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Abstract
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Keywords
Computer use, internet, retirement, instrumental variables, compliers

JEL Codes
J14, J21, J24

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Abstract

Inability to cope with Information and Communication Technology (ICT) might represent a threat for older individuals' social inclusion. This paper analyses the effect of retirement on the familiarity with ICT of older individuals. To account for the potential endogeneity of retirement with respect to ICT knowledge we instrument retirement decision with the age-eligibility for early and statutory retirement pension schemes. Using data from the Survey of Health Ageing and Retirement in Europe we show that retirement reduces the computer literacy and the frequency of internet utilization for men and women. This effect is heterogeneous for women with respect to their propensity to opt for early or statutory retirement schemes. The exit from the labour market does not reduce ICT familiarity for the former, but it does for the latter. The negative retirement effect on ICT knowledge is stronger for white-collar workers, whose occupations require a more intense use of these skills as compared with blue-collar jobs.

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1. Introduction

The use of Information and Communication Technology (ICT) is a major issue for older individuals. Based on data drawn from the 2003 wave of the Eurobarometer, Peacock and Künemund (2007) show that the percentages of computer users and internet users among individuals aged 55-64 amount only to 35% and 26% respectively and fall to 11% and 8% when considering those aged 75 or over. A decade later, OECD (2017) shows that in OECD countries the percentage of individuals aged 55-74 using internet reaches 63%, but in all countries the percentage of internet users in this age range is lower than the overall percentage in the country. Although the access to ICT of older individuals shows a positive trend, they are still at risk of falling behind the rest of the population. Inability to cope with ICT might represent a threat for older individuals' social inclusion. For instance, ICT might make it easier to communicate with relatives and social network members by e-mail, video-call and chat applications (Wellman, 2001). They might also be of help to organize leisure activities, including travelling or going to museums or the theatre (Näsi et al., 2012), or to deal with the increasing digitalization of services, for instance those in the health care sector that offer online procedures to simplify the booking of medical examinations and the report withdrawal. Moreover, computer and internet usage are important tools to reduce the participation costs associated with financial markets investments and portfolio management. Everything else constant, familiarity with ICT is expected to improve individuals' well-being by supporting the strength of their social ties and providing a manifold support to the activities in which they are, or would like to be, engaged.

In this paper we investigate the effect of retirement on the computer and internet use of older individuals in Europe. Data are drawn from the waves 5 and 6 of the Survey of Health, Ageing and Retirement in Europe (SHARE). Our sample includes individuals aged 50-69 and living in thirteen European countries plus Israel.

Retirement is a major life-course event and the literature has already studied its effects on several domains relevant for the social inclusion of older individuals, such as physical health (see Coe and Zamarro, 2011), mental health (see Avendano and Berkman, 2005 for a review and Belloni et al.,

2016 for an investigation based on SHARE data) and cognitive functioning (see for instance, Celidoni et al., 2017 and Mazzonna and Peracchi, 2017 for two recent contributions). Our paper offers to the literature the assessment of the retirement effects on the older individuals' familiarity with ICT, which is a key factor shaping the opportunities available to them to interact with others and strengthen their social inclusion. Employment might guarantee a continuous access to the development of ICT facilities. Gaining at work a higher familiarity with word-processing, spreadsheet elaborations, emailing, video-calling, web-browsing and search engines can have immediate spin-offs on the various ways in which individuals can avail themselves of ICT in their non-labour market activities. Nevertheless, the sign of the effect of retirement on ICT knowledge is a priori ambiguous. On the one hand, individuals who retire have no longer available the opportunities provided by their jobs to maintain and develop their knowledge of ICT, making their skills more at risk of fading away or becoming obsolete. On the other hand, the exit from the labour market might expand the amount of time available for leisure activities and this might act as an incentive to exploit current ICT knowledge as well as to improve it through learning-by-doing or interactions with social network members. Which of these two effects prevails remains an empirical issue.

Analyzing the causal effect of retirement on the familiarity with ICT is complicated by the potential endogeneity arising in this context. Unobserved characteristics are likely to affect both retirement decisions and skills in managing ICT. For instance, ambition and dedication might make workers more willing to invest in their ICT knowledge in order to increase their productivity and improve their job prospects. As long as these skills are rewarded in the labour market, individuals with higher familiarity with ICT devices might also find attractive to delay their exit from the labour force (Biagi et al., 2013 and Friedberg, 2003), bringing about reverse causality concerns. Moreover, individuals who have a higher marginal utility of leisure might have found outside the labour market the occasions and the incentives to invest in their ICT knowledge, for instance in order to organize their leisure time. Everything else constant, these individuals might be active computer and internet users and

would like to retire as soon as possible to expand the amount of time devoted to their non labour market activities.

We address the potential endogeneity of retirement using an instrumental variable approach. Our instruments are based on institutional information concerning the eligibility ages for early and statutory retirement, which vary across country, gender and birth cohort, as well as over time.

The main findings of our analysis come from the instrumental variable estimation of linear probability models specified separately by gender. As for men, our results show that retirement decreases the familiarity with ICT by inducing a statistically significant decrease in the probability of using computers and internet. As for women, we detect a heterogeneous effect. Women who retire as soon as they become eligible for early retirement schemes have a propensity to use computers and internet that is not hampered by their exit from the labour force. Instead, women who retire only once become eligible for statutory retirement exhibit a significant reduction in their propensity to use ICT devices. Early and statutory retirement female compliers appear to be different with respect to some key observable characteristics. The former are less educated and more likely to work as blue collar workers than the latter. All these attributes are negatively correlated with using a computer at work in our sample. This evidence suggests that individuals who carry out jobs in which ICT contents are less pervasive are also less likely to have their ICT knowledge hampered from retirement. Moreover, early retirement compliers are more likely to have a cohabiting partner. Even if the end of their working career is likely to decrease their propensity to use ICT devices, this negative effect might be counterbalanced by the incentives to use ICT to organize their joint leisure time with partners. Finally, for both genders, the negative retirement effect on ICT knowledge is stronger for white-collar workers, whose occupations typically require a more intense use of these skills than blue-collar jobs. For white-collars, the disadvantages of retirement causing a detachment of individuals from the use of ICT at work appear to be stronger.

The paper continues as follows. Section 2 presents the data. Section 3 describes our estimation strategy. Section 4 discusses our findings. Section 5 summarizes a robustness analysis. Section 6 concludes.

2. Data

We use the waves 5 and 6 of SHARE, which have been collected in 2013 and 2015 respectively. SHARE is a multidisciplinary and multi-country survey whose population of reference consists of individuals aged 50 or over and their spouses living in Europe and Israel. Data are collected by CAPI questionnaires that are ex-ante standardized and allow meaningful cross-country comparisons of respondents' answers. SHARE interview gathers information on several dimensions relevant for individual well-being, including employment, health, social and family networks, income and wealth. In our sample we include individuals who self-classify themselves as either at work or retired from work[1]. We consider only individuals who are currently at work as employees or whose last job was as employees. We decide to exclude current and former self-employed individuals because they might formally retire but remain partially involved in their previously-run business (for instance, a family business), blurring the distinction between retirement and employment. Retirement is considered an absorbing state: no transitions from retirement back to work are allowed[2].

The questionnaires administered in the interviews conducted in waves 5 and 6 of SHARE elicit respondents' computer literacy and internet use by means of two questions. The first question asks to rate computer skills by answering to the question "*How would you rate your computer skills?*" according to the predetermined scale "*1. Excellent, 2. Very good, 3. Good, 4. Fair, 5. Poor, 6. I never*

[1] The question asks "*In general, which of the following best describes your current employment situation?*" Answering categories are the following: "*1. Retired, 2. Employed or self-employed, 3. Unemployed, 4. Permanently sick or disabled, 5. Homemaker, 97. Other*". The questionnaire remarks that the category "*1. Retired*" refers to retired from own work only.

[2] We further exclude individuals who transit to retirement from either a long period (at least two waves) of unemployment or from disability and women who retire after having declared being homemaker as prevalent economic status in previous waves. Among individuals always observed as retired, we exclude those who declare to have never worked.

used a computer[3]". The second question focuses on the use of internet and asks "*During the past 7 days, have you used the Internet, for e-mailing, searching for information, making purchases, or for any other purpose at least once?*" (Yes/No).

These two questions allow describing two different aspects of the familiarity with ICT of older individuals. The former question provides us with a self-assessment of the level of computer literacy, which includes, but it is not confined to, browsing the web since it also reflects skills with other computer applications and with managing hardware issues. Based on this question, we derive a binary indicator that takes on value 1 when individuals have at least good computer skills and zero otherwise (*pcgood*). The latter question instead provides a summary measure of the frequency of utilization of internet in the last seven days. We therefore generate a binary measure that takes on value 1 if the individual reports to have used internet in the last week (*internet*). Considering these two measures outlines to what extent older individuals are successful in managing ICT devices and how much frequently they use these skills.

Our sample includes 19,188 observations for men and 22,681 for women aged 50-69 and living in Denmark, Sweden, Belgium, Luxembourg, France, Germany, Austria, Switzerland, Spain, Italy, Estonia, Czech Republic, Slovenia and Israel. Overall, 50% of respondents in our sample think they have at least good computer skills and 72% browse the web at least weekly. Figure 1 shows that for both genders there is a sizeable North-South gradient in the familiarity with ICT of older Europeans. For instance, in Denmark the percentage of men who rate their computer skills as at least good is 76%, whereas it is 33% in Spain. If we look at the other countries, we see that computer literacy is higher in Switzerland and Sweden and lower in Estonia and Czech Republic. Similar patterns arise for women. As for internet use, 72% of the men in our sample have used internet at least once in the last week. This percentage shrinks to less than 60% in Spain, Italy, Czech Republic, Slovenia and Estonia, whereas it jumps to more than 85% in Denmark, Sweden, Switzerland and Belgium. These

[3] The last answering category is selected by the interviewer only if respondent spontaneously declared she has never used a computer.

empirical findings align with the evidence presented in OECD (2017). Web users among individuals aged 50 or over are overall more widespread in Northern Europe than in Mediterranean countries, mimicking the pattern arising from computer skills.

Figure 1: Computer skills (left panel) and percentage of individuals who have used internet in the last seven days (right panel), by country and gender.

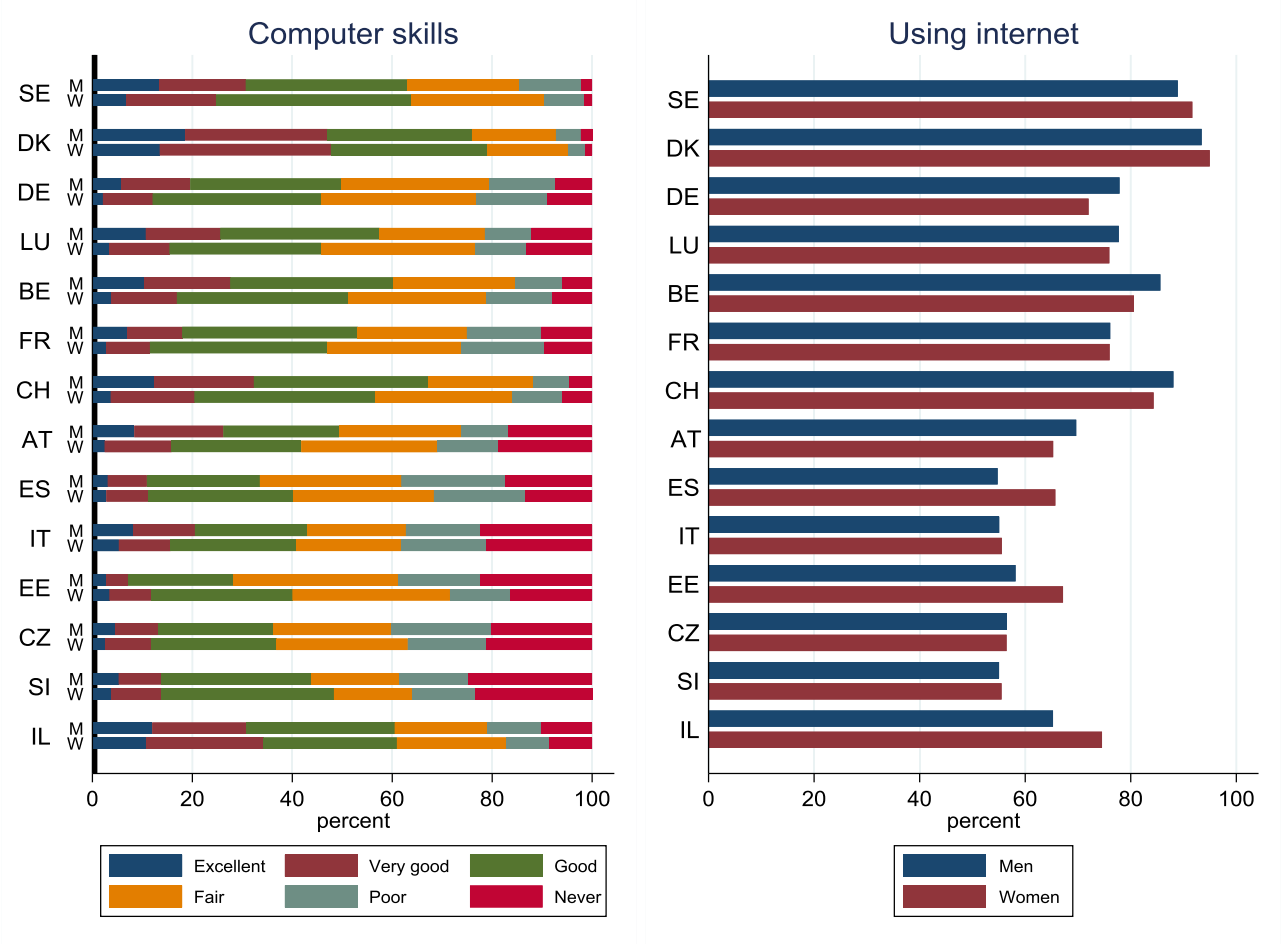


Table 1 presents the sample averages of the variables used in the analysis by gender and retirement status. In the sample, 48% of men and 46% of women are retired. The fractions of individuals reporting good computer skills (*pcgood*) or frequent internet use (*internet*) by retirement status provide prima facie evidence of the negative correlation between retirement and computer literacy. On average, 60% of male workers have at least good computer literacy, whereas only 40% of male retirees reach this level of skills. This difference is confirmed when looking at women. In all the countries considered, men and women at work declare to have higher computer skills than retirees.

This evidence is clearly descriptive as differences between workers and retirees are partly attributable to other individual characteristics (such as age), that we are controlling for in the following analyses. We exploit contextual information concerning Social Security systems to determine whether an individual meets the age requirements set by early retirement (ER) and statutory retirement (SR) schemes. Whereas for current employees we consider the age requirements in place at the time of the interview, for retirees we consider those in place at the reported retirement year. Table 1 shows that at the time of the interview almost all retirees satisfy the age requirement for an Early Retirement (*eligible_ER*) scheme (92% for men and 96% for women), whereas 69% of male retirees and 81% of female retirees are age eligible for a Statutory Retirement (*eligible_SR*) pension. On the contrary, the fractions of workers eligible to ER or SR schemes are much lower. Overall, only one fourth of workers meet the age requirement for the ER route and less than 10% do so for SR.

In the sample, 45% of men have lower or upper secondary education and 29% have tertiary education. They are on average 60.8 years old, most of them live with a partner (85%), 90% have children and 56% have grandchildren. Women are less likely to live with a partner (73%) and to work (or to have worked) as blue collars (22% versus 37%) than men, but they are more likely to work in the public sector (44% versus 31%). Among both men and women, about 4% declare to be in poor health. Consistently, the average number of limitations with (instrumental) activities of daily living is remarkably low for both men and women as most of the individuals in our sample do not suffer of these problems[4]. For both genders, retirees are 8 to 9 years older than workers, less healthy and more likely to have worked as blue collars and in the private sector.

Table 1: Sample averages of the variables used in the analysis.

	Men			Women		
Variable	All	Workers	Retired	All	Workers	Retired

[4] Activities of daily living include dressing, walking across a room, bathing or showering, eating, getting in and out of bed and using the toilet. Instrumental activities of daily living include using a map, preparing a hot meal, shopping for groceries, making telephone calls, taking medications, doing work around the house or garden, managing money, leaving the house independently, accessing transportation services and doing personal laundry. The last three activities are considered in wave 6 only.

pcgood	0.51	0.60	0.40	0.49	0.60	0.36
internet	0.72	0.82	0.61	0.72	0.84	0.58
eligible_ER	0.56	0.24	0.92	0.58	0.25	0.96
eligible_SR	0.35	0.05	0.69	0.40	0.06	0.81
couple	0.85	0.85	0.85	0.73	0.76	0.70
lower/upper secondary educ.	0.45	0.46	0.44	0.45	0.44	0.45
tertiary educ.	0.29	0.34	0.24	0.30	0.37	0.23
age	60.8	57.1	65.0	60.2	56.4	64.7
poor health	0.04	0.02	0.07	0.04	0.03	0.07
adl	0.08	0.04	0.13	0.08	0.05	0.11
iadl	0.09	0.04	0.15	0.12	0.07	0.19
blue collar	0.37	0.34	0.41	0.22	0.17	0.27
public sector	0.31	0.28	0.34	0.44	0.43	0.45
children	0.90	0.90	0.90	0.92	0.91	0.92
grandchildren	0.56	0.42	0.71	0.63	0.50	0.78
wave 6	0.44	0.43	0.45	0.45	0.45	0.45
Observations	19,188	10,055	9,133	22,681	12,319	10,362

3. Empirical strategy

To address the effect of retirement on the familiarity with ICT, we estimate the following linear probability model:

$$y = \beta_0 + \beta_1 retired + \boldsymbol{\beta_2'} \boldsymbol{x} + u \qquad (1)$$

where y is the outcome variable considered, $retired$ is the key explanatory variable, $\boldsymbol{x}$ is a vector of individual and household characteristics and u is the error term. As mentioned above, we run all our econometric specifications separately by gender.

The set of controls in the vector $\boldsymbol{x}$ includes country of residence fixed effects, a second order polynomial of age, a time fixed effect to discriminate between observations of the waves 5 and 6 of SHARE, education (*lower/upper secondary* and *tertiary education*; having less than secondary education is the baseline group), current health (*poor health*), number of limitations with activities of daily living (*adl*), number of limitations with the instrumental activities of daily living (*iadl*), a set of controls for the family structure (*couple*, *children* and *grandchildren*) and country-specific quartile dummies for household net wealth (*hh wealth second/third/fourth quartile*). Moreover, we control

for job characteristics. For current employees this information refers to their current job, for retirees it refers to their last job before retirement (*blue collar* and *private sector*).

Ordinary least square (OLS) estimation of equation (1) provides a consistent estimate of the causal effect of retirement on ICT knowledge (β_1) only if retirement is not correlated with the error term u. However, the unobserved component u summarizes personal traits, such as ambition and dedication, which might affect both the timing of retirement and the propensity to maintain up-to-date their ICT knowledge. For instance, individuals with a stronger labour market attachment and a stronger desire to meet career and job promotion goals might be more likely to delay retirement and more likely to invest in their human capital, which includes the proficiency in computer and web utilization, in order to keep their knowledge up-to-date and reap the rewards offered by the labour market for these skills. This reasoning also suggests the presence of a reverse causality issue: in a labour market characterized by continuous technological innovations, individuals who are more prone to invest in their ICT knowledge are also more likely to face the working conditions that make retirement postponement more attractive. As long as retirement lowers the familiarity with ICT, failing to control for this source of heterogeneity might lead to a spurious amplification of this negative effect.

Moreover, the error component u includes individual heterogeneity in the marginal utility of leisure. Individuals who place a higher importance on their leisure time activities might have developed better ICT knowledge to organize them regardless of their job characteristics and might have a stronger desire to retire as soon as possible to expand the amount of leisure time available. Neglecting this dimension of heterogeneity across individuals would lead to an attenuation in the negative effect of retirement emerging at the descriptive level and documented in Table 1.

We solve this potential threat to the identification of the causal effect of retirement on ICT knowledge using an instrumental variable strategy. We rely on two dummy variables $eligible\_ER$ and $eligible\_SR$ indicating whether respondents are eligible to early and statutory retirement schemes respectively. As discussed in the previous section, these variables are defined by combining individual-level information for country of residence, gender and birth-cohort with country-specific

institutional information reflecting the minimum age requirements needed to access the early and statutory retirement routes. See Online Appendix A for details on the eligibility rules.

Figure 2 and 3 report the proportion of males and females who are retired as a function of the years since/to eligibility age, for statutory and early retirement respectively. These figures show that there are sizable increases in the proportion of retired at both statutory and early retirement age (in Online Appendix B we report the same figures separately for each country, Figures B.1- B.4).

Figure 2: Proportion of retired since/to statutory retirement age. All countries.

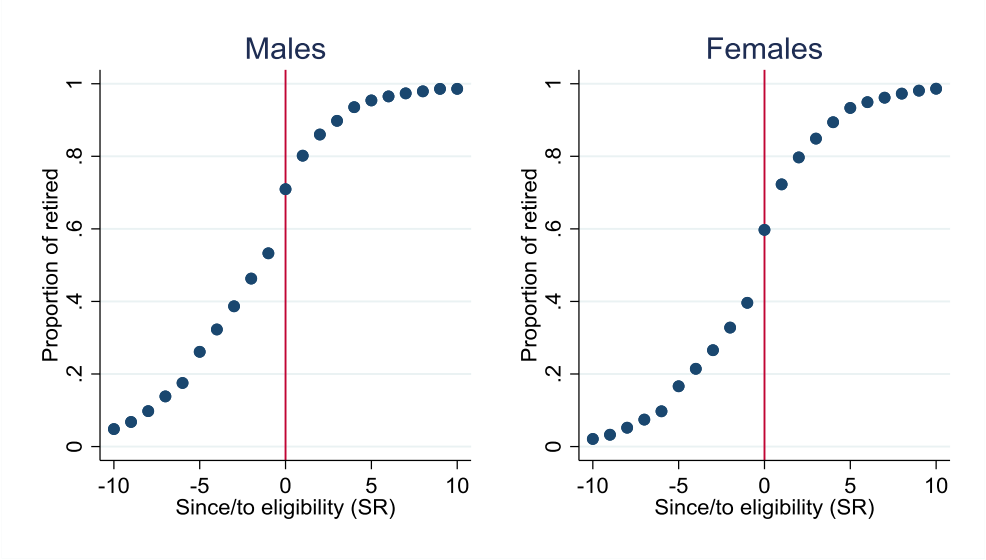
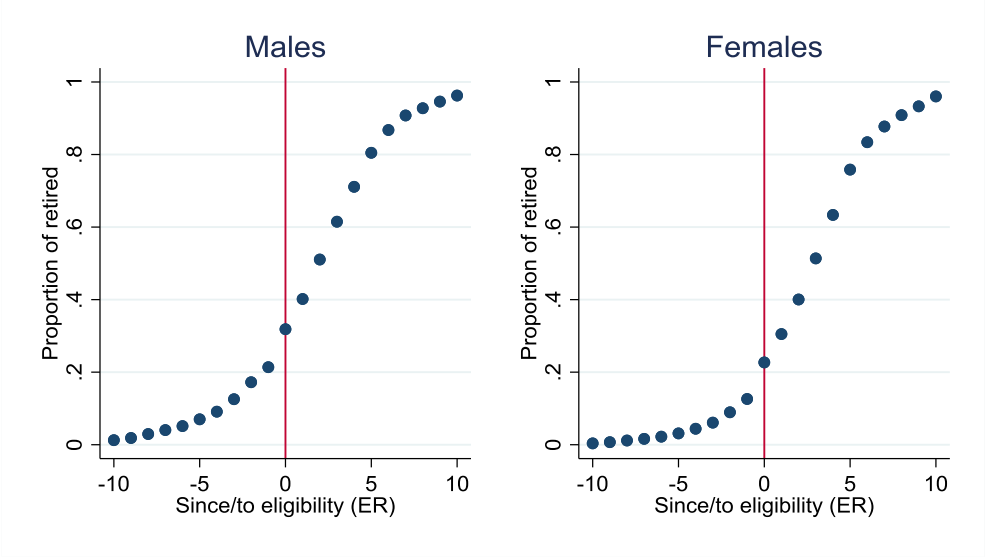


Figure 3: Proportion of retired since/to early retirement age. All countries.



Using institutional information concerning pension systems makes us confident that our instruments are not under the direct control of the individuals and are arguably exogenous (Angelini et al., 2009; Battistin et al., 2009; Rohwedder and Willis, 2010).

4. Results and discussion

In Table 2 we report OLS estimates of equation (1) using as outcome our two binary measures of familiarity with ICT in turn.

Table 2: Probability of having at least good computer skills and having used internet in the last seven days. Linear probability models estimated by OLS.

	Men		Women	
	(1)	(2)	(3)	(4)
VARIABLES	pcgood	internet	pcgood	internet
retired	-0.049***	-0.047***	-0.071***	-0.067***
	(0.011)	(0.010)	(0.011)	(0.010)
couple	0.037***	0.056***	-0.025***	0.011
	(0.011)	(0.010)	(0.008)	(0.007)
lower/upper secondary educ.	0.112***	0.133***	0.129***	0.134***
	(0.010)	(0.010)	(0.009)	(0.010)
tertiary educ.	0.284***	0.226***	0.212***	0.220***
	(0.012)	(0.011)	(0.011)	(0.010)
age/10	0.299*	0.398***	0.634***	0.641***
	(0.157)	(0.138)	(0.142)	(0.124)
age squared/100	-0.034**	-0.043***	-0.062***	-0.063***
	(0.013)	(0.012)	(0.012)	(0.010)
poor health	-0.080***	-0.086***	-0.058***	-0.087***
	(0.016)	(0.017)	(0.015)	(0.016)
adl	-0.013	-0.000	0.010	-0.001
	(0.009)	(0.009)	(0.008)	(0.008)
iadl	-0.015**	-0.025***	-0.047***	-0.040***
	(0.007)	(0.008)	(0.007)	(0.007)
blue collar	-0.254***	-0.212***	-0.253***	-0.240***
	(0.009)	(0.009)	(0.009)	(0.010)
public sector	-0.010	-0.000	-0.005	0.018***
	(0.008)	(0.007)	(0.007)	(0.006)
children	0.023*	0.044***	-0.033**	0.022**
	(0.013)	(0.012)	(0.013)	(0.011)
grandchildren	-0.029***	-0.003	-0.015*	-0.026***
	(0.009)	(0.007)	(0.008)	(0.007)
wave 6	0.004	0.049***	0.010**	0.063***
	(0.005)	(0.004)	(0.005)	(0.004)
constant	-0.221	-0.284	-1.170***	-1.013***
	(0.469)	(0.409)	(0.425)	(0.364)

Observations	19,188	19,188	22,681	22,681

Note: Additional controls: household wealth quartiles, country dummies. Standard errors clustered at the individual level. *** p<0.01, ** p<0.05, * p<0.1.

The first two columns refer to men. In the first column we consider the probability of having at least good computer skills. The coefficient on the dummy variable $retired$ is negative and statistically significant. It shows that, conditional on observable covariates in the $\boldsymbol{x}$ vector, the probability of having good computer literacy reduces by 4.9 percentage points for those who are retired. This variation is sizeable as it accounts for about 10% of the sample average for this outcome. The second column reports the estimates when considering the probability of having used internet in the last week. Retirees are 4.7 percentage points less likely than employees to use internet in the time period of reference. On average, the proportion of web users in our population of interest decreases by 7%. As before, this variation is statistically significant.

As for the other control variables, we notice that the probabilities of having good computer literacy and browsing the web at least on a weekly basis are significantly higher for individuals with higher education and higher wealth levels, who live in a couple and are healthier. Cross-country differentials remain substantial even after conditioning on the right-hand-side variables in our specifications.

Columns 3 and 4 summarize the results of the same analysis conducted for women. Likewise men, female retirees are significantly less likely to have good computer skills (-7.1 percentage points) and less likely to use internet frequently (-6.7 percentage points).

The OLS results neglect any endogeneity issue of retirement with respect to familiarity with ICT. In particular, the error term u is assumed to be uncorrelated with retirement decisions, although we argued in the previous section that both reverse causality and unobserved heterogeneity might cast doubts on this assumption. In what follows, we relax this assumption and estimate the model in equation (1) using instrumental variable techniques and relying on the exogenous variability induced by heterogeneity in eligibility rules for early and statutory retirement schemes (*eligible_ER* and *eligible_SR*).

Table 3: Probability of having at least good computer skills and having used internet in the last seven days. Linear probability models estimated by 2SLS.

	Men		Women	
	(1)	(2)	(3)	(4)
VARIABLES	pcgood	internet	pcgood	internet
retired	-0.104**	-0.079**	-0.092***	-0.070**
	(0.044)	(0.038)	(0.030)	(0.030)
couple	0.038***	0.056***	-0.025***	0.011
	(0.011)	(0.011)	(0.008)	(0.008)
lower/upper secondary educ.	0.111***	0.133***	0.128***	0.134***
	(0.011)	(0.012)	(0.010)	(0.010)
tertiary educ.	0.280***	0.224***	0.211***	0.220***
	(0.012)	(0.013)	(0.014)	(0.013)
age/10	0.213	0.347**	0.604***	0.636***
	(0.187)	(0.168)	(0.155)	(0.167)
age squared/100	-0.023	-0.037**	-0.058***	-0.063***
	(0.016)	(0.015)	(0.013)	(0.015)
poor health	-0.074***	-0.083***	-0.057***	-0.087***
	(0.016)	(0.017)	(0.017)	(0.016)
adl	-0.012	0.000	0.010	-0.001
	(0.008)	(0.009)	(0.008)	(0.009)
iadl	-0.014**	-0.025***	-0.046***	-0.040***
	(0.007)	(0.008)	(0.007)	(0.006)
blue collar	-0.253***	-0.211***	-0.253***	-0.240***
	(0.010)	(0.010)	(0.009)	(0.011)
public sector	-0.008	0.000	-0.004	0.018***
	(0.009)	(0.007)	(0.008)	(0.007)
children	0.020	0.043***	-0.033**	0.022*
	(0.013)	(0.012)	(0.013)	(0.011)
Grandchildren	-0.027***	-0.002	-0.015*	-0.026***
	(0.009)	(0.008)	(0.008)	(0.008)
wave 6	0.003	0.048***	0.009	0.063***
	(0.006)	(0.005)	(0.006)	(0.005)
Observations	19,188	19,188	22,681	22,681
Endogeneity test p-value	0.211	0.366	0.439	0.928
Sargan-Hansen p-value	0.513	0.794	0.187	0.097
eligible_ER	0.241***		0.215***	
	(0.025)		(0.027)	
eligible_SR	0.209***		0.370***	
	(0.024)		(0.031)	
Weak identification	132.141		217.888	

Note: Additional controls: household wealth quartiles, country dummies. Standard errors are clustered by country and cohort. *** p<0.01, ** p<0.05, * p<0.1. Stock-Yogo weak ID test critical values: 10% maximal IV size 19.93, 15% maximal IV size 11.59, 20% maximal IV size 8.75, 25% maximal IV size 7.25.

Table 3 provides Two-stage Least Square (2SLS) estimates separately by gender and for the two outcomes considered in the analysis. Columns (1) and (2) present estimation results for men and show that our previous OLS findings are reinforced by the instrumental variable estimation. Once controlling for the possible endogeneity of retirement, its effect on computer literacy and frequency of web utilization doubles. Male retirees are now less likely to have good computer literacy and use internet at least once in a week by 10.4 and 7.9 percentage points respectively. These reductions amount to 20% and 11% of the sample averages of these two outcomes.

At the bottom of Columns (1) of Table 3 we report first-stage coefficients for the two instruments used: *eligible_ER* and *eligible_SR* prove to be strongly correlated with retirement decisions. Everything else constant, those who are eligible for early or statutory retirement schemes are significantly (at the 1% level) more likely to be retired. The probability of being retiree increases by 24.1 and 20.9 percentage points when the individuals become eligible for early retirement and statutory retirement pension schemes respectively. A more formal test to detect weak instruments is the F-statistic of the joint significance of the instrumental variables in the first-stage equation. The F-statistic takes a value well above the Stock and Yogo (2005)'s critical values (which are reported below the table) suggesting that instruments are relevant.

Given that our model is over-identified - we have two additional instruments for one endogenous regressor – we can compute the Sargan-Hansen over-identification test. This test allows to check the validity of the instruments, in other words whether they are uncorrelated with the error term, u. We report the p-values of the Sargan-Hansen tests for the specification in Columns (1) and (2) and conclude that the validity of the over-identifying restrictions is not rejected. We also report the results of an endogeneity test showing that the null hypothesis of exogeneity for our retirement explanatory variable is not rejected at conventional significance levels.

The evidence provided so far for men suggest that retirement induces a reduction in individuals' computer skills and frequency of internet use with a consequent decrease in the familiarity with ICT of older males.

Turning our attention to women, Column (3) and (4) of Table 3 show that 2SLS point estimates are close to OLS values and significant at the 5% level[5]. We need to interpret these results with caution though, as their reliability require that the instruments in the 2SLS specification are relevant and valid. First-stage coefficients and the F-statistics on the additional instruments lead us to conclude that our instruments are indeed relevant. However, the inspection of the p-values of the Sargan-Hansen statistic shows that in the specification having computer literacy as dependent variable the null hypothesis of validity of the overidentifying restrictions is not rejected at conventional levels, although it is not as largely supported as we found for men. As for web utilization, the null hypothesis of the Sargan-Hansen test is instead rejected. This result is unexpected given that our instruments, which are routinely-used to account for the endogeneity of retirement in micro-data based analyses as discussed above, mainly depend on two dimensions that are arguably exogenous: the age of respondents at the time of the interview and the eligibility rules of the pension schemes for early and statutory retirement.

The mechanics of the 2SLS estimator and of the Sargan-Hansen statistic suggest that the rejection of the null hypothesis of the Sargan-Hansen test might be explained by the presence of heterogeneity in the effect of retirement identified by the 2SLS estimator rather than the endogeneity of the instruments. In the 2SLS set-up with one endogenous regressor and two additional instruments, the estimation of the causal effect of interest is based on the information provided by two groups of compliers (Angrist and Pischke, 2009). Eligibility to early retirement schemes defines a group of compliers consisting of individuals who retire as soon as they qualify for the early retirement option (*early retirees*). Eligibility to statutory retirement schemes instead defines a group of compliers who find the exit from the labour market less attractive and retire only once they become eligible to the

[5] We investigate the consequences of changing the threshold to discriminate between proficient and non-proficient computer users. Table C1 in Online Appendix C reports the results for specifications in which the binary outcome for computer literacy is equal to 1 when individuals have very good or excellent computer skills and 0 otherwise. For women the 2SLS point estimate is lower than in the benchmark case considered in Table 3 but the coefficient remains statistically significant. For men, the reduction in the point estimate is wider (it shrinks by two thirds) and the coefficient becomes statistically insignificant. This pattern can be explained by the fact that this alternative outcome variable identifies highly skilled computer users whose proficiency is less likely to be scarred by retirement.

statutory retirement scheme (*statutory retirees*). Notice that the sets of compliers cannot be directly identified in the data as they include not only retirees who left the labour force when they met the age eligibility criteria to retire but also current workers who will exit the labour market in the future as soon as they become eligible to withdraw pension benefits.

Using both instruments jointly leads to identify an average treatment effect coming from a weighted average of the effects for the two groups of compliers. The Sargan-Hansen test assessing the exogeneity of the overidentifying restrictions compares the second stage coefficient estimates produced by considering each instrumental variable one at a time (Angrist and Pischke, 2009). If the retirement effect does not vary between complier groups, finding that both the exactly-identified IV estimators have the same probability limit is consistent with the null hypothesis that the instruments are exogenous. On the contrary, as long as the effect of retirement significantly varies across the complier groups, we will reject the null hypothesis of the over-identification test even if our additional instruments are truly exogenous. Rejecting the null hypothesis of the Sargan-Hansen test would then be a matter of heterogeneous effects and not of endogenous instruments. We now investigate whether this is the case in our sample.

We re-run our instrumental variable estimation for women using the two additional instruments one at a time and show estimation results in Table 4. Our estimating equations are now exactly identified. Columns (1) and (2) of Table 4 refer to the early retirees. We find that the effect of retirement on computer literacy and on the probability of using internet at least weekly are negative, but in both cases insignificant. The first-stage parameter estimate of *eligible_ER* is strongly significant and the weak instrument test does not reject the null that the instrument is relevant.

Table 4: Probability of having at least good computer skills and having used internet in the last seven days. Linear probability models estimated by 2SLS in the women sample using one instrument at a time.

	Early retirees		Statutory retirees	
	(1)	(2)	(3)	(4)
VARIABLES	pcgood	internet	pcgood	internet

Retired	-0.040	-0.012	-0.112***	-0.094***
	(0.050)	(0.045)	(0.034)	(0.034)
Observations	22,681	22,681	22,681	22,681
Endogeneity test p-value	0.526	0.199	0.195	0.362
eligible_ER	0.265***			
	(0.031)			
eligible_SR			0.400***	
			(0.033)	
Weak identification	73.501		149.103	

Note : Additional controls: couple, education dummies, age, age squared, poor health, adl, iadl, household wealth quartiles, blue collars, public, have children, have grandchildren, time dummy, country dummies. Standard errors clustered at the country and year of birth level. *** p<0.01, ** p<0.05, * p<0.1. Stock-Yogo weak ID test critical values: 10% maximal IV size 16.38, 15% maximal IV size 8.96, 20% maximal IV size 6.66, 25% maximal IV size 5.53.

The third and the fourth columns of Table 4 report estimation results for the statutory retirees. Retirement significantly reduces their probability of having good computer literacy and using the web at least on a weekly basis by 11.2 percentage points and 9.4 percentage points respectively. The comparison between the results found for early and statutory retirees indicates the presence of heterogeneity in the retirement effect. Consistently with the evidence in Table 3 showing a more marked rejection of the null hypothesis of the Sargan-Hansen test for the web utilization outcome, Table 4 points out that the difference in the magnitude of the retirement effect between early and statutory retirees is wider for this outcome. Finally, we formally tested the significance of the difference between the retirement effects obtained for the two complier groups by following a bootstrap procedure. We carried out 500 replications of our 2SLS estimation based on bootstrap samples stratified by wave and country of residence.

Table 5: 2SLS estimation using one instrument at a time in the women sample. Differences in the retirement coefficients between early retirees (ER) and statutory retirees (SR).

	Coeff.	Std. error	Lower bound 90% CI	Upper bound 90% CI
pcgood				
eligible_ER	-0.041	0.044	-0.105	0.033
eligible_SR	-0.114	0.031	-0.164	-0.065

Difference	-0.073	0.049	-0.157	-0.001
internet				
eligible_ER	-0.012	0.034	-0.066	0.045
eligible_SR	-0.094	0.024	-0.135	-0.056
Difference	-0.083	0.039	-0.149	-0.022

Note: Standard errors and 90% confidence intervals are obtained by 500 bootstrap replications. Bootstrap samples are stratified by country and wave.

As reported in Table 5, the differences in the causal effect of retirement on ICT knowledge between early and statutory retirees are statistically different from zero for both outcomes. This is a further piece of evidence in favor of the hypothesis that the rejection of the null hypothesis of the Sargan-Hansen test in Table 3, when considering both instruments jointly, is motivated by heterogeneity in the retirement effects between complier groups.

Once ascertained that the effects of the exit from the labour force on the familiarity with ICT of women differ with respect to their propensity towards delaying retirement or not, it is worth investigating why such heterogeneity arises. We address this issue by comparing the distributions of a set of observable attributes for the two groups of female compliers. As argued above, the set of compliers associated with our instrumental variables cannot be directly identified in the sample. Nevertheless, the instrumental variable framework allows to characterize the distribution of their characteristics. Consider the instrument *eligible (ER/SR)* and a given binary attribute *w*, following Angrist and Pischke (2009), we can write:

$$\frac{\Pr(w=1|\text{compliers for } eligible)}{\Pr(w=1)} = \frac{E(retired|eligible=1,w=1)-E(retired|eligible=0,w=1)}{E(retired|eligible=1)-E(retired|eligible=0)} \quad (2)$$

This expression defines the probability that the ER eligible or SR eligible compliers have attribute *w* equals to 1 compared to the overall sample. The right-hand side of the equation shows that this is the

ratio of the coefficients on $eligibleER$ (or $eligibleSR$) in the first stage equations calculated in the sub-sample of women for whom w=1 and in the overall sample.[6]

We describe compliers' distribution with respect to a vector of attributes including age (being 60+ or younger), education (having spent a number of years in full time education higher than the country-specific median), having poor health, having a household net wealth higher than the country-specific median, job characteristics (blue/white collar and private/public sector), living as a couple, having children, having grandchildren. Table 6 summarizes the results of our characterization of compliers. Along with point estimates of the relative probabilities and their difference between compliers' groups, we report the standard error and the 90% confidence interval for the difference obtained by 500 bootstrap replications[7].

Table 6: Compliers' characterization in the sample of female early retirees (ER) and statutory retirees (SR).

		Coeff.	Std. error	Lower bound 90% CI	Upper bound 90% CI
Years of educ. above median	ER	0.744	0.035	0.689	0.801
	SR	1.029	0.030	0.982	1.080
	Difference	-0.285	0.045	-0.361	-0.214
Blue collar workers	ER	1.377	0.071	1.252	1.483
	SR	1.036	0.041	0.972	1.105
	Difference	0.341	0.082	0.203	0.475
Public sector	ER	1.021	0.038	0.955	1.080
	SR	0.897	0.026	0.855	0.941
	Difference	0.124	0.046	0.047	0.196
Living as a couple	ER	1.019	0.020	0.987	1.051
	SR	0.966	0.016	0.940	0.992
	Difference	0.053	0.025	0.012	0.091

Note: Standard errors and 90% confidence intervals are obtained by 500 bootstrap replications. Bootstrap samples are stratified by country and wave.

We find that early retirees are on average significantly less educated than statutory retirees as they have a lower probability of having a number of years spent in full-time education higher than the

[6] In the first stage regressions we additionally control for the set of variables included in our main specifications in Table 4.

[7] As before, the bootstrap samples are stratified by country and wave. All the dimensions not reported in Table 5 do not reveal any significant differences between the two compliers' groups.

country-specific median. Further, they are more likely to work or to have worked as blue collars. To validate this finding, we look at the probability of using a computer at work in our sample. We consider the current job for the employees and the last job before retiring for the retirees. We find that the probability of using a computer at work decreases by 40 percentage points for individuals with at most primary education compared to higher educated individuals and by 60 percentage points for those working as blue collars compared to white collars. Moreover, finding a higher concentration of previous public sector employees among early retirement compliers is in line with the higher generosity characterizing, particularly in the past, the pension system eligibility criteria for this group of workers.

Overall, this evidence suggests that the knowledge of ICT obtained at the workplace is probably negligible for early retirees and that their familiarity with ICT devices, if any, has been achieved outside the labour market and not for work-related purposes. As suggested by our findings, these individuals are unlikely to face a reduction of their familiarity with ICT due to retirement.

Finally, female early retirees are significantly more likely to have a cohabiting partner and this suggests that they might prefer to anticipate retirement in order to spend their leisure time with the partner. This higher value put on the retirement option might lead to an incentive to use computers and web in order to organize this joint leisure time by, for instance, travelling or enjoying recreational activities in the area of residence, compensating a potential negative effect of retirement on their familiarity with ICT.

5. Robustness analyses

As reported in our analysis of compliers' characterization, the presence of ICT widely differs across jobs. There is a negative gap of 60 percentage points in the probability of using a computer at work for blue collars with respect to white collars in our sample. As a consequence, we might argue that the drop in ICT familiarity associated with retirement emerging from our results may be driven by the white-collar workers, who were more substantially exposed to ICT at the workplace. The negative

consequences of retirement on ICT knowledge are expected to be wider for this group of workers since their exit from the labour market precludes them from exploiting the intense utilization of ICT devices and applications featuring their jobs. Table 7 reports the results of our analysis when our specifications are estimated by 2SLS separately for the blue and white collars. Our hypothesis is confirmed by the data. Indeed, the point estimates are largely higher for white collars and the coefficients on the retirement dummy are insignificant for blue-collars.

Table 7: Probability of having at least good computer skills and having used internet in the last seven days by type of occupation (white and blue collars). Linear probability models estimated by 2SLS.

	Men		Women	
	(1)	(2)	(3)	(4)
VARIABLES	pcgood	internet	pcgood	internet
		White collars		
Retired	-0.142**	-0.108**	-0.096**	-0.081**
	(0.066)	(0.050)	(0.039)	(0.037)
Observations	12,053	12,053	17,771	17,771
		Blue collars		
Retired	-0.037	-0.020	-0.068	-0.019
	(0.059)	(0.047)	(0.043)	(0.062)
Observations	7,135	7,135	4,910	4,910

Note : Additional controls: couple, education dummies, age, age squared, poor health, adl, iadl, household wealth quartiles, blue collars, public, have children, have grandchildren, time dummy, country dummies. Standard errors clustered at the country and year of birth level. *** p<0.01, ** p<0.05, * p<0.1.

Given the age range of our reference population (50-69), the type of occupation can be considered as pre-determined in our analysis. Actually, we found that less than 2% of workers switch from blue- to white-collar jobs (or vice versa) in our sample. Nevertheless, the type of occupation of an individual is not random and an endogenous sorting, potentially correlated with omitted determinants of ICT knowledge - for instance job career expectations and propensity to invest in human capital - might be at work. We address this concern by estimating our equations of interest by Fixed-Effects (FE)-2SLS on the subsample of individuals who are interviewed in both wave 5 and 6. As long as the omitted variables causing the endogeneity of the type of occupation, as well as of retirement, do not vary over

time, the FE transformation will remove them. The 2SLS estimator allows to take into account additional time varying heterogeneity, for instance related with reverse causality issues, causing the endogeneity of retirement decisions. The advantages of the FE-2SLS estimator to control for whatever time-invariant individual heterogeneity potentially correlated with our regressors come at the cost of requiring enough variability over time of all the variables involved in our estimation exercise. Indeed, the identification of the effect of retirement on ICT knowledge rests on observing enough individuals transiting from work to retirement and becoming eligible for ER or SR over the short time period (about two years) under consideration. In our longitudinal balanced sample, only 9% (7%) of men (women) transit from work to retirement, 10% (9%) of men (women) become eligible for ER and 13% (10%) for SR between wave 5 and 6. By using FE, we not only eliminate all time-invariant heterogeneity (observed and unobserved) but also throw away information about differences between individuals, which constitutes the major source of variability for these variables in our sample.[8] The results produced by the FE-2SLS estimator are reported in Table 8. It is reassuring that in two out of the four specifications considered (having at least good computer skills for men and web utilization for women) the effect of retirement on ICT knowledge remains negative, sizeable and statistically significant[9]. Instead, the effect of retirement on the proficiency in computer use of women becomes statistically negligible but the estimated coefficient has a huge standard error and this points to a loss of precision in the estimation due to the low within-variability in the data. Finally, the effect of retirement on the web use of men becomes positive and statistically significant. This latter result is clearly striking as compared to the evidence previously reported in Table 3. We argue that rather than weakening the main findings of our paper, this result is driven by an additional source of heterogeneity in the retirement effect. As discussed above, in our FE-2SLS the identification of the retirement effect is led by individuals who switch from work to retirement between the two waves.

[8] The within variability of the retirement dummy and the instruments is always less than one third of their between variability.

[9] The Sargan-Hansen test statistic rejects the null hypothesis for the proficiency of computer use of men, suggesting the presence of effect heterogeneity analogous to that discussed for women in the previous section.

These workers have then retired quite recently. The increase in the web use of men after retirement identified by the FE-2SLS estimator might be a short-run effect of their exit from the labour market. To reconcile our findings based on the 2SLS estimator in Table 3 with this positive effect shown by the FE-2SLS estimates, we estimate by 2SLS a specification on our full sample in which the retirement dummy is replaced by a set of dummies allowing the retirement effect to vary with the number of years since retirement. The results are reported in Table C2 in Online Appendix C and actually suggest that the retirement effect is not constant over time. Within the first year after retirement, retirees are more likely than workers to use internet but afterwards this gap flips and retirement starts to have a detrimental effect on the familiarity with the use of web.

Table 8: Probability of having at least good computer skills and having used internet in the last seven days. Linear probability models estimated by FE-2SLS on the longitudinal sample.

	Men		Women	
	(1)	(2)	(3)	(4)
VARIABLES	pcgood	internet	pcgood	internet
Retired	-0.171*	0.155**	-0.017	-0.154**
	(0.098)	(0.075)	(0.095)	(0.065)
Observations	13,320	13,320	16,474	16,474
Individuals	6,660	6,660	8,237	8,237
Endogeneity test p-value	0.094	0.027	0.919	0.023
Sargan-Hansen p-value	0.038	0.466	0.628	0.469
eligible_ER	0.090***		0.037**	
	(0.022)		(0.017)	
eligible_SR	0.172***		0.223***	
	(0.030)		(0.029)	
Weak identification	25.597		36.428	

Note: Additional controls: first difference of couple, age, age squared, poor health, adl, iadl, household wealth quartiles, blue collars, public, have children, have grandchildren. Standard errors clustered at the country and year of birth level. *** p<0.01, ** p<0.05, * p<0.1. Stock-Yogo weak ID test critical values: 10% maximal IV size 19.93, 15% maximal IV size 11.59, 20% maximal IV size 8.75, 25% maximal IV size 7.25.

6. Conclusions

In this paper we analyse the effect of retirement on the familiarity with ICT of older individuals. In particular, we focus on the probability of having good computer literacy and using internet at least on a weekly basis in a sample of current and previous employees aged 50-69 and living in thirteen European countries plus Israel. Data are drawn from the waves 5 and 6 of SHARE.

As retirement is likely to be correlated with the error term due to reverse causality and/or omitted variables, we use an instrumental variable estimation strategy exploiting the eligibility of individuals to early and statutory retirement schemes. Our main results come from linear probability model specifications estimated via two stage least squares. Male retirees have a probability of having good computer literacy that is 10 percentage points lower as compared with that of their counterparts still at work. On average, the probability of having a good control of computer devices and applications reduces by about 20%. Analogously, retirement is found to decrease their probability of using internet at least once in a week by 11%.

As for women, we find that the effect of retirement varies with the propensity to opt for early or statutory retirement exit routes. Retirement does not hamper the familiarity with ICT for women who want to retire as soon as they become eligible for early retirement (early retirees). Instead, the retirement effect is significantly negative for those who retire only once they qualify for the statutory retirement scheme. In this group, retirement reduces the probability of having good computer literacy by 23% and the one of using internet by 13%.

This pattern shows the presence of heterogeneous average retirement effects in the two groups of compliers defined by our instruments. Early retirees are less educated and more likely to be blue collar workers. These characteristics are found to be negatively correlated with the use of a computer on the job in our sample. We interpret this finding as evidence supporting the hypothesis that these individuals have developed their computer skills, if any, outside their labour market activities and retirement is then not expected to reduce them. Rather, the expansion of leisure time might be an incentive for their improvement. This conclusion is consistent with the finding that early retirees are also more likely to have a cohabiting partner and then might use the web to organize their joint leisure

time. We also showed that the negative retirement effect on computer skills is stronger for white-collars and this can be explained by higher diffusion of ICT devices and applications in their occupations, which these workers are no longer exposed to after exiting the labour market.

Overall, the pension reforms implemented in the last decades that tightened the age eligibility requirements for pension benefits might have produced an externality in the production of ICT knowledge at later ages. Older individuals who would be otherwise less likely to use ICT find in the postponement of their retirement from the labour force an occasion to invest in their proficiency with the use of computers and internet, increasing their familiarity with ICT. This knowledge can produce spillover effects in their non-labour-market activities. Facilitating contacts with social network members, coping with digitalized services and supporting the organization of leisure time activities improve the well-being of older individuals and secure their social inclusion in the golden years.

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Appendix A: Early and normal retirement eligibility criteria

The initial sources of information about early and normal retirement eligibility criteria are Gruber and Wise (1999, 2010), Wise (2012), the Mutual Information System on Social Protection (MISSOC) database[10] and Social Security Administration (SSA) data on Social Security Programs throughout the World.[11] Other country specific auxiliary data sources are reported below. ER = early retirement. SR = statutory (normal) retirement.

Austria (see Staubli and Zweimüller, 2013)
ER: 60 for men and 55 for women until 2001. From 2001 until 2004, early retirement for men depends on year of birth. For men it is 61 for those born in 1942 and 62 for those born in 1943 onwards. For women from 2001 to 2010 the early retirement eligibility age is 56 for those born in 1947, 57 for those born between 1948 and 1951, 58 for those born between 1952 and 1954, 59 for those born in 1955 and 1956, 60 for those born in 1957 onwards. From 2005 onwards, the early retirement eligibility age is 62 for men.
SR: 65 for men and 60 for women.

Belgium (see Jousten *et al*., 2010)
ER: No early retirement until 1966, 60 afterwards for men, for women 55 until 1986 and 60 from 1987. For both men and women, 61 in 2014, 62 in 2016, but still possible to retire at age 60 with sufficient number of years of contributions.
SR: 65 for men, for women 60 until 1996, 61 from 1997 to 1999, 62 from 2000 to 2002, 63 from 2003 to 2005, 64 from 2006 to 2008, 65 from 2009.

Denmark (see Bingley *et al*., 2010)
ER: 60 for both men and women (Partial pension).
SR: 67 until 2003, 65 from 2004, for both men and women.

France (see Hamblin, 2013)
ER: No early retirement until 1963. 60 from 1963 to 1980, 55 from 1981 onwards.
SR: 65 until 1982 and 60 from 1983 to 2010; from 2011 60 for those born up to 1952, 61 for those born between 1953 and 1954 and 62 for those born since 1955.

Germany (see Berkel and Börsch-Supan, 2004, and Mazzonna and Peracchi., 2014, DRV 2015)
ER: For men, no early retirement until 1972, 60 from 1973 until 2005, 63 from 2006 onwards. For women, no early retirement in 1961, 60 from 1962.
SR: 65 for all until 2011, 67 from 2012.
Italy (see Angelini *et al*., 2009, and Mazzonna and Peracchi, 2014)
ER: from 1965 to 1995, early retirement was possible at any age with 35 years of contributions[12] (25 in the public sector) for both men and women; from 1996 it was stepwise increased up to 60 for both the private and public sector (61 for self-employed). From 2012 it is 62 for both men and women.
SR: The statutory retirement age was 60 (65 in the public sector) for men and 55 (60 in the public sector) for women from 1965 to 1993. Several consecutive reforms (1992, 1995 and 1998) increased the statutory retirement age to 65 for men and 60 for women with step-wise increments from 1994.

[10] https://www.missoc.org/missoc-database/comparative-tables/
[11] https://www.ssa.gov/policy/docs/progdesc/ssptw/
[12] We use work experience to define eligibility.

The statutory retirement age is 66 from 2012 for men. For women, it is 65 in 2012 (there is the possibility to retire at 62 in the private sector and at 63 for self-employed), 66 in 2013 (63 for private sector employees and 64 for self-employed); in 2016 65 for private sector employees and 66 for self-employed.

Spain (see Blanco, 2000, and Mazzonna and Peracchi, 2014)
ER: 64 until 1982, 60 from 1983 to 1993, 61 from 1994 for both men and women. From 2013, 61 for involuntary early retirement or partial pension, 63 for voluntary early retirement, we take the lower.
SR: 65 for both men and women. Rising gradually to 67 from 2013 to 2027.

Sweden (see Mazzonna and Peracchi, 2014)
ER: No early retirement until 1962, 60 from 1963 to 1997, 61 from 1998 onwards.
SR: 67 for both men and women until 1994, 65 from 1995 onwards.

Switzerland (see Dorn and Sousa-Poza, 2003 and Mazzonna and Peracchi, 2014)
ER: No early retirement until 1996 for men and until 2000 for women. Then, 64 for men from 1997 until 2000 and 63 from 2001, for women 62 from 2001 (two years before SR age).
SR: 65 for men, for women 63 until 1963, 62 from 1964 until 2000, 63 from 2001 to 2004, 64 from 2005.

Czech Republic
ER: Early retirement is possible up to two years before normal retirement age.
SR: For men 60 from 1961 to 2002, 61 from 2003 to 2008, 62 from 2009 to 2015, 63 from 2016. For women, statutory retirement age depends on the number of children:

	0 child	1 child	2 children	3/4 children	5+ children
Up to 1999	55	55	55	55	55
From 2000 to 2002	56	56	56	56	56
From 2003 to 2006	59	58	57	56	55
From 2007 to 2011	60	59	58	57	56
From 2012 to 2014	61	60	59	58	57
From 2015 onwards	62	61	60	59	58

Slovenia (OECD, 2013; Polanec et al, 2013; Guardiancich, 2010; Ahcan and Polanec, 2008; Majacen and Verbič, 2008; Mimir et al., 2004)
ER: Before 1993, no early retirement. From 1993 to 2014, 58 for male; 59 from 2015 onwards. For women, 53 from 1993 to 2001, 54 from 2002 to 2004, 55 from 2005 to 2007, 56 from 2008 to 2010, 57 in 2011 and 2013, 58 in 2014 and 2015, 59 from 2016 onwards.
SR: Before 1993, 55 for men 53 for women (40/38 years of contribution and no age requirements, we assume they start working at age 15). From 1993, 65 for men. For women, 61 from 2002 to 2004; 62 from 2005 to 2007; 63 from 2008 to 2013; 65 from 2014 onwards.

Estonia (Schmähl and Horstmann, 2002)
ER: 60 for men. For woman, 55 before 2004; 56 from 2004 to 2006; 57 from 2007 to 2009; 58 from 2010 to 2012; 59 from 2013 to 2015; 60 from 2016 onwards.
SR: 63 for men, for women 58 before 2004, 59 from 2004 to 2006, 60 from 2007 and 2009, 61 from 2010 to 2012, 62 from 2013 to 2015, 63 from 2016 onwards.

Israel
ER: No early retirement.
SR: 65 for men and 60 for woman up to 2004. From 2005 to 2009, 66 for men and 61 for women. 67 for men and 62 for women from 2009 onwards.

Luxemburg
ER: For both men and women, 65 as SR up to 1992. 60 from 1993 onwards.
SR: 65 for both men and women.

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Appendix B: Retirement decisions and age eligibility

Figure B.1: Proportion of retired since/to statutory retirement age by country. Males.

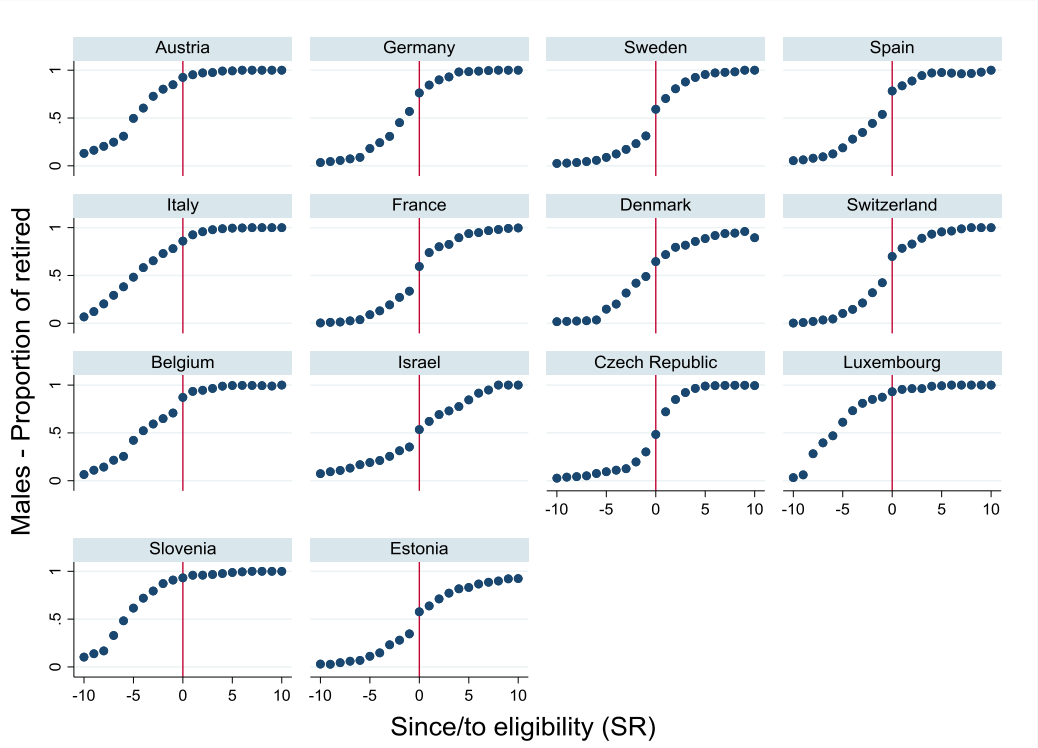


Figure B.2: Proportion of retired since/to statutory retirement age by country. Females.

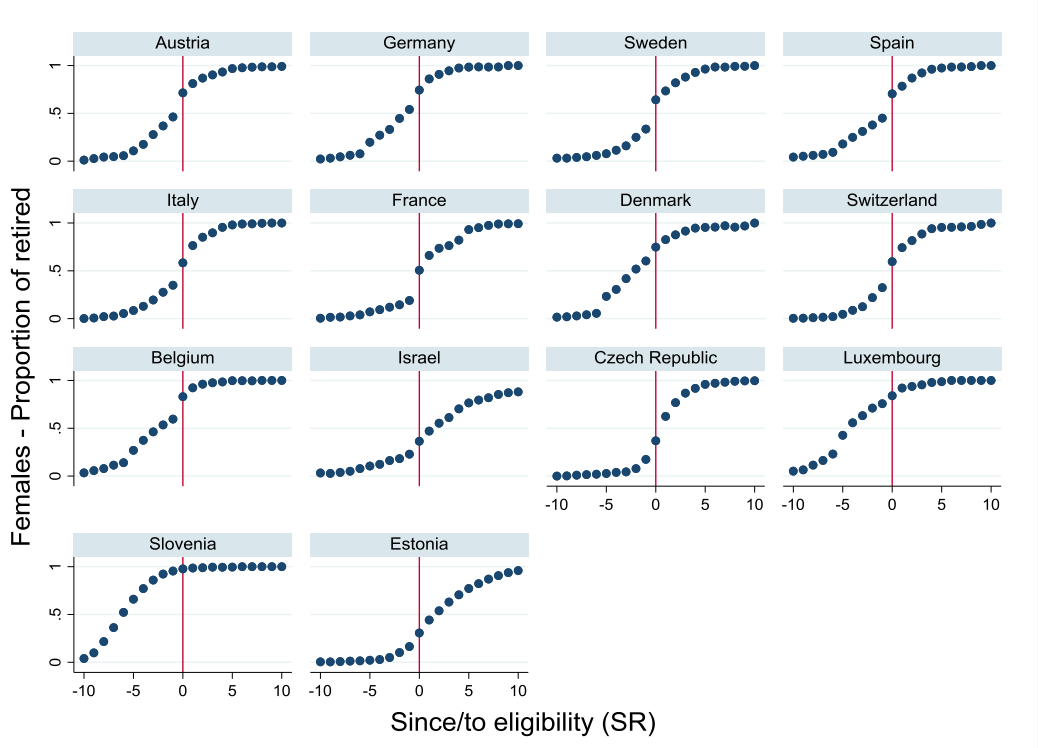


Figure B.3: Proportion of retired since/to early retirement age by country. Males.

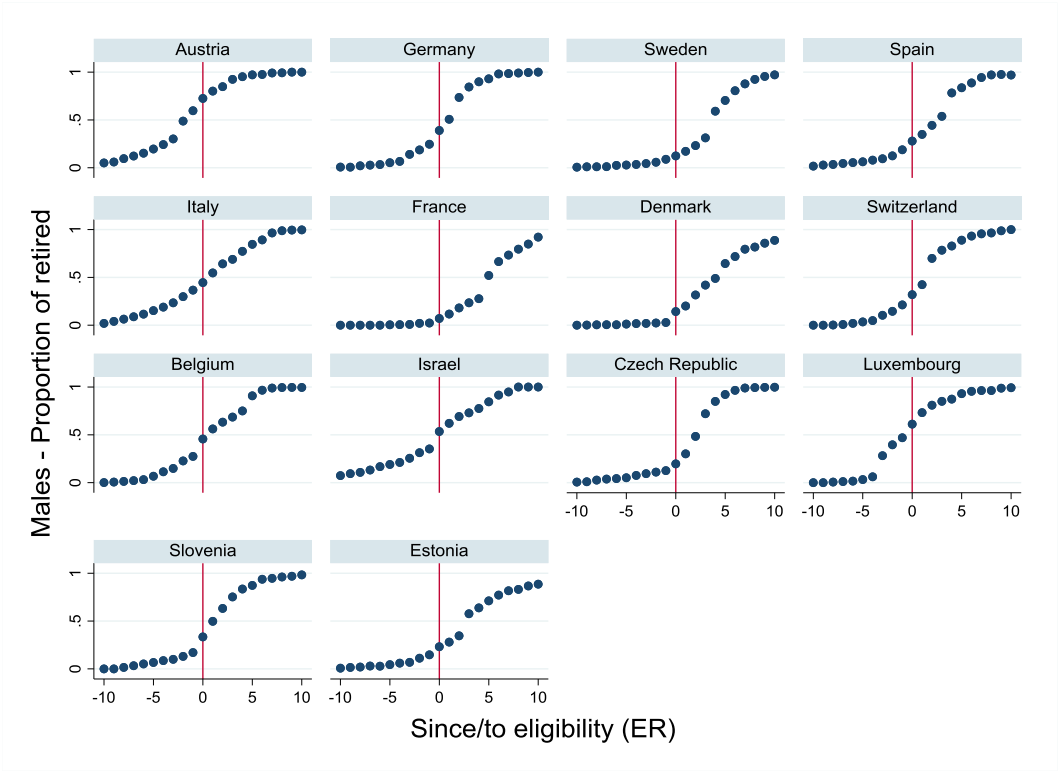
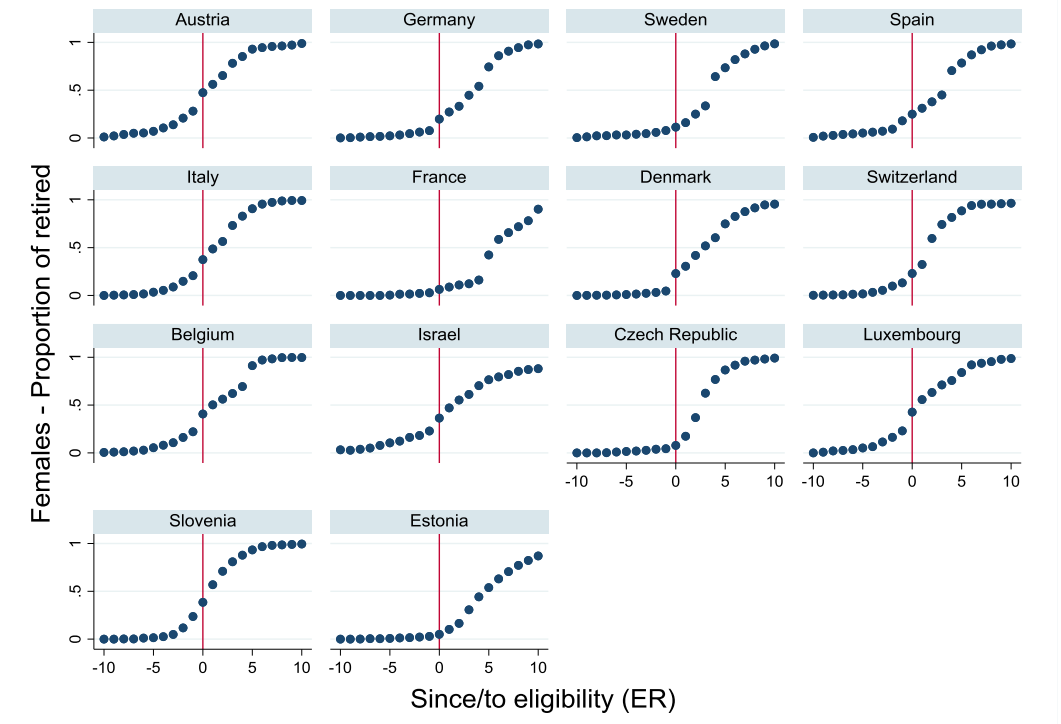


Figure B.4: Proportion of retired since/to early retirement age by country. Females.



Appendix C: Robustness analyses – additional tables

Table C1: Probability of having at least very good computer skills. Linear probability models estimated by OLS and 2SLS for men and women.

	Men		Women	
	(1)	(2)	(3)	(4)
VARIABLES	OLS	2SLS	OLS	2SLS
Retired	-0.039***	-0.032	-0.062***	-0.052**
	(0.010)	(0.038)	(0.009)	(0.021)
Observations	19,188	19,188	22,681	22,681
Endogeneity test p-value		0.907		0.609
Sargan-Hansen p-value		0.483		0.930

Note: Additional controls: couple, education dummies, age, age squared, poor health, adl, iadl, household wealth quartiles, blue collars, public, have children, have grandchildren, time dummy, country dummies. Standard errors clustered at the country and year of birth level. *** p<0.01, ** p<0.05, * p<0.1. Stock-Yogo weak ID test critical values: 10% maximal IV size 19.93, 15% maximal IV size 11.59, 20% maximal IV size 8.75, 25% maximal IV size 7.25.

Table C2: Probability of having used internet in the last seven days. Linear probability models estimated by 2SLS for men.

	(1)
VARIABLES	2SLS
Reference group: workers	
Less than 2 years in retirement	0.126*
	(0.070)
From 2 to 3 years in retirement	-0.186***
	(0.053)
More than 3 years in retirement	-0.105**
	(0.052)
Observations	19,188
Endogeneity test p-value	0.033
Sargan-Hansen p-value	0.743
Weak instruments	13.239

Note: Additional controls: couple, education dummies, age, age squared, poor health, adl, iadl, household wealth quartiles, blue collars, public, have children, have grandchildren, time dummy, country dummies. Standard errors clustered at the country and year of birth level. *** p<0.01, ** p<0.05, * p<0.1. Stock-Yogo weak ID test critical values: 5% maximal IV relative bias 12.20, 10% maximal IV relative bias 7.77, 20% maximal IV relative bias 5.35, 30% maximal IV relative bias 4.40.