Determinants of the Digital Divide: Evidence from France

Mathilde Aubouin

2022-22 Document de Travail/ Working Paper

EconomiX - UMR 7235 Bâtiment Maurice Allais
Université Paris Nanterre 200, Avenue de la République
92001 Nanterre Cedex

Site Web : economix.fr
Contact : secreteriat@economix.fr
Twitter : @EconomixU

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Mathilde Aubouin*

September 14, 2022

Abstract

The COVID-19 crisis accelerated the digital transition and reinforced households' existing digital divide. This paper aims to identify determinants of digital inequalities in access, usage, and type of usage in France and the reasons for the non-access to the internet. Using French Institute of Statistics (INSEE) surveys between 2007 and 2019, we show that generation, education, and income are significant determinants of digital consumption. The gender digital gap exists only among older generations. The digital divide is mainly a problem of internet access in France. Disparities in usage narrow once an individual has access to and uses the internet. Based on our results, we recommend investing in digital education and implementing financial support to reduce the digital divide.

Keywords– Digital Divide; internet use; internet access; Pseudo-panel methods; France

JEL Classification– L86; L96; O33

*maubouin@parisnanterre.fr, EconomiX-CNRS, University of Paris Nanterre. The author would like to thank Lionel Ragot for his feedback and advice. The author would also like to thank Marc Baudry, Didier Blanchet, Thomas Chuffart, and Saïd Souam for their valuable comments and suggestions.

1 Introduction

In 2019, OECD (2019) highlighted that: *"safe digital technologies improve the lives of those who have the skills to use them."* The appropriate use of digital technologies can facilitate access to essential services, such as health, education, banking, and administrative services. One year later, the COVID-19 crisis and the numerous resulting lockdowns have accelerated the digital transition and reinforced the need to access and use digital tools.[1] OECD (2020) points out that digital inequalities have increased during this crisis and it is essential to consider it. For this purpose, it is necessary to identify most affected individuals by the digital divide and the determinants of these inequalities. This paper investigates the digital divide in France by exploring three research issues. What are the determinants of inequalities in internet access and use? Are there digital disparities in the variety and type of internet use? Finally, what are the reasons for not accessing the internet?

Several issues emerge from the digital divide which represents disparities in access and use of digital technology between individuals. From a macroeconomic point of view, digital inequalities can hinder the digital transition and, therefore, its impact on productivity and economic growth. Eichengreen (2015) argues that the effect of technology depends strongly on its range of application and use by economic actors, from households to firms. Reducing digital inequalities is also an issue for the well-being of households. OECD (2019) emphasizes that digital literacy facilitates participation in society in various areas. For instance, public services are increasingly present online and teleconsultation for medical purpose is developing in order to improve health care access. Digital illiteracy is also a drag for access to employment as an increasing number of jobs require a basic digital skill (Berger & Frey, 2016). Eynon *et al.* (2018) also point out that digital access and usage contribute to social class mobility. In 2019, 67,5% of French people considered that having internet access is important to feel integrated into our society.[2] While digital technology improves the well-being of those who use it (Pénard *et al.* , 2013), it tends to exclude those who do not, whether it

[1] The digital transition refers to the diffusion of digital technologies in the economy and the society, both in terms of adoption and use by economic agents.

[2] ARCEP, Baromètre du Numérique, 2019. Downloaded in July 2022. `https://www.data.gouv.fr/fr/datasets/barometre-du-numerique/`.

concerns participation in society or the labor market. Given the benefits of accessing and using digital technologies, the term digital divide seems appropriate, even though digital exclusion may be voluntary.

This paper contributes to the literature by overcoming several limits. While the digital transition is still ongoing, most researches use cross-sectional data. The literature emphasizes that determinants of digital inequalities differ across countries. Therefore, the investigation of the French digital divide, which remains poorly studied, is important. This paper applies panel data methodology using French Institute of Statistics (INSEE) household surveys on Information and Communication Technologies (ICT) between 2007 and 2019. It allows to capture the temporal evolution of digital consumption over thirteen years and characteristics of the French case. Furthermore, we study several levels of the digital divide. We provide an in-depth empirical investigation of inequality's determinants in internet access and use. The diversity of online activities in which individuals engage can create opportunities. Therefore, we also focus on internet users and explore whether disparities exist in the variety and type of internet usage (administrative and banking services, social networks, e-commerce, collaborative economy, and job searching). It provides a profile of the most affected by the digital divide regarding access and diversity of internet use. Identifying barriers to digital access is essential to establish effective public policies to reduce the digital divide. Hence, we also focus on individuals who do not have internet access at home and investigates the reasons behind the non-access to internet (cost, utility, skills, and security issues).

Our results highlight significant inequalities between generations.[3] The younger have better access and use of digital technology than the older ones. The access and use of digital technology are improving over time for all French households. In addition, intra-generational inequalities appear through income and education levels. A gender gap in favor of men emerges from our estimates. However, this gap only exists for older generations and is not present for younger generations. The household size only impacts the probability of accessing the internet at home, not the usage. Our results also show that the population density is

[3]A generation is a group of individuals born in the same period of years. The underlying idea is to study the probability of being affected by the digital divide depending on whether the individual was born relatively close to the diffusion of digital technology.

not a determinant of the digital divide in France, suggesting that digital infrastructure is not an important barrier to digital access in France. The urban/rural digital gap is mainly a problem of access to broadband, not internet access. Focusing on internet users to study the diversity and type of internet usage, intra-generational inequalities are no longer as apparent. Individuals' probability of engaging in an online activity mainly depends on their generation. Finally, we highlight that the lack of skills and interest, as reasons for not accessing the internet, mainly concerned the older, while the younger are more affected by financial barriers. In light of our results, we discuss public policies implemented in France to reduce the digital divide. We conclude that investments are made to improve digital skills and to provide access to quality infrastructure, but a financial support policy for access is missing.

The remainder of this paper is structured as follows. Section 2 provides a literature review of digital divide determinants. Methodology and data are presented in Section 3. Section 4 displays empirical results. Section 5 discusses the results in the context of French public policies. Finally, Section 6 concludes.

2 Literature review

The digital divide was first studied as a problem of access to ICT. Goolsbee & Klenow (2002) study the determinants of computer adoption in the United States of America (USA) in 1997. They find strong local spillover effects in computer diffusion, such as living in an area with a high proportion of computer ownership and having a friend or family member who owns a computer. Since computers have become more widespread, studies have turned to the adoption of more recent technologies. Prieger & Hu (2008) investigate the determinants of broadband access in the USA. They highlight that the demand for broadband access is higher for individuals with high incomes and levels of education and lower for individuals from ethnic minorities. Reddick *et al.* (2020) obtain similar results, but, studying the case of San Antonio, they point out that while digital disparities are often perceived as a rural/urban divide, there are inequalities within cities themselves. A second level of the digital divide is

rapidly highlighted and concerns the disparities in usage once the individual has access to digital equipment (Hargittai, 2002). Indeed, access is a necessary but not sufficient condition for the effective use of digital technologies. Furthermore, Montagnier & Wirthmann (2011) point out that the main determinants of digital access and use can differ. Considering 18 European countries, Canada and South Korea, in 2008, they identified income level, children's presence, and living in an urban area as the main determinants of computer and internet access. Internet use is more influenced by age, economic inactivity, and education. Korupp & Szydlik (2005) find that computer and internet's usage in Germany between 1997 and 2003 mainly depend on education, using a computer at work, income, having teenagers or young adults in the home, gender, and being born in the *"computer"* generation. Helsper (2010) underlines a digital gender gap in the use of the internet in favor of men that is smaller among young people. Nevertheless, it also points out that this difference between young and old is not only due to a generational effect but also depends on different life stages (occupation and marital status). Schleife (2010) observes disparities in internet use among German counties. She demonstrates that these disparities are not explained by differences in population density but rather by differences in the composition of individual characteristics of each county. Besides the socio-demographic characteristics, Goldfarb (2006) emphasizes the major role of the university in the diffusion of digital technology. Its impact is even more significant the lower the income of the individual.

Once an individual has access to the internet and uses it, disparities in the mode of use can exist between individuals. Using a survey conducted in 2001 in the USA, Goldfarb & Prince (2008) determined that while income is a key determinant of digital adoption, the lower-income individuals tend to spend more time online when they have internet access. They explained this result by the differences in the opportunity cost of leisure time. Pantea & Martens (2013), Haight *et al.* (2014), and van Deursen & van Dijk (2014) find similar results for low-income individuals in France, Germany, Italy, Spain, and United Kingdom, migrants in Canada, and individuals with disabilities in the Netherlands, respectively. Hitt & Tambe (2007) highlight that a high-quality infrastructure, such as broadband access, increases the time spent online. Nevertheless, these disparities in time spent online are not necessarily

inequalities. Especially since digital overuse, which is more frequent among individuals with a low level of education, harms well-being (Gui & Büchi, 2021). Studies have, therefore, turned to the *"quality"* of use rather than the quantity. Hence, Pantea & Martens (2013) and van Deursen *et al.* (2015) point out that individuals with a high level of education use the internet for improving their human capital, while the least educated for leisure. In the same line, Elena-Bucea *et al.* (2021) point out that the most educated have greater use of online services (banking, submitting government forms, making medical appointments, and taking online courses). Social network adoption is more influenced by age. Consequently, digital inequalities emerge from the diversity and way of using the internet, not from the average time spent online.

Some authors focus on the reasons explaining digital exclusion. Selwyn (2006) and Eynon & Helsper (2011) point out that reasons for not using computers (no interest/no need, no knowledge, no access to a computer, too expensive) depend on the individual's socio-demographic characteristics, but also on whether he has used the internet in the past or not. Using British and Swedish surveys between 2005 and 2013, Helsper & Reisdorf (2017) also observe that reasons for digital exclusion among non-users and ex-users differ over time and between countries. The main reason for the non-use of the internet was a lack of interest for British and Swedish. The lack of skill and no internet access were also important determinants. Ex-users in both countries mention a lack of interest. Nevertheless, many British ex-users do not use the internet anymore because of the cost, which is not the case for Swedish ex-users. Finally, reasons for the non-use of the internet may vary over time. Between 2005 and 2013, non-access to the internet and lack of skills are declining as barriers to internet use in Great Britain, but not Sweden. In contrast, lack of interest is increasingly mentioned as an answer for the non-use of both countries.

Recent literature emphasizes the existence of a third-level digital divide that addresses inequalities in digital use outcomes (Scheerder *et al.* , 2017). Pénard *et al.* (2013) show that internet users are more satisfied with their lives than non-users. However, they highlight disparities among users: the influence of the internet on well-being is more substantial among the younger and the poorest individuals. Bartikowski *et al.* (2018) find that the perceived

effect of digital is weaker for ethnic minorities than other users. Castellacci & Tveito (2018) also indicate that the impact of digital use on well-being depends on individual characteristics such as psychological functioning, capabilities, and framing conditions. Finally, Lythreatis *et al.* (2022) note that further levels of the digital divide may concern algorithmic awareness and data inequality.

3 Methodology and Data

3.1 Pseudo Panel methods

To study digital inequalities our empirical methodology is based on panel model. It enables to control for individual heterogeneity and considering series dynamics (Baltagi, 2013), especially since the digital transition is still ongoing. The general model to estimate is:

$$y_{it} = x_{it}\beta + \alpha_i + \lambda_t + \epsilon_{it} \tag{1}$$

$$i = 1, ..., N; t = 1, ..., T$$

where y_{it} is the dependent variable for the individual i at time t, x_{it} a vector of explanatory variables for individual i at date t, β a vector of parameters to be estimated associated with the explanatory variables, α_i the fixed effect of individual i, λ_t the time fixed effect for each period t, and ϵ_{it} the *independent and identically distributed (i.i.d)* error term.

In the annual ICT Household survey used in this paper, individuals are not the same every year. Since the samples differ each year, we do not have panel data but 13 individual cross-sections. We use pseudo-panel method, theorized by Deaton (1985), to overcome this problem. This method enables the use of independent cross-sectional data in a panel model and is used to address a variety of issues in economics.[4] For this purpose, individuals

[4]Pseudo-panel methods are often used to analyze household behavior because the same individuals are rarely interviewed each year in surveys. Gardes *et al.* (2005) use it to compute elasticities of food consumption, Bernard *et al.* (2011) household electricity demand, and Imai *et al.* (2014) to identify determinants of child nutritional status. Pseudo panel is also used with other data such as real estate transactions (Baltagi

are no longer considered but cohorts. These cohorts represent groups of individuals with common fixed characteristics over time. In our case, these characteristics are generations; their common characteristic is to have been born in the same period. In a second step, we form cohorts according to generation and gender.

The principle of pseudo-panel is to replace individual variables of the panel model by their intra-cohort means. Equation (1) is transformed as:

$$y^*_{ct} = x^*_{ct}\beta + \alpha^*_c + \lambda_t + \epsilon^*_{ct} \tag{2}$$

$$c = 1, ..., C; t = 1, ..., T$$

where for a variable z, $z^*_{ct} = E(z_{it}|i \in c)$, y^*_{ct} is the expectation of the dependent variable for cohort c at survey date t, x^*_{ct} a vector of the expectations of the explanatory variables for cohort c at survey date t, β a vector of parameters associated with the explanatory variables, α^*_c the fixed cohort effect, λ_t the time fixed effect for each period t, and ϵ^*_{ct} the error term.

The true values of y^*_{ct} and x^*_{ct} are not known. Only the average of the values observed in the sample for the individuals of the same cohort are known and can be used. The model is then:

$$\overline{y}_{ct} = \overline{x}_{ct}\beta + \overline{\alpha}_c + \lambda_t + \overline{\epsilon}_{ct} \tag{3}$$

$$c = 1, ..., C; t = 1, ..., T$$

where for a variable z, $\overline{z}_{ct} = \frac{1}{n_{ct}} \sum_{i \in c} z_{it}$ and n_{ct} the number of observations in cohort c at time t.

To avoid measurement errors, Verbeek & Nijman (1993) demonstrate that from 100 individuals per cohort, the averages calculated tend towards their true value. They advise that cohorts should be composed of at least 200 individuals to avoid measurement errors. Estimation biases are then neglected. Nevertheless, increasing the cohort size reduces the number of cohorts in the panel and increases the heterogeneity in each cohort. It may increase the estimator's variance and decreases its efficiency. It is, therefore, necessary to

et al. , 2015).

conduct a trade-off between cohort size and the number of cohorts to avoid any measurement error. Moreover, fixed effects can be considered constant over time if the criteria for selecting our cohorts is stable over time and if each cohort is large enough as specified by Verbeek & Nijman (1993). When the three conditions are respected (large enough cohorts, enough cohorts, and stable selection criterion for cohorts), the model (3) may be estimated as a regular panel with fixed effect, i.e., using a within estimator obtained after performing a within transformation to the model. This estimator is a least-squares estimator applied to the variables of the transformed model. Note that Pseudo Panel methods decrease the potential endogeneity bias through the aggregation of individual data (Gardes *et al.* , 2005).

Our dependent variables (presented in detail in the next section) are initially qualitative, such as y_i equals 1 when the individual performs the task (has access to the internet, uses the internet, does a specific activity online) and 0 if not. The dependent variable is logit transformed in order to obtain a linear logit share equation (Considine & Mount, 1984). The dependent variable is now a logarithm of the share ratio, and the model is linear in parameters, enabling us to estimate the model as a regular panel model. The estimated model is:

$$\ln(\frac{\bar{y}_{ct}}{1-\bar{y}_{ct}}) = X_{ct}\beta + \alpha_c + \lambda_t + \epsilon_{ct} \tag{4}$$

with $\ln(\frac{\bar{y}_{ct}}{1-\bar{y}_{ct}})$ the explanatory variable of cohort c at date t, X_{ct} is a vector of average explanatory variables for cohort c at survey date t, α_c the cohort fixed effect, λ_t the time fixed effect, and ϵ_{ct} the $i.i.d$ error term.

3.2 Data and descriptive statistics

3.2.1 Cohorts

This paper uses the annual ICT Household Survey from INSEE between 2007 and 2019. It collects information on individual and household characteristics, access to ICT, use of computers, use of the internet, ICT skills, and security on the internet. Households living in French Overseas Departments are not surveyed before 2009. As a consequence, we only

consider households residing in metropolitan France. Moreover, we only take into account individuals aged 24 to 82. Indeed, young people are poorly represented in the survey as they are usually interviewed when financially independent and individuals surveyed after age 82 (the average life expectancy in France) can no longer represent their generation as wealthier individuals tend to live longer. This restriction enables us to have a relatively stable population over time and use pseudo-panel methods. In addition, we consider cohorts present in the 13 years of our sample to work on a balanced panel.

In a first step, when studying inequalities in access and use, we compose cohorts of two-year generations. In total, we have 23 cohorts per year, corresponding to 299 observations. On average, a cohort is composed of 288 individuals, and only 20 cohorts, representing 6,7% of the sample, are composed of less than 100 individuals (see Table B.1), preventing measurement errors (Verbeek & Nijman, 1993). Including a variable for gender may have difficulties in capturing gender specificity in a pseudo-panel, since a dummy variable represents the percentage of individuals in the cohort with a specific characteristic. For gender, it will be approximately 50% for each cohort. Consequently, we estimate a second model where cohorts are distinguished by generation and gender. This new distinction by gender increases the number of cohorts and, therefore, decreases the number of individuals in each cohort. To have enough individuals in each cohort, we consider five-year generations. It results in 36 cohorts per year for 216 observations. Each cohort is composed of 346 individuals on average, and 12 cohorts are composed of less than 100 individuals, representing 5% of the sample (see Table B.2). In the second part, we restrict the sample to the population who uses the internet and, in the third, to those who do not have access to the internet. We change cohorts' composition to respect Verbeek & Nijman (1993) conditions. For the examination of internet usage's variety with only the internet users, cohorts are made of five-year generations composed, on average, of 537 individuals (see Table B.3). For the investigation of reasons for the non-access to the internet with only the population without any internet connection at home, we consider ten-year generations composed, on average, of 281 individuals (see Table B.4). As a robustness check, we re-estimate all the model by changing the cohort compositon. We do not observe any substantial change.

3.2.2 Descriptive statistics

Dependent variables: measures of different levels of the digital divide

Inequalities in digital access and use

To analyze inequalities in digital access and use, we consider two questions of the survey: does the individual have access to an internet connection at home (*Access*), and does he use the internet (*Use*)? Access to the internet is not necessarily a fixed connection but can also be mobile.

Table 1 shows that the diffusion and adoption of digital technologies is an ongoing process. Between 2007 and 2019, households with internet access at home drastically increased from 48% to 82%.[5] Internet users have increased similarly since only 51% of French people over 15 years old used the internet in 2007 compared to 80% in 2019. The difference between access and use is that an individual may have access to the internet at home but not use it because the subscription is initiated by another household member. Alternatively, an individual may not have access to the internet at home but uses it outside the home (e.g., at work, in a public library). We can also observe that access has increased more rapidly than use. Before 2011, the share of users was higher than individuals with an internet connection at home. Since 2011, this trend has been reversed.

Table 1: Share of French with an internet connection at home (Access) and who have used the internet in the year (Use) between 2007 and 2019 (in %)

	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Access	47,7	54,6	49,8	56,8	72,3	75,2	75,6	79,3	80,1	80,9	80,2	81,9	82,4
Use	51,8	58,2	51,1	58,3	70,9	74,9	74,7	78,4	80,1	79,2	79,5	79,4	80,3

Source: INSEE annual household survey on ICT between 2007 and 2019. Only individuals over 15 years old and living in metropolitan France are considered.

Diversity of use among the online population

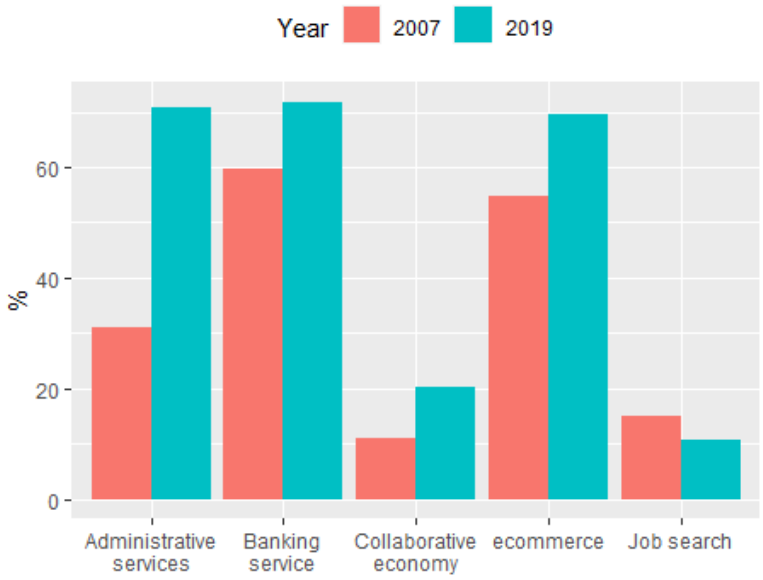
In the second part, we restrict the study to internet users. The purpose is to analyze if

[5]We consider that having access to the internet is a choice for the individual. However, the infrastructure may not be accessible. For example, if the internet is unavailable in the locality (although we show that this is not a major barrier in France). Moreover, if the individual is renting his dwelling, he may not be able to request the installation of an internet connection.

disparities in use are also present when individuals access and use the internet. We consider six usages of the internet: (i) use online banking services, (ii) fill out or send administrative forms, (iii) buy a good online, (iv) create a profile or post messages on social networks, (v) search for a job on the internet, and (vi) sell products and services on online sites. Variables are described in Table A.1 in the appendix.

We have chosen these activities for their diversity. Some are more related to leisure or social interaction such as the use of social networks, others to commercial activities such as buying (e-commerce) and selling goods online (collaborative economy). The rest is linked to the use of online organizational services such as online job search, administrative, and banking services. Figure 1 shows that these activities do not have the same utilization rate and, for most of them, their utilization has increased since 2007.

Figure 1: Average uses of different activities on the internet in 2007 and 2019



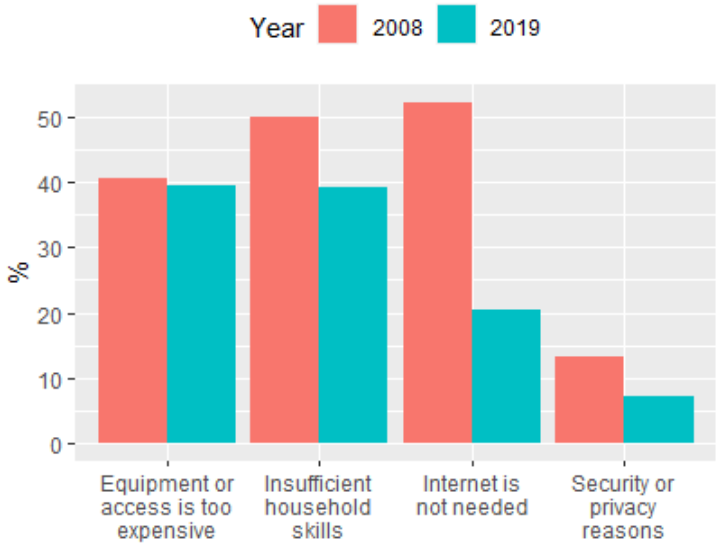
Source: INSEE annual household survey on ICT between 2007 and 2019. Only Internet users are considered.

Reasons for the non-access of the internet at home

To investigate the reasons behind digital exclusion, we restrict the sample to individuals

who do not have internet access at home. The purpose is to understand the different barriers to digital access according to socio-economic characteristics. We consider the four main reasons for not having internet access at home (see Figure 2): (i) the equipment or access is too expensive, (ii) internet is not needed, (iii) insufficient household skills, and (iv) security or privacy reasons.[6] Variables are described in Table A.2 in the appendix.

Figure 2: Average reasons declared to explain the non-access to internet at home in 2008 and 2019



Source: INSEE annual household survey on ICT between 2007 and 2019. Only individuals without any internet connection at home are considered.

Explanatory variables: potential determinants of the digital divide

While the digital transition is still underway, access and usage of digital technologies differ among individuals. Table 2 reveals that individual's average characteristics vary depending on whether we study the entire population or only those who have access to the internet and use it. For instance, the average age is lower when we only consider individuals who have access to and use the internet. Figure 3 displays the share of individuals who have used the

[6]Between 2007 and 2019, only 6% of French households do not have an internet connection because of a lack of digital infrastructure. We, therefore, do not consider this reason.

internet according to age between 2007 and 2019. We observe that the use of the internet is decreasing with age. We can also notice that it increases over time. Therefore, an individual aged 50 in 2019 uses, on average, the internet more than an individual aged 50 in 2007.

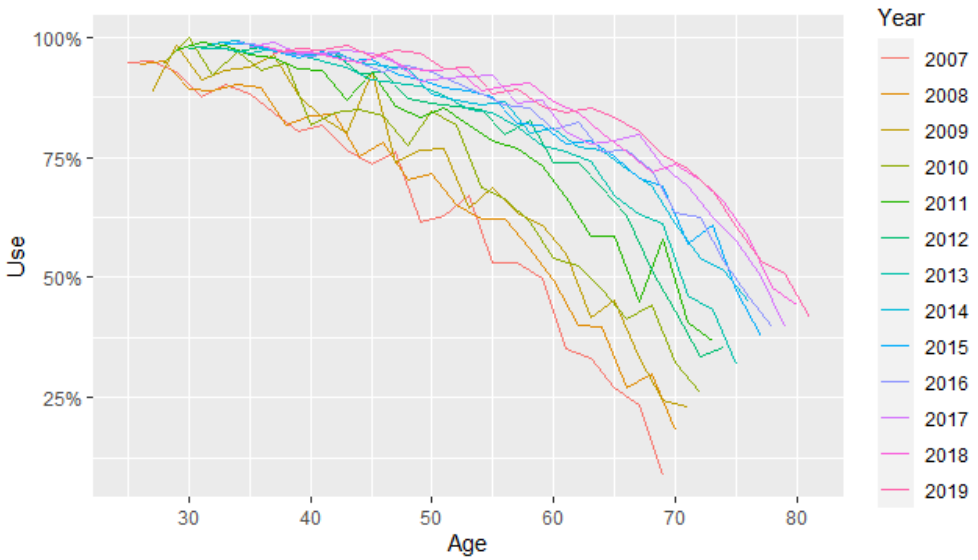
Table 2: Descriptive statistics

Variable	**All**	**Use**	**Access**
Age (mean)	54.3	52.1	52.6
Woman (%)	50.2	49.5	49.5
Household size* (mean)	1.92	1.98	2.01
Monthly income			
- less than 1000€(%)	9.29	6.60	6.27
- between 1000 and 1500€(%)	17.1	13/8	13.8
- between 1500 and 3000€(%)	39.5	39.8	40.1
- more than 3000€(%)	34.1	39.8	39.7
Education level			
- Low (%)	52.2	43.3	45.1
- Middle (%)	26.8	31.3	30.4
- High (%)	21.0	25.3	24.5
*Urban unit size***			
- rural area (%)	25.1	24.6	24.7
- 2,000 to 4,999 residents (%)	6.81	6.68	6.71
- 5,000 to 9,999 residents (%)	6.07	5.98	5.98
- 10,000 to 19,999 residents (%)	5.10	4.97	5.00
- 20,000 to 49,999 residents (%)	6.50	6.28	6.30
- 50,000 to 99,999 residents (%)	7.26	7.05	7.07
- 100,000 to 199,999 residents (%)	6.29	6.29	6.24
- 200,000 to 1,999,999 residents (%)	22.8	23.2	23.1
- Paris (%)	12.9	14.8	14.7

Note: INSEE annual household survey on ICT between 2007 and 2019. All the variables are described in Table A.3 in the appendix.
*Number of persons over 15 years old in the household.
**Percentage calculated for the 2013-2019 period.

Figure 4 illustrates the evolution of the use of the internet for different generations over time. It shows an upward trend over time for all generations. In other words, digital use increases with time, regardless of age. Several other trends are also observable. First, the younger the generation, the higher the internet use, reflecting the trend that younger generations have grown up with the spread of digital tools. Furthermore, younger generations

Figure 3: Share of individuals who have used the internet in the year according to age between 2007 and 2019



Source: INSEE annual household survey on ICT between 2007 and 2019.

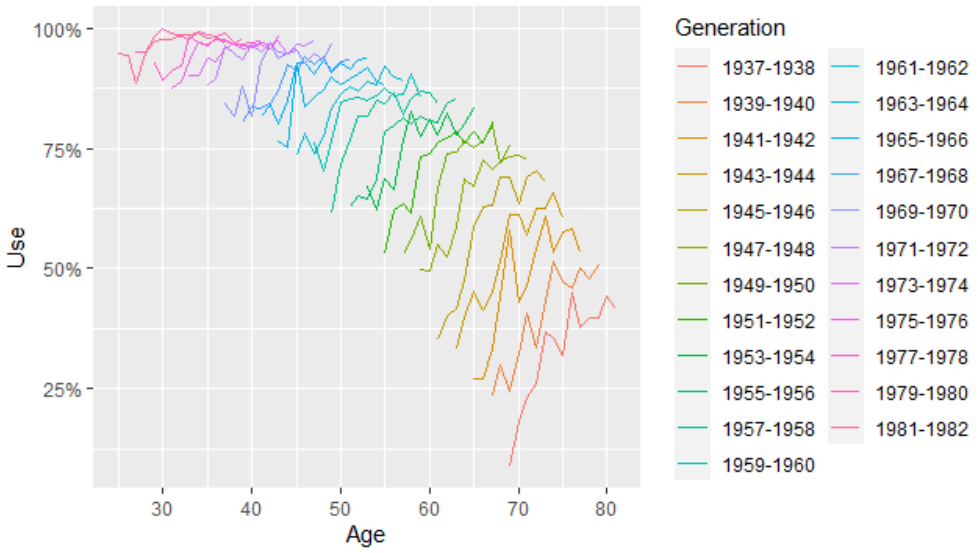
have a relatively similar internet use despite their different ages, enhancing the digital lag of the older generations. However, there appears to be a catch-up phenomenon: Figures 3 and 4 indicate a faster increase in internet usage over time for older generations. Generational characteristics and temporal dimension seem to be essential determinants of digital consumption.

We also notice that income and education levels can influence internet access and use. Internet users are more present among individuals with a high level of education. Between 2007 and 2019, 95% of individuals with a degree above Bac+2 used the internet, while only 58% of individuals below the baccalauréat used it.[7] 89% of individuals with a diploma between baccalauréat and Bac+2 used the internet. Standard of living and education appear to facilitate access and use of digital technology, which is not surprising since the two main barriers to home internet access are lack of skills and cost.

The environment could affect access to an internet connection, but it can also influence usage. To the question *"In which context did you learn most to use digital tools?"*, 31% of

[7]The baccalauréat is the French high-school diploma. Bac+2 (Baccalauréat+2) degree corresponds to the second-year university degree.

Figure 4: Share of individuals who have used the internet in the year according to age from one generation to another



Source: INSEE annual household survey on ICT between 2007 and 2019.

French people in 2017 answered alone, while 22% answered with family members, and 13% with friends and colleagues.[8] 14% and 10% have learned to use digital tools during their initial and continuing education, and 10% have never learned to use them. We also notice that the average number of people over 15 in the household is higher when considering only those with home internet access or who use it than the entire population.

Even if the lack of infrastructure is not one of the main reasons for the non-access to the internet at home, we decide to examine the impact of the residence location. To this aim, we first study the effects of the region's population density where the individual lives. Population density may be considered a proxy of the urban area and digital infrastructure. Indeed, there are *"white spots"* in France, i.e., territories not covered by any internet operator, which are often located in areas with a low population density. Since 2013, the INSEE ICT survey has provided information on the size of the urban unit where the surveyed individual lives. We, therefore, estimate our model with another specification over a shorter period (2013-2019) but with more precise information on the place of living.

[8]ARCEP, Baromètre du Numérique, 2017. Downloaded in July 2022. `https://www.data.gouv.fr/fr/datasets/barometre-du-numerique/`.

The explanatory variables of our study are chosen according to the trends highlighted in this section. Therefore, we consider the year of birth of the individual (generation), the income bracket of the household, the level of education, the gender, the household size, density of the region, and size of the urban unit as potential determinants. The description and source of all our variables are presented in Table A.3 in appendix.

4 Empirical results

This section presents our estimation results of the determinants of different levels of the digital divide in France. As a reminder, we estimate the equation (4), and the dependent variables change according to the digital divide level studied. Four models are estimated. Models (1) and (3) consider the variable income bracket, while models (2) and (4) the level of education as income and education levels are highly correlated. Models (3) and (4) are estimated only between 2013 and 2019 and consider the size of the urban unit instead of the density. In the first sub-section, inequalities in internet access and use are studied among the whole population. The second subsection focuses on disparities in internet usage among internet users. The last sub-section focuses on individuals without internet at home. Results tables are presented in appendix C.

4.1 Inequalities in digital access and use

Socio-economic determinants

Our estimations are presented in Table C.1 in appendix. The income bracket and the level of education appear to be significant drivers of digital access and use. More specifically, earning more than 1500 euros per month is a significant determinant of digital access and use.[9] The degree level is also a determinant of digital access and use, especially for individuals

[9]Performing a Wald test, we find that estimated coefficients associated to the variable "monthly income between 1000 and 1500 euros" and "monthly income of less than 1000 euros" are not statistically different.

with a degree level higher than the high-school diploma.[10] Comparing the *adjusted* R^2, the impact of education appears to be more important for the use than the access. On the contrary, the income level is a more significant determinant of the access than the usage of internet. Indeed, a lack of financial resources can be a barrier to household internet access. However, once a household has access to the internet, the main obstacle to use is the lack of digital skills. This is coherent with Goldfarb (2006)'s results, which emphasizes the role of educational institutions in digital diffusion. Having many people over 15 at home makes it easier to access materials but does not impact the internet's use. Indeed, a household can have an internet connection because a member uses it, even if the surveyed individual does not use it. Our result differs from Korupp & Szydlik (2005) who found that having teenagers or young adults at home was a determinant of computer and internet access in Germany between 1997 and 2003.

In addition to these intra-generational disparities, we find significant inter-generational inequalities. Cohort-fixed effects highlight that the younger the generations, the more they have an advantage in accessing and using digital (see Figures 5 and 6). These inequalities are more substantial among older generations for digital access and use. Inter-generational inequalities are more pronounced when studying use than access.

All the time-fixed effects in the model are significantly different from zero and increase with time (Figures 7 and 8). This means that access and use of digital technology has increased over time regardless of the individuals' characteristics. Nevertheless, a plateau seems to be reached for the usage: time-fixed effects between 2014 and 2019 are not significantly different from each other. This is not the case for time-fixed effects for access, even if the increase has been lower in the last few years. These results highlight the need for public policies to reduce the digital divide. Note that time-fixed effects can also capture the improvement in internet coverage of the territory or the decrease in the price of hardware and internet connection (Arcep, 2022).

[10]Estimated coefficients associated with the variable middle level and high level of education are not statistically different, both for access and use estimations.

Figure 5: Cohort effects for Access

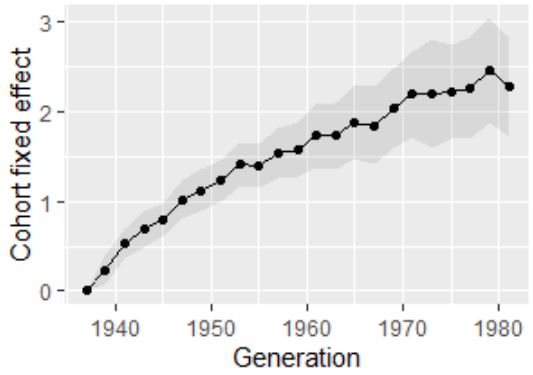
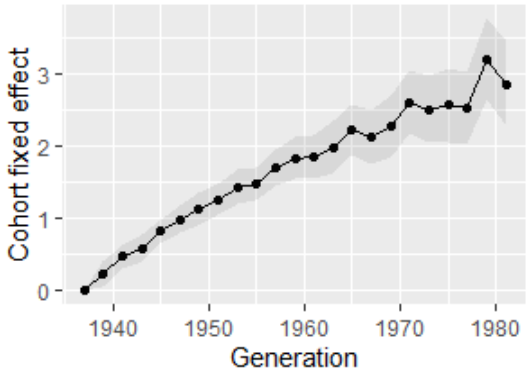


Figure 6: Cohort effects for Use



Note: The 1937-1938 generation is the reference cohort. Each fixed effect is to be compared to this cohort. A positive fixed effect significantly different from 0 means that the generation has an advantage in digital access and use over the 1937-1938 generation. The grey area represents the 95% confidence interval of fixed effects for each generation of the models (2) in Table C.1

The digital urban/rural divide

None of our measures of urbanization (density and size of the urban unit) are significant regardless of the estimated model (see Table C.1 in appendix).[11] Our results show no difference between living in Paris or in a rural area. The living area has no impact on digital access and usage. This result is consistent with Schleife (2010) who demonstrates that disparities in internet use among German counties are not explained by differences in population density but rather by differences in the composition of individual characteristics of each county. The digital divide is more prevalent in rural areas because, on average, the population is older and has lower incomes than in urban areas. This is consistent with the fact that among households that do not have an internet connection at home, only 6% explain it by the absence of broadband infrastructure in their locality.

Therefore, the residence, often considered an infrastructure proxy, does not appear to be a barrier to digital access and use. This result is important because this has not always been the case, especially in the early days of internet diffusion when infrastructures were

[11] As a robustness check, we tested all models by changing the urban unit size's reference and the division of the urban units into five urban units instead of nine (rural area, between 2,000 and 19,999 inhabitants, between 20,000 and 199,999 inhabitants, between 200,000 and 1,999,999 inhabitants, and Paris). Results remain unchanged.

Figure 7: Time fixed effects for Access

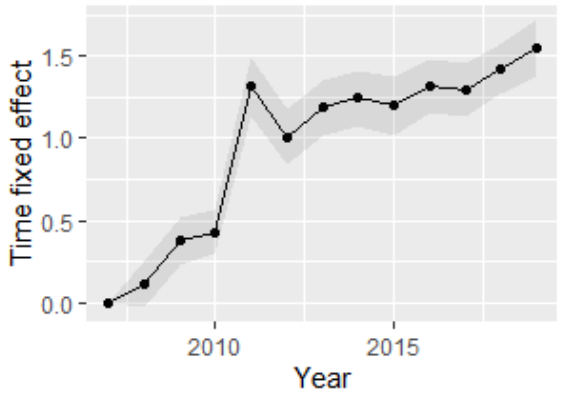
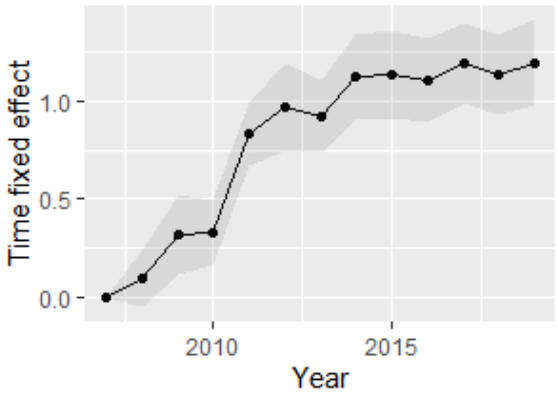


Figure 8: Time fixed effects for Use



Note: 2007 is the reference year. Each time fixed effect is to be compared to this year. A positive fixed effect significantly different from 0 means that the year has an advantage in digital access and use over 2007. The grey area represents the 95% confidence interval of the time fixed effects of the models (2) in Table C.1

located in the most profitable areas, i.e., in the most densely populated areas. Meanwhile, the internet coverage of the French territory has improved thanks to various laws. For instance, the law on the digital divide in 2009 enabled the creation of a fund for the digital development of territories, whose objective was to assist in implementing the infrastructure required for broadband access in areas where electronic communications operators cannot make the necessary efforts.[12] The perception that residence is a key determinant of the digital divide is also based on the fact that the quality of internet service varies across locations. In 2019, the mobile coverage rate was 92,1% in metropolitan France, but only 81,5% of housing and offices benefited from broadband and 52,9% from very high-speed broadband (Antoine & Simon, 2020). Moreover, Croutte & Muller (2021) point out that, among internet users, rural people are less satisfied than urban people with their internet connection. They also highlight that 11% of French internet users consider that an insufficient quality of internet service is a barrier to internet use. Among the non-internet users, only 4% consider the quality of internet service as a barrier. Therefore, there is a digital divide between cities and countryside, not due to a lack of infrastructure but to its quality.

[12]French law n°2009-1572 of December 17, 2009 on the fight against the digital divide.

The digital gender gap

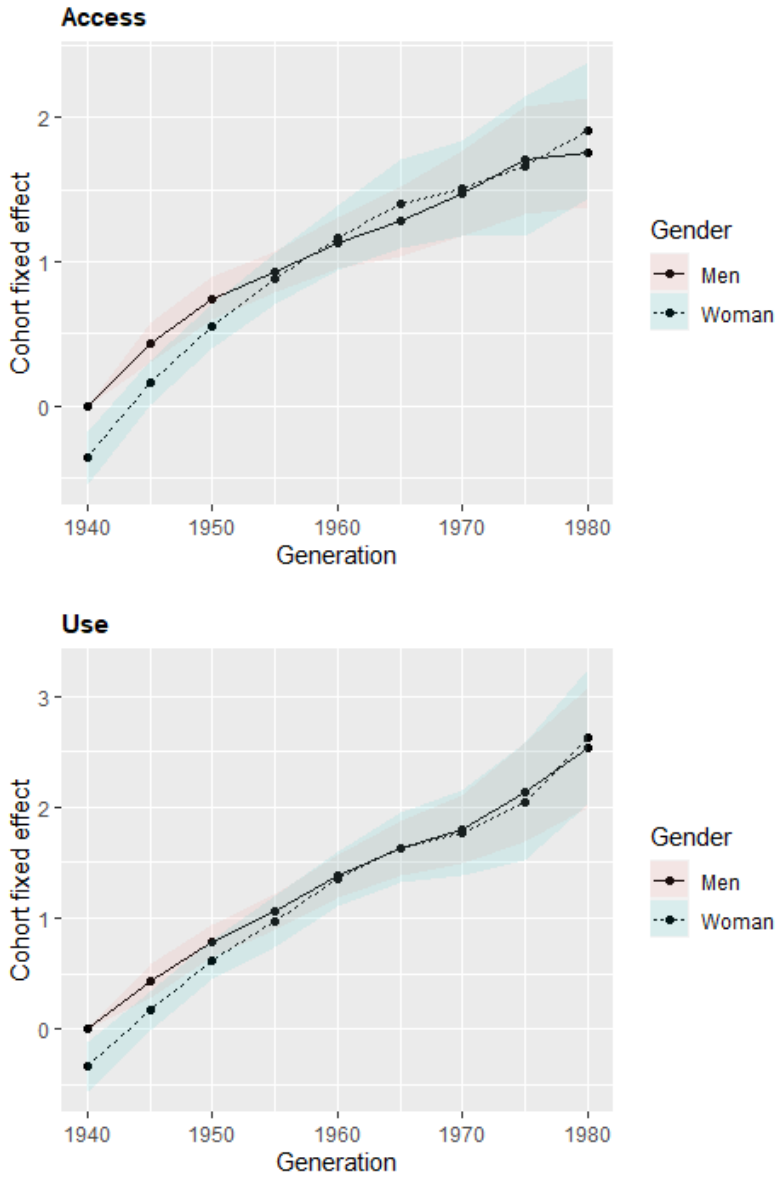
In this section, cohorts are separated by gender. It enables us to compare the cohort effect between women and men of the same generation. At the same time, it allows us to evaluate the robustness of our first results. Results are presented in Table C.2 in the appendix. We find that fixed effects of the same generation are statistically different according to the gender of the individuals born between 1938 and 1952, both for access and usage (see Figure 9). The younger cohort's fixed effects value is the same for each generation of a different gender. Consequently, there is a digital gender gap favoring men for the older generations, but this gap does not appear for younger generations. We obtain the same results as the two-year generation, consolidating previous results.

4.2 Disparities in the diversity of internet use

In this section, we are interested in whether these intra and inter-generational inequalities exist in usage once an individual has access to the internet and uses it. In other words, do an individual's socioeconomic characteristics influence the diversity and the type of internet usage? Although other variables influence the probability of doing an online activity, we restrict the analysis to the explanatory variables used in the previous section. Results are presented in Table C.3 in the appendix.

We have highlighted the existence of inequalities in access and use of digital technology in France, to the detriment of the poorest, the least qualified, and the oldest generations. Once an individual uses the internet, disparities observed in the previous section are not necessarily present. The effects of degree level, gender, and the number of inhabitants depend on the activity and are not always significant. The level of qualification is only a determinant of buying goods online. Individuals purchasing goods on the internet generally have a degree above the bachelor's level. The income level only impacts the probability of selling goods online but in the opposite way. Low-income individuals are more likely to participate in the collaborative economy. It is due to the additional income possible through the sale of

Figure 9: Generation and gender effects



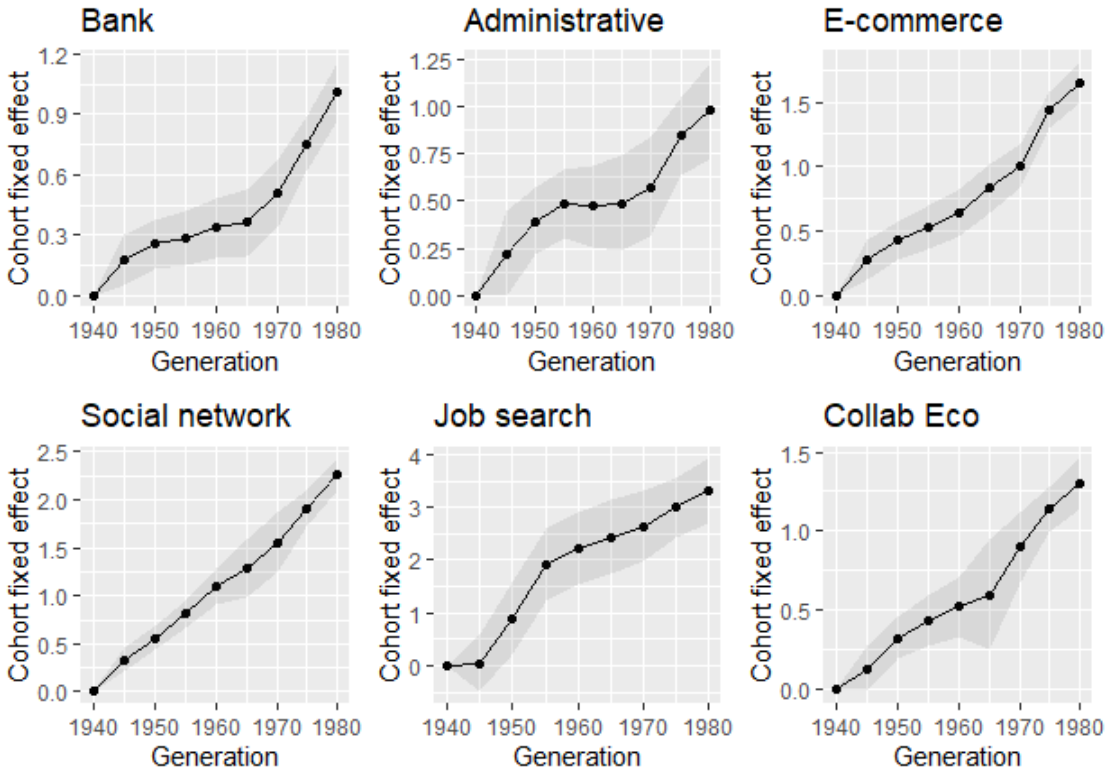
Note: The 1936-1938 men generation is the reference cohort. Each fixed effect is to be compared to this cohort. A positive fixed effect significantly different from 0 means that the cohort has an advantage in digital access and use over men from the 1936-1938 generation. The red (blue) area represents the 95% confidence interval of the men (women) fixed effects for each generation of models (2) in Table C.2

second-hand goods, which is more necessary for households with low purchasing power.

Intra-generational inequalities are not as pronounced when we focus on the diversity of activities performed online, but inter-generational inequalities are still present for all

selected activities (see Figure 10). Probabilities of shopping online, being on social networks, and selling goods online (collaborative economy) increase with the generation's youth. The generational effect is less pronounced for the other activities considered. Young people are more likely to do their administrative procedures online, but generational differences are less marked than in other activities. For instance, the 1953-1957 generation has no lower probability of doing an administrative procedure on the internet than the 1968-1972 generation. The probability of using online banking is high for younger generations, but there is no significant difference between the 1938-1942 and 1963-1967 generations. Online job searching is the activity the less affected by inter-generational inequalities. The differences observed between the older generations and the 1953-1957 and later generations are simply because these generations are of working age.

Figure 10: Cohort effect on the probability of doing an activity online



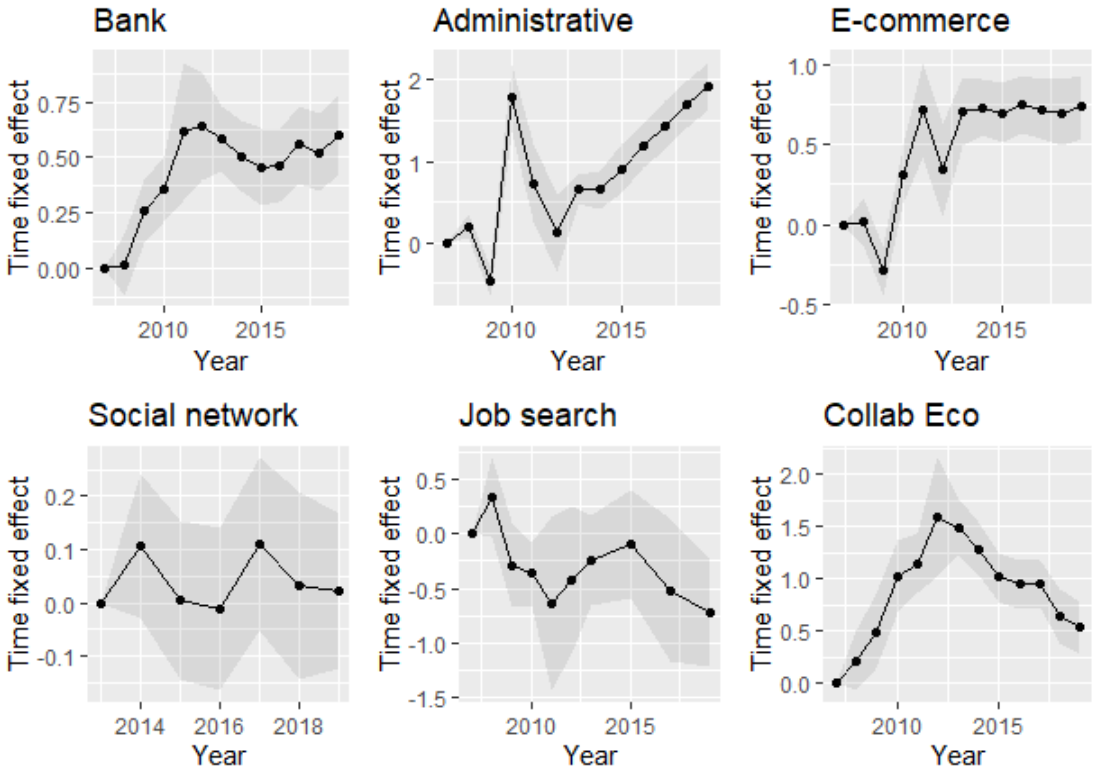
Note: the 1938-1942 generation is the reference cohort. Each fixed effect is to be compared to this cohort. A positive fixed effect significantly different from 0 means that the generation has an advantage in digital access and use over the 1938-1942 generation. The grey area represents the 95% confidence interval of fixed effects for each generation of the models (1) in Table C.3

Time effects depend on activities studied (see Figure 11). The probabilities of being on social networks and doing online job searches have not changed over time. The likelihood of completing administrative procedures online has increased significantly over time. Two changes can be observed. First, 2010 was marked by an increase in the number of individuals doing their administrative procedures online. It can be due to the creation of the site *mon.service-public.fr* by the French government in December 2008, enabling citizens to register on electoral lists, to declare a change of address, a death, a loss of identity papers, and to create a company or an association. In 2010, this site was improved and simplified, mainly by extending access to its services to the whole territory.[13] Before, only a few pilot municipalities had access to its online services. In 2014, the French government pursued its project to modernize the public service by merging its various sites to simplify all administrative procedures. Other laws have also enabled the increase of online managerial procedures, particularly the obligation to declare revenues online for households with internet access in 2016. French government's investment in digitizing public services appears to produce results. Online banking and purchasing goods also experienced increased usage over time, but only until 2011. Finally, the sale of goods online increased until 2014 and has then declined. Goudin (2016) explain that the collaborative economy has experienced growth following the economic and financial crisis of 2008 because it was perceived as a way to save or earn additional revenue.

To conclude, once an individual has access to and uses the internet, intra-generational inequalities in usage disparities are not present anymore, but intergenerational inequalities are still prevalent. The inequalities concerning the non-usage of online banking and administrative services are more concerning due to the dematerialization of these services. The priority is to focus on digital access marked by more significant inequalities to overcome the digital divide. For this purpose, it is essential to identify barriers to digital access in France.

[13] `https://www.senat.fr/rap/a09-106-6/a09-106-64.html`.

Figure 11: Time effect on the probability of doing an activity online



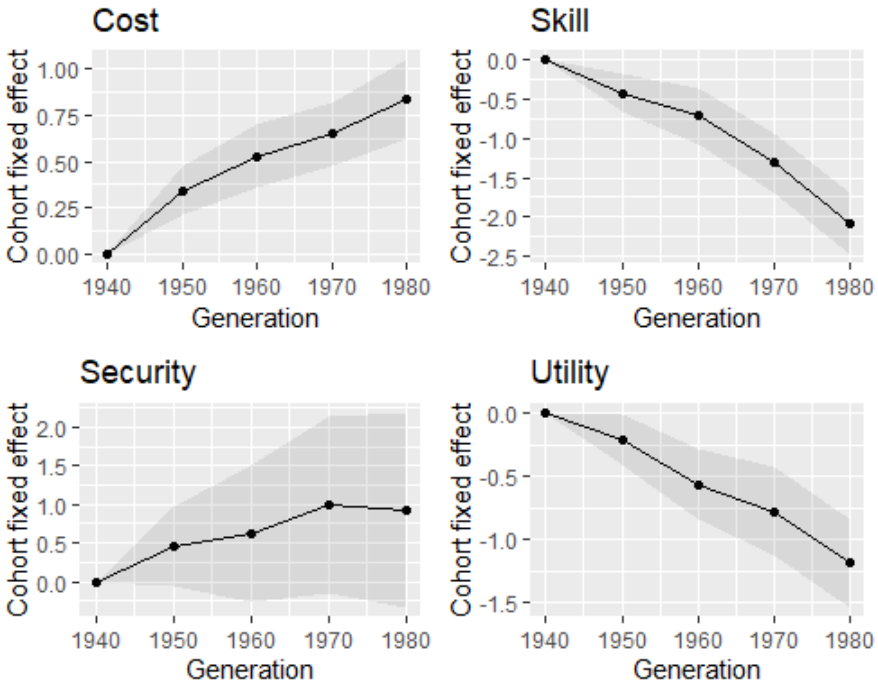
Note: the 2007 is the reference year. Each time fixed effect is to be compared to this year. A positive fixed effect significantly different from 0 means that the year has an advantage in digital access and use over the year 2007. The grey area represents the 95% confidence interval of the time fixed effects of the models (1) in Table C.3

4.3 Reasons for non-access to internet

We have noticed that internet access in France has significantly increased between 2007 and 2019. Nevertheless, there are still French people without an internet connection. Our previous results indicate a slowdown in the increase in the number of households with an internet connection. Therefore, this section investigates why these households do not have internet access at home. For this purpose, we restrict the sample to households without internet access at home. Sub-sections 4.1 and 4.2 provide a profile of individuals most affected by the digital divide to know where public policies should focus. Understanding and knowing the different barriers to digital access will allow adapting these public policies to different populations. Estimation results are presented in Table C.4 in appendix.

Reasons for not accessing the internet differ by generation (see Figure 12). The older generations are more affected by a lack of digital skills. Moreover, they do not always see the internet as useful, suggesting that some of the digital exclusion is voluntary. This explanation is subject to some caution. Not being online can exclude a person, especially in countries where administrative procedures for public services are done online. The lack of interest may be due to a lack of knowledge and skills. Financial barriers to digital access mainly concern the younger generation. Security and privacy issues are not more prevalent in one generation than in another.

Figure 12: Cohort effect on the probability of not having internet for a reason



Lecture: the 1935-1944 generation is the reference cohort. Each fixed effect is to be compared to this cohort. A positive fixed effect significantly different from 0 means that the generation has an advantage in digital access and use over the 1935-1944 generation. The grey area represents the 95% confidence interval of fixed effects for each generation of the models (1) in Table C.4

The level of income and education are essential determinants of access and use of digital technology in France, but they do not explain the differences in reasons for not accessing the internet. The more skilled tend to consider security and privacy issues less of a barrier

to internet access than the less skilled. They are also more likely not to have an internet connection because they are not interested in it. Education and standard of living do not impact the likelihood of not having the internet for financial reasons or lack of skills. Women are more affected by financial barriers than men. In the other cases, the other explanatory variables (gender, density of living areas, household size) are not determinants of digital exclusion.

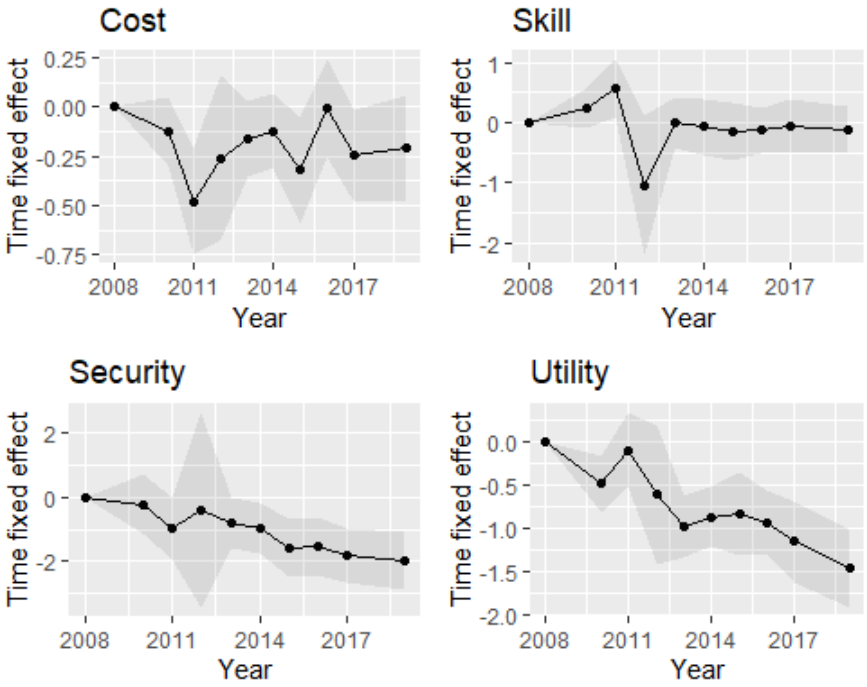
Finally, the probability of not having an internet connection because of security concerns and lack of interest decreased between 2007 and 2019 (see Figure 13). It can be due to several reasons. Firstly, the lack of trust in digital is lowered through legislation strengthening online security and requiring digital platforms to protect privacy, as initiated by the General Data Protection Regulation. The increase in internet interest can be due to the rise in online administrative tasks. Moreover, if having an internet connection becomes essential, individuals can subscribe to an internet contract even if they are still concerned about privacy and security issues. Financial and skill constraints remain important barriers to internet access. It should be noted that although these reasons are still as much stated in the offline population, the latter has drastically reduced since 2007.

5 Discussion

In response to the COVID-19 crisis, the French government considered digital as one of the pillars of the recovery plan. To reduce the digital divide, 250 million euros are dedicated to digital inclusion. In this section, we compare our results with the public policies implemented in France.

One of most affected populations by the digital divide is the elderly population. We highlight that their main barrier is a skill issue. Implementing digital education is, therefore, crucial. This training must be concentrated on the oldest populations but can also be offered to the poorest and the less educated. It must also explain advantages of using the internet and, in particular, an introduction to administrative procedures that can be carried out

Figure 13: Time effect on the probability of not having internet for a reason



Note: the 2008 is the reference year. Each time fixed effect is to be compared to this year. A positive fixed effect significantly different from 0 means that the year has an advantage in digital access and use over the year 2008. The grey area represents the 95% confidence interval of the time fixed effects of the models (1) in Table C.4

online, such as income tax returns declaration. Although security and privacy issues are decreasing barriers to internet access, the French people are still concerned about these issues. Digital education is also a way to avoid misuse of the internet, which can result in security or privacy problems. To address this issue, the French government offers "digital passes" that enable individuals with digital difficulties to follow dedicated formations. Training, taking into account issues mentioned above, would reduce digital inequalities.

The lack of digital skills is not the only barrier to digital access; the cost of equipment and connection is also an important reason for not accessing the internet in France. Our results highlight that financial barriers mainly concern the younger. These populations are less likely to be affected by the digital divide, but when they are, it is rarely for lack of interest. These excluded individuals are, therefore, necessary to target. However, no financial support

dedicated to digital access is offered as pointed out by Vall (2020) who propose implementing "equipment checks" for the rental or purchase of digital equipment.

Some French, especially the elderly, do not find the internet useful. A report of Défenseur des droits (2019) recommend that non-digital and accessible solutions be offered for essential services (e.g., tax returns, aid requests); otherwise, there is a risk of excluding part of the population and increasing inequalities.

6 Conclusion

Bridging the digital divide is one of the objectives of the United Nations Development Program. OECD (2018) emphasizes that digital technologies give several opportunities, such as *"offer additional income, additional employment opportunities, and improved access to knowledge and general information."* In addition, inequalities in digital access and skills can drag on productivity and economic growth (Eichengreen, 2015). Therefore, reducing digital inequalities appears to be essential.

This paper studies determinants of the digital divide in France at different levels. Firstly, we get interested in internet access and use inequalities. Our results demonstrate intra and inter-generational inequalities in internet access and use, which decrease over time. Income and degree level are significant determinants of internet access and use. The household's size has a positive impact on access but not on usage. There is a gender digital gap in favor of men among older generations. Finally, we find no urban/rural digital divide in access and use in France. When we examine the variety and types of online uses of French people, we find that inter-generational inequalities in favor of younger people remain strong for several online activities. However, intra-generational inequalities among internet users are low. The French digital divide is mainly a problem of access and use. Finally, we highlight that barriers to internet access differ among individuals. Older people are more affected by a lack of skills and interest, while younger people are affected by financial barriers. Lack of interest, security, and privacy barriers are decreasing over time. Lack of digital skills and

financial costs remain the two main barriers to internet access. Therefore, we recommend continuing to invest in digital education and creating a financial aid system to access digital equipment. We also advise not to dematerialize all public services to avoid reinforcing the digital divide.

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A Variables description

Table A.1: Description of the variables of the different usage of the internet

Variable	Description	Available years
Administrative	The individual has used the internet to fill out or send administrative forms	2007-2019
Bank	The individual used the internet to access his bank account	2007-2019
E-commerce	The individual has used the internet to buy a good online	2007-2019
Social Network	The individual has used the internet to create a profile or post messages on social networks	2013-2019
Job search	The individual used the internet to search for a job	2007-2013, 2015, 2017, and 2019
Collaborative Economy	The individual has used the internet to sell products and services on online sites (eBay, Leboncoin, etc.)	2007-2019

Source: Households ICT surveys, INSEE, 2007-2019

Table A.2: Description of the variables of the reasons for the non-access to the internet

Variable	Description	Available years
Cost	Household does not have internet at home because of equipment or access is too expensive	2007-2017 and 2019
Utility	Household does not have internet at home because internet is not needed	2007-2017 and 2019
Skills	Household does not have internet at home because of insufficient household skills	2008-2017 and 2019
Security	Household does not have internet at home for security or privacy reasons	2008, 2010-2017, and 2019

Source: Households ICT surveys, INSEE, 2007-2019

Table A.3: Description and sources of the explanatory variables

Variable	**Description**	**Source**
Generation	Year of birth	ICT Household survey, INSEE
Woman	Be a woman	ICT Household survey, INSEE
Household size	Number of persons over 15 years old in the household	ICT Household survey, INSEE
Density	Population density of the region where the individual lives	INSEE & Eurostat
Urban unit size		
- rural area	Live in a rural area	ICT Household survey, INSEE
- 2,000 to 4,999 residents	Live in an urban unit of 2,000 to 4,999 residents	ICT Household survey, INSEE
- 5,000 to 9,999 residents	Live in an urban unit of 5,000 to 9,999 residents	ICT Household survey, INSEE
- 10,000 to 19,999 residents	Live in an urban unit of 10,000 to 19,999 residents	ICT Household survey, INSEE
- 20,000 to 49,999 residents	Live in an urban unit of 20,000 to 49,999 residents	ICT Household survey, INSEE
- 50,000 to 99,999 residents	Live in an urban unit of 50,000 to 99,999 residents	ICT Household survey, INSEE
- 100,000 to 199,999 residents	Live in an urban unit of 100,000 to 199,999 residents	ICT Household survey, INSEE
- 200,000 to 1,999,999 residents	Live in an urban unit of 200,000 to 1,999,999 residents	ICT Household survey, INSEE
- Paris	Live in Paris	ICT Household survey, INSEE
Monthly income		
- less than 1000€	Earn a monthly income of less than 1000€	ICT Household survey, INSEE
- between 1000 and 1500€	Earn a monthly income between 1000 and 1500€	ICT Household survey, INSEE
- between 1500 and 3000€	Earn a monthly income between 1500 and 3000€	ICT Household survey, INSEE
- more than 3000€	Earn a monthly income of more than 3000€	ICT Household survey, INSEE
Education level		
- Low	Below baccalauréat (high school diploma)	ICT Household survey, INSEE
- Middle	Between the baccalauréat and the second-year university degree	ICT Household survey, INSEE
- High	Higher than two years of higher education	ICT Household survey, INSEE

B Cohort's size

Table B.1: Cohort's size: two-year generation

Generation	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
1937-1938	114	180	152	104	106	147	345	147	218	285	243	260	281
1939-1940	140	162	131	121	101	152	314	197	223	261	256	285	323
1941-1942	96	149	102	104	93	179	269	142	237	300	301	278	293
1943-1944	112	149	128	140	127	234	405	225	314	318	298	324	345
1945-1946	111	168	139	133	138	232	466	252	390	395	370	343	379
1947-1948	147	243	171	160	172	351	576	380	468	530	482	533	478
1949-1950	164	227	176	157	184	345	571	402	514	532	488	515	508
1951-1952	155	219	148	138	168	306	540	359	443	543	507	451	528
1953-1954	146	209	154	145	150	320	561	315	449	516	423	517	501
1955-1956	142	189	145	121	158	288	474	322	453	514	496	499	466
1957-1958	127	191	151	103	174	275	463	303	446	518	443	480	479
1959-1960	139	175	123	111	149	287	503	308	477	527	468	475	527
1961-1962	144	188	104	111	145	294	445	299	450	519	461	425	484
1963-1964	119	198	126	86	138	268	492	261	394	494	444	457	476
1965-1966	137	218	120	106	149	282	447	279	454	490	413	426	455
1967-1968	138	194	119	88	122	291	496	243	440	459	443	393	468
1969-1970	146	202	125	110	145	281	415	283	476	471	366	420	442
1971-1972	153	182	114	78	153	341	461	281	424	461	407	426	422
1973-1974	164	192	97	73	144	318	486	303	430	437	390	428	426
1975-1976	112	164	89	66	109	266	440	235	431	415	316	404	376
1977-1978	97	148	67	64	112	270	413	218	394	391	362	376	385
1979-1980	99	146	61	37	94	275	366	273	391	417	313	319	368
1981-1982	76	146	44	37	76	221	362	268	395	433	344	361	375
Total	2978	4239	2786	2393	3107	6223	10310	6295	9311	10226	9034	9395	9785

Table B.2: Cohort's size: five-year generation by sex

Generation	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Woman													
1938-1942	157	207	204	159	138	226	364	201	258	363	382	388	400
1943-1947	159	256	201	199	188	338	472	323	419	480	451	487	494
1948-1952	240	347	231	207	222	395	657	420	513	700	596	648	606
1953-1957	187	273	208	183	210	364	601	374	508	649	616	643	631
1958-1962	170	248	155	146	221	352	558	342	479	652	565	579	603
1963-1967	168	265	159	141	165	377	543	329	462	600	539	534	580
1968-1972	120	131	93	81	120	222	315	205	311	355	284	331	334
1973-1977	172	246	115	89	164	394	565	322	495	546	448	479	509
1978-1982	123	205	75	45	126	372	484	347	480	531	455	463	455
Total	1496	2178	1441	1250	1554	3040	4559	2863	3925	4876	4336	4552	4612
Men													
1938-1942	132	188	113	117	108	185	395	211	310	343	287	325	347
1943-1947	129	168	141	152	170	319	667	352	526	494	467	420	484
1948-1952	161	235	189	170	209	416	762	523	671	644	631	611	654
1953-1957	166	213	174	128	182	401	660	419	622	646	546	611	601
1958-1962	175	218	140	134	163	347	627	412	666	647	564	563	622
1963-1967	153	260	144	101	174	313	634	322	612	615	544	526	606
1968-1972	99	156	94	67	95	210	358	210	379	344	299	305	321
1973-1977	150	188	103	84	137	314	558	324	553	501	442	505	486
1978-1982	103	157	65	59	108	270	460	304	513	515	380	441	480
Total	1268	1783	1163	1012	1346	2775	5121	3077	4852	4749	4160	4307	4601

Table B.3: Cohort's size: five-year generation (internet users)

Generation	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
1938-1942	57	97	84	38	115	153	272	217	293	344	349	367	382
1943-1947	101	171	155	59	188	392	650	460	619	628	630	640	652
1948-1952	203	316	240	97	297	596	965	723	908	1036	971	941	1004
1953-1957	222	302	254	92	305	628	937	652	912	1074	940	1048	1048
1958-1962	239	333	223	94	324	601	964	661	1012	1135	1017	104	1079
1963-1967	246	405	251	88	303	626	1006	602	978	1133	993	980	1102
1968-1972	171	230	160	70	194	411	583	400	663	658	560	602	636
1973-1977	278	379	203	82	289	686	1035	627	1021	1019	876	946	980
1978-1982	207	333	125	52	231	631	878	648	998	1042	834	900	917
Total	1724	2566	1695	672	2246	4724	7290	4990	7404	8069	7170	6528	7800

Table B.4: Cohort's size: ten-year generations

Generation	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2019**
1935-1944	422	548	442	392	282	464	859	393	586	649	608	522
1945-1954	373	508	340	313	227	413	687	362	524	533	502	471
1955-1964	224	294	190	140	100	234	341	218	330	354	298	270
1965-1974	183	222	99	74	42	112	186	99	184	158	170	119
1975-1984	78	146	39	29	23	76	95	49	98	84	61	51
Total	1280	1718	1110	948	674	1299	2168	1121	1722	1778	1639	1433

C Estimation results

Table C.1: Estimation results for Internet Access and Use with two-year generations.

	Access				**Use**			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Woman	0.501	0.252	1.330*	0.590	0.615	0.534	1.930**	1.434*
	(0.414)	(0.408)	(0.707)	(0.710)	(0.442)	(0.390)	(0.779)	(0.786)
Household size	0.374***	0.274*	0.146	0.271	0.055	0.019	0.029	0.084
	(0.141)	(0.154)	(0.244)	(0.210)	(0.148)	(0.172)	(0.325)	(0.275)
Density	0.001	0.002*	-	-	0.000	0.000	-	-
	(0.001)	(0.001)	-	-	(0.001)	(0.001)	-	-
Monthly income								
- less than 1000€	*ref.*	-	*ref.*	-	*ref.*	-	*ref.*	-
- between 1000 and 1500€	0.681	-	0.288	-	0.713	-	0.314	-
	(0.757)	-	(1.026)	-	(0.852)	-	(1.637)	-
- between 1500 and 3000€	1.485***	-	2.755***	-	1.717***	-	2.615**	-
	(0.463)	-	(0.821)	-	(0.618)	-	(1.084)	-
- more than 3000€	2.183***	-	3.880***	-	1.825***	-	3.202**	-
	(0.528)	-	(0.937)	-	(0.693)	-	(1.272)	-
Education level								
- Low	-	*ref.*	-	*ref.*	-	*ref.*	-	*ref.*
- Middle	-	1.692***	-	1.816***	-	2.680***	-	1.493*
	-	(0.536)	-	(0.586)	-	(0.590)	-	(0.843)
- High	-	1.102**	-	4.098***	-	2.661***	-	4.446***
	-	(0.539)	-	(0.851)	-	(0.531)	-	(1.163)
Urban unit size								
- rural area	-	-	*ref.*	*ref.*	-	-	*ref.*	*ref.*
- 2,000 to 4,999 residents	-	-	-0.136	-0.639	-	-	0.428	0.068
	-	-	(1.213)	(1.272)	-	-	(1.136)	(1.187)
- 5,000 to 9,999 residents	-	-	-0.761	0.036	-	-	1.173	1.855
	-	-	(1.269)	(1.468)	-	-	(1.580)	(1.575)
- 10,000 to 19,999 residents	-	-	1.157	-0.847	-	-	3.198	1.457
	-	-	(1.583)	(1.599)	-	-	(2.062)	(1.861)
- 20,000 to 49,999 residents	-	-	-1.298	-1.755	-	-	0.179	-0.075
	-	-	(1.143)	(1.179)	-	-	(1.310)	(1.337)
- 50,000 to 99,999 residents	-	-	-1.069	-0.921	-	-	-0.625	-0.513
	-	-	(1.012)	(1.058)	-	-	(1.257)	(1.253)
- 100,000 to 199,999 residents	-	-	0.712	-0.707	-	-	1.229	-0.396
	-	-	(1.291)	(1.319)	-	-	(2.203)	(2.060)
- 200,000 to 1,999,999 residents	-	-	-0.111	-0.478	-	-	1.256	0.701
	-	-	(0.764)	(0.704)	-	-	(1.258)	(1.185)
- Paris	-	-	0.683	0.279	-	-	2.042	1.386
	-	-	(0.892)	(0.941)	-	-	(1.326)	(1.236)
Generation								
- 1937-1938	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*	*ref.*
- 1939-1940	0.233***	0.232***	0.177***	0.231***	0.318***	0.232**	0.201**	0.221***
	(0.087)	(0.078)	(0.067)	(0.083)	(0.093)	(0.091)	(0.084)	(0.080)
- 1941-1942	0.503***	0.527***	0.467***	0.497***	0.569***	0.476***	0.463***	0.462***
	(0.083)	(0.080)	(0.068)	(0.093)	(0.085)	(0.084)	(0.078)	(0.095)
- 1943-1944	0.682***	0.691***	0.578***	0.531***	0.756***	0.591***	0.600***	0.503***
	(0.092)	(0.099)	(0.097)	(0.112)	(0.083)	(0.091)	(0.103)	(0.122)

- 1945-1946	0.773***	0.800***	0.752***	0.747***	0.976***	0.819***	0.921***	0.870***
	(0.075)	(0.090)	(0.085)	(0.115)	(0.079)	(0.084)	(0.093)	(0.116)
- 1947-1948	1.007***	1.025***	0.991***	0.934***	1.220***	0.989***	1.122***	1.013***
	(0.083)	(0.108)	(0.092)	(0.118)	(0.086)	(0.098)	(0.104)	(0.134)
- 1949-1950	1.116***	1.121***	1.105***	1.000***	1.402***	1.129***	1.275***	1.124***
	(0.083)	(0.116)	(0.084)	(0.143)	(0.089)	(0.110)	(0.116)	(0.164)
- 1951-1952	1.211***	1.227***	1.247***	1.115***	1.534***	1.265***	1.455***	1.284***
	(0.085)	(0.117)	(0.084)	(0.123)	(0.086)	(0.107)	(0.116)	(0.157)
- 1953-1954	1.393***	1.413***	1.352***	1.238***	1.730***	1.440***	1.538***	1.377***
	(0.090)	(0.122)	(0.093)	(0.133)	(0.101)	(0.122)	(0.127)	(0.168)
- 1955-1956	1.367***	1.393***	1.404***	1.340***	1.770***	1.487***	1.640***	1.548***
	(0.094)	(0.122)	(0.090)	(0.128)	(0.105)	(0.116)	(0.133)	(0.168)
- 1957-1958	1.508***	1.536***	1.484***	1.371***	2.027***	1.697***	1.864***	1.712***
	(0.106)	(0.143)	(0.120)	(0.158)	(0.115)	(0.130)	(0.150)	(0.184)
- 1959-1960	1.552***	1.577***	1.568***	1.374***	2.190***	1.829***	1.986***	1.760***
	(0.112)	(0.156)	(0.131)	(0.166)	(0.131)	(0.146)	(0.181)	(0.213)
- 1961-1962	1.725***	1.737***	1.715***	1.552***	2.270***	1.857***	2.130***	1.928***
	(0.129)	(0.178)	(0.164)	(0.202)	(0.137)	(0.154)	(0.203)	(0.241)
- 1963-1964	1.725***	1.732***	1.674***	1.439***	2.438***	1.986***	2.166***	1.906***
	(0.130)	(0.188)	(0.177)	(0.216)	(0.165)	(0.182)	(0.233)	(0.271)
- 1965-1966	1.879***	1.886***	1.787***	1.470***	2.699***	2.223***	2.514***	2.181***
	(0.140)	(0.204)	(0.191)	(0.230)	(0.144)	(0.178)	(0.246)	(0.301)
- 1967-1968	1.888***	1.850***	1.846***	1.420***	2.693***	2.127***	2.592***	2.161***
	(0.138)	(0.215)	(0.194)	(0.249)	(0.144)	(0.184)	(0.253)	(0.315)
- 1969-1970	2.124***	2.034***	2.115***	1.637***	2.980***	2.279***	2.798***	2.271***
	(0.134)	(0.225)	(0.201)	(0.293)	(0.174)	(0.216)	(0.257)	(0.352)
- 1971-1972	2.362***	2.197***	2.388***	1.702***	3.468***	2.606***	3.167***	2.420***
	(0.125)	(0.239)	(0.190)	(0.277)	(0.163)	(0.221)	(0.255)	(0.370)
- 1973-1974	2.439***	2.199***	2.291***	1.531***	3.489***	2.510***	3.194***	2.374***
	(0.155)	(0.305)	(0.164)	(0.307)	(0.134)	(0.234)	(0.211)	(0.393)
- 1975-1976	2.519***	2.217***	2.512***	1.653***	3.635***	2.562***	3.274***	2.344***
	(0.119)	(0.266)	(0.158)	(0.320)	(0.157)	(0.254)	(0.183)	(0.393)
- 1977-1978	2.614***	2.270***	2.651***	1.807***	3.660***	2.525***	3.334***	2.409***
	(0.134)	(0.287)	(0.163)	(0.325)	(0.156)	(0.259)	(0.200)	(0.420)
- 1979-1980	2.815***	2.461***	2.635***	1.784***	4.355***	3.202***	3.911***	2.975***
	(0.153)	(0.295)	(0.197)	(0.355)	(0.165)	(0.283)	(0.235)	(0.432)
- 1981-1982	2.693***	2.276***	2.566***	1.740***	4.022***	2.853***	3.755***	2.871***
	(0.104)	(0.280)	(0.146)	(0.321)	(0.162)	(0.299)	(0.204)	(0.437)
Year								
- 2007	*ref.*	*ref.*	-	-	*ref.*	*ref.*	-	-
- 2008	0.062	0.111	-	-	0.024	0.093	-	-
	(0.084)	(0.072)	-	-	(0.076)	(0.074)	-	-
- 2009	0.307***	0.374***	-	-	0.313***	0.317***	-	-
	(0.080)	(0.072)	-	-	(0.113)	(0.103)	-	-
- 2010	0.382***	0.430***	-	-	0.377***	0.328***	-	-
	(0.075)	(0.070)	-	-	(0.099)	(0.085)	-	-
- 2011	1.632***	1.314***	-	-	1.146***	0.832***	-	-
	(0.106)	(0.091)	-	-	(0.108)	(0.081)	-	-
- 2012	0.765***	1.009***	-	-	0.870***	0.970***	-	-
	(0.148)	(0.084)	-	-	(0.208)	(0.115)	-	-
- 2013	1.302***	1.188***	*ref.*	*ref.*	1.029***	0.924***	*ref.*	*ref.*
	(0.067)	(0.085)	-	-	(0.068)	(0.094)	-	-
- 2014	1.360***	1.244***	0.105	0.083	1.222***	1.121***	0.100	0.093

	(0.071)	(0.085)	(0.086)	(0.089)	(0.083)	(0.112)	(0.148)	(0.143)
- 2015	1.343***	1.197***	0.179**	0.108	1.212***	1.136***	0.183	0.151
	(0.079)	(0.093)	(0.090)	(0.103)	(0.086)	(0.114)	(0.149)	(0.149)
- 2016	1.449***	1.316***	0.243***	0.209**	1.173***	1.104***	0.082	0.078
	(0.069)	(0.080)	(0.086)	(0.093)	(0.078)	(0.109)	(0.146)	(0.147)
- 2017	1.438***	1.295***	0.249***	0.204**	1.275***	1.195***	0.159	0.147
	(0.070)	(0.080)	(0.090)	(0.093)	(0.080)	(0.105)	(0.145)	(0.136)
- 2018	1.549***	1.418***	0.358***	0.312***	1.201***	1.132***	0.111	0.088
	(0.070)	(0.077)	(0.091)	(0.102)	(0.083)	(0.104)	(0.145)	(0.143)
- 2019	1.684***	1.547***	0.494***	0.451***	1.267***	1.198***	0.182	0.166
	(0.073)	(0.086)	(0.083)	(0.099)	(0.087)	(0.109)	(0.145)	(0.142)
Constant	-3.834***	-2.671***	-3.176***	-1.273	-3.296***	-2.473***	-4.187**	-2.423**
	(0.518)	(0.368)	(1.187)	(0.779)	(0.665)	(0.356)	(1.698)	(0.935)
Observations	299	299	161	161	298	298	161	161
Adjusted R^2	0.962	0.960	0.975	0.974	0.967	0.969	0.976	0.977

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Robust standard errors are reported in parentheses.

Lecture: cohort fixed effects are to be compared to the cohort of reference.

Table C.2: Estimation results for Internet Access and Use with three-year generations separated by gender.

	Access		**Use**	
	(1)	(2)	(1)	(2)
Household size	0.289*	0.213	0.062	0.037
	(0.147)	(0.136)	(0.159)	(0.146)
Density	0.000	0.000	-0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Monthly income				
- less than 1000€	*ref*	-	*ref*	-
- between 1000 and 1500€	1.447*	-	0.846	-
	(0.744)	-	(0.768)	-
- between 1500 and 3000€	1.275**	-	1.148**	-
	(0.580)	-	(0.581)	-
- more than 3000€	1.907***	-	1.767**	-
	(0.566)	-	(0.697)	-
Education level				
- Low	-	*ref*	-	*ref*
- Middle	-	1.930***	-	2.749***
	-	(0.464)	-	(0.671)
- High	-	1.212**	-	2.325***
	-	(0.478)	-	(0.566)
Generation				
Women				
- 1938-1942	-0.187	-0.363***	-0.216*	-0.340***
	(0.119)	(0.091)	(0.130)	(0.111)
- 1943-1947	0.385***	0.161**	0.402***	0.168*
	(0.096)	(0.079)	(0.096)	(0.089)
- 1948-1952	0.833***	0.549***	0.986***	0.622***
	(0.078)	(0.077)	(0.080)	(0.092)
- 1953-1957	1.206***	0.882***	1.406***	0.970***
	(0.071)	(0.089)	(0.075)	(0.115)
- 1958-1962	1.505***	1.164***	1.860***	1.352***
	(0.084)	(0.112)	(0.083)	(0.128)
- 1963-1967	1.780***	1.399***	2.251***	1.630***
	(0.099)	(0.158)	(0.103)	(0.160)
- 1968-1972	1.982***	1.506***	2.554***	1.766***
	(0.093)	(0.166)	(0.131)	(0.193)
- 1973-1977	2.311***	1.656***	3.133***	2.046***
	(0.126)	(0.246)	(0.129)	(0.268)
- 1978-1982	2.686***	1.908***	3.889***	2.627***
	(0.102)	(0.237)	(0.158)	(0.307)
Men				
- 1938-1942	*ref*	*ref*	*ref*	*ref*
- 1943-1947	0.509***	0.438***	0.552***	0.431***
	(0.079)	(0.071)	(0.076)	(0.075)
- 1948-1952	0.856***	0.746***	0.972***	0.791***
	(0.069)	(0.074)	(0.073)	(0.077)
- 1953-1957	1.056***	0.929***	1.249***	1.053***
	(0.072)	(0.072)	(0.083)	(0.081)
- 1958-1962	1.261***	1.132***	1.610***	1.380***

	(0.085)	(0.089)	(0.098)	(0.096)
- 1963-1967	1.459***	1.278***	1.957***	1.626***
	(0.106)	(0.122)	(0.115)	(0.125)
- 1968-1972	1.755***	1.471***	2.318***	1.801***
	(0.124)	(0.148)	(0.119)	(0.155)
- 1973-1977	2.263***	1.704***	3.054***	2.129***
	(0.102)	(0.190)	(0.118)	(0.226)
- 1978-1982	2.371***	1.753***	3.530***	2.533***
	(0.100)	(0.192)	(0.156)	(0.269)
_cons	-2.859***	-1.722***	-2.169***	-1.635***
	(0.607)	(0.294)	(0.610)	(0.316)
Observations	234	234	234	234
Adjusted R^2	0.964	0.966	0.966	0.969
Time Fixed-Effect	Yes	Yes	Yes	Yes

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Robust standard errors are reported in parentheses.

Lecture: cohort fixed effects are to be compared to the cohort of reference.

Table C.3: Estimation results for Online population.

	Bank		**Administrative**		**E-commerce**		**Social network**		**Job search**		**Collab eco**	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Household size	0.061	-0.009	0.347**	-0.046	0.137	0.014	-0.193	-0.151	0.601*	0.675**	0.079	0.142
	(0.132)	(0.146)	(0.172)	(0.203)	(0.122)	(0.110)	(0.241)	(0.203)	(0.340)	(0.337)	(0.203)	(0.190)
Density	0.000	0.000	0.002**	0.002**	0.001	0.001*	-0.002*	-0.002**	-0.001	-0.001	-0.002**	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.001)	(0.001)
Monthly income												
- less than 1000€	*ref.*	-	*ref.*		*ref.*	-	*ref.*	-	*ref.*	-	*ref.*	-
- between 1000 and 1500€	-1.926	-	2.468	-	-4.029*	-	0.038	-	-0.486	-	-5.016***	-
	(1.342)	-	(3.091)	-	(2.136)	-	(1.760)	-	(4.520)	-	(1.850)	-
- between 1500 and 3000€	0.087	-	3.734	-	-1.699	-	-1.350	-	-4.452	-	-2.999**	-
	(0.986)	-	(2.658)	-	(1.334)	-	(1.380)	-	(3.677)	-	(1.301)	-
- more than 3000€	-0.779	-	3.025	-	-1.373	-	-1.007	-	-2.382	-	-3.836**	-
	(0.935)	-	(2.611)	-	(1.439)	-	(1.256)	-	(3.645)	-	(1.607)	-
Education level												
- Low	-	*ref.*	-	*ref.*	-	*ref.*	-	*ref.*	-	*ref.*	-	*ref.*
- Middle	-	0.938**	-	1.993**	-	2.498***	-	-0.493	-	0.783	-	0.731
	-	(0.405)	-	(0.953)	-	(0.416)	-	(0.667)	-	(1.288)	-	(0.642)
- High	-	0.900	-	0.220	-	1.361**	-	-1.276	-	0.582	-	0.635
	-	(0.545)	-	(1.447)	-	(0.520)	-	(1.148)	-	(1.476)	-	(0.884)
Woman	-0.185	-0.092	-0.412	-0.342	-0.695	-0.884**	0.630	0.535	3.937**	3.678**	-1.490***	-1.583***
	(0.430)	(0.454)	(0.971)	(1.207)	(0.511)	(0.357)	(0.629)	(0.677)	(1.483)	(1.564)	(0.412)	(0.475)
Observations	117	117	117	117	117	117	63	63	86	86	117	117
Adjusted R^2	0.870	0.870	0.927	0.934	0.947	0.961	0.982	0.982	0.935	0.931	0.920	0.914
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort Fixed-Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed-Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Robust standard errors are reported in parentheses.

Table C.4: Estimation results for reasons of non-access of Internet at home.

	Too expensive		**Lack of skills**		**Security**		**Not useful**	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Woman	-1.247*	-1.250**	0.522	1.293	-1.945	-1.949	-0.622	-0.711
	(0.629)	(0.569)	(1.052)	(1.276)	(3.206)	(2.341)	(1.067)	(0.979)
Household size	0.152	0.197	0.111	0.699	-1.791	-2.223**	-0.876	-1.008**
	(0.240)	(0.227)	(0.503)	(0.677)	(1.152)	(0.891)	(0.541)	(0.478)
Density	0.000	0.000	0.001	0.001	0.000	0.005	0.000	-0.002
	(0.001)	(0.001)	(0.002)	(0.001)	(0.003)	(0.003)	(0.001)	(0.002)
Monthly income								
- less than 1000€	*ref.*	-	*ref.*	-	*ref.*	-	*ref.*	-
- between 1000 and 1500€	0.471	-	2.895*	-	-4.445*	-	1.211	-
	(0.684)	-	(1.505)	-	(2.616)	-	(1.168)	-
- between 1500 and 3000€	0.168	-	0.907	-	-5.472***	-	1.532*	-
	(0.662)	-	(0.879)	-	(1.573)	-	(0.882)	-
- more than 3000€	0.375	-	3.084**	-	-4.340	-	0.209	-
	(0.498)	-	(1.298)	-	(2.617)	-	(0.811)	-
Education level								
- Low	-	*ref.*	-	*ref.*	-	*ref.*	-	*ref.*
- Middle	-	-0.330	-	-0.037	-	4.191*	-	0.230
	-	(0.558)	-	(1.364)	-	(2.107)	-	(0.757)
- High	-	0.248	-	-0.645	-	-5.928***	-	2.325***
	-	(0.642)	-	(1.389)	-	(1.497)	-	(0.798)
Constant	-0.486	-0.246	-2.282	-2.000	6.081**	1.705	0.905	2.564**
	(0.614)	(0.572)	(1.511)	(1.368)	(2.926)	(1.715)	(1.271)	(1.115)
Observations	50	50	50	50	50	50	50	50
Adjusted R^2	0.931	0.931	0.956	0.940	0.792	0.829	0.948	0.951
Cohort Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Robust standard errors are reported in parentheses.