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**Educational inequalities:**  
**Do they affect the relationship between Internet and economic growth?**

**Introduction**

The impacts of information and communication technologies (ICT) on economic growth were extensively discussed by researchers within the context of productivity debates in the 1990s. Traditionally, empirical evidence has shown that the effects of ICT on economic growth depend on how these technologies are used, and on skills and education levels (e.g. Bresnahan, Brynjolfsson and Hitt, 2002; Hargittai, 1999; Kiiski and Pohjola, 2002). Human capital facilitates ICT diffusion, since more educated people are prone to adopt and use innovations (Rogers, 2003; Kiiski and Pohjola, 2002; Quibria, Ahmed, Tschang and Reyes-Macasaquit, 2003), thus helping to develop network effects (Andrés, Cuberes, Diouf and Serebrisky, 2010) and impacting on economic growth.

Moreover, the literature on the digital divide has also emphasized the existence of disparities in access and use of ICT, which usually appears to be associated with other within-country social divides, such as differences in human capital endowments (Billon, Marco and Lera-López, 2009; Oyelaran-Oyeyinka and Lal, 2005; Quibria et al., 2003). The evidence shows that richer and more educated individuals are those who use computers and access the Internet to a greater extent (Keniston, 2004). In many

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9 developing countries, the bulk of Internet users belong to the most educated sector of  
10 the population, whereas the majority lags behind not only in terms of general education,  
11 but also in terms of technical and language skills needed to use the Internet, therefore  
12 creating a gap that may affect its diffusion (Kenny, 2003).  
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17 Within the diffusion theory, the heterogeneity models (Rosenberg, 1972)  
18 attribute a critical role to disparities in educational levels to explain the differences in  
19 diffusion rates (Geroski, 2000; Karshenas and Stoneman, 1995). Rogers (2003) also  
20 highlights the role of socio-economic characteristics of adopters in explaining how  
21 innovations are adopted. The flows of knowledge and information spread across  
22 individuals according not only to their levels of education but also on how education is  
23 distributed and disseminated. The proximity/distance among adopters and their  
24 similarities/differences in terms of certain socio-economic features, such as education,  
25 influence technology diffusion (Boschma, 2005; Basile, Capello and Caragliu, 2012). In  
26 this sense, the educational distribution within a country may condition the way in which  
27 the information and knowledge associated with technology use are disseminated  
28 throughout the productive and social system and therefore its impacts. The existence of  
29 inequalities, such as those related to education may influence the communication flows  
30 between individuals and therefore the impacts of information and knowledge sharing.  
31 Information and knowledge flows take place among “peers”, between “ups” and “ups”,  
32 on the one hand, and between “downs” and “downs”, on the other (Rogers, 2003). In  
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addition, as also mentioned, the dissemination of information and the transmission of codified and tacit knowledge (Storper and Venables, 2004) may be related to several cognitive, social and technological proximities associated to the existing educational structure, with potential impacts on economic growth.

As far as we know, there have not been any studies into the relationship between educational inequality and Internet use, nor on how these relationships impact on economic growth. The available empirical evidence often refers to the links between ICT and income inequality (Fuchs, 2009; Hyytinen and Toivanen, 2011; Tselios, 2011). Furthermore, those studies exploring educational inequality effects on economic growth do not include ICT use in their models (Castelló and Doménech, 2002; Rodríguez-Pose and Tselios, 2010). Additionally, the only study that analyses the joint impact of inequality and Internet use on economic growth (Noh and Yoo, 2008) only focuses on the effect of income inequality, not considering the role played by educational inequalities.

This paper seeks to fill this gap by investigating the impact of Internet use on economic growth and the extent to which education inequality modulates this impact for a panel data set of 94 countries between 1995 and 2010. We use panel data approach to fully capture the determinants of growth, and examine whether the impacts vary according to development levels. In comparison with the previous literature (Choi and Hoon Yi, 2009; Noh and Yoo, 2008; Qiang and Xu, 2012), we contribute to the

literature in several ways. First, we provide evidence on the impacts of Internet use on economic growth in the period of greatest diffusion of Internet. Second, we investigate the role of educational inequalities as a social feature that may influence the impacts of Internet use on growth. Third, by differentiating the analysis by income levels we provide new evidence on how the impacts of Internet on growth may vary according to development levels.

The paper is organized as follows. Following this introduction, section two is devoted to the literature review. Section three presents the empirical model and variables. The data and methodology are shown in section four. Section five presents the empirical analysis. The final section provides the main conclusions and policy implications of our work.

## Literature review

### *Human capital: impacts on ICT use and economic growth*

Individuals with higher educational level are more willing to accept the risks and uncertainty associated with innovations (Rogers, 2003; Kiiski and Pohjola, 2002). Education has often been considered as a critical factor and a precondition for ICT use because it provides the skills required for using and taking advantage of ICT (Benhabib and Spiegel, 2005; Rosenberg, 1972; Quibria et al., 2003; World Bank, 2011). Empirical evidence shows that the higher the level of education, the higher the

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probability of Internet use (Goldfarb and Prince 2008; Ono and Zavodny 2007; Rice and Katz 2003). Some studies, using national surveys, have verified the important role of education at the personal level, Haight, Quan-Haase and Corbett (2014) in Canada, and Zhu and Chen (2013) in China are recent examples.

The empirical evidence has also shown a positive impact of education on ICT diffusion in different countries. Chinn and Fairlie (2007), for a panel of 161 countries, highlighted that differences in educational levels are a relevant factor to explain the global digital divide. Demoussis and Ginnakopoulos (2006), for a sample of European countries, also found that the level of Internet use is positively affected by education. Wunnava and Leiter (2009), employing cross-sectional data from 100 countries (developed and developing countries), showed that education has a positive effect on Internet diffusion. Other studies have explored ICT diffusion for different levels of development obtaining far from conclusive results for developing countries (Bagchi and Udo, 2007; Kiiski and Pohjola 2002; Balamoune-Lutz; 2003; Kottemann and Boyer-Wright, 2009; Pick and Azari, 2008). However, several researchers have found positive impacts of human capital on ICT diffusion in areas such as Latin America (Chong and Micco (2003) and Asian countries (Quibria et al. (2003).

Theoretical models have highlighted the role of human capital to explain differences in the economic growth rates of countries. The theory of endogenous economic growth, which began with seminal works by Romer (1986) and Lucas (1988),

emphasizes the role played by human capital in the generation and diffusion of knowledge, and the importance of knowledge spillovers in explaining long-term economic growth (Aghion and Howitt, 1992; Grossman and Helpman, 1991; Romer 1987, 1990). Nelson and Phelps (1966) and Benhabib and Spiegel (2005) consider that human capital determines the capacity of a country to generate knowledge and that knowledge is necessary to assimilate new knowledge. Lucas (1988) presented a model in which human capital is considered the factor that explains positive per capita GDP growth in the long run.

There exists a wide amount of empirical papers that, using different measures to approach human capital, find evidence of the positive effect of this factor on the economic growth not only for advanced countries (see Temple 2000), but also for developing ones (Hanushek, 2013). Furthermore, the skilled labour force influences firm's productivity and performance as well as growth in the long term (Kottemann and Boyer-Wright, 2009).

However, as Temple (1999) points out, the empirical evidence is far from conclusive. Along with papers that point to the positive effects of human capital (Hanushek, 2013; Kottemann and Boyer-Wright, 2009) we also can find studies that obtain opposite findings (Pritchett, 2001). Two of the possible reasons given by Temple (1999) in this respect are associated to the problems of correctly measuring human

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capital (Hanushek, 2015), as well as to the existence of alternative channels through which human capital can influence economic growth.

*Internet and economic growth*

ICT and the Internet, in particular, facilitate the spread of information and the transmission of knowledge, favouring information networks that may lead to knowledge spillovers across firms, regions and countries (Andrés et al., 2010), and thus contributing to economic growth (Chu, 2013; Kenny, 2003). At the microeconomic level, evidence has shown that the Internet facilitates communication and coordination within and outside firms, lowers transaction costs, and increases efficiency and productivity. Internet use also fosters product and processes innovation, new business models and new models of firms’ cooperation impacting on economic growth (Chu, 2013; Czernich, Falck, Kretschmer and Woessmann, 2011).

The empirical evidence on the impacts of Internet use at the country level is still less prolific, and although they show a generally positive relationship, they are no conclusive. Some studies have considered relatively large sample of countries in long periods of time. For example, an initial study (Espiritu, 2003) showed a positive impact of Internet on economic growth using a sample of 36 developed economies for the period 1980-1999. However, the OLS regressions do not include fixed effects, and do not take into account the endogeneity of some independent variables. More recently,



and using cross-country panel data for 207 countries in the period 1991 to 2000, Choi and Hoon Yi (2009) also detected a very positive and significant effect of Internet use on economic growth (after controlling for investment ratio, the government consumption ratio and inflation). Meijers (2012) captured the positive impact of Internet use on economic growth from a sample of 94 countries in the period 1990 to 2008. However, the effect was indirectly obtained through the effect of Internet use on openness to trade.

Other papers have made distinction among countries depending of the level of economic development, emphasizing differences in the impact of ICT. For example, Yousefi (2011) obtained that the impact of ICT on economic growth differs across different income groups of countries through a study of 62 countries in the period 2000–2006, playing a major role in the growth of high- and upper-middle-income countries. In contrast, Qiang and Xu (2012) did not find a robust economic impact of Internet use for the period 1980–2009. When using cross-sectional analysis, the effects are found only in developing countries. Nevertheless, when the fixed effect specification was employed, they found that Internet use showed a larger impact in rich countries. However, there is no evidence on the effect of Internet use on economic growth when they take into account endogeneity in the explanatory variables.

Chu (2013) examined whether the impact of Internet use on economic growth varies during recession periods. Using a panel of 201 countries for the years 1988–2010

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alongside an OLS model, the results demonstrate that, although lower, the impact of Internet penetration on real GDP per capita is still positive. According to the results, a 10 percentage point increase in the Internet penetration rate raises real GDP per capita by 0.59 and 0.57 percentage points in economic growth and recession periods, respectively. The author points to the role played by the deceleration in broadband infrastructure growth during the recession period as a factor that it is likely to explain the lower growth in Internet usage. In fact, Internet use and its impacts are strongly tied to the existence of the broadband infrastructure, in which developing countries clearly lag behind developed ones.

Using broadband adoption as a proxy for the development of the Internet (Strykowski, 2012), many studies have also found a positive relationship between broadband penetration and economic growth, particularly among OECD countries (e.g., Czerncich et. 2011; Koutroumpis, 2009). Some studies have found differences among different economic levels. For example, Thompson and Garbacz (2011) find higher positive effects of mobile broadband in economic growth for low-income countries than for other countries.

Other studies have considered the different impact of several information technologies on economic growth. For example, Vu (2011) provided that the marginal effect of Internet users on economic growth is larger than that of mobile phone and

personal computers, although the effects decrease as the penetration of these technologies grows.

As mentioned above, the literature has also demonstrated that the potential outcomes derived from ICT require complementary investments, such as those associated with human capital. As Holt and Jamison (2009) point out, the benefits derived from ICT impacts are only possible after a period of human capital adaptation. In the future, this adaptation process – first registered in the United States and later in the European Union, and mainly regarding computers – might also be registered for other technologies in some developing countries. However, the reality is that there are many relevant features of developing countries that may affect ICT outcomes, such as low levels of human capital and significant levels of education inequalities; these may constitute a barrier to Internet usage and to the critical mass needed to benefit from knowledge spillovers that could impact on economic growth.

#### *Education inequalities and Internet diffusion*

Education provides the skills required for using and taking advantage of ICT. Within the diffusion theory, the heterogeneity models (Rosenberg, 1972) attribute a critical role to disparities in educational levels to explain the differences in diffusion rates (Geroski, 2000; Karshenas and Stoneman, 1995). Rogers (2003) associates diffusion of innovations with the importance of the socioeconomic variables that may determine the

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impact of innovations more than the innovation itself. The existence of inequalities, such as those related to education and income may influence the communication flows between individuals and therefore the impacts of information and knowledge sharing. Information and knowledge flows take place among “peers”, between “ups” and “ups”, on the one hand, and between “downs” and “downs”, on the other. In addition, as also mentioned, the dissemination of information and the transmission of codified and tacit knowledge may be related to several cognitive, social and technological proximities associated to the existing educational structure, with potential impacts on economic growth.

Several strands in the literature highlight the role played by interpersonal interactions as a critical channel for the diffusion of codified and tacit knowledge (Storper and Venables, 2004). Information and knowledge flows are not automatic and cognitive proximity is needed to communicate, understand, assimilate and process new information (Jaffe, 1986; Boschma, 2005). The capacity of absorbing, creating and transmitting new knowledge requires a similar cognitive base to understand and process it effectively (Marrocu, Paci, and Usai, 2011). Moreover, along with cognitive proximity, also relational, social and technological proximities (Basile et al. 2012) favor the creation of “cognitive spaces” that act as channels that facilitate interactive and collective learning processes (Capello and Spairani, 2006) that are also considered key determinants to guarantee a strategic use of ICT and therefore its impacts on growth.

Within this framework, differences in educational levels constitute an important factor to explain technology diffusion and its impacts.

### Empirical model

This paper aims to investigate the effect of Internet use on economic growth through studying the influence of the links among educational inequalities and Internet use, as well as other factors relevant to economic growth. First, we aim to explore whether there is a positive relationship between Internet and economic growth. Second, we investigate whether educational inequality may affect the impact of Internet use on economic growth.

To answer these questions, we use an empirical economic growth model following Barro (1991) that includes specific variables to capture the effect of Internet use on economic growth, the influence of human capital inequalities, and the joint impact of human capital inequalities and Internet use on growth.

$$\begin{aligned} \Delta GDP_{i,t-(t+5)} = & \beta_1 GDP_{i,t} + \beta_2 HK_{i,t} + \beta_3 Exp_{i,t} + \beta_4 Internet_{i,t-(t+5)} \\ & + \beta_5 EducIneq_{i,t} \cdot Internet_{i,t} + \beta_6 EducIneq_{i,t} + \beta_7 Z_{i,t} + u_{i,t} \end{aligned}$$

with  $i$  denoting countries and  $t$  time;  $\Delta GDP_{i,t-(t+5)}$  is the five-year growth of per capita GDP;  $GDP_{i,t}$  is the log of per capita income in  $t$  (this term is added to allow for conditional convergence; see Barro, 1991);  $HK_{i,t}$  is the log of human capital;  $Exp_{i,t}$

denotes the log of life expectancy;  $Internet_{i,t-(t+5)}$  is the log of five-year average number of Internet users per 100 people;  $EducIneq_{i,t} \cdot Internet_{i,t}$  is the interaction term between educational inequality and the average number of Internet users;  $EducIneq_{i,t}$  is educational inequality;  $Z_{i,t}$  is a vector of additional variables; and  $u_{i,t}$  is the error term.

We expect a negative sign for GDP according to the conditional convergence hypothesis. Following the theoretical academic literature, we expect human capital to contribute positively to economic growth. As mentioned above, human capital is one of the key elements that foster economic growth (Lucas, 1988; Romer, 1986). It has at least two roles that explain its relationship with growth. First, it determines the capacity of a country to generate knowledge (Lucas, 1988). Second, human capital is necessary to assimilate new knowledge (Nelson and Phelps, 1966; Benhabib and Spiegel, 2005). In order to form a better picture of a country's human capital endowment, life expectancy tries to capture the quality of human capital (Barro, 1999). Life expectancy has been traditionally included in growth models in line with Barro (1991), capturing human capital quality. Also, life expectancy is usually considered as a proxy for workforce's health (Bloom, Canning and Sevilla, 2004), and the empirical literature has demonstrated that improvements in population's health may increase human capital, in particular in developing countries (Hanushek, 2013). In addition to the productivity gains, life expectancy also may contribute to increase human capital accumulation since

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9 expected returns to investment on education are higher (Bils and Klenow, 2000).  
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11 Consequently, life expectancy is expected to have a positive impact on economic  
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13 growth.  
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15 We include Internet users per 100 people to measure Internet use. We expect a  
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17 general positive effect of this variable on economic growth. To examine the extent to  
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19 which the existence of human capital inequalities influences the Internet's impact on  
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21 economic growth, we include the interaction term between educational inequality and  
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23 average Internet users. However, as educational inequality may affect economic growth  
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25 in many other ways, it is important to include this variable separately in our empirical  
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27 model so as to prevent us from capturing a biased coefficient for the interaction term  
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29 between educational inequality and average Internet users. Nevertheless, as previously  
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31 mentioned, the literature does not provide conclusive findings about the relationship  
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33 between educational inequalities and growth. According to some authors (Rodríguez-  
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35 Pose and Tselios, 2010), educational inequalities might be an incentive for individuals  
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37 to attain higher educational levels and to boost human capital investments. Other  
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39 researchers, such as Birdsall and Londono (1997) and Castelló and Doménech (2002)  
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41 show the negative impact of education inequality on economic growth. Castelló-  
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43 Climent (2010) finds similar results for low- and middle-income economies, and she  
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45 also obtains a positive effect for high-income countries.  
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Following Barro (1991), empirical papers have considered a high number of different additional variables. We have included those that could be important to determine the impact of ICT on economic growth. Thus, we include the average investment ratio ( $I_{i,t-(t+5)}$ ) – computed as gross domestic investment to GDP – as it contains ICT investment among other types of investment given the difficulties in obtaining a reliable and comparable measure of ICT investment at the international level (OECD, 2010). The coefficient of investment is expected to have a positive sign (DeLong and Summers, 1991; Mankiw, Romer and Weill, 1992). As high inflation is associated with macroeconomic instability, the coefficient of inflation ( $Inf_{i,t-(t+5)}$ ) is expected to be negative (Barro, 1995).

Finally, we have introduced the variable Internet competition ( $Comp_i$ ), which classifies the level of competition in Internet services at the national level, and is distinguished between three different stages: monopoly, partial competition, and full competition. Promotion of competition policy and telecommunication liberalization has proven to be a key factor explaining both Internet use and network effects through price cuts in access and services, quality improvements and new innovations (Andrés et al., 2010; Billon et al., 2009; Dasgupta, Lall and Wheeler, 2005). Also, competition stimulates economic efficiency and lowers costs while promoting the activity of the most competitive and productive firms, and therefore encouraging economic growth



(Badran, 2011; Thompson and Garbacz, 2011). We expect a positive sign for the relationship between Internet competition and economic growth.

### Data, Variables and Methodology

The data we have employed are taken for the 1995–2010 period because Vu (2011) finds a structural change in economic growth since the second half of 1990s. This author considers the rapid penetration of ICT is plausibly expected to be among the emerging drivers of such growth. Data for per capita GDP, life expectancy, investment ratio, inflation and Internet users are from the World Bank (2011). Human capital is measured using the average years of secondary and tertiary schooling for members of the population aged 25 and over, and it is taken from Barro and Lee (2011). Following Castelló and Doménech's (2002) methodology, human capital inequality is computed as a Gini coefficient for the population aged 25 years and over. Finally, Internet competition is from ITU (2012). Table 1 gives descriptive statistics for the used variables.

**Table 1.** Summary Statistics.

Variable	Obs.	Mean	Std. Dev.	Minimum	Maximum
$GDP_{i,t-(t+5)}$	282	0.122	0.111	-0.116	0.580
$I_{i,t-(t+5)}$	276	3.067	0.200	2.304	3.747

$HK_{i,t}$	282	0.631	0.533	-0.972	1.823
$Exp_{i,t}$	282	4.215	0.125	3.731	4.372
$Inf_{i,t-(t+5)}$	282	0.319	0.396	-0.068	3.540
$Internet_{i,t-(t+5)}$	282	2.145	1.745	-2.737	4.510
$EducIneq_{i,t}$	282	0.218	0.161	0.004	0.831
$EducIneq_{i,t} * Internet_{i,t-(t+5)}$	282	-0.130	0.271	-1.594	0.393

Source: Authors' own calculations

We use the fixed effects (FE) model to take into account the existence of fixed effects (national legislation, cultural aspects, etc.), which may possibly correlate with explanatory variables while still avoiding cross-sectional heterogeneity bias. Thus, we use the two-stage least squares estimator (2SLS) to address endogeneity, as it is the most efficient instrumental variables estimator (Wooldridge, 2002). However, finding suitable external instruments is a complex task, so we use the lags of the variables as instruments (Arellano and Bond, 1991). This is a common practice in estimations that have to tackle endogeneity problems.

Empirical Results

Table 2 contains the coefficients of the different regressions that we have estimated. Column (1) reflects the aggregated model without including education inequality as a separated variable.

The results are as expected. The initial per capita GDP coefficient is negative and significant, pointing to conditional convergence. Human capital and life expectancy coefficients are both non-significant in line with previous findings in the literature. Finally, the investment ratio and inflation show positive and negative coefficients, respectively.

Internet use has a positive impact on economic growth, while the interactive term between educational inequality and Internet use is negative. As the variable measuring the interactive term between educational inequality and Internet users might partly capture the effect of educational inequality on economic growth, we ran a regression (Column 2) in which we included education inequality to avoid omitted variable bias. As shown, the interactive term is still negative. Finally, Internet competition is shown to be especially important for economic growth.

Table 2. Per capita GDP growth regression models.

Variables	(1)	(2)	(3)
$GDP_{i,t}$	-0.675*** (0.073)	-0.678*** (0.075)	-0.625*** (0.079)
$I_{i,t-(t+5)}$	0.130* (0.067)	0.130* (0.067)	0.167** (0.069)
$HK_{i,t}$	-0.058 (0.077)	-0.050 (0.086)	-0.153** (0.071)
$Exp_{i,t}$	0.193 (0.221)	0.194 (0.221)	0.480*** (0.172)
$Inf_{i,t-(t+5)}$	-0.048*** (0.013)	-0.047*** (0.013)	-0.037*** (0.013)
$Internet_{i,t-(t+5)}$	0.054*** (0.007)	0.055*** (0.008)	
$Internet_{i,t-(t+5)} * HI$			0.027*** (0.010)
$Internet_{i,t-(t+5)} * MI$			0.070*** (0.008)
$Internet_{i,t-(t+5)} * LI$			0.009 (0.007)
$EducIneq_{i,t}$		0.066 (0.265)	0.002 (0.207)
$EducIneq_{i,t} * Internet_{i,t-(t+5)}$	-0.126** (0.058)	-0.124** (0.058)	
$EducIneq_{i,t} * Internet_{i,t-(t+5)} * HI$			0.008 (0.015)
$EducIneq_{i,t} * Internet_{i,t-(t+5)} * MI$			-0.063*** (0.015)
$EducIneq_{i,t} * Internet_{i,t-(t+5)} * LI$			0.066*** (0.011)
$Comp_i$	2.480*** (0.506)	2.482*** (0.505)	
$Comp_i * HI$			2.010*** (0.487)

Comp <sub>i</sub> * MI			1.546*** (0.468)
Comp <sub>i</sub> * LI			1.018*** (0.392)
Observations	157	157	157
Adjusted R <sup>2</sup>	0.60	0.60	0.64

(\*), (\*\*) and (\*\*\*) denote significance at the 10%, 5%, and 1% levels, respectively. White's heteroskedasticity-robust standard errors in parentheses. Estimated coefficients of time dummies are not reported to save space.

Source: Authors' own calculations

According to the theoretical contributions aforementioned, the results obtained may vary according to the level of development of a country. We use dummies to distinguish among low (LI), middle (MI) and high-income (HI) countries based on the World Bank's classification. Regression in column (3) disaggregates the Internet use variable and the interactive term into three groups according to the country's wealth. The results reveal the positive impact that Internet users have on growth for high- and middle-income countries. However, this effect is non-significant in the case of low-income countries. The interactive term reveals that educational inequality reduces the positive effect of Internet use for middle-income countries. However, Internet has a positive impact on low-income countries although this impact is not direct but through educational inequality. Finally, Internet competition seems to be an important determinant for economic growth for all the income levels.

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**Conclusions and Discussions**

We have examined the impact of Internet use, education inequality and the joint impact of both variables on economic growth, along with traditional variables employed in the growth literature for a set of 94 countries between 1995 and 2010. Using panel data approach, we also examine whether the impacts vary according to development levels. The findings show a positive and significant impact of Internet use on economic growth, while the interactive term between Internet and educational inequality is negative and significant. When we disaggregate by income levels, Internet use is positively associated with economic growth for medium- and high-income countries. As for the interactive term, educational inequality reduces the positive effect of Internet use for middle-income countries, perhaps because of difficulties in developing an incipient middle class with access to the educational level needed to facilitate Internet adoption (Koutroumpis, 2009). For low-income countries, Internet shows an indirect positive impact on growth through educational inequality. This result can be related to the fact that in earlier stages of development, the existence of a rich class with high education levels is more willing to pay to use the Internet, which encourages its adoption. Given the earlier stages of the process and difficulties in access for the rest of the population, the existence of this wealthier class will have a positive impact on growth. Finally, Internet competition is shown to be especially important for economic growth for all income groups, although the effect is greater for high-income countries.

The findings emphasize the importance of taking into account differences in economic and social structure when analysing ICT impacts on growth. Our results indicate that in order to assure the potential benefits from the Internet, public actions should consider not only the supply side of the Internet diffusion process, increasing Internet competition and improving Internet infrastructures, but also increasing human capital investments oriented to reduce social divides, especially in developing countries where inequalities may influence the impacts of Internet use. Along with other measures, policies oriented to reduce the human capital gap would allow the countries to reach the critical mass needed to reap the benefits of Internet diffusion on economic growth, and to promote incentives to invest in education, as well as better perceive the benefits of such investments. Our results also suggest the need for coordination among the several public policies, but mainly those oriented to Internet diffusion and education, which would take into account the specificity of each development model. Moreover, it may require collaboration between policies at different levels of the governance structure (national, regional and local). Finally, the different impacts of Internet use, educational inequality and the level of competition on economic growth may suggest the need to develop more differentiated public policies which consider the various goals. In the short-term, some public policies could have an immediate effect on economic growth; for example, measures devoted to boosting Internet services competition, as well as measures to promote Internet diffusion and new investments in

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education. In the long-term, the reduction of educational inequality could have a more significant effect on economic growth.

This study presents some limitations. First, we have only considered Internet use, not other information technologies. Second, we have not considered the potential spatial effects between countries. Therefore, future research should investigate the effects of education inequalities on other information technologies, such as broadband or mobile phones, as well as possible spatial effects. However, the lack of data series for less developed countries may result in more missing values and therefore affect the relevance of the results.

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