



# ICT productivity and firm propensity to innovative investment: Evidence from Italian microdata <sup>☆</sup>

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## Abstract

Employing a large and detailed data set from Italian manufacturing firms, we provide some insight into the link between information and communication technology (ICT), productivity and the innovative level of investment. Our results support the hypothesis that ICT is different from conventional capital in the rate of technological progress, the compatibility between old and new capital and the extent of learning by doing. We compute ICT marginal productivity across different clusters of firms and its impact on output growth. Depending on their attitude to innovation, firms are found to be appreciably more ICT productive when non-leading technologies are adopted. We find that ICT has a disproportionately wide impact on growth compared to the share in total investment that it represents.

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## 1. Introduction

A number of scholars have explored the link between ICT and productivity growth at firm level. Although some research concludes that ICT has negative or insignificant effects (Loveman, 1994; Berndt and Morrison, 1995 among others), since the beginning of 1990s there has been growing consensus that there is a strong positive link (Barua and Lee, 1997; Lehr and Lichtenberg, 1999; Brynjolfsson and Hitt, 2000a; Greenan et al., 2001).

Research on ICT productivity has been carried out in various ways and can be summarised under three general headings: workplace and labour reorganisation, bias in the estimations, and vintage capital models.

According to a wide range of studies ICT requires significant workplace and labour reorganisation at firm level. ICT is only a small component of a complex set of causalities (skill, infrastructure, organisation, diffusion, adoption, adaptation, etc.) which include both tangible and intangible aspects. If such ‘complete cluster of associate complements’ do not improve together, many ICT benefits may be lost and ICT becomes mainly a cause of higher costs rather than improving output (Brynjolfsson and Yang, 1997; Bresnahan et al., 2002).

Several contributions focus on ‘skill-biased’ technological change, according to which investment in ICT is associated with reductions in the workforce and an increase in the demand for highly educated workers as well as in workplace reorganisation (Black and Lynch, 2001; Bresnahan et al., 2002; Caroli and Van Reenen, 2002; Acemoglu, 2002; Piva et al., 2005; Pini and Santangelo, 2005).

Some research argues that low ICT productivity may come from the bias in the econometric estimation, which is a result of the peculiarities of ICT. Siegel (1997) shows that investment in ICT can cause changes in output and labour quality, which are not properly accounted for when estimating the growth of the real output and inputs. Thus it gives rise to a measurement error in the dependent variable and biases ICT productivity estimates.

A third line of research reconsiders ICT productivity in the light of vintage capital models. It argues that the characteristics of ICT may exacerbate learning problems when new capital is introduced in the production process (Cooley et al., 1997). Yorukoglu (1998) emphasises that information technology intrinsically differs from conventional capital in the rate of technological advance, the compatibility between old and new capital and the extent of learning by doing. ICT investment is lumpier than conventional capital and requires larger and more frequent learning. Using a model where replacement (i.e. the substitution of expired capital for new and more innovative one) is explicitly considered, he finds large drops in productivity at replacement dates. Since learning-by-doing is implicitly associated with the level of innovation the new capital embodies, he concludes that learning by doing, together with the very nature of information technology, may be at the cause of the downward bias of ICT productivity estimates.

In this paper we investigate the link between the innovative level of investment and ICT productivity in a large and detailed sample of Italian firms during the period 1995–97. Focussing on the additional contribution of ICT investment to productivity, we find evidence of such compatibility problems. These appear to be more severe when firms replace traditional with more innovative capital.

The introduction of new technology has a twofold effect on productivity. On one hand, the technology embodied in new and more efficient capital has positive effects on productivity. On the other technological improvements brings uncertainty due to learning and reorganisational effects. These negatively affect ICT returns.

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