



# Information and communication technologies, human capital, workplace organization and labour productivity: A comparative study based on firm-level data for Greece and Switzerland

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## ABSTRACT

This paper describes a comparative empirical study of the effect of information and communication technology (ICT) capital, human capital and new organizational practices on labour productivity in Greek and Swiss firms. We use firm-level data collected in 2005 through a common questionnaire administered to samples of similar composition (e.g. similar firm sizes, similar sectors), from which we construct econometric models with similar specifications for Greece and Switzerland. The analytical framework is based on a firm-level production function. We find statistically significant positive effects for physical capital, ICT capital, human capital and “employee voice”-oriented organizational practices for both samples. We also identify considerable differences: Swiss firms are more mature and more efficient than Greek firms at creating, using and combining these ‘new’ production factors.

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## 1. Introduction

In the modern economy, in addition to traditional production factors (physical capital, labour), there are some ‘new’ factors that are becoming very important, such as human skills (often referred to as ‘human capital’), workplace organization (often referred to as ‘organizational capital’), information and communication technologies (ICT), and knowledge. In most developed and developing countries firms make big investments to acquire and use these new production factors; thus, their contribution to and impact on firm performance is of critical importance. There has been considerable research about the impact of ICT

investments on firm performance but until recently, there has been very little empirical evidence of a positive contribution of ICT investment on firm performance. This lack of empirical evidence has given rise to the ‘ICT Productivity Paradox’ (Brynjolfsson, 1993). More recent research in this area has produced evidence of the positive contribution of ICT investment to several measures of firm performance (see, e.g., OECD, 2004), probably reflecting improvements in the exploitation of ICT by firms. In addition, the contribution of human capital to economic growth at the aggregate, sector and firm levels has been researched and recognized (e.g., Barro, 1999; Middendorf, 2006), and there is an increasing interest in new organizational practices, such as ‘employee voice’ and new forms of ‘work design’, and their impact on firm performance (e.g., Murphy, 2002; Black and Lynch, 2002).

There is also some acknowledgement in the literature of the existence of complementarities between ICT capital,

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human capital and new organizational practices, all of which are of critical importance for firm performance. These complementarities have been regarded as a fundamental characteristic of an emerging new ‘firm paradigm’ in the modern economy (Milgrom and Roberts, 1990).

However, although there are some similarities among the conclusions made by these studies, there are also several differences, which (at least to some extent) might be due to variations in sample composition (the samples of the above studies come from different sectors and industries), the variables and model specifications, and the nature of the investigations (cross-sectional versus longitudinal). Further empirical research is required, therefore, into the impact of ICT capital, human capital and new organizational practices, and their combined effect on firm performance. To this end, this paper describes a comparative empirical study of the effects of ICT capital, human capital, new organizational practices and their combined use, controlling for knowledge capital, on labour productivity in Greek and Swiss firms. The analytical framework is based on a firm-level production function. Both the Greek and the Swiss parts of this study are based on firm-level data collected in 2005, through the same questionnaire, from samples of similar composition (firm size classes and sectors), and they use the same variables and model specifications; thus, they are comparable.

The contribution of this study to the empirical literature is three-fold. First, ours is the first completely comparative empirical study of the research areas outlined above, in two quite different countries, that gives particular attention to the issue of complementarity. Second, it is the first study of this type with a focus on Greece, whose economy is quite different from the economies of the highly developed countries, which have been the subject of most of the empirical studies in this area. Third, this study explicitly takes account of possible endogeneity problems in the right-hand side variables in a cross-section.

The structure of this paper is as follows: Section 2 presents the conceptual framework of the study; Section 3 provides a review of the relevant empirical literature. The Greek and Swiss data are described in Section 4. Section 5 presents and compares the patterns of ICT use, new organizational practices and human capital in Greece and Switzerland. Section 6 describes how the variables are constructed and the specification of the two types of econometric models used in this study. The results of the econometric estimates for both samples are presented and discussed in Section 7. Finally, we summarize the results and compare the findings for Greece and Switzerland in Section 8.

## 2. Conceptual framework

### 2.1. The new firm model

Since the early 1990s, we have witnessed a constellation of important changes to the production process, such as the extensive use of computer-aided production technologies, advances in ICT, emergence of new ideas about how to organize firms, changes in the skill requirements

for labour and changes in employee preferences toward more flexible working conditions. Based on these changes, many authors have begun to postulate a shift to a new ‘firm paradigm’. Some focus mainly on technological changes, and others find the introduction of new organizational practices a central characteristic of this ‘paradigm change’. There is another group of authors who concentrate primarily on the shift in firm demand to high-skilled labour since the late 1980s, and analyze the determinants of this shift. In this section, we briefly review some of this literature.

Milgrom and Roberts (1990, p. 511), focusing mainly on manufacturing, proclaim the replacement of the ‘mass production model by the vision of a flexible multiproduct firm that emphasizes quality and speedy response to market conditions while utilizing technologically advanced equipment and new forms of organization’. Changes in production techniques and their implications for firm efficiency and performance constitute the main thrust of their theoretical analysis. Lindbeck and Snower (2000, p. 353) analyze the shift from ‘‘tayloristic’ organization (characterized by specialization by tasks) to ‘holistic’ organization (featuring job rotation, integration of tasks and learning across tasks)’. In a later paper, Lindbeck and Snower (2003) elaborate the idea of the ‘firm as a pool of factor complementarities’, thus identifying factor complementarity as a determinant of a firm’s boundaries. Bresnahan et al. (2002) take the relative demand of skilled-labour as the starting point of their analysis and consider the increased use of ‘complementary systems’ of information technologies, workplace organization and product innovation as drivers of skill-biased technical change. A common characteristic that is central in all these types of studies is the existence of complementarities among several factors which mutually enhance their impact on firm performance.

### 2.2. Role of ICT

The benefits of ICT for a firm include savings on inputs, general cost reductions, greater flexibility and improvements in product quality. The new technology may save on labour or on some specific labour skills; it may also reduce capital needs through, for example, increased utilization of equipment and reduction in inventories or space requirements. This new technology may also lead to higher product quality or better product development conditions. Moreover, the new technology may also increase the flexibility of the production process, allowing for the exploitation of economies of scale (see, e.g., Milgrom and Roberts, 1990, 1995). A specific feature of ICT is related to networking and communication. As new technologies reduce the cost of lateral communication, firms use these technologies to facilitate communication among employees and reduce co-ordination costs. Monitoring technologies can reduce the number of supervisors required in the production process. Thus, the use of ICT has direct implications for firm organization.

While inventions that lead to improvements in ICT are readily available throughout the economy, complementary organizational changes involve a process of co-invention

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