

Edgardo Bucciarelli\* - Nicola Mattoscio\* - Domenico Scamuffa<sup>†</sup>

**E-LEARNING DIFFUSION AMONG EUROPEAN SMEs AND  
ITS RELATIONSHIP WITH ECONOMIC PERFORMANCE**

**Abstract**

This paper is aimed to explore the issue of e-learning adoption among European small and medium enterprises (SMEs). By performing a regression analysis, valuable insights are provided into the pattern of investments in corporate e-learning made by European SMEs and the potential connection between the percentage of firms implementing electronically-aided learning and economic performance. A cluster analysis is then performed in an effort to identify differences and similarities in e-learning diffusion within Europe.

**JEL CLASSIFICATION:** O10; O40; O52; O57.

**KEYWORDS:** ECONOMICS OF EDUCATION AND TRAINING; KNOWLEDGE ECONOMY; SMALL AND MEDIUM ENTERPRISES; CORPORATE E-LEARNING; ECONOMIC PERFORMANCE.

**1. E-learning as a means for vocational training in SMEs and a driver for competitiveness: an overview**

At the European Council held in Lisbon in March 2000, the European Union set itself a new strategic goal for the next decade: “to become the most competitive, dynamic and knowledge-based economy in the world capable of sustainable economic growth with more and better

\* Department of Quantitative Methods and Economic Theory, University of Chieti-Pescara, Viale Pindaro 42, Pescara 66127, Italy. Tel.: +39 085 453 7583; fax: +39 085 455 7980; e.bucciarelli@unich.it.

‡ Department of Quantitative Methods and Economic Theory, University of Chieti-Pescara, Viale Pindaro 42, Pescara 66127, Italy. Tel.: +39 085 453 7583; fax: +39 085 453 7980; mattoscio@unich.it.

† Department of Quantitative Methods and Economic Theory, University of Chieti-Pescara, Viale Pindaro 42, Pescara 66127, Italy. Tel.: +39 085 453 7583; fax: +39 085 453 7980; domenico.scamuffa@unich.it.

jobs and greater social cohesion” (EU-Council, 2000). The need for delivering such an ambitious programme arises due to the profound changes occurring in the economic and social life of society, resulting from the challenges brought about by market globalization and the new knowledge-based economy. In advanced economies, this emerging scenario is grounded on rapid knowledge creation and the ease of its access, which ultimately engender efficiency, quality and equity (Foray, 2000). No wonder, then, that investment in education and training has become the mainstay for securing competitiveness in global markets and the primary fuel for economic growth. This is particularly true for the case of small and medium enterprises, for knowledge may play a major role in helping tackle competition and gain qualitative advantages.

At the European level, significant attention has been directed towards the role of vocational education and training (VET), which consists in learning programmes aiming to equip people with skills and competences to be used in the labour market. The importance of VET activities for individuals, firms and society as a whole, is nowadays widely recognized and perceived as a key element for lifelong learning (EU-Commission, 2008).

By solely focusing on firms, it is possible to narrow down the scope of analysis of education and training processes to continuing vocational training (CVT), which ranges from short vocational training courses to accelerated and lifelong training courses. CVT usually includes either internal courses designed and managed by the enterprise itself, or external courses developed by a network of enterprises or social partners, at local or regional level. Firms are increasingly investing in continuing vocational training, which is conceived as an engine for innovation and a means for increasing labour force productivity.

In such a respect, a central role is played by the ability of individuals and firms to use information and communication technologies (ICT). The tight connection between education and training and information technology has opened the door to the birth and development of e-learning.

E-learning is a typology of interactive distance learning based on electronic media (the Internet, intranets, satellite broadcast, etc.) for

managing and delivering education and training services. The use of electronically-aided learning is spreading worldwide in the training and development industry to such a pace that it has been heralded as the "e-Learning Revolution" (Sloman, 2002). The knowledge delivered via network technology has become strictly intertwined with the provision of staff training in organizations, whose main goal is to develop the talent and skills of company employees. These technology-based training solutions are changing the way corporations deliver training in nearly all segments of the business process. In this respect, e-learning enables businesses to remove distances (by distributing training to multiple locations easily and conveniently), to lower expenses, to facilitate training access of a large number of workers, to simplify complex processes such as information overload and to make the organization more flexible (Welsh *et al.*, 2003).

From a purely economic perspective, Castillo-Merino and Sjöberg (2008) address e-learning within the general context of the role of human capital and ICTs in explaining differences in earnings, productivity levels and economic growth. In this connection, economic literature situates the diffusion and productive use of ICTs (to which e-learning has to be placed in) at the base of growth estimates for many countries (Brynjolfsson and Yang, 1997; Jorgenson *et al.*, 2005; Jorgenson, 2009). In particular, if the existence of complementarities between technical and organizational change and skilled labour input do explain productivity gains at the industry level, e-learning could act as a driving force for productivity increases.

In addition, e-learning, by improving education and training, can bring considerable benefits both for individuals and society as a whole. From the point of view of the individual, human capital theory predicts that an increase in an individual's level of educational attainment positively affects its productivity in the labour market, which is the basic explanatory variable for wage differentials (Mincer, 1974; Cipollone, 1995). Other individual benefits gained by higher levels of education, directly related and complementary to wages, are higher participation rates in the labour market and a lower probability of being unemployed (de la Fuente and Ciccone 2003). In a macro-economic context, differences in growth rates across countries are assumed to be

considerably due to differences in human capital levels and its rates of accumulation (Lucas, 1988; Romer, 1990). In this light, e-learning may impact positively on growth, by improving labour force skills and thus helping drive technical change, besides supporting new technology adoption and diffusion.

Turning to the specific benefits of e-learning for firms, education via network technology should in principle appeal to all companies of any size and sector, especially to small and medium-sized enterprises interested in increasing productivity or boosting efficiency in a cost-effective way (Sambrook, 2003; Roffe, 2004). This notwithstanding, whereas we can observe an increased use and impact of e-learning in large companies, the uptake of technology-based training solutions in SMEs is very slow and does not meet initial hopes and expectations (Atwell, 2003). Other recent studies (Hamburg *et al.*, 2005; Beer *et al.*, 2006) seem to confirm these findings, showing a limited use of e-learning in small firms and mostly with reference to activities of rather poor quality. An interview survey carried out by Chang (2003) suggests that workers in large organizations mostly prefer electronically-aided learning, while workers of SMEs exhibit a preference for traditional vocational training or face-to-face learning. These results may actually be explained by a number of potential drawbacks and barriers met by SMEs when embarking on e-learning implementations: first, the fear that learning activities not directly involving teachers may be less effective than traditional forms of education (Welsh *et al.*, 2003); second, the start-up and maintenance costs associated with e-learning systems (Garrot *et al.*, 2008); third, the lack of the necessary learning culture, expertise and accompanying infrastructures for using electronically-aided learning (Admiraal and Lockhorst, 2009); finally, the modelling of commercial e-learning software on the requirements of large companies or higher education (Atwell, 2003; Hamburg and Engert, 2007). Additionally, with respect to European SMEs, two further critical flaws have been identified, concerning the lack of integrated support services for SMEs - particularly in the field of education and training - and the need to strengthen cooperation with other firms, training providers and public bodies (Hamburg *et al.*, 2007).

## 2. The diffusion of e-learning among European SMEs

The main objective of the present work is to identify a possible correlation between the percentage of European firms using e-learning for staff training and the gross domestic product (GDP) per capita<sup>1</sup> relative to the country under investigation. In such a respect, we collect the annual data provided by Eurostat (2010) concerning the percentage of small and medium enterprises (SMEs) - i.e. those firms employing a number of workers comprised between 10 and 249 units - which adopt e-learning systems for training and education of their employees. The limited time period (2003-2008) covered by the data represents a constraint, but some useful insights may be still gained from the analysis carried out.

The paper is structured by first providing a descriptive analysis concerning the adoption of e-learning among European SMEs. It then turns to an analysis of dependence and a cluster analysis considering GDP and e-learning penetration among European small and medium-sized enterprises. Results are presented and discussed in the next section. Descriptive statistics are first discussed before carrying out formal econometric tests to correct for the lack of information concerning some countries and avoid mistakes regarding data replacement. We compare countries on the extent to which their businesses use online channels for staff training. For every year in the time frame specified, Table 1 shows the number of countries with available data and the lowest and highest percentage of SMEs using e-learning systems every year in Europe. In addition, other summary statistics such as mean and standard deviation are reported in the table.

<sup>1</sup> Gross domestic product (GDP) is defined as the value of all goods and services produced less the value of any goods or services used in their creation. The volume index of GDP per capita in Purchasing Power Standards (PPS) is expressed in relation to the European Union (EU-27) average set equal to 100.

**Tab. 1. Summary statistics of e-learning diffusion among European SMEs (2003-2008)**

	N	Min	Max	Mean	Variance
2003	14	3	31	17,0714	69,456
2004	22	8	48	23,9091	137,42
2005	24	11	47	23,8333	109,449
2006	26	10	44	26,0385	105,878
2007	27	12	50	29,9630	136,345
2008	27	13	53	29,1852	117,695

As indicated in Table 1, the average percentage of European SMEs making use of e-learning tools has increased by 12% since 2003. Though representing a positive growing trend, recent statistics highlight that, in the best cases, only one out of two SMEs have invested in web-based solutions for staff training purposes. The variability of the phenomenon through the time span examined is quite high, thus suggesting a not uniform diffusion of corporate e-learning among European countries.

This last remark is further confirmed by Figure 1, which presents the distribution of European countries by rate of e-learning adoption among SMEs in 2008. The percentages of small and medium-sized enterprises using e-learning systems vary greatly across Europe. In most countries, corporate e-learning is actually implemented by less than 30% of the SMEs, while only in Lithuania this percentage exceeds 50%.

**Fig. 1. Distribution of European countries by rate of e-learning adoption among SMEs (2008)**

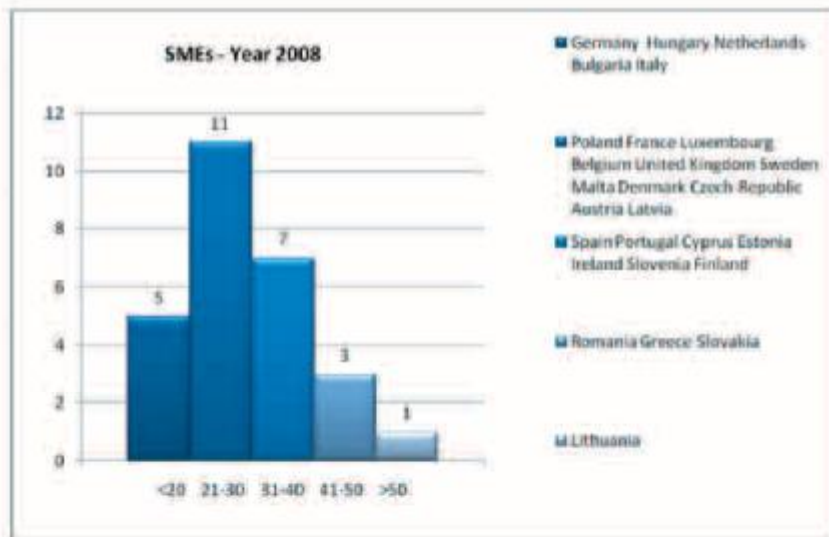


Table 2 reports the minimum and maximum values (the percentage of adoption - followed by the year in parentheses) of corporate e-learning penetration scored by the EU countries through the time span specified.

**Tab. 2. MIN and MAX values of e-learning adoption among European SMEs (2003-2008)**

Countries	Min	Max	Countries	Min	Max	Countries	Min	Max
Austria	20(03)	28(08)	Germany	15(08)	20(04)	Netherlands	8(03)	5(06)
Belgium	13(04)	24(07)	Greece	31(05)	47(08)	Poland	20(08)	35(04)
Bulgaria	12(05)	25(04)	Hungary	9(04)	17(06)	Portugal	15(05)	33(08)
Cyprus	39(06)	48(04)	Ireland	19(05)	26(08)	Romania	29(04)	41(08)
Czech Republic	28(08)	37(07)	Italy	3(03)	17(08)	Slovakia	27(04)	48(08)
Denmark	7(03)	27(08)	Latvia	29(05)	33(07)	Slovenia	29(04)	46(07)
Estonia	24(05)	38(07)	Lithuania	4(06)	53(08)	Spain	22(03)	33(08)
Finland	29(03)	40(08)	Luxembourg	10(03)	22(08)	Sweden	19(03)	26(07)
France	10(06)	32(08)	Malta	19(05)	47(07)	United Kingdom	17(05)	27(07)

By and large, Italy, Hungary, Germany and the Netherlands have the lowest achievements in e-learning diffusion, with only a fifth of SMEs adopting web-based solutions for staff training. Presumably, the disappointing performance of these prosperous countries is due to their preference for traditional face-to-face education. This is the case for Italy especially, where, in spite of the incentives for e-learning diffusion in private and public corporations, education and training systems seem to be still reluctant to the implementation of electronically-aided learning solutions. On the contrary, the high percentages (approaching 50%) shown by Greece, Lithuania, Cyprus and Malta represent a clear indicator of how largely corporate e-learning is used in less advanced European economies. Arguably, this comes as a consequence of the growing number of foreign firms investing in these countries in the last few years, owing to the low costs of labour force and raw materials.

These newly-formed companies have mostly implemented e-learning solutions for vocational training because of their cost-saving techniques able to enhance performance, innovation and commitment of their employees in a rapid and effective manner.

### **3. E-learning, SMEs and economic performance: an empirical investigation**

Based on the evidence outlined above, further investigations are made by using an analysis of dependence and a correlation test. A linear regression is carried out to estimate the relationship between GDP per capita (independent variable) and the percentage of SMEs using e-learning tools (dependent variable). The summarizing table of the main outcomes is reported below.

**Tab. 3. Regression results using a linear function**

Year	R-squared	Coefficient ( $\beta$ )	T	Coefficient R
2003	0,092	123,647	1,104	0,304
2004	0,233	202,596	2,467	0,483
2005	0,083	105,923	1,409	0,288
2006	0,054	76,314	1,169	0,232
2007	0,255	181,079	2,926	0,505
2008	0,003	17,186	0,260	0,052

Table 3 highlights the scarce model's goodness-of-fit to the observed data, being R-squared estimates rather low. In all six years, the positive sign of the regression coefficients implies a direct linear relation between GDP and percentages of e-learning diffusion among SMEs. The correlation values present the same trend, thus indicating that both variables increase together. In addition, the results of the T-statistics test are significant only for 2004 and 2007, and, as a consequence, the value of  $\beta$  is not significant for 2003, 2005, 2006 and 2008.

Besides this, the percentage change of GDP per capita is included in a subsequent analysis. This is calculated by applying a logarithmic transformation, which has the effect of removing non-stationarity in the mean when used in conjunction with differencing. The percentage change in GDP from period to period is thus approximately represented by:

$$\log gdp_t - \log gdp_{t-1} = \log \quad (1)$$

**Tab. 4. Regression results using a log scale function**

Year	R-squared	Coefficient ( $\beta$ )	T	Coefficient R
2003	0,104	638,627	1,182	0,323
2004	0,219	766,583	2,367	0,468
2005	0,086	454,077	1,435	0,293
2006	0,063	336,935	1,265	0,250
2007	0,240	729,831	2,812	0,490
2008	0,001	51,475	0,183	0,037

Table 4 provides a summary of the main results for the logarithmic regression. It must be mentioned that the R-squared is relatively low in this regression, too. The  $\beta$  coefficients show positive values, thus implying a direct relationship between the two variables under scrutiny. Furthermore, the T-statistics values are significant only for 2004 and 2007. In order to find the best-fit model to the data, the linear regression estimates - resulting from the log transformation - are compared with the results of other modelling functions (quadratic, cubic, compound, exponential, etc.). The results concerning the best models obtained for every year from 2003 to 2008 are reported in Table 5.

**Tab. 5. Summary of the best models (2003-2008)**

Time	Dependent	Method	Rsq	d.f.	F	Sigf	ho	h1	h2	h3
2003	PERC	CUB	0,156	3	0,615	0,620	19,05	17,33	-4440,45	127262,90
2004	PERC	CUB	0,295	3	2,511	0,091	19,11	31,9,06	706,99	-35699,43
2005	PERC	CUB	0,160	3	1,272	0,311	20,11	495,26	153554,32	8879293,56
2006	PERC	CUB	0,207	3	1,915	0,157	26,67	448,26	-11659,99	74025,70
2007	PERC	CUB	0,264	3	2,755	0,066	25,75	138,24	2965,70	-28031,90
2008	PERC	CUB	0,147	3	1,322	0,292	27,75	214,05	820,98	-38037,80

In the above table, the entry “dependent” refers to the dependent variable (percentage of companies implementing e-learning tools for vocational training), while the entry “method” concerns the model best fitting to the data. “Sigf” expresses the alpha error level (p-value) associated with the result of the Fisher statistics (shortened as “F” in the table). As indicated in table 5, the cubic function yields the best fitting to the data in every year of the time span considered. Figure 2 and Figure 3 present the results of all the estimated modelling functions respectively referred to 2003 and 2008.

Fig. 2. Scattergram plot of regression models (2003)

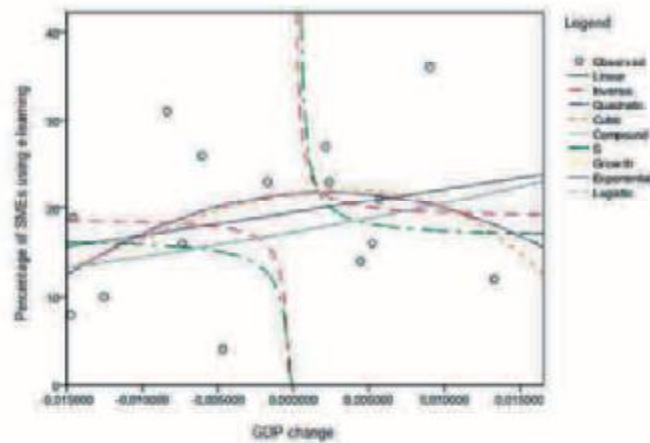
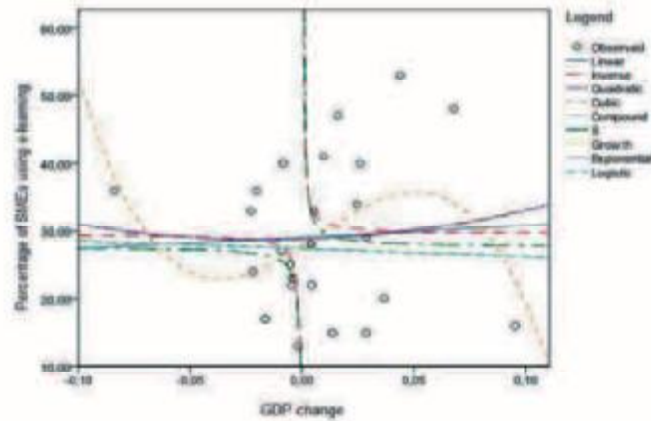


Fig. 3. Scattergram plot of regression models (2008)

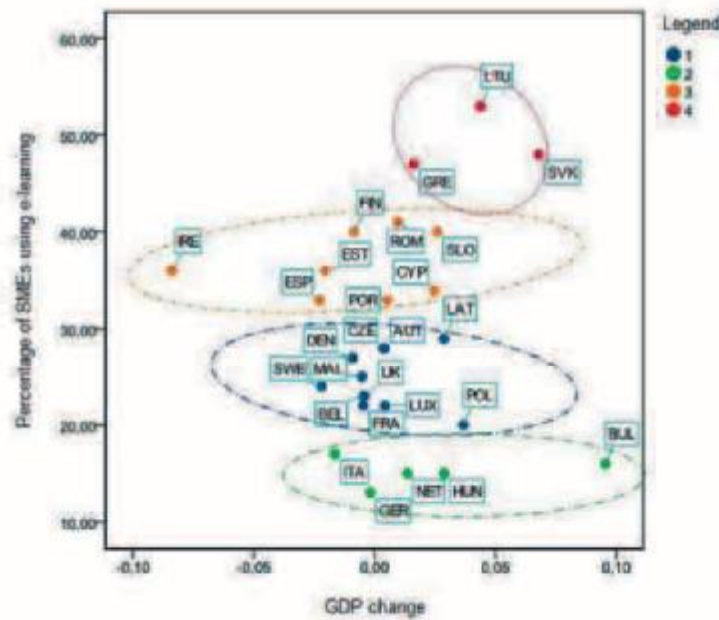


A cluster analysis is then performed in an effort to identify differences and similarities concerning e-learning diffusion and GDP change across Europe. In this way, we can most effectively identify relations among variables which were not highlighted in the models above. In order to measure distance for the observed data, Euclidean distances are calculated with the following formula:

$$d(i,h) = (\sum_j (x_{ij} - x_{hj})^2)^{1/2} \quad (2)$$

The results concerning year 2008 are shown in Figure 4. At a first glance, the high degree of dispersion achieved provides a confirmation of the scarce goodness of fit to the data of the models used above.

Fig. 4. Cluster groups of European countries by e-learning penetration and GDP change (2008)



The final cluster solution suggests four distinct and fairly homogenous clusters in this broad sample of countries. A first grouping (Cluster 4 in the above figure), is made up of three small economies (Greece, Lithuania and Slovakia) which show medium to high rates of economic growth in 2008 and high levels of corporate e-learning among SMEs. A second cluster (Cluster 3) composed of countries quite diverse for socio-economic status (from Finland to Romania), is average to high in terms of e-learning implementations, though showing mixed results as to GDP change. A third group (Cluster 1) includes the bulk of Europe, with low percentages of e-learning use and opposite evidence with respect to GDP change. The last grouping (Cluster 2) contains Italy, Germany, the Netherlands, Hungary and Bulgaria, which are the worst performing in terms of diffusion of corporate e-learning. Although Ireland (which experienced a deep economic recession in 2008) and Bulgaria (whose economy grew by almost 10%) ideally should be

considered as outliers, both countries are included in a grouping in order to better highlight their performance in terms of e-learning use.

#### **4. Conclusive remarks**

The paper was mainly intended to evaluate the diffusion of e-learning activities among European SMEs and its relationship with the economic performance of EU countries. By and large, regression results showed a scarce goodness-of-fit of the model to the observed data. This notwithstanding, both the linear function and the logarithmic transformation indicated a direct relationship between GDP per capita and corporate e-learning penetration, expressed as percentage of European SMEs using e-learning for staff training purposes. By a comparison with the estimates of other modelling functions, the cubic function proved to be the best fitting to the data in every year of the time span specified. A cluster analysis was finally performed in an effort to identify differences and similarities in e-learning diffusion within Europe: results indicated an uneven distribution of countries within clusters with no uniform socio-economic or geographical connection.

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