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Monograph "The Economics of E-learning"

Introduction

A Theoretical Framework for the Economics of E-learning

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Abstract

The economics of e-learning was identified as a key priority for virtual campuses in the consultation workshop held in Brussels on 23 November 2004. The eLene-EE (Economics of E-learning) project has aimed to increase knowledge on the incentives to create virtual campuses and initiate teaching methods for education based on ICT and its effects, ensuring that this is efficiently carried out while reflecting the various situations at the partner universities. This RUSC special issue on the economics of e-learning shows the theoretical framework we have defined and some of the results we have obtained within the eLene-EE project, funded by the European Commission.

Our findings have clear policy implications and will help e-learning designers, learners, financers, and decision makers to build up, adapt, and improve their initiatives. The project is divided into five integrated research and development work packages (WP) with participants from universities in the eLene consortium (from Sweden, France, Spain, Italy and Poland).[1]

Keywords

e-learning, economics of education, knowledge economy, universities, productivity

Un marco teórico para la economía del e-learning

Resumen

La economía del e-learning *se identificó como una prioridad clave en el taller de asesoría de campus virtuales celebrado en Bruselas el 23 de noviembre de 2004. Con esta idea, el proyecto eLene-EE (Economía del* e-learning*) ha tratado de ampliar el conocimiento relativo a los incentivos para crear campus virtuales e iniciar métodos de enseñanza en la educación basada en las TIC y sus efectos, asegurando que esto se lleve a cabo eficazmente mientras refleja las diferentes situaciones de las universidades asociadas. Este número especial de RUSC sobre la economía del* e-learning *muestra el marco teórico que hemos definido y algunos de los resultados que hemos obtenido en el proyecto eLene-EE, que ha sido financiado por la Comisión Europea.*

1. For further information on eLene-EE, please visit our site: http://www.elene-ee.net

Nuestros resultados tienen unas implicaciones políticas claras y ayudarán a los diseñadores, estudiantes, financieros y gestores de e-learning *a crear, adaptar y mejorar sus iniciativas. El proyecto se divide en cinco paquetes de trabajo de investigación y desarrollo (WP) integrados por participantes de universidades del consorcio eLene (universidades de Suecia, Francia, España, Italia y Polonia).*

Palabras clave

e-learning, *economía de la educación, economía del conocimiento, universidades, productividad*

Introduction

From an economic perspective, economic and business activities are characterised by profound changes that modify the behaviour of all economic agents. These changing trends explain an economic change that can be framed within a wide context: the emergence of the knowledge-based economy. The development of this new scenario in developed economies is characterised by rapid knowledge creation and easy access to knowledge, conditions that generate greater efficiency, quality and equity (Foray, 2004). The Evidence for the advent of a knowledge-based economy is seen in the increase and improvement of knowledge-intensive activities throughout all industries of the economy more than in the continuous expansion of a specialized productive sector (Eliasson, 1990). The key differences in economic dynamics from the economies of earlier periods can be identified in the quality improvement of the production factors through a process based on the creation of new knowledge and ideas and their incorporation in physical and human capital.

In general terms, this transformation process is based on a technological revolution – the digitalisation process. It is built upon a dynamics of spatial and temporal market expansion – globalisation and it feeds back according to the changes of the patterns of demand of families and companies. This process has a clear through-line: the intangible value of the economic activity that, in other words, is the progressive consolidation of a new knowledge-based economy (Vilaseca and Torrent, 2004).

ICT is not the only causal factor in the global knowledge economy,[2] but it is clear that with ICT the knowledge-based economy has found a suitable technological base because there has been a clear interrelation between the upsurge of knowledge-intensive activities and the production and diffusion of ICT. Digital technologies are now consolidated as one of the necessary instruments to develop network activities and increase knowledge in the economic sphere. The complex interaction between the emergence of digital technologies and their production is profoundly transforming economic activities. ICT has become a key component of this economic transformation, with the rise of a new production sector that extends its synergetic effects not only to other branches of activity, but also to all other economic activities. This social background of knowledge has impregnated the economic activity to such a point that, currently, we can quote a growing number of interdisciplinary studies that sustain the following hypothesis: ICT is the technical paradigm on which the current dynamics of the industrial revolution is based.

A consensus has emerged that the diffusion and the productive use of ICT (through its effects on knowledge creation and transfer across industries) can be situated at the material basis of the economic growth of many developed countries since 1995 (Nordhaus, 2002; Jorgenson, Ho and Stiroh, 2005). The main driving forces behind this are a combination of the speed of technological change and product improvement in semiconductors and the continuing fall in their prices. Falling IT prices have provided important economic incentives for the effective diffusion of digital technologies among the different industries in the economy. This rate of price decline is a key component of capital costs, and it can be explained by the impact of rapidly growing stocks of computers, communication equipment and software.

Within this analysis of the sources of productivity growth in the paradigmatic model of the USA, we can come to three main conclusions: first, in terms of output, gross output growth, as well as intermediate input growth and value-added growth can be explained by a set of relatively small industries that produce information and communication technology (computers and office equipment, electronic components, communication equipment and computer services) and service industries. Second, in terms of capital services, the majority of US industries have re-

2. Authors such as ABRAMOVITZ and DAVID (1996) demonstrate that technological discontinuity can be dated well after the switch of developed economies towards knowledge-intensive activities.

sponded to declines in relative prices of capital (a direct externality from ICT-producing industries) and have shifted their investment patterns to ICT assets, a fact that is showed by the faster growth in ICT assets than in non-ICT assets, and by the growing share of ICT capital in total capital services; the rapid acceleration of ICT capital services is a widespread phenomenon that has benefitted almost every industry, especially those within the ICT-using sector. And third, in terms of labour, the productivity growth after 1995 has been accompanied by major changes in the allocation and composition of the work force, since the positive trend in labour quality during the period 1995-2000 is explained by the rise in average levels of educational attainment, as older and less-qualified workers retired and left the labour force and, complementarily, young workers improved their education attainment.

The age profile of workers has also changed, with young workers receiving premium rates closer today to the more experienced workers than in the past. This empirical finding is consistent with the hypothesis of a skill-biased technical change and the existence of complementarities between ICT inputs and young workers. Therefore, these results show the effects of the ICT revolution on labour markets, particularly the fact that college-educated workers were the main source of employment growth throughout the period 1977-2000, although the evolution was more varied in the interval 1995-2000, due to a stabilization of the education attainment levels and a high economic growth drawing in workers with lower cognitive skills. There is a link between productive uses of digital technologies and labour composition; in particular ICT-producing and ICT-using industries show an increasing demand for ICT skills, which has been associated an expansion of the education industry.

Another important conclusion is the considerable variation in labour productivity growth, in TFP growth, in the quality of labour and employment growth, and in capital services gains, across industries and across time. This fact indicates the important differences between industries in terms of production processes, input demand and allocation, and growth prospects, strengthening the hypothesis of the existence of complementarities between technical and organisational change and skilled labour input to explain productivity gains at the industry level. Nevertheless, it is remarkable that ICT-producing and the majority of ICT-using industries have experienced a substantial growth in these indicators since 1995.

It should be pointed out that the diffusion of a new technology is a long and complex process of building complementarities at many levels, within the concepts of technological and organisational trajectories and progressive adjustment of economic and social capacities to a technological revolution (Freeman and Soete, 1997). The full realization of the potential of ICT (as a general purpose technology) is a long process that is contingent on significant technical, organisational and institutional adjustments (Foray, 2004). It must also be taken into account that ICT requires new industrial and innovative organisations built around a network and strongly based on digital technologies uses, and that the high degree of innovation in digital technologies leads to the need for continuous adaptation to a perpetual and radical technological change that underlies the economic base of productivity gains. In other words, an organisational culture of change is needed at the company level to deal with the constant upgrading of software and hardware that leads to constraints of interconnectivity and interoperability for the user.

The way to address the issue of ICT complementarities has emerged as a focus of analysis in the industrial organisation literature, within the framework of the investment theory. From this perspective, the two main adjustment categories in the process to exploit the potential benefits of ICT usage at the company level are concentred in the organisation of the production processes and the demand for specific skills and abilities.

Concerning the first category, we adopt the thesis that the main driver of organisational change in firms is the need to adapt to changing competitive conditions. In this field, there is a mutually beneficial relationship between organisational change and ICT investments. Digital technology is a key element to facilitate new organisational practices, such as lean production, team-working, more decentralization in strategic decision making activities, and a closer interaction with customers and providers of intermediate inputs (Bresnahan *et al.*, 2002; Cristini *et al.*, 2001). Therefore, ICT availability and usage increase firms' capacity to adapt their organisational structure to these new network requirements. At the same time, efficient ICT use by firms requires some specific organisational changes in order to maximize the exploitation of their technological capabilities. How ICT and organisational change are combined within a firm will determine the efficiency level achieved and, therefore, the degree of productivity gains. Company-level organisational change can take many forms, but they can generally be classified into three broad systems (Murphy, 2002): 1) The restructuring of production processes (including Total Quality Management practices, lean production systems, Just-In-Time methods and business re-engineering processes); 2) Management systems and employee involvement schemes (with practices such as

decision-taking decentralization, teamwork, knowledge management, flexible work arrangements and flexible compensation); and 3) External re-organisation that emphasises customer orientation, outsourcing and company networking.

There is also an important relationship between development and diffusion of digital technologies and demand for specific skills and abilities devoted both to the production industries of technological innovation and to labour input of the broad economy. These skills can be separated into two main classes: 1) cognitive (or technical) skills related to ICT production and use, especially those needed for the correct use of digital technologies that allow individuals to surpass the constraints derived from the continuous and accelerated upgrading of digital innovations; and 2) non-cognitive skills (or "soft-skills") or abilities that are not directly related to the production requirements but also necessary because they enhance individual development and social participation (Levin, 1998). The latter includes entrepreneurship, adaptation to changes, cooperation, teamwork, knowledge transmission, problem solving, decision making, information management, self-programming, learning abilities (especially bias to continuous learning or "long-life learning") and communication skills; these abilities are not new, but they are crucial to fit the new technical change requirements and to keep up with the constant change in economic activities.

There is a large amount of empirical evidence that demonstrates the beneficial effects in terms of company productivity of these complementary relations between the two above mentioned innovations, ICT adoption and organisational change, and the demand for skilled workers. The main conclusion from this work is that company performance improves when digital use is accompanied and co-integrated with a re-organisation of business processes and labour management, and the participation of more qualified workers.

In summary, education has a critical role in sustaining economic and productivity growth based on ICT investment and usage, not only for its direct allocation to the innovation processes of those industries responsible for knowledge creation, but also for its importance in efficient use of digital technologies by workers across industries in the economy and the improvement of the individual's capacities for knowledge management, transfer and productive usage. Therefore, organisations on the supply side of the education industry, where universities are included and have an important role, have significant challenges along two main lines: 1) to generalise access to education across the population and encourage the improvement of educational attainment levels, to respond to the social demand of a life-long learning offer, and to fit with workers' needs for specific skills and abilities, and 2) to adapt their organisational and institutional structure to the innovation process for effective and efficient ICT use in teaching and management activities through the adoption of new business models, and to achieve an intensive use of digital technologies in the teaching and learning processes (courses and programs) in order for students to attain the ICT skills and abilities required in the labour market by teaching them how to use and, what is more important, how to apply digital technologies to their professional activities.

In this field, e-learning is an opportunity to encourage a general ICT policy in universities that can favour their organisational adaptation to digital requirements in terms of better performance, and to offer students a continuing education that may lead to the development of skills better linked with the production needs of the knowledge economy.

Positive externalities of e-learning

Education must be considered as a key investment in modern economies because, as we have shown, within the framework of a knowledge-based economy there are strong and positive complementarities between economic activity and education in the explanation of economic growth. E-learning can contribute to the beneficial dynamics by increasing access to education in society as a whole, avoiding traditional constraints related to space, time and pace of teaching and learning systems, and allowing education access to many people who would otherwise not enrol on courses.

We can affirm that education leads to important benefits, both for individuals and for society as a whole. In economic terms, human capital accumulated as a result of the educational process should be considered as a mixed good, i.e. a private good with public externalities. The nature of education goods leads to the distinction between private and social educational benefits.

From the point of view of the individual, and following the human capital theory approach, the increase in an individual's level of educational attainment is consistent with an increase in their productivity in the labour market, which is the reason for higher wages for more educated workers. Since the time of Mincer (1974), who estimated that around 10% of wage increases in the USA was attributable to an individuals' schooling, a huge amount of empirical evidence[3] has demonstrated a high positive correlation be-

tween individuals' educational levels and wages. Therefore, taking into account age and experience, better-educated workers earn more than their less-educated peers (Cipollone, 1995). However, education is not the only explanatory variable of wage differentials. There are other variables, sometimes difficult to measure, affecting labour market outcomes: individuals' innate ability, social and economic status, family background or other social factors. But, as pointed out by Hinchliffe (1995), earnings functions and path analysis of the effects of individuals' background characteristics on occupational attainment and earnings have indicated that, while much of the variance remains unexplained, the largest single indicator is education. Indeed, it has also been proven that a virtuous circle arises within the complementary relations between education and income, so that education can explain higher earnings for workers while higher income causes increases in the demand for education (Sianesi and Van Reenen, 2002).

Other benefits from higher levels of education, directly related and complementary to wages, are 1) the increased likelihood of participating in the labour market and 2) the decreased probability of being unemployed. Participation in the labour market and unemployment rates are closely related to education (OECD, 1997 and 1998; De la Fuente, 2003), and help to explain the economic benefits for individuals.

An important concern is that the benefits of educational investments for individuals extend beyond increases in earnings and employment conditions to other factors that have an indirect effect on economic benefits. Education has a positive impact, among others factors, on health (Taubman and Rosen, 1982; Desai, 1987), on intergenerational cognitive development (Angrist and Lavy, 1996; Lam and Dureya, 1999), on developing more rational organizational and financial competence, and better analytical skills (Lassibille and Navarro Gómez, 2004), on a greater likelihood of participating in politics and social decision mechanisms (Campbell *et al.*, 1976), on adopting a better consumption technology and a greater efficiency in making consumer choices (Rizzo and Zeckhauser, 1992) and on higher rates of saving (Solomon, 1975). All these additional advantages are real benefits from education but they are difficult to measure in monetary terms.

From a social point of view, education plays an important role in determining the level and the distribution of income, in company (and institutions in general) productivity and in economic growth.

Firms and institutions benefit from the disposal of more educated employees through two main channels: 1) through the positive effect of education and training on the improvement of productivity levels and rates of growth (Dearden *et al.*, 2000; Bresnahan, Brynjolfsson and Hitt, 2002), and 2) through the spill-over effects from better-educated workers. Therefore, the effects of higher levels of educational attainment are shown not only in the higher productivity of educated workers, but also in the increase of other workers' productivity as a result of learning by imitation and improving their skills from working with them (London Economics, 2005).

For society as a whole, the empirical evidence suggests that there is a positive relation between education (through human capital formation mechanisms) and economic growth (Lucas, 1988; Romer, 1990; De la Fuente and Ciccone, 2002; Jorgenson, Ho and Stiroh, 2005), with special force when technological change is considered (Psacharopoulos and Patrinos, 2004). These economic benefits estimations are usually based on gross wages across the economy and on the fiscal incomes derived from industries' economic growth.

There are also other social benefits that indirectly affect performance of economies through different channels. Education produces external effects that have a positive incidence on agents other than those benefiting from it. These externalities, such as social cohesion, political stability, and citizen participation in public policy issues, are difficult to identify and, even more so, to measure. Nevertheless, some authors have tried to identify and quantify educational externalities (Weisbrod, 1964; Havenam and Wolfe, 1984; Heckman and Klenow, 1997; McMahon, 2000; Acemoglu and Angrist, 2000; or Davies, 2002) by three main methods: 1) consumer surplus or welfare improvements, 2) expenditure on related private goods, and 3) hedonistic pricing models. The results of these studies show that the extent of social spill-overs explains the existence of significantly higher returns on investment in education for societies. The most plausible sources of these externalities are the link between human capital and the rate of technological change, and the indirect effect of education on productivity and employment through the quality of institutions that may be considered as a component of social capital (De la Fuente and Ciccone, 2002).

3. Some recent contributions to this field are: DE LA FUENTE (2003), HARMON, WALKER and WESTERGAARD (2001), CARD (2001), ASHENFELTER, HARMON and OOSTERBECK (1999), LASSIBILLE and NAVARRO GÓMEZ (1998), OECD (1998) and PSACHAROPOULOS (1994).

In addition, the increase of individual and social human capital allowed by e-learning provision and e-learning contribution to develop workers' e-skills may help to reduce skill-biased technological change effects on wage distribution in labour markets.

From the point of view of labour economics, it is well documented by both theoretical developments and empirical findings that technological change has a significant impact on the labour market. This topic has been an important concern of economic research, and the discussion has intensified in the two last decades due to the general ICT adoption in the economic sphere (Spitz, 2003). A key observation in this field is that highly skilled workers, and especially those with higher levels of educational attainment, are more likely to use computers in their job (Krueger, 1993). These facts have led to a major consensus in the labour economics literature that a burst of new technology causes a rise in the demand for highly skilled workers, which in turn implies an increase in the wages of skilled workers relative to unskilled workers. This hypothesis is known as the Skill-Biased Technological Change (Acemoglu, 2002; Acemoglu, 1998).

Some research (Berndt et al., 1992; Berman et al., 1994; Kaiser, 2000) has shown that during the last decades there has been a structural shift towards the increase in deployment of white-collar work in most sectors of developed economies and a rise in employment of workers with high levels of formal education. Moreover, other studies (Wolff, 2000; Autor et al., 2001) have found that the change in employment patterns resulted in an upgrading of cognitive and interactive skills and a decreasing demand for manual skills. This is simultaneous with the increase of ICT investment and adoption by firms. The link between ICT and the demand for high-skilled labour is due to the fact that the introduction of digital technologies alters the skill requirements of occupations in three main ways (Spitz, 2003): 1) ICT capital substitutes repetitive manual and repetitive cognitive activities, 2) ICT capital is complementary to analytic and interactive activities, and 3) ICT capital increases the requirement for computing skills. This relation underlies the evidence that compared to previous technological revolutions (that aimed to routinize manual tasks), digital technologies are additionally capable of replacing simple human cognition such as perceiving, choosing and manipulating processes, and searching and managing information. Additionally, computer technologies are complementary to analytical and interactive activities. There is also evidence that ICT capital does not substitute whole occupations, but is limited to certain tasks. This limited substitution relationship, pointed out by Bresnahan (1999) shifts the demand for labour towards workers with higher levels of education who are considered to have a comparative advantage in performing analytical and interactive tasks. Thus, computer technologies shift the relative skills requirements of occupations towards analytical and interactive activities.

E-learning in higher education

Universities stand at the centre of the knowledge-based economy development as they are currently one of the main agents providing education within the education industry.

There has been major development in the education industry in recent years in part as a consequence of the growing empirical evidence on the effect of improving educational attainment on economic and productivity growth. The increase of the education market has also been facilitated by the emergence and diffusion of digital technologies. The use of ICT in the production process that leads to the provision of education and training is transforming the way education suppliers are developing this. New opportunities have emerged to integrate pedagogical and technological resources, to increase flexibility across the learning process, and to improve communication between teachers and students and the interaction between different educational resources (Collis, 1996). The increasing use of ICT and particularly Internet in the educational process of universities across OECD countries explains the growing adoption of e-learning systems and the development of online courses in universities (European Co mmission, 2004; University of Southern California, 1990-2006; OECD/CERI, 2005).

The digital-based change in the provision of education is not constrained to the teaching and learning process, but also affects organisational structure and management practices of education suppliers.

Since the mid-nineties there has been an increasing belief that the use of e-learning systems in universities may lead to improved efficiency in the production of education, in terms of scale (number of student enrolments), students' achievement and costs (OECD, 1998).

Vilaseca and Castillo (2005) have studied six e-learning universities around the world[4] over a period of time

4. These universities are: Athabasca University (Canada), Capella University and Jones International University (United States), the Virtual University of Monterrey Technologic Institute (Mexico), the Open Learning Agency (Australia) and the UOC (Universitat Oberta de Catalunya), Spain.

in order to analyse the determinants of cost-efficiency in e-learning production by universities. The results show that cost-efficiency is due to three complementary effects: 1) the attainment of scale economies based on high fixed costs and low marginal costs; 2) the enablement of productive capacity expansion without an increase in fixed costs and 3) the trend towards a rise in variable costs consistent with decreasing marginal costs.

Therefore, e-learning production by universities will be accompanied with a relative high investment in ICT infrastructure and digital applications, as well as in methodological issues (course designs, didactic materials, etc.) and labour adjustments at the university level. This capital accumulation required for e-learning development may lead to a saving in costs, especially if universities are able to exploit some economic benefits based on the use of digital technologies.

There is already empirical evidence that e-learning policies in universities are important driving forces for quality improvement and strategic planning promotion. Following on from this, universities must continue with the research on efficient institutional models for the provision of high quality education based on the use of digital technologies.

eLene-EE (Economics of e-learning)

In this special issue of RUSC on the economics of e-learning, some results of the eLene-EE project are presented in different papers. eLene-EE[www1] is a project of the eLene group (e-learning network) funded by the European Commission e-learning programme, running from February 2006 to July 2008.

The above sections contain the main questions eLene-EE researchers aim to address in order to discuss and provide evidence on which variables make virtual campuses and e-learning provision by European universities an efficient way to provide higher education: How much does it really cost to set up and run a virtual campus? What impact does e-learning have on student performance and what are the possible spill-over effects? What indicators do we have at our disposal to track the efficiency of e-learning? And can e-learning help to bridge the digital divide?

These topics are analysed in the four core content workpackages of the eLene-EE project:

WP 1. Cost-benefit analysis of net based higher education

The main question in WP1 is whether or not e-learning is an efficient use of resources, i.e. what are the main benefits and costs for society? One important aspect of the analysis is to consider effects, or outcomes, for different stakeholders (e.g. students, universities and policy makers). Although an investment may be beneficial for one stakeholder, it might not be beneficial for another. This raises the question of how costs and benefits should be divided between stakeholders in order to create a correct incentive structure.

WP 2. Student performance of e-learning

The main questions in WP2 are whether the uses of ICT affect student performance and whether the uses of ICT affect student performance differently depending on the subject. These are two important questions that need attention in order to ensure quality in and efficient training from virtual mobility including the right choice of tools available from existing technology. WP2 aims to provide answers to these questions with hypotheses and data from ongoing training and data from a carefully designed experimental set-up performed within the WP. Students performing well are a condition for creating benefits in the context of WP 1.

WP 3. Indicators of e-learning

The WP3 partners decided to work on indicators relevant at the HEI level and indicative of the regional, state or European ICT policy. Our aim is to collect data on indicators of e-learning progression in HEI with information characterising them and useful to aggregate and analyse data on policy perspectives. In consequence, we will work with a double approach. One is at the micro economic level, based on HEI business and management perspectives, integrating dimensions of the quality of services provided to the customer and specific indicators with a Balanced Score Cards approach. The other is at the macro economic level, looking at e-learning progression in our societies to identify indicators of its development.

[www1] http://www.elene-ee.net/

WP 4. Digital divides and e-learning

While the dividend of educational ICT seems obvious, countries may not meet the appropriate conditions in using these technologies and may fall into the digital divide. These technologies may enhance social exclusion and different groups within the societies will not benefit from them. The aims of this Work package 4 are threefold: Firstly, we want to characterize the variety of digital divides in matters of educational ICT and to understand how to bridge them. Secondly, we want to illustrate the differences of the digital divide in terms of uses, what factors contribute to it as well as its various forms. There will be a special focus on the concepts of digital choices and digital trajectories. Thirdly, we will look at the main explanations of digital divides in matters of performance. Why do some institutions, students, countries perform better than others? Is there any "productivity paradox" in the higher education sector? Is there a "Skill Biased Technological Change" in matters of educational ICT?

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