The macro-economic benefits of adult learning

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Abstract

Over the last more than 50 years a large number of studies have reviewed the relationship between education and economic growth and found a strong positive effect. The empirical evidence got even better, when studies include not only the duration of education, but also the quality of education, measured on PISA and PIAAC. Although the empirical evidence appears quite convincing and well founded, it is neither theoritically compelling nor empirically without contradiction that variation in economic growth rates and innovation should largely be due to initial education, while further education is of minor importance only. This paper reviews the literature and provides some analytical arguments and statistical indications that adult learning might be more important then perceived so far.

1. Introduction and background

Over the last more than 50 years a large number of studies have reviewed the relationship between education and economic growth and found strong positive effects. Starting with Schultz (1961, 1975), Denison (1962) and Beckers (1963) human capital was frequently considered an important ingredient to economic development and growth. Yet, empirical evidence was limited and human capital part of the residual only; thus, the role education played remained open. In a later study, Denison (1979) found that the two factor, labour and capital explained 60% of variations in growth rates, while the remaining 40% were due to differences in factor productivity. Of these 40%, 11% was due to education and 29% based on knowledge advancement.

In the late 1980s, the emerging of the endogeneous growth theory, based on theoretical considerations from Romer (1986) and Lucas (1988) as well as advanced empirical studies, beginning with Mankiw/Romer/Weil (1992) lead to an important improvement with regard to better understanding and explaining the contribution of education to growth. Recent research claims to explain up to 70% of the growth miracle. At the same time, higher education is considered a major factor for innovation.

In contrast to these findings, we found in previous studies some evidence that certain forms of adult learning correlate strongly with innovation performance, measured on the basis of selected indicators of the Innovation Union Scorebord (Cedefop 2012[2]). Furthermore, in another study (FiBS/DIE 2013), we established some preliminary evidence that adult learing indicators correlate with economic growth rates.

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[2] The underlying research was conducted on behalf and published by Cedefop, but undertaken by FiBS.

Time-lag considerations even improved the cross-setional model.[3] This paper builts upon this research and aims to provide additional analytical and empirical evidence for the underlying assumption that further education, taking place after initial education and entering the labour market, is likely to be relevant for innovation and growth. Section 2 provides a short overview on the state of the art of the economic literature on education, growth and innovation, section 0 provides some data indicating that adult learning might be more important for growth and innovation than perceived so far. In section 4 we present econometric results concerning the link between adult learning and economic growth as well as on adult learning and innovation.

2. A brief review of the present research on the relationship between education, growth and innovation

As already mentioned briefly, the last more than fifty have seen much research on education and growth as well as on education and innovation, even though empirical evidence remained sketchy. The upcoming of the new growth theory is considered an important step forward.

Romer (1986) assumed economies of scale because to external effects from insufficiecies in properties rights. If intellectual properties cannot be fully appropriated and safeguarded, the exclusion principle will not work properly and others (third parties) can appripriate this knowledge without large costs, enabling to foster technological advancement. Thus, Romer assumes (almost) freely accessible technological knowledge.

In contrast, Lucas (1988) based his theory on individual human capital, that, although bound to a certain person improves not only its owner productivity, but also that of other production factors. Lucas calls "this h_a effect external, because though all benefit from it, no individual human capital accumulation decision can have an appreciable effect on ha, so no one will take into account in deciding how to allocate his time" (Lucas 1988, p. 18).[4]

Sala-i-Martin (1996) developed this approach further, by deviding the external effect into an intra-firm (enhancing the productivity of colleagues) and an inter-firm externality, based upon the level of educational of an economy. The advantage of this human capital approach seems that it may better explain, why growth rates between countries can diverge. In this regard, the approach from Romer (1986) seems less convincing.

A third approach to endogenise the human capital in growth models is the extended Solow-model from Mankiw, Romer and Weil (1992). According to their empirical results, a model – covering the factors work and capital as well as the exogeneous factors savings and population growth – explains more than 50% of the differences in GDP per capita across countries. Extending this model through the factor human capital results in explaining more than 80% of these differences.

3 This study is part of a project "Macro and regional economic costs, financing and returns to further education", funded by the German Federal Ministry for Education and Research as part of the research programme "Innovation in Weiterbildung". We gratefully acknowledge this support.

4 Implicitly, this assumption leads to a departure from the assumption that the factor work is paid according to his marginal productivity.

Despite its merits, a major short-coming of these and other studies is that they rely only the (average) years of (formal) education. During the last 20 years, particularly due to the work from Woessmann (2002) and Hanushek/Woessmann (e.g. 2012, 2015), a stronger focus was laid on the quality of human capital. Their research suggests that the quality of human capital is more important, rather than the duration of education. Following Hanushek and Woessmann (2012, 2015), education quality accounts for around 70% to 75% of variations in growth rates across countries, when controlling for GDP per capita in 1960, the starting year of analysis, whereas education attainment itself does not play a statistically significant role anymore.

The recent improvements in explaining the role of education for economic growth reveal a strong predictory power, i.e. countries faring better in international competence studies, such as, for example, PISA or TIMSS, show higher growth rates than countries ranking lower. When focussing at regional (continental) development, the East-Asian growth miracle as well as the Latin American developments show strong correlations to education development, and here in particular to quality.

Yet, despite this strong empirical relationship, it raises the question why “only” the quality in intial (formal) and general education, assessed at teenager age, should play a role in this regard. Some reasons indicate that it is rather likely that the various forms of CVET, such as, for example, learning in the workplace, professional training etc., contribute also to growth and innovation. The explanatory role of adult learning would only vanish completely in such a model, if it does not alter the (average) competence level or structure, as measured in international assessment studies, at all. However, learning is as other goods linked to depreciation, knowledge, skills or competencies weaken if not or only rarely employed (see PIAAC for example – pointing; Brunello 2001; Hanushek et al. 2015). Apart from employing KSC this requires certain forms of ‘updating’ or ‘re-learning’.

Following the analyses of Hanushek et al. (2015), the role of CVET becomes particularly important. They find a trade-off between vocational learning, earlier and easier transition into the labour market, but also (on average) earlier labour market exit, and general education, commonly up to tertiary education, and later labour market entry and exit. They argue that vocational learning is linked to more specific knowledge that depreciates at higher rates, resulting in earlier labour exit, while general education allows higher basic competencies and lower depreciation rates. The core concern for this study is that this finding would suggest higher CVET rates for those with vocational qualifications, while the opposite is commonly true, i.e. participation in adult learning correlates with level of initial education and is higher for those with tertiary education than with secondary education.[5] The higher participation rate of those with general education, which is probably identical with a higher education degree, in lifelong learning might be one factor, among others, why they remain longer in the workforce. The analysis by Hanushek et al. (2015) confirms that those with general education participate more in adult learning than those with vocational education, particular from age 50 onwards.

5 The analysis by Hanushek et al. (2015) may have certain short-comings, even though they account for unobserved factors. It is even for Germany not fully clear, to which qualification the analysis exactly refers. A general (upper) secondary education graduate usually moves on to vocational or higher education, whereas the vocational pathway is commonly either at the same level of formal upper secondary education than almost any other vocational programmes or, in some, more rare cases linked at the so-called post-secondary, non-tertiary education level. Apart from some exceptions, where an individual does not enter either of these pathways, a person with a general upper secondary qualificiation, but without another vocational or higher education qualification has dropped-out from one of these pathways. Furthermore, is remains open to which extent differences in competence levels exist.

Furthermore, knowledge enhances, new technologies arrive and/or existing technologies develop further, due to (product, process or organisational) innovation, research and development, etc. requesting adults, those employed but also those unemployed or even not in the workforce, to keep up to date with these developments. Research indicates that those with higher levels of education adapt, for example, new technologies easier and faster than others and are more open for such technologies.

Even though the empirical evidence seems quite compelling one question remains: why should only initial education, taking place within the first 25 years of life, be accountable for long-term growth rates, while education and training taking place later in life and throughout the 40 or even 50 years of works would be of rather limited relevance. In this regard, it is striking that continuing vocational education and training (CVET)[6], although key to keep human capital up-to-date, to adapt to recent developments, receives hardly any attention. Among the very few exceptions is the study from Bassanini et al. (2006) arguing that growth effects are likely for (workplace) training, which is their synonym for CVET, because they consider education and (workplace) training as complements; however, they provide no further evidence for the macroeconomic relevance of adult learning. In this regard, it appears that this paper is a starting point for focussing explicitly the economic role of CVET. This following section reviews some facts, why the role of CVET might be more important than acknowledged so far.

3. Some indications why further training might be relevant for growth and innovation

Figure 1 provides and overview on the participation rate of countries in CVET, according to the most recent adult education survey (AES 2011), and links those to GDP per capita. The trend line suggests that a relationship between both indicators may exist. The (bi-variate) correlation is highly significant and explains more than 50% of the variation; controlling for relevant factors, such as education attainment (share of adult population with tertiary education), do not affect this finding. However, of course, further and more sophisticated analyses are required to confirm (or not) such correlations.

Figure 2 links the participation rates in AES 2011 to the share of employees working in knowledge intense and knowledge extensive sectors of the economy. It clearly highlights that a positive correlation exists with regard to the share of employees in knowledge intense branches and a negativ concerning the share of employees in knowledge extensive sectors. The correlation between CVET participation rates in countries and the share of employees in knowledge intensive sectors of the economy, even when controlling for GDP per capita, economic growth rate in 2011 and even when controlling for both variables at the same time. Thus, the share of employees in knowledge intensive branches is very likely to be a driver for participation in CVET.

6 Some studies refer to training (e.g. Brunello et al. 2006, Bassanini et al. 2006), though not distinguishing between initial and continuing education and training.

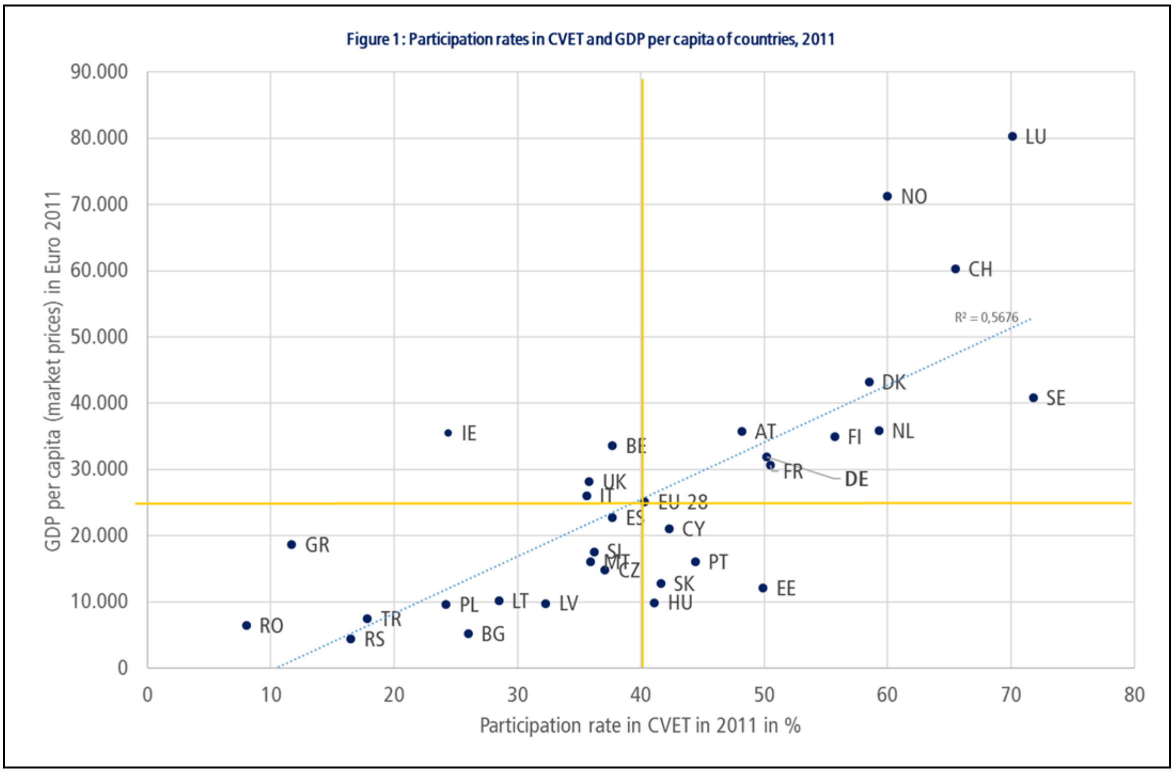

Figure 1: Participation rates in CVET and GDP per capita (2011)

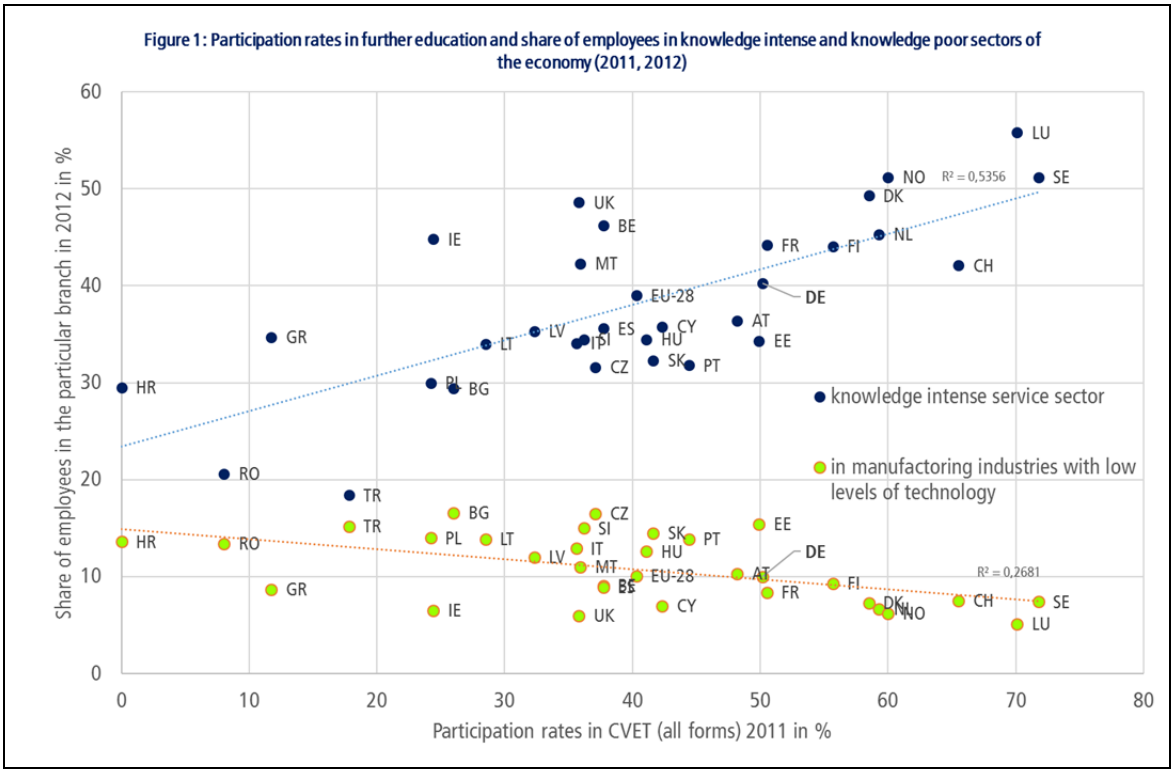

Figure 2: Participation rates in CVET and share of employees in knowledge intense and knowledge extensive sectors of the economy (2011)

The correlation for knowledge extensive branches is less clear. Here seems GDP per capita an important factor, when controlling for it, while when controlling for GDP growth rates in 2011, a significant negative correlation can be identified.

These results indicate that CVET is a factor in relation to growth and raise the question, whether GDP per capita requests more CVET or whether participation in CVET drives economic growth.

Country	PISA 2000	PIAAC 26 to 28
	Standard scores	
Australia	0,9	-0,4
Austria	0,2	0,4
Canada	0,9	-0,4
Czech Republic	-0,4	0,9
Denmark	0,2	0,7
Finland	1,0	1,6
Germany	-0,6	0,4
Ireland	-0,2	-1,1
Italy	-1,8	-0,9
Japan	1,7	1,4
Korea	1,4	0,4
Norway	-0,3	0,0
Poland	-1,4	-0,7
Spain	-1,1	-1,9
Sweden	0,1	0,7
United States	-0,5	-1,2

Table 1: Changes in the relative competence level of the PISA-2000 generation until age 27 (PIAAC)

Eventually, Table 1 reviews the relative competence levels of 15 year-old students according to PISA 2000 and investigates how the competence level of this cohort changes over the next 12 years. The PIAAC-study 2012 looks at the competences of the adult population from 15 to 64 years of age, and allows a detailed look at age age group. Those, who were 15 years old in 2000 are aged 27 in 2012. Looking at the relative position of 15 years olds in 2000 and those aged 26 to 28 in 2012 according to PIAAC reveals some interesting changes. While, for example, 15 year old Australians scored 0.9 standard deviation above mean in 2000, the same groups, now aged 26 to 28, scored 0.4 standard deviation below average in 2012. A similar picture turns out for Canada. In contrast, Czech and German youngsters improved their relative position from 0.4 and 0.6, respectively, standard deviations below average to 0.9 and 0.6 standard deviations above average. Other countries show similar changes in either direction. This indicates that changes in the relative “international ranking” position are rather likely to happen, for whatever reason.[7]

Adult learning – a short overview on surveys and datasets

Five major surveys are available providing data on participation in lifelong learning, with some focus on Europe. The adult education survey (AES) conducted in 2007 and 2011, reviews participation in adult learning during the 12 months prior to the survey. It is a self-contained survey referring to “all learning activity (i.e. intentional learning) undertaken throughout life, with the aim of improving knowledge, skills and competences, within a personal, civic, social, and employment related perspectives” (Eurostat AES metadata). This includes formal and non-formal activities, while informal learning activities, such as self-learning, are not considered.

The LLL ad hoc module of the European Labour Force Survey (LFS) covers "all purposeful learning activity, whether formal or informal, undertaken on an ongoing basis with the aim of improving knowledge, skills and competences" (Eurostat LFS-LLL metadata); “informal learning activities” include “non-formal education” as well as “informal learning”. It looks at the four weeks prior to the survey and collects data every year.

The Continuing Vocational Education and Training Survey (CVTS) reviews learning activities in enterprises employing 10 or more staff. Here, participation rates refer to the percentage of employees participating in continuing vocational training courses (all enterprises). Thus, learning activities refer particularly to non-formal training, while informal learning is neglected and persons who are not employed are also excluded. The CVTS was conducted in 1999, 2005 and 2010.[8]

Not surprisingly, the data on participation in adult learning vary a lot across surveys, due to the different designs, definition of/focus on adult learning and, in particular, the reference period. Despite differences in detail, some common pictures emerge across most studies: participation rates are commonly higher in the Nordic countries and lowest in the South-Eastern countries, they increase with education and qualification, i.e. they are highest for those with higher education and least for lowly educated. Older people (starting from age 50+ or 55, depending on survey) participate less, although due to employment situation rather than age, while also the lower average level of education plays a role. Eventually, participation in formal education is much lower (while requiring more time input) than in non-formal training, which is much shorter.

Eventually, some trade-offs seem to appear between participation rates and duration of training, i.e. higher participation rates are in line with shorter duration and between participation rates of companies and employees, even though a positive link exists, i.e. the share of employees in company-provided training increases with level on companies providing training opportunities.

Two additional surveys were conducted in particular with regard to adult competencies, the IALS (International Adult Literacy Survey) was conducted in 18 countries during the period 1994 to 1994, the PIAAC (Programme of International Assessment of Adult Competencies) collected data on 16- to 64 year olds in 2012 and included more than 20 countries. Not surprisingly, again, adult competencies increase

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7 A possible explanation are differences in the education and training system after age 15, but also varying youth unemployment levels. Investigations in this regard are left to the future.

8 While the LFS is conducated annually anyway, data for AES and CVTS are also collected in 2015/16,

with the level of initial education, as pariticipation in adult leaning does. PIAAC contains also data on participation in adult learning.

With regard to the analysis by Hanushek and Woesann (2012) an interesting feature is a comparison between competence levels of 15-year olds according to PISA (2000 and 2012) and PIAAC.

A matter of concern with regard to adult learning, compared to primary, secondary and large parts of tertiary education, is the huge variety of adult learning programmes, even within countries. An hour of computer learning or a conference participation of some hours or days is considered as adult learning (in some surveys) as is a formal master craftsman programme, lasting several months or even years. Thus, adult learning is much more heterogeneous in nature, than initial education. It is therefore not surprising that the rates of return to such programmes vary substantially (for a review see, for example, FiBS/DIE 2013).

4. Empirical analyses

4.1 Adult education and growth

Investigating the macro economic role of adult learning, the relationship between AES participation rates and real GDP growth rates over time is analysed on the basis of cross sectional data for the years 2007 and 2011 as well as simulated (interpolated) panel data, which is more promising.[9]

	FE1	FE2	RE1	RE2
	Real GDP growth	Real GDP growth	Real GDP growth	Real GDP growth
AES participation	0.827***	1.048***	0.569**	0.542**
Time lag of AES participation (participation rate in previous year)		0.274**		0.355****
GDP per capita	3.248*	1.142	-0.389*	-0.477***
Year dummy	yes	yes	yes	yes
N	44.000	37.000	44.000	37.000
r2_w	0.627	0.731	0.489	0.609

Standardised Beta Coefficients. Significance levels: *p < 0.10, **p < 0.05, ***p < 0.01, ****p < 0.001

Table 1: Fixed effects estimation results of AES participation on growth. Years 2007 and 2011

Table 1 presents the results of four regression models, differing concerning their estimation method, Fixed Effects (FE) vs. random effects (RE) estimation, and the inclusion of the lag of participation in adult learning as an independent variable (in FE 2).[10] Regression results for all models suggest a positive rela-

9 For the analysis of panel data, advanced panel estimation methods are necessary. Elaborate information on the different estimation methods, reasons underlying the choice of the fixed and random effects estimation method, as well as choice of control variables and time effects is provided in the section 0.

10 As in all cases when dealing with regression models containing variables with missing data on certain countries and time points, it is important to keep in mind that the estimation excludes these missing observations and regression results are hence not applicable to these. It was previously mentioned that AES data does not include Luxembourg. Furthermore, OECD

tion between AES participation and real GDP per growth. This effect holds even when (additionally) controlling for the time lag of AES participation, which shows that it is not merely caused by serial correlation, i.e. differences in participation rates of countries being based on differences participation rates in the past. Furthermore, regarding FE 2 and RE2 (R^2), the models with the highest goodness of fit value "within their estimation method", both AES participation and the time lag of AES participation are significant, which suggests that participation in adult learning has a positive impact not only on short term but also on long term growth. Furthermore, the strength of the relationship between participation in AL and growth, as measured by the respective beta coefficient, is strong – regarding strictly RE results (RE1, RE2), even the strongest of all variables. Interestingly, GDP per capita and growth appear to have an only barely significant (FE1) or insignificant (FE2) relationship, when regarding FE models. Regarding RE models, suggests this relationship to be negative, if only barely significant in RE1. Overall, a negative relationship between GDP per capita and real GDP growth which can be explained by the fact that countries with high economic performance may have less scope for growth as they are approaching steady state growth rates.

To sum up, results suggest that countries with higher AES participation rates show higher growth rates than countries with lower rates (after accounting for differences in economic performance and time effects). These results serve as a first indication of a positive relationship between participation in AL and economic growth, suggesting short term as well as long-term benefits for the countries of analysis.[11]

4.2 Adult learning and innovation

In another study, published by Cedefop (2012) the impact of different measures of participation in and provision of training on innovation in the EU-27 Member States and Norway was reviewed. More precisely, the effect of different measures of participation in and provision of training – participation in adult learning (AL), the share of training enterprises, HR practices, employee participation in CVT courses, workplace learning and costs of CVT as share of total labour cost – on innovation performance was analysed. Bivariate estimation results (see Table 2) suggest that strong and significant linear relationships exist between all previously stated measures of participation in and provision of training in the EU27 and Norway. Participation in AL hereby shows the highest correlations (r = 0.67) with innovation performance.

Interestingly, when comparing the correlations of these further education (CVET) indicators with that of tertiary education, the study finds adult learning as well as company-provided training have stronger correlations with innovation performance than tertiary education. Various bivariate and multivariate analyses were carried out to further analyse the relationships of these indicators and innovation performance. Positive correlations between different variables linked to adult learning and innovation were observed. In addition, participation in adult learning was found to covariate positively with innovation performance.

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data on GDP per capita does not cover Bulgaria, Latvia, Lithuania, Malta, Romania and Cyprus. Furthermore, as previously stated, all coefficients are to be interpreted in comparison to the base level, year 2007, ceteris paribus. A more detailed regression table, as well as more detailed discussion on regression results, is provided in the section 0.

11 The same model was estimated using Labour Force Survey (LFS) participation rather than AES participation rates for the time frame regarded. In contrast to the model with AES participation rates, regression results for participation in AL were not significant. One possible explanation is that the countries included in the LFS differ slightly. Furthermore differences may be attributed to differences in the survey population of the AES and LFS. Given that the LFS rates incorporate the age group 15+, they may be considered a less precise measure of adult learning than AES rates.

Bivariate estimation results		
Dependent	**Independent**	**Correlation coefficient r**
innovation index (2010)	participation in AL (2009)	0.67***
innovation index (2010)	share of training enterprises as% of total (2005)	0.66***
innovation index (2010)	HR index (2009)	0.58***
innovation index (2010)	employee participation in CVT courses (2005)	0.57***
innovation index (2010)	Other forms of learning in enterprises index (2005) (2005)	0.51**
innovation index (2010)	costs of CVT as% of total labour cost (2005)	0.45*
participation in AL (2009)	Other forms of learning in enterprises index (2005)	0.56***
participation in AL (2009)	HR index (2009)	0.57**

*p < 0.05 (significant); **p < 0.01 (highly significant); ***p < 0.001 (extremely significant)

Table 2: CVT provision and participation, and innovation (Cedefop 2012)

While the significant correlation between participation in adult learning and innovation performance could not be confirmed in “smaller” multivariate analyses including the highly significant control variable cognitive factors (i.e. task-complexity aspects of work organisation), a factor analysis accounting for multiple important indicators linked to innovation retrieved interesting results in this regard. Before elaborating these results, background information on the countries of analysis as well as factors must be provided.

The study used a factor analysis to explore if human capital formation has an actual effect on innovation performance. To generate the human capital factor, variables representing participation in and provision of adult learning were collapsed in one factor, explaining 66.6% of the variance.

As portrayed by Table 3 the human capital formation factor correlates with share of training enterprises, employee participation in CVT courses, firms’ investment in CVT, participation in AL, workplace learning and the human resources (HR) index. Of the 6 variables collapsed, participation in adult learning (LFS 2009) had the fourth highest loading, after the first three variables related the CVET.

In addition, although not as interesting in the context of this study as the first factor, a second factor ‘Organisation typology’ was generated, in which variables representing different work organisation types (discretionary learning, taylorist and traditional) were collapsed. While all three work organisation forms showed high loadings, those of the latter two types were negative, while discretionary learning had a positive loading. This factor explained 80.79% of the variance.

Human capital formation	Components (factors) 1
participation in AL (LFS 2009)	0.799
share of training enterprises as% of total (2005)	0.916
employee participation in CVT courses (2005)	0.848
workplace learning index (2005)	0.764
HR index (2009)	0.735
costs of CVT as% of total labour cost (2005)	0.821

Table 3: Human capital formation (Cedefop 2012)

Overall, multivariate regression results suggest that task complexity (cognitive factors) and human capital formation are the two driving factors of innovation performance rather than participation in higher education (HE), the latter being frequently used as an indicator of innovative ability. Concerning the significant link between the human capital factor and innovation performance, it should be noted that results suggest this link to be strongly driven by CVET variables. Furthermore, the strong significant effect of task complexity on innovation performance portrays the importance of learning-intense (working) environments for innovation. The results of this study clearly indicate that adult learning in its varies forms may play an important role with regard to innovation in Europe.[12]

Dependent	Independent	Beta coeffcient	R^2
Innovation index (2010)	Factor 1 (Organisation typology)	0.11	0.84
	Factor 2 (Human Capital Formation)	0.27*	
	GDP per capita (2010)	0.03	
	Cognitive factors (all years)	0.78***	
Source: Cedefop 2012	Share of tertiary education (2005)	-0.004	

Table 4: Regression results (Cedefop 2012)

The role of CVET is indirectly also highlighted in another study, which found that tertiary education itself is not sufficient to contribute to innovation (Vosskamp, Nehlsen and Dohmen 2007). In this study, the authors found that a relationship between age, share of tertiary educated people and innovation exists. A (weakly) significant correlation could be identified between the patent intensity of countries and the share of the tertiary educated population in the age group of 45 to 54 year olds, only. Disaggregating the figures into the shares of ISCED 5B and ISECED 5A/6 revealed that (weakly) significant correlations could be identified for the shares of ISCED 5B in the age cohorts of 35 to 44 and 45 to 54 year olds, while no even one significant correlation could be identified for ISCED 5A/6. This finding would suggest, firstly, that tertiary education has to be complemented by continuing education and, secondly, that shorter tertiary programmes are more important than longer programmes. Although ISCED 5B refers in several countries, such as, for example, Germany to practically-oriented programmes, it is not yet clear, whether this plays a

12 Furthermore, the results suggest that focusing on tertiary education in the Innovation Union Scoreboard (IUS) is narrowing the role of education and training with regard to innovation and recommend the inclusion of CVET-indicators in the IUS.

role. Section 0 provides more in-depth information, particularly on methodological issues, but also on additional findings.

Based on these findings for two major components of economic development – innovation and growth – the following sections investigate, whether results can be confirmed by additional research and how this can be explained theoretically.

4.3 Adult Learning and Innovation – an update on the basis of newer IUS-data

Figure 3 shows the relationship between the share of enterprises providing CVT and the innovation performance of the particular countries in 2010; Figure 4 shows the same "input indicator" but in relation to IUS-results in 2013. The R^2 presented in the upper left of Figure 3 suggests a relatively strong relationship for 2010, but far less for 2013, which is also visible by the spread of countries across the graph. This suggests that companies' training provision is strongly linked to innovation performance in the short-run, but less in the medium-term. The squares in both figures highlight the group of countries represented in the partnership. Germany is among the countries at the top, though having the lowest share of companies providing CVT to their employees in relation to innovation performance.

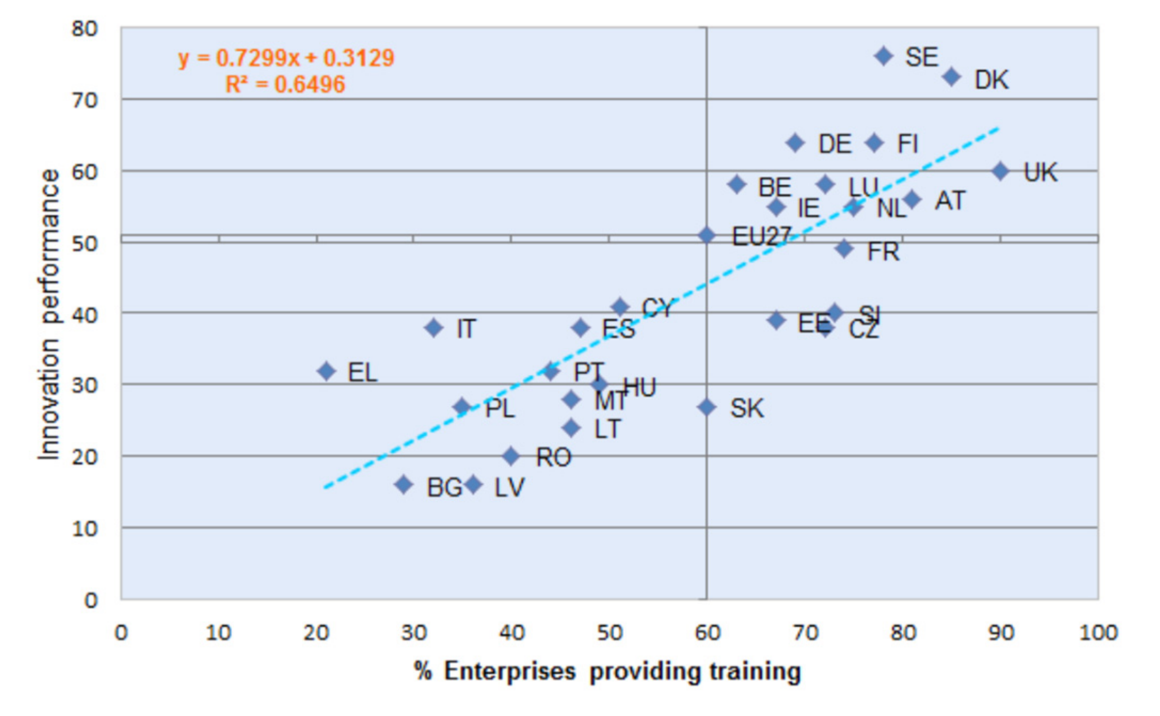

Figure 3: The share of enterprises providing training and innovation (IUS 2014)

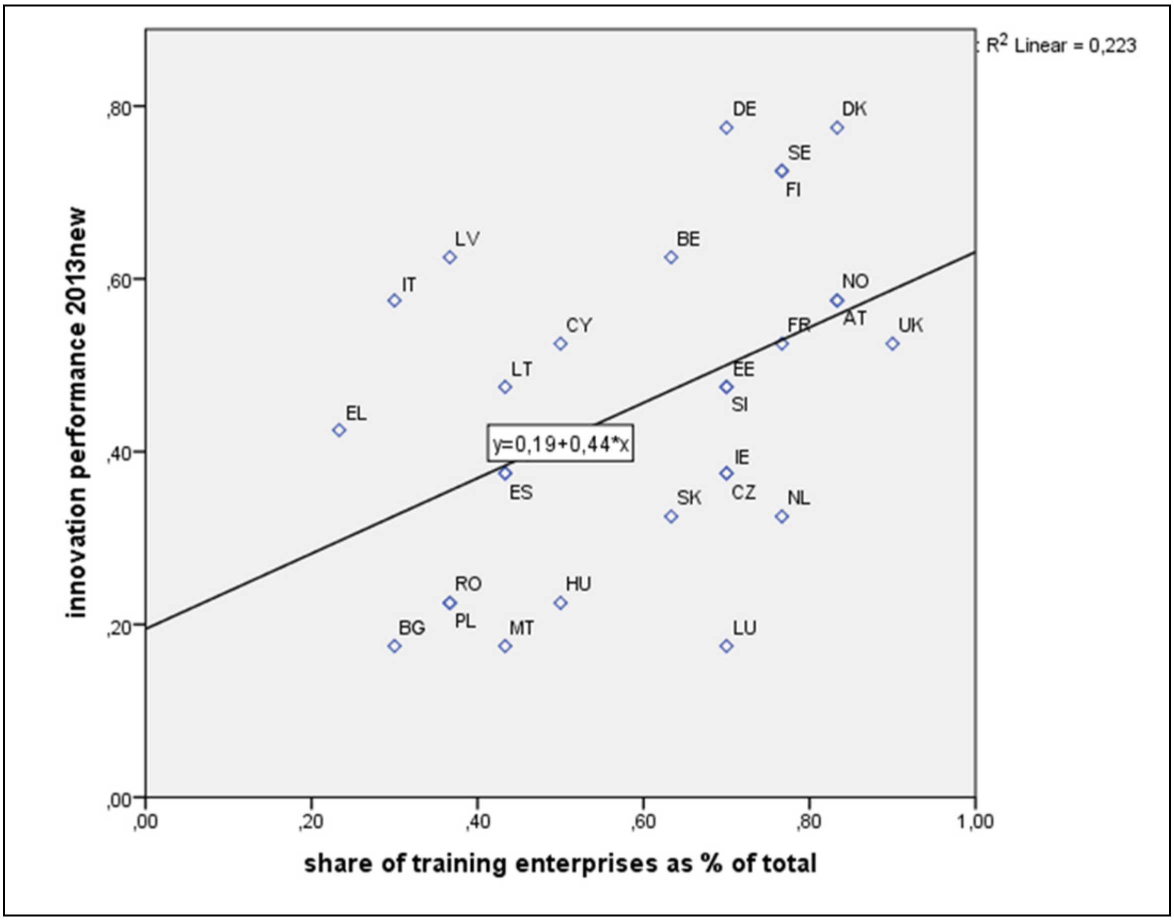

Figure 4: The share of enterprises providing training and innovation (IUS 2010)

Figure 5 shows the relationship between indicator "cognitive factor" as measured by European Working Conditions Survey (all years) and innovation performance in 2013 (IUS 2014). Even though the innovation leaders are at the top, the correlation is much weaker, which is also the case for the share of tertiary education graduates in the adult population (see Figure 6).

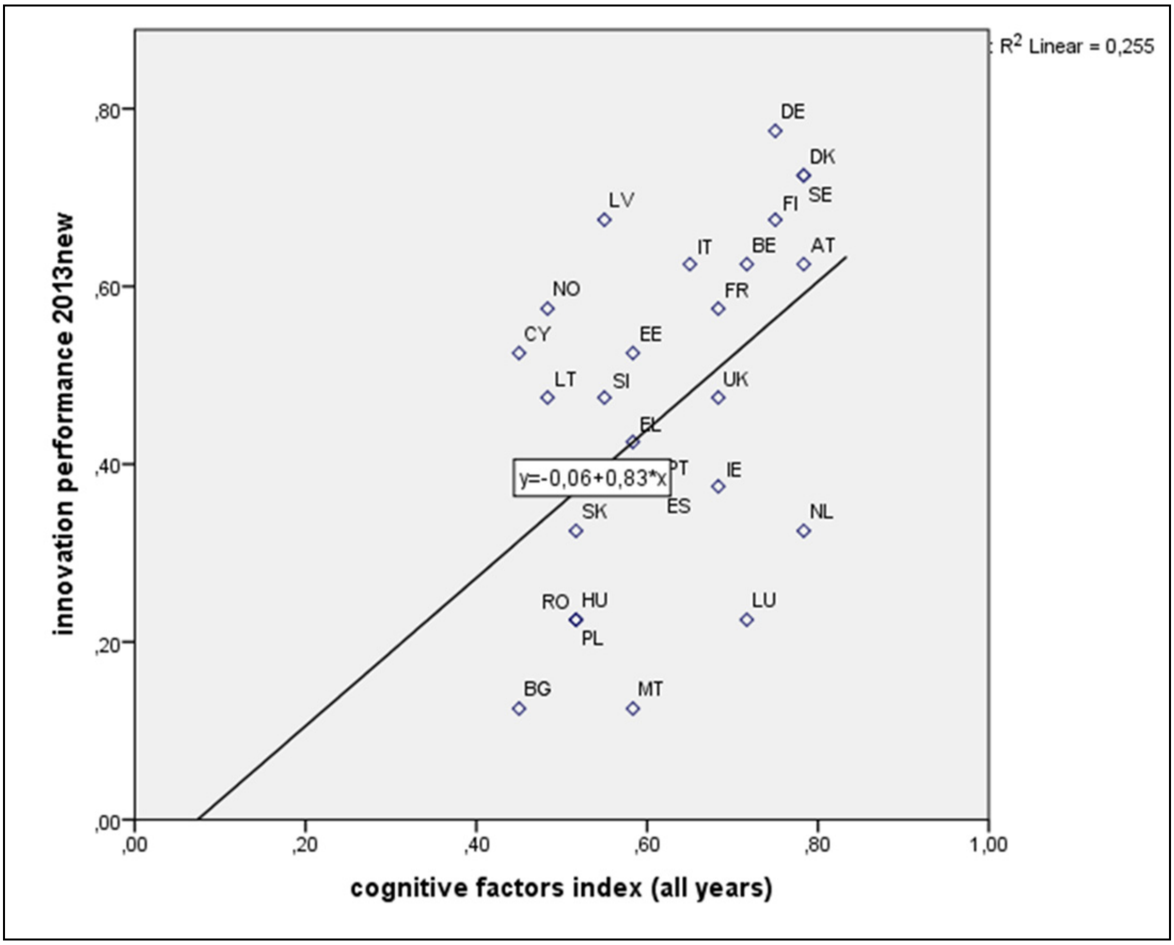

Figure 5: The role of cognitive factors for innovation (IUS 2014)

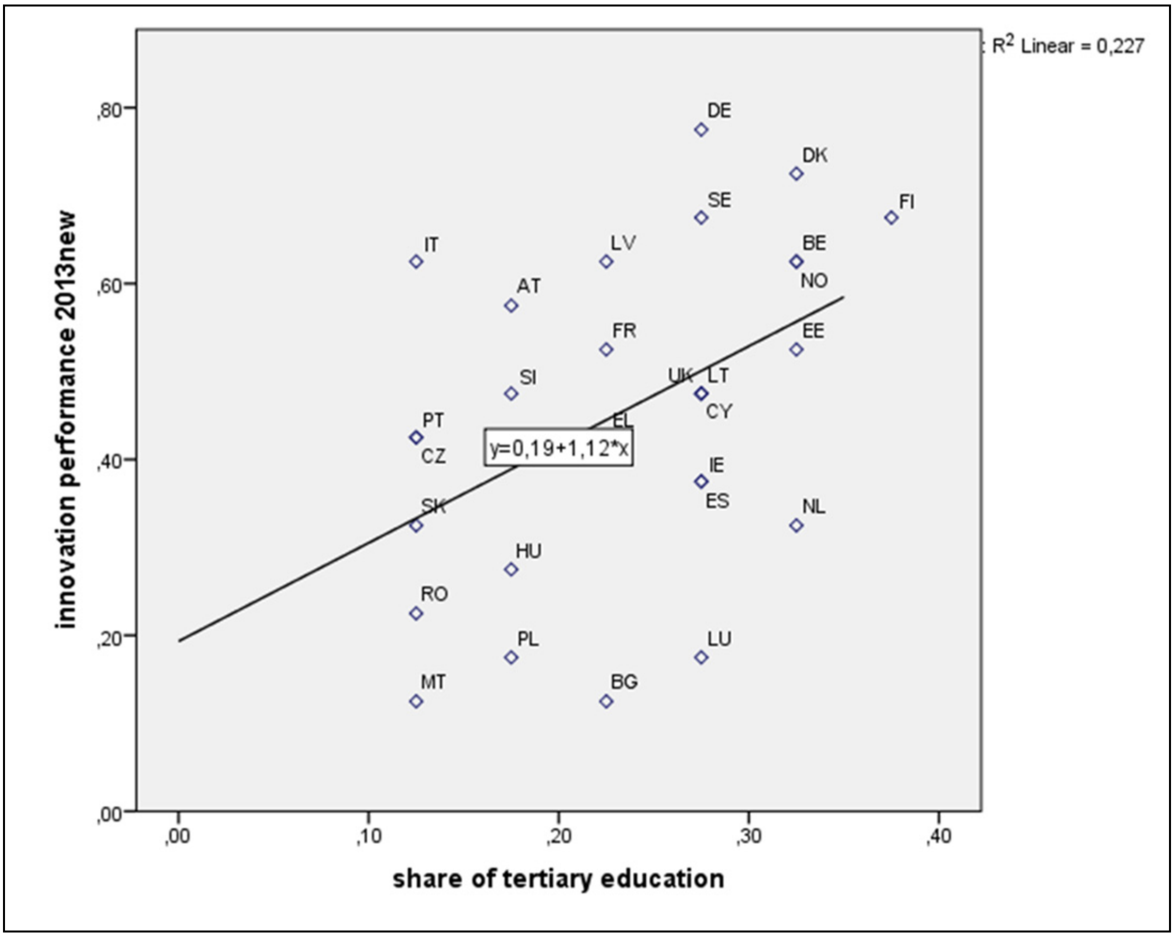

Figure 6: The share of tertiary educated adults in relation to innovation (IUS 2014)

4.3 Empirical relations between Adult Learning and Innovation: Multivariate analysis

Coefficients[a]

Model	nonstandardised coeff. B	SE	standardised coeff. Beta	t	significanc
(constante)	-,490	,300		-1,632	,127
REGR factor score 1	,049	,046	,254	1,079	,300
REGR factor score 2	,022	,052	,113	,419	,682
cognitive factors index (all years)	1,582	,496	,874***	3,189	,007
share of tertiary education (2005)	,991	,466	,408*	2,127	,053
GDP per capita (2010)	-,002	,001	-,645*	-2,699	,018

a. dependend variable: innovation performance 2013new

For innovation performance in 2013 significant Beta coefficients for cognitive factors, GDP per capita and (less) share of tertiary education (red frame)

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Figure 7: Factors driving innovation (IUS 2014) – a multi-variate analysis

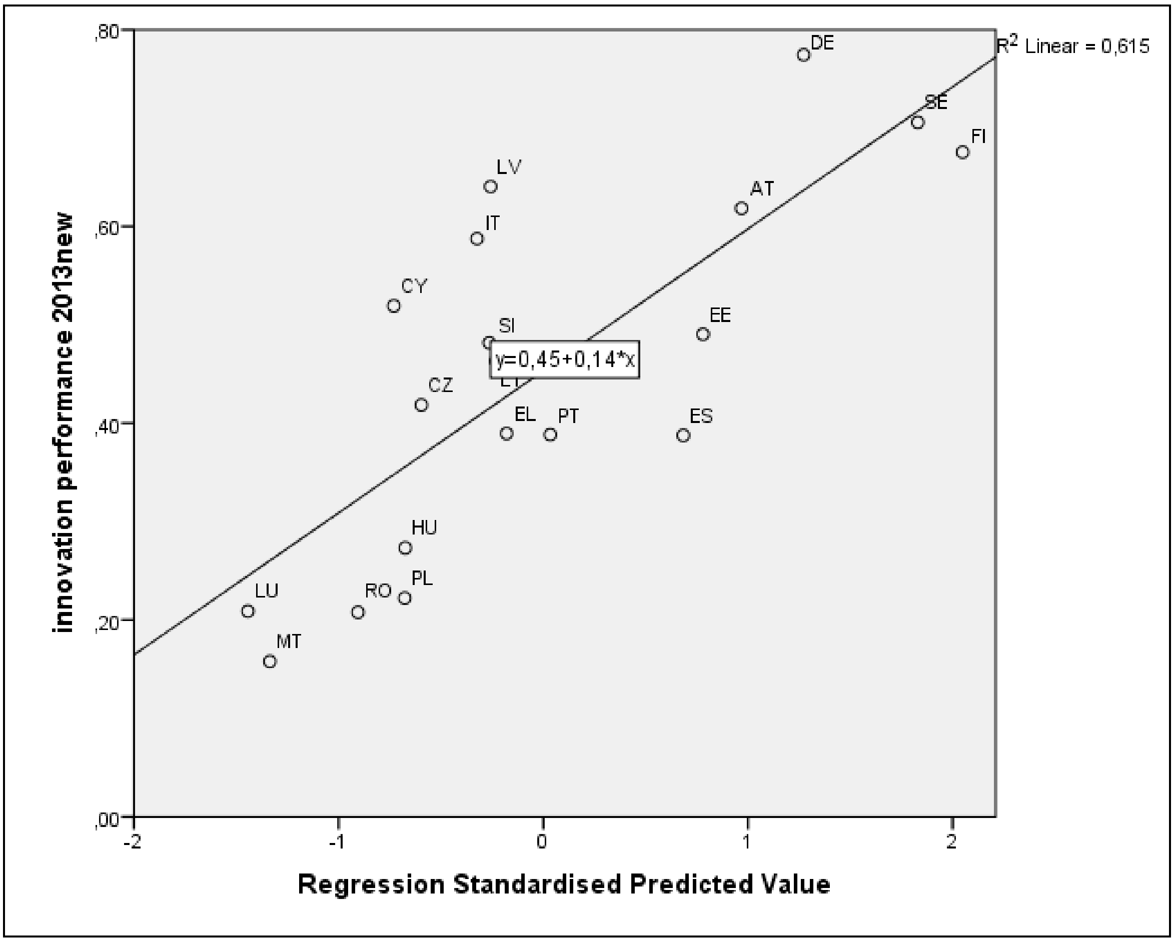
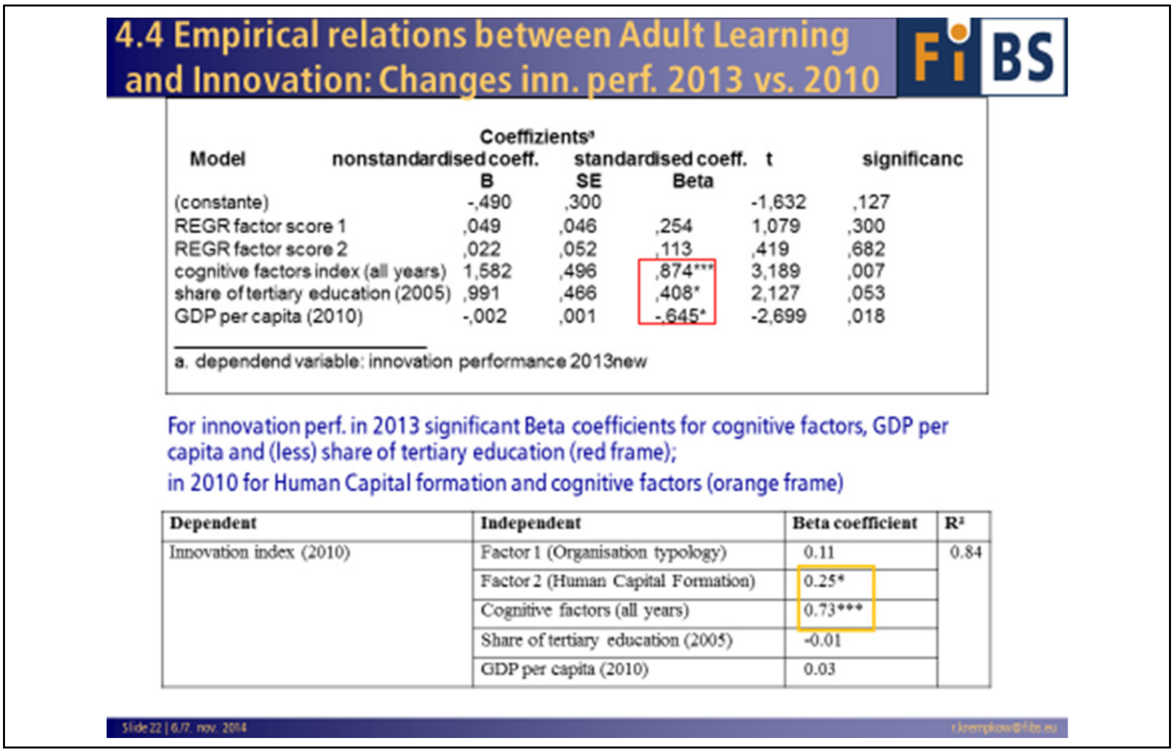


Figure 8: Factors driving innovation (IUS 2014)

Figure 7 shows the results of a multi-variate regression analysis in relation to explaining the driving factors for innovation performance in the year 2013 (IUS 2014). It highlights the importance of cognitive factors, being the only factor with a strong and highly significant correlation. In contrast, the role of higher education is only weakly significant and much weaker. Figure 8 translates these findings into a graphical presentation.



4.4 Empirical relations between Adult Learning and Innovation: Changes inn. perf. 2013 vs. 2010

Coeffizients[a]

Model	nonstandardised coeff. B	SE	standardised coeff. Beta	t	significanc
(constante)	-,490	,300		-1,632	,127
REGR factor score 1	,049	,046	,254	1,079	,300
REGR factor score 2	,022	,052	,113	,419	,682
cognitive factors index (all years)	1,582	,496	,874***	3,189	,007
share of tertiary education (2005)	,991	,466	,408*	2,127	,053
GDP per capita (2010)	-,002	,001	-,645*	-2,699	,018

a. dependend variable: innovation performance 2013new

For innovation perf. in 2013 significant Beta coefficients for cognitive factors, GDP per capita and (less) share of tertiary education (red frame);
in 2010 for Human Capital formation and cognitive factors (orange frame)

Dependent	Independent	Beta coefficient	R^2
Innovation index (2010)	Factor 1 (Organisation typology)	0.11	0.84
	Factor 2 (Human Capital Formation)	0.25*	
	Cognitive factors (all years)	0.73***	
	Share of tertiary education (2005)	-0.01	
	GDP per capita (2010)	0.03	

Figure 9: : Factors driving innovation (IUS 2014 and 2010) – a multi-variate analysis

Figure 9 complements the previous findings with a second regression analysis with the same factors, though in relation to innovation performance in 2010. It turns out that cognitive factors are, again, the only factor with a highly significant, though with a somewhat weaker correlation. In contrast to Figure 7, Human capital formation is the second, weakly significant factor, while neither the share of tertiary educated adult (in 2005) nor GDP per capita (2010) is not significant.

Innovation Index (all indicators)	2009		2011		2013	
	Beta	Sig	Beta	Sig	Beta	Sig
1 (constant)						
REGR factor score 1 for analysis 1	0,16		0,17		0,15	
REGR factor score 1 for analysis 2	0,07		0,17		0,13	
cognitive factors index (all years)	0,94	* * (*)	0,87	* * (*)	0,84	* * (*)
share of tertiary education (2005)	0,38	*	0,37	*	0,4	*
GDP per capita (2010)	-0,66	* *	-0,67	* *	-0,61	* *

Figure 10: Time lag considerations in relation to innovation

Since these results suggest that relationships may vary over time, Figure 10 reviews the linkages between the same factors and innovation (all indicators). The multi-variate analysis shows an interesting result: the cognitive factor index (all years) is the only variable that remains highly significant over all years, though with a slightly decreasing value. The share of higher education graduates among the adult populations is significant and remains rather stable over time. GDP per capita has a significant, but negative impact at a rather stable level. However, it is possible that is explanatory power may slow down over the years.

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Annex 1: Relationship between adult learning, growth and innovation – methodology and more detailed results

This annex serves to provide detailed information on the estimation techniques and models used in the multivariate regression analyses of AES participation on **real GDP growth** over time. In this chapter, the first series of models, already briefly presented within this study, is elaborated. Thereafter, the results of a second series of models, based on simulated data and discussed only within the annex, are briefly introduced.

First regression model series – based on 2007 and 2011 AES participation data

In the estimation presented in this study, the effect of AES participation on real GDP growth over time was analysed, considering data on the years 2007 and 2011[13]. For such an investigation, the use of panel data is required, i.e. a dataset in which the behaviour of entities is observed over time. These entities can for example be states, companies, individuals or, as in our case, countries. Given the complexity of panel data, different forms of estimation methods may be necessary to use than when dealing with other forms of data, such as cross-sectional data. Several different forms of advanced panel estimation methods exist, the most common being pooled ordinary least squares (POLS), fixed effects (FE) and random effects (RE) estimation. The choice concerning which of these estimation methods to use depends on data characteristics.

In order to decide which of these estimation types is most suitable for the panel data at hand, poolability tests are crucial in order to ensure that the data can be pooled, and thus analysed. POLS is a suitable panel estimation method when observations are pooled over time or cross-sectional units – in our case years and countries. In the case of our analysis, poolability tests rejected the use of POLS estimates. When POLS cannot be used for analyses of panel data, random or fixed effects estimation is typically considered. The main difference between fixed and random effects estimation can be summarised as following. For each entity (in this case country), fixed effects (FE) estimation controls, i.e. accounts, for time independent characteristics which are possibly correlated with the inde-pendent variables included in the model. This could for example be the effects of certain structures in the adult learning sector, which do not vary over time and are possibly correlated with participation in adult learning (AL). To sum up, using fixed effects estimation removes the effect of constant variables over time, allowing us to analyse the impact of variables that vary over time. In contrast, random effects (RE) estimation allows the inclusion of time-invariant variables, as it considers the variation across entities, in this case countries, to be random.

As in the case of POLS, tests are used to confirm which estimation method is best suited for the data at hand. Concerning the use of RE estimation, the Lagrange Multiplier (LM) test confirmed the

13 In addition to AES participation rates retrieved via Eurostat, OECD data on GDP per capita and real GDP growth was used to form the data base on which both series of models were estimated.

poola22bility of RE estimates, signaling these estimates to be more suitable for the regression analysis than POLS estimates. However, further testing is required to ensure that RE and not FE estimation is most suitable for the analysis of the panel data at hand. FE estimates are preferred to RE estimates when differences in coefficients are systematic. Using RE estimates in such a situation would imply the use of inconsistent estimates[14]. In order to test for systematic differences in the coefficients of a certain model, the Hausman specification test is used. Given that test results did not confirm the existence of systematic differences, RE or FE estimates may be used for the analysis.

Due to these test results, Table 1 presents multivariate regression results (standardised beta coefficients and significance levels) retrieved using fixed and random effects estimation. All analyses, irrespective of their estimation method, aim to analyse the relationship between participation adult learning (independent variable) and real GDP growth (dependent variable) over time. Hence, partici-pation in adult learning represents the main effect of interest. In addition to participation in adult learning, a set of different control variables are included in all models, in order to reduce possible bias caused by omitted variables, i.e. endogeneity. In order to account for differences in economic per-formance across countries, GDP per capita – which represents one of the most commonly used vari-ables in this respect – is included. Furthermore, it is important to keep in mind that trends and/or sea-sonality may play a role when the relationship between different variables over time is analysed. Many variables are likely to be trending over time and may fluctuate in similar patterns. Failing to account for this, i.e. not accounting for time effects, may result in (significant) relationships being suggested between variables only because similarities in trending exist between them (Wooldridge 2009). Time effects can be accounted for either by including a so-called year trend or year dummies. In the case of this study, the latter method was chosen[15].

While the previously mentioned control variables, GDP per capita and time effects are included in all models, an additional variable to the variables in FE1 and RE1 – a time lag in participation in adult learning – is included in the models FE2 and RE2. The underlying reason for this is that in doing so, inferences on whether or not participation in 2007 may have contributed to affecting growth rates in 2011 can be made[16]. This is interesting, as participation in AL is likely to affect growth with some delay. In addition, including a time lag ensures that the relationship between adult learning and growth is not merely a consequence of serial correlation, i.e. differences in participation rates of countries in later years being based on differences participation rates in the past.

Regarding the results of Table 5, all coefficients are interpreted in comparison to the base level, year 2007, all else equal (‘ceteris paribus’).

Regardless of which of the four models are regarded, a positive effect of AES participation on real GDP growth is visible. This effect holds even when controlling for the time lag of AES participation (FE2, RE2). Furthermore, both AES participation and the time lag of AES participation are significant, which

14 If an estimator converges in probability to the population parameter as the sample size, N, “grows to infinity”, it is considered to be a consistent estimator (Wooldridge 2009).

15 When using year dummies, one year dummy less than the total number of years in the data is omitted to form the so-called base level. In the case of our analyses in both series of models, the year dummy 2007 forms the base level.

16 Please note that as only regard the years 2007 and 2011 are regarded in our first series of models, the time lag in participation in 2011 is the participation rate in 2007. However, when data on a greater number of years, as in the second series of (simulation) models, is included, the time lags of participation refer to participation rates in the previous years. Hence, the one year time lag of participation in 2011 is the participation rate in 2010, the two year time lag of participation in 2011 is the participation rate in 2009, etc.

suggests that participation in adult learning has a positive impact on short term as well as long term impacts on growth.

Regarding the coefficients of the other variables in the different models, the significance of the year dummy 2011 demonstrates the importance of controlling for time effects in our model. The coefficient of this year dummy shows us the change in real GDP growth between 2007 and 2011, which was not caused by changes in AES participation in AL or GDP per capita. Regarding the negative beta coefficient on the year dummy 2011, we can infer that real GDP growth was significantly lower in 2011 than in 2007 (controlling for AES participation and GDP per capita). While the previously discussed effects of participation in AL (positive) and time effects (negative) hold across all models, the picture is not as clear, when regarding GDP per capita.

Regarding the two FE models, a barely significant positive relationship (at the 10 percent significance level) between GDP per capita and growth is only visible when regarding FE1, the FE model with the comparatively lower goodness of fit (R^2) value. In contrast, both RE models suggest significant negative relationships between real GDP growth and GDP, although the coefficient of GDP per capita in RE1 is only barely significant (at the 10 percent significance level). However, the model with the higher goodness of fit of both RE models, RE2, suggests a highly significant negative relationship.

	FE1	FE2	RE1	RE2
	Real GDP growth	Real GDP growth	Real GDP growth	Real GDP growth
AES participation	0.827^{***}	1.048^{***}	0.569^{**}	0.542^{**}
Time lag of AES participation		0.274^{**}		0.355^{****}
GDP per capita	3.248^{*}	1.142	-0.389^{*}	-0.477^{***}
2011	-0.898^{****}	-0.819^{****}	-0.545^{****}	-0.526^{****}
N	44.000	37.000	44.000	37.000
r2_w	0.627	0.731	0.489	0.609
r2_o	0.000	0.066	0.411	0.582

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

Table 5: Fixed effects estimation results of AES participation on growth. Years 2007 and 2011.

First regression model series – based on 2007 and 2011 AES participation data

The previous estimation analysed the effect of AES participation on **real GDP growth** over time on the basis of data on the years 2007 and 2011, given that AES participation data exists only for these two years. However, if one is interested in analysing a broader range of time, i.e. the time frame 2007-2011 including data on each of the five years, respective data can be created by means of a simulation. In order to simulate data, assumptions are required. In our analysis, we regarded the participation rates in 2007 and 2011 and assumed that between these two rates participation increased (decreased) steadily, i.e. by the same rate each year (the difference in the rates in 2007 and 2011 divided by four). For example, participation in AL in EE increased from 42% in 2007 to 50% in 2011, hence by 8%. Assuming a steady rise in participation rates by 2% (8/4) each year, we arrive at following participation rates for EE: 42% in 2007, 44% in 2008, 46% in 2009, 48% in 2010 and finally 48% in 2011. For other countries, data on participation in AL in the years 2008-2010 was simulated accordingly. For the case that data on participation in AL was available only for one of the two years in a particular country, it was assumed that rates increased (if only data on 2007 was specified, e.g. in the case of IE), or decreased (if only data on 2011 was specified, as in the case of LU) according participation rates of the average European country[17].

Despite dealing with different data than those underlying the estimation of the previously introduced series of models, tests again confirmed the use of RE over POLS estimation. Similarly, test results did not confirm the existence of systematic differences between RE or FE estimates, so that both estimation methods may be used for the analysis of the second series of models. In comparison with the first series of models, variables in the tested second series of models are similar, with the difference that a higher number of year dummies as well as time lags (due to the higher number of years analysed) are included.

Regarding the regression results in the comparatively large number of simulated RE and FE models in the following two tables, an interesting result is that participation in adult learning is found to have a positive effect on real GDP growth in all but one FE model (FE), while the opposite holds when regarding the RE estimation results. Both FE and RE estimation results suggest that there is no significant effect of GDP per capita on real GDP growth. The same holds for lags in AES participation. While significant relationships with growth can be seen in few exceptional (FE5, RE5), the significant effect fades once additional lags are included (models FE6, RE6, FE7, FE7, FE8, RE8). Although one could argue that dropping (individually) insignificant time lags from the model would increase efficiency, tests prove (all) time lags to be jointly significant (FE8, RE8).

Overall, this second series of estimation provides very ambiguous results. Based on simulated data, fixed effects estimation suggests that a positive relationship between participation and growth existed over half a decade, i.e. countries with higher participation rates in this time frame also had higher growth rates. The same conclusion can however not be derived, when regarding RE estimation results. All in all, one could argue that the higher goodness of fit values of the FE estimation models give reason to believe that their results are better suited to draw conclusions on the relationship between participation in adult learning and growth than their RE counterparts. However, regresson results must be interpreted with caution as they are based on simulated data. In addition, it is important to keep in mind that results of all models assume a steady change in participation over the time frame 2007-2011. In future studies, an interesting new approach could be to assume non-linear changes in the participation rate over time. This, however, is beyond the scope of this study.

17 Regarding the EU-27 average (data provided by Eurostat), total participation in AL increased from 35% in 2007 to 41% in 2011, i.e. by 1.5% each year.

	FE3	FE4	FE5	FE6	FE7	FE8
	Real GDP growth	Real GDP growth	Real GDP growth	Real GDP growth	Real GDP growth	Real GDP growth
Participation in AL	0.542**	0.592**	0.678***	0.751***	0.747***	0.566
GDP per capita	1.554	1.442	1.562	1.345	1.353	1.763
2008 (simulated)	-0.453****	-0.466****	-0.461****	-0.462****	-0.461****	-0.486****
2009 (simulated)	-0.989****	-1.013****	-1.014****	-1.003****	-1.001****	-1.018****
2010 (simulated)	-0.359****	-0.381****	-0.396****	-0.394****	-0.366****	-0.401****
2011 (simulated)	-0.418****	-0.440****	-0.467****	-0.476****	-0.481****	-0.502****
One year lag in participation in AL		0.032	-0.076	-0.069	-0.070	-0.053
Two year lag in participation in AL			0.159**	0.072	0.071	0.097
Three year lag in participation in AL				0.145	0.160	0.171
Four year lag in participation in AL					-0.032	-0.057
Five year lag in participation in AL						0.550
N	115.000	112.000	109.000	106.000	103.000	101.000
r2_w	0.731	0.732	0.743	0.745	0.746	0.753
r2_o	0.119	0.123	0.110	0.133	0.128	0.106

Standardized beta coefficients; Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

Table 6. Fixed effects estimation results of AES participation on growth. Years 2007-2011 (simulation).

	RE3	RE4	RE5	RE6	RE7	RE8
	Real GDP growth	Real GDP growth	Real GDP growth	Real GDP growth	Real GDP growth	Real GDP growth
Participation in AL	0.190*	0.155	0.174	0.192	0.189	0.180
GDP per capita	-0.101	-0.102	-0.105	-0.114	-0.116	-0.113
2008 (simulated)	-0.350****	-0.355****	-0.352****	-0.358****	-0.357****	-0.355****
2009 (simulated)	-0.938****	-0.947****	-0.943****	-0.942****	-0.941****	-0.938****
2010 (simulated)	-0.245****	-0.251****	-0.253****	-0.253****	-0.239****	-0.236****
2011 (simulated)	-0.268****	-0.277****	-0.282****	-0.291****	-0.289****	-0.290****
One year lag in participation in AL		0.052	-0.050	-0.046	-0.047	-0.047
Two year lag in participation in AL			0.128*	0.013	0.012	0.011
Three year lag in participation in AL				0.154	0.172	0.172
Four year lag in participation in AL					-0.027	-0.011
Five year lag in participation in AL						-0.024
N	115.000	112.000	109.000	106.000	103.000	101.000
r2_w	0.707	0.707	0.714	0.717	0.718	0.716
r2_o	0.630	0.627	0.635	0.643	0.642	0.643

Standardized beta coefficients; Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

Table 7: Random effects estimation results of AES participation on growth. Years 2007-2011 (simulation).

The following table provide further estimates on adult learning and innovation

Dependent	Independent	C	Sig. C	B	Beta	Sig.	R^2
Innovation index (2010)	Labour productivity per hour (2009)	0.15	0.05	0.35	0.66	0.00	0.43
Innovation index (2010)	Participation in AL (LFS)	0.28	0.00	1.61	0.67	0.00	0.45
Innovation index (2010)	Other forms of learning in enterprises index (2005)	0.23	0.01	3.26	0.51	0.01	0.26
Innovation index (2010)	Costs of CVT as% of total labour cost (2005)	0.18	0.10	0.17	0.45	0.02	0.21
Innovation index (2010)	Share of training enterprises as% of total (2005)	0.08	0.38	0.61	0.66	0.00	0.43
Innovation index (2010)	Employee participation in CVT courses (2005)	0.17	0.04	0.83	0.57	0.00	0.32
Innovation index (2010)	Share of tertiary education (2005)	0.17	0.10	1.16	0.49	0.01	0.24
Innovation output index (2010)	HR index (2009)	0.05	0.46	0.35	0.50	0.01	0.25
Innovation index (2010)	HR index (2009)	-0.35	0.13	1.35	0.58	0.00	0.34

Dependent	Independent	C	Sig. C	B	Beta	Sig.	R^2
Innovation index (2010)	Other forms of learning in enterprises index (2005)	0.13	0.03	1.21	0.18	0.21	0.69
	R&D/GDP (2009)			0.14	0.73	0.00	
Innovation index (2010)	Work organisation index (2010)	0.63	0.04	-0.71	-0.23	0.24	0.48
	Participation in AL (2009)			1.99	0.82	0.00	
Innovation index (2010)	Other forms of learning in enterprises index (2005)	0.12	0.18	1.79	0.28	0.17	0.38
	Employee participation in CVT courses (2005)			0.64	0.42	0.04	
Innovation index (2010)	Other forms of learning in enterprises index (2005)	0.22	0.00	1.11	0.17	0.35	0.49
	Participation in AL (2009)			1.45	0.58	0.00	
Innovation index (2010)	Work organisation index (2010)	-0.08	0.76	-0.39	-0.13	0.39	0.71
	Participation in AL (2009)			0.01	0.35	0.07	
	Cognitive factors (all years)			1.06	0.64	0.00	
Innovation index (2010)	Work organisation index (2010)	-0.39	0.07	-0.12	-0.04	0.76	0.71
	Cognitive factors (all years)			1.32	0.74	0.00	
	Share of tertiary education (2005)			0.53	0.23	0.09	
Innovation index (2010)	Other forms of learning in enterprises index (2005)	-0.37	0.10	1.24	0.19	0.26	0.59
	HR index (2009)			0.94	0.38	0.03	
	GDP per capita (2010)			0.00	0.46	0.01	
Other forms of learning in enterprises index (2005)	Participation in AL (2009)	0.04	0.00	0.22	0.57	0.00	0.32
Participation in AL (2009)	Workplace Learning (2005)	0.00	0.87	1.47	0.57	0.00	0.32
Participation in AL (2009)	Innovation index (2010)	-0.02	0.45	0.28	0.67	0.00	0.45
Participation in AL (2009)	HR index (2009)	-0.21	0.03	0.53	0.56	0.00	0.31

Source: Cedefop (2011).

Table 8. Estimation results of the EU-27 and Norway

Dependent	Independent	C	Sig. C	B	Beta	Sig.	R^2
Innovation index (2010)	Labour productivity per hour (2009)	0.09	0.19	0.43	0.74	0.00	0.55
Innovation index (2010)	Participation in AL (LFS)	0.28	0.00	1.71	0.69	0.00	0.46
Innovation index (2010)	Other forms of learning in enterprises index (2005)	0.22	0.01	3.51	0.53	0.01	0.28
Innovation index (2010)	Costs of CVT as% of total labour cost (2005)	0.18	0.11	0.17	0.45	0.02	0.20
Innovation index (2010)	Share of training enterprises as% of total (2005)	0.05	0.57	0.67	0.70	0.00	0.49
Innovation index (2010)	Employee participation in CVT courses (2005)	0.17	0.05	0.83	0.57	0.00	0.32
Innovation index (2010)	Share of tertiary education (2005)	0.15	0.14	1.26	0.52	0.01	0.27
Innovation index (2010)	Other forms of learning in enterprises index (2005)	0.13	0.04	1.44	0.21	0.15	0.70
	R&D/GDP (2009)			0.13	0.72	0.00	
Innovation index (2010)	Work organisation index (2010)	0.55	0.08	-0.56	-0.18	0.36	0.50
	Participation in AL (2009)			1.99	0.81	0.00	
Innovation index (2010)	Other forms of learning in enterprises index (2005)	0.12	0.19	2.03	0.31	0.14	0.39
	Employee participation in CVT courses (2005)			0.60	0.40	0.06	
Innovation index (2010)	Other forms of learning in enterprises index (2005)	0.21	0.00	1.34	0.20	0.25	0.54
	Participation in AL (2009)			1.53	0.60	0.00	
Innovation index (2010)	Work organisation index (2010)	-0.11	0.70	-0.45	-0.14	0.34	0.72
	Participation in AL (2009)			0.71	0.29	0.14	
	Cognitive factors (all years)			1.17	0.68	0.00	
Innovation index (2010)	Work organisation index (2010)	-0.36	0.10	-0.04	-0.01	0.93	0.68
	Cognitive factors (all years)			1.21	0.71	0.00	
	GDP per capita (2010)			0.00	0.18	0.26	
Innovation index (2010)	Work organisation index (2010)	-0.36	0.09	-0.24	-0.08	0.55	0.72
	Cognitive factors (all years)			1.33	0.78	0.00	
	Share of tertiary education (2005)			0.46	0.19	0.16	
Other forms of learning in enterprises index (2005) (2005)	Participation in AL (2009)	0.04	0.00	0.21	0.55	0.00	0.30
Participation in AL (2009)	Workplace Learning (2005)	0.69	0.82	1.42	0.55	0.00	0.30
Participation in AL (2009)	Innovation index (2010)	-0.03	0.33	0.28	0.69	0.00	0.46
Participation in AL (2009)	HR index (2009)	-0.21	0.03	0.53	0.56	0.00	0.31

Source: Cedefop (2011).

Table 9: Estimation results of the EU-27

Annex 2: Background information on the IUS

As the Innovationn Union Scoreboard (IUS) (previously: European innovation Scoreboard) is employed for the analysis in this study and might not be known by anyone, the section provides a brief overview on the IUS.

Figure 11 gives an overview of the various indicators included in the Innovation Union Scoreboard, highlighting the three sections, enabler, firm activities and outputs, which themselves consist of several sub-groups of indicators. Each sub-group consists of two to five sub-indicators. Figure 12 shows the ranking of countries based on this set of indicators and reveals that the four Nordic countries and Germany are the innovation leaders in the European Union, and that Italy, Hungary and Poland are among the moderate innovators. The group of followers and modest innovators is not represented in this partnership.

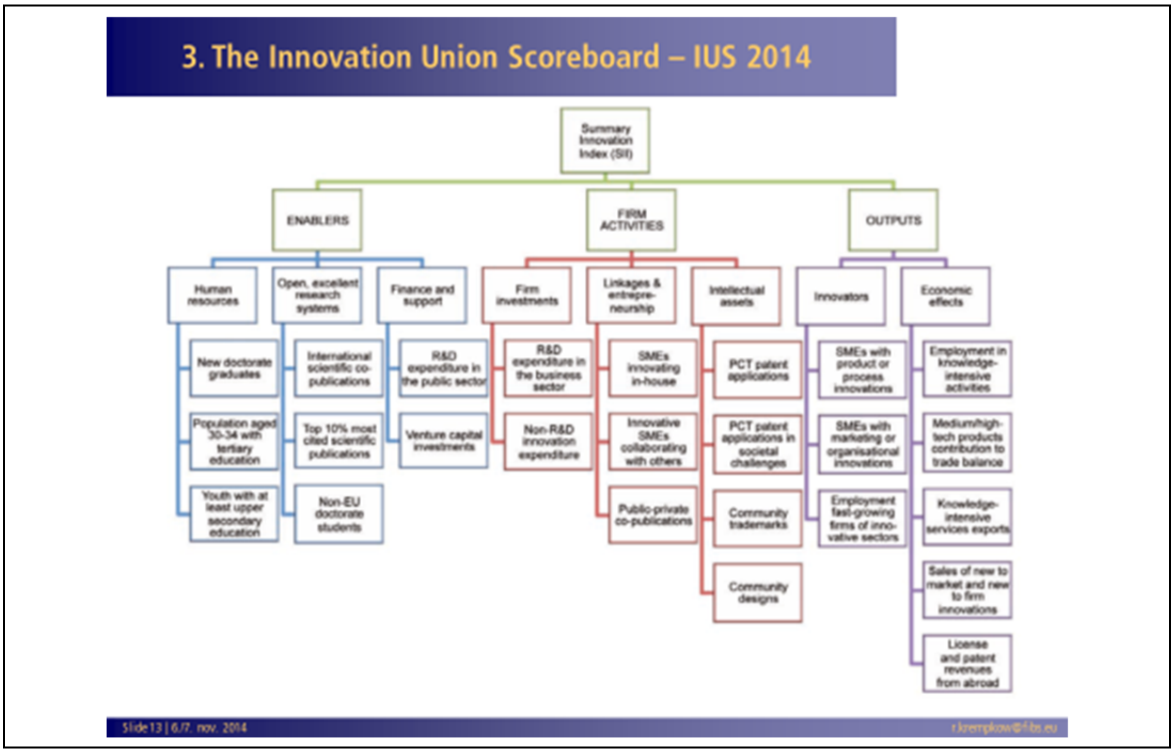

Figure 11: The innovation indicator system of the IUS 2014

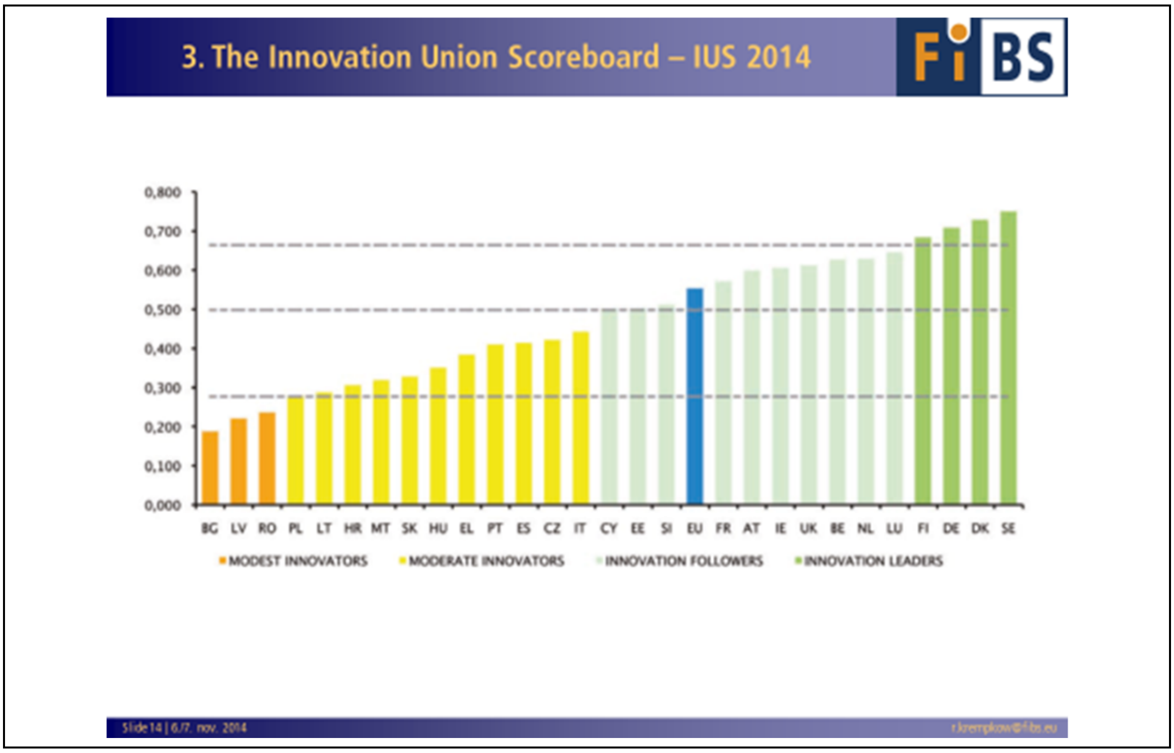

Figure 12: The results of the IUS 2014 - Innovation indicators

However, when considering the relationship between adult learning it seems appropriate to rely on those indicators referring to innovation performance. As shown by the list of indicators ônly throughput and output parameters were included in the analysis of the innovation performance:

Firm investments

2.1.1 R&D expenditure in the business sector

2.1.2 Non-R&D innovation expenditure

Linkages & entrepreneurship

2.2.1 SMEs innovating in-house

2.2.2 Innovative SMEs collaborating with others

2.2.3 Public-private co-publications

Intellectual Assets

2.3.1 PCT patent applications

2.3.2 PCT patent applications in societal challenges

2.3.3 Community trademarks

2.3.4 Community designs

Innovators

3.1.1 SMEs introducing product or process innovations

3.1.2 SMEs introducing marketing/organisational innovations

3.1.3 Employment fast growing firms of innovative sectors (NEW)

Economic effects

3.2.1 Employment in knowledge-intensive activities

3.2.2 Medium and high-tech product exports

3.2.3 Knowledge-intensive services exports

3.2.4 Sales of new to market and new to firm innovations

3.2.5 Licence and patent revenues from abroad