EUROPEAN LABOUR PRODUCTIVITY AND CORPORATE E-LEARNING ACTIVITIES: AN EMPIRICAL ANALYSIS

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Abstract
The purpose of this analysis is to test the hypothesis which growth in workers' competency level is affected by educational, training and workplace features. We focused above all on the corporate e-learning activities and labour productivity, in order to identify differences between European countries. Our findings showed some statistical significances related to six variables concerning a macro view of knowledge and innovation in the workplace, whereby we highlighted the comparison of mutual positions of European countries on the basis of a potential component of investments in human capital which is e-learning. According to statistical significativity we specifically noted that most Northern European countries have a comparative advantage in terms of labour productivity and direct investments than those in the south.

1. Introduction

It is well-known that the composition of the EU and that of the euro area have changed tremendously over the recent years, with the relative proportion of larger countries shrinking. Among the 15 countries the euro area comprised in 2008, three of them were large countries (Germany, France and Italy), one of middle size (Spain) and the remaining 11 were of small or very small dimension and this remains true whether size is considered in demographic or in economic term (Laurent and Le Cacheux, 2006). It is also common knowledge since Olson's (1965) seminal work that, when collective action is needed in whole group's interest, the decision making process becomes all the more arduous as the group is bigger and more heterogeneous, especially sidewise. The smaller countries will usually tend to make advantage of their small size sometimes also in adopting opportunistic and free rider strategies. Those trends are getting even stronger within the current EU and euro area's institutional framework, because of such decision-making process rules as unanimity and the thresholds adopted for qualified majority voting, or the "open method of coordination" whose different variants - more especially those on employment policy, social protection and even more importantly, those on the implementation of the reformed "Lisbon Strategy" - encourage competition between member states and tend to make collective decision-making difficult, if not impossible, also in the field of labour politics and investments in human capital resources such as education & training activities (Welsh E., *et al.*, 2003; Black S. and Lynch L., 2004; Daelen M., *et al.*, 2005).

2. Methodology and analysis

We performed a quantitative analysis reckoning with several variables related to 2008 for EU member countries and their aggregates. The variables considered are: GDP *per capita* in PPS, corporate e-learning applications for training and education of employees, labour productivity per person employed, total investments as percentage of GDP, business investments as percentage of

GDP, direct investments flows as percentage of GDP. The first is a descriptive analysis and in table 1 we reported the results of this preliminary stage:

Variables	Minimum	Maximum	Mean	Variance	Skewness	Kurtosis
GDP	41,30	276,40	102,8029	1939,428	1,940	6,558
Corporate e-learning	13,00	54,00	28,7576	109,002	0,639	-0,263
Labour productivity	37,20	175,80	95,0886	869,469	0,430	0,707
Total investments	16,30	33,40	22,9371	16,613	0,966	0,418
Direct investments	-48,50	261,20	9,9647	2074,273	5,333	30,467
Business investments	13,80	27,70	19,6125	11,599	0,726	0,022

Table 1: descriptives statistics (source: our elaboration on Eurostat data, 2010).

Considering the year 2008, the first variable investigated is the GDP *per capita* in PPS[135]. This variable was analyzed for European countries and for its qualified aggregate EU-27, EU-25, EU-15, Euro Area and other countries. The GDP has a minimum value of 41.30 while the maximum level is 276.40. This shows a high variability between countries, which is confirmed by the index variance of GDP. In this case, 41.30 is referred to the value of GDP in Bulgaria together with the Czech Republic, Estonia, Greece, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Portugal, Slovenia, Romania, Slovakia, Turkey and Croatia. Turkey has a GDP not compliant with the European Union average. Moreover, the value of kurtosis gives an idea about its very high amount and therefore with a greater distribution of countries on tail areas of normal distribution which is confirmed by the index of symmetry which restrains an asymmetric outcome compared to normality. These conclusions can be deduced similarly respect to the variable of direct investments as a percentage of GDP since its minimum value is negative at -48.50 reached by Iceland and its maximum level is reported by Luxembourg at 261.20. This dispersion of the data shows a high variability with asymmetry and kurtosis somewhat distorted compared to normal distributions. Instead, variables such as corporate e-learning applications, labour productivity, total investments and business investments provide values quite normal with a range of potentially more manageable. Before addressing a regression analysis on the phenomenon under observation, we calculated a matrix correlation (table 2) to emphasize the major variable correlations between variables:

Variables	GDP	Corporate e-learning	Labour productivity	Total investments	Direct investments	Business investments
GDP	1,000	-0,201	0,909*	-0,440	0,776	-0,435
Corporate e-learning	-0,201	1,000	-0,182	0,253	-0,090	0,239
Labour productivity	0,909	-0,182	1,000	-0,575	0,565	-0,525
Total investments	-0,440	0,253	-0,575	1,000	-0,182	0,954*
Direct investments	0,776	-0,090	0,565	-0,182	1,000	-0,207

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[135] This indicator has been rescaled, i.e. data are expressed in relation to EU-27 = 100. The volume index of GDP *per capita* in Purchasing Power Standards (PPS) is expressed in relation to the European Union (EU-27) average set to equal 100. If the index of a country is higher than 100, this country's level of GDP per head is higher than the EU average and vice versa.

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Labour productivity	0,909	-0,182	1,000	-0,575	0,565	-0,525
Total investments	-0,440	0,253	-0,575	1,000	-0,182	0,954*
Direct investments	0,776	-0,090	0,565	-0,182	1,000	-0,207
Business investments	-0,435	0,239	-0,525	0,954	-0,207	1,000

Table 2: correlation matrix (source: our elaboration on Eurostat data, 2010).

In table 2 we pointed out with an asterisk the two most significant correlations which are represented by the following: the GDP compared to labour productivity and total investments compared to business investments. In fact, these latter variables demonstrate an almost perfect correlation between them, showing an excellent direct relationship. A less significant correlation, but still positive, is also between GDP and direct investments. The other variables have converged to correlations rather insignificant and even some kind of relations are negative. We noted that labour productivity is negatively related to total investments, business investments and corporate e-learning activities: this indicates a discrepancy between the variables under study[136] bringing back a reverse relation because when a variable growths, the other reacts in the opposite way. Once the correlation analysis, we moved to that of regression[137]. The following table reports the regressions analyzed and their results:

Variables: dependent – independent	r	R square	Coefficient β	T
Corporate e-learning – GDP	0,102	0,01	-0,024	-0,564
Labour productivity – GDP	0,924	0,853	0,605	13,641
Business investments – Total investments	0,96	0,922	0,79	18,817
Corporate e-learning – Business investments	0,582	0,338	1,099	4,107
Corporate e-learning – Labour productivity	0,074	0,005	-0,031	-0,426

Table 3: model summary (source: our elaboration on Eurostat data, 2010).

This inspection confirms the previous investigation conducted with the correlation. In fact, for some variables we have an excellent goodness of fit of theoretical data to those observed, for other variables it occurs to a lesser extent. The following highlights the regressions individually identified from best fit, indicating the dependent variable at first and then the independent one:
1) Labour productivity – GDP: in this regression analysis, the results show a strong direct relationship between the two variables. This indicates that when GDP rises, the labour productivity increases; so those countries with a higher GDP have even an increased general economic activity. The results confirm an excellent response to the goodness of fit and

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[136] Labour productivity with total investments, labour productivity with business investments and labour productivity with corporate e-learning activities.
[137] Note that the regression coefficient values and the correlation coefficient values overlap, as the constant *y=bx* has been omitted from the model.

significativity of regression coefficient, as the test on the hypotheses[138] stands on a large enough value being equal to 13.641.

2) Business investments – Total investments: this analysis also confirms a good direct relationship between the two variables and whereas total investment increases, there is a proportional raise in business investment. Even in this case, countries with greater investments mainly gear the same on business investments[139]. The results of test of the regression coefficient confirm the significance of analysis reaching a value exceeding 18.

3) Corporate e-learning activities – GDP: we obtained a relationship quite zero which would indicate a relative neutrality of the variable GDP compared to the one referring the activities in corporate e-learning. In fact, the increase of GDP in European countries do not get more investment in corporate e-learning. It would seem that the use of e-learning systems in education & training firms activities is mainly influenced by other socio-economic and cultural features; verifications of the analysis also confirmed the meaningless of the parameter studied.

4) Corporate e-learning activities – Business investments: this study shows a good direct relationship between the two variables. The results are established at a mean values level and the test of verification of the regression coefficient is significant. It follows that corporate e-learning activities are influenced more by business investments and then countries which largely invest in this regard will also use a part of them in corporate e-learning training systems. So e-learning applications are also affected indirectly by GDP, as the same business investments are greater in those European countries with a higher GDP.

5) Corporate e-learning activities – Labour productivity: this elaboration is inconclusive at the level of statistical tests as increasing in labour productivity, investments in corporate e-learning systems appear inconsistent. Verification of the regression coefficient explains the irrelevance of the analysis reaching a low value close to zero. This result may appear confusing and it will require an our future study.

Once regression analysis is carried out, we moved to principal component analysis. Considering the six variables presented above, we calculated eigenvalues in order to call attention to the variability:

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3,343	55,716	55,716	3,343	55,716	55,716
2	1,323	22,057	77,773	1,323	22,057	77,773
3	,891	14,846	92,619	-	-	-
4	,359	5,979	98,598	-	-	-
5	,055	,919	99,517	-	-	-
6	,029	,483	100,000	-	-	-

Table 4: total variance explained (source: our elaboration on Eurostat data, 2010).

The table 4 reveals that the first two eigenvalues explain a percentage of 77.7 about the referring distribution, and considering a third eigenvalue, we reach a percentage of 92.62 about variability

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[138] The test statistics (T-statistics), which represents the model testing hypothesis, is not significant for values ranging from –2 to +2.

[139] The values referred to "total investment" and "business investment" represent percentages of GDP and, hence, are influenced by GDP of each countries.

explained. It can be inferred that the first two eigenvalues are sufficient to expound the variability of our study as the 77.77 per cent of variability described is still a good result analysis. In order to interpret the outcomes obtained from principal components is crucial to dissect the matrix of correlations between the components themselves and the variables which contributed to their setting up. Below are given these correlations:

Variables	Component	
	1	2
GDP	,884	,419
Corporate e-learning	-,335	,293
Labour productivity	,894	,214
Total investments	-,789	,560
Direct investments	,651	,628
Business investments	-,777	,555

Tabel 5: component matrix (source: our elaboration on Eurostat data, 2010).

Table 5 sets a focal point on the importance of variables than the first two principal components. The first principal component shows up a high interest in relation to the variables GDP and labour productivity, which can be explicated as a factor connected to the productivity of the European countries. The second main component has, on the whole, quite low values with more relevance to direct investments as percentage of GDP. We synthesized the first component in "labour productivity" (component 1) and the second one in "direct investments" (component 2). Below is a chart summarizing the analysis with two main components representing the reference coordinates and the position of European countries compared to the two main components. Furthermore, these countries were divided into four clusters calculated by the method of Euclidean distance between countries:
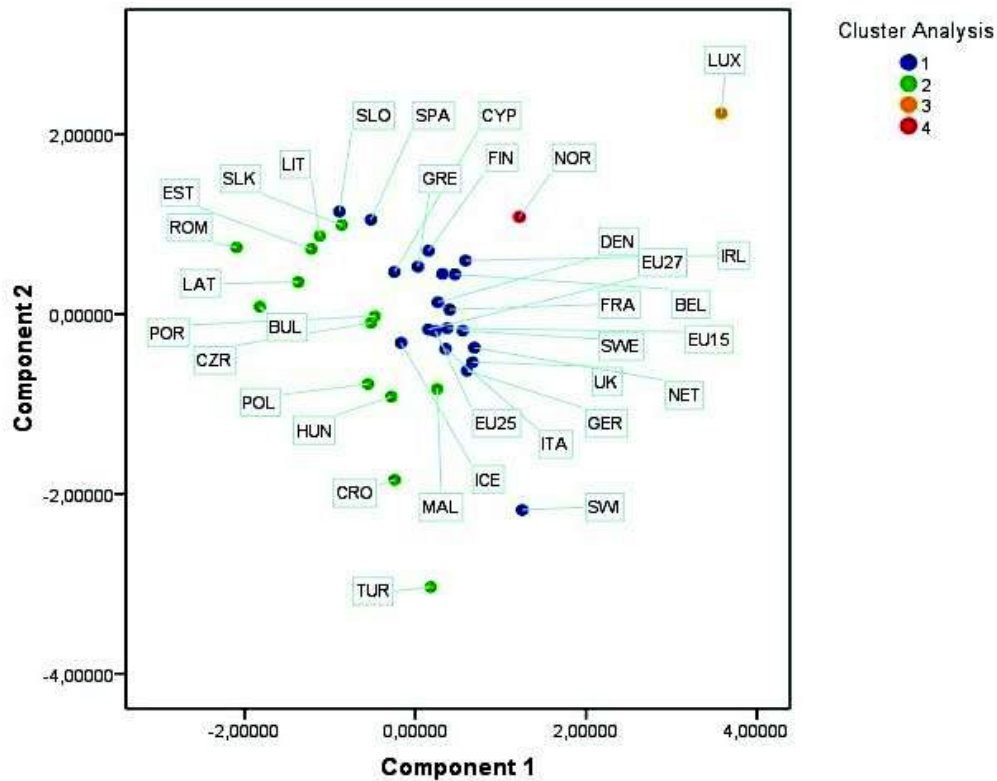
Figure 1: PCA and cluster analysis (source: our elaboration on Eurostat data, 2010).

From figure 1 we gather a number of considerations. The first principal component (labour productivity) shows a range of variation ranging from -2 to +4. While the second principal component (direct investments) has a range of variation ranging from -4 to +2. The first cluster is composed of a single European country that is the case of Luxembourg. This country ranks at the top and right of the figure 1 showing the overall higher rate of labour productivity and investments compared to other European countries. A second cluster is represented by Norway, even though it seems close to the remaining clusters, it still remains at a high level of productivity and investments. The third cluster is represented by most of European countries, which in this case show a positive productivity and investments lower than Norway and Luxembourg. The countries in this cluster are: Slovenia, Spain, Ireland, Italy, France, Finland, Ireland, Belgium, Denmark, Sweden, United Kingdom, the Netherlands, Germany and Switzerland. The latter (Switzerland), although it has a positive labour productivity, holds negative investments. The fourth cluster concerns the European countries which present a negative productivity and investments. The last cluster pertains countries such as: Slovakia, Estonia, Lithuania, Romania, Latvia, Portugal, Austria, Czech Republic, Bulgaria, Poland, Hungary, Malta, Turkey and Croatia. Turkey, in particular, contains the lowest values among European countries with negative investments and output null and void.

3. Concluding remarks
The objective of our study was to analyze the different European countries based on the six variables taken into account. The variable GDP *per capita* in PPS has affected especially the countries distinguishing from each other. For example, Luxembourg has the highest GDP *per capita*, followed by Norway. These two countries appear to have a labour productivity and direct investments higher than others. But fundamentally the most significant cluster is certainly the

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third, namely the one where we find countries such as Italy, France and Germany, which are in a situation similar to the average of the EU in terms of labour productivity and direct investments, but in a possible future scenario will certainly reach higher levels, in spite of the current global crisis. Indeed, considering the wider time span 2003-2007 (Bucciarelli, Giulioni, Muratore, *et al.*, 2008) it is emerged a larger growth of GDP and investments for these three countries. In conclusion, all the European countries go through a phase of stable productivity of the work which needs to be reinforced by processes of research & development and of innovation. It is a sort of best practice the unsatisfactory result found for the variable corporate e-learning, which shows for many EU countries a meagre tendency to new technologies of the latest corporate training. If there were a more implementation of education and training there would be a better development of labour productivity (Becker G. S. and Murphy K. M. 1992; Acemoglu D. and Zilibotti, 2001; Daelen M., *et al.*, 2005).

References
1. Acemoglu D. and Zilibotti F. (2001), *Productivity differences*, Quarterly Journal of Economics, N116, pp. 563-606.
2. Andersen P. and Gruen D. (1995), *Macroeconomic policies and growth*, in Andersen P., Dwyer J. and Gruen D. (eds.), *Productivity and Growth*, Reserve Bank of Australia, Sydney, pp. 279-319.
3. Barro R. J. (2000), *Inequality and growth in a panel of countries*, Journal of Economic Growth, N. 5, pp. 5-32.
4. Becker G. S. and Murphy K. M. (1992), *The division of labour, coordination costs and knowledge*, Quarterly Journal Of Economics, N. 107(4), pp. 1137-1160.
5. Black S. and Lynch L. (2004), *What's driving the new economy? The benefits of workplace innovation*, Economic Journal, N. 114, February, pp. 97-116.
6. Bucciarelli E., Giulioni G., Muratore F. *et al.* (2008), *E-learning in European SMEs: economic insights*, in Gibson I. (editor), XX World Conference on Information Technology, SITE 2009, Charleston, SC (USA), ISBN 1-880094-67-3, pp. 1754-1759.
7. Daelen M., Miyata C., Op de Beeck I., Schmitz P.-E., van den Branden J. and Van Petegem W. (2005), *E-learning in continuing vocational training, particularly at the workplace, with emphasis on Small and Medium Enterprises*, Final report (EAC-REP-003), European Commission.
8. Dawe S. and Nguyen N. (2007), *Education and training that meets the needs of small business: a systematic review of the research*, Adelaide, Australia, National Centre for Vocational Education Research.
9. De Fraja G. (2001), *Education policies: equity, efficiency and voting equilibrium*, Economic Journal, N. 111 (May), C104-C19.
10. Gordon R. J. (2002), *Technology and economic performance in the American economy*, NBER working paper.
11. Laurent E. and Le Cacheux J., (2006), *Integrity and efficiency in the EU: the case against the European economic constitution, centre for European studies*, working paper series, N. 130, Harvard University.
12. Olson M. (1965), *The logic of collective action*, Cambridge, MA, Sapir A. (2003).
13. Rullani E. (1997), *Tecnologie che generano valore: divisione del lavoro cognitivo e rivoluzione digitale*, Economia e politica industriale, N. 93, pp. 141-167.
14. Shaked M. and Shanthikumar J. G. (1994), *Stochastic orders and their applications*, Boston, Massachussets, Academic Press.
15. Welsh E., Wanberg C., Brown K. and Simmering M. (2003), *E-learning: emerging uses, empirical results and future directions*, International Journal of Training and Development, Vol. 7, N. 4, pp. 245-258.

16. World Bank (2001), *World development report 2000/2001: attacking poverty*, New York, Oxford University   Press.
17. Zilibotti F. (1995), *A Rostovian model of endogenous growth and underdevelopment traps*, European Economic   Review, N. 39, pp. 1569-1602.