Vienna Study on Inclusive Innovation for Growth and Cohesion: Modelling and demonstrating the impact of eInclusion

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e-inclusion
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European Commission
Information Society and Media

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The opinions expressed in this document are those of the authors and do not necessarily reflect the views of the European Commission

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1. INTRODUCTION

By Cristiano Codagnone

1.1. Policy context and theoretical inspiration

When in the Spring of 2000 EU leaders proclaimed in Lisbon the goal of turning the 'Old Continent' into a competitive knowledge economy preserving social cohesion, many observers on both shores of the Atlantic sceptically looked at it as the unrealistic and rhetoric attempt to preserve an old' European compromise 'between growth and the preservation of the so called 'social model'. Almost a decade later the context has changed and the idea that 'broad based growth' is the only way to real and solid prosperity is now much more widely accepted. The expression 'broad-based growth' resonates in many of the writings and speeches of new US President Barack Obama, where it is often associated also to the need of increasing digital inclusion in society. Including more individuals is no longer exclusively seen as a moral imperative, a remedial policy, or a matter of showing the 'charitable face' of market economies, rather it is pragmatically recognised as being an economic opportunity tightly connected to sustainable and durable economic growth[3]. These views are at the core of the *Renewed Social Agenda*, a Communication the Commission released already in July of 2008 well before the full dimension and dire consequences of the ensuing financial, economic and social crisis were fully acknowledge internationally, which stresses the needs for social innovation as one of the strategic avenues out of the current crisis by increasing opportunities, access and solidarity (European Commission 2008a)[4].

In the field of eInclusion we can talk about a new "I power 2" or "I^2"paradigm, standing for Inclusion and Innovation. There are probably few fields where Inclusion and Innovation are so entwined and can in principle virtuously feed each other as that of inclusive services supported by ICT. Technology driven innovation in service provision has an impact on economy and society and finds market sustainability only inasmuch as the adoption and appropriation of such services in everyday life activities are wide and expanding among citizens and across all value chains. The market potential of Independent Living applications for older people, for instance, is huge and their implementation can considerably reduce current spending for long term care and improve the lives of the elderly and their relatives by keeping them in their home (see Figure 16, p. 43). Yet this potential will not be unlocked until innovative policies and regulatory solutions, as well as investments by industry, expand their adoption. The promises of eGovernment have not fully materialised because use remains limited and, thus, efficiency gains for administrations are marginal while the social groups most in need of government services are cut out. eInclusion means both inclusive ICT and the use of ICT to achieve broader social inclusion objectives and, thus, it is about both inclusive technological innovation and innovative ways to deliver inclusive policies by using ICT. Under conditions of financial turmoil and socio-economic crisis governments are going to face increasing budget constraints and they may lean toward cutting their budget for ICT investments. This would be a strategic mistake for investing in Inclusive ICT could contribute to ease those same financial pressures currently putting public budget at strains.

It is the contention of this study that digital exclusion/inclusion is the quintessential form of social exclusion/inclusion today. The inspiration of this claim comes from a combined reading of the work of two great theorists of our time as Castels (1996) and Sen (1999, 2000). Much before the digital divide and then eInclusion became policy priorities Castels characterised the new trajectory of development of our societies as one toward "informationalism", shaping a new mode of production termed "informational capitalism" that substitutes industrial capitalism (1996). This produces a new network based form of social organisation. New technologies, thus, catalyse the process of dis-embedding and re-embedding of individuals within the fabric of society which, already before the full advent of new ICT, was seen as a characteristic of late modernity[5] . Such processes can lead to a new form of "networked individualism", which can either result in further isolation and exclusion, or instead favours mobility and access to resources. Potential exclusion from relevant networks is the new source of inequalities as opposed to the

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[3] Obama's vision rests on a new research and policy agenda that has emerged in US academic and policy circles since at least 2005. For recent economic arguments in favour of broad based growth coming from US academia and think tank see for instance Sperling (2005) and the Brooking Institution 'Hamilton Project' where 'broad-based growth' is considered as the key pillar for the future of American society and one of the lines of research in the project (see for instance Altman et al, 2006.)

[4] Available online at: http://ec.europa.eu/social/BlobServlet?docId=453&langId=en.

[5] See Giddens (1994)

concept of "exploitation" typical of the industrial order. It is within this context that the study of digital inequalities must be analysed and the policies of eInclusion framed. We would claim, actually, that digital exclusion is the quintessential and paradigmatic form of social exclusion in this new social order. In this respect physical and material access is only a small part of the problem: ensuring access is a necessary condition but not sufficient at all. Social change is pushing more and more at the individual level the competition for being included in terms of jobs but also of social relations, of informed participation to the public debate and, last but not least, of forming one's identity. Intensity and quality of use of ICT play a crucial role in helping individuals position themselves within this new order. As our everyday work lives are increasingly entangled in activities and relations enabled by ICT, being digitally excluded is a new source of inequalities as it can result into exclusion from relevant networks and social relations, jobs and leisure opportunities, and from informed participation to the public debate. This contention can be further appreciated if we fully grasp the fact that today digital means or lack thereof, are shaped and at the same type shapes those relative capabilities and relative 'functionings" determining social exclusion or inclusion at large. As shown by Sen (1999, 2000), the inclusion or exclusion of individuals and groups within society is shaped by their relative 'functionings', namely their relative capability to function and achieve desirable outcomes such as for instance finding a job. These relative "functionings", depending on individuals' possession of resources and on their social relations, at the same time shape and are shaped by the digital means possessed by them. If one is in a condition of poor functionings this will reduce digital means, which in turn will result in missed opportunities compared to others. Natalia, a recent immigrant to Germany, recounted how when first interviewing for a job she was asked for an e-mail address and was given a web address where to fill an online application form, which hampered her search until she acquired these digital means thanks to a local level initiative providing digital skills finalised to finding a job[6]. During the Ministerial Debate on eInclusion in Vienna it was stressed how a large majority of jobs today requires an online application and by default exclude those lacking digital means, as well as the disabled due to lack of eAccessibility. It is, thus, evident how eInclusion support initiatives can help achieve important benefits for individuals, which can add up to societal outcomes.

1.2. Objectives and benefits of the study

The Commission **i2010**[7] policy framework, by calling for an inclusive Information Society and by stressing the importance of demonstrating tangible impacts, has set in motion an important process in the domain of eInclusion. A landmark in this process was the 2006 **Riga Declaration**[8] where the European governments committed themselves to clear, bold, and measurable targets. The European Commissions and the Ministers of some 30 European countries committed to efforts aimed to achieve the following four key targets:

1) **Gaps in Internet usage** between current average use by the EU population and use by older people, people with disabilities, women, lower education groups, unemployed and "less developed" regions should be reduced to a half, from 2005 to 2010;

2) **Geographical Divides**. Significantly reduce regional disparities in Internet access across the EU, increase the availability of broadband (coverage) in underserved locations, and aim for broadband coverage to reach at least 90% of the EU population by 2010;

3) **Inclusive e-Government**. Promote and ensure accessibility of all public web sites by 2010. Designing and delivering key services and public service policies in a user centric and inclusive way, using channels, incentives and intermediaries that maximise benefits and convenience for all so that no one is left behind;

4) **Digital Literacy**. Reduce by half by 2010 the digital literacy gap between the EU population and the unemployed, immigrants, people with low education levels, people with disabilities, and elderly, as well as marginalised young people.

[6] In depth interview reported in Codagnone, ed. (2008).

[7] Available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2005:0229:FIN:EN:PDF

[8] Ministerial Declaration, Approved unanimously on 11 June 2006, Riga, Latvia, available online at: http://ec.europa.eu/information_society/activities/einclusion/docs/brochures/riga_dec.pdf

The 2007 Communication **on eInclusion**[9] stressed the potential tangible and quantifiable benefits estimated in its supporting **Impact Assessment**[10].

This monograph, firmly rooted in these policy antecedents, represents an important progress toward evidence based eInclusion policy making and impact measurement.

While primarily focussed on the social and economic impact of eInclusion, the work also analysed the root causes behind processes of digital inclusion or exclusion and derived from it important implications for policy. In order to do so: a) about 300 hundreds theoretical and empirical sources have been reviewed; b) 1000 cases of eInclusion support initiatives were screened and 125 of them analysed in depth[11]; c) a wide ranging review of the economic literature on the impact of ICT was conducted; d) an econometric model to assess the impact of possessing or lacking digital skills on employability and wage differentials was designed and run. In addition to this, the Vienna Study also leveraged and analysed the empirical evidence from another project funded by DG Information Society and Media on ICT potential for the economic and social inclusion of immigrants and ethnic minorities (realised by the Join Research Centre of the European Commission Institute of Prospective Technological Studies, IPTS)[12]. The sheer breadth and depth of the theoretical and empirical evidence gathered and analysed in this study is unique and makes it a ground breaking contribution to the field.

It provides robust evidence on some of the areas of eInclusion impacts, proposes a practical checklist of measurement indicators for practitioners, and in general makes a strong case in highlighting the potential tangible benefits of eInclusion. Yet, it also shows that currently limited awareness about the need of demonstrating tangible benefits and measurement capacities characterise the practice of eInclusion support initiatives. Much, thus, remains, to be done to produce the systematic and robust evidence of impacts needed to convince policy makers and all stakeholders that eInclusion is worth it.

Today, also as a result of the catalyst role played by the European Commission, the importance of digital inclusion support initiatives is widely acknowledged. Yet, the development of eInclusion policies in Europe is uneven and not yet a clear priority in many countries, while existing initiatives are still fragmented and in need of better coordination (see European Commission 2007b; Foley *et al* 2008).

The unprecedented opportunities offered by new technologies require co-ordination and partnership to ensure that potential benefits are enhanced and shared by all citizens. These opportunities are not yet fully understood by many stakeholders. One way of tackling this challenge is by highlighting the economic and non-economic benefits of digital inclusion, since this should act as a catalyst for eInclusion awareness and action amongst those in either the public or private sector not yet aware or convinced of the importance of eInclusion policies and related support initiatives. Sceptics might be persuaded to place greater emphasis on eInclusion if they believe economic as well as social and equity benefits will arise from increasing the pool of digitally active citizens. In the course of this study 1000 cases of eInclusion initiatives were screened but despite the sheer size of this sample only a few were found that reported reliable and good quality information on their tangible economic benefits. So the first and very important empirical finding is that measurement awareness and activities among practitioners in the field of eInclusion initiatives are very modest and need to be further developed.

1.3. Brief notes on terminology used

First, we consider the concept of “digital divide” inadequate and outdated and we never use it when illustrating our views and approach. The concept is used in the text only when referring to previous approaches.

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9 Available online at:
http://ec.europa.eu/information_society/activities/einclusion/docs/i2010_initiative/comm_native_com_2007_0694_f_en_acte.pdf

10 Available online at::
http://ec.europa.eu/information_society/activities/einclusion/docs/i2010_initiative/comm_native_com_2007_0694_1_en_divers1.pdf

11 Reported in the Compendium to this Main Report, available at:
http://ec.europa.eu/information_society/activities/einclusion/library/studies/docs/eco_compendium.pdf

12 The preliminary overview of the study on ICT for immigrant and ethnic minorities (Codagnone, ed. 2008) can be downloaded at:
ftp://ftp.jrc.es/pub/users/kluzest/Codagnone_ed_2008.pdf

Second, and related to the above, in the reminding of this report we will use the term "***eInclusion***" mostly when referring to policies and supporting initiatives and measures. On the contrary we use the expression "Digital Inclusion" when discussing and describing the existing situation and the various socio-economic causes and processes shaping whether individuals or social groups have access to, or make us of, ICT. In this context, alongside digital inclusion, we will also use its opposite "digital exclusion", as well as the expression "digital inequalities".

Third, it is our claim that access to ICT matters less than use and appropriation, while the concept of use is clear we anticipate here that by appropriation we mean *the process by which individuals incorporate ICT in their daily practices of working, dealing with government, learning, staying in contact with friends, entertaining themselves, buying goods and services, getting information and joining in the public sphere, etc*.

Fourth, a brief illustration of how we use concepts that are fundamental in the field of measurement and evaluation of policies and public service provision is needed. **Inputs** are the support initiatives with their costs. By ***Outputs*** it is meant the final product of such initiatives, whose production is mostly within the control of those implementing them. ***Outcomes*** are the direct and intermediate changes produced for specific constituencies as a result of the initiatives, whose occurrence depends also on some intervening variables[13]. The term ***Impacts*** is used to indicate broader and longer term changes for economy and society as a whole, to which policy initiatives contribute together with several other intervening variables[14]. To make this more concrete in the educational field, for instance: the input is the overall budget for the educational system; the output could be "number of students taught"; a possible outcome "educational attainment level reached"; and the impacts an "educated labour force" and "increased system productivity and competitiveness". When discussing the issue at hand in a general and generic way, however, the simple term 'impact' will be used.

The reminding of this report comprises 8 sections, of which 5 are the core of the document and 3 are annexed to it. They include a first section on the policy context and the theoretical foundations for understanding the processes of digital inclusion/exclusion and their implication for policy design (**Section 2**), the presentation of the General Model or **Bigger Picture** of eInclusion potential impacts (**Section 3**), the summary of the key findings and implications of the review of the economic literature and of the econometric application (**Section 4**), the illustration of the proposed practical oriented measurement framework and indicators and some illustrative evidence from case studies (**Section 5**). In the conclusive **Section 6** we highlight the main findings of the study and make some policy recommendations. Annex I (**Section 7**) provides a discussion of more operational delivery benefits of eInclusion that are not treated in **Section 3**. Annex II (**Section 8**) reports the full version of the review of the economic literature and of the econometric application, where all sources are referenced and the data supporting the econometric tests are presented in 21 tables (see in **§ 8.5**).

[13] For the sake of brevity we use the term outcomes to refer to both direct and intermediate ones, although they could be distinguished according to their distance from the output in terms of the number of possible intervening variables

[14] In this sense they are synonymous with the expression 'end outcomes'.

2. FROM ACCESS TO APPROPRIATION AND IMPLICATION FOR POLICY

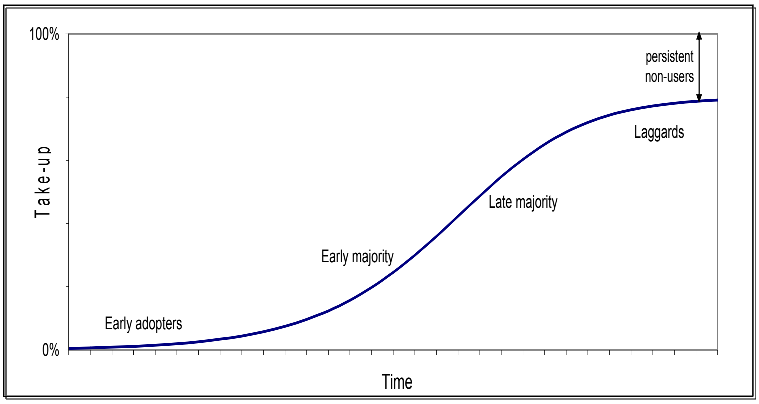
By Cristiano Codagnone and Paul Foley

2.1. The state of play of digital inclusion and eInclusion policies in Europe

The first question one should ask is to what extent support policies are needed. The answer to this question depends on which of two competing views policy makers adopt, one we term ‘S-shaped optimistic view’ and the other ‘Differentiation view’.

S-shaped optimistic view. The paradigm here is one assuming that a better functioning of market mechanisms and increased competition would make it possible to reduce the costs and to widen access to ICT products and services by the greatest number of users. The analogy used here is with telephony or television. The argument is that differences in use of ICT among groups simply reflect their position on an S-shaped curve differentiating from early to late adopters. As users catch up and move on the S-shaped curve, most differences will disappear apart from a very small proportion of the population (see figure below).

Figure 1 Typical S-Shaped innovation diffusion curve



Source: Authors’ elaboration

Judging from available empirical evidence, the optimistic view does not seem to find support. Progress toward the policy targets agreed in Riga Ministerial Declaration has been slow[15] and there are no signs corroborating the optimistic S-Shaped view that, as the functioning of market mechanisms increases access, the laggards will catch up. According to the latest Eurostat data commented in the i2010 Annual Report (European Commission, 2008b, pp. 33-36) in 2007 regular Internet users in Europe were 51% of the total population (up 6% from 2006) or about 250 millions, whereas those who have never accessed the Internet were 40%, leaving a 9% that may have access to the Internet but do not use it regularly. So we can conclude that there are about 242 millions Europeans who are still digitally disengaged and probably excluded. Disparities in Internet usage by socio-economic groups and especially between groups at risk and the average population are still substantial. In 2006 only 45% of Europeans used the Internet but with clear differences:

- age: 73 % of those aged 16-24 but only 10% of those aged over 64;
- Level of education: 77% with high education, 25% of those with low education level;
- Employment status: 38% of unemployed and 17% of economically inactive persons compared to 60% of those employed, and 84% students[16]

What we see in reality is that if the current trends persist the Riga target of halving disparities in Internet use (by 2010 will be met only in 2015, and possibly exclusionary processes may increase as a result of the pace of change in technologies, as conveyed by one of the curves in the figure below[17]

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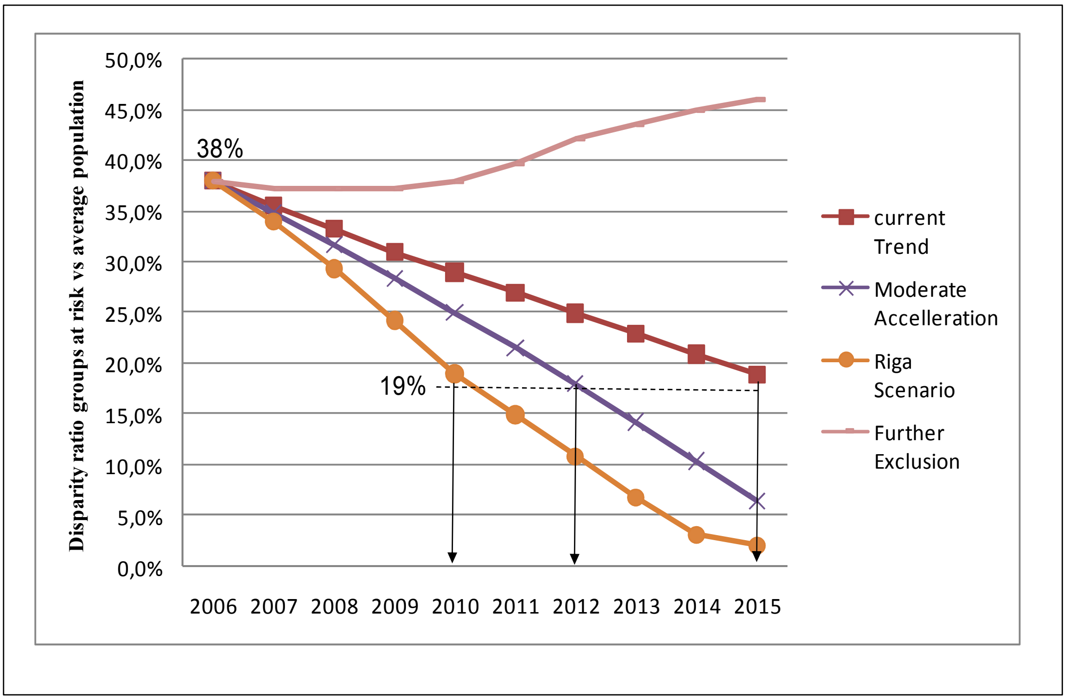
[15] See the Riga Ministerial Declaration (http://ec.europa.eu/information_society/activities/einclusion/docs/brochures/riga_dec.pdf) and 2007 Riga Dashboard European Commission report providing evidence on the progress toward the targets set in Riga and to be reached by 2010 (http://ec.europa.eu/information_society/activities/einclusion/docs/i2010_initiative/rigadashboard.pdf).

[16] Riga Dashboard, pp. 3-4.

Figure 2 Riga Targets: alternative paths (based only on Internet disparity ratio)



Source: Generated by the authors with theory informed parameters from Riga Dashboard projections.

This data, in our view, support much more strongly the differentiation view.

The Differentiation View. Individuals are not necessarily all on the same S-Shaped curve and, as access may equalise, new disparities will emerge in the effectiveness of use and benefit one can extract from ICT. So market mechanisms are not sufficient and policy support is needed.

Which of the two views finds stronger support is not indifferent for policy. If we assume and show that disadvantaged groups are simply a few paces behind in the same S-shaped curve as other groups, the gaps will be filled over time and only minimalist policies will be needed. On the contrary, if we assume and show that disadvantaged groups are on a qualitatively and radically different trajectory and are left behind as the rest of the world moves ahead, it follows that more active policy intervention is needed to fill the gaps.

Starting from 2005, at least within the policy process at EU level the simplistic digital divide as a matter of access the market will solve have been gradually abandoned. This is visible, for instance, in the following paragraph extracted from the final report from eEurope Advisory Group Work Group No.2 on e-inclusion (Kaplan 2005: p. 4):

> …the current focus on ICT access, upon which most policies are based and evaluated, failed to capture the real challenge of e-inclusion. e-inclusion is nothing more than social inclusion in a knowledge society. Access to ICT tools, networks and services, and even "digital literacy", are at most preconditions for e-inclusion. Beyond that, the real issue is whether ICT make a difference in an individual's ability to take part (in work, social relationships, culture, democratic life, etc.) in society as it is, or as it becomes

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[17] The graph in has been generated by modifying the parameters of the logistic curve on which the projections of the Riga Dashboard are based on the basis of theoretically reasoning. At the current pace and without stepping up and rationalising supporting policy measures the Riga's targets would be met only by 2015 ("Current Trend" in Figure 2). Yet leaving the status of policies as they are now could also lead to a more negative scenario leading to further exclusion ("Further Exclusion" in Figure 2), as more people could further fall behind also as a result of unchecked technological and market developments raising new barriers that stop or hinder the efforts of those trying to catch up. A moderate acceleration scenario would achieve the Riga target in 2012 and by 2015 would reduce the gap to slightly above 5% ("Moderate Acceleration" in Figure 2). The more optimistic *Riga Scenarios* would reach the 19% target by 2010 and by 2015 would lead us close to fully digital included society.

It would be clearly beyond the scope and space of this report to review in depth the status of eInclusion policies both at EU (considering not only DG INFSO, but also DG EMPL and DG EAC) and Member States level. Also because for such review there are the two most recent and extensive examples cited earlier (European Commission 2007b: pp. 23-28[18]; Foley et al, 2008: *passim*). On the basis of these two sources we can briefly outline some key elements of the current status of eInclusion policies. At a general level:

- Countries are at different stages of development in their adoption and recognition of a role for digital technologies as channel of inclusion. Countries like the UK have well established policies regimes and are at the forefront in considering digital inclusion issues. Others such as France (where a Minister of State for the Digital Economy was recently appointed) and Austria are due to announce policies shortly In most other countries there is no ad hoc digital inclusion policy and the issue find a brief treatment with other broader policies;
- Federal/decentralised countries (Australia, Austria, Belgium, Canada, Germany Italy, Spain and the United States) are "obliged" to adopt bottom-up approaches and there is little central strategic policy making and a lot of fragmentation;
- Regardless of countries peculiarities, policies are fragmented across both sectors (employment policies, educational policies, information society policies, telecommunication regulatory policies) and tiers of governments (national, regional, local), as well as across the public/private dimension. This is true also for EU level policies. In other words eInclusion is not mainstreamed and coordinated and tackled in systemic ways, relying on the interaction of all possible instruments and all stakeholders;

In terms of specific measures:

- Overall access policies can be considered so far only very moderately successful. Efforts at spreading coverage have been relatively successful but differences in the geographic coverage of broadband clearly point to persisting market failures not yet successfully addressed by policies. Tax relief and other fiscal measures to overcome financial barriers have achieved some success but present some limits. In many cases they have been limited to people already in employment thus missing the unemployed. Public Internet Access Points (PIAPs) and awareness campaign have had little impact because only in a few cases have they been embedded in deeper and broader local level policies and contexts. In general the cases of successful access policies show that they focus on the measures targeting the most deprived communities and complementing other local actions. it can be concluded that access policies have not yet addressed effectively market failures, they are fragmented, not sufficiently targeted to groups at risks and deprived communities, and not mainstreamed into wider social inclusion policies;
- The situation of eAccessibility is clearly unsatisfactory: market failure is evident; at national level accessibility policies have been set but little enacted;
- The situation of usability is unsatisfactory and many potential users drop out due poor level of human/computer interaction;
- The quality in the technical means of access (broadband at home and adequate hardware and software is a main source of digital that has been little addressed by policies);
- Use of eGovernment by socially disadvantaged groups is minimal (eLost 2007 and 2008) and little has been done to produce services better targeted to different groups of users;
- Digital literacy initiatives tend to be generic and are not sufficiently targeted and linked to everyday life needs. While commendable, these efforts fail to tackle the more subtle and sophisticated cognitive skills required increasing quality of use and, consequently, the benefits derived;
- Policies using ICT to improve employability are very scattered and fragmented, as is the provision of other advanced empowering mechanisms provided by actions in field such as e-Democracy, e-Learning and ICT for social capital.

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[18] This source has also critically included other policies reviews such as for instance Empirica (2005, 2006) and Tavistock (2007).

2.2. Understanding process of digital inclusion/exclusion

Access is a necessary but insufficient condition to ensure digital inclusion and the achievement of the desirable individual benefits and societal outcomes that can derive from it. These are a matter of use and appropriation of ICT, which unveils the question of digital inequalities. The move from a focus on "digital divide" as a matter of access to issues of use and appropriation has been gradually emerging in contributions bringing to light the more complex world of "digital inequalities" (see for instance Bonfadelli 2002; DiMaggio *et al* 2004; DiMaggio and Hargittai 2004; Kaplan 2005; Liff and Shepherd 2004; Loader and Keeble 2004; Norris 2001; van Dijk 2005)[19]. The fundamental hypothesis derived from both theory and empirical work is that what matters is "***appropriation***" defined as ***the process by which individuals incorporate ICT in their daily practices of working, dealing with government, learning, staying in contact with friends, entertaining themselves, buying goods and services, getting information and joining in the public sphere, etc***[20]. In this respect appropriation marks a step further than use. It conveys the idea that individuals do things through ICT that are meaningful to them and do not simply and generically use ICT. The next two boxes provide support to this hypothesis, the first by reporting the key insights from field work done on the use and appropriation of ICT buy immigrants and ethnic minorities, the second by stressing the peculiarities of ICT as compared to mass media. In particular, Box 2 overleaf introduces the analogy with 'cultural goods', which are further elaborated by briefly recalling the theories and findings on inequalities with respect to the latter[21]. The past teaches us that as access to education, culture, information increased, social differentiation emerged in the use that different social groups could make of them. The relatively privileged seek advantage by accumulating types of such broadly defined cultural goods that are more richly rewarded. In this respect a theory elaborated in the 1970s, the so called "knowledge gap" theory (i.e. Tichenor *et al* 1970), is quite relevant in our context. According to this theory people of high socioeconomic status are always advantaged in exploiting new sources of information. Because of their privileged social locations, they find out about them first; and because of their high incomes they can afford to access them while they are new. Moreover, schooling provides an initial cognitive advantage that enables the well-educated to process new information more effectively, so that their returns to investments in knowledge will be higher. As a consequence, not only do the socio-economically advantaged learn more than others, but the gap is destined to grow ever larger due to their advantage in access to new sources of information.

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[19] From the perspective of the history of the social sciences and research this change of focus is a natural and expected trend. It is sufficient to look at this history to find many fields where initially researchers looked dichotomously at access to broadly defined resources and then moved to more sophisticated analysis as basic access grew. In the field of education in the USA (Collins 1979), just to provide one example, initial analysis focused on attendance and graduation by different social groups, to then widen the analysis to additional parameters (inequality in access to college-preparatory tracks and elite universities, or variations among different kinds of children in class size, school resources, or the availability of advanced placement). Naturally this was not due to the increased intellectual curiosity of scholars but was a response to changing process of social differentiation creating new forms of inequality within the ranks of the college educated, alongside the old kind of inequality between those with and without college educations.

[20] Use of this concept, though in different variations can be found in number of approaches that can labelled as 'constructivist theories of technology' such as "social shaping of technology", the "appropriation of technology in everyday life", and the "technology domestication processes" perspectives (see for instance Lie and Sørensen, eds., 1996; Silverstone *et al* 1990 and 1992; Silverstone and Hartman 1998; William and Edge 1995). These approaches are a particular application to the domain of ICT cultural and social studies of consumption (see for instance Miller, ed., 1995).

[21] For an overview see DiMaggio (2001) and DiMaggio *et al* (2004).

Box 1 Evidence from field work on ICT use and appropriation by immigrants and ethnic minorities[22]

> If we consider the immigrants and ethnic minority population as a whole data aggregated recently by the European Commission (2008c and 2008d) clearly show that they are at a disadvantage if compared to the host society population with respect to number of dimensions (education, employment, housing, access to public services and health, etc). This notwithstanding, the findings of the earlier mentioned IPTS study for four countries (France, Germany, Spain and United Kingdom) show that in terms of access to, and basic use of, ICT IEM show same or even higher levels as compared to the host society population.
>
> Yet, in depth exploratory field work has evidenced how barriers and source of inequalities emerge when considering the process of ICT appropriation and its social context, where multi-faceted social exclusion factors are at work. Against this background in-depth interviews and case studies found that generic digital literacy initiatives or Public Internet Access Points (PIAPs) do not produce meaningful results for those for whom they are developed, unless they are linked to purposeful and substantive interest and needs (i.e. digital literacy as way of learning the language of the host country or PIAPs providing job finalised skills are impactful).
>
> Furthermore, it has been shown that under dire conditions of social disadvantage, such as in a culturally isolated and socio-economically deprived neighbourhood, support measures to help individuals use ICT do not produce any noticeable outcome and are actually resisted.

Box 2 The peculiarity of ICT as new digital media

> First, ICT as new digital media are very different from mass media, which has clear implications in underscoring the importance of use/appropriation as opposed to mere access. Mass media and particularly television has had without doubt a great impact on society, and this is recognised both by those who see it positively and those who see it negatively (McQuail 2005). It has had a broadly defined integrative effect and to some extent brought together social groups earlier embedded in separated 'information spheres'. For this to happen what mattered was simply the ever and fast increasing access to television.
>
> Modern ICT understood as digital media are not related to a communication across a whole society and are appropriated in a much more diverse and multi-contextual manner (context of game and play, work contexts, educational contexts, administrative contexts etc.). Having this in mind we can argue that the establishment of digital media in different everyday contexts contributes to create new mechanism of inclusion and/or exclusion. Digital media can be conducive to inclusion if individuals are capable of using and appropriate them in such a way to improve their functioning in economy and society and to participate in multiple networks. If this does not happen, then a further mechanism of social exclusion occurs. Moreover, digital media can also have a segregation effect if used in monothematic fashion, for instance by marginal youth to reinforce a sub-culture of withdrawal. So it is evident already from these considerations that what matters is not access but whether ICT are used for the articulation of social functioning and communicative networks on different levels and in different context spheres (private, work, education, administration etc.). In this way the issue of digital exclusion become related to that of inequality, for particular groups in society find it more difficult than others to make sense of digital media and to use them to their advantage.

The lesson of "knowledge gap" research for students of the Internet is that "access" is never enough to ensure productive use. Moreover, the concept of ***habitus*** elaborated by the famous French sociologist Pierre Bourdieu (1984) in his cultural approach to class differences is also relevant. The ***habitus***, resulting from power relations and struggles that reproduce themselves across generations, provides the conceptual categories and frames of action used by individuals to interpret and respond to the social world. The ***habitus*** is reflected in consumption patterns that are extrinsic manifestations of class differences of taste and norms. So consumption at the same time is shaped by, and reinforces, norms and cultural styles embedded in class differences. So, for instance, the familiarity or aversion to use ICT will be shaped by attitudes linked to social position in society, that might be as a result hard to break (in the case of aversion). This cultural oriented analysis of how social position (class or status) shape a mental *habitus* (in the sense used by Bourdieu) with respect to the perception of ICT should not be overlooked.

[22] The findings summarised in the box are from the mentioned IPTS study on ICT and immigrants and are reported in full in Codagnone, ed. (2008).

So the lessons that can be derived from this literature is that as ICT penetration rates increase so will the likelihood of new kinds of inequality due to differentiation in the capability of extracting benefits from their use[23]. Moreover, the insights from the "knowledge gap theory" and from Bourdieu's concept of *habitus* bear clear relevance to the cultural capital shaping individuals competences to use ICT, which is in policy parlance the issue of digital literacy. As van Dijk has shown (2005)[24], such competences range from the operational form of switching on PC and using basic software and browser (to topic of most widespread digital literacy programmes) to the strategic form of defining the purpose of use within the vast universe of available possibilities with the aim of improving one's position in terms of desirable benefits and outcomes. Evidently as we move from the operational to the strategic competence inequalities are likely to become relevant. This discussion provides the layers upon which our heuristic model of digital inclusion/ exclusion rests. At a very basic level it can be stated that digital inclusion/exclusion in society is shaped by the interaction between, on the one hand individual and group level characteristics that we call "functionings" (see *infra*), and on the other by what we can group together as 'supply side factors' including market and industry (in general and with particular reference to the ICT sector) and the government as provider ICT supported public services. The degree to which, individuals using ICT do indeed achieve desirable outcomes is shaped again by functionings and supply but depends also on other intervening variables (Figure 3). Additionally (Figure 4) government can affect these processes in its role as regulator (mostly impacting the supply side) and as producer of support policies measures and incentives (impacting both the individuals and groups and the supply).

The position and resources individuals and groups possess shape their means in general and their digital means in particular, thus, influencing their level of digital inclusion and their capacity to achieve benefits from the use of ICT. In other words they can be a source of either digital inequalities or digital opportunities. At the level of individuals and groups more transitory potential sources of digital inequalities are gender and age. They may be expected to reduce naturally as males and females have access to the same education and occupation opportunities and as older cohorts' age. On the other hand, we have other factors that can be the source of digital inequalities in a more structural and permanent way. These are related to socio-economic gaps (education, occupation, income)[25], to relational gaps (level of embeddedness in social network and degree of social capital characterising the community of residence) and disabilities. We can relate these factors to the issue of digital inclusion/exclusion and more generally of social inclusion/exclusion by adopting the perspective of the authors who have studied multidimensional poverty, deprivation and social exclusion (i.e. Arjan de Haan 1997; D'Ambrosio et al. 2002; Tsakloglou and Papadopoulos, 2002a; 2002b; Sen 1999, 2000).

As we anticipated in the introduction, given the pervasiveness of ICT in contemporary society, digital means or lack of them become an important factors in shaping social exclusion or inclusion. In this respect we adopt Sen's concept of functions and capacities, or 'functionings', that are required in modern societies.

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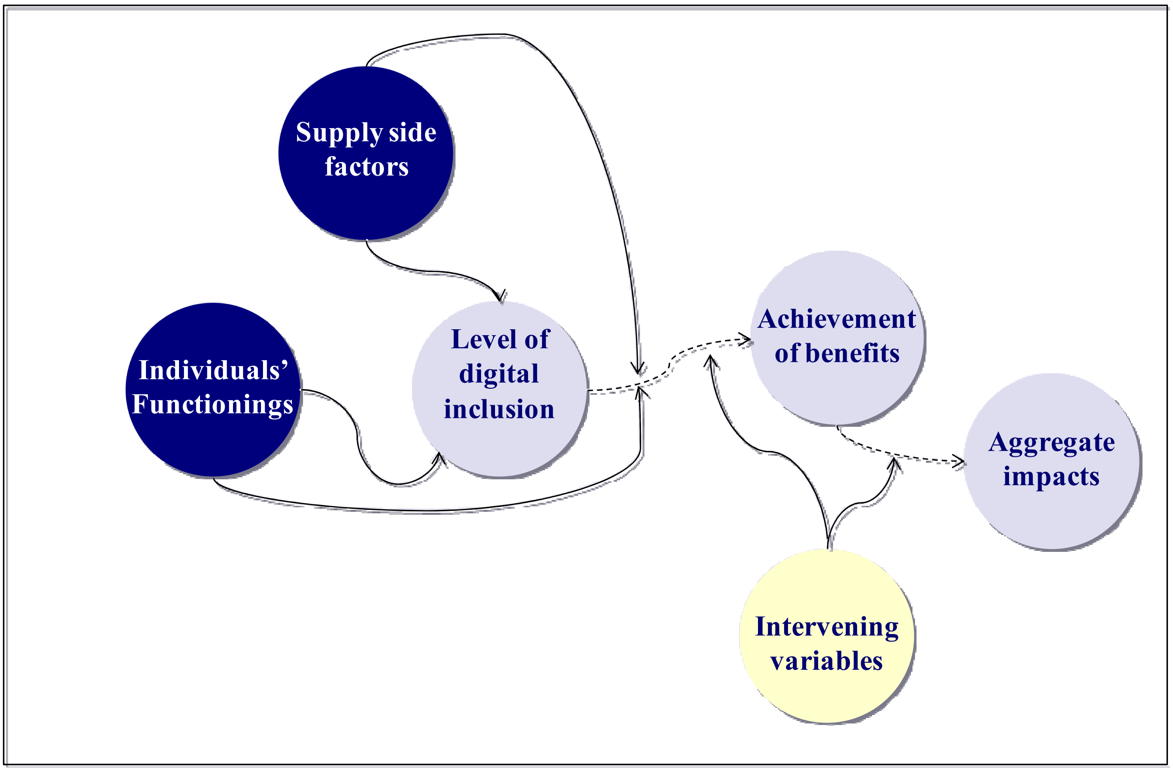
[23] In this respect see for instance Bonfadelli (2002).

[24] The typology includes the following forms of competences: a) **Operational competences**. The skills needed to use a PC and basic software including the browser to navigate the Internet. These mostly coincide with the topics of basic training courses standardised following the inspiration of the European Computer Driving License (ECDL); b) **Informational competences**. Intended as the capability to retrieve and manage effectively the information and contents available, they can be further distinguished into: b_1) Formal informational competences. These refer to the capability to move around the way information is organised in terms of navigation (i.e. mustering a single web site understanding its different structure and using the tool to move within it). These can be acquired and improved as a result of repeated use; and b_2) Substantial informational competences. They concern the capacity to search, select, know and evaluate information. It is a substantial competence the ability to evaluate the credibility of a web site almost intuitively, or the capability to logically structure a search and then follow the right thread of hits. This sort of competence is harder to achieve only as a result of usage and is more related to individuals pre-existing cognitive and cultural assets; c) **Strategic competences**. These are needed to define the purpose of use within the vast universe of available possibilities with the aim of improving one's position in terms of desirable benefits and outcomes.

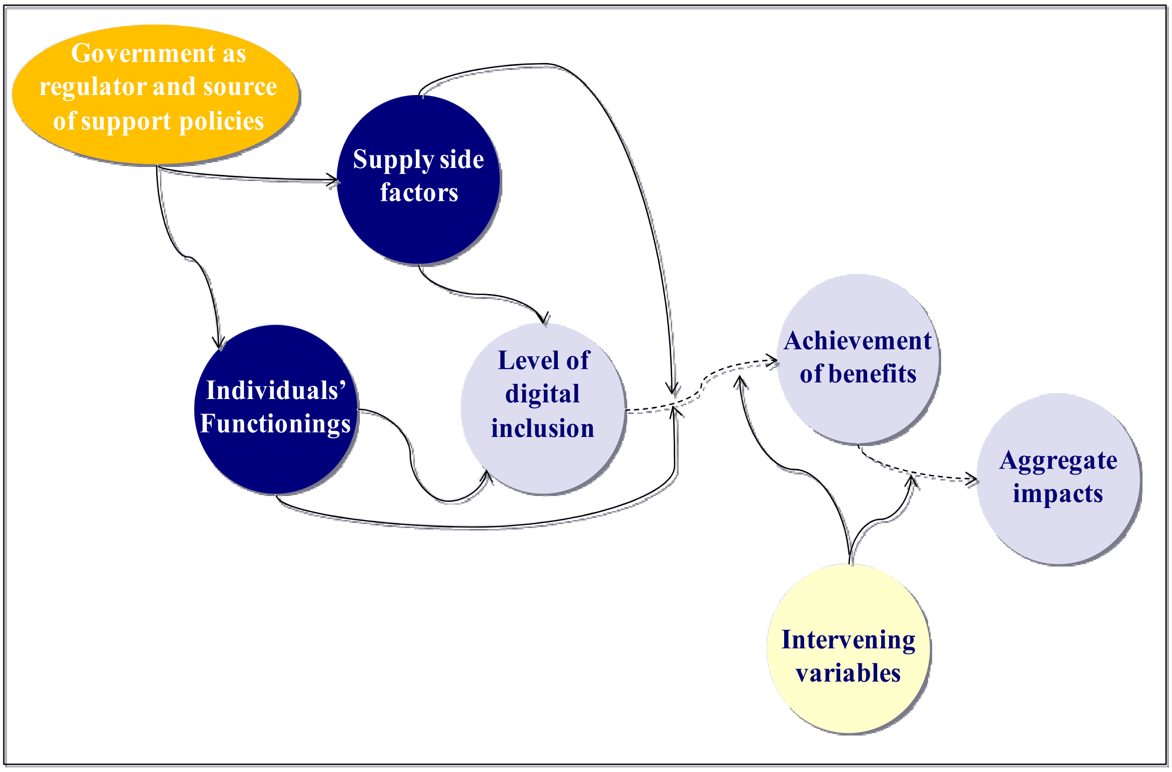
[25] Compounded by ethnicity factors and/or access to citizenship rights for immigrants and ethnic minorities.

Figure 3 Shaping digital inclusion and its outcomes



Source: Authors' elaboration

Figure 4 Shaping digital inclusion and its outcomes: adding policy



Source: Authors' elaboration

This concept appreciates physical and intellectual capacity, education and skills, alongside the economic and social constraints at household, community and wider level. There are a number of relevant aspects in Sen's approach which we first briefly report below and then show how they bear to the issue of digital inclusion/exclusion:

1) **Relative functionings**. What matters are ***relative functioning and relative capabilities*** possibly presenting different gradation rather than absolute dichotomic ones, as they result in difference in benefits and outcomes in social and economic life (i.e. education, job).

2) **Capability deprivation**. Poverty is seen as producing a ***capability deprivation*** (that is, poverty seen as the lack of the capability to live a minimally decent life), of which social exclusion can be directly a part. Additionally, being excluded from social relations can lead to other deprivations, thereby further limiting living opportunities for those in a full blown situation of poverty or relatively worsening the situation of those who are not in full poverty but are less included in social relations.

3) **Constitutive versus instrumental relevance**. An important distinction is made: between the constitutive relevance and the instrumental importance of exclusion. Constitutive relevance occurs when being excluded is in itself a deprivation with an intrinsic importance on its own (for example, not being able to relate to others and to take part in the life of the community can directly impoverish a person's life. It is a loss on its own, in addition to whatever further deprivation it may indirectly generate). In contrast, there are relational and functioning deprivations that are not in themselves negative, but which can lead to very bad results. For example, not being able to use a credit card is not intrinsically distasteful, yet through causal linkages can lead to other deprivations, and missing opportunities. Causally significant exclusions of this kind can have great instrumental importance: they may not be impoverishing in themselves, but they can lead to impoverishment of human life through their causal consequences (such as the denial of social and economic opportunities that would be helpful for the persons involved).

First, the implications for our perspective of the emphasis on '**relative functionings**' are two: a) it further reinforces our view that what matters the most is not simply lack or presence of access, but rather the relative differences in use and the related capabilities to extract benefits and outcomes. A given set of functionings shape individuals digital means and in turn their capacity to effectively use ICT; b) public policies can at least reduce such the differences in the benefits that can be extracted from ICT use through measures that attempt to equalise e-capabilities directly (i.e. helping individuals use them) or indirectly (using ICT to help individuals who are unlikely to use them effectively by themselves).

Second, the lack of capabilities to use ICT as a new mean of social relation and participation is a source of additional deprivations that could add to capability deprivation for those already in a socially less favourable situation with multiple disadvantages but could also reduce the full capabilities of individuals who are in other dimensions fairly included (i.e. middle class elderly, or the educated disabled who have or could have a job).

Third, it is evident that digital inequalities produce a form of exclusion that is not intrinsically distasteful but that has very clear instrumental importance: those who are not digitally active and proficient may not be excluding themselves, but they are denied the many benefits of digital inclusion that will be discussed in next section.

Within the concept of 'functionings' adapted to the specific context of digital inclusion/exclusion we can envisage a number of factors such as:

- Demographic characteristics (age and gender);
- Socio-Economic Status (SES): education, income, socio-professional and employment status;
- Physical abilities;
- Place of residence (urban versus rural)
- Social embeddedness and social capital[26].

The combination of these factors certainly determines whether individuals or groups have access to and, especially, use and appropriate ICT in an effective way.

[26] The dynamic of social relations at individual and community level can have positive or negative. Social support from relatives or friends, for instance, can help individuals with lower score on some of the parameters of SES become aware of the benefits of ICT and use them. Even in a community that can be characterised as disadvantaged as whole if one or more individuals start using ICT then they can become a social conduit by convincing family members, friends and neighbours (all possibly even less privileged) on the usefulness of using ICT and help them do it. This can be evidently supported by policies at local level.

As a matter of fact, following the chain from access to capacity to achieve benefits, they influence /shape:

- **Access**
  - Material. The financial means to buy hardware, software and connection or the availability of public place to access;
  - Mental. Lack of motivation, lack of awareness about useful services, cultural resistance, perceived lack of skills, lack of trust, etc.;
- **Digital means**: Provided that access is available, individuals functionings influence:
  - Technical means of access (hardware, software and quality of connection). Persistence and breadth of use is a direct function of the quality of the technical means of access available to individuals. Slow connections and limited software capabilities constraint the breadth of use, cause frustration and can weaken motivation thus possibly causing dis-adoption;
  - Place of access. It defines the degree of autonomy and regularity of use, both of which are higher if one has access at home or in a social setting of his/her liking. More autonomy and regularity in use increase the chances of appropriation and of eventual achieve benefits;
  - Basic skills. Here, following Van Dijk typology of competences discussed before, we mean the basic and operational competences needed to use ICT;
  - Availability of social support. Social support from relative, friends, colleagues, or community social workers can help late adopters persist and improve in their use, thus counterbalancing potential skills gaps
- **Appropriation and achievement of benefits**. If the level of digital means reach a sufficient level, individuals functionings still influence with potentially uncertain result the following:
  - Purpose definition. Capacity to define the purpose of use within the vast universe of available possibilities;
  - Selection of possibilities. Capacity to identify and choose those possibilities that are most likely to improve one's position in terms of desirable benefits and outcomes;
  - Effective appropriation. Skills for regular and expanding use and incorporation of digital possibilities (eventually leading to achievement of benefits).

It is worth noting that the last point is heavily dependent of what van Dijk call 'strategic competence', which is a combination of strictly defined digital skill and of other cognitive and educationally related skills.

Access, use/appropriation and capacity to extract benefits, however, are also shaped by what we called supply side factors, to which we now turn.

Markets and governmental forces continuously transform and re-shape the field and contribute to make eInclusion a moving target (either closer or further away). This is why under the 'supply side factors' label we included both market/industry and the government, for the latter is also a provider of ICT driven services. An illustrative list of supply side influences framed looking only at the negative side and without considering potential policy interventions include:

- **Supply side influence on access:**
  - Market failures limiting material access: this can take two forms: a) broadband suppliers not catering specific areas and communities; b) little competition making connection and software not affordable for certain groups;
  - Supply of ICT service failure: private sector and government not providing accessible ICT services, thus excluding the disabled;
  - Communication failures: Lack of awareness on the side of users may be due to insufficient campaign from the supply side, and this is especially relevant for public services;
- **Supply side influence on digital means**:
  - Intellectual property regime**:** the interaction between the strategies of large software corporations and existing intellectual property regimes limit the affordability to more appropriate software;
  - Moving target effect: when suppliers of ICT supported services adopt new and more sophisticated design using state of the art technological advancements this can make the technical means of access available to users (type of connection, hardware and software) obsolete/insufficient and, thus, exclude them from a satisfactory fruition. In this case use becomes ineffective and can lead to dis-adoption;

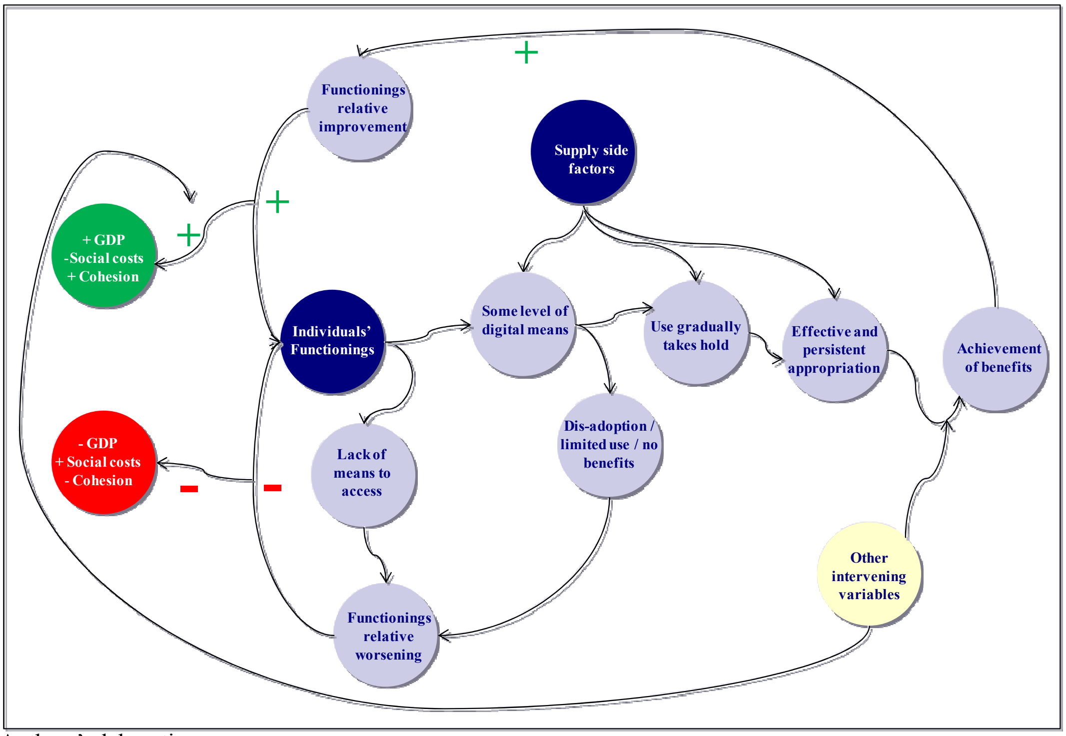
    - Usability: technical complexities and insufficient usability of private and public ICT driven services create barrier as they increase the level of digital skills needed;
- **Supply side influence on appropriation and achievement of benefits**.
    - No relevant services at all. If an individual has some potential to appropriate but finds no service or content whatsoever meeting his/her interests, then appropriation and achievement of benefits will never occur ;
    - Services not targeted and/or not easy to identify/use. Individuals may not use ICT simply because they do not find any really attractive services specifically targeted to their substantive and purposeful interests and needs. Alternatively if these services exist, they are either not easy to find or to use for certain groups of users. This shortcoming is particularly salient for the 'government as provider'. Since the provision of eGovernment and eHealth services is made possible by the usage of public money, it is a clear failure when they are not targeted to, or difficult to use by, those individuals and groups that need them the most;
    - Lack of multi-channel and intermediaries supported public service provision. Directly related to the above and in relation to the groups characterised by lower means (no material or mental access, limited digital means, lack of advanced skills) the lack of multi-channel services provision and of intermediary supporting individuals taking advantage of ICT driven services amount to a relative worsening of opportunities for those in more difficult situation. This, in fact, result in policies missing the target for which they have been allegedly formulated and implemented

In light of the discussion conducted so far the figure overleaf presents the model of digital inclusion/exclusion processes and how they contribute to social inclusion/exclusion. In this version we do not include the role of policies, which is addressed in next paragraph.

Individuals' functionings together with supply side factors shape access to ICT and especially the likelihood that, once access is achieved, use persists and turns into effective appropriation, eventually generating benefits to the individuals, naturally depending also on other intervening variables[27]. Even when access is available, the functioning capabilities of individuals can still result in use inequalities depending on the level of digital means (inadequate technical means, insufficient basic skills, etc) available and on the behaviour of the supply side (low usability of services, moving target effect, etc). Advanced skills on the side of individuals and capacity to provide purposeful targeted and easy to find/use services on the side of the supply determine the likelihood of moving from left to right in the model. If regulatory actions and eInclusion specific support measures are adopted one can make the hypothesis that an increasing number of individuals will become digitally engaged, and as they continue to use ICT, depending on other intervening factors for which we cannot account here, would eventually be able to achieve sought benefits (i.e. jobs or a better job, educational opportunities, better access to health, to welfare benefits, increased consumer welfare, etc). If this happens there is a positive feed-back return on their functionings (contributing to social inclusion), which could eventually add up to macro level positive impacts. On the contrary if there is no access at all or if after access and initial use there is dis-adoption, it is evident that this leads to a negative feed-back on individuals functionings (contributing to social exclusion), which could eventually add up to macro level negative impacts.

[27] For instance, even if individuals, through the use of ICT, acquire new skills and increase their networks they still may not able to find a job or a better job under conditions of economic crisis or, if they are from migrants minorities, due discriminatory practices.

Figure 5 Modelling digital inclusion/exclusion

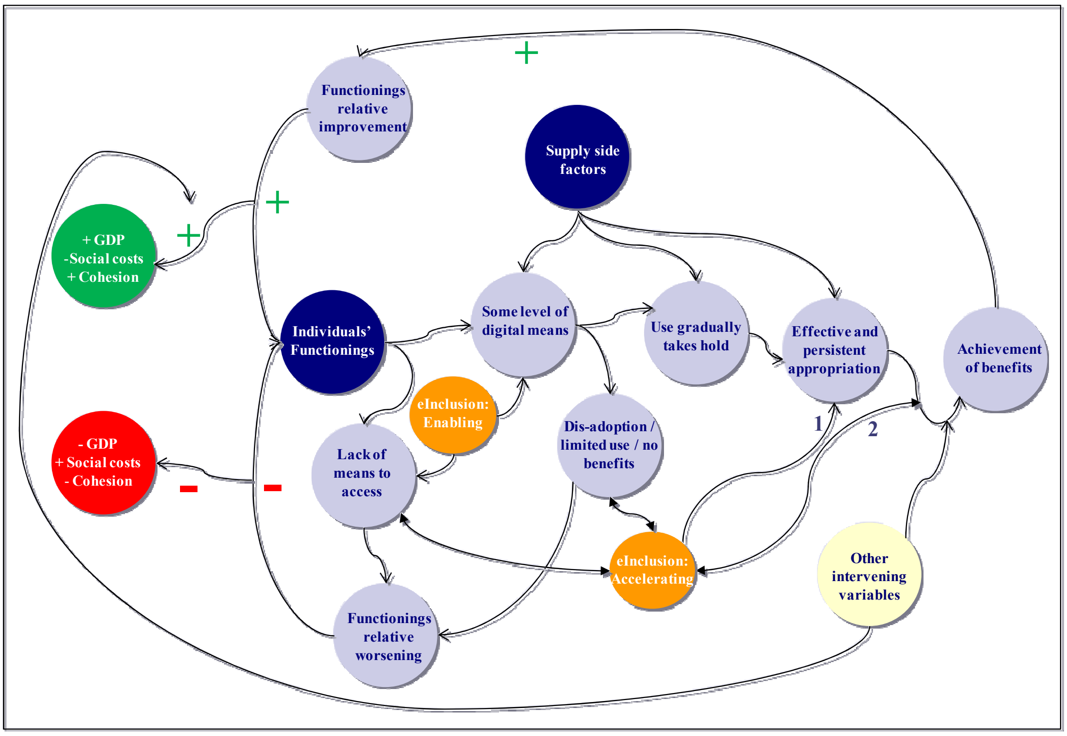


Source: Authors' elaboration

2.3. Implications for eInclusion policies

Here we look again at the modelling of digital inclusion/exclusion processes bringing inside the picture the role of policies with the help of Figure 6 below. Before illustrating the reasoning behind the figure, a notation on the graphic representation is needed: the arrows from the two policies bubble go directly to some of the possible results of the processes only for reason of space, it is intended that they do so by either targeting individuals or the supply side.

Figure 6 Modelling digital inclusion/exclusion and the role of policies



Source: Authors' elaboration

The measured aimed at lowering access barriers (termed here **Enabling**), either by targeting the individuals with direct support or by attempting to shape the supply through regulation and/or incentives, can increase access and by improving the digital means situation also generic use. This may result in an increase of Internet usage, which per se does not guarantee achievement of concrete outcomes. Access *per se*, however, is not conducive to any outcome unless those today digitally disengaged are supported in acquiring the needed awareness and competence and in seeing a clear link between using ICT and some purposeful everyday life needs or interests. This can be achieved by direct measure supporting individuals acquire skills and use ICT for clear purpose or by change in the supply of ICT based services to make them more clearly and better targets to purposeful needs of specific groups (this measure can be termed **Accelerating**). Such measures are pictured in the graph as impacting the likelihood of appropriation and effective use, as well as other element we discuss later. Improvement of supply is particularly important for the provision of online public services. It falls within Riga's area of "Inclusive e-Government" and it is a very strategic and important one. It concerns the transformation of public services through ICT to help vulnerable people become more self-sufficient and empowered in their dealings with government, better achieve what they are entitled to, as well as improve their awareness of, and access, to health thorough e-Health services.

The final elements conveyed by Figure 6 that need to be explained are the arrows linking the bubble of "Accelerating measures" backward to lack of access and dis-adoption and further to the achievement of benefits and the meaning of the two numbers. All this has to do with the idea, already anticipated in some passages of **§ 2.2**, that in conditions of extreme disadvantage it is not realistic to expect individuals to use autonomously and effectively ICT. Moreover, also for groups with some digital means, non supported use may still result in relative worsening of conditions. Effective use of ICT is correlated with advanced skills, which in turn depend on existing level of "functionings" especially in term of cognitive and cultural capital. These more advanced competences are those that enable individuals to better select the purpose of use more conducive to socially and politically desirable outcomes and thus further distancing less privileged individuals. This means that, even as the latter becomes newly engaged digitally and capable of improving their use, in relative terms this may not entirely reduce inequalities compared to the former: despite persistent and increasingly effective use, groups at risk may be less able to achieve benefits in comparison with more endowed individuals and groups. The implication of this consideration, however, explain the two numbers in the figure, namely that policies, besides (1) ***helping individuals use ICT***, should also aim at (2) ***using ICT to help them***, that is when individuals will never use ICT or needs support to increase the likelihood of achieving desired benefits. This is an approach that is not very widely followed in most Member States, but that is being pursued in UK where for instance the digital inclusion as a policy domain is defined as "the use of technology, either directly or indirectly, to improve the lives and life chances of disadvantaged people and the places in which they live" (Digital Inclusion Team, 2007: p. 5). Moreover, it must be stressed that this duality of eInclusion policy finds support in the Riga Declaration where it is affirmed that "eInclusion" means both inclusive ICT and the use of ICT to achieve wider inclusion objectives.

In conclusion, as digital inequalities concern use and appropriation patterns and the mere support to individuals to use ICT hardly achieve any result in conditions of dire social disadvantages, two implications for eInclusion policies and support measures emerge. First, support measures aimed at removing barriers and enable access are needed but will not have any major impact *per se*, unless they are part of a holistic and integrated policy together with measures linking ICT to purposeful and targeted needs and interests. It is only when use of ICT acquires a clear purpose that it will endure and lead to regular and effective usage. Providing basic digital literacy *per se* may trigger initial use but may as well end up in dis-adoption if the purpose for using ICT is unclear. Moreover, using digital literacy, for instance, as a way of teaching a language or providing job finalised skills, not only favour the incorporation of ICT into substantive activities and ensure regular usage, but it also directly tackle social inclusion issues. Second, policies should also aim at those individuals who, given their condition of deprivation, will probably never become users of ICT but should at least benefit indirectly from them. In other words initiative should not simply strive to "***Help individuals us ICT***" but should also move more swiftly and consistently to "***Use ICT to help them***" by way of multi-channel delivery, eEnabled front-liners and social workers, and of integration of intervention across different policy domains (for eInclusion and neighbourhood regeneration policies). This can ultimately lay the foundation for social inclusion and new forms of ICT enabled entrepreneurship.

Matching the discussion so far from the evidence extracted from the 1000 cases of eInclusion initiatives screened in the box overleaf we propose a typology of measures including four main groups.

As seen, so far we did not include measures aimed at increasing **broadband coverage** neither into the enabling nor into the accelerating measures. This is explained by two reasons. First, such measures can fall into either one of the two categories, depending on the specificities of each concrete measure. If the measure aims only, by way of incentives to industry and/or PPP, to bring the infrastructure in a given remote areas, then if falls into the enabling category. If on the contrary foresee an integrated set of measures where broadband is a component of a regional growth strategies (including for instance also support and training to SME and individuals to use ICT to boost their businesses and careers), then it falls into the accelerating category. Second, if broadband adoption takes place in earlier underserved region this has a potential horizontal multiplier effect to the regional economy and society as a whole, that is for all individuals and groups and for businesses and not only for groups at risk. With the power of high speed connection, in fact, a number of online activities and corresponding services become possible, which may lead to the increased supply of online public services by local authorities of local eCommerce and eBusiness initiatives, etc. In this respect if supported by accompanying measures leading to adoption, broadband coverage may result in achieving most of the output/outcomes associated to other measures. Although, it must be stressed, it would do so with some time lags. The impact of broadband would deserve a separate theoretical and empirical treatment, which is beyond the scope of this study.

Box 3 Empirically informed typology of eInclusion support initiatives

As a result of the 1000 digital initiative cases screened the following typology of support measures is proposed. The bullet points are only exemplificative and not exhaustive of the possible outputs of the three types of measure

1) Enabling Measures, for instance:

- Tax relief schemes to purchase a PC and/or subscribe for connectivity;
- Provision of Public Internet Access Point (PIAPs);
- Basic digital literacy training (i.e. ECDL);
- eAccessibility and "design for all" measures;
- Broadband coverage *per se*

2) Inclusive public services measures, for instance:

- ICT supported measures to increase access to welfare entitlements. For instance an integrated set of measures including: eEnabled front-liners who visit people in their homes, benefits buses, and online benefits calculators, online enabled smart cards to enable socially excluded groups to receive school meals or attend leisure centres without stigma, online advice and support to the unemployed, eMentors.
- ICT supported measures for access to Health. Online applications together with eHealth mentors to improve the access to health information and services by groups at risk
- ICT for independent living. ICT enabled home monitoring and other advanced solutions to help the elderly with chronic problems and/or impairments to remain as much as possible in their home
- Multi-channel delivery and eIntermediation across all policy relevant domains. This is a cross-cutting measures that would improve the access and use of all kind of public services

3) Skills and opportunities measures, for instance:

- Purposeful digital literacy and training (i.e. digital skills finalised to game oriented learning for marginalised youth or to acquire jobs skills)
- Job seeking and matching measures (i.e. online jobs marketplaces with off and online CVs building tools and assistance);

4) Community/territorial measures, for instance:

- ICT supported community building. For instance: the transformation of simple PIAPs into real **comm**unity centres supported by eMentor and local eChampions spreading the word (bottom up awareness campaign) and supporting neighbours start access and then use ICT for basic browsing, for more substantive needs, as well as for culture, leisure and entertainment. Such centres should be embedded deeply and broadly into the local level contexts and related policies challenges. This would be a measure supported by ICT that target the most deprived communities and are integrated with other local level measures.
- Broadband supported regional growth strategies. (see above in text).

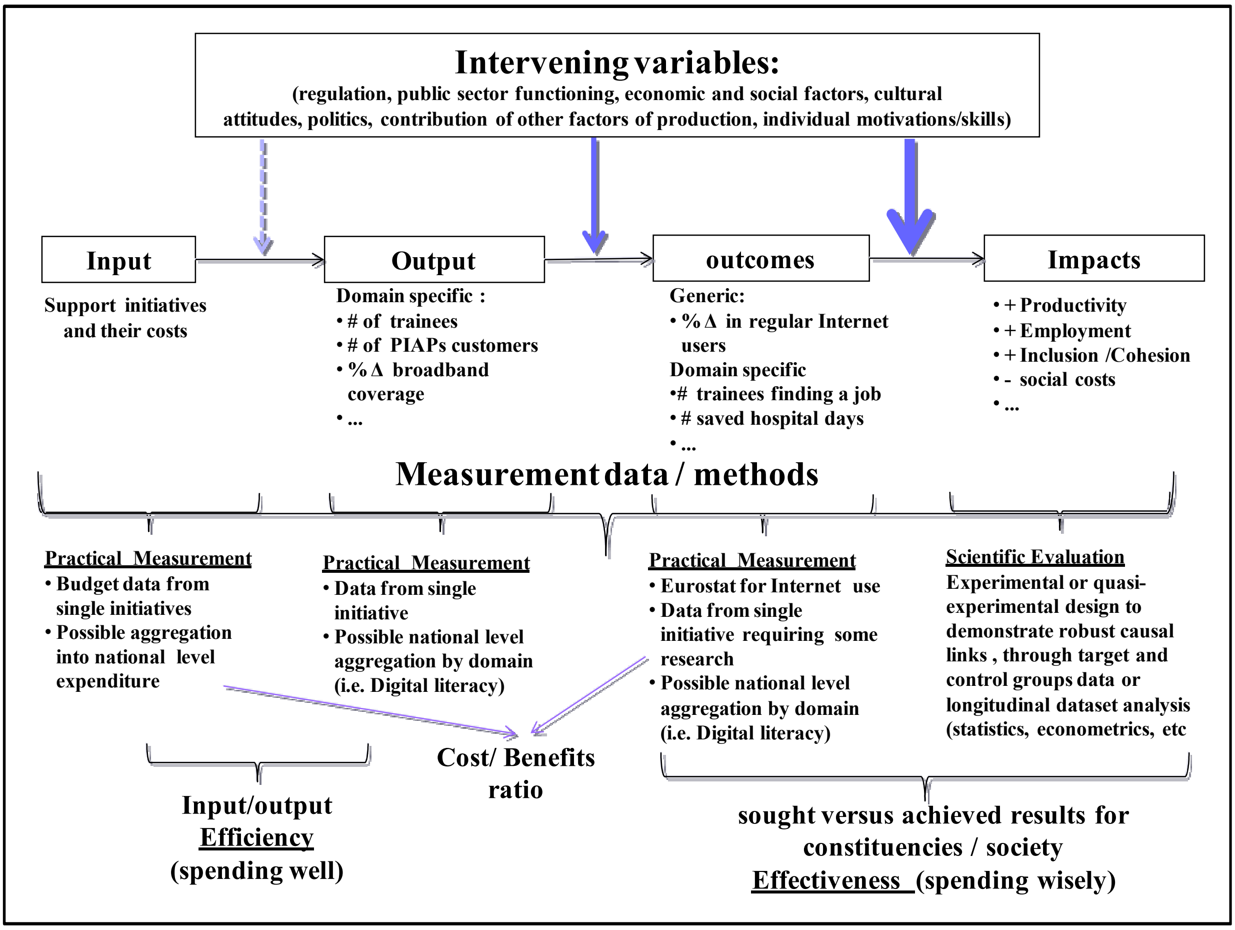
3. THE BIGGER PICTURE

By Cristiano Codagnone and Paul Foley

3.1. Premise: what to measure and how

The figure below provides the conceptual framework for public sector measurement and evaluation adapted to the eInclusion domain. The figure already contains, although in sketchy fashion, the exemplification of possible outputs, outcomes, impacts and the indication of data and methodological requirements, which are further briefly discussed below.

Figure 7 What to measure and how in the eInclusion domain



Source: Authors' elaboration

Inputs are the various types of initiatives (see **Box 3**) and their monetary and non-monetary costs. While this is the important cost side of the equation, it has been shown how frequently in the evaluation of public programmes a full quantification of costs is lacking[28] . The eInclusion domain is no exception to this, as out of the 1000 cases screened for this study, very few reported meaningful data on costs. Data need to be gathered at the level of single initiatives and could be possibly aggregated at national level, although the fragmentation of eInclusion policies and measures across government layers and verticals (and the involvement and contribution from the third and private sectors) can make an aggregate assessment of the costs of eInclusion policies difficult.

The outputs in the various specific domains of eInclusion initiatives (see **Box 3**) may include the number of marginalised young individuals trained in digital literacy courses, the number of regular customers of PIAPs, and the number of homes with assistive and monitoring technologies for the impaired elderly, etc.

[28] See for instance Johnstone et al. (2005).

These are data easy to collect at the level of single initiatives and are fairly available from the screened cases. National level aggregation, however, is lacking.

With data on input and output one can measure the efficiency of the initiatives as the output/input ratio and monitor over time input efficiency (doing the same with less) and output efficiency (doing more with the same)[29]. While certainly important, it is the contention of this study that efficient delivery comes after effectiveness (see *infra*) in the eInclusion domain. Provided more efforts are made to account for costs, at the micro-level this is a fairly feasible indicator to build and to measure systematically.

Somewhere in between an output or outcome is the increase in digital inclusion measured as a proxy by the percentage changes in the number of regular Internet users. National and Eurostat survey provide plenty of data aggregated at national level, although more granular break down of data by various parameters is needed. These data can mostly be used to measure the overall progress in a given country, but it would be difficult to identify the contribution of single initiatives to changes in the number of regular Internet usage. As several of the cases analysed show, individual initiative should try to gather data on their clients by following their progresses either while they are still benefiting from an initiative or afterwards through follow up questionnaire and interviews. They should also use, if available, locally based statistics on Internet usage

Effectiveness is the core priority of eInclusion, defined as the capacity to achieve sought changes for the constituencies and for economy and society as a whole, in terms of individual capabilities and aggregate inclusive results. This entails moving from output to outcomes and impacts, which brings into the picture a gradually increasing number of intervening factors and makes measurement and evaluation more challenging. Attributing a result to the original inputs and outputs it is more troublesome as one should control for intervening variables.

At the level of single initiatives, however, outcomes can be measured, as shown with two examples. The Irish initiative Fast Track to IT (FIT)[30], providing IT training and job matching services for marginalised youth, has kept track between 1999 and 2008 of both the numbers of trained individuals and of those who found a job requiring the skills provided by the courses (respectively 6500 and 3500). UK Online Centres, a multi-purpose and networked eInclusion initiative to socially disadvantaged individuals[31], have documented the outcomes in various domain (jobs, educational achievements, etc) its users obtained by longitudinally following them through survey and interviews[32]. With this sort of data no generalisation would be possible but a practical oriented cost/benefit ratio for the single initiatives could certainly be calculated. In practice, though, very few eInclusion initiatives among those screened self- reported anything close to an outcomes and many improperly presented as outcome or even impact what in practice were either output or declared target rather than achieved outcomes. This fact, although not functional to the objective of the study, it represents an important empirical finding: the eInclusion domain is characterised by little measurement awareness and capacities.

As the distance between the eInclusion initiatives and the object of measurement increases, so does the number of intervening factors, which is especially the case when the focus is on intermediate outcomes and impacts. This fact conveyed **Figure 7** ***distinguishing practical measurement from scientific evaluation.*** Starting from input and up to direct outcomes of the kind exemplified above for the FIT it is pragmatically possible to measure in a more simplified fashion, in other words without having to rigorously control for intervening variables. When, however, one aims to attribute an intermediate outcome or real impact (i.e. end outcome) to the output produced by an initiative, this requires a methodological robust way to control for intervening variables and establish a causal link and rule out that it is simply a spurious link or a mere correlation. Such a sophisticated approach is what we term “scientific evaluation” and must be pursued through experimental (when one can compare the effect on a “treated group” and on a “non treated control group”) or quasi-experimental (longitudinal analysis of a dataset of observations) design and data[33].

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[29] For general analysis of public sector efficiency see Afonso *et al* (2005 and 2006); Mandl *et al* (2008)

[30] See www.fit.ie

[31] See http://www.ukonlinecentres.com/consumer/ .

[32] Documented in several reports (see for instance Goodison *et al* 2004; UK Online Centre 2007)

[33] For a classic methodological debate on establishing causality in policy and programme evaluation see, among many others, for instance Campbell (1963, 1969).

Currently it is hardly possible to test through a rigorous methodology causal relations going all the way from the Input (eInclusion policies) to intermediate outcomes for the simple reason that we do not have aggregate reliable data that could be used to enter the input into a statistical or econometric model. We do not have reliable and longitudinal data, for instance, on amount of investments into eInclusion policies to enter into a model together with: a) level of digital inclusion and/or of digital skills (data fairly available); and b) various intermediate outcomes or impact for which statistics are widely available (i.e. employment). The various forms of eInclusion initiatives are spread across the various regions and localities ins such a fragmented way that using dummy or nominal scale variables to characterise different territorial unit of analysis (and then compare with measures of digital inclusion and outcomes) would require a lot of subjective judgement seriously weakening the exercise. In some scattered cases and with some luck one could find a situation of so called "natural experiment": a well identified group that has received a 'policy treatment' and a similar group that did not. For instance, this would be the case if we had data on the employment situation of the marginalised youth being targeted by FIT and on marginalised your living in the same area but not benefiting from FIT services. Yet, since eInclusion initiatives are by definition universal it is unlikely to find clear cut cases of 'treated groups' and 'non treated' control group.

Still challenging but more feasible is to identify and then empirically test the links between the ***observable levels*** of broadly defined ***digital inclusion*** (Internet usage, digital skills, but also access and use of certain services) and the ***observable level*** of ***employability*** or other desirables impacts. It is evident that, if using a fairly long series of data and controlling for all other possible intervening variables, we can prove that ***higher digital skills are associated with higher employability***, this would not be irrelevant from a policy perspective. Certainly it would not mean that, if we go out and provide a PC and basic digital literacy courses to 3 million unemployed, they will immediately get a job. It is, however, safe to state that increase digital skills can strengthen employability.

If we consider some of the key output that eInclusion policies can produce there is a fair amount of theoretical support in the scientific literature and especially in economics, from which one can make hypothesis on how the can lead to outcomes and impact. Yet, with the exception of the relation between digital skills and labour market /productivity outcomes, there is still a dearth of proven empirical evidence due to lack of data. For quite some time economists studying ICT have mostly focussed on macro-economic models and data where variables reflecting digital inclusion end up in the traditional black box[34]. Micro-economic model using longitudinal dataset capturing digital inclusion dimensions can test and prove robust causal relations. Not many dataset of this kind, however, are readymade and available for use and need to be constructed to include all of the eInclusion relevant variables. Those available mostly enable to test only the relation between digital skills and labour market outcomes: probability of being employed and wage differentials reflecting different labour productivity levels. Such datasets are available for some key Member States but are not readily comparable to be used into a single comparative econometric model, unless substantial efforts are invested into making them compatible. Emerging model and empirical test are available to test the impact of broadband coverage on economic growth, but they are not yet consolidated and the relations found are still disputed[35].

Leaving aside the distinction between scientific evaluation and practical oriented measurement and despite the cited data limitations preventing robust empirical test, it is important to still have the **Bigger Picture** in mind, which we present in next paragraph. The Bigger Picture is a theory and empirically informed ex ante model of the key potential outcomes and impacts of eInclusion policies.

Within the various causal links identified by the **Bigger Picture**, using longitudinal datasets with several points of observation (2000, 2002, 2004, and 2006) for Italian workers and firms, we have econometrically tested the relations between digital skills and labour market / productivity outcomes. Within this study it was not feasible to carry out the work needed to render several national longitudinal

[34] In this case the box is that of Total Factor Productivity. Moreover, it has been shown that growth accounting models and aggregated macro or sectoral data cannot provide direct evidence of causal relationships and are hence of limited scope if one is interested in policy questions (see more in § 8.1.

[35] Although not yet consolidated and fully robust in terms of the causal links identified, given the novelty of broadband, there are some studies especially in the US that, comparing in a cross-sectional fashion different localities, have shown that broadband has a positive impact at the local level increasing employment, number of business created, on value of residential property, and eventually on local economic growth (see for instance Gillet *et al* 2006; Ford and Koutsky 2006). For Europe some exploratory 'rule of thumb' evidence can be found in a recently published report by DG Information Society where the ACTNOW Cornwall initiative and the case of the Italian Piedmont Region are studied in depth and some estimates of the overall impact of broadband presented. (http://ec.europa.eu/information_society/eeurope/i2010/docs/benchmarking/broadband_impact_2008.pdf).

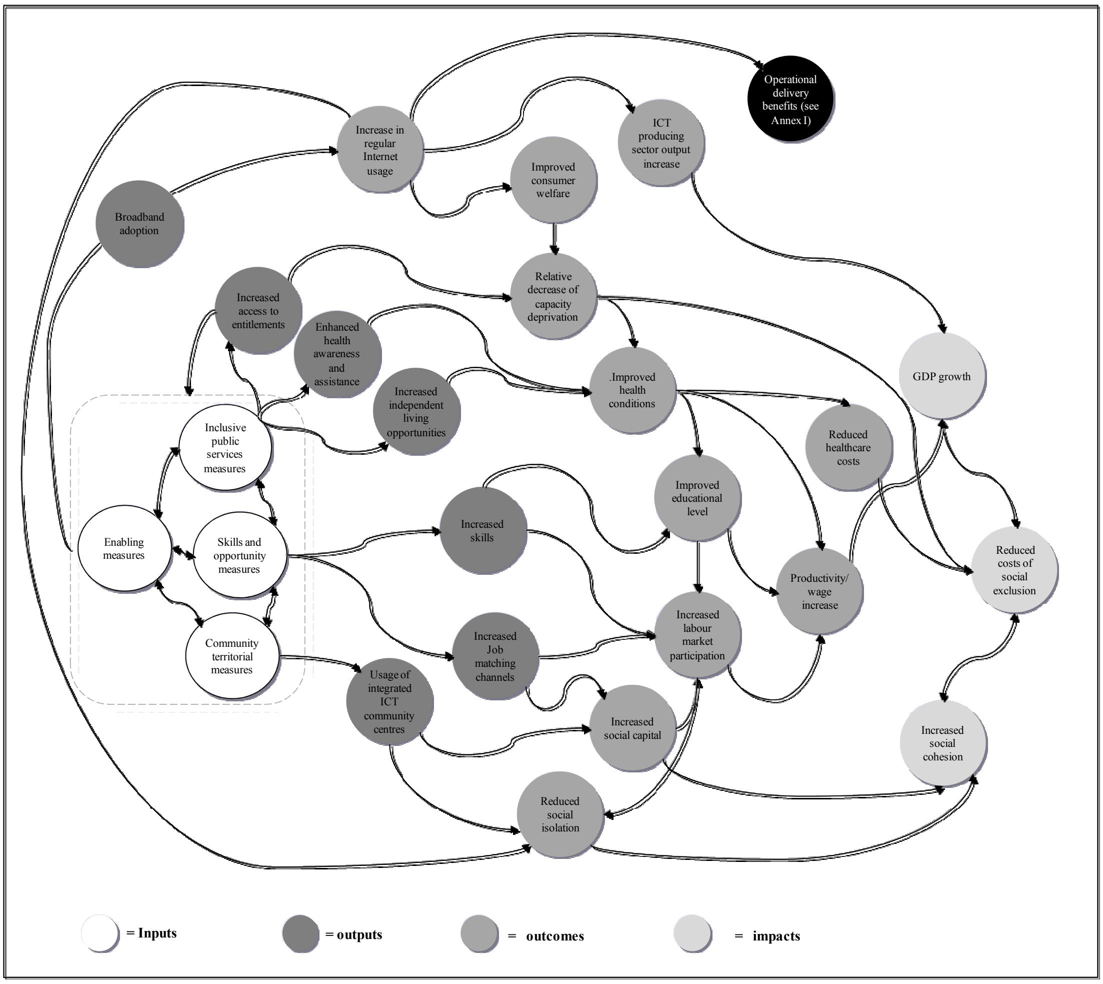
datasets comparable to enter them into a single econometric model. The results we obtained are compared to similar findings from other countries to provide some general and preliminary conclusions. New national and comparative studies of this kind will be needed to further strengthen this evidence. A simplified account of this econometric test is reported in **Section 4** while its full version illustrating all methodological and data technicalities, as well as a very substantial review of the literature, is described in Annex II (**Section 8**).

In addition we mapped the **Bigger Picture** against the case level evidence gathered and analysed to extract a framework and several indicators as a tool for practical oriented measurement by eInclusion practitioners, which is the object of **Section 5.**

3.2. The Bigger Picture

To our knowledge there have been no other models that capture the main outputs and outcomes of eInclusion as the one we developed and rendered graphically in Figure 8 below.

Figure 8 General Model snapshot



Source: Authors' elaboration

Numerous studies have been undertaken to define and measure social exclusion (United Nations, 1995; Social Exclusion Unit, 1998; Oppenheim, 1998; Scottish Parliament, 1999; Levitas, 2000; Micklewright, 2002; Joseph Rowntree Foundation, 2005, 2006, 2007; Council of European Union, 2006; SWRA, 2008). Many of these studies have noted the multi-faceted nature of inclusion. For example the UK Social Exclusion Unit described social exclusion as 'a shorthand label for what can happen when individuals or areas suffer from a combination of linked problems such as unemployment, poor skills, low incomes, poor housing, high crime environments, bad health and family breakdown' (SEU 1997). Others have suggest similar definitions - 'the inability to participate effectively in economic, social, political and cultural life, alienation and distance from the mainstream society' (Duffy 1995) or 'the dynamic process of being shut out from any of the social, economic, political and cultural systems which determine the social integration of a person in society' (Walker and Walker 1997:8). Social exclusion, in all these definitions, is presented as a multi-faceted and inter-related problem (Levitas, 1999). Previous studies of social inclusion have generally been static and considered or presented the components of exclusion separately (for example Work Research Centre, 2004 and Social Exclusion Unit, 2005). Few of the previous studies have tried to conceptualise and initiate measurement of the inter-related nature of these multi-faceted components. Key components included in the conceptualisation of this new model and the supporting literatures are considered in next section, whereas here we synthetically introduce its logic.

The model assumes that integrated eInclusion policies include “enabling” measures tackling barriers, measures linking ICT to substantive and purposeful needs and activities and to community and territorial renewal and growth strategies, all of which are delivered in a multi-channel fashion and with the support of eEnabled front-liners and care givers. Its potential contributions are many-fold. It maps all the potentialities of eInclusion and can be used to set policy targets. It provides several directions and hypotheses for the development of empirical measurement and evaluation. It can be used *ex ante* to structure business cases and construct estimates or to develop macro level scenarios using various policy modelling techniques (i.e. system dynamics) and supporting software packages.

It is best to introduce the model by explaining its overall structure, which going from left to right starts with the supporting measures input (white bubbles). Next come outputs in dark grey bubbles and the outcomes they can produce (grey bubbles). Finally, on the right of the model are the macro level end outcomes or impacts (light grey bubbles. The policy inputs reflect the typology presented earlier (**§ 2.3**) but in a simplified fashion to ensure the simplicity and brevity of the model. The different group of measures and initiatives are represented within a common shaded box and with reciprocal links to convey the prescriptive idea we advanced that they should actually be integrated. The generic output of increasing digital inclusion, proxied by the level of regular Internet usage, is seen as jointly produced by the mix of the various types of supporting measures. In addition, accelerating measures are seen as producing output/ outcome linking use of ICT to substantive and purposeful interest. While not possible to show graphically, it is implied that these also entails the better provision of services without users having to utilise the technology or have ICT skills. For example some services can be better co-ordinated using technology, but the user does not have to be aware of this. A good example of this is the use of PDAs by ‘meals-on-wheels’ volunteers in Derwentside, UK. Doctors, hospitals, social services and other groups all have access to the PDA system and meals-on-wheels volunteers are able to ‘keep an (informed) eye’ on their primarily elderly clients and thus provide a more joined-up service. They can check adverse reactions to treatments and inform clients about future appointments and events. This provides an enhanced level of care and service to clients without the clients ever having to use technology

The model overcomes a problem that was apparent in some previous studies, such as those developed by Foley and Ghani (2005) and Codagnone and Boccardelli (2006), which attempted to incorporate both efficiency operational benefits related to delivery (mostly accruing to public administrations) and outputs and outcomes for constituencies and economy and society as a whole in a single diagram or conceptualisation. Including outputs and outcomes in the model and excluding the efficiency gains or benefits obtained during the delivery of eInclusion services has two main advantages. Firstly, for the citizen/user digital delivery offers important advantages but these are probably incidental benefits (i.e. time saved, 24/7 access, channel choice) that are encountered (momentarily) when using the service. The real longer-term substantial benefits for citizen/users are the outputs and outcomes represented in Figure 14 which address many of the core components of social exclusion. Secondly, for government efficiency benefits derived during the more effective delivery of the service, in a similar way to the citizen or user they are incidental and not always the key goal of the initiative or digital service delivery. They can obviously be significant (in money and non-money value), but they distract from the key goal of analysing the outputs and outcomes from eInclusion projects and initiatives. In many ways they represent different types of benefit associated with the delivery of the service that should be analysed separately from the key outputs and outcomes examined in the model. The efficiency gains from service delivery are excluded from Figure 9 and are treated separately in **Annex I** (**Section 7**) to this report.

3.3. Bigger Picture underlying reasoning

Below we briefly illustrate the reasoning underpinning the causal links of the model depicted in Figure 8, except for the link with labour market and productivity for they are treated separately, synthetically in **Section 4**, and at length in **Section 8** (Annex II).

ICT and Entitlements. This is a very relevant and important topic that was not contemplated in the preliminary framework of the 2007 Impact Assessment (European Commission 2007b). Social scientists and economists have repeatedly shown that many individuals eligible for public assistance through welfare programs and services (including unemployment benefits) do not actually apply to such assistance (some estimates for the Temporary Aid to Needy Families in the U.S. shows that less than 50% of eligible households files an application). Studies of the relationship between eligibility and actual participation have found that welfare participation decisions depend not only on individual risk factors, but also on the social context in which individuals operate (Blank and Ruggles 1996, Blume and Durlauf 2006, Manski 2004, Cohen-Cole and Zanella 2008). The main impact of the social context on participation to a welfare program operates though two different effects. On the one hand we have the information effect, according to which people can learn from similar individuals about benefits and costs of welfare programs, besides receiving info on practical issues such as: applications, deadlines etc. On the other hand we have stigma effects, according to which people do not like to be associated to welfare programs that certify their poor economic and social conditions (embarrassment of receiving public funds). ICT supported measures can have an impact on both aspects. On the one hand they make information about the program more easily accessible, hence increasing the take-up rate among the eligible individuals and family. Moreover, they reduce the stigma effect, since the whole procedure becomes more anonymous. Increased access to such welfare provisions raise income and reduce poverty, that is they tackle one of the component of capacity deprivations and relatively improve individuals functionings (i.e. Arjan de Haan 1997; D'Ambrosio et al. 2002; Tsakloglou and Papadopoulos, 2002a; 2002b; Sen 1999, 2000). The increased available income and the potentially increased trust in public services can also lead to fruition of health services and improve health conditions, and by this way also educational attainment and eventually labour market participation. Eventually the improved coverage of those eligible by welfare programmes and services can reduce the cost of social exclusion (by reducing crimes, alcoholism and other dire social problems) and contribute to social cohesion. Finally, this output and related outcome can have a feedback on policy formulation and delivery as shown by the back arrow in Figure 8. Increasing the numbers of the policy takers / services users amount to expanding the empirical evidence on the basis of which policies and services can be evaluated and re-designed.

ICT and health. During the 1990's many economists were concerned that the traditional Solow growth model (which stressed the role of capital deepening and technological progress) was too simplified to account for the many factors affecting growth. Hence, the research agenda became one of developing growth models with cumulative factors different from physical capital that could be considered engines of growth. Examples of such effort are Mankiw et al (1992) and –especially- Barro (1996), who develops a growth model including physical capital inputs, level of education, health capital, and the quantity of hours worked. He found that an increase in health indicators raises the incentives to invest in education and a raise in health capital lowers the rate of depreciation of health. In an empirical analysis, Bloom et al. (2004) found that health capital is a significant variable for economic growth, while Strauss and Thomas (1998) in a review the empirical evidence of the relationship between health and productivity that establish correlations between physical productivity and some health indicators. In brief better health conditions affect human capital and physical productivity (by way of reduced number of days lost due to health problems). Accordingly, if appropriate measures supported by ICT improve health awareness and assistance positively impacting health conditions, this in turn reverberates into productivity directly (less days lost) and indirectly (by increased educational level). Additionally improve health conditions achieved in the more efficient way enabled by ICT can reduce healthcare costs.

ICT Matching functions and network effects. Recent research focused on unemployment determinants has adopted 'a search approach' to the labour market (for a review of the various research and findings see Pissarides 2002). The intuition is that labour demand and supply do not meet in a fully competitive labour market. On the contrary, there exist a series of frictions (mainly informative) whose consequences are that labour demand does not meet in a costless fashion with labour supply. The presence of frictions implies that firms and workers, before production can take place, need to invest time and resources to find a good match[36]. In these models the process by which firms and workers meet is represented by a matching function, whose parameters are determined by the institutional framework and by the factors that can facilitate the match between labour supply and labour demand. ICT has been shown to have an important impact on those factors, and hence reduce the equilibrium unemployment rate (see Ziesemer 2002). Related to the matching function but treated in a separate literature is the topic of individual networks as conveyor belt to find a job. The original intuition came in fact from sociology and not from economics and was contained in the ground breaking and seminal article of 1973 by Mark Granovetter[37] showing how the more instrumental and 'weak ties' (that is acquaintances rather than relatives and close friends) are the most powerful ways of finding a job. Subsequently this insight has been explored and empirically tested mostly by economist. Bayer *et al* (2005), for instance, found that significant social interactions have an impact on a wide range of labour market outcomes, including employment and wages, while Borghans *et al* (2002) have estimated that in the U.S. between 70% and 80% of jobs are found through networking. The impact of ICT on improving individuals' network and in supporting the matching function is straightforward (see for instance Zinnbauer 2007). Various measures supporting disadvantaged social groups and individuals better network increase their chance of finding a job directly through ad hoc platforms and indirectly by widening their networks of acquaintances.

ICT and Consumer Welfare. Increased competition and better flowing information should enable consumers to improve their utility function by getting products and services at the best quality/price ration conditions. This is, however, hampered by switching costs. Switching costs are considered to play a large and increasing role in competition and strategy. From an economics perspective, they are considered as potential sources of market power and therefore often considered with suspicion[38]. On the contrary, in the marketing literature, they are appraised as tools that firms can use to increase value added and are therefore considered positively. Whatever is one's opinion on the desirability of switching costs, both the economics and the marketing literature agree about their origin (see Chen and Hitt, 2006). Switching costs can arise due to the following reasons:

- Search costs: these are costs that consumers must incur to locate an alternative seller. This affects not only the initial purchase and also subsequent purchases as well, since an uninformed consumer will tend to maintain his initial provider;
- Transaction costs: these are the costs related to starting a new business relationship[39] (or terminate an existing one);
- Learning costs: these are the costs related to the amount of money, effort and time that have to be devoted to learn about a new product or a new provider/seller.
- Compatibility and network effects. Often it is the case that the value of a good or service is enhanced by: i) the degree of compatibility with other goods or services and ii) the number of other users. In these cases the coordination costs of moving from an inferior to a superior technology can be outweighed by the coordinating costs of changing all users and all equipments to the new technology
- Contractual switching costs: these are costs that the consumer has to pay whenever he/she changes provider.

There is clear empirical evidence that these costs are reduced when information is delivered in an easy-to-use format. ICT can have an impact on most of these aspects. First ICT tend to lower search costs (much of the literature on Internet and search costs shows that Internet lower search costs, induces switching and leads to more competitive markets, see Baye et al., 2006). Second, ICT tend to lower transaction costs as well, making starting and closing economic relationship much easier and cheaper. ICT can also reduce learning costs and coordination cost related to network effects and compatibility. Finally, ICT can have an indirect impact on coordination costs as well, since –by lowering search costs- they reduce the likelihood of signing contracts that lock-in consumers.

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36 This is why these models are called "Search Models".

37 Granovetter (1973) reworked and refined in Granovetter (1995).

38 It is customary to distinguish between exogenous and endogenous switching costs. The first are given to firms and originate from institutional arrangements or by the level of technology. On the contrary endogenous switching costs are generated by firms with the intent to augment customer retention and market power. For reviews see Farrel and Klemperer, 2007; Seetharam, 1999).

39 Examples of this type of costs are shopping costs, travel costs or costs related to opening new accounts.

Using ICT to better compare and find product and services could be an important aspect especially for socially excluded individuals usually confined to those available in their place of residence, where sellers are likely to enjoy location rent. If increased use of the Internet enable them to access better products and prices at competitive prices, this in turn contribute to a relative decrease of their capacity deprivation and eventually can impact social cohesion (increased participation in economy and society).

ICT industry output effect. In **§ 8.1** the in-depth review of the economic literature amply documents the important impact that the ICT producing sectors have on productivity and GDP growth, which is pleonastic to anticipate here. It is a quite reasonable to assume that if the pool of digital included individuals increase, so will the aggregate consumption of ICT products and services. This is bound to increase the ICT producing sectors output and, thus, further contribute to their impact on productivity and growth. Despite its intrinsic logic, this line of reasoning does not find much support in the literature and cannot be tested empirically for the digital inclusion variable cannot be included in the growth accounting models that estimate the impact of the ICT producing sectors. Accordingly, while we maintain this outcome in the model, for its quantification we cannot but stick to the static educated guess produced in the 2007 Impact Assessment (European Commission 2007: pp. 133-134). Finally it is worth noting that also regional broadband support measure can positively impact the ICT producing sector output, although for lack of space this link is not fully visible in the graphic snapshot of the model: as anticipated in the bottom left corner the arrow departing from the "broadband adoption" output stops at suspensions dot, but is meant to continue and reach the "ICT producing sector output" outcome at the top right corner of the graph.

ICT supported community building. Before illustrating how support measures can produce output and outcomes, the explanation of what is meant for social capital is needed. While the concept has acquired policy-making prominence and become popularised in the work of economists for the World Bank first and other international, our understanding is informed by classical sociological works (i.e. Coleman 1998; Granovetter 1973 and 1985; Portes 1998; Putnam 2000). In this respect there are two approaches to social capital one macro and one micro. The macro concept is used in the to the work of Robert Putnam who considers it mostly as a general characteristic of a community or a society, where social capital is a synonymous of systemic trust, social connectivity (diffuse solidarity and support networks), civic spirit and participation. The best operational definition of the micro level concept of social capital is that provided by Portes who define it as 'the ability of actors to secure benefits by virtue of membership in social networks and other social structures' (1998: 6).

The micro concept is more relevant for the matching and network effect of ICT treated earlier (see point 4.), whereas the macro concept applies better to ICT supported measures targeting communities, especially in re-generation efforts. These measures, however, can also produce more instrumental micro level networks that can be harnessed, for instance, to find a job.

The availability of community centres supported by ICT can greatly enhance social capital and to reduce social isolation in deprived communities. Individuals can learn to use ICT to have access to culture, leisure and entertainment, to connect with old and new friends. This also results in acquiring skills that reverberate on all other output and outcomes, although this could not be rendered graphically.

It must be added that the reduction of unemployment that can be produced by increased digital literacy and skills can also reduce social isolation and increase social capital. We can appreciate this by considering the negative impacts of unemployment evidenced by Sen (2000):

- Unemployment can be a significant causal influence in heightening ethnic tensions as well as gender divisions. Since immigrants are often seen as people competing for employment (or "taking away" jobs from others), unemployment feeds the politics of intolerance and racism;

- People in continued unemployment can develop cynicism about the fairness of social arrangements, and also a perception of dependence on others;

- Unemployment may generate loss of cognitive abilities as a result of the unemployed person's loss of confidence and sense of control;

- Unemployment and declining self-confidence can be very disruptive of social relations and of family life. It may also weaken the general harmony and coherence within the family;

- Unemployment has a detrimental impact on social activities, such as participation in the life of the community, which may be quite problematic for jobless people.

So on the one hand increased labour participation resulting from improved digital inclusion and skills, besides contributing to quantifiable economic outcomes, can also reduce the list of social isolation, apathy and tension listed above. On the other hand, if unemployment persists, such negative effects can be partially offset by the increase of social capital at community level, to which the availability of ICT supported community centres could contribute.

Broadband.

Measures aimed at spreading broadband coverage and reducing geographic divides can be of two kinds. First, they can consist only in bringing broadband in a give region without other connected initiatives, which reduce access barriers but does not ensure sustainable usage and other outcomes / impacts. Second, they can be part of a more comprehensive regional growth strategy with accompanying measures to stimulate demand and trigger new activities. This is, for instance, the case of Cornwall ACTNOW initiative (See Figure 13, p. 42) This approach to broadband diffusion, besides better ensuring regular usage, can also produce important socio-economic impacts, including growth of regional GDP. There are emerging studies providing evidence of the economic impact of broadband, especially for the US (see for instance Gillet *et al* 2006; Ford and Koutsky 2006).

4. DIGITAL SKILLS, LABOUR MARKET, AND PRODUCTIVITY

By Cristiano Codagnone, Federico Biagi and Valentina Cilli

In this section we summarise as much as possible in layman terms: a) the full review of the relevant economic literature conducted as background both to the elaboration of the Bigger Picture and to the design and application of our econometric test; and b) the analysis and findings of the econometric test. The full version of both is reported in the form of **Annex II** in **Section 8**. For the sake of clarity and brevity in this section we do not cite the supporting literature, for all of the statements to be found in the next paragraphs are further specified and fully referenced in **§ 8.1**. In the same way we do not report the data supporting the econometric applications, which are presented in Figure 21 through Figure 26 in **§ 8.3** and in Table 1 through Table 21 in **§ 8.5**.

4.1. Introduction

The wide and exhaustive review of the economic literature conducted in this Study shows that there is still some way to go before most of the impact of digital inclusion impacts identified in our general model can be tested using econometric models. A large majority of economic analysis of ICT has concentrated in demonstrating its overall effects on productivity and economic growth using macro-economic models (i.e. growth accounting), whose utility from the perspective of eInclusion policies is dubious. Stated simply, such models only tell that more investments in ICT may increase productivity and spur growth without explaining how and through which more specific effects. Micro-economic approaches have challenged such model and unequivocally shown that they do not identify robust causal relations. Yet, simplifying in a short sentence a large body of literature, it can be stated that these new micro-economic approaches has mainly concentrated in challenging the impact of ICT *per se* on productivity and in showing that this impact is complementary to organisational restructuring. The intuition behind this shift was that, by using such micro level data, it would become possible to understand the complex links between ICT development, adoption and ICT diffusion in the economy. The micro-economic literature insight being that there exist time lags between technological change in ICT and productivity growth due – among other reasons- to learning by doing, lags in organizational restructuring and by the ***level and quality of ICT take up and skills by individuals and households***.

Basically none of these micro-economic studies has explicitly and directly tested the effects of variables reflecting digital means (or inequalities), nonetheless looking at this literature from the combined perspective of ICT relation to productivity, wage and employment, it is possible to identify three effects with implications for eInclusion policies. In the context of the ICT revolution possessing digital skills: 1) avoids human capital depreciation and increase broadly defined employability[40]; 2) can be the sources of wage differentials reflecting different productivity levels; 3) it is a multiplier of the effect of ICT capital investment and contributes to increase firms productivity[41].

These are the three questions addressed in the economic literature that, in our view, can be looked at from the perspective of digital inclusion/ exclusion. Accordingly, our econometric application empirically tested the hypothesis that the diffusion of technology within the economy has a significant impact on workers' productivity and wages, hence affecting the shape of the labour and income distribution. If ICT are complementary with skilled/high-education labour and substitute for unskilled/low education labour, we would expect the diffusion of ICT to improve the position of highly skilled and highly educated workers and to worsen the one of low skill and low education workers.

Such outcome, which we could interpret as the main labour market effects of the digital inequalities, has –as a policy implication- that we should try to improve the position of low skill/low-education workers by increasing their technological skills, in order to make their human capital less depreciable.

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40 ICT tend to increase the substitution of labour with capital, though in different ways for different groups of workers. Given capital-skills complementarity, technological revolutions tend to favour educated/skilled labour at the expenses of uneducated/unskilled labour, hence decreasing the relative demand for workers with low education and poor skills. So it is possible that workers without digital skills are more likely to lose their job. Looked from a different perspectives unemployed searching for a job have greater chances to find it if they possess digital skills (except evidently for low level tasks and/or for traditional industries little affected by the ICT revolution)

41 ICT has an impact on both capital and labour productivity, which implies that workers with digital skills can leverage the ICT investments made by firms, perform their task better, and increase output per capita

If policies do this, not only address a social problem, but also produce an externality for firms by increasing the skill set of the labour force.

4.2. ICT and employment

Parallel to the investigation of the relationship between ICT and productivity/growth, a growing body of literature studying the effects of new technologies on employment and the wage distribution has emerged. This literature, initially focused mainly on the U.S. and only later looking at the experience of other countries, has tried to analyze the impact of ICT on the labour market, under the hypothesis that ICT adoption and use by firms have a positive impact on skilled labour (and hence firms') productivity, while being a substitute for unskilled labour (skill-biased technological change hypothesis). This increased relative productivity of skilled workers, from a labour market perspective, implies that new technologies tend to raise the demand for relatively skilled labour and reduce demand for relatively unskilled labour. This fact has two main implications. First, it should increase the incentives to accumulate human capital, given that the returns from skilled labour are higher. Second, the different impact of technology on skilled and unskilled labour can reduce the employability and/or the chance of remaining in employment of the latter, as well as result in serious distributional issue which shows up in both increased wage differentials between skilled and unskilled workers and higher relative unemployment for unskilled workers.

Studies have documented how access and ability to use technology as either individuals or networks affects employability, since it affects both the decision to enter the labour market (the labour participation decision) and the likelihood of obtaining job offers that are later accepted (the transition from unemployment to employment). These are effects that clearly show up at the individual level, since it has been proven that wage trajectories, employment and labour supply decisions along the life-cycle tend to be affected by the "ICT skill level" of individuals.

Finally, since empirical evidence shows that ICT skills are concentrated in the young adult generations, a rapid pace of technological progress in ICT producing sectors and a high rate of ICT adoption in ICT using sectors can lead to a decline in (relative) productivity for older workers (aged 50-64), making their exit from the labour market more likely and, thus, exacerbating the financial problems that characterize an ageing Europe.

In the US empirical tests on the relation between ICT skills and use and employability / likelihood of remaining employed have produced significant coefficients[42], while for Germany the evidence is less clear-cut. Accordingly empirical evidence on this issue for Italy is very interesting as it can be compared to, contextualised within, the experience of these countries.

For testing the impact of ICT on labour market outcomes (both for employability and wage differentials) we have used data from the Bank of Italy *Survey of Household Income and Wealth* (SHIW), which, every two years, provides data on a sample of about 8,000 households, representative of the Italian population. It contains detailed information on demographics, income and wealth at the individual and household level. This dataset provides four different waves of data (2000, 2002, 2004, 2006), and thus enable both a cross-sectional and longitudinal analysis of outcomes. ***These data provide unique and valuable information for the question analyzed here, since they enable us to estimate whether digital skills and ICT use at work are positively influencing wages and the probability of remaining employed***.

In testing whether there is a robust causal relationship between the probability of being employed and digital skills, (among others variables) we have controlled for: 1) gender; 2) age (we considered three different age groups: 15-34; 35-49; 50-64); 3) education (at most intermediate school; at least secondary education). In all the regressions we also control for civil status, region of residence and household income. The intuition is that these variables are going to affect such a relationship and must be controlled for to associate the analysed outcome only to digital skills and ICT use.

In this respect it is worth reporting here a general finding that is relevant both for the analysis of employability and of wage differential we performed. A general and raw analysis of the data shows that there is a serious digital exclusion issue for older and less educated individuals and -among these- especially for women. Diffusion of digital skills and ICT use among these groups is substantially lower

[42] Friedberg (2003) –analyzing the impact of ICT skills and use on the likelihood of being employed for U.S. older workers- concludes that, on average, older males would have remained employed one extra year if they all had possessed good PC skills and had access to a PC on the job.

than for others in Italy. In terms of labour market outcomes, this implies that these two groups are likely to suffer more from lower employability and lower wages.

We analysed the same set of observations across the four waves and developed a *Probit* regression to test the relations of interest. This technique is used when using non continuous variables such as the employment status.

Looking at data in ***a cross-section fashion and without controlling for education and other variables*** we found that for ***almost all of the groups considered the likelihood of being employed is lower for individuals without digital skills*** (see Table 1 in **§ 8.5**).

When ***controlling for education and other variables***, but still in a cross-section fashion, we found that ***digital skills and use of ICT have a positive effect on employment probability for both males and females in the age group 50-64 and for females in the age group 35-49, in both cases regardless of the level of education (though the effect is stronger for groups with higher education)***

Yet the most reliable effects are those that we have estimated dynamically (see tables 3 through 13 in **§ 8.5**), following individuals from year 2000 up to year 2006. These further specify the results above, confirming some and raising issues for further investigation for others (i.e. for females).

The key findings of the longitudinal probit regression are as follows:

- ***Males aged 35-49 with low education but with digital skills and experience in using ICT have (on average) a 5% higher employment probability*** than males in the same age-education group without such skills and experience;

- ***Males aged 50-64 with higher education and with digital skills and experience in using ICT have close to a 20% higher employment probability*** than males in the same age group with higher education but without such skills and use experience;

- ***Results for females in the same age groups (35-49 and 50-64) are mixed and do not lend themselves to any conclusive finding***, except that there is a relation between digital skills and ICT use with probability of remaining employed for the 35-49 age group but it is milder than for males.

The most evident finding is that the ICT revolution is making life much harder for older workers as it produces a depreciation of their human capital. Looking at it from a different perspective, for older workers the acquisition of digital skills contribute to a reduction in the human capital depreciation rate. This has important policy implications impacting also on the sustainability of welfare and pension systems in Europe. eInclusion policies should target this group with skills supporting measures, and by doing so would also produce an externality for firms by increasing the human capital of the labour force.

ICT effect on employability, though milder, is also significant in the age group 35-49 and also support the importance of targeted eInclusion policies.

As for females, the mixed results suggest the need for further comparative investigation as such contrasting picture occurs again when looking at ICT and wage differentials (see later). These results can have two possible explanations, one technical and one substantive. The technical one related to the characteristics of the dataset is explained fully in Annex II and we will not deal with it here. The substantive reason may be related to the fact that discriminatory practices are at work: digital skills are less rewarded for females as opposed to males, and this may explain why the data do not show significant correlations. This is, however, a preliminary hypothesis in need to be further investigated in a separate *ad hoc* study.

4.3. ICT and wages

The ability to use technologies has been shown to be positively correlated with wages, so that more technologically skilled individuals (even after controlling for individual fixed effects) receive a wage premium. From an historical perspective, skill-biased technological change is not a novelty of the last two decades. What is new is the simultaneous rise in wages and employment shares of skilled workers. If we try to interpret this phenomenon within a simple demand and supply model, this suggests that, in spite of the remarkable increase of the relative supply of highly educated and skilled workers, the widespread diffusion of ICT has generated an even greater increase in their relative demand. Moreover, new technologies influence wages not only directly but also by changing the way in which firms and the labour market are organised, thus higher wages reflect higher productivity. ***From a policy perspective, one of the most relevant questions that have been addressed by the empirical literature studying the relationship between the ICT revolution and the labour market is the one related to the effects of the former on the wage distribution and the incentives to accumulate human capital.***

First, in the US already in the late 1980s Krueger well known research claimed that computer use accounted for wage premium ranging from 13.9% to 17%. Similar research and two digits (from 10% to 15%) wage premium associated to ICT skills have been found also for France, Germany and the UK.

However, as for the case of the impact of ICT on productivity claimed by growth accounting models, also these studies and the claim that wage differential can be entirely attributed solely to ICT skills have been challenged.

Put it in layman terms, the studies showing wage differentials seem to provide the idea that if we gathered a pool of individuals, taught them some ICT skills and provided them with a PC to exercise at home, then they would all get higher wages in their current job or a better paying job. The critiques to these studies suggest that there are probably other factors at work explaining wage differentials and not simply ICT skills. In technical terms they suffer from ***unobserved heterogeneity bias***, in exemplificative fashion the fact that the econometrician does not capture the unobserved variable "individuals' ability" in general. In this case we impute wage differentials to ICT skills, whereas such skills depend on such individual ability, which in turn is the source of higher wages. This is compounded by the fact that employers do not provide PCs randomly but probably do so for the most productive workers. If this is the case, the causality direction from ICT to wage differential is seriously called into question. From a more technical point of view, the critique of studies *a la* Krueger show that the issue of unobserved ability cannot be captured with a cross-section analysis, as this does not allow to fully control for individual fixed effects. This is instead possible if we have for each individual several observation across time (longitudinal analysis). In an experiment conducted in France the wage differential estimated in a cross-section analysis was of 17%, whereas it went down to 6% when estimated using a longitudinal analysis.

Overall, we feel that the "Jury is still out" and a final verdict on the relationship of wage differential (reflecting productivity) with digital skills and ICT use has not been written. For this reason our additional and entirely new empirical findings on the Italian case are very interesting and promising as they can help bringing evidence on one or the other side of the debate if compared to those we mentioned for other countries (France, Germany, the UK, and the U.S.)

The dataset used is the same as that described earlier (see **§ 4.2**), so we describe here only the key technicalities, and especially the solution adopted to avoid the bias deriving from not controlling for individual ability.

The potentially most fruitful strategy to avoid the ***unobserved heterogeneity bias*** with respect to individual ability for which studies *a la* Krueger have been criticised ***is to bring directly an observable measure of ability into the regression***. If we control for such a measure by including it among the explanatory variables, we can then try and estimate a robust causal relation between ICT skills and wage differential, which is no longer picking up the ability component (because we have already controlled for it).

This is exactly the strategy we used in our exercise, where -as a control for ability- we took the final grade that the individuals obtained at the time of graduation either from High school or College[43]. Given that we have constructed a longitudinal dataset (so that for each individual we have more than one observation) for all individuals (including those with education no higher than Junior High school) we applied a methodology developed by Chamberlain, which allowed us to control for (some) other unobservable fixed effects, while at the same time avoiding differencing the data (which would cause a loss of observations on the variable reporting PC skills, which is available only in year 2000 and therefore constitutes an individual fixed effect).

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[43] In case of individuals with College degrees, who -by definition- have also completed High school, we used the degree from their highest and most recent educational achievement. For those who do not have a High school diploma we do not have information on their school grades and so we could not include it in the regression.

The findings commented here are supported by the summary tables 14 through 17 that are reported in **§8.5** of **Annex II**.

Even after introducing a variable meant to control for individual ability, ***our findings confirm that when moving from a cross-section analysis to a longitudinal one the wage differential related to ICT skills decreases***.

Yet, we also find that the ***relation between ICT skills and wage differential exists and is significant***. This differential is not into a two digit range ***but it is still sizeable*** (**5%- 6% on average**) and, given our technical approach, ***this is a very robust finding that corroborates those found for France in a similar manner***.

Looking more into the specific the main findings (after controlling for : age, experience, sector, workers qualification and education, and individual ability), are the following

- For ***males with lower education or with an high school diploma*** we find that possessing ***digital skills and using ICT accounts for a wage differential of between 5% and 6%***;

- Results are clearly ***gender specific***: possessing ***digital skills and using ICT is never associated to a significant wage premium for females***;

We can comment these two findings and highlight some policy or research implications. The first finding is very important for, even after controlling for many variables and for individual ability, we have significant effects of digital skills and ICT use on male wages. Even more interestingly, these effects are not equal across education groups: they are sizeable and significant only for those groups with lower or high school level of education. Hence we can read these findings as suggesting that:

digital skills do not receive a market premium in the case of highly educated individuals, ***since in this case they are implicit job and skill requirements...***

...however, for less educated individuals such skills are not implicitly required and attached to them there exists a clear and significant wage premium.

In terms of policy analysis this means that interventions directed at increasing the technological abilities of those with low or intermediate education are likely to produce a more significant impact on workers' wages, while at the same time reducing digital exclusion.

The second finding is more complex to read and would probably require some terms of comparison from other countries to determine to what extent it is peculiar to the Italian social structure and labour market. Unfortunately results based on comparable data and methods are not yet available. One technical possibility explaining this finding has to do with selection issues that are discussed **§ 8.3** and we do not consider here. The alternative explanation would be that wage discrimination might be at work. If female wages are compressed, their increased productivity due to the possession of digital skills or to the use of an ICT on the job is not reflected in higher wages.

If this would be the case – we would expect that this might happen not only Italy but also in other countries with similar social structures and labour markets (at least Greece, Portugal and Spain, and possible some of the 12 new Member States, without ruling out other cases such as Austria, Germany, France[44]) – the policy implications would be of high relevance. Currently, in fact, basic data on regular Internet usage have led many to comment that the gender gap in terms of digital inclusion is closing up. Yet, when looking more in depth to the issue as when analysing the relation between digital skills and wage differential it is possible to find that this gaps is taking different forms.

We think that this finding and the related issue certainly deserves more attention and should be the focus of future comparative European research.

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44 We would be surprised to find similar results in the UK, Scandinavia and the Netherlands.

4.4. ICT and firms productivity

The micro-economic literature rests on the intuition that investment in ICT and firms' characteristics (human capital, workplace organization, frequency and level of product and process innovation, management etc) are very much interrelated. This has at least two consequences: first, not all firms experience the same productivity change for an identical investment in ICT activities; second, we expect to observe some lags between the timing of the investment in ICT and the timing of the increase in productivity, due to the need of restructuring the firm environment, including the introduction of new skills in its labour force. The first contribution in this direction by Bresnahan and associates tested and proved the hypothesis that ICT affect labour demand not only directly but also indirectly through other firm-related changes. That is ICT is embedded in a cluster or related innovations, notably organizational changes and product innovation. They look at the relationship between changes in labour productivity and in the composition of the wage bill on the one hand and variables capturing organizational change, ICT and product innovation on the other hand. In this approach also issues of team working and the extent to which workers have authority over their pace and method of work are considered. What they find is that ICT investment and variables capturing workplace organization are both individually and jointly significant. What this means is that, taken alone, ICT investment and changes in workplace organization (as expected) tend to rise firm's productivity, in a statistically and economically significant way (by 3% for ICT and by 2% for workplace organization). The coefficient on the interaction term between ICT investment and the fraction of workers with a College degree is positive and significant (the point estimate is 0.05), hence indicating that there are complementarities between the composition by education of the workforce and the returns to investing in ICT. While these results concern the US , similar and consistent findings have been found also for the United Kingdom.

Accordingly empirical evidence on the issue of ICT and firms productivity for Italy is very interesting as it can be compared to, contextualised within, the experience of countries such as the US and the United Kingdom.

For testing the impact on labour productivity of organizational innovations and investment in ICT by Italian manufacturing firms in the period 1995-2003 we use data from the 7th, 8th and 9th waves of the *Indagine sulle Imprese Manifatturiere* by Capitalia (formerly Mediocredito Centrale). This is the only Italian survey, and one of a few in Europe, containing information on the introduction of organizational innovations by firms. These data were gathered in year 1998, 2001 and 2004 respectively, through questionnaires handed to a representative sample of manufacturing firms within the national borders, and supplemented with standard balance-sheet data. Questionnaires collect information over the previous three years. Some questions are year-specific (and for them we have three different answers, one for each year) while others are wave-specific (and hence we have a unique answer for the three years). One of the questions is whether firms have introduced any innovation (including product, process, organizational) in the previous three-year period (so that for each wave we only have a unique answer). Firms' representatives are also asked whether investment in ICT was made in the previous three years and for those who answer "*yes*" a question follows on the size of this investment (expressed in monetary terms). The questionnaire also contains questions on the degree of openness of the firm, on the fact that the firm belongs to a group, on the composition of the labour force by education and skills and on R&D spending. These data are then matched with balance sheet data, so that information on sales, cost, profits, and capital stock can be obtained (these data are year-specific, so that for each wave we have three records)

The findings commented here are supported by the summary tables 18 through 21 that are reported in **§ 8.5** of **Annex II**.

In the analysis we regressed the dependent variable (the log of per-capita real output) on each of the potentially relevant explanatory variables (one at a time).

The first interesting result is that per-capita real capital is positively and strongly correlated with per-capita real output, while at the same time ICT investment shows no significant relation with productivity (per capita real output). This confirms ***also in the Italian case that –per se- ICT investment in the manufacturing sector does not appear to have a positive impact on average labour productivity***.

Second, we find a ***significant and positive coefficient for the effect of organisational innovation on labour productivity at firms' level***. This is an important finding since the literature reviewed show that organizational innovations can produce effects only when they are implemented in the proper firm environment and using the proper investments. ICT investment is one of the key conditions for success of firms' restructuring, the other being the other being the education and skill composition of the work-force.

Third, after running conditional logit model (i.e. a logit model with fixed effects for longitudinal data) where we analyze the effect of some potentially relevant explanatory variables on the probability of observing an organizational innovation, ***we find that the variables correlated with organisational innovation are: 1) being part of a group; 2) exporting a sizeable share of output; 3) number of workers engaged in R&D activities; 4) the share of workers with higher education; 5) the share of workers performing skilled tasks (including those requiring ICT skills), 6) the amount of money invested in workers' training, 7) the fact that the firm has engaged in some R&D and, finally, 8) the fact that the firm has made investment in ICT***.

We now turn to our production function regression, where we regressed the per-capita real output on the per-capita capital stock and on the *organizational innovation* dummy, where we control for sector specific dummies[45] and for wave specific dummies[46]. Being concerned about the endogenous nature of the organizational innovation dummy, we performed both OLS and Instrumental Variable (IV) estimation and our IV results show that -after controlling for other variables- there is ***a positive and significant coefficient (0.48) on the organizational innovation dummy. At the same time we find that organizational innovations are more likely to happen if the firm has invested in ICT and R&D (besides being part of a group, exporting a sizeable part of its output and having invested in training programs for workers and management).***

In conclusion we extract the following story.

ICT investment, per se, does not appear positively and significantly correlated to our measure of labour productivity, even when we do not control for other factors (i.e. even outside from the *ceteris paribus* hypothesis).

However, we have evidence that organizational innovations do have an impact on labour productivity, and such innovations need to be implemented using the appropriate human and technological capital.

The analysis clearly show that the skill composition of the work force (and investment in training) combined the presence of investment in ICT are among the factors that mostly affect the probability of adoption of some organizational innovation, which in turns result in productivity gains.

So looking at ICT impacts on firms' productivity with the lenses of eInclusion policies one can extract two implications. The first, already underlined in the introduction of this section, is that firms' productivity, employability and wage differentials are all part of the same coin and to some extent related to the diffusion of ICT use and skills in economy and society. The second is that, leaving aside policy silos, we argue that the reach of eInclusion policies should also include Small and Medium Enterprises and target them with measures of two kinds: a) advice and training to owners and managers to combine ICT investments to organisational restructuring; b) training to employees to increase their digital skills.

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[45] These are meant to control for sector specific time-invariant effects that might affect average labour productivity.

[46] These are wave-specific factors (such as the sampling strategy) that might have an effect on measured labour productivity.

5. CASE LEVEL EVIDENCE AND PRACTICAL MEASUREMENT INDICATORS

By Cristiano Codagnone, Annalisa De Luca and Valentina Cilli

5.1. Objectives, scope and limits of case level evidence

Following the distinction made earlier (**§ 3.1**) between scientific evaluation and practical measurement, starting from the "Bigger Picture" the work then proceeded into two directions. One being that discussed in the previous section, the other consisting in mapping the general model against the practical cases existing out there in order to: a) simplify the model and define a practical measurement framework for those domains of initiatives most recurrent in the field; b) find from existing eInclusion initiatives across EU27 (and covering all of the most important domains) evidence of outputs produced and outcomes achieved for the constituencies.

In order to achieve the objectives and produce the output illustrated above we have screened the following sources that provided access to an aggregation of certified eInclusion cases:

- ePractice.eu : total of 30 cases[47];
- Booklet prepared for the Lisbon Ministerial Debate on eInclusion of December 2007: total of 153 cases, (most of the 153 cases are the same as those found in ePractice.eu)[48];
- Cases from the European Broadband Project Award for 2007: total of 50 cases[49];
- Vienna Ministerial Conference awards short-listed cases: total of 35 cases[50] (we know that there have been 465 submissions but we were not granted access to them do not know to what extent they overlap with others);
- Solution4inclusion.org: 621 cases, which however are 95% UK and so we only selectively used them[51]

As a result 1000 cases of eInclusion initiatives were screened that cover in a fairly balanced ways all of the EU27 Member States, of which 125 were analysed in more depth and are reported in Compendium to the final Full Report of the study. This data gathering and analysis of cases helped define the simplified conceptual framework illustrated in the figure below but, as anticipated, yielded only very limited evidence on measured outputs and, especially benefits. It must be stressed that the majority of cases with some good enough, although not perfect, evidence of outcomes come mainly from the UK and Ireland.

In total we screened, net of overlapping, about 1000 cases of eInclusion initiatives but despite the sheer size of this sample: ***only 52 report some information on what can be broadly interpreted as output/impact and of these the overwhelming majority comes from the UK. If we restrict the definition and consider outcomes strictu sensu and especially the expression in monetary value, the total does not reach 10!*** [52]

From these 1000 in the Compendium we report 125 cases that we selected applying two filters: a) we strived as much as possible to include cases from all of the EU27; b) we selected all those cases where there were information that at least came close to what can be considered an output or an outcome or a broadly defined impact (yet as the reader will see, these kind of evidence is very limited). So, although not what we expected and not functional to our objective, nonetheless the first and very important empirical finding is that: ***within the field of eInclusion practitioners measurement and evaluation activity is***

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47 www.epractice.eu

48 http://ec.europa.eu/information_society/activities/einclusion/docs/bepartofit/contributions_booklet.pdf

49 http://ec.europa.eu/information_society/events/broadband_gap_2007/exhibition/index_en.htm

50 http://www.e-inclusionawards.eu/

51 http://www.esd.org.uk/solutions4inclusion

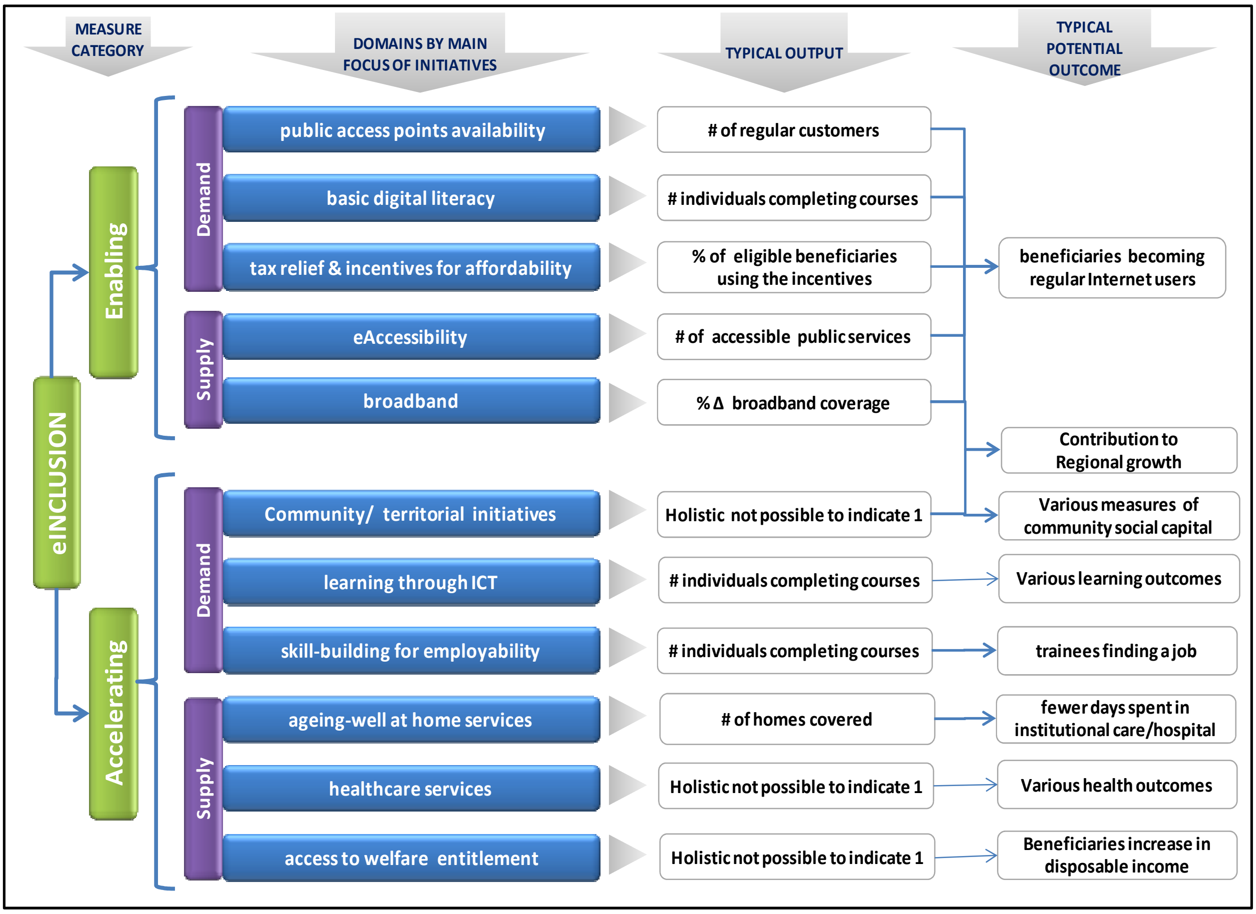
52 Please note that, given time and resources constraints, for what concern the evidence on costs and output/outcomes by necessity we had to rely on self-reported information from the identified cases and did not attempt to gather this information, when missing, through field research and interviews.

basically lacking. It was striking, for instance, how within the ePractice.eu cases codified as belonging to the eInclusion domain the section title "Impact" is often filled in with information that are not clearly related to impact but mostly to objectives, context and other topics. At best one can find in this section information about output and only in a very few cases information on impact. ***This finding convinces us of the urgent need to increase among awareness and capacity practitioners in the field of measuring the output and outcomes of eInclusion initiatives.*** In order to still pursue our objectives and produce the expected output, for the prioritisation of areas of Initiatives with their corresponding output/outcome we resorted to the criteria of occurrence of cases in the various domain we identified.

5.2. Simplified conceptual framework and measurement tool

The figure below illustrates the simplified and prioritised conceptual framework obtained by mapping the General Model against the gathered and analysed case level evidence.

Figure 9 Simplified and prioritised conceptual framework: snapshot



Source: Authors' elaboration from mapping the Bigger Picture against case level evidence

As it is usually the case, empirical reality is always more complex, nuanced and granular than even the best conceptual simplification could capture and, thus, the cases of eInclusion initiatives found at times overlaps more than one domain and their inclusion into only one it is a selective choice. Initiatives cutting across one or more of the identified domains can apply indicators proposed for several of them. The checklist of indicators has been drafted in a general and flexible way so that can be adapted to the peculiarities of each concrete initiative. In this respect further detailed operationalisation in terms of indication of data sources and the calculation methodology will be needed, which is highly dependent on the specific context of each initiative and could not have been done *ex ante* in this study. Nonetheless, at a preliminary level three main sources of data needed for measurement have been identified: 1) internal records within reach of those managing the initiatives; 2) follow up surveys with beneficiaries to obtain information on a number of results achieved during and after benefiting from the initiatives; 3) various general and sector-specific statistics (mostly to estimate monetary value of outcome, or to weight some the output and outcome metrics).

5.3. Measurement indicators and illustrative evidence

Measurement indicators are presented in the following pages for eight of the eleven identified domains. Indeed indicators are not proposed separately for community building initiatives, for they are holistic and can apply indicators identified for other domains. No indicator is proposed for initiatives in the domain of healthcare services for they span to widely and each specific service requires its indicator. eAccessibility requires a separate treatment in its own right partially already presented by the European Commission funded MeAC Study[53] and it is not treated in this report.

The indicators and some examples from the case studies are reported below in fairly straightforward fashion requiring no other considerations, except some notations. When possible, most metrics should be broken down by target groups (the notation used below is SES standing for socio-economic status). In most cases the indicators are expressed in absolute values as if they were the zero measurement. Evidently as measurement become systematic they will have to be expressed also in terms of percentage change with respect to the previous time unit considered.

Figure 10 Measurement Indicators: Public Internet Access Points

Primary Output	Secondary Output/ or Outcome
# of regular users by SES (monthly or yearly)[1]	% of users progressing to take ICT courses[3]
average length of use of facilities per user[1]	% of users progressing to regular Internet usage[3]
% coverage by PIAPs of deprived communities[2]	% increase in Internet usage in the area[4]
PIAP /inhabitants ratio in deprived communities[2]	

Notes on data sources

1. Data from, and elaboration of, initiative internal records;
2. For initiatives managing a network of PIAPs and at national level (requires local area statistics);
3. Data from field observation and/or users surveys;
4. Local area statistics on Internet usage;

Illustrative evidence

Although **UK Online Centres** is much more than a network of PIAPs and more of a holistic and integrated ICT supported community building initiative, nonetheless some of its results have illustrative value also in this domain. In the period 2007-2008 76,000 people took their first steps on the Internet through UK Online Centres, whose users in 70% of cases are individuals affected by at least one indicator of social exclusion. Its network covers 78% of the most deprived communities in England. On average 40% of initial users from simply accessing progress to take up information, advice and guidance, further education or employment. A survey found that in the course of one year period 8% of UK Online Centres found a job and all of them were actively searching one, when only 66% was looking for a job before using the centres.

53 http://ec.europa.eu/information_society/activities/einclusion/library/studies/meac_study/index_en.htm

Figure 11 Measurement Indicators: Basic Digital Literacy Training

Primary Output	Secondary Output/ or Outcome
# of trainees completing course by SES[1]	% of graduates who takes on advanced courses [3]
Trainees as a % of potential target[2]	% of users progressing to regular Internet usage[3]
	% increase in Internet usage in the area[4]

Notes on data sources

1. Data from initiative internal records;

2. Data from internal records complemented by local area statistics on # of digitally excluded individuals;

3. Data from field observation and/or users surveys;

4. Local area statistics on Internet usage;

Illustrative evidence

Everybody Online (EOL) a UK initiatives providing digital literacy courses in several communities, in its 2007-2008 report show that in the local areas serviced Internet usage went up on average 11%, when for the same period the Office of National Statistics (ONS) reported a 3% decrease for England as a whole. This initiative also reports helping 76 users getting a job which has been valued at £670,000 in terms of state subsidies savings. This outcome is considered under a different domain, but this data calculated by EOL provides a good hint.

Figure 12 Measurement Indicators: Tax Relief & Incentives for Affordability

Primary Output	Secondary Output/ or Outcome
% of eligible beneficiaries using the incentives[1]	% increase in Internet usage[2]
# of beneficiaries over by SES[1]	Estimated € value of increased ICT consumption[3]

Notes on data sources:

1. Data from initiative internal records;

2. National or local areas statistics;

3. Estimates using market prices and, possibly, retail industry statistics;

Illustrative evidence

Un Computer in Famiglia, an initiative of the Regional Administration of Valle D'Aosta a grant of 700€ to any family legally resident in Valle d'Aosta with a child aged between 11 and 17 years old, for the purchase of a computer with Internet capability. 100% of the targeted beneficiaries were reached before the conclusion of the project. A survey found that 61% of the beneficiaries either had subscribe or planned to subscribe to an Internet ADSL connection service. It was estimated that the initiatives boosted the local economy by increasing sales of personal computers and related products.

Figure 13 Measurement Indicators: Broadband coverage

Primary Output	Secondary Output/ or Outcome
% Δ in broadband coverage in the area[1]	% penetration of broadband (households & firms) [1]
% Δ in average connection speed[1]	% increase in Internet usage in the area[2]
# of new providers offering broadband in the area[1]	# of new businesses / jobs[3] % Δ revenues for local businesses[3]
Subscription price in the area/average national price[1]	Estimates of impacts on area GDP[3]
If measure is part of an integrated approach and provides complementary initiatives, indicators proposed for other domains apply (see discussion in Box 9)	

Notes on data sources

1. Local area statistics, national statistics, data from providers active in the area, general Telco statistics;
2. Local area statistics
3. As trickle down effects will be felt with some lag, these indicators will need to be constructed over time with longitudinal gathering and elaboration of related statistics. Moreover, a comparison with similar data in areas still underserved and with those served by broadband for a longer time would strengthen the attribution of such outcomes to broadband

Illustrative evidence

The ACTNOW Cornwall initiative provides important insights into broadband driven strategies to spur regional growth and its outcomes. ACTNOW is dedicated to accelerating economic growth and social inclusion in Cornwall through the use of the Internet and ICT. The initiative drove the development of ADSL broadband infrastructure in the county and set out to promote the take-up of broadband and ICT by businesses. Broadband coverage, thus, was integrated by countless initiatives to stimulate demand on the side of businesses and citizens, as to make coverage worth for the providers and for the community by boosting business activity and jobs creation. The Initiative has achieved outstanding outputs, achieving its targets more than twice over and assisting a total of 10,000 businesses, which is well more than half of all businesses in the county. A further 2,000 businesses have received grants towards ICT investments, while, out of the 1,500 farms in Cornwall, 800 have now been helped to connect. In total (including residential users) Cornwall has an ADSL broadband penetration of 46% compared to the national average of 31.2% and the South West average of 37.9%. The economic impact is clear - it has been estimated that nearly 4,300 jobs have been secured and Cornwall's gross domestic product has benefited by more than £99 million per year since 2002. ACTNOW reports that four year after the launch of the project 10% additional yearly growth and 7% additional productivity increase per year in the business services sector can be observed in Cornwall as compared to the rest of the country.

Figure 14 Measurement Indicators: Learning Through ICT

Output	Outcome
# of trainees completing course by SES and by LPT[1]	% of trainees achieving evidence of skills progression[2]
# Trainees who are school teachers[3]	€ value of avoided extra costs[4]

Explanatory comments and notes on data sources

1. Data from initiative internal records. LPT= Learning problems tackled;
2. These initiatives use ICT tools to tackle a broad range of learning problems, ranging from basic literacy and numeracy, language problems for immigrants, up to the practice of learning as such. Accordingly the evidence of skills progression will vary depending of the specific learning problem tackled and so will the sources of data needed. For children and teen-agers with numeracy and literacy problems, for instance, evidence can come from the progression of their grades as the ICT based training progresses;
3. For initiatives targeting teacher;
4. In the case of initiatives targeting school pupils and students with problems, if successful they can save school the cost of support teachers and/or parents the costs of private lessons. Data for the estimates can come from school system pay scale and from hourly market rates for private lessons.

Illustrative evidence

Personalisation by Pieces (PbyP9), another British initiative, is an online service helping users structure their way of learning and record their learning progress. In addition, users can become part of a community of practice in which they can be experts themselves and help others. The initiative also brings together people with common goals, allowing for example parents to fully engage in the learning process of their children. In 2003, through a large scale trials in one school, PbyP services achieved acceleration in competencies of 3 years over in the 11-16 age range. In the last trial began in April 2007 500 of the 3000 involved have demonstrated progression as documented by exams performances.

Figure 15 Measurement Indicators: Skill-Building for Employability

Output	Outcome
# of trainees completing course by SES[1]	% of trainees who found a job[2]
# of job interviews secured for trainees by initiative[3]	€ value of increased employment[4]

Explanatory comments and notes on data sources

1. Data from initiative internal records. Within SES employment status and history should be detailed;
2. Data from directly from trainees after job interviews and/or follow up trainees surveys
3. For initiatives also offering an off and/or online job matching function (data from web metrics and/or internal records)
4. The easiest and more robust valorisation is the saving to the public budget in unemployment subsidies per trainee getting employed (data easily obtained from regulation and official labour and/or welfare statistics, issue to solve is on the basis of what time scale to calculated this value). It is also possible to calculate the tax revenue increase per new employee (data easily obtained from regulation and official tax revenue statistics.

Illustrative evidence

In the domain of initiatives aimed at enhancing skill-building for employability, the Irish Fast Track to IT (FIT) is a leading case. FIT is a unique industry initiative involving major local and international companies that are actively committed to the integration of marginalised job seekers into the workforce through the acquisition or marketable ICT skills (web masters, IT experts, etc). It also provides a job matching services for both graduates and employers FIT provides back-up advice, support and mentoring to FIT graduates for a period of up to 3 years after completion of their training course. Over the period 1999-2008 FIT has trained 6500 young unemployed, of whom a staggering 3500 found a job requiring the exact skills acquired through its courses (thus justifying the attribution of the outcome to it output). This amount to an impressive 54% outcome over output ration, which is estimated to have produced 10 million pounds worth of saving for the public budget.

Figure 16 Measurement Indicators: Ageing well at home long term care services

Output	Outcome
# of homes covered by ICT supported remote assistive and monitoring services in the area[1]	Relative increase of # of days at home for impaired elderly benefiting from the services[2]
# of visits by eEnabled care givers[3]	€ value of saving from reduced institutionalised care/ hospitalisation [4]
Number of calls managed by initiative call centre[3]	€ value of saving to the elderly or their relatives from reduced hours of paid caregivers[5]

Explanatory comments and notes on data sources

1. Data from initiative internal records. Such services have not yet reached a national level coverage in any of the EU27 Member States, so the initiative and the data will most likely concern a specific local areas;
2. Given uneven spread of such services, in practice these initiatives have data on a wide control group. For any given long term care problem and/or chronic disease standard clinical evidence provides statistics on average length of stay in institutionalised care or hospital. These statistics can be compared to the actual data generated by the initiative for the beneficiaries to extract the relative increase of days spent at home by them;
3. Assuming multi-channel and eIntermediation based service delivery (data from initiative internal records)
4. Same data as discussed under 2) above valorise using standard statistics about the daily cost of institutionalised care and/or hospitalisation (net of the cost of technology and its maintenance, of call centre operation, and of involved care givers;
5. Market price for one day of private care giver multiplied by the number of estimated days they were needed before family were provided the service

Illustrative evidence

The new possibilities and tangible outcomes that technology has opened up in the field of monitoring the elderly at home are well illustrated by the Dementia Care initiative implemented by the West Lothian Council, in Scotland. The initiative reduces social isolation for older people and the disabled people through technological devices installed in peoples home (bed occupancy sensor, a smoke detector, a wandering client sensor, a flood detector, and a temperature extremes sensor that work in conjunction with a Lifeline 4000 home unit to raise an alert to the West Lothian Care line as soon as any problems occur and trigger visits by care givers). The total yearly cost of the services (including technology, maintenance, call centre and the time of support team) for any given serviced home (usually consisting of two older people) is £ 7000 to be compared to the £91,000 yearly cost for two people in a retired home, that is a net yearly saving of £ 84,000 (for NHS or for citizens out of pocket expenditure).

Figure 17 Measurement Indicators: Access to Welfare Entitlements

Output	Outcome
# of off and/or online eligibility checks delivered to potential beneficiaries	% of reached beneficiaries who obtained new benefits or backdated benefits
# of home visits by eEnabled social workers	€ value of additional benefits per beneficiary
# of claims filled in at home or online by potential beneficiaries	% of reached beneficiaries who are in condition of extreme poverty

Notes on data sources

All data should come from the initiative internal records from and should be complemented by statistics on the total pool of eligible beneficiaries.

Illustrative evidence

Advice NI is a Northern Ireland Social Security Agency initiatives providing consultation through experts and through a website portal to ease access to social welfare, to enhance the effectiveness of social and advice workers and to assist those receiving social benefits such as tax credits. A total of 3,283 eligible beneficiaries have been reached and 1,837 of them (56%) managed to obtain a holistic Benefit Entitlement Check. Of these 44% further obtained the benefits they were entitled too. On average £700k of new benefits and £80k of backdated benefit per reached beneficiaries were disbursed on an annual basis. It has been estimated that for every £1 invested in the initiative £21 of benefits were generated for beneficiaries.

The Benefit Express Service Team (BEST) is a team of eEnabled officers from the UK Benefits Division at Halton Borough Council, who uses newly-developed Information and Communication Technologies (ICT) to deliver real–time, online access to benefit claim records that can be updated from citizens' homes. The general concept is based on sending a team of mobile operatives on to a housing estate or shopping centre with a highly mobile, visual presence (Benefits Express Bus) - equipped with laptops, linked in real-time (by GPRS) with the benefits processing section at head office. The initiative has been so well received both by young and old people that 98% of customer expressed satisfaction in the survey that has been carried out. Furthermore, it has been estimated that benefits claim turnaround times have been reduced to 48 hours and there has been reduction of over 80% in the paperwork sent to the claimant.

6. CONCLUSIONS

By Cristiano Codagnone

eInclusion will play a key role in the new agenda of social innovation

The recession we have entered at the time of writing (early 2009) will cause less revenue from taxation, increasing spending for unemployment benefits and other welfare measures, to which one must add the resources already deployed to offset the banking crisis and those that are currently being allocated to support strategic industries. As EU President Barroso has recently affirmed during a workshop of the Bureau of European Policy Advisers (BEPA) [54], social innovation to design implement creative ways of meeting social needs is the positive way to cope with these challenges. Among these new ways Barroso listed topics clearly falling within the eInclusion domain such as web-based social networks, delivery of healthcare at home and many more.

A long way from simplified approaches to digital divide as a matter of mere access

Countless outstanding initiatives can be found across Europe that help people get started with the Internet, find a job, improve learning performance, enjoy ageing at home, establish new businesses, getting what they are entitled to, and much more. The Riga Declaration was a watershed landmark in the eInclusion policy process and subsequent initiatives by the Commission further worked as a catalyser. Some national governments have also placed great emphasis and invested much efforts and resources. A long way has been walked since all discussions were about digital divides and access, expected to be solved easily and speedily by the mere functioning of the market.

Policy and investments needed to turn risks into opportunities

Despite existing limitations on both practical oriented measurement and scientific evaluation, this report has provided plenty of evidence on the potential benefits that increasing digital inclusion could yield and on the risks that leaving large numbers of individuals ‘digitally behind’ can further exacerbate inequalities and social exclusion at large. As digital skills are a source of either opportunities or inequalities, innovative policies efforts and industry investment to turn the tide toward the former are strongly needed.

ICT can worsen the condition of low skilled workers and can push older workers out of employment

In particular important policy implications can be drawn from the evidence of the economic literature and econometric analysis regarding labour market outcomes and productivity. Looking in a combined way at the impact of ICT on productivity, wages and employment, it emerged clearly how this is a fundamental economic, social and policy question, with clear implications from an eInclusion perspective. The ICT revolution improves the position of highly skilled and highly educated workers and worsens that of low skill and low education workers, which represents the main labour market effect of digital inequalities.

eInclusion should offset these trends and give more attention as a target of policy to older workers

Accordingly, policies should help low skill / low-education workers and unemployed increase their digital skills to offset human capital depreciation so that they can retain or find jobs and possibly also increase their wages. If policies achieve this goal, not only they address a social problem, but at the same time produce a positive externality for firms by increasing the skill set of the labour force. A particular and noteworthy finding, concerning a group not scoring high so far within eInclusion policies agenda, is that the ICT revolution is making life much harder for older workers as it produces a fast depreciation of their human capital, even for those possessing high level education. They find it more difficult to retain their job and to find a new one if they lose it, which can often lead to early retirement decisions and negatively impact financially on the already strained European social security systems (less revenues and more costs). It is important, thus, that eInclusion policies designed ad hoc for this target group are implemented to offset this trend.

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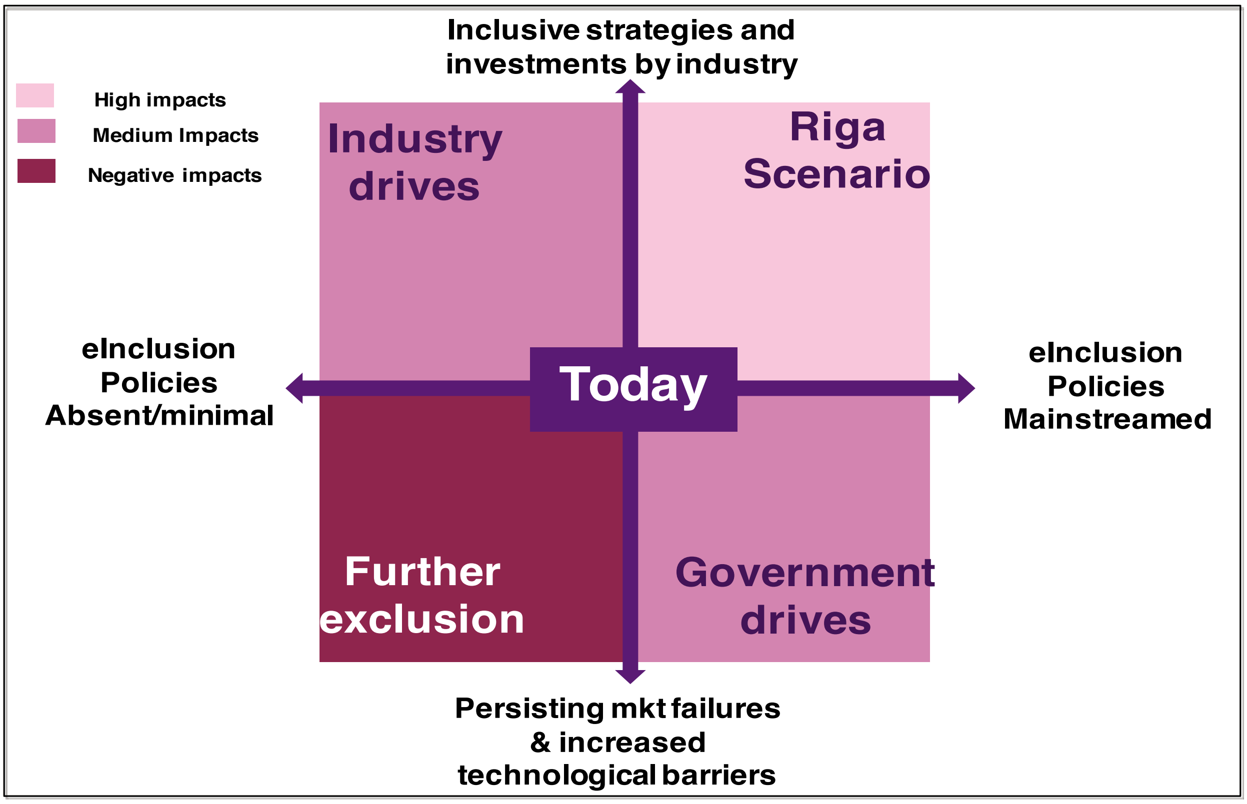
[54] On January 20, 2009, EU President Barroso met social innovation experts and stakeholders in Brussels, following a workshop organised by the Bureau of European Policy Advisers (BEPA) on social innovation. A summary of Barroso declaration is available at: http://ec.europa.eu/social/main.jsp?langId=en&catId=89&newsId=445&furtherNews=yes .

The scenarios plotted in the figure below leads toward the very final considerations.

Figure 18 Possible Future Scenarios: Policy and Industry Commitment



Most likely government will initially drive and gradually bring along industry

The axes reflect two possible extremes for the way public policies and industry behaviour may change with respect to eInclusion, which results in four alternative scenarios, whereas the centre represent the situation today. The Riga Scenario with full commitment and optimised action on the side of both the public sector and industry is naturally the most desirable one, which would achieve the highest level of impact. While today we are still far from this Riga Scenario and its future realisation it is high uncertain, it can also be ruled out that developments will lead in the direction of the "Further Exclusion" scenario. The actual future will depend on the interaction between government and industry, which will determine to what extent we can move somehow in the direction of the Riga Scenarios. While interest and commitment from industry is noteworthy, it is considered likely that government will have to initially drive and gradually bring along industry. This will be a matter for each national government and its lower tiers to decide and act upon, a matter on which it is beyond the scope of this report to advance recommendations.

Support from the Commission through traditional instruments should continue

In this context the Commission, in line with the subsidiarity principle, should continue to play a catalyst and coordination role and support cross national deployment pilots and applied research through traditional instruments such as the Framework Programme and the Competitiveness and Innovation Programme (CIP)

The Commission could bring on board key global industry players into a European eInclusion Compact

Yet, there is also an innovative initiative the Commission can undertake by adapting to the eInclusion field the model of the **UN Global Compact**[55], which is the world's largest voluntary corporate responsibility initiative involving countless numbers of corporation. The Commission could engage major industry players (many already active such as eBay, Microsoft, Hewlet Packards and many more) into a European eInclusion Compact. This would bring together business committed to aligning their operations and strategies with key principles and actions, such as for instance in the domain of eAccessibility,

55 www.unglobalcompact.org

Employment Long ICT Learning especially for older workers, support to ICT driven community building initiatives and the various other areas reviewed in this report. This would provide key industry players with a common channel to ensure that markets, technology, and government advance in ways that benefit economies and societies and achieve the broad based growth, from which also their revenue and profit depends. This would also become a platform for a better coordination and mainstreaming of currently scattered initiative.

Further raise awareness and bring the sceptics on board the eInclusion 'ship'

As seen, progresses toward the targets set in Riga are lagging behind schedule and uneven both across countries and within countries as geographic divides persist. It has been shown that eInclusion is not a priority in many countries, and efforts remain fragmented. There is, thus, a clear need of further raising awareness on the benefits that expanding the pool of the digitally included can bring to economy and society to bring on board the sceptics still numerous among decision makers in both the public sector and in industry.

Build measurement capacities among eInclusion practitioners

It has been shown, however, that lack of measurement capacities among eInclusion practitioners has produced so far, except for a few countries (most notably the UK and Ireland), little demonstration of tangible outcomes and cost/benefits monetised analysis. Out of the 1000 cases of eInclusion initiatives screened only 52 report some information on what can be broadly interpreted as output/impact and of these the overwhelming majority comes from the UK and Ireland. If we restrict the definition and consider outcomes *strictu sensu* and especially their expression in monetary value, the total does not reach 10 (excluding the UK and Ireland). It can be safely stated that in the practice of eInclusion measurement and evaluation activity is considerably lagging behind similar fields such as eGovernment and eHealth.

Commission to support capacity building through Benchlearning and ePractice

This study has produced some input to this process by elaborating a conceptual measurement framework and several measurement indicators that could be further disseminated among practitioners to increase their measurement capabilities, so that they can publish the hard evidence needed to raise awareness and convince policy makers and industry stakeholders to invest in eInclusion. This could be supported by the European Commission within existing instruments such as the Benchlearning Activities and the good practice exchange portal (www.epractice.eu).

"eInclusion economics" promising…

Turning to what can be termed "eInclusion Economics", both promising trends and bottlenecks have been identified. A General Model has been proposed that identifies several causal links between eInclusion support initiatives and socio-economic impacts, which is strongly supported by the relevant theoretical literature.

Research efforts and funding should focus on micro-economic models

Yet, robust empirical evidence can be produced only for what concerns labour market outcomes, whereas there is still some way to go for other domain due to constraints on availability and international comparability of needed micro-level longitudinal datasets (the comparability problems applies also to the analysis of labour market outcomes). This is so because for a long time economists studying the impact of ICT have mainly used aggregate data in growth accounting model to estimate the relation with productivity and GDP, which do not take into account variables reflecting digital inclusion. Future national and international funding of economic research aimed at assessing the impact of eInclusion should, thus, support projects using micro-economic model and building longitudinal datasets.

7. ANNEX I DELIVERY BENEFITS

By Paul Foley

7.1. Overview of delivery benefits

As explained earlier efficiency gains or benefits obtained during the delivery of eInclusion were excluded from the conceptualisation in Figure 8. These are treated separately as 'service delivery benefits' contained in next two figures. The two figures distinguished between those accruing to government and those accruing to users.

Figure 19 Service/operational benefits to government providers

Time savings
- Reduced processing through common standards for data and processes
- Time saving of public servants
- Reduced error rates, re-work, complaints
- Reduced need for multiple collections of data from single customers
- More flexible working hours

Information benefits
- More accurate, up-to-date and cleaner data and more reliable information
- Capacity for greater information sharing across government

Risk benefits
- Improved risk management
- Improved security and fewer security breaches

Future cost avoidance
- Lower costs for future projects through shared infrastructure and valuable knowledge
- Reduced demand for service (through better information provision), e.g. health
- Reduced need for future government capacity expansion
- Encouragement of increased take-up of other e-services

Resource efficiency
- Reduced redundancy through integrated systems
- More effective use of existing (e and non-e) infrastructure and reduced capacity wastage

Direct economic benefits
- Reduced fraud
- Reduced travel costs, field force expenditure
- Reduced publication and distribution costs
- Reduced costs through the need for reduced physical presence

Non-monetisable benefits
- Better knowledge of customer needs and services
- Integrated view of customers
- Increased resilience through multiple channels

Other . . . . . .

Source: Authors' elaboration from Foley and Ghani (2005)

Figure 19 above and Figure 20 below contain a large number of 'traditional' benefits, but it also includes a number of softer indicators. Research into so-called *hard indicators,* such as economic resources and outputs to monitor effectiveness and efficiency, has recently been complemented by growing interest in the introduction of *soft indicators* examining user satisfaction, social cohesion, consumer welfare and trust (Bouckaert and Van de Walle, 2003; Holzer et al, 2003). There are two key difficulties for studies in this area. Firstly, what other (primarily non-financial or softer measures) public benefits can arise from eInclusion activities? Secondly, how can these softer indicators be identified, categorized and measured?

Figure 20 Direct and indirect delivery benefits for users

Direct benefits

- Better quality of service
- Improved delivery reliability
- Better service consistency
- Tailored service / personalisation
- Better choice of appointment date / time
- Increased choice / service access
- Increased time availability of services / convenience
- Increased channel choice
- 24/7 access
- Reduced transaction time-savings
- Enhanced opportunities to cross-sell eServices
- Reduced time in unemployment
- Others . . . . .

Indirect benefits

- Improved customer satisfaction
- Better communication with customer
- Increased access to information
- Increased customer feedback / suggestions
- Increased transparency of processes
- Improved experience when dealing with Government
- Improved image of public sector
- Customer complaint reduction
- Others . . . . .

Source: Authors' elaboration from Foley and Ghani (2005)

Non-financial measures are important because they address significant, but less tangible issues, such as service quality and customer satisfaction that are important to the citizen or society. These frequently get omitted from financial measures concentrating on harder measures. For example from an economic viewpoint there is no direct financial benefit for government in utilising ICT to offer a greatly enhanced service to users unless it reduces the cost of service provision. However, the enhanced service may provide higher levels of quality, satisfaction and transparency for the user with a reduction in environmental impact. These may be significant outcomes for users and greatly enhance their opinion and trust in government, encouraging them to use more eGovernment or eInclusion services in the future.

Development of a checklist of other (primarily non-financial) public benefits or softer measures, such as those in two figures 15 and 16 provide a valuable complement to the main focus of the research and address the issues of human and social capital.

These softer measures can be derived from together two strands of literature (public value and public sector scorecards) that address issues associated with recording broader public benefits.

7.2. Public value

Public value refers to the value created by government through services, laws regulation and other actions. The value added by government is the difference between these benefits and the resources and powers which citizens decide to give to their government (Kelly et al, 2002).

The concept of public value provides a useful way of thinking about the benefits, goals and performance of public policy, including eInclusion. It provides a yardstick for assessing activities produced or supported by government (including services funded by government but provided by other bodies such as private firms and non-profit organisations, as well as by government regulation).

Much of the new public management reform agenda that dominated the 1980s and 1990s was premised on the applicability of management techniques across both public and private sectors (Moore, 1995, 2003). This approach led to some important gains, such as the elevation of consumer interests and the clarification of objectives and responsibilities. However, new public management practices often emphasised narrow concepts of cost-efficiency over other considerations (i.e. the focus was on technical rather than allocative efficiency). Those things that were easy to measure tended to become objectives and those that could not were downplayed or ignored. However, improvements in efficiency were not synonymous with increases in public value.

Public value provides a broader measure than is conventionally used within the new public management literature, covering outcomes, the means used to deliver them as well as trust and legitimacy. It addresses issues such as equity, ethos and accountability. Current public management practice sometimes fails to consider, understand or manage this full range of factors.

Business makes use of sophisticated techniques to measure and manage value. Public value aims to provide a similar yardstick for assessing performance within the public sector. For something to be of value it is not enough for citizens to say that it is desirable. It is only of value if citizens – either individually or collectively – are willing to give something up in return for it. Sacrifices are not only made in monetary terms (i.e. paying taxes/charges). They can also involve granting coercive powers to the state (e.g. in return for security), disclosing private information (e.g. in return for more personalised information/services), giving time (e.g. as a school governor) or other personal resources (e.g. blood). The idea of opportunity cost is therefore central to public value.

By reviewing these foundations or building blocks of Public Value it is possible to understand how they inter-relate, how eInclusion service provision can generate value and thus emphasise the wider public benefits of eInclusion.

There are many things which government can do which are valued by the public. Public service theorists assert that the key things which citizens tend to value fall into three broad categories:-

- Services
- Outcomes
- Trust and legitimacy.

These overlap to some extent. However, they provide a useful foundation for thinking about the dimensions of public value in more depth. A brief consideration of the ways value is created in each of these three categories, below, provides an insight into the way the development of non-economic benefits could be developed to examine social cohesion and consumer welfare and other 'softer' benefits.

7.3. Types of value

Value created by services. Evidence suggests that user satisfaction is likely to be shaped by a wide range of factors.

- Customer service: Private sector studies have highlighted that the way people are treated by staff ranks only just behind quality and price of product in determining their satisfaction.

- Information: There is a strong correlation between satisfaction with different services and whether people feel they are well informed about them.

- Choice: There is some evidence that enhanced levels of choice can boost user satisfaction, even if it does not have a discernible impact on service outcomes. .

- Use of services and advocacy: Whether people have used specific services, as opposed to only hearing about them through the media, is significant in determining their satisfaction.

All of these are important in the context of enhancements that can be provided by eGovernment and eInclusion. Customer service can be improved and a more personalised service provided through the use of ICT. Government emails, portals and better search technologies found on the Internet have the potential to provide users with more information. The ability of eGovernment to provide new service delivery channels and 24/7 access will enhance customer choice. Cross-sell opportunities will also be enhanced and lead to greater use of services as more personalised information is known about users and services are better targeted at potential new users.

Value of outcomes - The public has always seen outcomes as a core part of the contract with government. For example, there is value in safe streets beyond the quality of police services, benefits (as our study shows) to low unemployment over and above quality of service offered by the employment support agencies.

It is important to highlight that public value is frequently produced as a joint effort between citizens and government. Government alone cannot deliver lower crime and reduced unemployment social norms of behaviour are critical.

Governments have increasingly sought to focus attention on outcomes. Service Level Agreements (SLAs), the adoption of portfolios of indicators and other targets to specify the outcomes have become commonplace. Genuine outcomes are seen as better targets than narrower outputs or activity measures, which risk being distorted.

Value of trust and legitimacy - The third main source of public value is trust, legitimacy, and confidence. Trust is a complex and multi-dimensional concept. The causal link between trust and good government is a contested one (Braithwaite and Levi, 1998; Christiansen and Lægreid, 2003; Donovan and Halpern, 2002; Lægreid, 1993; Rothstein and Stolle, 2002; Kampen et al, 2003).

Trust is also influenced by contextual and socio-demographic factors. People in more advantaged social positions, be they occupational, educational, economic or contextual (associated with social deprivation), tend to have greater propensity for civic engagement and stronger networks for social support. These individuals also tend to trust people more and have greater overall satisfaction with work and life (Li et al, 2003)

Wider social changes, world events, service levels and the behaviour of political leaders and institutions all have a part to play in determining the confidence and trust of individuals in government. Actions that seek to boost trust by delivering on one of these dimensions may be affected by, or even undermined by changes in one of the others. Nonetheless, it seems obvious that eInclusion has the ability to provide a more positive attitude to trust in government through improved customer service, enhanced employment opportunities, the provision of more information and participation.

Much of the literature examining public value is notable for its lack of measures or metrics to examine components of the three broad categories that underpin citizen value:-

- Services
- Outcomes
- Trust and legitimacy

To overcome this anomaly a second body of literature (founded on balanced scorecards and public sector scorecards), rich with measures but somewhat weaker on theory, could be utilised.

It is our contention that these two bodies of literature could be brought together to provide a framework to categorise and measure the non-financial or softer indicators of public benefits that can be expected to arise from eInclusion. The brief discussion below and Figure 5 are regarded as a starting point or foundation for research that could further investigate the two core areas (and other literature) to derive and then test of a longer checklist of softer non-economic indicators.

Balanced scorecards and public sector scorecards have been developed to examine performance in organisations that exist in an environment that does not have a simple profit based metric of success. Scorecards weigh up all the different factors that contribute to a valuable overall outcome. Some government bodies are beginning to use these approaches.

The public sector scorecard is a performance measurement and management framework specifically designed for the public and voluntary sectors. It is based on the balanced scorecard (Kaplan and Norton, 1992) which has proved highly successful in the private sector. The main difference between the public sector scorecard and the balanced scorecard is the incorporation of an additional 'strategic perspective' in the public sector scorecard that examines the organisation's progress against its main aims and objectives (Moullin, 2002).

Moullin (2004) argues that this is vital in the public sector since unlike the private sector financial performance is not the undisputed primary objective. There are also several differences in methodology. The public sector scorecard places additional emphasis on stakeholder satisfaction and contribution, on process mapping and risk management – all of which are of considerable importance in the public sector and in relation to the citizen focus usually advocated for electronic service delivery and eInclusion projects.

8. ANNEX II ECONOMETRIC APPLICATION FULL VERSION

By Federico Biagi

8.1. Review of the Literature

Introduction

Given the enormous and pervasive diffusion of Information and Communication Technologies (ICT) in modern economies, understanding the impact of ICT on productivity, wages and employment is a fundamental economic, social and policy question. These aspects should be studied together because technological revolutions have many effects. First, they have an impact on capital and labour productivity and hence on output per capital (the measure of productivity normally used in empirical studies). Second, ICT affect the substitutability between capital and labour, often leading to capital substituting for labour. Finally, these substitution effects do not affect all types of workers in the same way. Given capital-skill complementarity, technological revolutions tend to favour educated/skilled labour at the expenses of uneducated/unskilled labour, hence increasing the relative unemployment rate for workers with low education and poor skills and increasing the wage differential between workers with high education/skills and workers with low education/skills. In our empirical work we will look at all these issues.

From studies based on aggregate and sector data, conducted in the last decade mainly for the U.S. and Europe (but they also include Japan, Australia and Canada) it appears that the ICT revolution has had a relevant impact on productivity and growth, but such an impact has been far from homogeneous. In the U.S., in the period 1995-2006, productivity for non-farm businesses grew at 2.7 percent, while productivity in manufacturing grew at 4 percent. This increase in productivity, well above the one experienced in the previous twenty years, has been considered the outcome of a technological revolution giving rise to the New Economy. The rise in productivity in period 1995-2006 has been attributed mainly to the effect of ICT on capital deepening, labour quality and total factor productivity. The studies that have tried to disentangle the impact of these different factors on average labour productivity for the U.S. have found that capital deepening contributed almost sixty percent of the growth in average labour productivity while total factor productivity contributes almost thirty seven percent[56]. These findings are overall consistent with those obtained when looking a wider set of countries. Considering growth accounting exercises based on aggregate national accounts data, Colecchia and Sharer (2002) and Timmer *et al*. (2003) find that both the direct contribution to GDP of ICT investment and Total Factor Productivity (TFP) in ICT producing sectors and the indirect effect of the technological revolutions (in the ICT using sectors) are responsible for the overall effect of ICT diffusion on productivity and growth (depending on the decade considered, ICT contributed between 0.2 to 0.9 to growth). Analogously, Biagi (2008a), using an econometric approach on aggregate data for the period 1982-2002, finds that the diffusion of ICT has had a positive and significant effect on (average) growth rates, also increasing the speed of convergence towards steady states (see also Biagi and Riggi, 2007 for an analysis for the impact of ICT at the regional level).

Decomposing total factor productivity into ICT and non-ICT components, Jorgenson et al. (2004) find that the non ICT components are increasingly important for productivity growth post 1995. This result –which stresses the importance of ICT diffusion on the performance of ICT using sectors- lead scholars to look for ICT direct and indirect effects at a lower level of aggregation (two-digit sectors). The intuition was that by using such data it would became possible to understand the complex links between ICT development, adoption and ICT diffusion in the economy, hence incorporating some of the insights coming from the micro literature (see the inspiring work by Bresnahan, Brynjolfsson and Hitt), which stressed the existence of time lags between technological change in ICT and productivity growth (due – among other reasons- to learning by doing, lags in organizational restructuring and by the level and quality of take up by individuals and households). Following this intuition, O'Mahony and van Ark (2003) - using the *Industry Labour Productivity Database* - find that, on average, both in E.U. and in the U.S., ICT producing sectors showed positive and accelerating productivity rates (the differences between E.U. countries and the U.S. are not always in favour of the latter) while in ICT using sectors (mainly services) the gains in productivity are higher in the U.S. (non ICT sectors have experienced lower productivity growth both in the U.S. and in the E.U.).

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56 See Jorgenson et al. (2004). For other studies focused on the U.S. see: Jorgenson and Griliches (1967); Jorgenson (2001); Jorgenson and Stiroh (2000); Jorgenson et al. (2002).

Unfortunately, studies based only on aggregate country data and even sector data cannot provide direct evidence of causal relationships and are hence of limited scope if one is interested in policy questions. In particular, studies based on growth accounting exercises - which, is worth remembering, are based on very stringent assumptions to start with (for a discussion see Barro, Sala-i-Martin, 2002) – cannot provide robust evidence on causal relations. Moreover, when considering ICT, serious measurement issues emerge that cast even more doubts on the reliability of the estimates of growth accounting exercises. In fact, as emphasized by Bosworth and Triplett (2000), all the effects of changes in variables that are not fully captured by market transactions appear in TFP. This is particularly relevant for ICT, given that the ICT revolution has given rise to a General Purpose Technology (GPT, i.e. a technology that increases the productivity of other factors) for which many of the external effects are not likely to be internalized[57]. Evidence in favour of this is coming from studies that document the correlation between measures of ICT penetration and growth in TFP for the U.S. (see Jorgenson, 2003).

This has lead scholars to look for even more disaggregated data, such as firm or household level micro-economic data, in order to obtain robust estimates of causal relations with respect to the variables of interest[58]. Often these studies had to rely on administrative data, but sometimes it has been possible to design ad-hoc dataset that provided a wider picture of the effects of ICT diffusion and adoption at the firm/household level. Examples of such research line for the U.S. are the works by Brynjolfsoon, Bresnahan and other MIT scholars and those by Black and Lynch, who stress the role of ICT on organizational change and firm restructuring, while for the U.K. we have Crespi et al. (2007), who –using a longitudinal dataset for U.K. firms- test the impact of ICT on growth controlling for variables proxying for organizational change.

Parallel to the investigation of the relationship between ICT and productivity growth, a growing body of literature studying the effects of new technologies on employment and the wage distribution emerged. This literature, initially focused mainly on the U.S. and only later looking at the experience of other countries, has tried to analyze the impact of ICT on the labour market, under the hypothesis that ICT adoption and use by firms have a positive impact on skilled labour (and hence firms') productivity, while being a substitute for unskilled labour (skill-biased technological change hypothesis). This increased relative productivity of skilled workers, from a labour market perspectives, implies that new technologies tend to raise the demand for relatively skilled labour and reduce demand for relatively unskilled labour (these effects are stronger the more skilled labour is complementary with capital; see Krusell et al, 2000). This fact has two main implications. First, it should increase the incentives to accumulate human capital, given that the returns from skilled labour are higher, and second, the different impact of technology on skilled and unskilled labour can create a serious distributional issue which shows up in both increased wage differentials between skilled and unskilled workers and higher relative unemployment for unskilled workers (see Juhn et al, 1993; Katz and Murphy, 1992; Krueger, 1993; DiNardo and Pischke, 1997; Berman et al., 1998; Brunello et al., 2000; Biagi and Lucifora, 2008). These effects show up both at the firm level (where we expect the composition of the wage bill between skilled and unskilled labour to vary according to the diffusion of ICT and the pace of innovation) and at the individual level, given that wage trajectories, employment and labour supply decisions along the life-cycle tend to be affected by the "ICT skill level" of individuals.

Empirical evidence (see Miniaci and Parisi, 2005; Miniaci and Parisi 2006) shows that ICT skills are concentrated in the adult and young generations, so that a rapid pace of technological progress in ICT producing sectors and a high rate of ICT adoption in ICT using sectors can lead to a decline in (relative) productivity for older generations, making their exit from the labour market more likely, exacerbating the financial problems that characterize an ageing Europe (see: Aubert et al. 2004).

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57 The limits of growth accounting are even more evident if such method is applied to the public sector, for both substantial and technical reasons (Garicano and Heaton 2007; OECD 2006). The technical reason has to do with the very limited reliable data that can be used to measure the output of public sector bodies. The substantial reason has to do with the fact that using a given production function cannot capture the radical innovation that IT enabled public services can produce internally (productivity and efficiency) and as a result of take by users (better services and opportunities for them and additional efficiency impact for public sector bodies)

58 In general, if we are interested in capturing and measuring the effects of shifts in exogenous policy variables (such as incentives to R&D related to IT, cost of education, availability of infrastructures directed to IT diffusion) on the endogenous variables (R&D spending, innovation, IT adoption, re-organization of the production process, skill upgrading by workers, workers productivity, wages and employment to name a few), we need to use micro data (i.e. typically data at the firm level), possibly repeated in time (i.e. longitudinal data). Only this type of data can offer the richness of variables that are necessary to estimate the causal relationship we are generally interested to.

The ability to use technologies has been shown to be positively correlated with wages, so that more technologically skilled individuals (even after controlling for individual fixed effects) receive a wage premium (Acemoglu 1998, 2001; Juhn et al., 1993; Haisken-DeNew et al. 2004; Katz and Murphy, 1992; Krueger 1993; Di Nardo and Pischke, 1997). Analogously, some studies (Friedberg, 2003; Biagi et al., 2007) have documented how access and ability to use technology as either individuals or networks affects employability, since it affects both the decision to enter the labour market (the labour participation decision) and the likelihood of obtaining job offers that are later accepted (the transition from unemployment to employment)[59].

From an historical perspective, skill-biased technological change is not a novelty of the last two decades. What is new is the simultaneous rise in wages and employment shares of skilled workers. If we try to interpret this phenomenon within a simple demand and supply model, this suggests that, in spite of the remarkable increase of the relative supply of highly educated and skilled workers, the widespread diffusion of ICT has generated an even greater increase in their relative demand (see Biagi and Lucifora, 2008). Moreover, new technologies influence wages not only directly but also by changing the way in which firms and the labour market are organised. From a policy perspective, one of the most relevant questions that have been addressed by the empirical literature studying the relationship between the ICT revolution and the labour market is the one related to the effects of the former on the wage distribution and the incentives to accumulate human capital.

These are the questions addressed in the economic literature that have implications from the perspective of digital inclusion/ exclusion,. Accordingly, our econometric applications empirically test the hypothesis that the diffusion of technology within the economy has a significant impact on workers' productivity and wages, hence affecting the shape of the labour and income distribution. If ICT are complementary with skilled/high-education labour and substitute for unskilled/low education labour, we would expect the diffusion of ICT to improve the position of highly skilled and highly educated workers and to worsen the one of low skill and low education workers. Such outcome, which we could interpret as the main labour market effects of the digital inequalities, has –as a policy implication- that we should try to improve the position of low skill/low-education workers by increasing their technological skills, in order to make their human capital less depreciable.

Starting from the late 1980s, cross-sectional estimates of a standard wage equation carried out for the United States (see Krueger, 1993, and Juhn et al.,1993) showed that the inclusion of a dummy for 'working with a computer' is not only significant but the wage premium associated with computer use ranges from 15% to 17% and has not shown a substantial decline over time (that is from late 1980s to the early 2000s). Similar cross-sectional studies with individual data carried out in Germany and France give rise to an almost identical wage premium. Although the causal interpretation of these results is open to question (the fact that only some workers use a computer can be simply a consequence of their greater unobserved ability or other individual characteristics), the regularity of the empirical evidence is noteworthy.

However, as already mentioned when discussing the productivity issue, the idea that the observed increase in wage inequality is simply due to unusually rapid skill-biased technological change has been questioned by many scholars on different grounds. Under the hypothesis that successful adoption of new ICT products and services in the ICT using sectors requires that technological advances are supported by appropriate human capital (i.e. human capital with the appropriate level of knowledge and ICT skills) and by appropriate managerial and organizational architecture, Bresnahan (1999) and Bresnahan et al. (2002) show that wage differentials and the skill composition of the labour force are affected by advances in Information Technology only when they are coupled with organisational changes in workplaces[60]. These studies had the effect of casting some doubts on the idea that the ICT revolution –per se- could be a sufficient explanation for the augmented rise in inequality observed in the 1990s and this has led some

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59 On this aspect it is important to notice that there exists an important literature (see Jones and Riddel, 2006), which stresses the quantitative relevance of discouraged workers, i.e. workers that are formally in the labour force but that are not really actively looking for jobs so that essentially end up being analogous to unemployed workers. Notice that technological endowments that affect potential workers productivity are not only affecting the decision of entering the labour market but are also affecting the process of exit from the labour market. This can happen when workers with lower technological skills more or less voluntarily exit from the labour force. There exists evidence that individuals with lower technological skills tend to exit the labour market at earlier ages. In our work we will hence look at the overall relationship between labour participation (entry/exit) differentiating by age group and gender, given that these are the most relevant aspects influencing it.

60 Similarly, Aghion and Howitt (2002) have developed a theoretical model in which the introduction of a general-purpose technology (such as IT) does not explain by itself short-run wage differentials, but only in conjunction with the presence of different degrees of adaptability of workers to new jobs or tasks.

authors to test empirically models in which ICT diffusion, work practices, and the skill composition of the work force are analyzed together (see Hall et al, 2008). Moreover, other studies (mainly by such authors as Di Nardo, Card, Lemieux and Fortin) have questioned the results obtained by Krueger and Juhn, Murphy and Pierce in the early 1990s –which showed the presence of a large and positive wage differential for workers using PCs- from an econometric perspective. We will review such studies more thoroughly later but the essence of their criticism is that such a premium is due to omitted variables that are positively and significantly correlated with use of PCs on the one hand and labour productivity on the other one, hence making the relationship between wages and use of PCs a spurious one.

Having an impact on labour productivity, ICT can affect workers' employability as well. Several studies analyze the impact of ICT on employment/unemployment. First, we have studies such as OECD (2004c), where the focus is on ICT employment, i.e. the share of employed workers that belong to ICT producing or ICT using sectors. What emerges from this study is that, for Europe, ICT employment has been raising overall in the last 10 years, with relevant differences among countries and sectors. Moreover, this study shows that ICT skills are not a homogeneous category. On the one hand we have specialized skills, that are very much needed in ICT producing sectors and "heavy" ICT using sectors, and on the other one we have basic ICT skills, which are needed mainly in "soft" ICT using sectors (the demand for both type of skills has been rising over time). Along similar lines, van Ark et al. (2003c) study the evolution of employment (and productivity) for the European Union relative to the U.S. for the period 1990-2000. The authors distinguish between ICT producing industries, ICT using industries and non-ICT industries (using the OECD STAN Database) and find that there are relevant differences between the E.U. and the U.S. First, during the 1990-1995 period employment was growing in the U.S. while falling in the E.U., even in ICT producing and ICT using sectors. Second, it is only in the period 1995-2000 that employment in all the three broadly defined sectors – and especially in ICT-producing sectors- increased in Europe as well (however at much lower rates than in the U.S.).

These findings at the macro/sector level need to be complemented with evidence at the firm and individual level. From firm-level studies we can see how adoption of ICT and possibly organizational change affect employment rates at the firm level. From individual-level studies we can learn if and how ICT skills impact on workers' employment.

Focussing now on studies at the firm level, Falk (2001), using the first and second wave of the Mannheim Service Innovation panel, finds that for German firms the introduction of new organizational practices and new ICT in the production process tend to be followed by employment growth, with the effect of organizational change more evident than the one of ICT. Firm -level evidence that ICT and process and product innovations are positively correlated with employment growth is found by Koellinger (2008), who uses a sample of the Nov/Dec 2003 enterprise survey e-Business Market W@tch. Evangelista and Savona (2003) look at the relationship between employment, innovation and ICT in the service sector in Italy, using data from the Community Innovation Survey for the period 1996-1998. They find that ICT tend to be a complement of skilled labour and a substitute for unskilled labour (hence increasing the demand for the former and decreasing the one for the latter), generating an effect on overall employment that depends on the relative strength of the two forces. Their results show that organizational change and ICT are positively associated with aggregate employment (the complementarity effect dominates) in most innovative and knowledge-based sectors, while a negative impact (the substitution effects prevails) is found for financial and capital-intensive sectors.

When looking at the relationship between individual ICT skills and employment, most researchers have focussed on individuals above age 45-50, since the impact of such skills seem to be particularly evident for this age group, for which the employment/unemployment issue tends to be very strongly associated with the retirement issue. This happens because, for this age group, unemployment and exit from the labour force for retirement are often not easily distinguishable. In fact, many countries have welfare programs that support the long-term unemployed until they reach the official retirement age. In all these cases the border between exit from the labour force for retirement and unemployment is extremely thin, and this explains why many scholars have concentrated on employment as a preferred alternative to a non-employment status (i.e. unemployment or retirement).

Bartel and Sicherman (1993) study the effect of technological change on the career of U.S. older workers. They notice that technological change can affect employability, influencing both the training decisions and the depreciation of the stock of human capital. They find that individuals tend to retire later in industries in which technological change is particularly rapid. Moreover they find that an unexpected rise in the depreciation rate of human capital, for instance following an unexpected rise in the rate of technological change, leads to earlier retirement.

Friedberg (2003) has investigated whether there exists evidence for the U.S. of a significant relationship between computer use and exit from the labour market for older workers (mainly due to retirement). The basic intuition for her analysis is that computers have affected the demand for labour in various ways. First, they tend to be a substitute for unskilled labour and routine tasks. Second, they have altered the performance of non-routine tasks, mainly held by skilled workers. Finally, computerization alters the "bundle of skills and tasks that define a job". These changes can affect mainly the employability (and hence the retirement choice) of older individuals, given that older generations tend to be less educated and hence more likely to be assigned to routine jobs. For these workers training may be generally less profitable given the higher investment costs and the reduced time horizon over which they can be recouped. Friedberg uses the U.S. Health and Retirement Study (from 1992 to 1996) to study how the frequency of computer use at work affects the transitions towards retirement of workers aged 50-62 in 1992. She takes into account the possible correlation between the use of the computer and the unobserved propensity to retire later by estimating a linear probability model using an instrumental variable approach. Her findings show that over a four-year horizon, even controlling for many individual, firm and sector characteristics, computer use tends to induce delayed retirement. She concludes that "holding everything else constant, the median retirement age if everyone had used a computer would have occurred 12 months later".

In a very similar framework Schleife (2006) uses the German Socio Economic Panel to investigate the effect of computer use at work on the retirement outcomes of employed males aged 50-60 in 1997. As Friedberg (2003), she models retirement by means of a linear probability model, distinguishing between different timing of retirement (transitions occurring within 1999 and those occurring within 2001 are studied separately). The potential endogeneity of computer use on the job is addressed by means of an instrumental variables approach that considers computer use at home as the additional instrument. Her IV results provide no evidence that Germans who use a computer at work tend to postpone their retirement.

The impact of ICT on firms' productivity

Recent contributions to the growth, industrial organizational and management science literature have stressed the increasing importance of knowledge as an autonomous factor contributing to the performance of firms and countries (see the pioneering contributions by Lucas, 1988 and Romer, 1986). This has opened a widespread analysis of the many impacts that knowledge has on society and on the different roles played by private and public institutions (given the public good nature that knowledge has). The main aspects that a knowledge-based economy raises are the following: (i) what is the impact of knowledge on productivity and growth; (ii) how is knowledge created and transmitted and (iii) what is the role that (mainly) public institutions have in fostering knowledge accumulation and diffusion (public institutions play a major role in shaping the overall education system and in providing the appropriate incentives and legal structures that make knowledge creation and dissemination beneficial for individuals and firms).

When considering firms - which both use and create knowledge- the major issues concern (i) what drives investment in new knowledge within the firm (e.g. R&D), (ii) what is the use of existing knowledge from within the firm (e.g. from past discoveries or knowledge-sharing with other divisions of the firm) (iii) what is the use of knowledge from outside the firms; (iv) what is the impact of knowledge on labour productivity.

The development and the diffusion of ICT can have an impact on all these aspects because they can affect (marginal) benefits and costs of knowledge creation and diffusion, hence affecting also individuals' and firms' productivity and therefore overall development patterns[61].

Focusing now on the relationship between knowledge, ICT and productivity in the private sector, two are the main key points stressed by the literature.

The most obvious channel by which ICT can affect the growth performance of a given country is through the direct effect imputable to ICT producing sectors. All the evidence shows that in the last decade E.U. countries, U.S. and Japan –at different times- have experienced an increase in TFP within the ICT producing sector, leading to higher GDP growth rates (the effect on GDP depends on the relative size of

61 ICT can also have an impact on growth through ICT effects on consumption levels and consumption composition. By lowering search and transportation costs, ICT can boost consumption of non ICT-goods. Moreover, technological progress in ICT producing sector, by lowering prices, leads to higher consumption of ICT goods (mobile phones, media technology etc.).

the ICT producing sector in the economy: see Hempell et al., 2004, and Maliranta and Rouvinen, 2004, for applications –respectively- to Germany and the Netherlands and to Finland). On the other hand, ICT diffusion has an indirect impact on productivity and growth that operates through various factors. First ICT adoption changes the pattern of production for many firms, since it enables faster, cheaper and more efficient product and process innovation. Hence, this line of research has studied whether ICT adoption and diffusion tend to be associated to R&D (assumed as a proxy for knowledge creation) and to the ability of firms to generate and absorb innovations that are generated elsewhere in the economy (this type of question can be analyzed only with longitudinal micro data that contain information on all these aspects; for an application to Italy see Parisi et al., 2006; Biagi and Parisi, 2007). The findings of this empirical literature show that the link between R&D expenditure and innovation is not very strong: firms that spend more on R&D do not appear to be relatively more innovative (casting doubts on public policies directed at subsidising R&D expenditure). However this literature generally finds some positive relationship between ICT investment and productivity[62]. Focusing on such a relationship, a strand of the literature has stressed that the impact of ICT adoption on innovative activity and hence productivity is far from being automatic. ICT become really productive –and hence lead to increased labour productivity- only when they are introduced in the proper firm environment. This requires efforts to design the proper managerial and organizational architecture: ICT adoption and firms' reorganization, in an attempt to maximize internal efficiency face to new technologies, become fundamental parts of firms' policies directed at acquiring and maintaining a competitive advantage (see Caroli and Van Reenen, 2001; for an application to the public sector see Garicano and Heaton, 2007). The precise measurement of these relationships necessarily requires the use of micro data that link labour productivity with R&D spending, ICT adoption, organizational change and product and process innovation[63] (micro data are also very important if one is interested in capturing the dynamics of productivity, as documented in Scarpetta et al.[64], 2002).

The intuition that investment in ICT and organizational architecture are very much interrelated has at least two consequences: first, not all firms experience the same productivity change for an identical investment in ICT activities, given that the former depends on firms' specific characteristics (human capital, workplace organization, frequency and level of product and process innovation, management etc.); second, we expect to observe some lags between the timing of the investment in ICT and the timing of the increase in productivity, due to the need of restructuring the firm environment .

The first paper to address this issue in an empirical context is Bresnahan et al. (2002) where they empirically test the hypothesis that "*computers affect labour demand not only directly…but indirectly through other firm-related changes. That is ICT is embedded in a cluster or related innovations, notably organizational changes and product innovation*" (Bresnahan et al.,2002; p.341). This study is based on the assumption that ICT, workplace organization, and product innovation are drivers of productivity change, with the consequence that improvements in labour productivity are not usually observed immediately after the introduction of ICT, but they require a time lag, due to the need of firm restructuring and re-organization. As they clearly say: "*In the long run, declines in the price of ICT cause the demand for all the complements to shift out. In any particular short run, however, only a subset of firms will have made successful investment in organizations and product quality*" (Bresnahan et al.,2002; p.343). Using a combination of data from the *Computer Intelligence Infocorp* (*CII*) database, the *Compustat* firm data and an ad-hoc cross section of organizational and human capital variables, they look at the relationship between changes in labour productivity and in the composition of the wage bill on the one hand and variables capturing organizational change, ICT and product innovation on the other hand. Organizational capital (and hence ICT changes) is measured as a linear combination of questions on team working and the extent to which workers have authority over their pace and method of work. What they find is that ICT investment and variables capturing workplace organization are both individually and jointly significant. What this means is that, taken alone, ICT investment and changes in workplace organization (as expected) tend to rise firms' productivity, in a statistically and economically significant way (by 3% for ICT and by 2% for workplace organization). Moreover, the interaction term between these two variables has positive and significant coefficient (equal to 0.06), showing that there are significant complementarities between firms' restructuring and investment in new technologies. As for the variables capturing the education

62 See Aw, Chung and Roberts (2000); Bernard and Jensen (1999); Bloom, Sadun and Van Reenen (2007); Clerides, Lach and Tybout (1998); De Loecker (2006); Girma, Greenaway and Kneller (2003); Van Biesebroeck (2005).

63 These types of data exist only for some of the countries and are not always fully comparable across different countries. A very useful dataset is the Community Innovation Survey-CIS. This dataset provides information at the firm level that is fairly homogeneous across (some) E.U. countries. In addition, some countries have survey data that link balance-sheet firm data to specific questionnaires on innovation, R&D and ICT adoption. A good example of the latter is the Italian *Indagine sulle Imprese Manifatturiere* by Capitalia-Mediocredito Centrale.

64 The OECD has started a firm-level project which involves ten OECD countries (United States, Germany, France, Italy, United Kingdom, Canada, Denmark, Finland, the Netherlands and Portugal).

composition of the firms' labour force (i.e. the fraction of workers with a College degree) they find that ICT enters with a negative but not significant coefficient. However the coefficient on the interaction term between ICT investment and the fraction of workers with a College degree is positive and significant (the point estimate is 0.05), hence indicating that there are complementarities between the composition by education of the workforce and the returns to investing in ICT[65]. Following this intuition various studies have attempted to quantify better the impact of workplace organization on growth (Black and Lynch 2004 and 2005, find that during the 1990's changes in organizational innovation are likely to have accounted for as much as 30% of output growth in the U.S.). To have a deeper understanding of the work practices that lead to higher productivity, Lynch (Lynch, 2007) contributed to the design of a U.S. representative survey of business, named *Education Quality of the Workforce National Employer Survey* (*EQW-NES*), which was then administered by the U.S. *Bureau of Census* in 1994 and 1997. The survey was meant to get precise information on how employers recruit workers, organize work, invest in human capital, and utilize education and training investments. The data from this survey were then matched with the *Census Bureau Longitudinal Research Database*, from which data on sales, capital expenditures, employment, material, labour costs and profits could be obtained. Analogously to Bresnahan et al. (2002) she finds evidence of complementarities between investment in human capital, information technology and organizational innovation. This evidence is particularly strong for the manufacturing sector (in the non-manufacturing sector the diffusion of ICT is much higher, hence making the identification of ICT complementarities with work-place organization more difficult).

At this point it is interesting to compare the results obtained for the U.S.[66] with those obtained for European countries, especially since many European countries have been building up a share of ICT capital similar to the U.S. but have not experienced an analogous increase in TFP.

Crespi et al. (2007) look at the relationship between productivity, organizational innovation and investment of ICT for the U.K., using micro data from the *Third Community Innovation Survey* (*CIS3*), an official stratified survey of firms with more than 10 employees, matched with data from the Annual Business Inquiry (ABI) production survey. Some of their findings are consistent with those of Bresnahan et al. (2002) and Lynch (2007), while others are innovative. Consistent with the literature previously discussed are the findings that: 1) ICT have a higher impact on productivity when one does not control for variables capturing organizational innovation; the impact falls when such a variable is included among the regressors; 2) ICT and organizational innovation are complements, so that their interaction term enters with a positive and significant coefficient; 3) there is no evidence of complementarities between organizational innovation and non-ICT investment; 4) above average periods of investment in ICT are associated with slowdowns in measured TFP in the short run. Findings that add to the literature are the following: 5) organizational innovations are affected by the competitive environment in which firms operate (firms who lost market shares in previous periods are more likely to introduce organizational innovations in the following periods); 6) U.S. owned firms are more likely to introduce organizational innovations (and hence to benefit more from investment in ICT); 7) firms that invest in ICT but do not contemporaneously invest in organizational innovations are more likely to experience a slowdown in productivity.

These findings are consistent with the following story: "*a) successful productivity growth needs both ICT and organizational change; b) periods of above average investment lower measured TFP growth; c) competition pressures firms to introduce organizational change and d) U.S. firms, controlling for competition, implement organizational change more readily than other firms*" (Crespi et al, 2007; page. 3).

Given the findings discussed in the literature here reviewed, it is particularly interesting to verify whether the impact of ICT on labour productivity and the complementarities between ICT and organizational change are confirmed for other E.U. countries as well. In the empirical part of our research we look at the Italian manufacturing sector using cross-sectional and longitudinal data from the Italian *Indagine sulle Imprese Manifatturiere* by Capitalia-Mediocredito Centrale.

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65 Notice that this has interesting implications for the analysis of the returns to computer skills, since complementarity between ICT and high education at the firm level should imply that highly educated workers should benefit more (in terms of productivity and hence wages) from the use of ICT on the job. This is a hypothesis that we will explore in the empirical part of the research.

66 See also the work by Ichniowski, Shaw and co-authors (summarized in Ichniowski and Shaw, 2003).

ICT and the labour market

Alan Krueger was the first to address the issue of whether employees who use computers at work earn more and whether the premium for using a computer can account for much of the change in the wage structure. Using the US *Current Population Surveys* (*CPS*) of 1984 and 1989, Krueger estimates an equation for the log of hourly wage which, among a number of other regressors, also included a dummy for working with computers. Even when controlling for a wide range of covariates (such as gender, marital status, race, experience, education, union membership, types of occupation), the coefficient on the computer dummy is found to be very significant and the wage premium associated with computers increased from 15% in 1984 to 17.5% in 1989. When a broader set of occupational dummies is included for 1989 the wage differential goes down to 13.9%, which, however, remains an economically very high value. The introduction of additional dummy variables meant to control for ability in the use of PC (as the use of computers for specific tasks such as word processing, electronic mail and so on) do not change Kruger's results substantially.

Thus, the idea that rapid skill-biased technological change during the 1980s was an important cause of the raising differentials in productivity and wages among different types of workers received a strong support from Krueger's contribution, which was especially influential because it used micro data, while previous empirical studies, supporting the same hypothesis, had been carried out exclusively at the industry level or using time-series of aggregate data. However, Krueger's approach suffers from unobserved heterogeneity bias. To clarify the problem, let's suppose that the observed wage differentials are primarily due to the unobserved (by the econometrician) ability (i.e. productivity) of different workers and that employers or senior managers do not assign computers at random but only to the most productive workers. If this is the case, Krueger's findings would be due entirely to the fact that the most productive workers are those equipped with computers and therefore no causal relationship between computer use and wages can be identified. To address the issue of unobserved heterogeneity, Krueger carried out further cross-sectional regressions of the wage equation including additional controls for unobserved heterogeneity. More specifically, using a smaller sample of individuals who attained only high school and controlling for individual characteristics that could be taken as proxies of inherent ability (such as parents' education, the GPA and the results in a cognitive test of vocabulary, reading and mathematics obtained in high school), Krueger estimates a wage premium for computer use of about 10%. These results induced Krueger to conclude that employees using computers in the workplace earn a 10 to 15% higher wage rate. Since most computer users possess a higher education, these results imply that computer use tends to increase the already high returns to education in the U.S..

Krueger's approach is questioned –among others- by Di Nardo, Pischke, Card, Lemieux, Fortin, Entorf and Kramarz.

Di Nardo and Pischke (1997) raise the issue of unobserved ability and point out that with a cross-section analysis one cannot fully control for individual fixed effects (that would be possible if we had at least two observations for each individual). To prove their point they estimate a wage equation similar to Krueger's with a large sample of German workers and find a substantial wage premium for using a PC at work (close to 19%) but a comparable premium also emerges for the use of other office tools (calculators, telephones and even pencils). These results suggest that the decision by the employer to provide workers with office tools is very much an ability-driven choice and that returns to the use of PCs are really returns to unobserved ability. So, if Di Nardo and Pischke interpretation is correct, the impact of computers on workers' productivity is much lower than expected. A similar conclusion is reached by Entorf and Kramarz (1997) who estimate a wage equation using a large sample of French workers (for the period 1985-87). A cross-sectional estimate similar to Krueger's produce a very high (17%) estimate of the wage premium for computer users but when the years of experience with computers are included in the regression, the premium for using a PC on the job is only 6%. Moreover, exploiting the longitudinal dimension of their sample, Entorf and Kramarz run a panel regression with individual-fixed effects (hence at least partially controlling for unobserved ability) and find that only experience with computers has a significant impact on wages. What this means is that PC use increases productivity but only with time, through a learning process (similar results[67] are obtained by Entorf et al,1999). Di Nardo et al. (1996) challenge Krueger's findings stressing the role of institutions in determining the rise in the returns to skills and education. They show that the decrease in Union's power has lead to a widening of the wage gap and

[67] It must be pointed out that a direct comparison between Krueger's results and those on European workers is not possible, since the latter do not take into consideration all the controls for individual characteristics that Krueger used and employ different measures of wages.

to an increase in the returns to education and skills that cannot be accounted for by the impact of the IT revolution alone.

Overall, we feel that the "Jury is still out" and a final verdict on the relationship between productivity and IT skills and use has not been written. For this reason additional empirical studies on the experience of countries different from the U.S. , Germany or France are very interesting. In our research we investigate the relationship between wages, employment, ICT skills and ICT use on the job using data coming from the Italian Survey of Households Income and Wealth, administered by the Bank of Italy.

8.2. Econometric application: object, scope, and dataset used

As anticipated, we look at the impact of ICT on both labour market outcomes and firms' productivity. These are very connected issues, since they are affected by the same underlying phenomena. Everything else constant, the diffusion of ICT at the firm level are likely to increase the productivity of non–ICT capital and labour, hence increasing the overall firm's productivity (defined as the ratio between real output and the number of employed workers). However, the diffusion of ICT makes the ceteris paribus assumption quite unrealistic, since ICT tend to have an impact on the substitutability between capital and labour. More specifically, a large body of theoretical and empirical literature has argued that ICT tend to be complementary with capital and high-skilled labour, while they tend to be substitute for unskilled labour. So it is evident that the diffusion of digital skills among the working age population can have a positive impact on labour market outcomes of individuals while at the same time being an enabler of ICT adoption and supporting organisational change, hence potentially leading to innovation and increased productivity for firms.

Given this context first we look at the impact of ICT on the labour market and then we study the impact of ICT on firms' productivity. In this respect, the diffusion and the adoption of ICT by firms can have a compositional effects on the demand for labour and hence on workers' welfare. In other words, we expect that ICT tend to drive up the demand for skilled and highly educated workers while reducing the one for low skill-low education workers. These two effects, which imply changes in relative employment rates and relative wages for skilled/unskilled workers, can strengthen the consequences of digital exclusion: workers who have lower skills – and in particular workers who have a low technological endowment (i.e. do not know how to deal with ICT) tend to be paid lower salaries or to be expelled altogether from the labour market. This is so also because less skilled workers are not instrumental to re-organisation and innovation and, hence, are a bottleneck to increase productivity. While we framed these implications from the negative side of the effect of digital exclusion, if such relations are proved to be at work they can also be looked at from a positive side: if eInclusion support policies are successful in increasing digital skills of individuals within the working age population, this will enable them to achieve better labour market outcomes and will also support firms efforts at increasing productivity by providing a more skilled labour force.

The scope for the empirical testing of the two mentioned impact is the use of micro-level longitudinal dataset from Italy. We can anticipate, however, that our findings, even if obtained looking only at the Italian experience, are very interesting because they add new evidence which corroborates the findings obtained for other European and non European countries that we reviewed in the various parts of **§ 8.1**. A complete generalization of the results obtained in this study to all the E.U. countries is clearly not possible, because each study uses a country-specific dataset[68] and also because each country has its own peculiarities that cannot be fully captured by looking at the experience of other countries. However, the fact that our results are in line with those obtained for other countries makes us confident that we are capturing the effects of economic forces -such as the ICT revolution- that are observed in many E.U. countries.

For testing the impact of ICT on labour market outcomes we use data from the Bank of Italy *Survey of Household Income and Wealth* (SHIW), which, every two years, provides data on a sample of about 8,000 households, representative of the Italian population. It contains detailed information on demographics, income and wealth at the individual and household level[69]. The 2000 wave provides us with information on the ability of individuals in the use of computers and, for those who are working, on

[68] Having a longitudinal dataset with observations obtained from different countries and representative of the underlying population for each country would allow us to obtain results in which similarities and differences among countries can be more easily appreciated.

[69] See Banca d'Italia (2002) for further details.

their use of a PC at work. Specifically, the 2000 survey, for each household member, records self-rated computer skills on an increasing five-step scale. We rearranged this scale in order to define a dichotomous variable that takes a value of one if the individual declares to have at least some ability in PC utilization and zero otherwise[70]. For people at work, the 2000 survey also collects information concerning whether they use a PC at work. Since half of the households participating to the sample belong to a longitudinal survey, we exploit the panel section coming from the 2000, 2002, 2004 and 2006 waves. ***These data provide unique and valuable information for the question analyzed here, since they enable us to estimate whether computer skills and computer use at work are positively influencing wages and the probability of remaining employed***.

For testing the impact on labour productivity of organizational innovations and investment in ICT by Italian manufacturing firms in the period 1995-2003 we use data from the 7th, 8th and 9th waves of the *Indagine sulle Imprese Manifatturiere* by Capitalia (formerly Mediocredito Centrale). This is the only Italian survey, and one of a few in Europe, containing information on the introduction of organizational innovations by firms. These data were gathered in year 1998, 2001 and 2004 respectively, through questionnaires handed to a representative sample of manufacturing firms[71] within the national borders, and supplemented with standard balance-sheet data. Questionnaires collect information over the previous three years. Some questions are year-specific (and for them we have three different answers, one for each year) while others are wave-specific (and hence we have a unique answer for the three years). One of the questions is whether firms have introduced any innovation (including product, process, organizational) in the previous three-year period (so that for each wave we only have a unique answer). Firms' representatives are also asked whether investment in ICT was made in the previous three years and for those who answer "*yes*" a question follows on the size of this investment (expressed in monetary terms). The questionnaire also contains questions on the degree of openness of the firm, on the fact that the firm belongs to a group, on the composition of the labour force by education and skills and on R&D spending. These data are then matched with balance sheet data, so that information on sales, cost, profits, and capital stock can be obtained (these data are year-specific, so that for each wave we have three records)

In the following paragraphs we will comment the findings produced by referring to a total of 21 tables that are reported in at the end of this Annex in **§ 8.5**.

8.3. ICT and the labour market

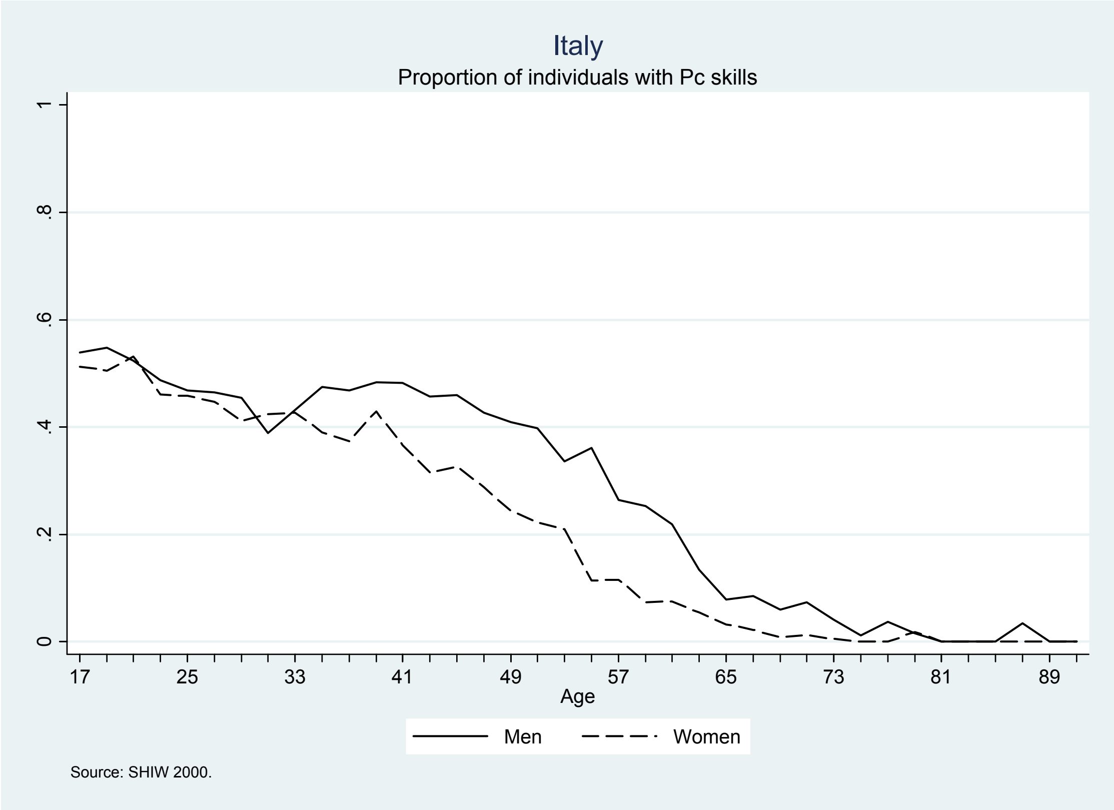
General data overview

The first thing we analyze is the distribution of PC skills in the population. This variable is a proxy for the individuals' digital skills (for a given individual, such a variable takes a value of 1 if that individual declares to have at least some ability in the use of PCs and zero otherwise). From Figure 21 we can notice two things.

[70] While this reduces the variability in our explanatory variable, it also has the effect of reducing the measurement error due to the fact that individuals self-evaluate their skills. In addition, adopting finer partitions produces severe multicollinearity problems in the econometric specifications presented in the following sections.

[71] The most recent survey run in 2004 includes also non-manufacturing firms in the Construction and Service sectors.

Figure 21 Distribution of individuals with PC skills in the population: by gender



First, there is clear evidence of a gender gap: women in the age interval 33-65 are less likely to possess skills in the use of PCs when compared to men. Second, there is clear evidence of strong intergenerational variation: younger generations tend to me more skilled than older generations (notice that the declining path relative to age is less evident for males than for females, and this partly explains the gender gap). Another interesting piece of information is coming from Figure 22 and figure 23 overleaf, where we look at the distribution in the population of the variable of interest (i.e. basic skills in the use of PCs), distinguishing by education level.

With respect to education we rearranged individuals in two groups: those with at most a Junior High School diploma (including those with no formal education) and those with at least secondary education (including those with a College degree). Here it is clear that –once we control for education- much of the gender gap disappears. In other words, males with higher (lower) education are quite similar to females with higher (lower) education. Notice also that the age profile for the distribution of basic PC skills for males and females with low education tends to be much flatter than the profile for individuals with higher education. This means that, for both males and females, the distribution of PC skills among individuals with lower education is not really a generational issue. It is only for males and females with higher education that the generational gap appears. Still, some differences between the genders remain, since the decline for males with high education starts at around 57 while for females it starts at around 50. Overall this seems to show that access to education and technological skills tend to be related and that the gender gap observed in Figure 21 is mainly driven by a gender gap in educational achievement.

Figure 22 Distribution of individuals with PC skills (male population): educational attainment

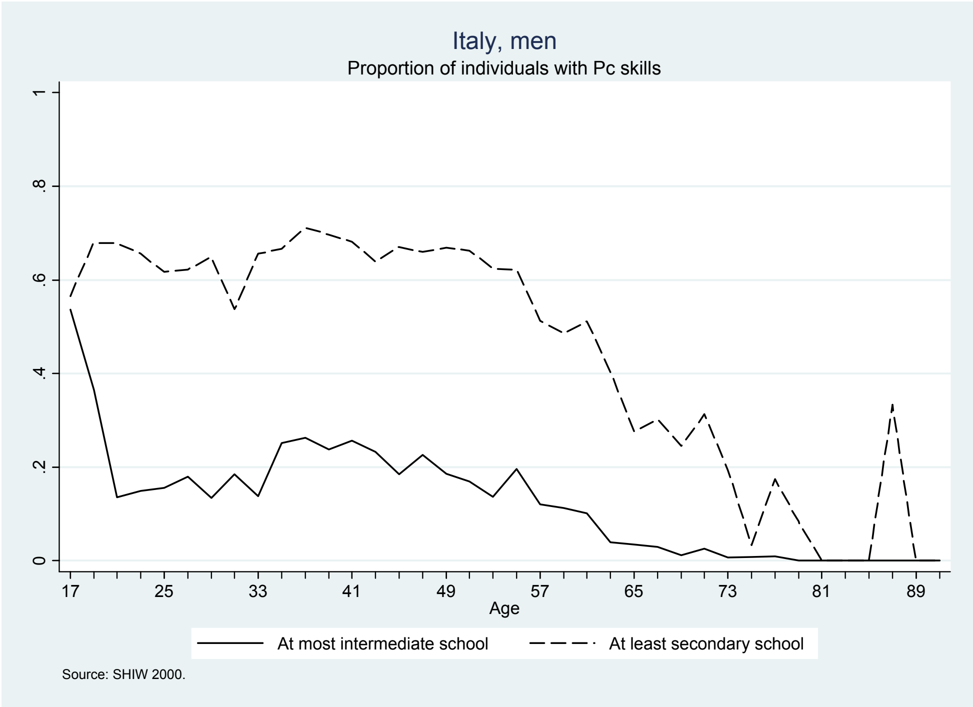
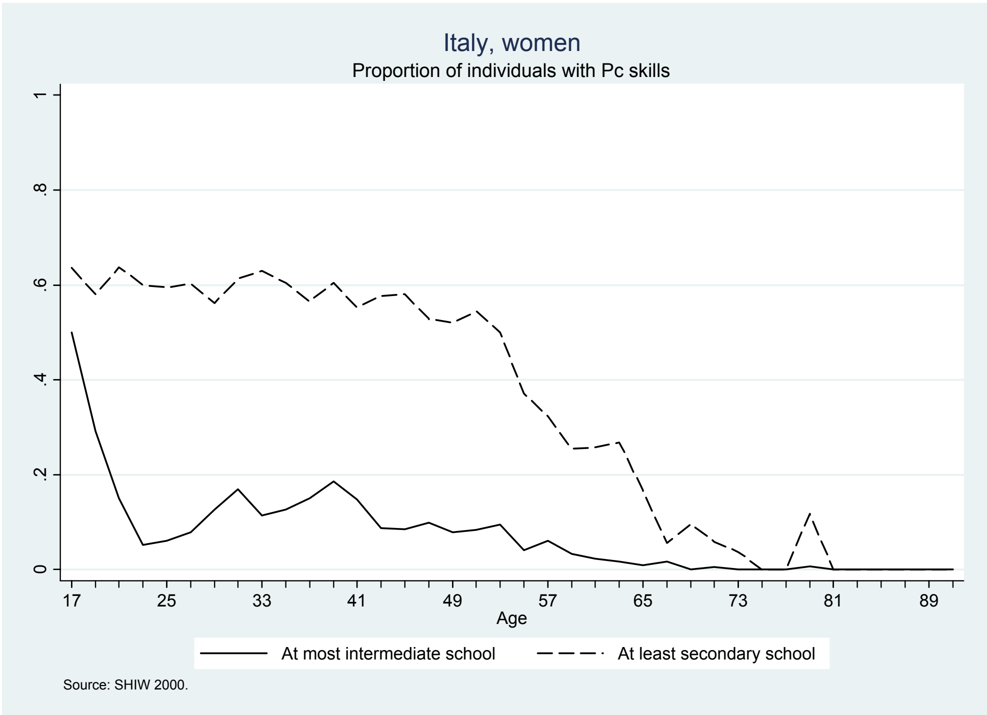
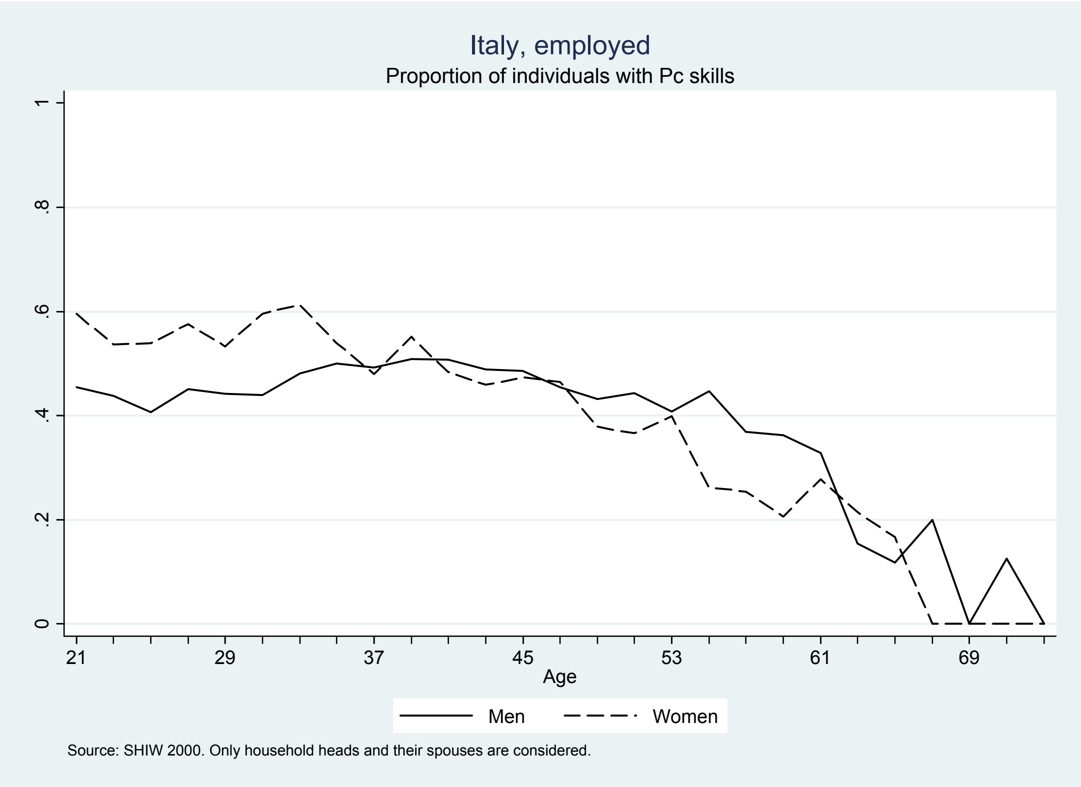


Figure 23 Distribution of individuals with PC skills (female population): educational attainment



It is also interesting to check whether the overall picture changes when we restrict our attention to employees (as opposed to residents). From Figure 24 we notice that –once we look at men and women who are regularly attached to the labour market, the gender gap documented in Figure 21 disappears. In fact, for younger generations, PC skills tend to be higher among women (the reverse is true for older generations), while for those between 35 and 50 the two profiles are not structurally different.

Figure 24 Distribution of individuals with PC skills among the employed: by gender



The fact that there is a clear educational gap in the distribution of digital skills in the Italian population emerges clearly from Figure 25and Figure 26 overleaf, where we look at males and females employees, distinguishing by educational attainment.

The first message that we get from this raw analysis of the data is that there is a serious digital exclusion issue for older and less educated individuals (and -among these- especially for women). In terms of labour market outcomes, this implies that these two groups are likely to suffer more from lower employability and lower wages. In the remaining part of this paragraph we will look at these employment and wage effects. First we look at the relationship between IT skills and IT use and employment probabilities and after we look at their impact on wages.

Figure 25 Distribution of individuals with PC skills (employed males): educational attainment

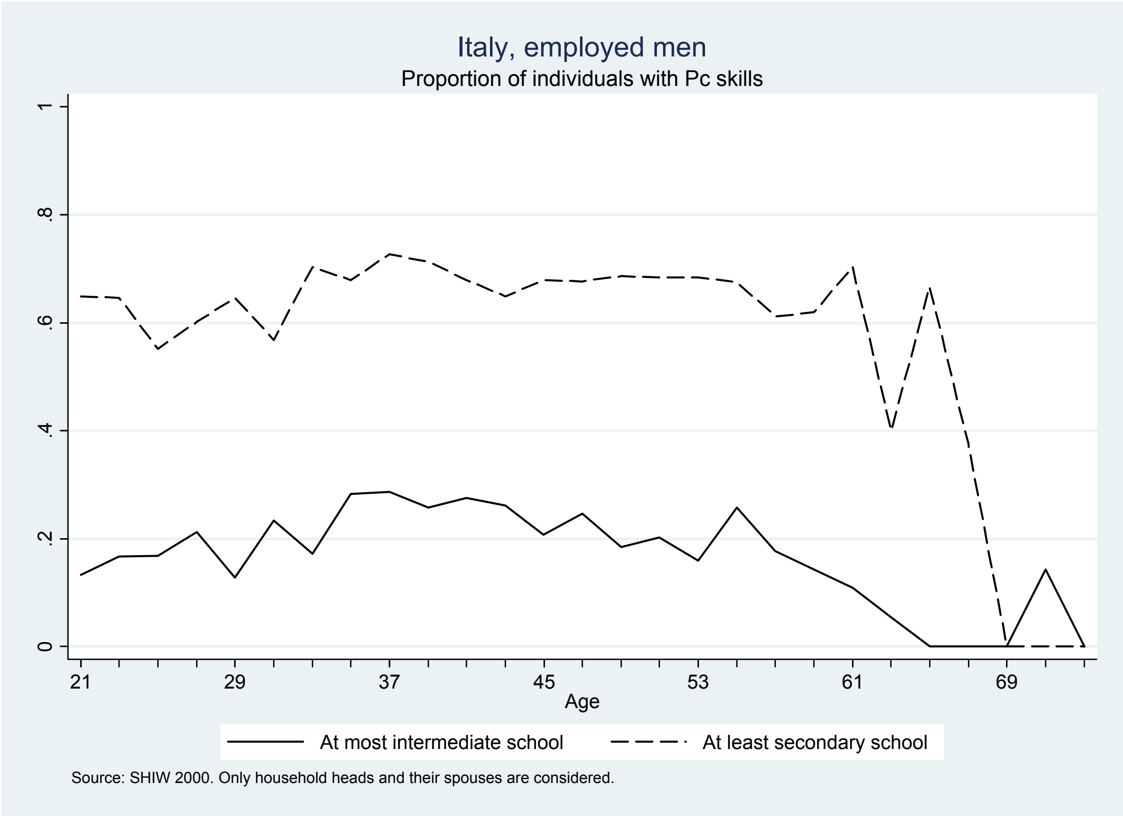
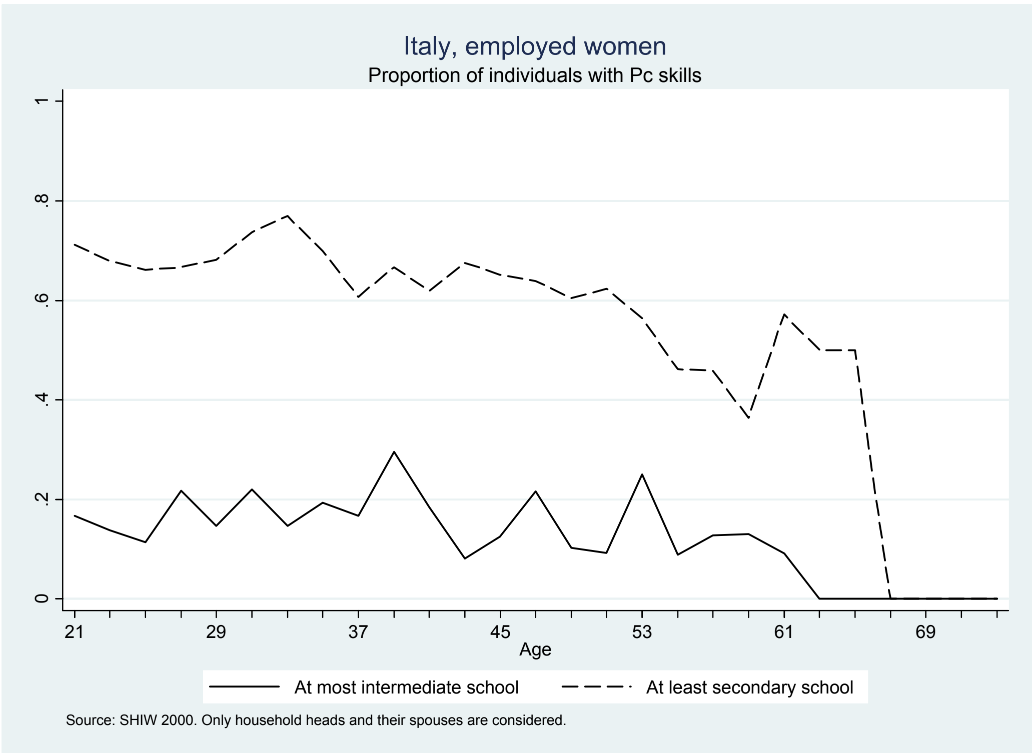


Figure 26 Distribution of individuals with PC skills (employed females): educational attainment



Employment

The empirical exercise we have performed verifies whether there is a clear relationship between the probability of being employed and the variable proxying digital skills. The intuition is that gender, age and education are going to affect such a relationship and hence we distinguish according to: 1) gender; 2) age (we consider three different age groups: 15-34; 35-49; 50-64); 3) education (at most intermediate school; at least secondary education). In all the regressions we also control for civil status, region of residence and household income.

We look at employment because we believe this to be more informative when considering the effects of digital exclusion. As already mentioned, for older workers –the group that is mostly affected by the lack of ICT skills- unemployment and exit from the labour force for retirement are seldom clearly distinguishable.

In Table 1 (which refers to the year 2000 SHIW wave), we report the employment probability for different age-gender groups. We can see that 51.3% of males in the age group 15-34 are employed (for females the percentage is 37.5), while when we look at the age group 35-49 such a probability goes to 92.6% (for females is 55.8). Finally, when we look at the age group 50-64, we notice that the likelihood of being employed goes down to 54.9 %(for females is 23.7). In Table 1 we also look at the probability of being employed conditional on both having and not having PC skills. Compared to the unconditional mean, we can notice that for all groups but one (males in the age interval 15-34) the likelihood of being employed is lower for individuals without digital skills. When we look at the differential impact of possessing PC skills on the employment probability we find that such a variable exerts a positive effect for all groups but one (again males in the age interval 15-34). Moreover, we notice that the positive impact on the employment probability is particularly higher for males in the 50-64 age group and for females in the 35-49 and 50-64 age groups. However these results should be read with caution, given that we are not controlling for variables –such as education- that might affect the individuals' ability in using ICT.

In Table 2 we estimate the impact of the variable of interest (digital skills) on the probability of being employed (again using the 2000 SHIW wave), distinguishing by educational attainment and controlling for age, civil status, region of residence and household income. Our results indicate that the effect of having PC skills on the employment probability of males and females (compared to those without PC skills) is positive for both males and females in the age groups 50-64 with both low and high education (the coefficients are higher for those with high education). Similarly, the effect is positive for females with both high and low education in the age interval 35-49 (the effect is stronger for the group with higher education), while we find mixed results for females and males in the youngest age groups (the effect is negative for males, while it is positive for females with high education and negative for females with low education: this result is quite puzzling, but it might reflect selection problems in these groups).

At this point we look at transition probabilities from employment to unemployment or out of the labour force for those who are observed in the year 2000 SHIW wave and in the following years. This means that we use only the longitudinal component of the SHIW dataset, i.e. we focus on those individuals that are observed at least twice. This adds a dynamic flavour to our exercise, since now we can look at the determinants of exit from the employment status. Notice that we are constrained to look at the employment dynamics of those who are observed in year 2000 because only for that year we have the information on PC skills and PC use on the job. But, due to the sampling strategy[72] followed by the Bank of Italy, this implies that we lose observations as we move away from 2002, towards 2004 and 2006. In other words, for the same groups of interest (say males in the age interval 15-34) the number of available observations is lower for the 2000-2004 transition (i.e. the transition that captures changes occurred between 2000 and 2004) than it is for the 2000-2002 transition[73].

In Table 3 we analyze the dynamics for males. The variable *Pr(transition)* is the probability of changing status from employment to out of employment in the sample: we can notice how such probability changes across age groups. The variables *Pr(transition|No PC skills)* and *Pr(transition|If the individual has PC skills)* are the probabilities of transition out of employment for those who -respectively- do not have and have IT skills (analogous considerations apply to the variable *use of PC at work*). The first thing we notice is that in the three transitions considered (2000-2002; 2000-2004; 2000-2006) having some ICT skills tend

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72 The SHIW dataset is a panel with refreshment: only 50% of the households interviewed in year 2000 are re-interviewed in year 2002, and only 25% of them are re-interviewed in year 2006.

73 For the group of males in the age interval 15-35 we have 512 observations for the 2000-2002 transition, 306 for the 2000-2004 transition and 204 for the 2000-2006. Similar patterns apply to all the other groups.

to be associated with a decrease in the likelihood of exiting the state of employment (i.e. having some PC skills increases the likelihood of remaining employed). For instance, if we look at the 2000-2002 transition for males we notice that the probability of exiting from employment is not affected by PC skills for individuals in the age interval 15-34, while it is significantly reduced by 3.5 and by 18.1 percentage points for –respectively- males in the 35-49 age group and males in the 50-64 age group. Given these preliminary results it becomes interesting to check whether they hold when we control for additional individual or household characteristics (among which education).

From Table 4 we notice that the negative effect of ICT skills on the transition out of employment is particularly evident for older males with higher education: estimated coefficients range from 0.138 to 0.219. This means that, for this group, having some PC skills is significantly and strongly associated to the state of employment because it reduces by 13 to 21 percentage points the probability of exiting such status. We have some evidence that males in the 35-49 age interval with some PC skills are more likely to remain employed as well, but the effect is less strong (the coefficient is 0.05). When we look at the relationship between transitions out of employment and the use of a PC at work (which implies that the person has some PC skills), we notice that the negative impact is confirmed and that it is particularly strong for the older group of males. Overall, these results seem to show that –for male employees- the digital inclusion issue is especially strong for older individuals: it is in this group of individuals where being "technologically endowed" has a strong economic and statistical negative effect on the probability of exiting from the state of employment (and hence a positive effect on the probability of remaining employed).

We now turn to female employees. From Table 6 we notice that the number of observations available is lower than for males: this reflects the fact that females tend to have a lower employment rate than males to start with (remember that we are looking at the employment dynamics of those who are employed in year 2000). This is particularly true in the 50-64 age group, given that women in Italy have always had a lower retirement age than men (we have only 199 observations for this group in the 2000-2002 transition, while for men of the same age group we had 422 observations). This implies that our estimates for females are relatively more reliable for the intermediate-age group. And for this group we notice that there exists a negative and significant effect of having PC skills on the probability of exiting from employment, which tends to be higher than the one observed for males. When looking at the effect of the variable "*using a PC at work*" we find analogous results. Next we check whether these results are robust to the introduction of additional controls (and hence to compositional variation).

From Table 7 we notice that –once controlling for education, age, civil status, region of residence and household income- the variable PC skills does not appear to be significant, except for females with low education in the 35-49 age group and for the 2000-2004 transition. The results for the variable capturing use of a PC on the job (see Table 8) do not show a consistent pattern: in some cases we find a positive effect (high education and 50-64 age group or low education and 15-34 age group) while in others the effect is negative, confirming the results obtained for males.

In Tables 9 through 13 we perform the same empirical exercise, focusing on the group of self employed (males and females). For males our results (see Table 9, Table 10 and Table 11) indicate that there is some evidence that having PC skills and using a PC on the job tend to reduce the likelihood of exiting from the state of employment, but this effect is mainly observed for the groups of older males, and especially for older males with lower education. When we look at females (Table 12 and Table 13) we confirm that the negative impact on the transition out of employment of both relevant variables tend to be concentrated in the middle and older age groups and is especially relevant for individuals with lower education (which in our context means at most intermediate education).

In conclusion, from the empirical analysis of employment dynamics and its relationship with digital skills and use of ICT on the job for the Italian population in years 2000-2006 we find that there exist some groups that are more likely to be at risk of exiting from the employment status due to their low level of digital skills. Our dynamic analysis, which follows individuals from year 2000 up to year 2006, shows that for male and female employees the probability of exiting from the employment status (towards unemployment, or simply out of the labour force) is reduced by the presence of PC skills and by the use of a PC on the job. This effect is quite small (around 5% and only in few specifications) for males in the 35-49 age intervals, for whom exit from employment is more likely to lead to unemployment. However, such negative effect is much stronger for males with high education in the 50-64 age group, for whom exit from the labour market mostly leads to retirement from the labour force (or early retirement[74]). For this group, having digital skills reduces the probability of exiting from employment by around 20 percentage points. The fact that the negative impact of digital skills and ICT use on the probability of exiting from employment (and hence the positive effect on the likelihood of maintaining the employment status) is observed only for older males with high education in our interpretation signals that for this group digital skills contribute to a reduction in the human capital depreciation rate. To put it in simpler words, for older males with higher education having some digital skills is a necessary requirement to be able to remain competitive with respect to younger generations of males with similar education.

As for females, the effect is less strong and it is observed mostly for the groups in the age interval 35-59. This is not a complete surprise given that the age at which retirement is eligible for females is lower than the one for males (for females aged between 36 and 49 in year 2000 retirement becomes eligible around the age of 50). For females the negative effect of PC skills and PC use on the probability of exiting from employment does not appear to be clearly related to education, perhaps due to the fact that females in the age interval 35-49 in year 2000 tend to be less educated than males in the same age group.

Wages

We now turn to wages. In this part of the research we analyze the relationship between digital skills and ICT use on the job (as measured by the variables PC skills and PC use discussed in the previous paragraph) on the one hand, and real hourly wages on the other. As documented in the literature review, this is a topic that has been studied extensively mainly with reference to the U.S. Some studies on Germany, France and the U.K exist and hence it is particularly interesting to verify whether the empirical evidence for Italy –whose labour market is different from the one of the UK, France or Germany- show evidence in favour of positive returns to digital skills and use of ICT.

When estimating the returns to technological skills or technology use there exists a major problem which has to do with the fact that skills and use are not randomly distributed in the population. People invest in upgrading their technological skills because they expect to obtain a return from such an investment. Besides, ICT capital (such as PCs) is distributed to workers in light of their ability and potential productivity.

This means that the results obtained from empirical analysis have to be interpreted with extreme caution. Positive correlations between digital skills or ICT use and wages only mean that those who have higher skills or use a PC on the job tend to have higher wages, but it does not mean that we would be able to obtain the same increase in wages from everybody simply by teaching them some digital skills or providing them with a PC. To get to a conclusion of this type we would have to run a natural experiment where some individuals –randomly selected- are endowed with PC skills (for instance through training programmes) and are given a PC on the job. Only then we would be able to verify whether PC skills and PC use –per se- lead to an increase in productivity and hence in wages. Given that it is very difficult to rely on such natural experiments, we have to find other ways to get robust evidence from survey data, starting from the hypothesis that digital skills and ICT use are not to be found randomly but they are especially frequent among more able individuals. In other words, digital skills and ICT use might in fact simply be a proxy for some unmeasured ability factor. So, a potentially fruitful strategy is to bring directly an observable measure of ability into the regression. If we control for such a measure by including it among the explanatory variables, a positive and significant coefficient on digital skills or ICT use is no longer picking up the ability component (because we have already controlled for it) and it is more likely to measure the additional effect coming from ICT skills and use. This is exactly the strategy we use in our exercise, where -as a control for ability- we use the final grade (relative to the average for similar degrees) that the individuals (who have at least completed High school) obtained at the time of graduation (either from High school or College[75]). For those who do not have a High school diploma we do not have information on their school grades and so we cannot include them in the regression. Moreover, given that we have constructed a longitudinal dataset (so that for each individual we have more than one observation) for all individuals (including those with education no higher than Junior High school) we can apply a methodology developed by Chamberlain which allows us to control for (some) unobservable fixed effects, while at the same time avoiding differencing the data (because by differencing the data we would get rid

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[74] At this age unemployment is still a possibility but often early retirement is a valid alternative to the former.

[75] In case of individuals with College degrees, who -by definition- have also completed High school, we use the degree from their highest and most recent educational achievement.

of all the time-invariant fixed effects, including those that measure IT skills and use, which are recorded only in the year 2000 survey).

Data are coming from the Bank of Italy SHIW dataset. As in the previous paragraph, we start from the year 2000 survey, where the questions on PC skills and PC use are present, and then we observe the wage pattern in year 2002 and 2004 for those that are observed in year 2000 (for which we have info on the variables capturing IT ability and use[76]). As for employment, the more we look further away in time (relative to year 2000) and the lower is the number of individuals for which we have observations (due to the sampling-with-refreshment strategy followed by the Bank of Italy we have a clear example of a trade off between time coverage and individual coverage).

First we look only at the SHIW year 2000 cross-section and we report some summary statistics on mean and median wages for different groups of individuals. In all our exercises we look at full-time employees working 12 months in sectors different from agriculture. For each individual we compute the real hourly wage and this is what the summary statistics and the following regressions refer to.

In Table 14 we look at the relationship between the variable capturing PC skills and hourly real wages. We distinguish by gender, by educational achievement (high and low education[77]) and by age (we consider three age groups: 25-35; 36-45; 46-55). From Table 14 we clearly see that PC skills and PC use are an education related phenomenon. Among those who have lower education, less that 30% of the population declares to have some PC skills or to use a PC on the job (males seem to be doing relatively better than females). However, when we look at the group with higher education the results are reversed: between 60 and 70% of males and females with such educational achievement possess PC skills and use a PC on the job[78].

Moreover, again looking at Table 14, it emerges clearly that for all the groups here considered mean and median wages are higher for those who possess PC skills (for instance, for the group of females with low education in the age interval 25-35, the mean (median) hourly wage for those with PC skills is 5.16 (5.44) Euro, while it is 5.08 (4.96) for those –within the same group- without PC skills).

In Table 15 we look at the relationship between real hourly wages and PC use at work. Again, we notice that -with few exceptions[79]- individuals with PC skills and those who use a PC on the job tend to have higher mean and median hourly wages.

However, the evidence produced so far is purely indicative, since we are not controlling for many covariates. Hence, our next step is to run a regression of real hourly wages on the potentially relevant explanatory variables. Our dependent variable is the log of real hourly wages and our control variables are: age, age squared, civil status, education, interactions between education and age, the normalized grade obtained when graduating from either High school or University[80], years of contribution to the social security system, job characteristics, sector of employment, firm's dimension, region of residence household size and non labour household income. For those who have a College degree we also control for the University and for the Faculty attended.

Our empirical analysis is conducted both on the year 2000 cross section (where we have 2512 observations for males and 1475 for females, one for each individual) and on the longitudinal panels obtained following those who are employed in year 2000 in year 2002 only (the *2002 panel*) and both 2002 and 2004 (the *2004 panel*). When we concentrate on the *2002 panel*, for males we have 1880 observations for 940 individuals while for females we have 1062 observations for 531 individuals (hence two observations for each individual). When we consider the *2004 panel*, for males we have 1743 observations for 581 individuals, while for females we have 978 observations for 326 individuals (hence

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[76] Due to the low number of observations available in year 2006 on those who are employed in year 2000 we do not consider the 2006 SHIW wave.

[77] High education means at least a High school diploma (and hence includes College graduates), while Low education means at most a Junior high school diploma (hence includes those with only primary education or no education).

[78] For instance, for females with low education we have 93 observations on individuals without PC skills in the age interval 25-35 and only 18 with PC skills in the same age interval. However, among females with high education in the same interval, 253 possess PC skills while 111 do not have them.

[79] These are mean wages for females with low education in the age group 25-35; mean and median wages for females with high education in the age group 36-45.

[80] As already mentioned, for College graduates we use only the degree for the highest educational achievement. Normalization of the grades is necessary to have interpersonal comparability on grades obtained at graduation.

three observations for each individual). So it can be noticed that -due to the sampling techniques adopted by the Bank of Italy- the number of individuals available for empirical analysis declines as we add more years[81].

The advantage of using the data in a longitudinal format comes from the fact that we have repeated observations on the same individual. This allows us to better control for individual unobserved fixed effects. Unfortunately, we cannot adopt a typical fixed-effect estimation because this would imply differentiating the data and hence eliminating all the time-invariant fixed effects, including the information on PC skills and PC use which are recorded only for year 2000. So, when running the wage regression for both panels, we rely on a methodology developed by Chamberlain according to which we use some individual-specific observable variables as proxies for the unobservable fixed effects. In our case these are individual-specific time-averages for age, age squared, household size and non labour household income. Finally, on both the *2002 panel* and the *2004 panel*, besides running a regression that adopts the methodology suggested by Chamberlain, we also run pooled OLS (in this case we do not introduce any form of control for individual-specific fixed effects). In all the cases our specifications are robust to arbitrary heteroskedasticity at the individual level.

As for the variable capturing education, we distinguish between Lower education (less than Junior high school, including no education), High school education and University education. This is a finer partition compared to the one used when presenting the summary statistics and it is due to the fact that we have noticed some relevant differences among the group of those with at least a High school diploma: High school graduates and College graduates do not appear to behave in the same way as far as the returns from IT skills and IT use are concerned.

In Table 16 we present the results concerning the PC skills variable. In col. 1 we report the results from the analysis of the 2000 cross-section. The first thing we notice is that there is a clear difference between genders: possessing PC skills is never associated with a significant wage premium for females. When we look at males we find that males with lower education or possessing a High school diploma tend to benefit from PC skills: for the first group wages tend to be higher by a factor close to 3% while for the second group the gain is close to 4%. Male College graduates do not seem to benefit from IT skills.

When we perform the same regression on both the *2002* and the *2004 panel* we can see that these results are confirmed and strengthened. First, females do not benefit –at least in term of wages- from the possession of PC skills. Second, the results for males are even stronger for the longitudinal dataset, when compared to those obtained using only the year 2000 cross-section. In fact, for the *2002 panel* we notice that the gain is close to 6% for the group with lower education and between 5.5% and 6% for the group with a High school diploma (coefficients obtained with the Chamberlain's method tend to de slightly higher). Finally, when we consider the *2004 panel* we have significant evidence of some positive effect (around 5.6%) for the group with High school diploma.

In Table 17 we have the results from the regression in which we include the variable PC use (instead of PC skills). Overall, these results are in line with those obtained when using PC skills. When using the 2000 cross section only we obtain evidence that the use of a PC on the job is associated with an increase in the wage rate for males with lower education (3.6%) and for males with a High school diploma (5.6%). We do not find similar evidence for females (irrespective of education) nor for males with higher education. When we look at the *2002 panel*, again we find that positive and significant effects exist only for males with lower and intermediate education: coefficients are 5.1% and 5.6 % for males with a High school diploma respectively using OLS and panel data fixed effect estimation (using Chamberlain methodology) while they are 6.2% for males with lower education. When we look at the *2004 panel* (for which the number of available individuals almost halves) we find evidence that males with a High school diploma and females with lower education benefit from the use of a PC on the job (coefficients are respectively 5.4% -with pooled OLS- and 6.8% -with fixed effect estimation- for the first group and 1% -in both cases- for the second group).

We read the results as very interesting mainly for two reasons.

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[81] In our wage analysis we do not consider the 2000-2002-2004-2006 panel (which is available) because the number of individuals in it is too low.

First they show that in Italy the positive effects of digital skills and ICT use on wages are gender specific: males benefit from technology while females do not. Since we do not believe that females are inherently less able to learn and use ICT, we need to look elsewhere for the causes of this finding. On the one hand we could have a selection issue. Females tend to have a more elastic labour supply and a higher reservation wage and by looking only at females employed full time we might be picking out only a special group of individuals and this might bias our estimates. This is especially true for females with low education (notice that for males with low education we found a positive effect of both IT skills and IT use): if we take the ratio of the number of females with low education who have PC skills (76) to the number of females that do not have such skills among those with the same educational attainment (327), we notice that this ratio (23%) is lower than the analogous ratio obtained for males (30%). If we do the same for the group with higher education we notice that the ratios are very similar between males and females (actually females with higher education tend to have PC skills more frequently than males: 207% against 199%). This means that the selection issue just described is likely to operate especially at lower levels of education (and lower wages) so that for those that we actually observe on the labour market PC skills and PC use do not seem to have an effect on their wages. But there is a secondary explanation for the finding that females do not benefit from technological skills and use of technology in terms of wages. This explanation has to do with the fact that wage discrimination might be at work. If female wages are compressed, their increased productivity due to the possession of digital skills or to the use of a PC on the job is not reflected in higher wages. At the moment we are not able to test which one of the two hypotheses is correct but this issue certainly deserves more attention.

The second very interesting insight from our analysis is that, even after controlling for age, experience, sector, workers qualification and education (including the grade obtained and the type of University attended when relevant) we have significant effects of digital skills and ICT use on male wages. But these effects are not equal across education groups. In fact, having PC skills and using a PC on the job are associated with significantly higher wages –with coefficients that range between 5.5% and 6% for the most reliable estimates[82]- only for the group of males with lower education and for the group of males with a High school diploma[83]. Hence we read our findings as suggesting that having PC skills or using a PC on the job do not receive a market premium for the group of males with a College degree because –for this group- these are implicit job and skill requirements. However, for the other two groups, IT skills and IT use are not implicitly required and attached to them there exists a clear and significant premium.

In terms of policy analysis this means that interventions directed at increasing the technological abilities of those with low or intermediate education are likely to produce a more significant impact on workers' wages, while at the same time reducing digital exclusion.

8.4. ICT and firms' productivity

The Capitalia dataset described earlier (**§ 5.2**) has most of the information that are required to test the impact of ICT investment and organizational restructuring on firms' productivity. However, balance sheet data do not provide us directly with the real variables that we want to use and hence the first step in our analysis is the creation of real output and real capital (balance sheet data provide info on sales and on the capital stock evaluated at historical values). After transforming the nominal variables into real variables we can run the regression that has on the left-hand side a measure of average labour productivity (the ratio of real output to non R&D workers) and on the right-hand side the explanatory variables that are likely to enter in a typical production function: the per-capita capital stock (obtained dividing the capital stock by the number of non R&D workers), a dummy variable that has a value of one if the firm has been involved in product or process innovation, a dummy variable equal to one if the firm has engaged in some organizational innovation (related to either product or process innovation) and a dummy variable equal to one if the firm has done some investment in ICT in the previous three years. We are not able to use the information on the monetary value of the investment in ICT because many of the firms that answered positively to the question on whether they invested in ICT investment do not provide information on the size of their investment. Basically, if instead of the dummy variable we had used the variable reporting the dimension of the ICT investment –hence gaining on the precision on our explanatory variable- we would have lost more than 50% of the observations.

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[82] The one that uses fixed effect estimation adopting Chamberlain's methodology

[83] While for the group with at most junior high education we do not have controls for their intellectual ability (assuming that grades can measure it), for the group of High school and College graduates we actually have this control.

Table 18 reports some summary statistics for the 7th, 8th and 9th waves of the Capitalia dataset. From these three cross sections we have created a longitudinal dataset[84]. These dataset is made up by firms that are observed at least in two successive waves. From Table 19 we notice that 459 firms are observed only in the 7th (years 1995, 1996, 1997) and in 8th wave (years 1998, 1999, 2000), while 924 are observed only in the 8th and in the 9th wave (years 2001, 2002, 2003). Finally, 488 firms are observed in the 7th, in the 8th and in the 9th wave. Hence our panel dimension changes by wave (and hence by year: remember that each wave reports information on three years). Table 19 also documents the response rate on some of the relevant variables in our panel. For instance, for the 7th and 8th wave panel, which is made up by 459 firms (observed three times in the 7th wave and three times in the 8th wave), we have a total of 2754 firm-year observations, while the firm-year observations on real output usable by us are 2295 (the difference between the two is due to missing observation for the variable of interest). If we do the same calculation for the other two panels and we sum up the total number of firm-year observation (12.690) and the total number of usable observations (10.819) we obtain a coverage rate of about 85%. The same has been done for other relevant variables, and we can notice that the lowest value is reached for the variable capturing R&D spending (only 31%: this is due to the fact that an answer of zero is reported as a missing value).

At this point, using the panel data so created, we run a preliminary exercise where we regress the dependent variable (the log of per-capita real output) on each of the potentially relevant explanatory variables (one at a time). This exercise is meant to 1) test the empirical relevance of the various explanatory variables and 2) identify potentially usable instrumental variables (more on this later).

The first interesting result is that per-capita real output is positively and strongly correlated with per-capita capital. What is even more interesting for our study, is the finding that the dummy variable representing ICT investment does not enter with a statistically significant coefficient when regressed against the log of per-capita real output. This suggests that –per se- ICT investment does not appear to have a positive impact on average labour productivity. This result is actually in line with some findings of the empirical literature that has showed that investment in ICT produces results only when coupled with organizational innovations. In fact, when regressing the log of per-capita real output on the "*organizational innovation*" dummy (which has a value of 1 if the firm has engaged in some form of organizational innovation in the three years considered by the wave) we obtain a significant and positive coefficient, suggesting that such a variable should enter into a productivity regression. We do the same for the dummy variable that takes the value of 1 if the firm has done some process or product innovation and we do not find evidence of a statistically significant relationship between such a variable and the log of average labour productivity.

At this point we have further investigated the relationship between the variable capturing organizational innovation and its determinants. This exercise is relevant for two reasons. First, most of the literature (see the review contained in **§ 0**) has found that organizational innovations can produce effects only when they are implemented in the proper firm environment and using the proper investments. Such literature has shown that ICT investment is a key determinant of the success of firms' restructuring, the other being the education and skill composition of the work-force. For these reasons we run a conditional logit model (i.e. a logit model with fixed effects for longitudinal data) where we analyze the effect of some potentially relevant explanatory variables on the probability of observing an organizational innovation. Second, by this exercise we are able to identify potentially useful instruments for the variable "*organizational innovation*", which –in the context of a production function regression- is likely to be endogenous (i.e. driven by the same factors that drive average productivity: we will come back later to the issue of endogeneity).

The results from this exercise, summarized in Table 20 show that the following variables are significantly correlated with the probability of observing an organizational innovation: the fact of being part of a group, the fact that the firm exports some of its output, the number of workers engaged in R&D activities, the share of workers with higher education[85], the share of workers performing skilled tasks, the amount of money invested in workers' training, the fact that the firm has engaged in some R&D and, finally, the fact that the firm has engaged in investment in ICT. Regarding such variable we notice that the coefficient on the ICT dummy variable has a coefficient equal to 0.61 and is highly significant (the other particularly significant coefficients are on the dummy variable for R&D spending and on the dummy related to being part of a group).

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[84] This is a very time consuming exercise for at least two reasons. First data from each cross section have to be cleaned. Second, the same variables are recorded with different names in the various cross/sections.

[85] By that we mean the share of workers with more than a High School diploma.

We now turn to our production function regression, where we regress the per-capita real output on the per-capita capital stock and on the *organizational innovation* dummy, where we control for sector specific dummies[86] and for wave specific dummies[87]. The first result is obtained using an OLS regression, using fixed effects and robust to unknown variance-covariance matrix. These results, summarized in Table 21, show that –once we control for the other factors included in the regression- the *organizational innovation* dummy does not appear to be significant. However, as already mentioned, we suspect that this variable is not exogenous with respect to average labour productivity. In other words, we suspects that the same forces that lead to organizational restructuring also lead to higher productivity. For this reason we need to instrument the *organizational innovation* dummy, finding variables that are strongly correlated with it but that at the same time are not correlated with our dependent variable (i.e. variables that affect the dependent variable only through the *organizational innovation* dummy). Candidates for such a role are the variables that enter with a positive coefficient in the logit equation for the *organizational innovation* dummy and that do not appear to be significantly correlated with the log of per-capita real output. Hence we instrument the *organizational innovation* dummy with the following variables: the investment in ICT dummy variable, the R&D dummy variable, and the "being part of the group" dummy variable, the exporting variable, mean sales for last period and mean expenditures on training programmes. When we use such variables our results change quite substantially, since the coefficient on *organizational innovation* enters with a positive and significant coefficient (0.48) in the productivity regression.

We read these results as suggestive of the following story. ICT investment, per se, does not appear positively and significantly correlated to our measure of labour productivity, even when we do not control for other factors (i.e. even outside from the *ceteris paribus* hypothesis). However, we have evidence that – as suggested by the theoretical and empirical literature reviewed in **§. 8.1**- organizational innovations do have an impact on labour productivity, and such innovations need to be implemented using the appropriate human and technological capital. This emerges clearly from the logit regression, where the skill composition of the work force and the presence of investment in ICT are among the factors that mostly affect the probability of adoption of some organizational innovation (which is affected also by the fact that the firm is part of a group, by the fact that the firm engages in R&D and by the fact that the firm exports a relevant share of it output). The message that emerges from this study is that ICT investment, per se, does not lead to higher productivity, which, however, can be obtained when a more coordinated restructuring plan is taken into consideration, a plan which has among its success determinants the presence of ICT investment[88] and of skilled workers.

Finally, we want to stress that our results are obtained looking at the manufacturing sector, where the impact of ICT is certainly different from the one observed in the service industry and for this reason our results should not be considered as universally valid.

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86 These are meant to control for sector specific time-invariant effects that might affect average labour productivity.

87 These are wave-specific factors (such as the sampling strategy) that might have an effect on measured labour productivity.

88 The fact that the education composition appears to have some effect on the success of the restructuring process seem to provide and indirect evidence that ICT tend to be complementary to skilled and educated human capital.

8.5. Supporting tables

Table 1 Effects on the probability of being employed: PC skills

PC skills	15-34	35-49	50-64
Males			
Pr(employed)	0.513***	0.926***	0.549***
	(0.009)	(0.006)	(0.010)
Pr(employed | No PC skills)	0.561***	0.882***	0.469***
	(0.012)	(0.010)	(0.012)
Raw variation if the individual has PC skills	-0.098***	0.096***	0.266***
	(0.017)	(0.011)	(0.021)
Num. of Obs.	3247	2116	2291
Females			
Pr(employed)	0.375***	0.558***	0.237***
	(0.009)	(0.010)	(0.009)
Pr(employed | No PC skills)	0.313***	0.443***	0.183***
	(0.012)	(0.013)	(0.009)
Raw variation if the individual has PC skills	0.130***	0.329***	0.397***
	(0.018)	(0.019)	(0.029)
Num. of Obs.	2922	2371	2287

Note: Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 2 Effects on the probability of being employed by education: PC skills

PC skills	15-34	35-49	50-64
Males			
High education	-0.111***	-0.002	0.125***
	(0.021)	(0.014)	(0.029)
Low education	-0.133***	0.013	0.092**
	(0.019	(0.017)	(0.036)
Num. of Obs.	3247	2116	2291
Females			
High education	0.052**	0.152***	0.200***
	(0.022)	(0.026)	(0.039)
Low education	-0.077***	0.074*	0.160***
	(0.026)	(0.044)	(0.053)
Num. of Obs.	2922	2371	2287

Note: We control for age, education, civil status, region of residence and household income. Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 3 Male employees, effects on the probability of transiting out of employment

	15-34	35-49	50-64
2000-2002			
Pr(transition)	0.082***	0.027***	0.249***
	(0.012)	(0.006)	(0.021)
Pr(transition | No PC skills)	0.091***	0.045***	0.328***
	(0.017)	(0.011)	(0.030)
Raw variation if the	-0.021	-0.035***	-0.181***
Individual has PC skills	(0.024)	(0.012)	(0.040)
Pr(transition | No PC use at work)	0.095***	0.036***	0.314***
	(0.015)	(0.009)	(0.028)
Raw variation if the	-0.045*	-0.025**	-0.195***
Individual uses a PC at work	(0.024)	(0.011)	(0.039)
Num. of Obs.	512	664	422
2000-2004			
Pr(transition)	0.069***	0.050***	0.397***
	(0.014)	(0.010)	(0.029)
Pr(transition | No PC skills)	0.086***	0.081***	0.472***
	(0.021)	(0.018)	(0.040)
Raw variation if the	-0.044	-0.060***	-0.163***
Individual has PC skills	(0.028)	(0.020)	(0.056)
Pr(transition | No PC use at work)	0.082***	0.072***	0.468***
	(0.018)	(0.015)	(0.036)
Raw variation if the	-0.054**	-0.056***	-0.202***
Individual uses a PC at work	(0.026)	(0.018)	(0.057)
Num. of Obs.	306	479	295
2000-2006			
Pr(transition)	0.083***	0.065***	0.581***
	(0.019)	(0.013)	(0.032)
Pr(transition | No PC skills)	0.086***	0.100***	0.624***
	(0.025)	(0.022)	(0.042)
Raw variation if the	-0.007	-0.068***	-0.099
Individual has PC skills	(0.040)	(0.026)	(0.065)
Pr(transition | No PC use at work)	0.080***	0.093***	0.652***
	(0.021)	(0.019)	(0.038)
Raw variation if the	0.015	-0.072***	-0.218***
Individual uses a PC at work	(0.050)	(0.023)	(0.069)
Num. of Obs.	204	368	234

Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 4 Male employees, effects on the probability of transiting out of employment by education: PC skills

PC skills	15-34	35-49	50-64
2000-2002			
High education	0.009	0.011	-0.139**
	(0.033)	(0.016)	(0.061)
Low education	-0.014	-0.050***	-0.098
	(0.045)	(0.015)	(0.075)
Num. of Obs.	512	664	422
2000-2004			
High education	-0.029	-0.000	-0.219***
	(0.041)	(0.019)	(0.078)
Low education	0.006	-0.055	0.073
	(0.058)	(0.036)	(0.105)
Num. of Obs.	306	479	295
2000-2006			
High education	0.014	0.000	-0.138*
	(0.050)	(0.026)	(0.082)
Low education	-0.017	-0.020	0.106
	(0.078)	(0.049)	(0.114)
Num. of Obs.	204	368	234

Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 5 Male employees, effects on the probability of transiting out of employment by education: use of PC at work

PC use at work	15-34	35-49	50-64
2000-2002			
High education	-0.010	0.018	-0.139**
	(0.031)	(0.015)	(0.055)
Low education	-0.094***	-0.036***	-0.107
	(0.027)	(0.012)	(0.097)
Num. of Obs.	512	664	422
2000-2004			
High education	0.009	0.004	-0.179**
	(0.036)	(0.016)	(0.071)
Low education	-0.073**	-0.068*	-0.033
	(0.035)	(0.036)	(0.125)
Num. of Obs.	306	479	295
2000-2006			
High education	0.082	0.008	-0.229***
	(0.056)	(0.022)	(0.078)
Low education	-0.074*	-0.039	-0.166
	(0.038)	(0.053)	(0.163)
Num. of Obs.	204	368	234

Note: We control for age, education, civil status, region of residence and household income. Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 6 Female employees, effects on the probability of transiting out of employment

	15-34	35-49	50-64
2000-2002			
Pr(transition)	0.113***	0.056***	0.246***
	(0.017)	(0.010)	(0.031)
Pr(transition | No PC skills)	0.132***	0.081***	0.250***
	(0.028)	(0.017)	(0.040)
Raw variation if the individual has PC skills	-0.035	-0.048**	-0.009
	(0.035)	(0.020)	(0.062)
Pr(transition | No PC use at work)	0.141***	0.071***	0.243***
	(0.024)	(0.014)	(0.035)
Raw variation if the individual uses a PC at work	-0.073**	-0.040**	0.012
	(0.033)	(0.019)	(0.071)
Num. of Obs.	336	534	199
2000-2004			
Pr(transition)	0.099***	0.061***	0.462***
	(0.021)	(0.012)	(0.042)
Pr(transition | No PC skills)	0.101***	0.103***	0.488***
	(0.030)	(0.022)	(0.054)
Raw variation if the individual has PC skills	-0.004	-0.082***	-0.065
	(0.041)	(0.025)	(0.085)
Pr(transition | No PC use at work)	0.103***	0.091***	0.481***
	(0.026)	(0.019)	(0.049)
Raw variation if the individual uses a PC at work	-0.011	-0.084***	-0.071
	(0.042)	(0.020)	(0.093)
Num. of Obs.	212	375	145
2000-2006			
Pr(transition)	0.077***	0.080***	0.670***
	(0.023)	(0.016)	(0.044)
Pr(transition | No PC skills)	0.097***	0.104***	0.697***
	(0.035)	(0.027)	(0.057)
Raw variation if the individual has PC skills	-0.040	-0.046	-0.064
	(0.045)	(0.033)	(0.090)
Pr(transition | No PC use at work)	0.085***	0.114***	0.691***
	(0.029)	(0.024)	(0.052)
Raw variation if the individual uses a PC at work	-0.023	-0.088***	-0.074
	(0.046)	(0.028)	(0.099)
Num. of Obs.	142	289	115

Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 7 Female employees, effects on the probability of transiting out of employment by education: PC skills

PC skills	15-34	35-49	50-64
2000-2002			
High education	0.017	0.002	0.097
	(0.040)	(0.021)	(0.076)
Low education	0.159	-0.070	-0.079
	(0.125)	(0.040)	(0.121)
Num. of Obs.	336	534	199
2000-2004			
High education	0.025	-0.032	-0.071
	(0.047)	(0.027)	(0.104)
Low education	-0.065	-0.098*	0.111
	(0.116)	(0.052)	(0.154)
Num. of Obs.	212	375	145
2000-2006			
High education	-0.000	-0.018	0.038
	(0.061)	(0.035)	(0.103)
Low education	-0.061	0.101	-0.109
	(0.076)	(0.094)	(0.171)
Num. of Obs.	142	289	115

Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 8 Female employees, effects on the probability of transiting out of employment by education: use of PC at work

PC use at work	15-34	35-49	50-64
2000-2002			
High education	-0.048	0.001	0.166**
	(0.038)	(0.019)	(0.077)
Low education	0.370**	-0.091***	-0.128
	(0.197)	(0.025)	(0.143)
Num. of Obs.	336	534	199
2000-2004			
High education	-0.005	-0.037*	-0.074
	(0.050)	(0.021)	(0.098)
Low education	0.106	-0.116***	0.180
	(0.225)	(0.033)	(0.168)
Num. of Obs.	212	375	145
2000-2006			
High education	0.018	-0.059*	-0.015
	(0.050)	(0.030)	(0.105)
Low education	-0.032	0.008	0.040
	(0.058)	(0.110)	(0.195)
Num. of Obs.	142	289	115

Note: We control for age, education, civil status, region of residence and household income. Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 9 Self-employed males, effects on the probability of transiting out of employment

	15-34	35-49	50-64
2000-2002			
Pr(transition)	0.073***	0.005	0.201***
	(0.025)	(0.005)	(0.032)
Pr(transition | No PC skills)	0.094**	0.009	0.225***
	(0.041)	(0.009)	(0.042)
Raw variation if the individual has PC skills	-0.041	-0.009	-0.068
	(0.051)	(0.009)	(0.064)
Pr(transition | No PC use at work)	0.092**	0.008	0.239***
	(0.036)	(0.008)	(0.040)
Raw variation if the individual uses a PC at work	-0.047	-0.008	-0.144**
	(0.048)	(0.008)	(0.060)
Num. of Obs.	109	219	159
2000-2004			
Pr(transition)	0.067**	0.030**	0.298***
	(0.032)	(0.015)	(0.043)
Pr(transition | No PC skills)	0.103*	0.029	0.347***
	(0.058)	(0.021)	(0.055)
Raw variation if the individual has PC skills	-0.071	0.000	-0.142
	(0.066)	(0.029)	(0.086)
Pr(transition | No PC use at work)	0.111**	0.025	0.333***
	(0.053)	(0.018)	(0.052)
Raw variation if the individual uses a PC at work	-0.111**	0.010	-0.133
	(0.053)	(0.031)	(0.090)
Num. of Obs.	60	135	114
2000-2006			
Pr(transition)	0.050	0.038**	0.424***
	(0.035)	(0.019)	(0.052)
Pr(transition | No PC skills)	-0.000	0.056*	0.492***
	(0.000)	(0.031)	(0.065)
Raw variation if the individual has PC skills	0.100	-0.036	-0.201*
	(0.069)	(0.037)	(0.105)
Pr(transition | No PC use at work)	0.040	0.046*	0.485***
	(0.040)	(0.026)	(0.062)
Raw variation if the individual uses a PC at work	0.027	-0.021	-0.216**
	(0.077)	(0.037)	(0.108)
Num. of Obs.	40	104	92

Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 10 Self-employed males, effects on the probability of transiting out of employment by education: PC skills

PC skills	15-34	35-49	50-64
2000-2002			
High education	-0.001	-0.003	-0.002
	(0.068)	(0.005)	(0.086)
Low education	0.109	-0.012	0.096
	(0.165)	(0.012)	(0.130)
Num. of Obs.	109	219	159
2000-2004			
High education	-0.033	0.012	0.126
	(0.080)	(0.038)	(0.140)
Low education	0.142	0.006	-0.212**
	(0.231)	(0.025)	(0.094)
Num. of Obs.	60	135	114
2000-2006			
High education	0.006	0.012	0.036
	(0.045)	(0.026)	(0.171)
Low education	0.351	-0.065	-0.297**
	(0.230)	(0.048)	(0.132)
Num. of Obs.	40	104	92

Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 11 Self-employed males, effects on the probability of transiting out of employment by education: use of PC at work

PC use at work	15-34	35-49	50-64
2000-2002			
High education	0.020	-0.003	-0.060
	(0.055)	(0.004)	(0.080)
Low education	0.195	-0.010	0.054
	(0.200)	(0.011)	(0.128)
Num. of Obs.	109	219	159
2000-2004			
High education	-0.019	0.028	0.259**
	(0.059)	(0.038)	(0.126)
Low education	-0.004	-0.007	-0.278***
	(0.142)	(0.029)	(0.080)
Num. of Obs.	60	135	114
2000-2006			
High education	0.004	0.027	0.068
	(0.045)	(0.028)	(0.181)
Low education	-0.178	-0.074	-0.319**
	(0.143)	(0.052)	(0.146)
Num. of Obs.	40	104	92

Note: We control for age, education, civil status, region of residence and household income. Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 12 Self-employed females, effects on the probability of transiting out of employment

	15-34	35-49	50-64
2000-2002			
Pr(transition)	0.043	0.103***	0.281***
	(0.030)	(0.031)	(0.057)
Pr(transition | No PC skills)	-0.000	0.148***	0.302***
	(0.000)	(0.049)	(0.064)
Raw variation if the individual has PC skills	0.069	-0.102*	-0.120
	(0.048)	(0.059)	(0.134)
Pr(transition | No PC use at work)	0.037	0.129***	0.293***
	(0.037)	(0.040)	(0.061)
Raw variation if the individual uses a PC at work	0.016	-0.092*	-0.126
	(0.064)	(0.055)	(0.166)
Num. of Obs.	46	97	64
2000-2004			
Pr(transition)	0.071	0.109***	0.452***
	(0.050)	(0.039)	(0.078)
Pr(transition | No PC skills)	0.083	0.154**	0.485***
	(0.083)	(0.059)	(0.089)
Raw variation if the individual has PC skills	-0.021	-0.114	-0.152
	(0.104)	(0.071)	(0.184)
Pr(transition | No PC use at work)	0.056	0.122**	0.474***
	(0.056)	(0.048)	(0.083)
Raw variation if the individual uses a PC at work	0.044	-0.056	-0.224
	(0.113)	(0.081)	(0.237)
Num. of Obs.	28	64	42
2000-2006			
Pr(transition)	0.143*	0.122**	0.618***
	(0.078)	(0.047)	(0.085)
Pr(transition | No PC skills)	0.111	0.138**	0.714***
	(0.110)	(0.065)	(0.088)
Raw variation if the individual has PC skills	0.056	-0.038	-0.548***
	(0.158)	(0.095)	(0.180)
Pr(transition | No PC use at work)	0.143	0.158**	0.677***
	(0.098)	(0.060)	(0.087)
Raw variation if the individual uses a PC at work	0.000	-0.158**	-0.677***
	(0.170)	(0.060)	(0.087)
Num. of Obs.	21	49	34

Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 13 Self-employed females, effects on the probability of transiting out of employment by education: PC skills

PC skills	15-34	35-49	50-64
2000-2002			
High education	0.032	-0.119	0.189
	(0.071)	(0.083)	(0.206)
Low education	-0.026	-0.081	-0.387***
	(0.056)	(0.054)	(0.124)
Num. of Obs.	46	97	64
2000-2004			
High education	-0.256	-0.111	0.204
	(0.289)	(0.103)	(0.328)
Low education	-0.025	-0.266**	-0.351
	(0.069)	(0.112)	(0.265)
Num. of Obs.	28	64	42
2000-2006			
High education	-0.271	0.093	-0.308
	(0.418)	(0.131)	(0.363)
Low education	0.477	-0.166	-0.996***
	(0.433)	(0.122)	(0.152)
Num. of Obs.	21	49	34

Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 14 Employees aged 25-55 in 2000, hourly wage by gender, age, education and PC skills

	Females		Males	
Education and Age	**No PCskills**	**PC skills**	**No PC skills**	**PC skills**
Low education				
25-35				
Numb. of obs.	93	18	255	63
Mean hourly wage	5.08	5.16	5.56	6.15
Median hourly wage	4.96	5.44	5.67	5.91
36-45				
Numb. of obs.	115	29	278	107
Mean hourly wage	5.62	5.99	6.39	7.20
Median hourly wage	5.46	6.06	6.20	6.95
46-55				
Numb. of obs.	119	29	317	87
Mean hourly wage	5.78	6.95	6.82	8.31
Median hourly wage	5.73	6.45	6.62	7.94
Total				
Numb. of obs.	327	76	850	257
Mean hourly wage	5.52	6.16	6.30	7.32
Median hourly wage	5.46	6.06	6.20	6.95
High education				
25-35				
Numb. of obs.	111	253	193	291
Mean hourly wage	5.99	6.88	6.28	7.04
Median hourly wage	5.71	6.45	6.07	6.45
36-45				
Numb. of obs.	124	275	140	339
Mean hourly wage	7.71	8.60	7.50	9.36
Median hourly wage	7.09	7.94	7.20	8.70
46-55				
Numb. of obs.	114	195	137	305
Mean hourly wage	8.84	9.55	8.35	10.99
Median hourly wage	8.02	8.27	7.45	9.93
Total				
Numb. of obs.	349	723	470	935
Mean hourly wage	7.54	8.25	7.25	9.17
Median hourly wage	6.90	7.45	6.95	8.27

Our sample includes individuals employed outside the agricultural sector and working full-time for the whole year. Only information about the main job is considered.

Table 15 Employees aged 25-55 in 2000, hourly wage by gender, age, education and PC use at work

	Females		Males	
Education and Age	**No PC use**	**PC use**	**No PC use**	**PC use**
Low education				
25-35				
Numb. of obs.	102	9	284	34
Mean hourly wage	5.09	5.08	5.59	6.35
Median hourly wage	4.96	5.29	5.71	6.21
36-45				
Numb. of obs.	128	16	322	63
Mean hourly wage	5.58	6.61	6.42	7.62
Median hourly wage	5.46	6.54	6.20	7.45
46-55				
Numb. of obs.	126	22	354	50
Mean hourly wage	5.80	7.18	6.95	8.53
Median hourly wage	5.74	6.54	6.74	7.89
Total				
Numb. of obs.	356	47	960	147
Mean hourly wage	5.52	6.58	6.37	7.63
Median hourly wage	5.46	6.34	6.20	7.20
High education				
25-35				
Numb. of obs.	151	213	249	235
Mean hourly wage	6.26	6.85	6.24	7.26
Median hourly wage	6.06	6.45	5.96	6.70
36-45				
Numb. of obs.	189	210	199	280
Mean hourly wage	8.39	8.26	7.88	9.49
Median hourly wage	7.74	7.60	7.20	9.05
46-55				
Numb. of obs.	169	140	182	260
Mean hourly wage	9.24	9.35	8.88	11.08
Median hourly wage	8.22	8.27	7.73	9.93
Total				
Numb. of obs.	509	563	630	775
Mean hourly wage	8.04	8.00	7.52	9.35
Median hourly wage	7.17	7.44	6.95	8.51

Our sample includes individuals employed outside the agricultural sector and working full-time for the whole year. Only information about the main job is considered.

Table 16 Employees aged 25-55 in 2000, linear regressions of the logarithm of the hourly wage (PC Skills)

PC skills	**15-34**	**35-49**	**50-64**
Males			
High education	-0.111***	-0.002	0.125***
	(0.021)	(0.014)	(0.029)
Low education	-0.133***	0.013	0.092**
	(0.019	(0.017)	(0.036)
Num. of Obs.	3247	2116	2291
Females			
High education	0.052**	0.152***	0.200***
	(0.022)	(0.026)	(0.039)
Low education	-0.077***	0.074*	0.160***
	(0.026)	(0.044)	(0.053)
Num. of Obs.	2922	2371	2287

Our sample includes individuals employed outside the agricultural sector and working full-time for the whole year. Only information about the main job is considered. Standard errors are robust to arbitrary heteroskedasticity in the error terms.

Note: We control for age, age squared, household size, civil status, education, interactions between education and age, diploma/university degree final mark, type of university degree, years of contribution, job characteristics, sector of employment, firm dimension, region of residence and other household income. Chamberlain panel data models plug time averages of age, age squared, household size and other household income in the specifications to control for unobserved individual effects. Standard errors of Pooled OLS and Chamberlain specifications are robust to arbitrary heteroskedasticity at the individual level in the error terms. Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 17 Employees aged 25-55 in 2000, linear regressions of the logarithm of the hourly wage (PC Use)

PC use	2000	2002 (panel)		2004 (panel)	
	cross-section	Pooled OLS	Chamberlain	Pooled OLS	Chamberlain
Males					
University	-0.029	-0.005	-0.002	-0.006	0.007
	(0.048)	(0.097)	(0.096)	(0.102)	(0.100)
High school	0.056***	0.051**	0.056**	0.054**	0.068**
	(0.018)	(0.026)	(0.026)	(0.031)	(0.031)
Lower education	0.036*	0.062**	0.062**	0.031	0.032
	(0.020)	(0.028)	(0.028)	(0.033)	(0.033)
Num. of obs.	2512	1880	1880	1743	1743
Num. of ind.	2512	940	940	581	581
Females					
University	-0.017	-0.056	-0.054	-0.049	-0.047
	(0.042)	(0.053)	(0.053)	(0.063)	(0.063)
High school	-0.004	-0.039	-0.039	-0.009	-0.011
	(0.021)	(0.031)	(0.031)	(0.038)	(0.038)
Lower education	0.004	0.063	0.067	0.100*	0.103*
	(0.033)	(0.046)	(0.046)	(0.055)	(0.056)
Num. of obs.	1475	1062	1062	978	978
Num. of ind.	1475	531	531	326	326

Our sample includes individuals employed outside the agricultural sector and working full-time for the whole year. Only information about the main job is considered. Standard errors are robust to arbitrary heteroskedasticity in the error terms.

Note: We control for age, age squared, household size, civil status, education, interactions between education and age, diploma/university degree final mark, type of university degree, years of contribution, job characteristics, sector of employment, firm dimension, region of residence and other household income. Chamberlain panel data models plug time averages of age, age squared, household size and other household income in the specifications to control for unobserved individual effects. Standard errors of Pooled OLS and Chamberlain specifications are robust to arbitrary heteroskedasticity at the individual level in the error terms. Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 18 Size of cross-sections and coverage for the Logistic regression

Size of the cross-sections			
Wave	**7th**	**8th**	**9th**
Firms	4495	3034	4178
Firm-years	13485	9102	12534
Organizational Innovation	3450	1146	3036
Coverage	77%	37-38%	73%

Table 19 Size of the longitudinal data and coverage for the productivity regressions

Size of the panel				
Waves	**7^{th}-8^{th}**	**8^{th}-9^{th}**	**7^{th}-8^{th}-9^{th}**	**Firms**
1995	459		488	947
1996	459		488	947
1997	459		488	947
1998	459	924	488	1871
1999	459	924	488	1871
2000	459	924	488	1871
2001		924	488	1412
2002		924	488	1412
2003		924	488	1412
Firm-years	2754	5544	4392	12690
Real Production	2295	4620	3904	10819 (85%)
Capital Stock	2689	2940	3749	9378 (74%)
Labour input	2752	5544	4387	12683 (99%)
R&D capital	1194	1142	1631	3967 (31%)

Table 20 Logistic regression for the probability of observing Organizational Innovations

Organizational innovation	Panel regression
Log of sales	0.36*
	(0.17)
Operating profits	-0.003
	(0.012)
Cash flow	-0.009
	(0.010)
Being part of a group	0.69**
	(0.21)
Exporting a significant part of output	0.59*
	(0.24)
Ratio of workers with high education over workers with low education	0.03*
	(0.014)
Ratio of workers with high skills over workers with low skills	0.001
	(0.0009)
Has invested in R&D	0.88***
	(0.16)
Share of workers involved in R&D	2.76*
	(1.08)
Has invested in ICT	0.61***
	(0.17)
Training expenditures	1.11*
	(0.50)
Age of the firm	0.016
	(0.025)
Number of observations	2563

Note: We also controlled for sector specific dummies.

Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

Table 21 Panel data estimation for the log of per-capita output

Log of per capita output	OLS	IV
Log of per-capita capital	0.28***	0.48***
	(0.04)	(0.088)
Organizational innovation	0.006	0.26***
	(0.016)	(0.014)
Number of observations	7299	7134

Note: We also controlled for sector and wave specific dummies.

Standard errors are in parenthesis. ***:p-value≤0.01, **:0.01<p-value≤0.05, *:0.05<p-value≤0.1

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