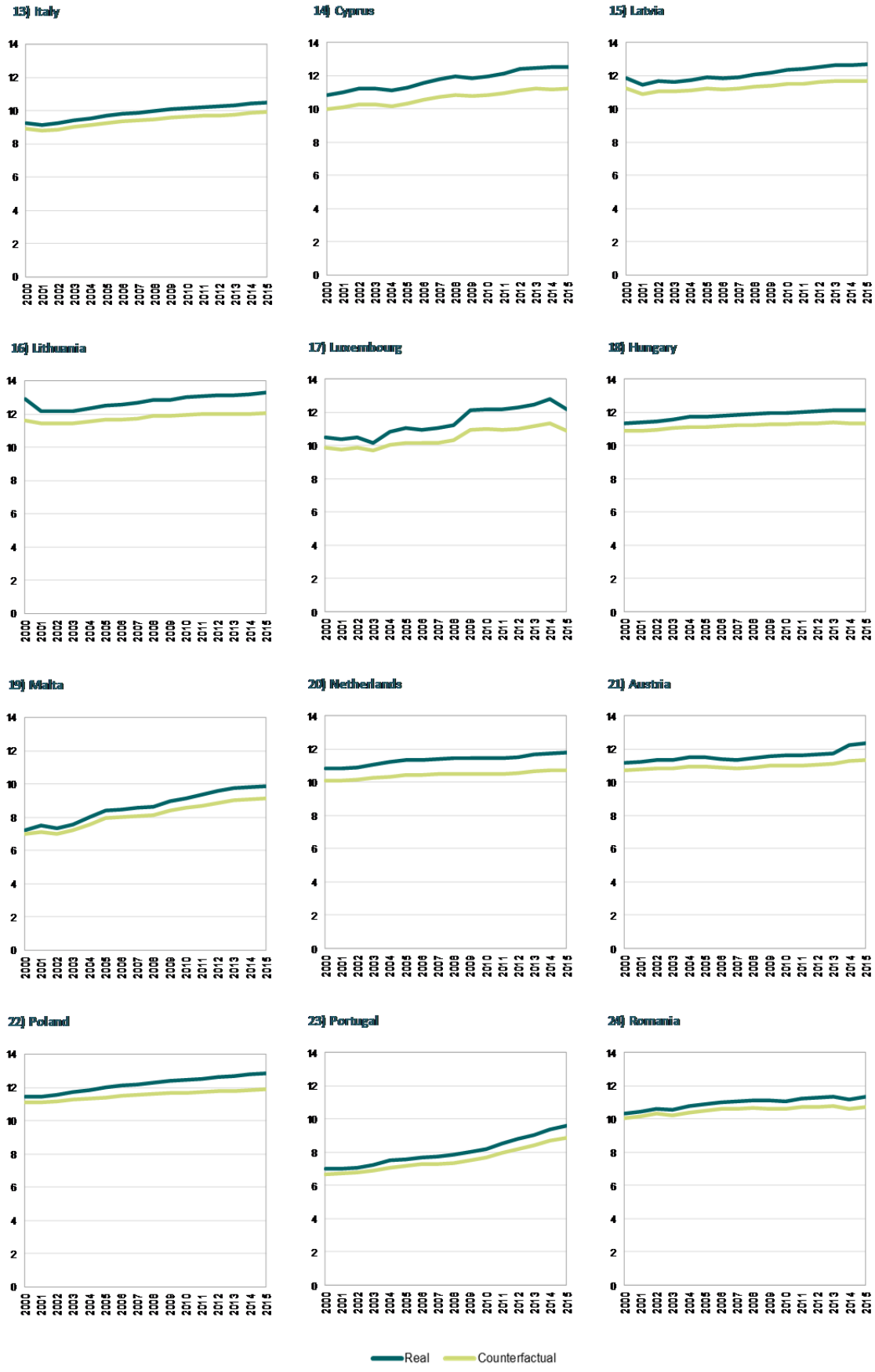
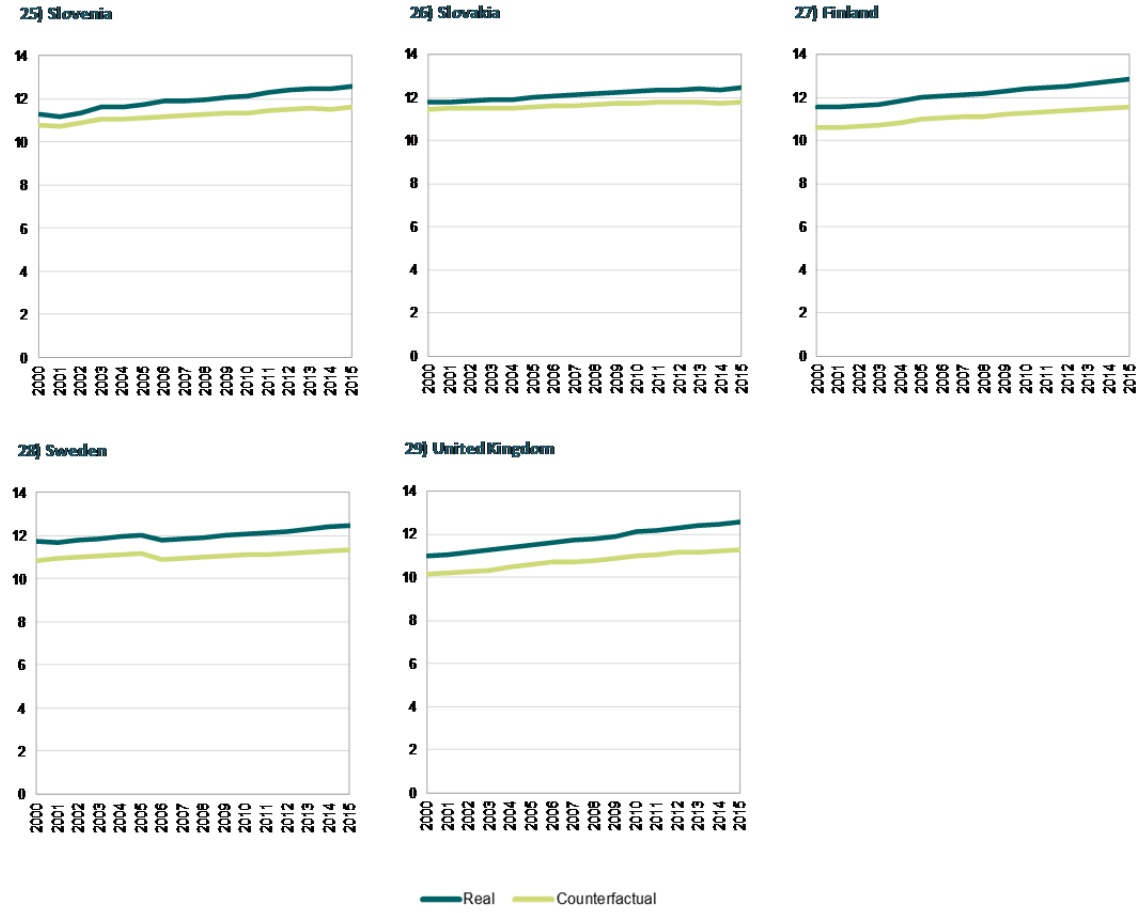


Figure 2. Higher education contribution to human capital. Mean years of schooling of active population between 15 and 64. International comparison. 2000-2015 *(cont.)*



Source: Eurostat and own elaboration

3.2. Direct contribution of universities to the increase in the activity rate

In previous sections, the importance of human capital in the socioeconomic development of countries has been highlighted. However, it would be of little use to invest resources to increase the human capital of the population if this human capital is not used for productive purposes. For society to benefit economically from the growth of individuals' human capital, it is first necessary for them to show their willingness to participate in the labour market and, secondly, to find employment. Therefore, a distinction should be made between potentially available human capital (that of the working age population), the human capital actually available (that of the working population) and the human capital actually employed (that of the employed population). Empirical evidence shows that individuals with a higher education level tend to participate more in the labour market, i.e., they have higher activity rates. Beyond simple statistics, studies show that this occurs regardless of other factors such as age, sex or nationality. This greater willingness to participate in the labour market on the part of individuals with more human capital occurs because, given that their educational investment allows them to obtain higher incomes, the opportunity cost in terms of income lost from their inactivity is higher than that of individuals with lower levels of study. This would explain why individuals with higher educational levels have higher activity rates.

Consequently, the level of education has a double effect on the individual endowments of human capital. First of all, because the greater the human capital of an individual, the greater the human capital they offer in the labour market. Secondly, because the greater the human capital of each individual, the more likely they are to be active. In short, the greater the available human capital of individuals in a society, the greater the human capital actually available to society, given that, *ceteris paribus*, society will have more active people and, in turn, each of them will have more human capital.

The previous section showed the important direct contribution of the HEIs to the human capital endowments of EU countries. Thus, HEIs indirectly contribute to increasing activity rates in EU countries through the higher activity rate of the graduates they train. This section quantifies the indirect contribution of human capital generated by HEIs to the activity rates of EU countries.

Figure 3 shows the activity rates by study levels during the period of 2000 to 2015 and allows us to observe the significant differences in activity rates between the various levels of education and, above all, that the higher the educational level of an individual, the greater their activity rate is.

In 2015, the activity rate of the EU population as a whole was 64.1%, compared with 81.4% for individuals with tertiary education. On the contrary, the activity rates of people with less than primary, primary and lower secondary education were only 44.1%, 37.3 percentage points lower than individuals with tertiary education. This greater relative willingness of university students to participate in the labour market occurs more intensely in countries such as Lithuania, where the activity rate of university students is 64 percentage points higher than people with less than primary, primary and lower secondary education, Poland (60.4 pp), and Czech Republic (54.4 pp). However, in countries such as the UK, Portugal and Spain the activity rate of university students is only roughly 30 points higher than that of people with lower level of education.

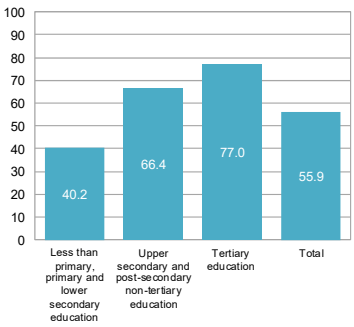
The above data show that individuals with a higher level of education (more human capital) participate to a greater degree in the labour market. It is also observed that the proportion of people participating in the labour market has increased quite consistently. In other words, not only has human capital increased but also the degree to which it is used. The data confirm that university students participate more in the labour market, and since HEIs train university students who are likely to be more active, we can conclude that through the generation of human capital HEIs contribute indirectly to the increase in the activity rate of EU countries.

The contribution of the HEIs to the increase in the activity rate is based on the construction of a *counterfactual activity rate*, a rate in which the positive impact on the activity rate of having a university degree is deducted. The difference between this counterfactual rate and the real activity rate in each country gives us a measure of the contribution HEIs make to the increase in the activity rate. The technical details of the procedure are described in **technical note 1.**

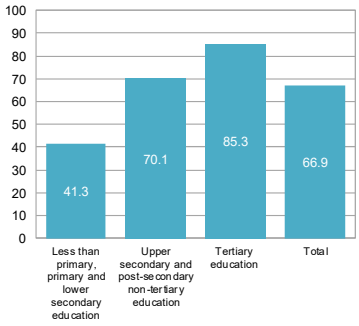
Figure 3. Activity rate by educational attainment level. International comparison. 2015

Figure 3. Activity rate by educational attainment level. International comparison. 2015 *(cont.)*

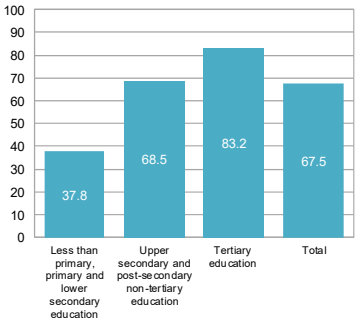
13) Italy



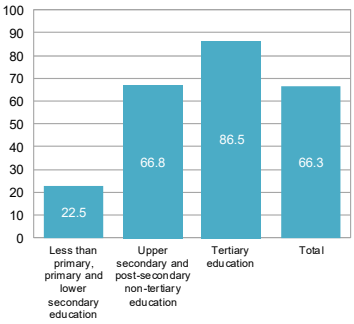
14) Cyprus



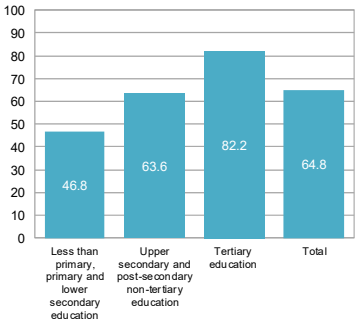
15) Latvia



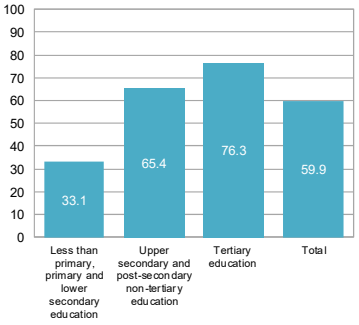
16) Lithuania



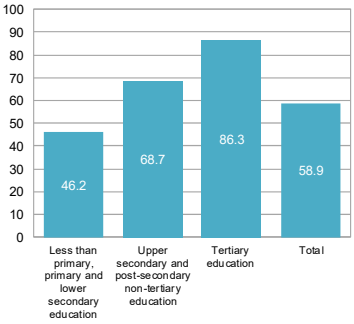
17) Luxembourg



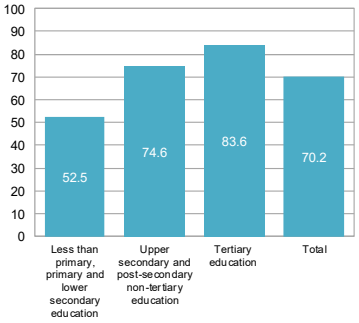
18) Hungary



19) Malta



20) Netherlands



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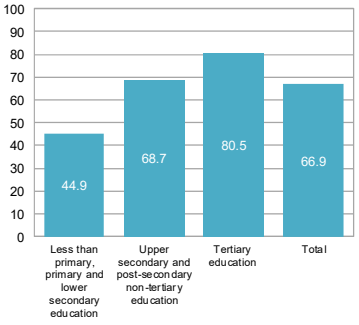
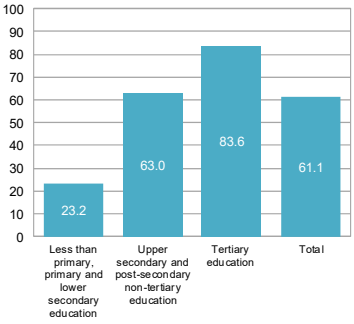
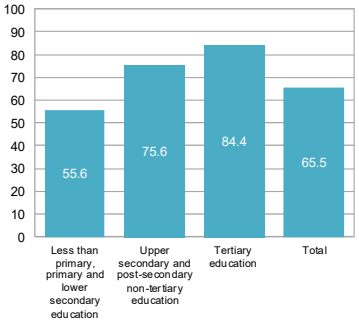


22) Poland



23) Portugal



24) Romania

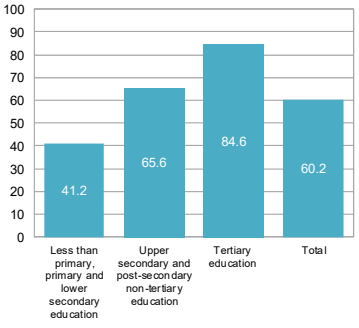
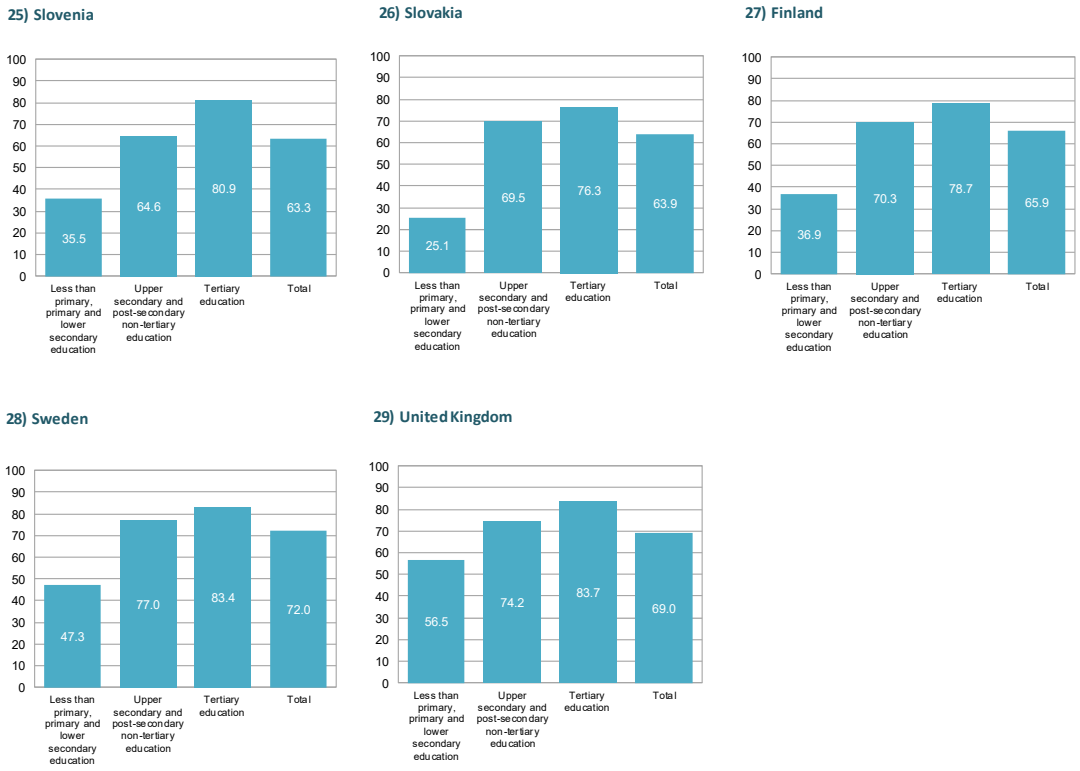


Figure 3. Activity rate by educational attainment level. International comparison. 2015 *(cont.)*



Source: Eurostat and own elaboration

The estimates presented in **technical note 1** indicate that in the EU, maintaining certain characteristics such as gender, age, nationality, those individuals with tertiary education are 8.3 p.p. more likely to be active than those with upper secondary education. This greater probability of university graduates being active has a positive impact on the activity rate of countries. For EU countries, **figure 4** shows the activity rate (AR) and the counterfactual rate (CF AR), which would be the case if HEIs had not trained any university students and, consequently, their graduates would have the same probability of being active as individuals with the immediately preceding level of education. [5]

The EU's activity rate in 2015 was 72.8%. If HEIs had not trained any university students, the activity rate would have been 70.8% (CF AR). Consequently, HEIs contribute by 2 percentage points to the increase in the EU activity rate, i.e., without the training of HEIs then the activity rate would be 2.8% lower. The figure shows that the contribution of HEIs to the increase in the activity rate, represented by the difference between the two rates is growing in most countries. This circumstance is associated with the increase of the population with university studies in the EU during the period analysed. In some countries the contribution is very significant such as Lithuania, where the activity rate would be 5.4% lower than the current one, Cyprus (5.4%), Ireland (4.7%) and Belgium (4.4%).

[5] Note that, according to the results presented in technical note 2, individuals with tertiary education are 8.3 p.p. more likely to be active than those with upper secondary education.

Technical note 1. Estimation of the counterfactual activity rate. Probit model for estimating the probability of labour participation

Individuals with higher education should have more human capital. , which increases their employability, as they are more productive and more attractive for firms. Human capital also improves their access to the labour market, providing higher wages and better conditions throughout their working life and reducing the risk of unemployment. The expected benefits from being employed would increase. Therefore, higher education should also lead to a greater likelihood of actively participating in the labour market since it would be more attractive.

As a first step to analyse the effects of higher education on the decision to participate in the labour market (activity), we postulate a model of labour participation which includes the maximum level of education attained as a determinant. It also includes other variables related to personal characteristics which are important for this choice. Probits of the probability of participation in 2014 are estimated for the EU-28 as a whole as well as for each individual country as:

$$ACT_{ijt} = \beta_0 + \gamma_x X_{ijt} + \varepsilon_{ijt}$$

where ACT_{ijt} is 1 if the individual *i* is active in period t and 0 otherwise; X_{ijt} is a vector of personal and family characteristics and ε_{ijt} is an error term. The vector of personal and family characteristics includes gender (male or female), nationality (national or foreign), age (being 15-24, 25-34, 35-44, 45-54 or 55+) and maximum level of educational attainment (lower secondary, upper secondary or tertiary education). All these explanatory variables are defined as dummies. The reference individual is a male, national, aged between 15 and 24 and with lower secondary as the maximum level of educational attainment. All data come from the EU-LFS microdata obtained from Eurostat. The sample refers to people of working age and includes all EU-28 countries.

Table A2 shows the estimated marginal effects for education, our variable of interest. Nevertheless, all the variables considered are indeed significant. For example, for the EU as a whole (table A1), the results show that females have, ceteris paribus, a lower probability of participation (10 p.p. less than males), as do foreigners (1 p.p less than nationals). The age dummies are also highly significant, showing an inverted-U pattern characterized by lower probability for younger and, especially, older people.

Table A1. Probit of the probability of activity. European Union-28. 2014

	Coefficient	Marginal effects
Female	0,394***	-0,10
Foreigner	-0,039***	-0,01
Upper secondary education	0,582***	0,15
Tertiary education	0,896***	0,24
Age 25-34	1,051***	0,28
Age 35-44	1,243***	0,33
Age 45-54	1,160***	0,31
Age 55 and higher	-0,454***	-0,12
Constant	-0,376***	
Number of observations	3.470.079	
Log pseudolikelihood	-199.636	
Pseudo R^2	0,308	

*Note: ***, **, * significant at 1%, 5% and 10 % respectively. The individual reference is a male between 16 and 24 years old, national, with lower secondary education (compulsory education, ISCED 2) as the maximum level attained.*

The effect of post-compulsory education is captured by the dummies for upper secondary and tertiary education. Both dummies are significant, indicating a positive effect on activity. Ceteris paribus, people with upper secondary education have 15.4 p.p. more probability of being active than those with only compulsory schooling or less. Tertiary education has an additional positive effect. The probability of an individual with higher education being active is 23.6 p.p. higher than in the case of someone with only compulsory education.

Table A2 summarizes the results obtained regarding individual EU countries and the effect of educational attainment. Both upper secondary education and tertiary education always have a positive and significant effect. Ceteris paribus, people with upper secondary education have more probability of being active than those with only compulsory schooling or less. This effect varies from 7.2 p.p. in Greece to 27.1 p.p. in Lithuania. The probability of an individual with higher education being active is higher than in the case of someone with only compulsory education. The range of estimated values for this effect goes from 15.5 p.p. in Luxembourg to 39.1 p.p. in Lithuania. Especially important for our aims, tertiary education has an additional positive effect compared to upper secondary education in all countries. This differential effect between tertiary upper secondary education is lower in countries such as Slovakia (2.2 p.p.), Sweden (3.7 p.p.) and Portugal (4.4 p.p.), while it is higher in others such as Romania and Lithuania (12 p.p.). For the EU-28 as a whole, the differential effect is 8.3 p.p.

Table A2. Probit of the probability of activity. Educational level marginal effects. 2014

	Upper secondary education	Tertiary education	Number of observations	Pseudo R^2
European Union (28 countries)	0,154***	0,236***	3.470.079	0,308
Belgium	0,141***	0,232***	83.686	0,378
Bulgaria	0,208***	0,291***	30.248	0,321
Czech Republic	0,213***	0,259***	36.045	0,368
Denmark	0,138***	0,219***	94.774	0,267
Germany	0,170***	0,242***	418.027	0,287
Estonia	0,268***	0,362***	19.965	0,326
Ireland	0,181***	0,269***	161.595	0,255
Greece	0,072***	0,169***	209.372	0,383
Spain	0,098***	0,152***	90.555	0,347
France	0,139***	0,219***	69.019	0,359
Croatia	0,169***	0,257***	32.403	0,351
Italy	0,178***	0,249***	525.335	0,310
Cyprus	0,123***	0,232***	34.241	0,327
Latvia	0,262***	0,357***	36.318	0,347
Lithuania	0,271***	0,391***	52.043	0,394
Luxembourg	0,080***	0,155***	11.358	0,372
Hungary	0,200***	0,248***	219.283	0,367
Malta	0,144***	0,259***	21.947	0,335
Netherlands	0,126***	0,216***	61.613	0,270
Austria	0,119***	0,188***	152.193	0,337
Poland	0,229***	0,344***	297.450	0,348
Portugal	0,121***	0,165***	144.727	0,315
Romania	0,105***	0,226***	207.391	0,283
Slovenia	0,088***	0,164***	54.237	0,400
Slovakia	0,223***	0,244***	85.029	0,363
Finland	0,205***	0,268***	23.934	0,284
Sweden	0,170***	0,207***	227.392	0,225
United Kingdom	0,207***	0,282***	69.899	0,292

*Note: ***, **, * significant at 1%, 5% and 10 % respectively. The individual reference is a male between 16 and 24 years old, national, with lower secondary education (compulsory education, ISCED 2) as the maximum level attained.*

Source: Eurostat and own elaboration

Figure 4. Higher education contribution to activity rate. International comparison. 2000-2015

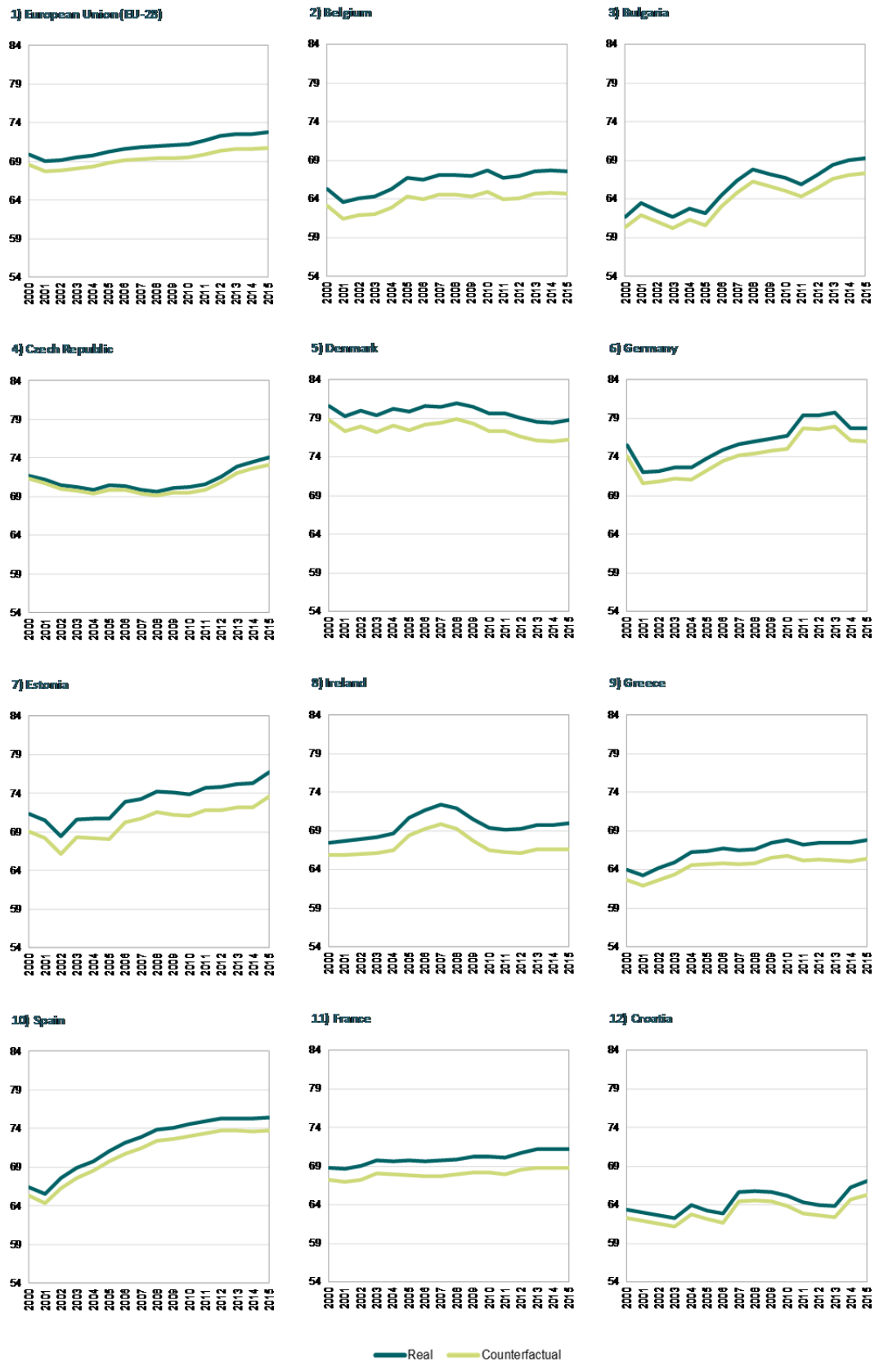


Figure 4. Higher education contribution to activity rate. International comparison. 2000-2015 *(cont.)*

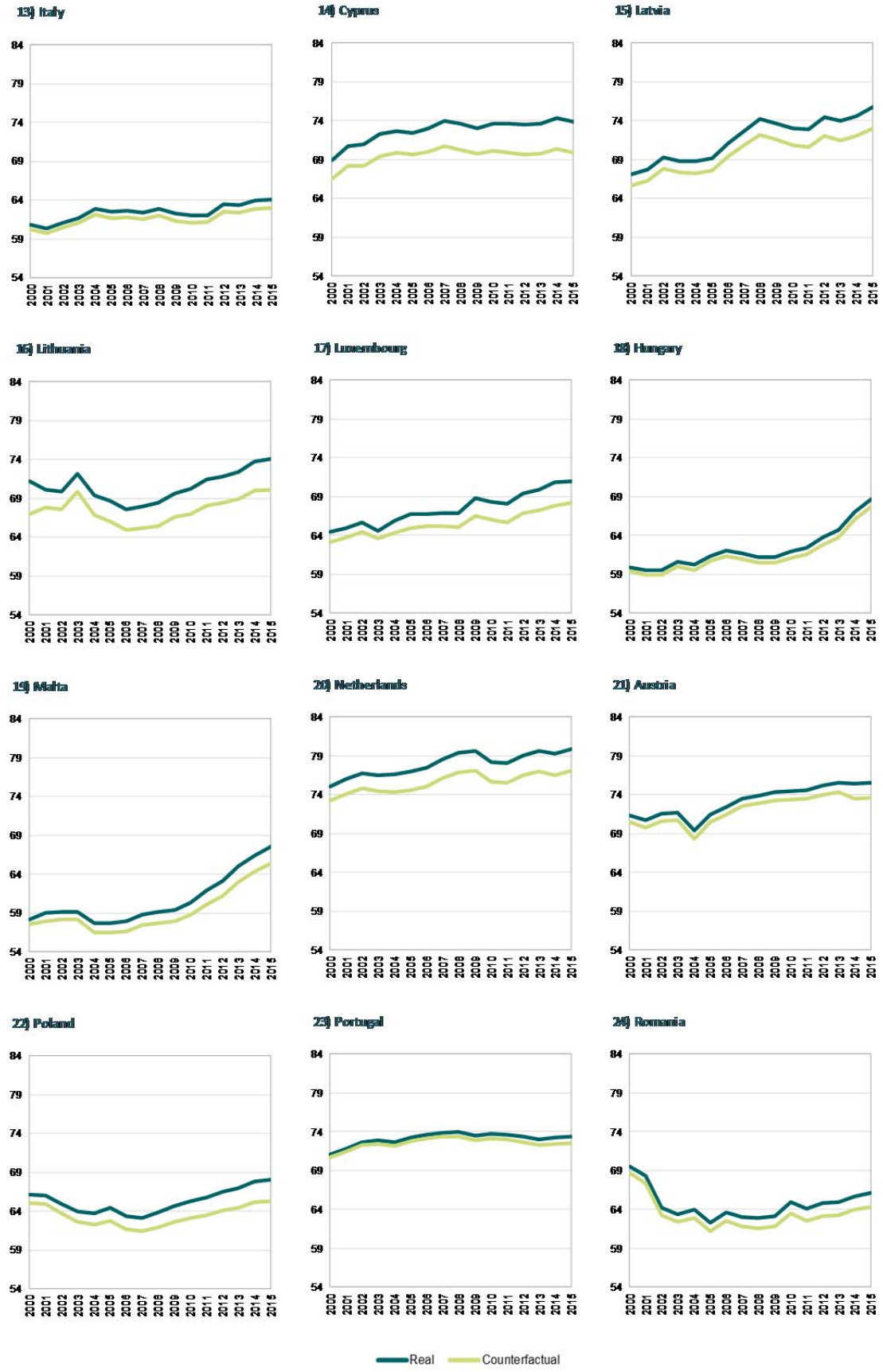
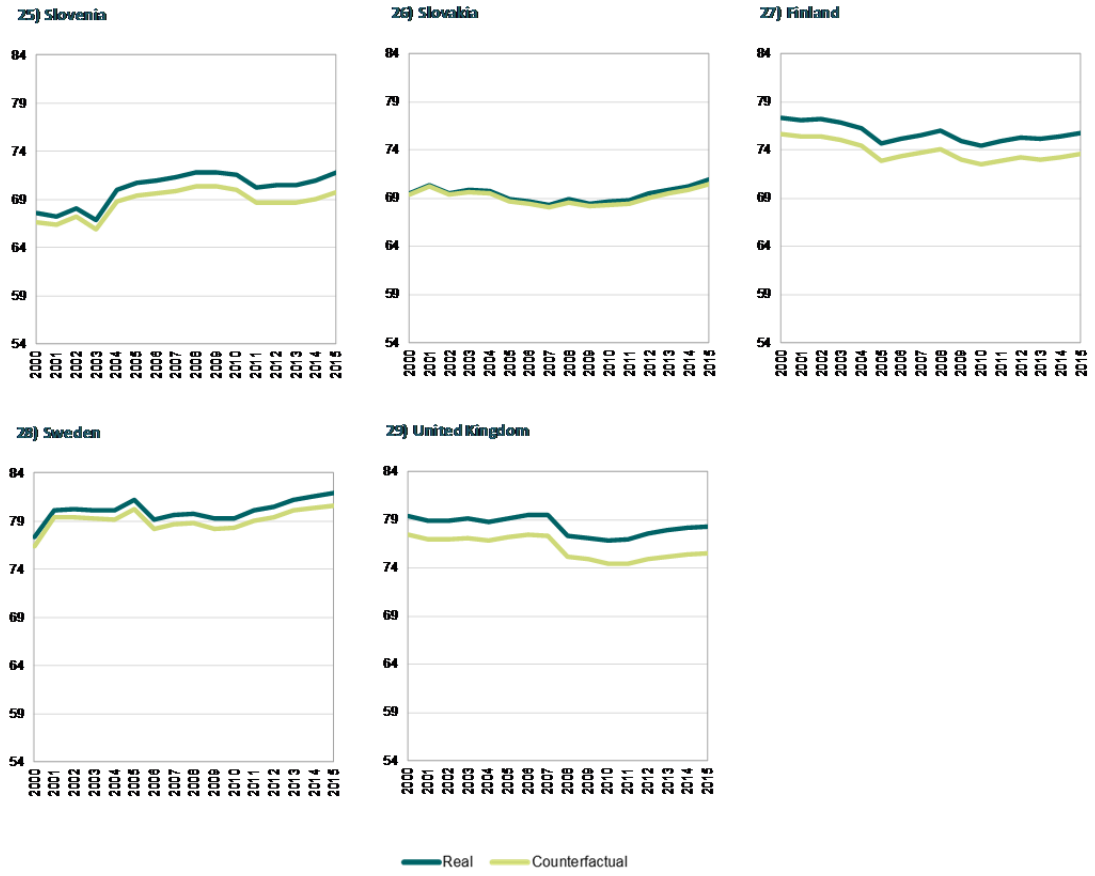


Figure 4. Higher education contribution to activity rate. International comparison. 2000-2015 *(cont.)*



Source: Eurostat and own elaboration

3.3. Direct contribution of universities to the increase in the employment rate

The previous sections highlighted the positive effects of education, direct and indirect, individual and collective, and thus having a trained population does seem to be crucial for the progress of modern societies. Also emphasized in the previous section was the importance of distinguishing between the *human capital which is potentially available* on the part of society (that of the working-age population), the *human capital actually available* (that of the active population), and the *human capital actually used* (that of the employed population.

In fact, not only do societies need to increase the educational levels of the population (increase the human capital potentially available), but also a large share of this should become available in the labour market through high activity rates which mean that most of the potentially available human capital is effectively available and, furthermore, that the largest share of it is not untapped from an economic point of view by being linked to unemployed people through low unemployment rates.

The previous section showed that human capital has a positive effect on the activity rate. This section demonstrates that human capital also has a reducing effect on the unemployment rate. In fact, university students have acquired specific skills that make them more productive in the short term

and generic competences that give them greater functional mobility, enabling them to adapt more easily to changes in the productive process or in the functional organization chart of companies, as well as greater geographical mobility. In these circumstances, better trained individuals are more attractive and employable for companies and thus HEIs indirectly contribute to reducing unemployment rates in EU countries through the lower unemployment rate of the graduates they generate. This section quantifies the indirect contribution of human capital generated by HEIs to unemployment rates in EU countries.

Figure 5 illustrates the unemployment rates by levels of study during the period 2000 – 2015, and allows us to observe significant differences in the unemployment rates between the various levels of education and above all, that the higher the educational level, the lower the unemployment rate.

Consequently, the unemployment rates of individuals with tertiary education in 2015 were 5.6% compared with 9.4% of the general unemployment rate or 17.4% of those with compulsory education as maximum. That is, the unemployment rate of individuals with tertiary education is 11.8 pp. lower than those with compulsory education and 3.8 p.p. lower than the general unemployment rate.

This higher relative employability of university students compared to groups with lower educational levels is more intense in countries such as Slovakia, where the unemployment rate of university students is 31.6 pp. lower than that of people with less than primary, primary and lower secondary education, and also Lithuania (22.6 pp) and Bulgaria (21.1 pp). However, in countries such as Romania, Portugal and Denmark the unemployment rate of university students is only 4-5 percentage points lower than people with compulsory education or less.

To calculate the contribution of HEIs to the increase in the employment rate, we shall proceed as in the previous section for activity rates, constructing counterfactual scenarios. Specifically, a *counterfactual employment rate* will be computed, which reflects the effect of having a university degree on the probability of being employed. The difference between the real employment rate and the counterfactual one will reflect the contribution of HEIs to the increase in the employment rate. The procedure is detailed in **technical note 2**.

Estimates indicate that, maintaining certain characteristics such as sex, age and nationality, an individual with tertiary education is 9.3 percentage points more likely to be employed than one with upper secondary education. This higher probability of HEI graduates being employed has a positive impact on the unemployment rate in the EU. **Figure 6** shows the difference between the real employment rate and the counterfactual employment rate of EU countries.

As shown in **figure 6**, the employment rate in the EU in 2015 was 65.8% whereas without the contribution of HEIs the rate would have been 63.3%, i.e., HEIs contribute to increasing the employment rate by 2.5 pp. In sum, without the indirect contribution of the forming of graduates by HEIs, the EU's employment rate would be 3.8% lower than the current one.

Figure 5. Unemployment rate by educational attainment level. International comparison. 2015

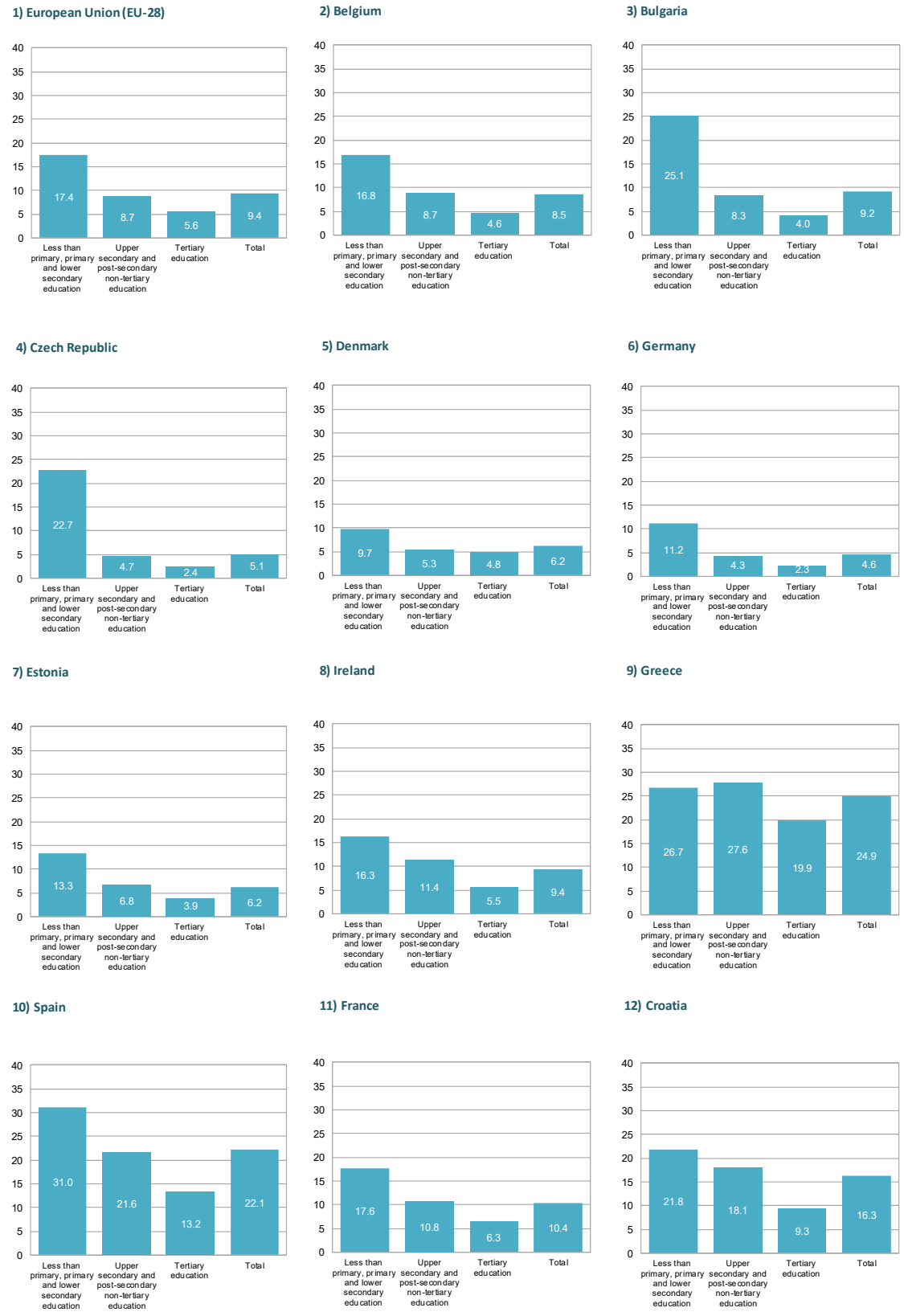
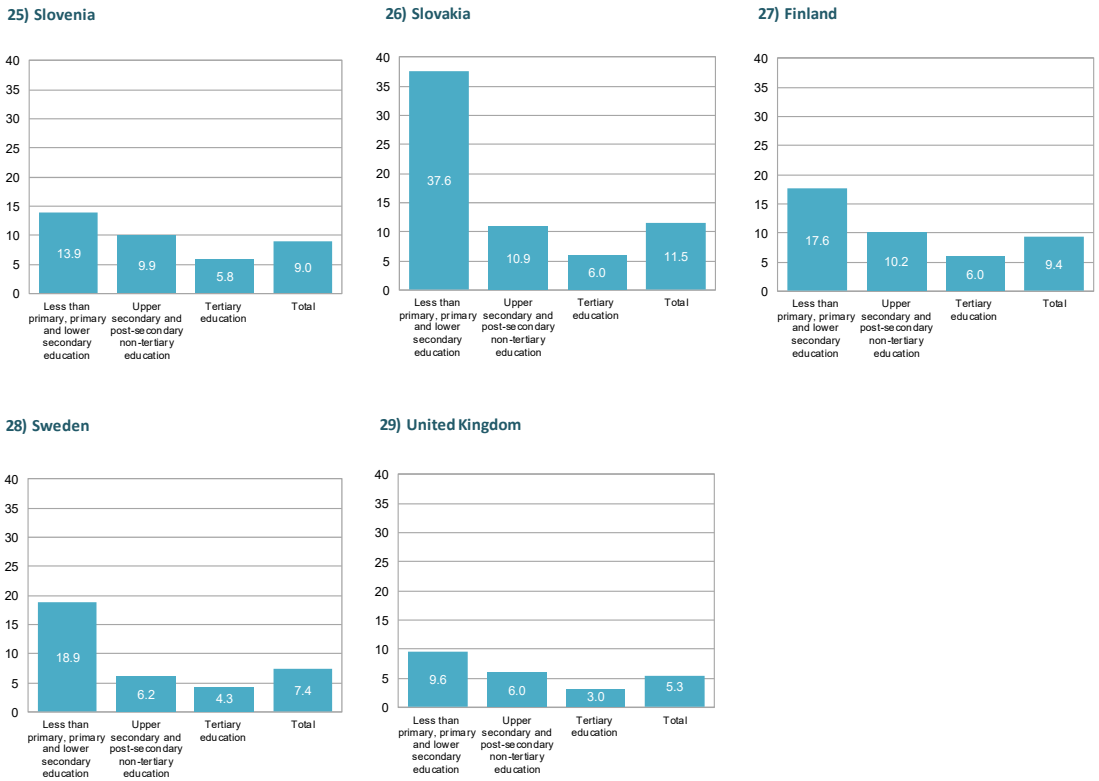


Figure 5. Unemployment rate by educational attainment level. International comparison. 2015 *(cont.)*

Figure 5. Unemployment rate by educational attainment level. International comparison. 2015 *(cont.)*



Source: Eurostat and own elaboration

Technical note 2. Estimation of the counterfactual unemployment rate. Probit model estimating the probability of employment

The previous results show that higher education plays a significant role in European labour markets, increasing the probability of participation. But this is not the whole story. One of the reasons higher education fosters participation is that it increases employability. As was commented previously, it is expected that people with higher education increase their productivity and, therefore, higher education should also lead to a greater likelihood of being employed for those who choose to participate in the labour market.

Therefore we can expect a double positive effect on employment coming from higher education: a higher participation effect and an additional effect through lower unemployment. To estimate the total effect on employment rates, probits of the probability of employment for the entire working age population are estimated for the EU-28 as a whole as well as for each individual country as:

$$EMP_{ijt} = \beta_0 + \gamma_x X_{ijt} + \varepsilon_{ijt}$$

where EMP_{ijt} is 1 if the individual i is employed in period t and 0 otherwise; X_{ijt} is a vector of personal and family characteristics, and ε_{ijt} is an error term. The vector of personal and family characteristics again includes gender (male or female), nationality (national or foreign), age (being 15-24, 25-34, 35-44, 45-54 or 55+) and the maximum level of educational attainment (lower secondary, upper secondary or tertiary education). These explanatory variables are defined as dummies. All data come from the EU-LFS microdata obtained from Eurostat. The sample refers to all working age individuals in 2014 and includes all EU-28 countries. The reference individual is a male, national, aged between 15 and 24 and with lower secondary as the maximum level of educational attainment.

The results are shown as the marginal effects of each variable on the probability of employment in 2014.They should be always interpreted as the differential effects with respect to the reference individual. Although table A3, showing the country results, focuses on the educational variables, all the explanatory variables are significant in general terms. Table A4 shows the complete results for the EU as a whole. Females have, ceteris paribus, a lower probability of employment (9 p.p. less than males), as do foreigners (4 p.p. less than nationals). The age dummies are highly significant showing again an inverted-U pattern, with a lower probability for older and younger people.

Table A4. Probit of the probability of employment. European Union-28. 2014

	Coefficient	Marginal effects
Female	-0,327***	-0,09
Foreigner	-0,135***	-0,04
Upper secondary education	0,610***	0,18
Tertiary education	0,934***	0,27
Age 25-34	0,923***	0,27
Age 35-44	1,156***	0,33
Age 45-54	1,149***	0,33
Age 55 and higher	-0,259***	-0,07
Constant	-0,681***	
Number of observations	3.470.079	
Log pseudolikelihood	-217.870	
Pseudo R^2	0,257	

*Note: ***, **, * significant at 1%, 5% and 10 % respectively. The individual reference is a male between 16 and 24 years old, national, with lower secondary education (compulsory education, ISCED 2) as the maximum level attained.*
Source: Eurostat and own elaboration

The total effect of educational attainment on the likelihood of being employed is both significant and positive. In comparison with someone with lower secondary education as the maximum level attained, the probability of employment is, ceteris paribus, 17.7 p.p. higher for individuals with upper secondary and 27 p.p. higher for those with tertiary education. It should be highlighted that both effects are higher than those previously estimated for the probability of participation (15.4 p.p. and 23.6 p.p. respectively). Therefore, tertiary education again has an additional positive effect compared to upper secondary education (9.4 p.p.). In this case the effect is higher than the one obtained previously for the participation choice (8.3 p.p.).

Table A3 summarizes the results obtained for individual EU countries and the effect of educational attainment on employment rates. In all EU countries post-compulsory education has a positive and significant effect. Ceteris paribus, people with upper secondary education have more probability of being employed than people with only compulsory schooling or less. This effect varies from 6.7 p.p. in Greece to 29.9 p.p. in Lithuania. The probability of an individual with tertiary education being employed is even higher. The range of estimated values for the differential effect compared to someone with only compulsory education goes from 17.2 p.p. in Luxembourg to 46.2 p.p. in Lithuania. In fact, tertiary education has an additional positive effect compared to upper secondary education in all countries. Furthermore, it should be stressed that the difference between tertiary and upper secondary is greater than the one previously obtained for only participation except in Malta and Romania. Nevertheless, this differential effect between tertiary upper secondary education is quite heterogeneous, in that it is lower in countries such as Sweden (4.8 p.p.), Portugal (6 p.p.) and Slovakia (6.6 p.p.), and higher in other countries such as Lithuania (16 p.p.) and Poland (14 p.p.).

Table A3. Probit of the probability of employment. Educational level marginal effects. 2014

	Upper secondary education	Tertiary education	Number of observations	Pseudo R^2
European Union (28 countries)	0,177***	0,270***	3.470.079	0,257
Belgium	0,156***	0,259***	83.686	0,335
Bulgaria	0,244***	0,348***	30.248	0,283
Czech Republic	0,246***	0,317***	36.045	0,329
Denmark	0,145***	0,227***	94.774	0,226
Germany	0,187***	0,272***	418.027	0,259
Estonia	0,282***	0,386***	19.965	0,275
Ireland	0,182***	0,301***	161.595	0,206
Greece	0,067***	0,187***	209.372	0,241
Spain	0,133***	0,222***	90.555	0,235
France	0,149***	0,247***	69.019	0,301
Croatia	0,178***	0,294***	32.403	0,276
Italy	0,188***	0,267***	525.335	0,269
Cyprus	0,122***	0,237***	34.241	0,238
Latvia	0,287***	0,410***	36.318	0,283
Lithuania	0,299***	0,462***	52.043	0,328
Luxembourg	0,085***	0,172***	11.358	0,338
Hungary	0,220***	0,291***	219.283	0,333
Malta	0,173***	0,282***	21.947	0,311
Netherlands	0,137***	0,243***	61.613	0,230
Austria	0,137***	0,211***	152.193	0,294
Poland	0,237***	0,377***	297.450	0,302
Portugal	0,117***	0,176***	144.727	0,235
Romania	0,098***	0,211***	207.391	0,246
Slovenia	0,101***	0,196***	54.237	0,321
Slovakia	0,291***	0,357***	85.029	0,298
Finland	0,216***	0,290***	23.934	0,246
Sweden	0,197***	0,246***	227.392	0,207
United Kingdom	0,220***	0,306***	69.899	0,266

*Note: ***, **, * significant at 1%, 5% and 10 % respectively. The individual reference is a male between 16 and 24 years old, national, with lower secondary education (compulsory education, ISCED 2) as the maximum level attained.*
Source: Eurostat and own elaboration

As with the activity rate, it is observed that the contribution of HEIs to the increase in the employment rate, represented by the difference between the two rates, is growing. This circumstance is related to an increase in the population with university studies in the EU during the period analysed. In some countries the contribution is very significant, such as in Lithuania, where the employment rate would be 8.8% lower than the current one, Ireland (-7.6%), Cyrpus (-7.2%), and Greece (-6.4%).

Figure 6. Higher education contribution to employment rates. International comparison. 2000-2015

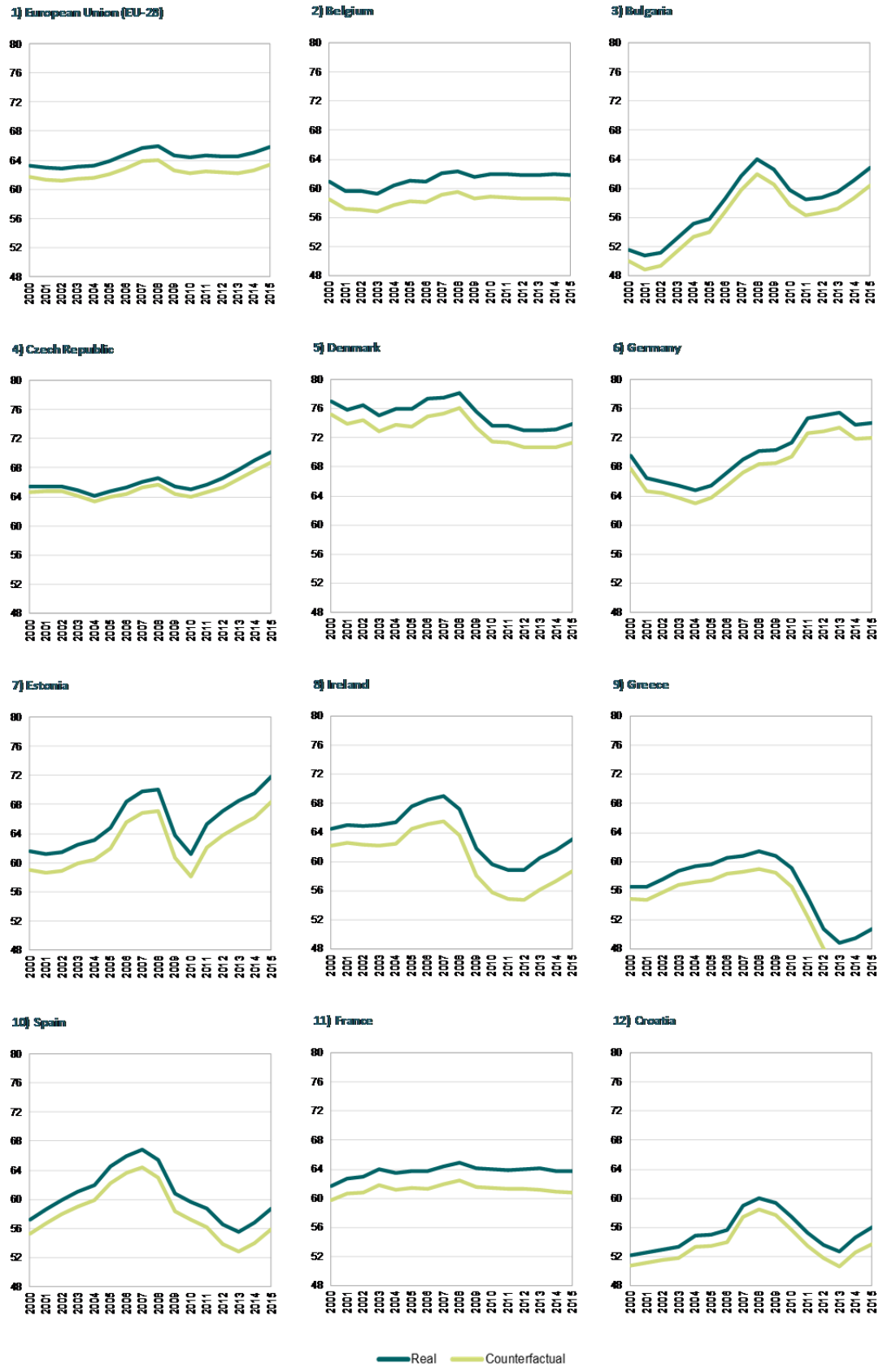


Figure 6. Higher education contribution to employment rates. International comparison. 2000-2015 *(cont.)*

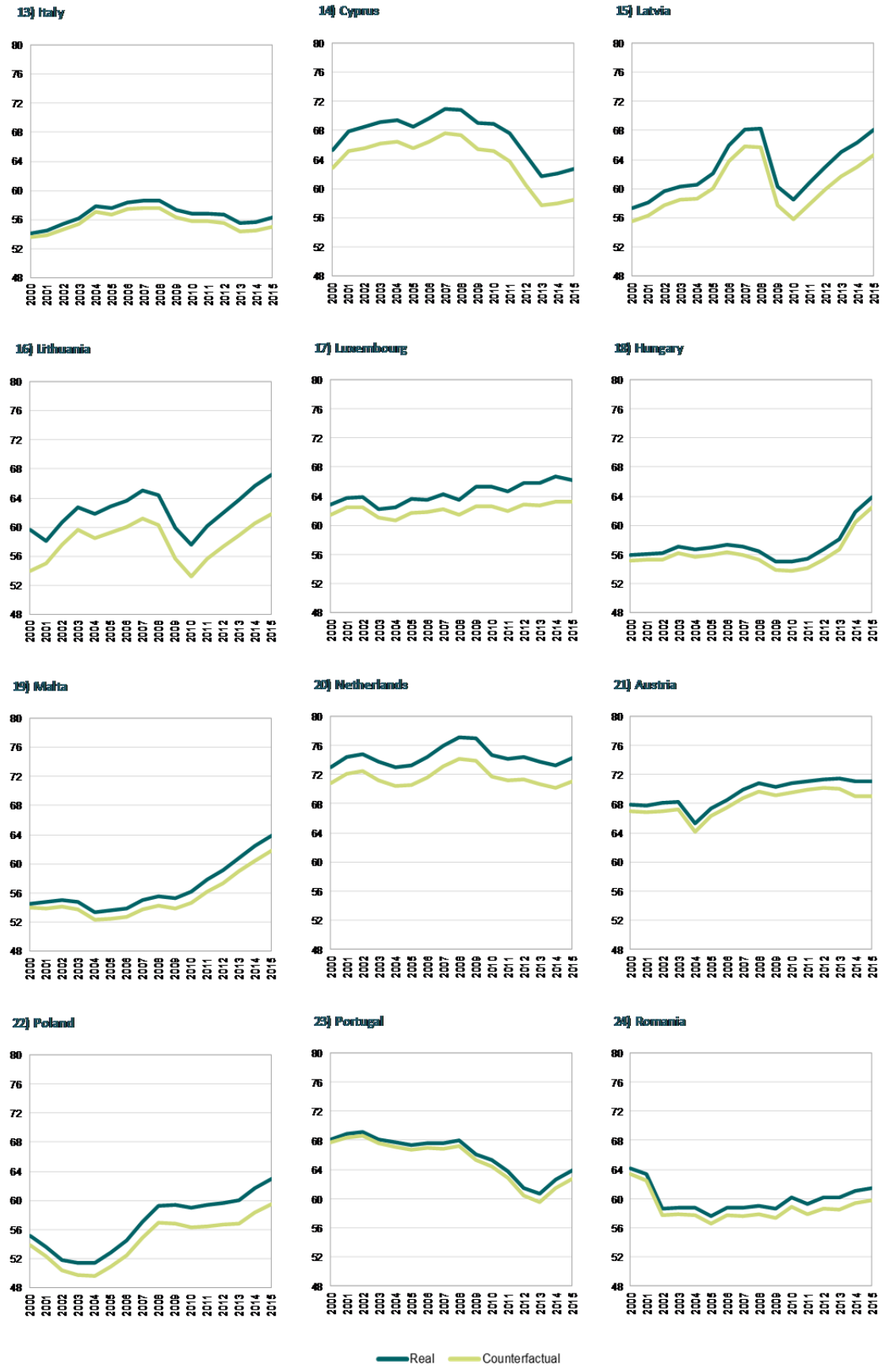
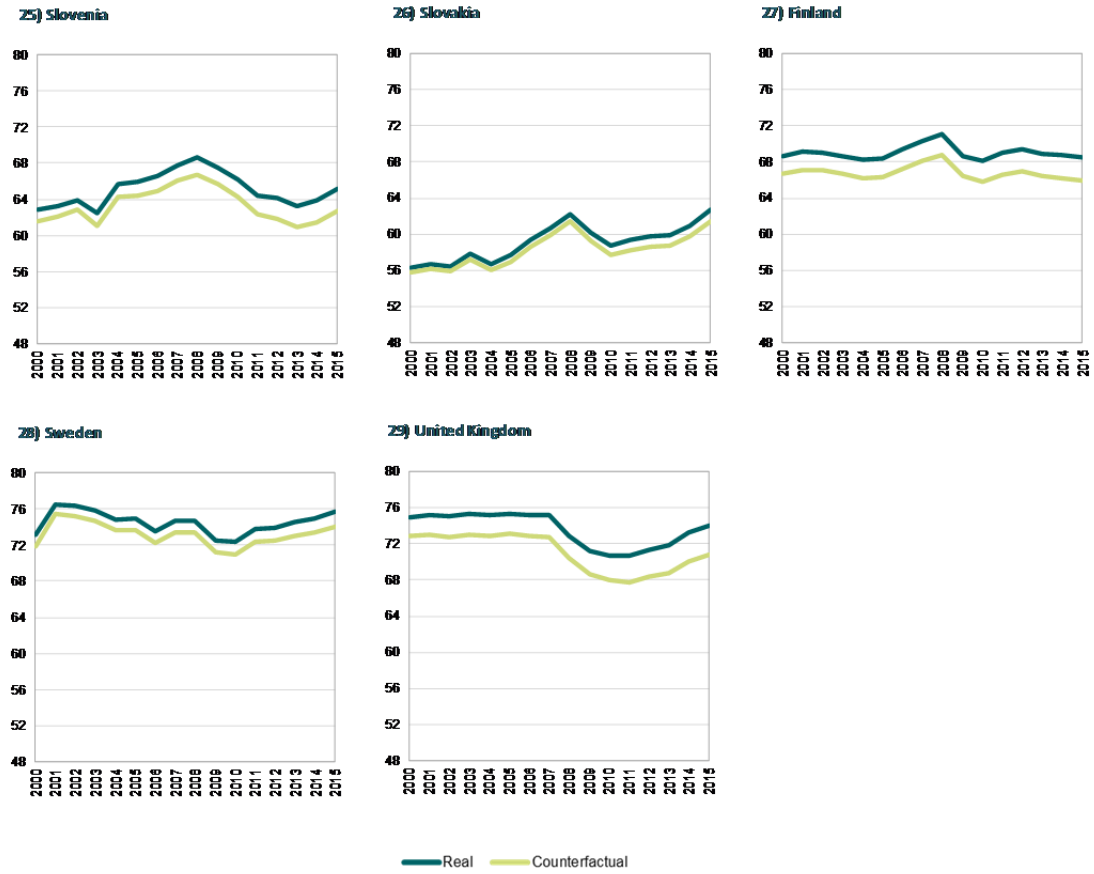


Figure 6. Higher education contribution to employment rates. International comparison. 2000-2015 *(cont.)*



Source: Eurostat and own elaboration

The evidence shows that HEIs have not only contributed significantly to the increase in human capital in EU countries, but also to their degree of availability and use through direct, indirect and induced contributions:

Direct contribution: this occurs because HEIs directly increase the available human capital of the population of their countries. Estimates indicate that HEIs in the EU are directly responsible for 7.2% of the human capital endowments of the EU working age.

Indirect contribution: this occurs because HEIs contribute to increasing the human capital effectively available in their countries through the willingness of their graduates to participate in the labour market. Estimates indicate that HEIs contribute 2 percentage points to the increase in the EU activity rate, i.e., without the training activity of HEIs, the activity rate would be 2.8% lower. Furthermore, HEIs contribute to increasing the use of human capital in their countries through the greater employability of their graduates. Estimates indicate that HEIs contribute 2.5 percentage points to the increase in the EU employment rate, i.e. without HEIs the employment rate would be 3.8% lower.[6]

[6] We could also speak of an additional induced contribution. Several studies indicate that the income and level of education of the parents are two relevant variables in the decisions of their children to follow university studies (Apodaka et al., 1991, Tejedor, 2003, Rahona, 2006, etc.). The higher level of education and income of a generation induces greater investments in human capital through its positive effect on

The combination of the two factors mentioned has a significant effect on the human capital used in Europe. The total years of study of the employed population in the EU-28 would have been, on average, 11.2% higher over the course of this century in comparison with the counterfactual scenario without HEIs. In addition, the magnitude of the difference attributable to HEIs increased from 9.5% in 2000 to 13.2% in 2015.

The effect is logically positive in all EU countries, although there is considerable heterogeneity in their magnitude (**figure 7**). The average values for the period 2000-2015 range from 5.7% in Czech Republic to 16.6% in Ireland. Thus, the impact is especially relevant in Ireland, Cyprus, Lithuania, Spain, Belgium, Estonia, the United Kingdom, Finland, Greece, France, Netherlands and Luxembourg. In all these countries, the difference with respect to the scenario without higher education exceeds 13%. However, in Czech Republic, Slovakia, Romania, Italy and Austria the average difference does not reach 8%.

There are also significant disparities between countries in the evolution of this impact over the period, although in most of them it is increasing. In countries such as Malta, Poland, Austria, Romania and Portugal the impact would now be double or more than that existing at the beginning of the century. On the contrary, its magnitude would have remained almost constant in Germany and would have fallen in Lithuania.

As a result of the above-mentioned, the estimates indicate that the total impact of HEIs' contribution would mean increases in the number of years of study of the employed population, ranging from around 8%, as in Slovakia and the Czech Republic, to levels close to 20%, as in Ireland, Cyprus, Lithuania and Spain.

Part of this effect, as mentioned earlier, is due to changes in employment rates associated with better education levels. In the counterfactual scenario without higher education, there would be fewer active people and a share of them would be less employable. In short, there would be less employed people. For the EU-28 as a whole, this double impact via the labour market would mean that the total years of study of the employed population would be, on average, 4% higher over this century than in the counterfactual scenario. The significance of this factor increases from 3.4% in 2000 to 4.7% in 2015.

This pattern is generally repeated in almost all European countries, with a positive and increasing effect, albeit with different intensity. Over the period the effect ranges, on average, from 1.7% in the Czech Republic to 8.1% in Lithuania. The impact is more than 5% in Lithuania, Ireland, Cyprus, Belgium, Greece, Spain, Estonia, France and Netherlands. However, in other countries such as the Czech Republic, Slovakia, Portugal, Sweden, Austria, Hungary and Italy, the impact does not reach half of that value. In all countries the impact has increased except in Lithuania, although the relative increase is more intense in countries such as Malta, Poland, Portugal, Austria, Slovakia and Romania,

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the decisions of later generations regarding university studies. Since HEIs increase the level of education and income of their graduates, additional increases in human capital are likely in the future and, therefore, higher rates of future activity. It should be noted that neither this type of induced effects (intergenerational) on human capital nor the positive influence on academic performance and school failure induced by human capital generated by HEIs are considered in this paper.

and weaker in Germany, Sweden and Estonia. As a result, the impact through the labour market would now be at maximum values for the period, ranging from 2.3% in Slovakia to 9.5% in Lithuania.

Figure 7. Higher education contribution to additional human capital. Relative increase of total years of schooling of employed population. International comparison. Percentage. 2000-2015

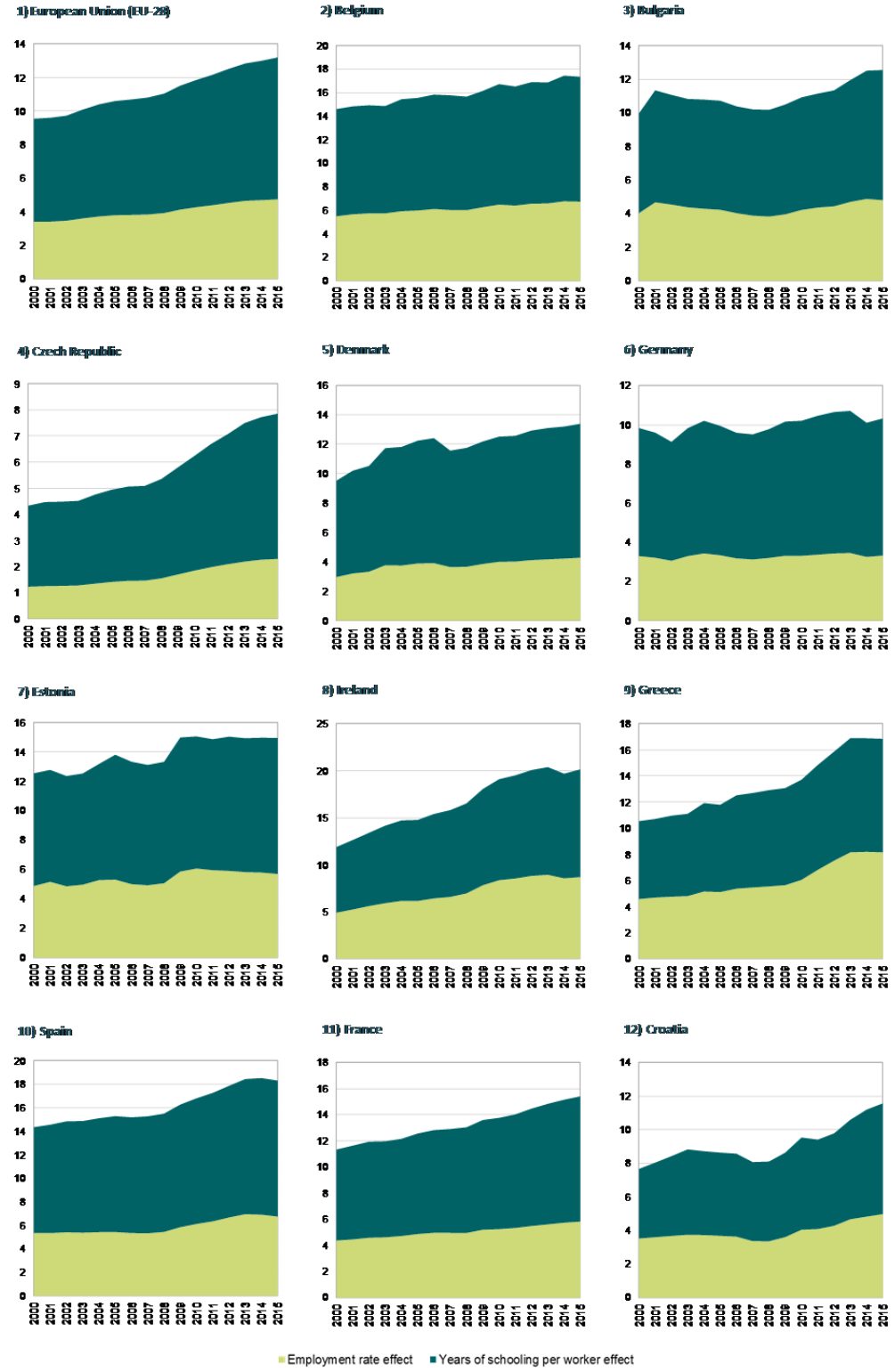


Figure 7. Higher education contribution to additional human capital. Relative increase of total years of schooling of employed population. International comparison. Percentage. 2000-2015 *(cont.)*

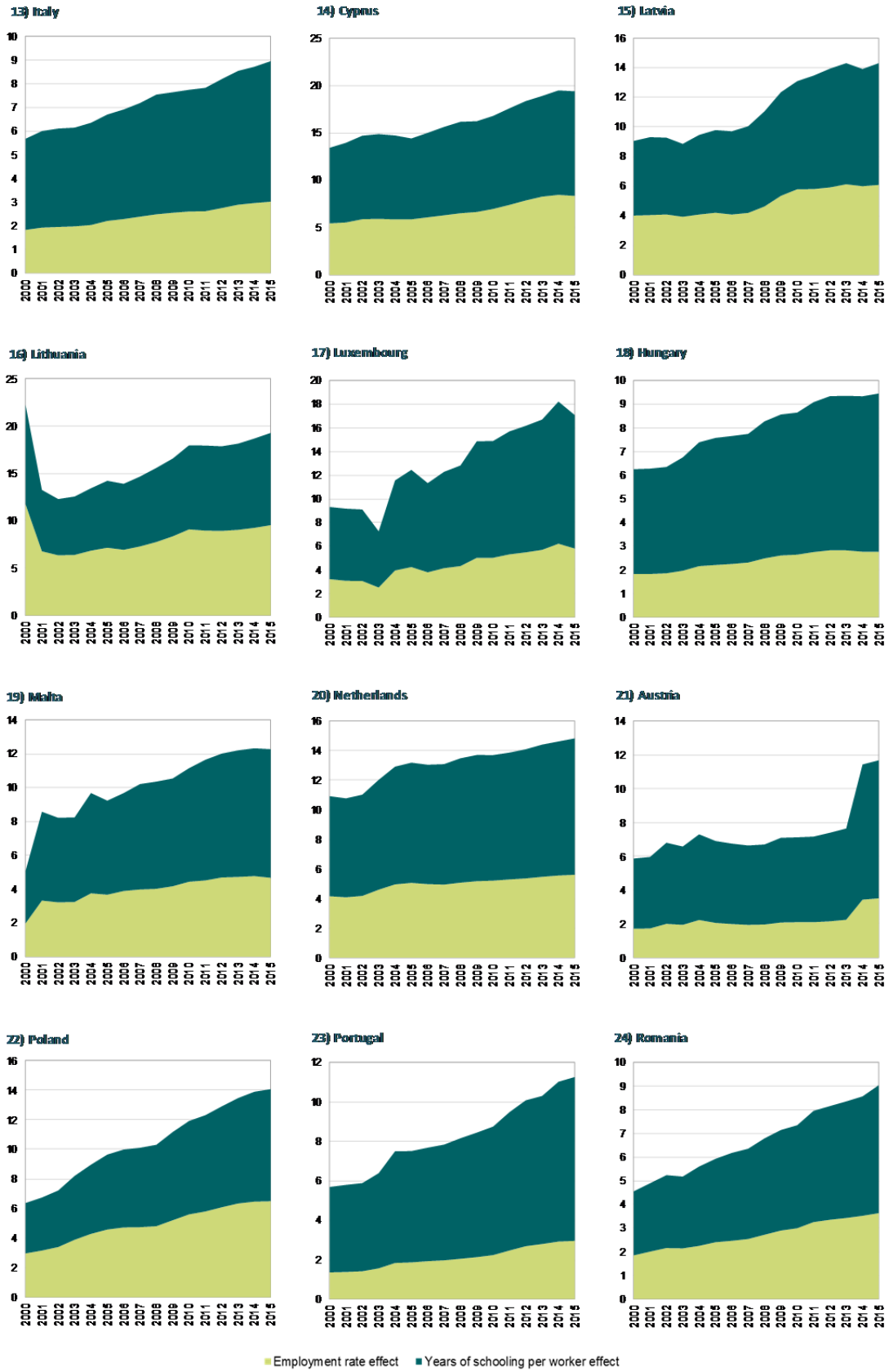
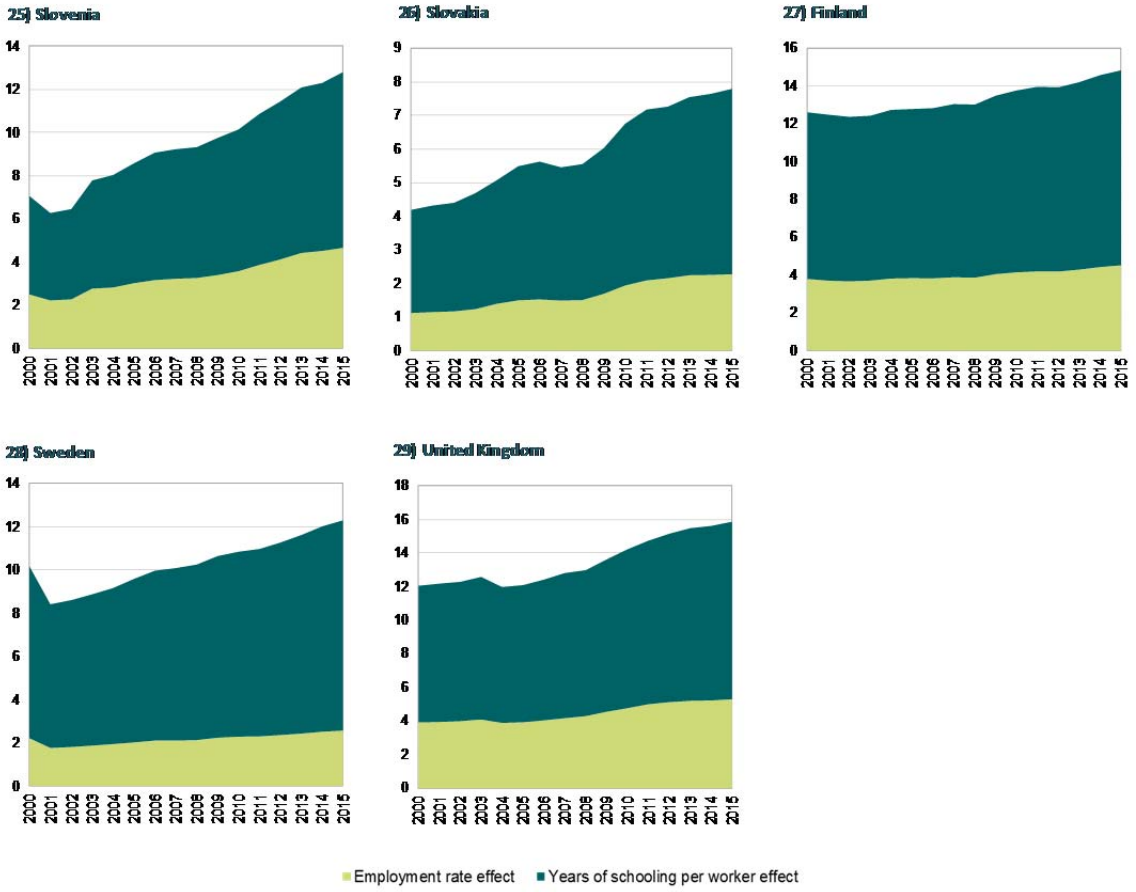


Figure 7. Higher education contribution to additional human capital. Relative increase of total years of schooling of employed population. International comparison. Percentage. 2000-2015 *(cont.)*



Source: Eurostat and own elaboration

Concerning the effect of the increase in the number of years of education per worker associated with the existence of higher education, it is even more intense. In the case of the EU-28 as a whole, it would represent a difference of 7.2% on average over the period with respect to the counterfactual scenario. The magnitude of the effect increased from 6.1% in 2000 to 8.5% in 2015.

Again, there is a marked inequality between countries. While this impact has exceeded 9% on average during the period in certain countries: Spain, Belgium, Ireland, Cyprus, Finland and the United Kingdom, in others it is between 4% and 5%: Romania, the Czech Republic, Slovakia and Italy. With the exception of Lithuania, the intensity of this impact increased in all countries, albeit at a different pace. The increase was higher in Malta, Poland, Romania and Austria whereas it was more moderate in Germany, Belgium and Finland. This general trend of growth means that the magnitude of this effect oscillates between 5.4% in Romania and 11.6% in Spain.

In general, the direct impact for most of the countries is larger than the indirect impact associated with the improvement of employment rates. For the EU28 as a whole, approximately two-thirds of the total impact would correspond to the direct impact (64.2% on average 2000-2015) and the remainder to the impact via the labour market. In addition, this distribution is very stable throughout the period analysed. The individual behaviour of member countries is also characterised by high stability throughout the period, but within a heterogeneous pattern in terms of the importance of each factor in the total impact.

In some countries the direct impact is of particular relative importance compared to the employment rate impact. Thus, the direct effect is between 70% and 80% of the total in Sweden, Portugal, Slovakia, the Czech Republic, Austria, Hungary and Finland. The opposite is the case in countries such as Lithuania, Poland and Greece where both effects have a similar relative importance.

4. The contribution of HEIs to the creation of technological capital

R&D activities and those of teaching are the two most important missions of universities in advanced societies. And although they may not be as visible as teaching activities, the fact is that through research, universities contribute to the socioeconomic development of their respective environments, generating, developing and transferring knowledge to companies and institutions.

It is common practice for universities to devote funds to research, which will ultimately provide the basis for technologies that are subsequently used by completely new private sector firms (Biggar, 2015). The development of such technologies is fundamental for the long-term competitiveness of their economies, but involves considerable time delays that are difficult to capture by traditional methods of economic impact analysis. Furthermore, via R&D activities, universities generate significant benefits through open innovation, providing an innovative environment and actively promoting the transfer of knowledge between academia and industry. In some cases, universities have led to the development of large-scale innovation centres that are important drivers of regional economic growth. This process usually occurs over many years and is difficult to take into account. The fact that the contribution through the R&D of universities is produced in the long term and often in an unspecific way makes it extremely complicated to measure. This section therefore focuses on quantifying the importance of these activities in the regional context and on measuring the most direct and quantifiable output: the technological capital generated. Technological capital is defined as the knowledge asset resulting from the accumulation of staff payment flows, inputs and investments in equipment, as well as the facilities which are necessary for R&D activities.

Figure 8 presents the Total intramural R&D expenditure (GERD) undertaken by the three agents for which Eurostat provides disaggregated data: Public Administration, Higher Education and Business and Private non-profit sector. As can be observed, the participation of HEIs is very significant and increases over time representing 20.9% in 2000 and 23.1% in 2014. In most countries HEIs are the second most important agent of expenditure on R&D, and in some cases the first, as in Greece, Cyprus, Latvia and Lithuania.

Figure 8. Total intramural R&D expenditure (GERD) by sectors of performance. International comparison. 2000-2014 (Millions euros)

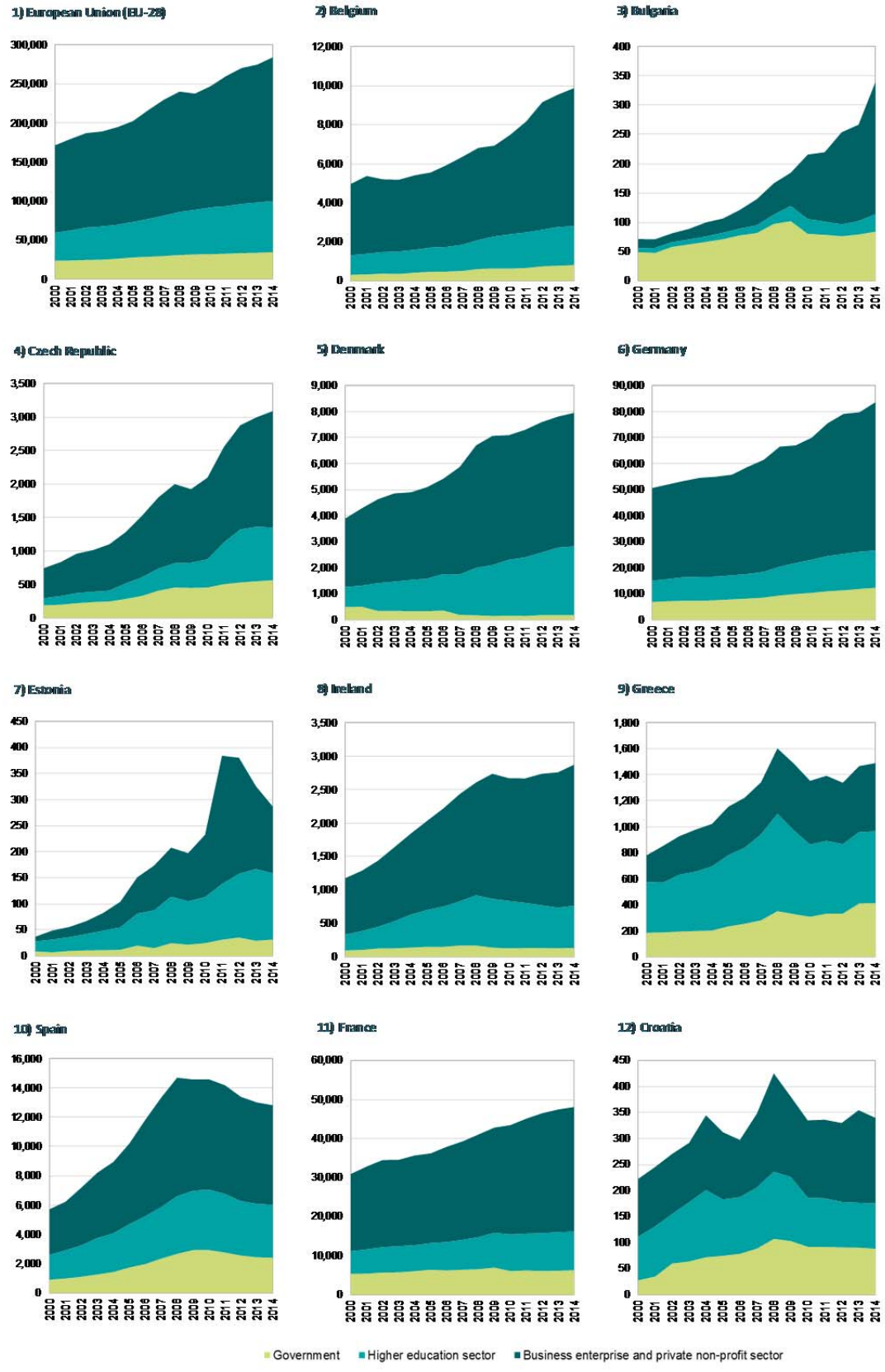


Figure 8. Total intramural R&D expenditure (GERD) by sectors of performance. International comparison. 2000-2014 (Millions euros) *(cont.)*

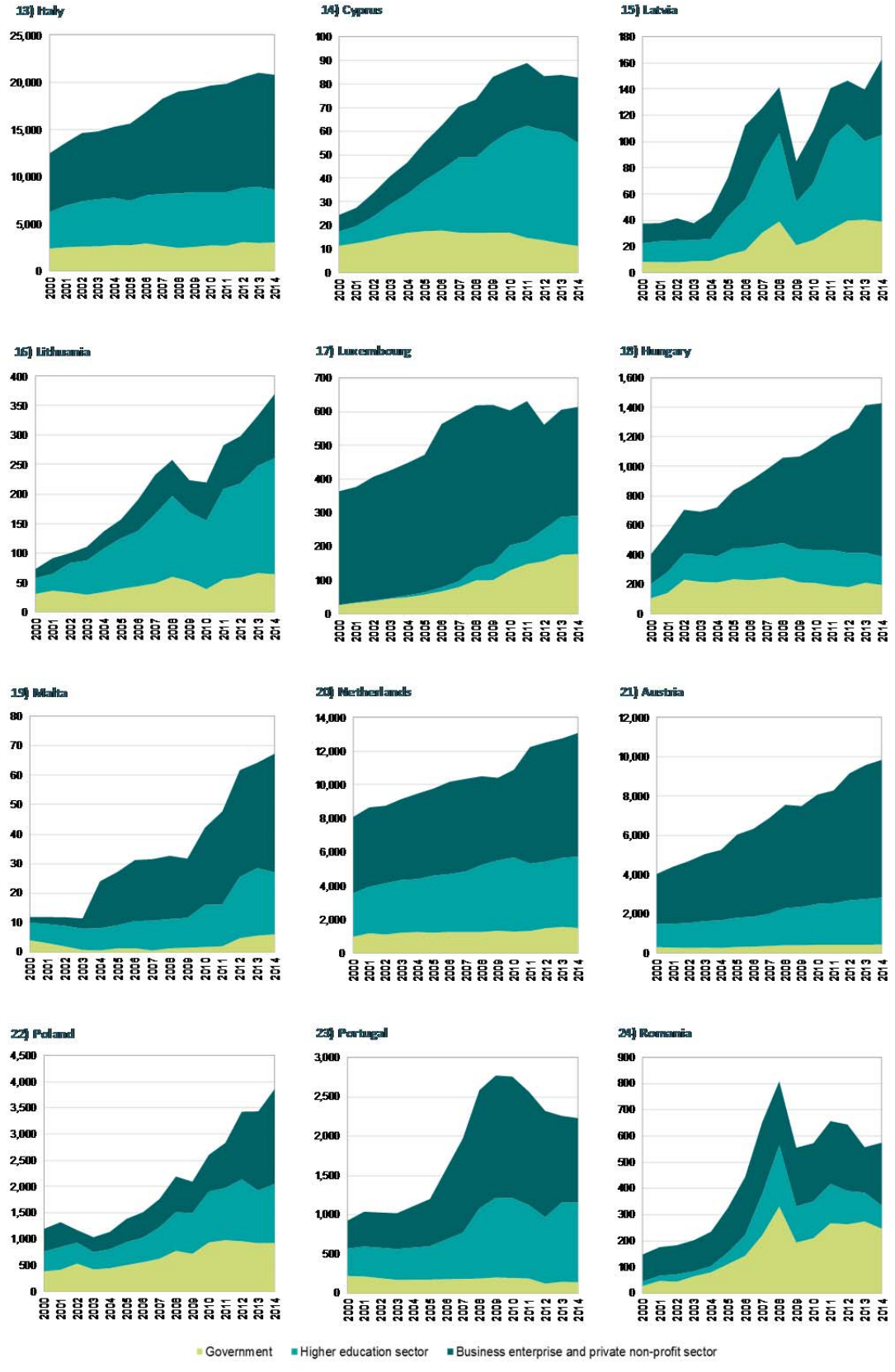
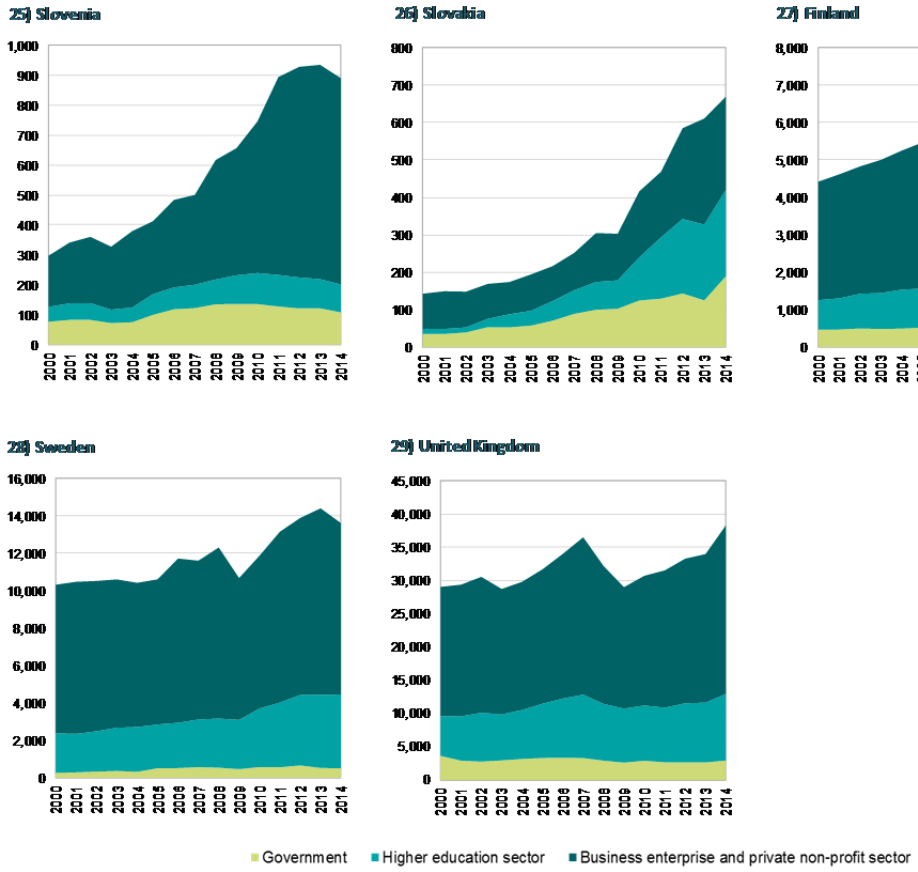


Figure 8. Total intramural R&D expenditure (GERD) by sectors of performance. International comparison. 2000-2014 (Millions euros) *(cont.)*



Source: Eurostat and own elaboration

Despite the importance of university R&D activities, unlike teaching, it has little visibility for much of society. As noted, this is due to the fact that the results of the research are materialized in the medium and long term when their results are applied directly or indirectly or because a part of the research does not have a specific purpose or a direct productive use, especially basic research. In these circumstances, it is more difficult for society to visualize the effects and, as a result, the achievements of university R&D activities tend to be undervalued.

This section offers a quantitative assessment of the contribution that HEIs make to generating technological capital via the resources allocated to R&D activities. Through these R&D activities, HEIs contribute to increasing the technological capital stock of their countries in a significant way, due to the important weight of HEIs' R&D expenditure in the total.[7] **Technical note 3** describes the procedure used to estimate the technological capital generated by HEIs.

[7] We shall use the definition of R&D expenditure established in the OECD's Frascati manual (2002), which states that all R&D expenditures are understood to be creative work undertaken on a systematic basis in order to increase the stock of knowledge and the use of that stock to devise new applications. This manual is the basic reference in the development of R&D statistics

Figure 9 illustrates the technological capital generated since 2000, the first year for which such data is available. In 2014, the total technological capital in the EU was 1.6 trillion euros, of which HEIs would have contributed 368 billion, or 23% of the total. The importance of HEIs in total technological capital is not homogeneous, however, with significant differences between countries. Those countries where the technological capital generated by HEIs is significant are Lithuania (52,6%), Cyprus (49.0%), Latvia (43.2%) and Greece (41.8%).

The effects of the economic crisis and the budget cuts in R&D are clearly reflected in the evolution of technological capital. While in the period 2000 to 2007 the average annual growth rate of EU technological capital was 2.5%, in the years of the crisis, as of 2008, the rate fell considerably to 2.4% per year. This lower growth of technological capital occurs in all countries without exception. In some countries such as Croatia, Romania and Luxembourg, the pre-crisis growth rate doubles or triples that of the previous period. These effects of the crisis are even more visible in the technological capital generated by HEIs. Thus, in countries such as Greece, the annual growth rate until 2007 was 8.3 times the post-crisis rate. Similarly, in countries such as Italy, Hungary, Romania, Lithuania, Cyprus and the UK, pre-crisis growth rates are 2 to 5 times higher than those following the crisis.

Technical note 3. Estimation of technological capital stock

To estimate the series of technological capital stock generated by HEIs, as was carried out by Pastor and Peraita (2015), the inventory method is used according to the expression:

$$KT_{i,t} = (1-d)\, KT_{i,t-1} + I_{i,t-q}$$

where $KT_{i,t}$ is the capital stock of period *t, d* is the rate of depreciation and *I* is the rate of investment in period *t*. Following Pakes and Schankerman (1984), the effects of investment in R&D are assumed to be incorporated into the technological stock with a delay of one year, so that the results of the R&D activities are not immediate *(q=1)*.

The capital stock is estimated as described below:

$$KT_{i,t} = \frac{I_{i,t-\theta}}{g+\delta}$$

g being the rate of growth of investment in R&D.

Following the work of Pastor and Peraita (2015), Pérez and Maudos (2007), Hall and Maraisse (1992), and Puente and Pérez (2004), we use a depreciation rate of 15%.

Figure 9. Technological capital. Higher education and others sectors. International comparison. 2000-2015 (2010 Millions euros)

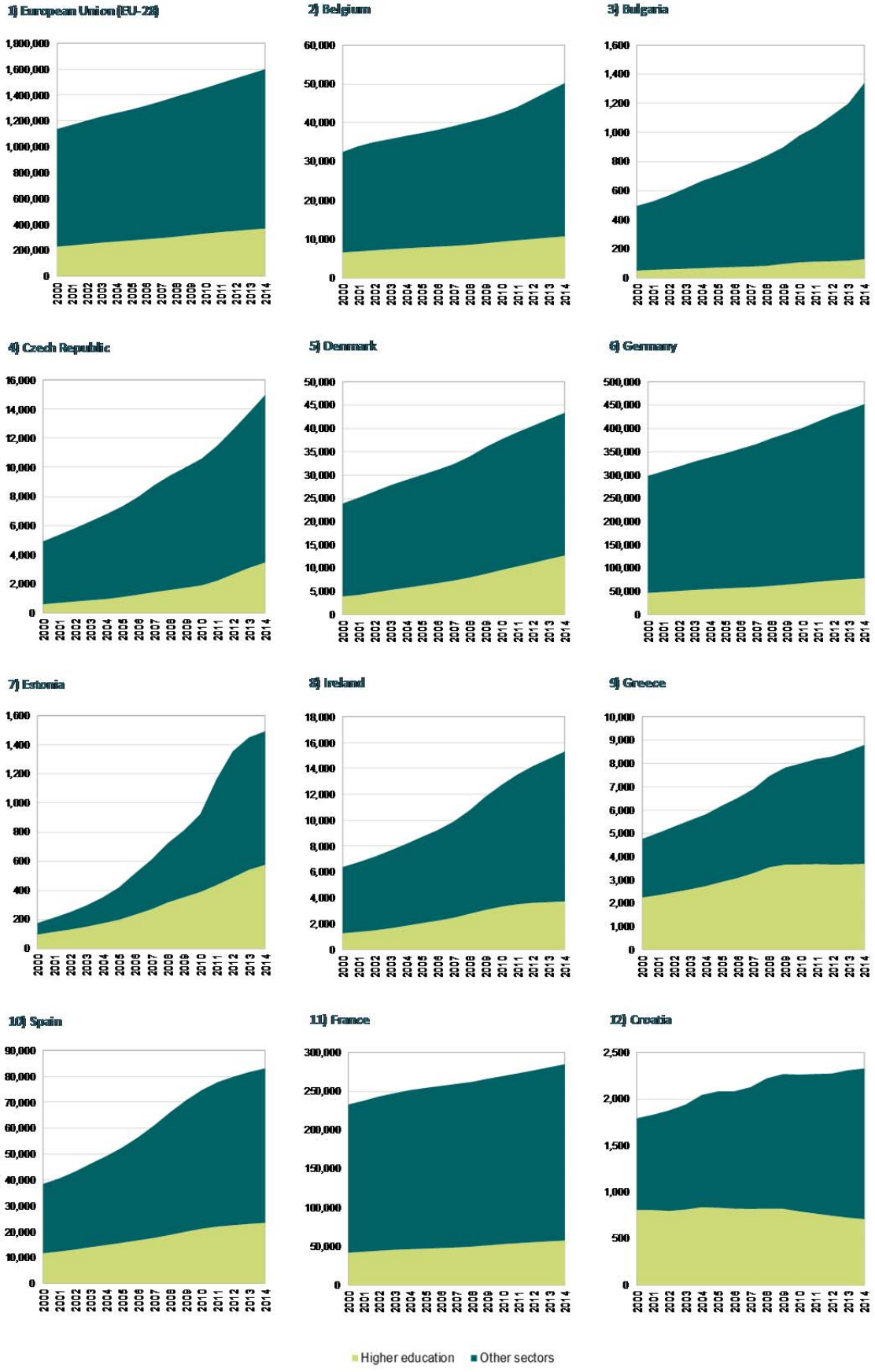


Figure 9. Technological capital. Higher education and others sectors. International comparison. 2000-2015 (2010 Millions euros) *(cont.)*

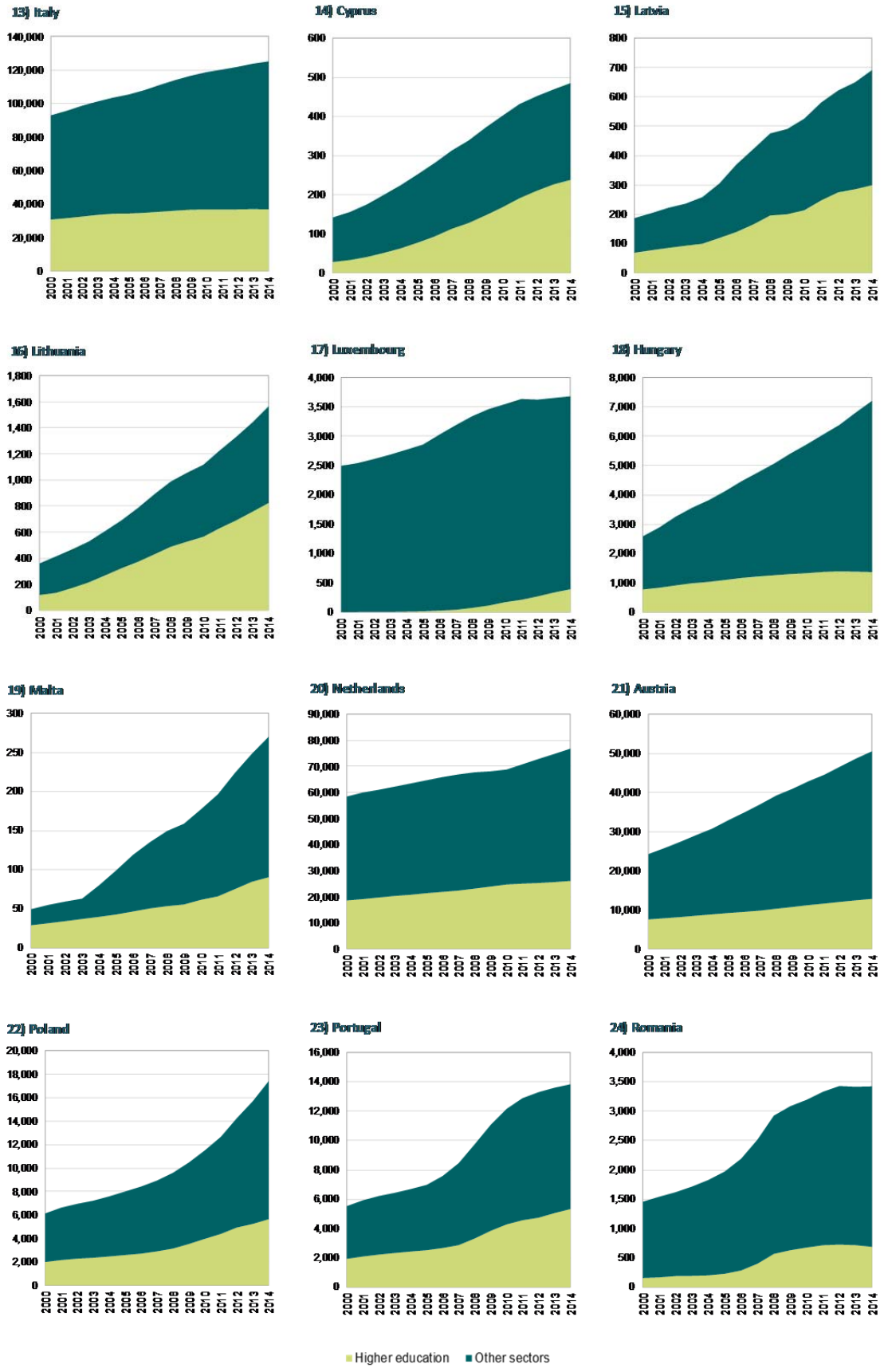
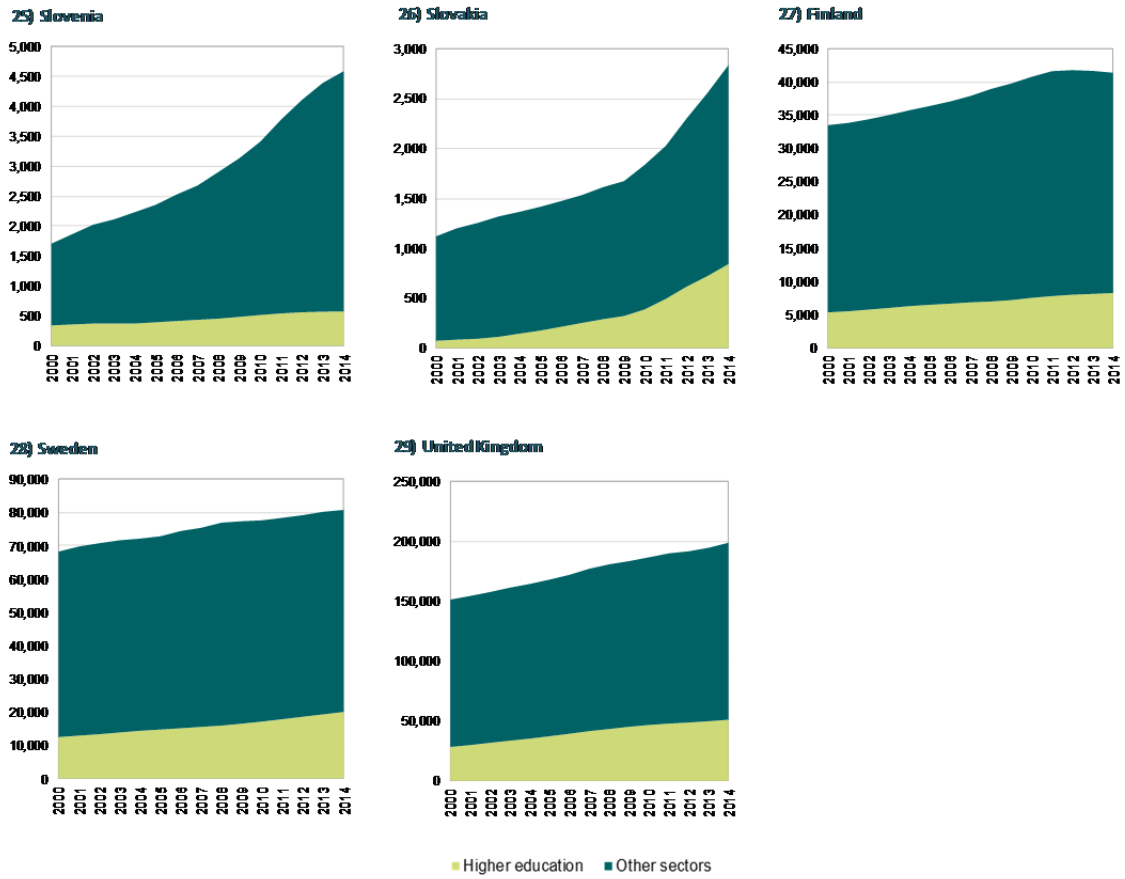


Figure 9. Technological capital. Higher education and others sectors. International comparison. 2000-2015 (2010 Millions euros) *(cont.)*



Source: Eurostat and own elaboration

5. Contribution of HEIs to economic growth

To compute the contribution made by HEIs to economic growth in EU countries, we shall use a growth accounting methodology, Solow (1957), which is very common in studies on the sources of output growth and productivity. This technique allows us to break down the economic growth of economies into the contributions corresponding to each of the factors of production, as well as to technical progress or factor productivity (TFP).

To briefly illustrate the methodology, we consider a production function in which output (*Y*) in each period (*t)* depends on the capital used (*K*), the quantity of different types of labour used, aggregating them by means of weights based on the years of study of the employed population(EYS), and the technological capital accumulated (*KT*):

$$Y_t=F_t(K_t,EYS_t,KT_t)$$

Note that, instead of considering the number of people employed, we consider the total years of study of the employed population (EYS), which is the product of two factors (EYS = AYS · L): average years of study (AYS) and number of people employed (L). This procedure allows us to collect both the contribution of human capital improvements (measured in terms of average years of study, AYS) and the contribution in the number of people employed (L).

Following this line of reasoning, HEIs contribute to economic growth in three ways: 1) through their influence on the total number of people employed (L) - quantity effect; 2) through their task of generating human capital (H) - quality effect; and 3) through the generation of technological capital (KT).

Technical note 4 describes the details of this technique and the data used. Specifically: [8]

- *Quantity effect:* To analyse the contribution of HEIs through the increase of people employed (quantity effect), we shall break down labour (EYS) in terms of quantity (L) and quality (AYS). Furthermore, we shall break down the quantity of labour into those jobs associated with the existence of HEIs (L^{HEI}) and those that would have existed without their existence (L^{CF}, counterfactual employed population).

- *Quality effect:* To analyse the quality effect, we shall break down the increase in the quality of the employment of EU countries (average years of study, AYS), in the share of the growth attributable to HEIs and the improvement in the average years of study of the employed population that would have occurred in the case of HEIs not existing, which in previous sections we have called average counterfactual years of schooling (AYS^{CF}).

- *Technological capital effect:* Finally, to estimate the contribution of HEIs to growth through the technological capital generated (technological capital effect), we shall break down the growth of total technological capital (KT) in the part attributable to HEI (KT^{HEI}) and the one that would have been accumulated without the contribution of HEIs (KT^{CF}).

Table 1 presents the growth of EU countries for the period 2000-20014 and breaks it down into the contribution of productive factors. The table shows the contributions of HEIs to the economic growth of EU countries. When assessing the contributions of HEIs, it should be noted that the intensity of this impact depends on its effect on the growth rate of the quantity, and quality, of employment and technological capital. Thus, this effect will tend to be more significant in countries where education, although less developed, has increased more strongly during the period analysed in relative terms.

[8] The impact on the demand side considered in the previous section is not considered in this one.

Technical note 4. Estimation of the contribution of HEIs to economic growth

Growth accounting, initially proposed by Solow (1957), is a technique commonly used to break down income growth into the contributions corresponding to the use of different quantities of each of the productive factors, taking into account the value attributed to their contributions. The basic idea is that assuming the existence of perfect competition and constant returns to scale, the contribution of each factor to production can be estimated through its own real growth rate multiplied by the share of that factor's income in the total income.

This implies assuming that each factor is remunerated in accordance with its productivity marginal. Furthermore, the share of production growth that is not explained by the contribution of each factor, i.e. the residue of Solow, also called growth of total factor productivity, is attributed to technical progress.

To analyse the contribution of labour to production growth, the labour total (EYS total years of study of the employed population) is broken down into two components: one associated with the contribution of HEIS and the other corresponding to the amount of work and average years of study that would be observed in the case of HEIS not existing, counterfactual scenario (CF). Thus, total labour growth (EYS) in each country can be expressed as the weighted average of the total labour growth associated with the existence of HEIs (EYS^{HEI}) and the counterfactual scenario (CF) which would be observed if they did not exist (AET^{CF}) according to the following expression:

$$\hat{EYS}_t = \left(\theta \hat{EYS}_t^{HEI} + (1-\theta)\hat{EYS}_t^{CF}\right)$$

where the circumflex symbol above the variables denotes rates of variation, θ Is the weight of the years of study generated by HEIs in the total and $(1-\theta)$ is the weight of the remaining years of study in the total. Specifically, if EYS_{t-1}^{HEI} and EYS_{t-1}^{CF} denotes the years of study generated by HEIs and the rest respectively:

$$\theta = EYS_{t-1}^{HEI} / EYS_{t-1}; \quad (1-\theta) = EYS_{t-1}^{CF} / EYS_{t-1}$$

Given that the total labour EYS is the product of the average years of study and of the number of people employed, equation (1) can be broken down, in turn, as:

$$\hat{EYS}_t = \left(\theta\left(\hat{AYS}_t^{HEI} + \hat{L}_t^{HEI}\right) + (1-\theta)\left(\hat{AYS}_t^{CF} + \hat{L}_t^{CF}\right)\right)$$

The above expression can be expressed by approximating the rate of variation by logarithmic differences:

$$deys_t = \left(\theta\left(days_t^{HEI} + dl_t^{HEI}\right) + (1-\theta)\left(days_t^{CF} + dl_t^{CF}\right)\right)$$

In the same way, technological capital can be broken down as follows:

$$dkt_t = \left(\psi dkt_t^{HEI} + (1-\psi) dkt_t^{CF}\right)$$

where dkt_t^{HEI} is the growth of technological capital associated with investments made by HEIs in R&D, dkt_t^{CF} is the growth of the technological capital of the rest of the region in the absence of HEIs, ψ is the weight of technological capital generated by HEIs in the total and $(1-\psi)$ is the weight of the remaining technological capital. Specifically, if

KT_{t-1}^{HEI}, KT_{t-1}^{CF} and KT_{t-1} are, respectively, the technological capital of HEIs, the rest of the technological capital and the total of technological capital in the initial year is the following:

$$\psi = KT_{t-1}^{HEI} \big/ KT_{t-1};\ (1-\psi) = KT_{t-1}^{CF} \big/ KT_{t-1}$$

With the above expressions, the break down of growth can be expressed as:

$$dy_t = da_t + \alpha dk_t + \beta\left[\left(\theta\left(days_t^{HEI} + dl_t^{HEI}\right) + (1-\theta)\left(days_t^{CF} + dl_t^{CF}\right)\right)\right] +$$
$$+\lambda\left(\psi dkt_t^{HEI} + (1-\psi) dkt_t^{CF}\right)$$

This last expression is the one that allows us to break down GDP growth (dy_t) into the contribution of capital (αdk_t), the quality of labour $(\beta days_t)$, the quantity of labour (βdl_t), technological capital (λdkt_t) and total factor productivity (da_t), and in turn, which part of these sources of growth is associated with HEIs. Specifically, $(\beta\theta days_t^{HEI})$ measures the share of growth related to improvements in the quality of the labour factor associated with HEIs via the human capital generated, $(\beta\theta dl_t^{HEI})$ measures the share of growth related to the increase in the number of people employed associated with HEIs through increases in the rate of activity and employment, and $(\lambda\psi dk_t^{HEI})$ the share of growth related to the technological capital generated by HEIs.

The results are obtained using the method described in technical Note 4 for the period 2000-2014. **Table 1** shows that HEIs would have boosted European growth, with a contribution of 0.61 pp. to the average growth rate of the EU28 (0.49 p.p. for the quantity and quality of human capital, and 0.06 p.p. for their contribution to the increase of technological capital). The contribution is positive in all countries, albeit the differences are notable. In Germany it is only 0.2 p.p. while in Malta and Portugal it is around 1.7 p.p. and in Cyprus, Spain, Luxembourg, Ireland and Greece it stands at around 1 pp.

With the exception of a few cases, the growth impulse from HEIs occurs more through the contribution of human capital than through R&D capital. Only in Lithuania, Estonia and Slovakia does the opposite occur. Furthermore, most of the increase in human capital associated with higher education corresponds to the direct impact of improving labour quality. The share related to the improvements in the employment rate associated with having higher education is markedly more moderate in all countries.

The contribution of higher education via technological capital is especially significant in the Baltic republics where it contributes between 3 and 4 tenths to the growth of the period. In the more developed economies with a better starting point, the contribution is below 0.1%.

Table 1. Economic growth sources. Universities economic growth contribution. 2000-2014 (percentage)

A) 2000-2007

	GVA	Tangible capital	Labour							R&D Capital			TFP
			Total	Universities			Contrafactual			Total	Universities	Contrafactual	
				Total	Quantity	Quality	Total	Quantity	Quality				
European Union	**2.27**	**0.53**	**1.71**	**0.48**	**0.04**	**0.44**	**1.23**	**0.91**	**0.32**	**0.20**	**0.06**	**0.14**	**-0.18**
Belgium	2.12	0.31	1.83	0.74	0.07	0.67	1.09	0.54	0.55	0.21	0.05	0.16	-0.23
Bulgaria	5.89	1.96	1.72	0.41	0.01	0.40	1.31	0.92	0.38	0.53	0.05	0.48	1.68
Czech Republic	4.52	0.94	0.71	0.21	0.02	0.19	0.50	0.37	0.13	0.66	0.14	0.52	2.21
Denmark	1.32	0.45	-0.39	-0.12	0.04	-0.16	-0.28	0.07	-0.35	0.35	0.14	0.21	0.91
Germany	1.62	0.22	1.01	0.08	-0.01	0.09	0.93	0.81	0.12	0.24	0.04	0.19	0.15
Estonia	7.07	3.12	0.90	0.08	0.01	0.07	0.82	0.80	0.03	1.42	0.58	0.84	1.63
Ireland	4.87	2.14	2.84	0.80	0.12	0.68	2.04	1.66	0.38	0.50	0.17	0.33	-0.61
Greece	3.73	0.84	2.03	0.70	0.07	0.63	1.33	0.88	0.44	0.43	0.21	0.22	0.44
Spain	3.47	1.28	4.30	0.90	0.03	0.87	3.40	2.61	0.79	0.53	0.14	0.39	-2.64
France	1.84	0.55	1.68	0.50	0.06	0.44	1.18	0.89	0.29	0.12	0.03	0.09	-0.51
Croatia	4.51	1.10	2.08	0.33	0.00	0.33	1.76	1.47	0.29	0.20	0.01	0.19	1.13
Italy	1.14	0.58	1.87	0.60	0.04	0.56	1.27	0.84	0.43	0.20	0.05	0.15	-1.52
Cyprus	3.90	1.32	3.57	0.82	0.09	0.73	2.75	2.22	0.53	0.90	0.43	0.47	-1.90
Latvia	8.47	2.32	0.66	0.01	0.01	0.00	0.65	0.72	-0.07	0.93	0.38	0.55	4.55
Lithuania	7.76	2.17	0.30	-0.55	-0.30	-0.25	0.85	0.52	0.33	1.03	0.60	0.43	4.26
Luxembourg	3.94	1.38	1.71	0.47	0.06	0.41	1.23	1.07	0.16	0.28	0.02	0.27	0.57
Hungary	3.61	1.22	0.85	0.42	0.04	0.39	0.42	0.17	0.26	0.70	0.14	0.55	0.85
Malta	1.54	0.93	3.41	1.69	0.12	1.57	1.72	0.59	1.13	1.15	0.32	0.83	-3.95
Netherlands	1.99	0.46	1.44	0.60	0.07	0.53	0.84	0.53	0.31	0.16	0.07	0.09	-0.07
Austria	2.33	0.50	0.82	0.20	0.02	0.18	0.62	0.51	0.11	0.48	0.09	0.40	0.53
Poland	4.04	0.94	1.07	0.63	0.14	0.50	0.44	0.27	0.17	0.43	0.14	0.29	1.60
Portugal	1.23	0.66	1.93	1.06	0.04	1.02	0.88	0.07	0.81	0.49	0.16	0.33	-1.85
Romania	6.02	1.13	0.27	0.79	0.06	0.73	-0.52	-1.08	0.56	0.62	0.14	0.49	3.99
Slovenia	4.46	0.81	1.73	0.57	0.07	0.50	1.16	0.87	0.28	0.52	0.05	0.47	1.40
Slovakia	6.16	1.38	1.17	0.22	0.02	0.19	0.95	0.85	0.10	0.36	0.15	0.21	3.26
Finland	3.00	0.54	1.15	0.40	0.02	0.39	0.75	0.40	0.35	0.14	0.05	0.09	1.17
Sweden	2.98	0.69	0.97	0.11	-0.01	0.11	0.87	0.75	0.12	0.11	0.05	0.07	1.20
United Kingdom	2.66	0.40	2.53	0.63	0.04	0.59	1.91	1.39	0.52	0.18	0.09	0.09	-0.46

Table 1. Economic growth sources. Universities economic growth contribution. 2000-2014 (percentage) *(cont.)*

B) 2007-2014

	GVA	Tangible capital	Labour							R&D Capital			TFP
			Total	Universities			Contrafactual			Total	Universities	Contrafactual	
				Total	Quantity	Quality	Total	Quantity	Quality				
European Union	**0.20**	**0.30**	**0.73**	**0.62**	**0.08**	**0.55**	**0.10**	**-0.23**	**0.34**	**0.19**	**0.06**	**0.14**	**-1.02**
Belgium	0.69	0.21	1.13	0.56	0.08	0.48	0.57	0.27	0.30	0.28	0.06	0.22	-0.93
Bulgaria	1.09	1.78	-0.30	0.39	0.08	0.32	-0.69	-0.82	0.12	0.61	0.06	0.55	-1.00
Czech Republic	0.57	0.61	0.40	0.34	0.06	0.28	0.06	-0.01	0.08	0.61	0.20	0.41	-1.06
Denmark	-0.20	0.12	0.51	0.59	0.06	0.54	-0.08	-0.46	0.38	0.34	0.16	0.17	-1.17
Germany	0.69	0.16	0.78	0.25	0.02	0.24	0.53	0.34	0.18	0.24	0.05	0.19	-0.49
Estonia	-0.02	1.23	-0.28	0.29	0.07	0.21	-0.56	-0.61	0.05	1.02	0.35	0.67	-1.99
Ireland	0.20	0.54	0.20	0.95	0.18	0.78	-0.75	-1.20	0.45	0.50	0.12	0.38	-1.05
Greece	-3.98	-0.05	-1.16	0.94	0.21	0.74	-2.11	-2.47	0.36	0.28	0.06	0.22	-3.04
Spain	-0.76	0.42	-0.24	0.94	0.13	0.81	-1.19	-1.70	0.52	0.35	0.09	0.26	-1.29
France	0.49	0.38	1.41	0.79	0.09	0.71	0.62	0.13	0.49	0.11	0.04	0.07	-1.41
Croatia	-1.59	0.63	-0.09	0.73	0.13	0.60	-0.82	-1.10	0.28	0.10	-0.05	0.16	-2.24
Italy	-1.20	0.11	0.73	0.63	0.05	0.59	0.10	-0.35	0.44	0.14	0.01	0.12	-2.18
Cyprus	-1.17	0.81	0.53	0.75	0.18	0.57	-0.23	-0.46	0.24	0.50	0.36	0.14	-3.01
Latvia	-0.76	-0.09	-0.68	0.65	0.14	0.52	-1.34	-1.54	0.21	0.56	0.28	0.28	-0.55
Lithuania	0.61	1.20	-0.32	0.56	0.15	0.41	-0.88	-0.98	0.10	0.65	0.38	0.27	-0.91
Luxembourg	1.02	1.15	3.45	1.45	0.18	1.27	2.00	1.23	0.77	0.16	0.11	0.05	-3.74
Hungary	0.14	0.51	0.63	0.23	0.03	0.19	0.41	0.35	0.06	0.47	0.03	0.44	-1.49
Malta	3.93	0.66	3.34	1.23	0.07	1.16	2.11	1.13	0.98	0.79	0.23	0.56	-0.86
Netherlands	0.30	0.27	0.17	0.41	0.06	0.35	-0.24	-0.44	0.20	0.16	0.06	0.10	-0.29
Austria	0.56	0.36	1.37	0.83	0.12	0.71	0.53	0.27	0.26	0.36	0.08	0.28	-1.53
Poland	3.05	1.79	0.78	0.51	0.13	0.38	0.27	0.18	0.08	0.76	0.26	0.51	-0.28
Portugal	-0.68	0.03	2.38	1.92	0.07	1.84	0.46	-1.09	1.56	0.56	0.25	0.31	-3.66
Romania	1.19	1.80	-0.64	0.13	0.06	0.07	-0.76	-0.65	-0.11	0.35	0.12	0.24	-0.32
Slovenia	-0.36	0.16	-0.05	0.64	0.13	0.51	-0.69	-0.88	0.19	0.62	0.05	0.57	-1.09
Slovakia	1.93	0.52	0.12	0.19	0.05	0.15	-0.08	-0.07	-0.01	0.70	0.32	0.38	0.59
Finland	-1.01	0.28	0.47	0.51	0.06	0.46	-0.05	-0.35	0.31	0.10	0.04	0.06	-1.86
Sweden	0.87	0.63	0.92	0.43	0.03	0.40	0.48	0.24	0.24	0.08	0.07	0.01	-0.75
United Kingdom	0.68	0.30	1.16	0.69	0.10	0.59	0.46	0.13	0.33	0.13	0.06	0.07	-0.91

Table 1. Economic growth sources. Universities economic growth contribution. 2000-2014 (percentage) *(cont.)*

C) 2000-2014

	GVA	Tangible capital	Labour							R&D Capital			TFP
			Total	Universities			Contrafactual			Total	Universities	Contrafactual	
				Total	Quantity	Quality	Total	Quantity	Quality				
European Union	**1.23**	**0.41**	**1.22**	**0.55**	**0.06**	**0.49**	**0.67**	**0.34**	**0.33**	**0.20**	**0.06**	**0.14**	**-0.60**
Belgium	1.41	0.26	1.48	0.65	0.08	0.57	0.83	0.41	0.42	0.25	0.06	0.19	-0.58
Bulgaria	3.49	1.87	0.71	0.40	0.04	0.36	0.31	0.05	0.25	0.57	0.06	0.51	0.34
Czech Republic	2.54	0.77	0.56	0.27	0.04	0.24	0.28	0.18	0.10	0.64	0.17	0.47	0.58
Denmark	0.56	0.29	0.06	0.24	0.05	0.19	-0.18	-0.19	0.01	0.34	0.15	0.19	-0.13
Germany	1.16	0.19	0.90	0.17	0.00	0.16	0.73	0.58	0.15	0.24	0.05	0.19	-0.17
Estonia	3.52	2.17	0.31	0.18	0.04	0.14	0.13	0.09	0.04	1.22	0.47	0.76	-0.18
Ireland	2.53	1.34	1.52	0.88	0.15	0.73	0.65	0.23	0.42	0.50	0.15	0.36	-0.83
Greece	-0.12	0.39	0.43	0.82	0.14	0.68	-0.39	-0.79	0.40	0.35	0.13	0.22	-1.30
Spain	1.36	0.85	2.03	0.92	0.08	0.84	1.11	0.46	0.65	0.44	0.12	0.32	-1.96
France	1.16	0.46	1.55	0.65	0.07	0.57	0.90	0.51	0.39	0.12	0.03	0.08	-0.96
Croatia	1.46	0.87	1.00	0.53	0.07	0.46	0.47	0.18	0.28	0.15	-0.02	0.17	-0.55
Italy	-0.03	0.35	1.30	0.62	0.04	0.58	0.68	0.25	0.44	0.17	0.03	0.14	-1.85
Cyprus	1.37	1.07	2.05	0.79	0.13	0.65	1.26	0.88	0.39	0.70	0.39	0.31	-2.46
Latvia	3.85	1.12	-0.01	0.33	0.07	0.26	-0.34	-0.41	0.07	0.75	0.33	0.41	2.00
Lithuania	4.19	1.69	-0.01	0.01	-0.07	0.08	-0.02	-0.23	0.21	0.84	0.49	0.35	1.67
Luxembourg	2.48	1.26	2.58	0.96	0.12	0.84	1.62	1.15	0.47	0.22	0.06	0.16	-1.59
Hungary	1.87	0.87	0.74	0.33	0.04	0.29	0.42	0.26	0.16	0.59	0.09	0.50	-0.32
Malta	2.73	0.80	3.38	1.46	0.09	1.37	1.92	0.86	1.05	0.97	0.27	0.69	-2.41
Netherlands	1.15	0.36	0.81	0.51	0.07	0.44	0.30	0.04	0.26	0.16	0.06	0.09	-0.18
Austria	1.44	0.43	1.09	0.52	0.07	0.45	0.58	0.39	0.18	0.42	0.08	0.34	-0.50
Poland	3.55	1.36	0.92	0.57	0.13	0.44	0.35	0.22	0.13	0.60	0.20	0.40	0.66
Portugal	0.27	0.35	2.16	1.49	0.06	1.43	0.67	-0.51	1.18	0.52	0.20	0.32	-2.76
Romania	3.60	1.46	-0.18	0.46	0.06	0.40	-0.64	-0.86	0.22	0.49	0.13	0.36	1.84
Slovenia	2.05	0.49	0.84	0.61	0.10	0.51	0.23	0.00	0.24	0.57	0.05	0.52	0.15
Slovakia	4.04	0.95	0.64	0.21	0.04	0.17	0.44	0.39	0.04	0.53	0.23	0.30	1.92
Finland	1.00	0.41	0.81	0.46	0.04	0.42	0.35	0.02	0.33	0.12	0.04	0.08	-0.34
Sweden	1.93	0.66	0.94	0.27	0.01	0.26	0.67	0.49	0.18	0.10	0.06	0.04	0.22
United Kingdom	1.67	0.35	1.85	0.66	0.07	0.59	1.19	0.76	0.42	0.16	0.08	0.08	-0.68

Source: Eurostat and own elaboration

The improvement of the human capital per capita of the employed population associated with HEIs has had an impact which also shows a high heterogeneity. Its magnitude is particularly high in countries such as Portugal, Malta, Spain, Luxembourg, Ireland and Greece, with contributions ranging from 0.68% to 1.43%. On the contrary, in Denmark, Slovakia, Germany, Estonia and Lithuania, this impact does not reach 0.2% per year.

In any case, these are contributions of greater importance than those linked to the increase in the rate of employment induced by higher education. The labour quantity effect of higher education is practically nil in countries like Germany and Sweden. Even in the countries where it is most relevant, such as Ireland, Greece, Cyprus and Poland, its magnitude would have been moderate during the period 2000-2014, without exceeding 0.15% in any country.

We distinguish between the period before and after 2007 to analyse possible changes associated with the crisis and the different phases of the economic cycle. Tables W2 and W3 offer the growth accounting results for the periods 2000-2007 and 2007-2014, respectively.

In the first place, it is necessary to point out that there are common features regarding the contribution of higher education in both periods. Both the effect through R&D capital, as well as the quality and quantity labour effects of higher education are positive with a few exceptions. Furthermore, the relative importance of the labour quality impact is constant, and is more significant than the R&D capital impact or the labour quantity impact in both periods.

In the EU28 as a whole, there is an increase in contributions linked to the increase in the human capital per capita of the employed population (from 0.44% per annum before the crisis to 0.55% in the subsequent period) and the employment rate, which doubles (from 0.04% to 0.08%). On the contrary, the contribution through R&D capital remains stable (0.06% in both periods).

Consequently, one aspect to be highlighted is the different behaviour of the contribution of higher education to growth. The crisis generally affected all sources of growth. The contribution of physical capital went from 0.53% prior to the crisis to 0.30%. The contribution of the labour factor estimated for the counterfactual scenario without higher education would have fallen from 1.23% to 0.1%, mainly due to the quantity impact that would have gone from 0.91% to -0.23%. The TFP would also have performed worse than in the pre-crisis period. However, the estimates obtained for the impact associated with higher education far from being reduced would have been maintained (R&D capital) or even increased (quality and quantity labour effects). In total, the contribution of education would have gone from 0.54% per year prior to the crisis to 0.68% after the crisis

These results indicate that higher education would have contributed to partially alleviating the negative impact of the crisis on the overall economic growth in Europe. However, there is also considerable heterogeneity between countries. The overall contribution of education, while remaining positive, would have worsened after the crisis in certain countries. This is especially the case in Romania and Malta, but also in Hungary, the Netherlands, Belgium and Cyprus. On the contrary, in Portugal, Lithuania, Denmark, Austria, Latvia, Sweden and Croatia, the contribution associated with higher education increased between 0.3% and 0.9% with respect to the pre-crisis period.

In short, the contribution of higher education to growth is very relevant in all European countries. It is undoubtedly one of the main sources of economic growth and also contributes to a more stable growth, with better performance during the crises than other growth engines

6. Contribution of HEIs to the increase in per capita income

The impact of HEIs on technological capital and the human capital endowments used do indeed affect growth, as we have seen, and therefore influence the relative levels of GDP per capita of the different countries at a given moment in time

Figure 10 shows the estimated impact of higher education in 2014, the last year for which all the necessary data is available, using the method described in technical note 5. The total contribution is considerable, standing at 22.75% for the whole of the EU28, indicating that GDP per capita is between one-fifth and one-fourth higher than it would have been in the absence of higher education. The contribution via R&D capital (11.8%) would be somewhat higher than that produced via human capital endowments (11%), but both are relevant. The impact of human capital would occur mainly through the improvement in the average years of labour per capita (labour quality effect) with a contribution of 8.5%. Although to a lesser degree, there would also exist a significant labour quantity effect due to the increase in the employment rates associated with higher education levels (2.5%)

Technical note 5. Estimation of the contribution of HEIs to income per capita

By applying growth accounting methods, the contributions of each input can be estimated with the differences in the levels of output or output per capita between two observations. These comparisons can be made between two periods of time for the same economy (the most common practice), but also between two different economies at one moment in time or the same economy in two different scenarios. Let these two observations be A and B, the approximation would be:

$$log\left(\frac{Y_A}{Y_B}\right) = log\left(\frac{TFP_A}{TFP_B}\right) + \frac{\alpha_A + \alpha_B}{2} log\left(\frac{K_A}{K_B}\right) + \frac{\gamma_A + \gamma_B}{2} log\left(\frac{KT_A}{KT_B}\right) + \frac{\beta_A + \beta_B}{2} log\left(\frac{H_A}{H_B}\right)$$

TFP is Total Factor Productivity, K is physical capital, KT is Technological capital, H is human capital (total years of education of employed population), α_i the share of physical capital income in the total income of i, γ_i that of technological capital income and β_i that of human capital (labour income). The contribution of each input is given by the relative variation in the use of the input multiplied by its share in total income.

Higher education has an influence through its effect on technological capital (TC) and human capital (H) endowments. Human capital is modified because human capital per capita varies from one employed person to another and because the job changes. Thus,

$$\frac{\beta_A + \beta_B}{2} log\left(\frac{H_A}{H_B}\right) = \frac{\beta_A + \beta_B}{2} log\left(\frac{h_A}{h_B}\right) + \frac{\beta_A + \beta_B}{2} log\left(\frac{L_A}{L_B}\right)$$

where h_i is the years of study per capita of the employed population (labour quality effect) and L_i the quantity of labour (labour quantity effect).[1]

This approach can be used to estimate the contribution of higher education to GDP per capita in each country by comparing actual results (A) with those corresponding to the counterfactual scenario without higher education (B).[2]

[1] In the later analysis, the hours worked were used as a variable representing the quantity of labour input.

[2] For each country, it is assumed that the weight of income of each factor in the total income in the counterfactual scenario (B) is the same as that observed (A).

As can be seen, significant positive effects are estimated for all countries, although their magnitude varies from one case to another. The channels through which these impacts materialize also differ from country to country.

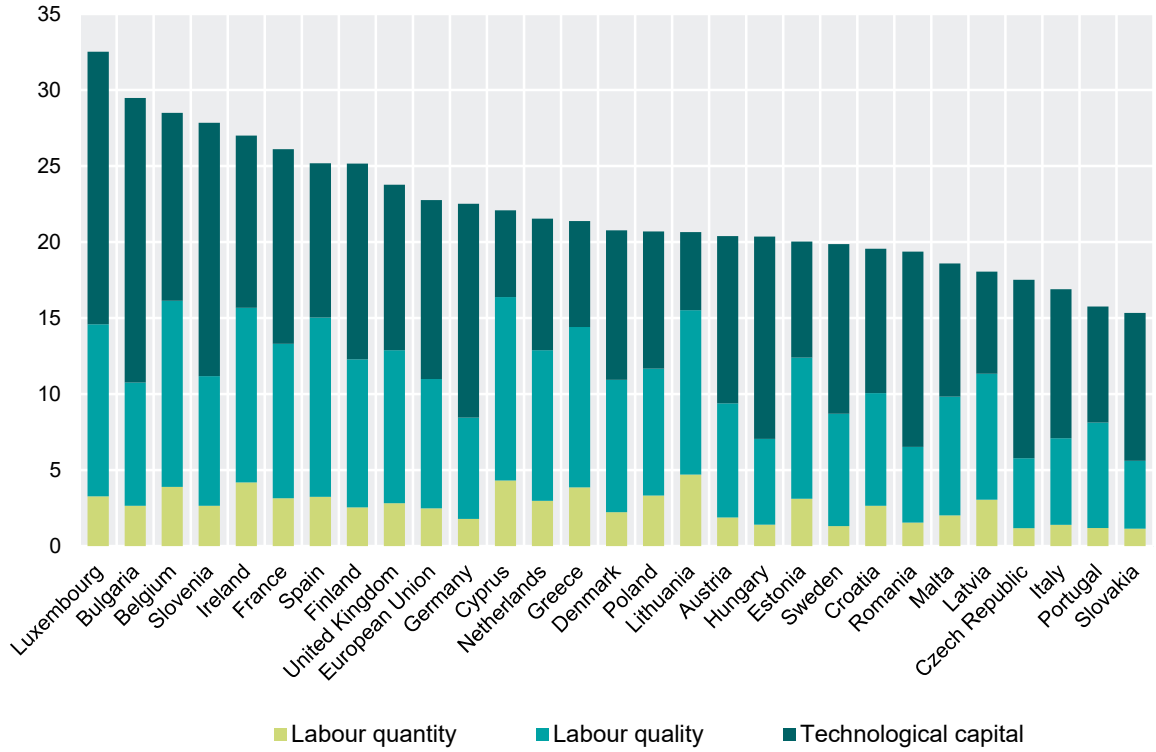
In Luxembourg, Bulgaria, Belgium, Slovenia, Ireland, France, Spain, Finland and the UK, the relative impact of higher education would be above the EU average, with total contributions ranging from 23.8% to 32.5%. In contrast, in Slovakia, Portugal, Italy, the Czech Republic, Latvia and Malta the contribution ranges from 15% and 19%

The impact through R&D capital is especially intense in Bulgaria, Luxembourg, Slovenia and Germany with values between 14% and 18.7% while in others, such as the Baltic republics, Cyprus, Greece or Portugal, it is between 5% and 8%.

The improvement in human capital per capita represents 10% more GDP per capita in Belgium, Cyprus, Spain, Ireland, Luxembourg, Lithuania, Greece, France and the UK. In Cyprus, Lithuania, Greece, Spain and Ireland the impact of higher education is even greater than that produced through R&D capital, whereas in Slovakia and the Czech Republic it is between 4% and 5%.

Finally, the increase in employment rates plays a minor role in all countries in quantitative terms, although in Lithuania, Cyprus and Ireland their magnitude exceeds 4% and in other countries it accounts for at least 1%.

Figure 10. Higher education contribution to GDP per capita. 2014 (% vs counterfactual scenario without tertiary education)



Source: Eurostat and own elaboration

The different magnitude between countries in terms of higher education contributions means that the relative situation of EU member countries is different from that which would have existed in the counterfactual scenario without universities. The differences are significant and would be up to 15% between countries.

7. Conclusions

HEIs make a significant contribution to the socioeconomic development of EU countries. This study has reviewed and quantified some of the most relevant economic contributions by the supply side of HEIs. With this objective, exercises have been designed that quantify these contributions as accurately as possible. The direct contribution to the generation of human capital and technological capital has been quantified, as well as the indirect contributions to increasing activity and employment rates, to economic growth and to increasing income per capita.

First, HEIs train part of the population and this activity means their human capital endowments and productive capacities increase, which results in the higher employability of these graduates. These positive microeconomic effects for individuals tend to drive aggregate employment rates. The activity of HEIs fosters participation in the labour market, thus increasing the activity rate and also, due to higher employability, reducing the risk of unemployment and unemployment rates. The result is an increase in employment rates, with a greater proportion of working-age people employed and producing goods and services (labour quantity effect). In addition, part of the employed population has higher levels of human capital thanks to higher education (labour quality effect).

Second, universities carry out a considerable part of R&D activity as part of their research function. That is, much of the accumulation of R&D capital corresponds precisely to higher education institutions (R&D capital effect), which also leads to greater economic development.

In short, because of the existence of the higher education sector, technological capital increases, as well as the labour input used and its quality. Economies are therefore able to achieve higher levels of production and income per capita.

This study has attempted to estimate the positive effects of higher education for the 28 countries belonging to the EU, covering the period 2000-2014. For this objective, a counterfactual scenario was estimated in which HEIs did not exist. In this alternative scenario without the R&D of higher education institutions, higher education graduates are assigned a level of human capital, participation in the labour market and employability like individuals of similar characteristics with post-compulsory studies. The imputation is based on the results of specific probit models for the probability of being active and for the probability of employment for each country using EU-LFS anonymized microdata.

The impact of higher education is obtained by comparing it with the counterfactual scenario in terms of differences in human capital used and technological capital, as well as differences in GDP per capita and growth rates.

The estimates obtained highlight the relevance of the economic effects of higher education. At present it would mean a 13% increase in the human capital used in the EU28, 23% in technological capital and a 22% increase in GDP per capita. In addition, the results of the growth accounting exercise indicate that higher education would have contributed 0.6 pp. to the average growth rate of the EU28 and would have contributed to alleviating the effects of the last crisis. In fact, estimates indicate that the contribution of higher education to the EU's overall growth would have increased after the crisis, unlike that of other sources of growth.

Furthermore, the results also show the importance of higher education to understand differences in national behaviours. Thus, the relative difference of human capital used with respect to the counterfactual scenario would now vary between 8% and 20% according to different countries. The differences would be even greater in terms of technological capital ranging from 9.6% to 52.6%. Likewise, GDP per capita would show differences between countries of up to 15% associated with higher education. Finally, the contribution of higher education to the average growth rate in 21st century shows differences which, in some cases, exceed 1 p.p.

In sum, this exploratory analysis of the economic effects of higher education indicates that educational institutions are a significant source of growth in European economies.

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