EXTENDED ABSTRACT

Title: "Regional economic growth and the effect of Information Communication Technology: what is beyond the expected value?"

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Subject area: **1**. Growth, convergence and development.

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Extended abstract:

Over the last years, the increasing diffusion of Information Communication Technology (i.e., ICT) is affecting considerably the analysis of many economic phenomena, including economic development, economic growth, productivity, and inequality. Indeed, the rapid pace of innovation that is happening in digital technologies, the large diffusion of the internet happened worldwide, the rise of the internet of things (IoT), and the effect of digital transformation and remote communications on education can all be considering significant aspects leaving their traces on national and regional development (Cardona et al. 2013; Kong, 2014; Stanley et al. 2018).

In the economic literature, the effects that ICT may have on economic growth has been tested from many different perspectives. For example, this relationship has been studied by evaluating the magnitude of positive effects of ICT diffusion at national and regional level (see, for the case of USA; Kretschmer, 2012), by considering the differences between tangibles and intangibles factors in Research and Development (R&D), and their diverse effects on economic productivity and growth (Kenny, 2003; Corrado et al. 2017).

In this line, a relevant issue attains the analysis of the potential effects of ICT diffusion on economic growth in different territorial contexts. Among others, Stanley et al. (2018) notice how the impact of ICT on growth may well change depending on where ICT diffusion happens. Particularly, a pivotal aspect to take into account is the differential in terms of economic development. On the one hand, more advanced regions that faces some economic slack may benefit greatly of technological advancements. On the other hand, fast growing developing regions that are highly converging could face diverse consequences. This may happen, for example, due to the presence of infrastructures, discrepancies in the propensity towards innovations, potentially different attitudes towards more uncertain investments, and the level of education in working population (see, for example, Mack and Faggian, 2013).

All these features lead to better consider heterogeneous effects while regressing economic growth on some ICT indicators to test for potential causality. Intuitively, when we estimate a model of conditional economic growth and convergence (e.g., Mankiw et al. 1992) augmented by variables that control for ICT advancements, it could be important to have a deeper look beyond linear regression estimates. This would allow to observe if mean regression tendencies are equivalent at each level of the conditional economic growth, or some tail discrepancies emerge. At this purpose, quantile regression is a suitable instrument to go beyond

average estimation and tackle some of the fallacies linked to standard regression (Friedman, 1992).

In the regional sciences there has also been a growing effort to better assess the impacts of ICT on economic growth at regional level. However, while considering a regional application it is very likely that spatial dependence characterizes the phenomenon under investigation (Anselin, 1988). The relevance of spatial spillovers in innovation had been previously recognized as an extremely important issue (Kang et al. 2017). Hence, the use of a quantile spatial specification would allow for unbiased estimation in the presence of spatial dependence, but also lead to a consideration of direct and indirect effects (see, LeSage and Pace, 2009) in a quantile frame.

In this paper the main objective is to add on to the literature of regional economic growth and ICT innovation by both exploring heterogenous effects over the conditional growth curve while considering spatial effects. We first apply quantile regression to a conditional model of economic convergence expanded using variables related to ICT and R&D in high tech as covariates. Hence, we exploit properties of quantile regression to go beyond average betas and asses if regions growing at faster paces show different dynamics from the slowly growing ones. Moreover, as we are also interested in regional mechanisms, we opt for a spatial specification that can avoid potential bias in the quantiles (Kim and Muller, 2003). Particularly, we select two different spatial specifications, Spatial Lag Model (SLM) and Spatial Durbin Model (SDM). Both spatial specifications are estimated using IVQR (Chernozoukov and Hansen, 2006; Chernozhukov and Hansen, 2017) and using spatial instruments in the quantile setting equivalently to the case of standard spatial models (Kelejian and Prucha, 1998; McMillen, 2013; Kelejian and Piras, 2017). The two specifications are compared at each different quantile in terms of goodness of fit using pseudo-R squared as in Koenker and Machado (1999).

Further, following the approach proposed by Tauer (2016), we compute an indicator based on the quantile estimation at high quantiles able to rank different regions in terms of their conditional growth performance. Thus, by focusing on the residuals from a 0.9 quantile - meant as distance from the high level of the conditional distribution - we visualize regions that more efficiently turn ICT diffusion and R&D in highly technological sector into economic growth (e.g., Cartone et al. 2021).

To test the effects of technological innovation in ICT on economic growth at different quantiles, we select NUTS 2 European regions between the years 2009 and 2016. We adopt a set of different variables as the spread of the robot manufacturing, use of home banking,

diffusion of internet connection at households, and the share of R&D employment in high tech to account for ICT diffusion at regional level. Results are shown for standard quantile and spatial quantile regression to evaluate differences when geographical spillovers are considered. Moreover, the efficient exploitation of new technologies to boost economic growth is assessed at regional level due to the indicator of growth performance. Lastly, the use of the spatial quantile methodology is discussed in terms of policy insights and suggestions to support policy makers in a wider diffusion of sustainable ICT innovation.

Keywords: quantile regression; spatial effects; spatial dependence; innovation.

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