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# The digital divide and E-government in European economies

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**ABSTRACT**

Even though the Internet usage is perceived to be widespread, senior citizens are relatively more reluctant to adopt new technologies. By relying on the Eurostat's Community Statistics on Information Society (CSIS) microdata for the period 2008–2017, we explore recent evolution of the digital divide across Europe. We analyse the difference in adoption of e-governance by younger and older Internet users as well as their reasons for not using e-government services (specifically by submitting completed forms to public authorities). Additionally, we seek to identify factors that determine the difference in the reluctance to adopt e-governance services by senior citizens and the young. By adopting Heckman selection methodology, we establish three categories of factors: those that have different effects for young and old (gender, household size, and population density), those having similar effects (economic activity), and those that have adverse effects for the young and the old (education). Based on empirical results, we suggest following venues for EU-wide policy actions: special attention should be given to older population in sparsely populated areas, specialised learning activities should be developed for older citizens with additional effort to promote inclusion of older women to participate in these learning activities.

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## 1. Introduction

Internet diffusion has already reached high levels in Western societies and European countries. According to the data from *Digital scoreboard,* use of overall fixed broadband Internet in European countries ranges from 56.9 percent in Finland and 57.8 percent in Bulgaria to 97.9 percent of households in Netherlands and 93.8 percent in the United Kingdom in 2019 (European Commission, 2020). However, data for older population are still not reaching the levels of Internet adoption recorded for younger generations (Barrantes Cáceres & Cozzubo Chaparro, 2019; Hargittai et al., 2019;

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Schehl et al., 2019; Seifert et al., 2017). While Internet is used by all or nearly all citizens from 25 to 34 years old, percentage of users in older age groups in many European countries is significantly lower. For example, in Bulgaria only 21 percent of citizens from 64 to 75 years old used Internet in 2019 and in Greece 29 percent (https://ec.europa.eu/eurostat/databrowser/view/ISOC_CI_IFP_IU__custom_21061/default/table?lang=en).

The existence of digital divide has long been established in the literature and is associated with the fact that older generations for the most part of their working life did not use computer technology (Loges & Jung, 2001). This led some researchers to suggest that digital divide will disappear (Gilleard & Higgs, 2008) because people who used computer technology during their active working life will continue its use after they are retired (Friemel, 2014). However, others believe that this will not be the case, among other reasons due to increased privacy concerns of older population (Loges & Jung, 2001) or physical limitations related to older age (Friemel, 2014).

Since the late 1990s, numerous governments have made huge investments in electronic government (e-Government) services. However, government efforts were contrasted by relatively low levels of user acceptance. Such an outcome came as surprise since e-governance was initially associated only with potential benefits. For example, it was assumed that e-government will support administrative reforms, i.e., it was expected that information technologies will reduce costs, improve the quality of services, and make government policies more effective. This view has also been adopted at the European level. The 2005 e-Government Declaration outlined a series of objectives relating to citizen inclusion, user-orientation and trust, moving the agenda beyond the provision of public services online to a broader vision of electronically enabled participation (European Commission, 2005). The issue suddenly became even more important during the outbreak of the global COVID-19 pandemics. The pandemics urged the governments to make availability of e-government services a priority on their policy agendas.

Previous studies have established that age does not have direct influence on the intention to use e-government services (Mensah & Mi, 2019). However, the literature is not conclusive on the effect of age on e-government adoption. While Welch et al. (2004) as well as Colesca and Dobrica (2008) find negative effect, Mensah and Mi (2019), as well as Venkatesh et al. (2014) did not find significant relationship between age and e-government adoption.

The main aim of this paper is to analyse the factors of digital divide in e-government non-adoption in European economies. While most studies focus on e-government services adoption in a single country or a comparison of few countries, the common policy agenda of European Union suggests that common factors should be sought to bring policy recommendations. Based on the empirical analysis in the paper, we identify following venues for policy actions: special attention should be given to older population in sparsely populated areas; specialised learning activities should be developed for older EU citizen; and efforts should be given to promote inclusion of older women in learning activities.

The paper adopts following structure. Next section briefly summarises relevant literature. Section 3 discusses the problem by presenting the key indicators. Section 4

presents empirical strategy and discusses the results, while the last section brings conclusions and roadmap for future research.

## 2. Literature review

Adoption of new technologies has attracted significant attention and resulted in abundance of models that explain mechanisms behind information technology adoption (Rad et al., 2018).

One of the often used models – unified theory of acceptance and use of technology (UTAUT) incorporates four key factors (performance expectancy, effort expectancy, social influence and facilitating conditions) and four moderators (age, gender, experience, and voluntariness) to explain acceptance and use of information technology in general (Venkatesh et al., 2003; Venkatesh et al., 2016). This comprehensive model incorporates eight theories on technology adoption including main components of other models such as the technology acceptance model (Davis, 1989) and theory of planned behaviour (Ajzen, 1991). It is also widely applied for explaining adoption of e-government services (e.g., Al-Shafi et al., 2009; McLeod et al., 2009; Venkatesh et al., 2011; Gupta, Dasgupta, & Gupta, 2008; Chan et al., 2010).

However, some argue that technology adoption models are not adequate to completely explain use of e-government services as they would need to incorporate user-centric approach in comparison to IT and e-commerce use (Wirtz & Kurtz, 2017) or they do not include components relevant for e-government such as security, trust, privacy and risk (Dwivedi et al., 2017). This resulted in the proposal of modified model of electronic government adoption – UMEGA (Dwivedi et al., 2017) that includes attitudes as a mediator between perceived risk, perceived usefulness, relative advantage, perceived ease of use, subjective norm, social factor, perceived behavioural control, facilitating conditions on the one side and behavioural intention on the other. One version of the model designed for e-government adoption also includes anxiety instead of perceived risk as a factor that affects attitudes (Rana et al., 2017). Verkijika and De Wet (2018) proposed an extended UMEGA model that incorporates computer self-efficacy, perceived trust in Internet and in government. Recently UMEGA was extended by three more variables: perceived service quality, trust in government, and intention to recommend the adoption of e-government services (Mensah, et al., 2020). All these models show better fit to e-government context in comparison to models designed for technology adoption in general.

Evolution of the Internet has been associated with the concerns regarding growing disparities in its use. Terms such as 'digital divide' and 'digital exclusion' became widely used in the literature (Van Dijk & Hacker, 2003) and corresponded to the discussions on other forms of social exclusion. Over the years, digital divide research has recognised different aspects of the phenomenon, starting with the problems of Internet adoption, access, and specific usage patterns between different population subgroups (Pearce & Rice, 2013). At the beginning, most research efforts recognised only adoption (e.g., have used the Internet vs. have never used the Internet) as the most important digital divide indicator. More recently, the usage (e.g., frequency of

Internet use) started to be considered as more relevant measure. Studies have associated Internet access with various socio-demographic dimensions such as income, education, gender, and age (Helsper, 2010; Korupp & Szydlik, 2005).

Beyond simple access gap (have vs. no-have), divide can occur in the context of Internet-related technology use, skills, and literacy. This divide is referred to as 'second-level digital divide' (Friemel & Signer, 2010), 'second order digital divide' (Dewan & Riggins, 2005) or 'skills divide' (Van Deursen & Van Dijk, 2011). In that context, it is important whether a person can associate potential benefits from the available technology that supports continuous usage. Studies have identified the main reasons for not using Internet to either motivational indifference (perceived uselessness of the information on the Internet or little relevance for one's life), or deficient knowledge (Peacock & Künemund, 2007; Selwyn et al., 2003).

When it comes to seniors' computer use, five main areas are explored in the literature: motivations and barriers of use, age-related differences, instructional tips and design, changes in attitudes and benefits and Internet use (Kim, 2008). According to Lee et al. (2011) Internet usage among seniors is influenced by (1) intrapersonal factors such as motivation and self-efficacy assessment, (2) functional limitations such as decline of memory or spatial orientation, (3) structural limitations such as costs associated with maintaining the appropriate technology level and (4) interpersonal limitations such as the lack of support to start using Internet or someone to send an email to. Niehaves and Plattfaut (2010) find that senior citizens´ use of internet strongly depends on expected performance. Computer and Internet skills of senior population affect their willingness to adopt new technologies that subsequently affects their quality of life (Berkowsky et al., 2017).

There is no clear *a priori* definition of an older or senior citizens and existing studies use different thresholds for the empirical analysis (Hunsaker & Hargittai, 2018). For example, Gilleard and Higgs (2008) suggest 50+; Selwyn et al. (2003) suggest 61+; Schehl et al. (2019) rely on 65+; Peacock and Künemund (2007) refer to those aged 65–74 as *young seniors* while Lee et al. (2011) call them *young-olds*. Even though senior Internet users tend to acknowledge benefits of use (Seifert et al., 2017), they often face fear of technology and computer anxiety (Van Dijk, 2006). Furthermore, health issues can also create significant impediments for the use of technology by senior citizens (Keränen et al., 2017; Hunsaker & Hargittai, 2018).

Different strain of literature focuses on the e-government. The common definition of e-government refers to the use of information and communication technologies (ICTs) by government agencies with the aim to deliver information and services to citizens, businesses, and public agencies (Carter & Belanger, 2005; Edmiston, 2003; Sipior & Ward, 2005; West, 2004). Public administration has, with technological advances and through the increase of range of e-governance services, been experiencing a change from the bureaucratic, inward-looking to a citizen-centric, outward-looking approach (Thompson et al., 2005).

Initiatives on e-governance may strongly contribute to making public services more effective, strengthening democracy (Von Haldenwang, 2004), reducing corruption (Goel et al., 2012; Hunady, 2019), increasing municipal transparency (Tejedo-

Romero & Araujo, 2020), intensifying competition among businesses (West, 2004), and economic growth (West, 2004) as well as improvements to ecological or environmental quality (Haigh & Griffiths, 2008). Twizeyimana and Andersson (2019) summarise public value of e-government into three dimensions: improved public services, improved administration, and improved social value. However, in developing countries those benefits are often either not present or are limited due to political, social, and economic obstacles (Ndou, 2004). Thus, contrary to only positive effects of e-government adoption, some authors raise concerns regarding specific side-effects.

For example, McNeal et al. (2008) claim e-government development becomes a double-edged sword: motivating e-government use brings benefits for some population groups while magnifying existing gaps for others. Thus, new technological tools of e-government may hold benefits only for certain segments of the population, contributing further to potential social exclusion. With the digital exclusion, e-government has not lived up to its possibilities and potentials (McNeal et al., 2008). There are few attempts in the literature that explore why this is the case.

In case of Finland, Taipale (2013) shows that gender and income moderate the link between the Internet and e-government service use. The more the women use the Internet, the more they use the government's electronic services. However, among men, the use of e-services does not increase similarly with the use of the Internet. Results also imply that e-service use increases with Internet use but only among the respondents with low-income levels. Additionally, education, children, income, and the size of the place of residence have major effects on the use of the government's e-services. Welch et al. (2004) find that age, gender, employment characteristics and the extent to which people use Internet in general affect use of e-government. In case of Romania, Colesca and Dobrica (2008) find that younger population is more likely to use e-government services but finds no link to gender or income. According to Yera et al. (2020), people with higher education as well as those who usually shop online are more likely to use e-government services.

In terms of interacting with government, special concerns are related to the issue of privacy. People in general do not adopt e-government services due to lack of trust in both Internet and government (Bélanger & Carter, 2008). Extant findings also indicate that older citizens trust in e-government more than younger citizens (Alzahrani et al., 2018). Issue of trust is not relevant to the use of e-government in business sector as much as it is important for individuals (Santa et al., 2019). However, role of trust for adopting e-government services is less pronounced in societies with higher level of democracy (Ghareeb et al., 2019). Adoption of e-government services can be potentially increased by recommendations of existing users. Mensah (2020) found that intention to recommend e-government services is determined by perceived usefulness.

The literature has implicated that there are various reasons for slow adoption of Internet among senior population. It has, contrary to initial assumption, also documented different obstacles to e-government adoption. Yet, there is still scarce evidence when it comes to analysing the evolution of digital divide in relation to the e-government acceptance. The next section presents the approach taken in this paper to contribute to the discussion of this issue.

## 3. Data and preliminary findings

The analysis relies on Eurostat Community Statistics on Information Society[1] (CSIS) micro data. CSIS data enable analysis on country level as well as cross-country comparisons. We focus on the two age groups: young (between the age 15 and 24) and senior (between the age 65 and 74). The data does not allow inspection of actual age of the respondent. Rather, the age brackets are available (less than 15- which is out of the target group for the Survey, 15–24, 25–34, 35–44, 45–54, 55–64, 65–74 and more than 75-out of the target group for the Survey). In most analysed countries, age group 15–24 is either still in education or just entering the labour market (as comparatively presented in the EU The Youth Guarantee programme, https://ec.europa.eu/social/main.jsp?catId=1079), while age group 65–74 is associated with the statutory retirement age in most EU countries (https://europa.eu/youreurope/citizens/work/retire-abroad/state-pensions-abroad/index_en.htm; https://www.etk.fi/en/work-and-pensions-abroad/international-comparisons/retirement-ages/) . The empirical analysis is based on the data for 2016 and 2017[2]. In the discussions we also consider eventual changes in trends in 2008–2017 period. Throughout that period, three questions related to the use of e-government services were administered in the Survey, each asking respondent whether she contacted or interacted with public authorities or public services over the Internet for private purposes in the last 12 months for the purpose of:

1. obtaining information from web sites;
2. downloading official forms;
3. submitting completed forms.

We create three dummy variables taking value 1 if the respondent answered positively to the respective question. Here we present the data for the year 2016, while the data based on the answers to the same questions in the year 2017 are presented in Appendix.

Obtaining information from government web sites is the least active form of e-government adoption, and it is the most widespread (Figure 1). Older population is not always less active than the young population. For example, even though the percentages are very similar in some countries (high in the case of Sweden, low in case of Romania), in Ireland older population is more likely to approach government web sites, while in Estonia the younger are more likely to seek government information online. This is probably related to other socio-economic characteristics of respective societies and cannot be only attributed to the likelihood of Internet services adoption. For example, in some countries young people tend to live longer with their parents (Italy), so it is less likely that they will interact with the government – other members of their households will be responsible for such tasks.

When looking at the 2008–2017 period[3], the data for all the countries does not reveal any specific trend in the dynamics of the gap. Regardless of whether youth or elderly are more likely to obtain information from public web sites, the data show that the gap is closing for some countries, widening for others, and remaining more or less the same for the rest. In fact, none of the other indicators analysed in this

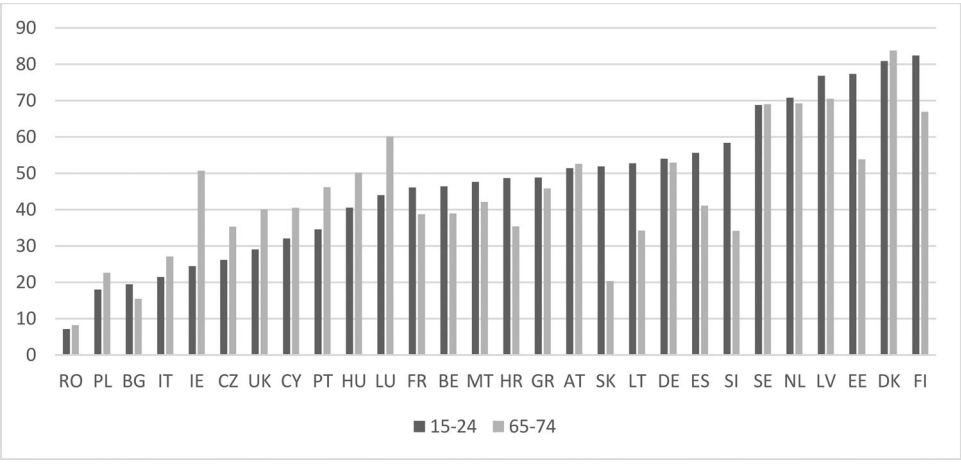


**Figure 1.** Obtaining information from web sites, 2016.
Source: Eurostat.

paper provided enough evidence to draw conclusions on the emerging trends during the analysed period. This could be partially attributed to the relatively short period under analysis in the present paper. Important changes in trends because of the COVID-19 pandemics will likely initiate specific trends in the near future.

Downloading forms from the government website requires more active participation from the citizens than simply looking for information (Figure 2). It assumes that citizens are looking for specific information and that they have the ability and skills to obtain that information. Therefore, the rate of adoption in most countries is lower in comparison to searching for information on the government web site. In addition to different adoption rates across EU countries, in this case as well we have countries where older population is more active (Ireland, Netherlands, UK) as well as countries where younger population is adopting this form of e-government services more (Estonia, Finland). The structure of the data presented in Figure 1 and Figure 2 is not the same. For example, percentages of both young and old searching government web sites are higher in Latvia than in Malta. At the same time, percentages of both young and the old downloading official web forms are higher in Malta than in Latvia.

Submitting forms on government web sites is the most active form of e-government adoption analysed in this paper. The data illustrate that the higher the activity required by the citizens, the lower the adoption (Figure 3). For example, in case of Germany almost 53 percent of older population did try to find information on the government web site in 2016, 31 percent downloaded a form, and only 17 percent submitted completed form. Comparative data for 2017 are: 50 percent finding information, 31 percent downloading forms and 15 percent submitting completed form.

We should also have in mind that e-government services are not equally developed (in terms of accessibility or quality) across European countries. In less digitalised countries e-government services are limited in their scope, and this is certainly reflected in percentage of citizens who can use them. However, data presented here clearly shows that simply creating opportunities for citizens to use e-government services will not lead to full adoption.

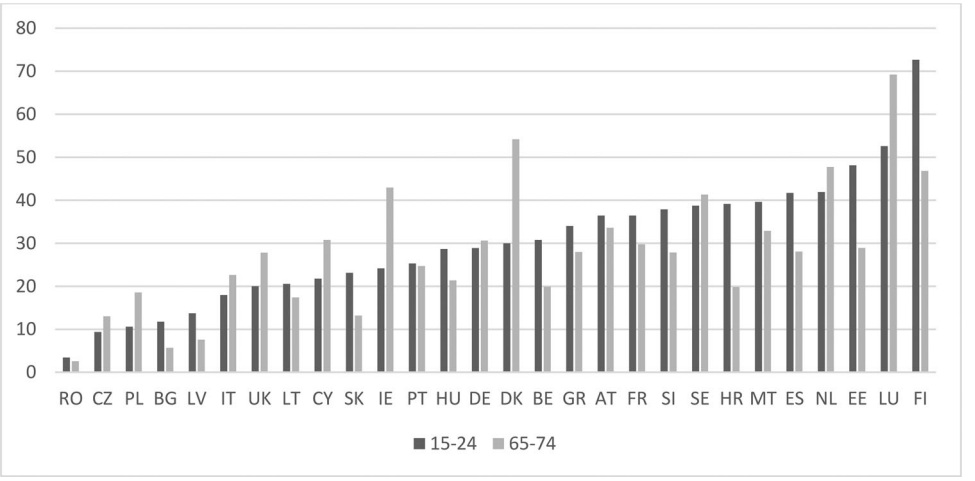


**Figure 2.** Downloading official forms, 2016.
Source: Eurostat.

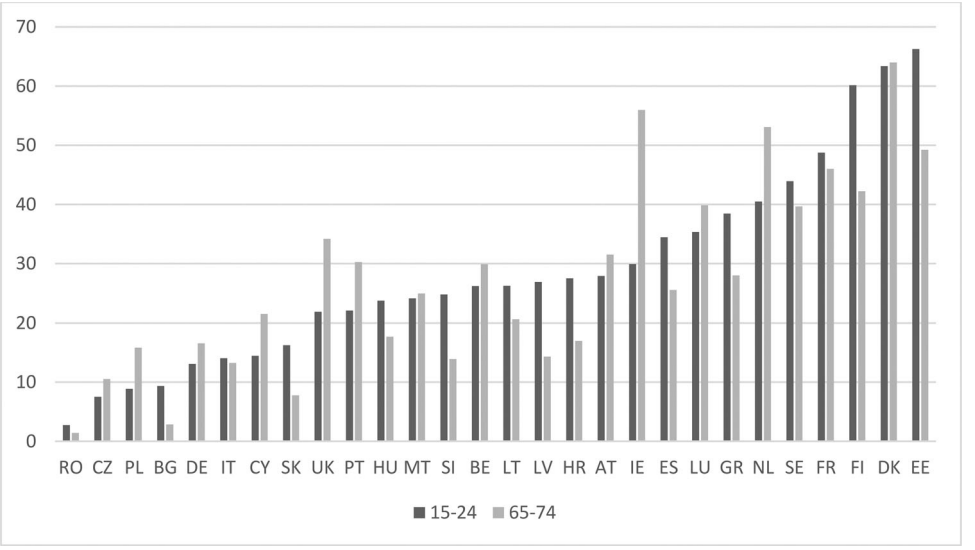


**Figure 3.** Submitting completed forms, 2016.
Source: Eurostat.

Having that in mind, we analyse what are the reasons respondents report for not engaging with government in an online environment. Focusing on the last question – submitting completed forms, it is interesting to note what the differences between young and old are when it comes to reasons for not submitting completed forms to government (Table 1).

The data in Table 1 show that for the young population, in most countries the most frequent reason for not submitting a form was that another person has done it instead of them. This is also important reason for older population (in Bulgaria,

**Table 1.** Reasons for not submitting completed form – percentage of respondents, 2016.

| | Older | | | | | Younger | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No service | Lack of skills | Security concerns | Electronic signature problems | Another person | No service | Lack of skills | Security concerns | Electronic signature problems | Another person |
| AT | 3 | 26 | 33 | | 32 | 9 | 14 | 36 | | 32 |
| BE | 2 | 22 | 7 | 6 | 9 | 8 | 4 | 6 | 3 | 57 |
| BG | | 24 | 32 | | 44 | 17 | 6 | 31 | 18 | 33 |
| CY | 2 | 34 | 5 | 3 | 31 | 12 | 8 | 8 | 4 | 30 |
| CZ | 7 | 27 | 15 | 8 | 20 | 10 | 5 | 8 | 8 | 46 |
| DE | 14 | 45 | 45 | | 20 | 35 | 4 | 23 | | 11 |
| DK | 5 | 26 | 8 | 5 | 38 | 11 | 8 | 8 | | 45 |
| EE | 5 | 45 | 5 | 3 | 60 | | 9 | 9 | 9 | 9 |
| ES | 6 | 31 | 13 | 8 | 61 | 25 | 16 | 11 | 16 | 42 |
| FI | 13 | 52 | 20 | 13 | 15 | 10 | 20 | 10 | | 50 |
| FR | 1 | 42 | 31 | | 13 | 4 | 7 | 18 | | 70 |
| GR | | 11 | | 2 | 91 | | 6 | 2 | 2 | 16 |
| HR | 9 | 20 | | 31 | 3 | 24 | | | 33 | 29 |
| HU | 4 | 35 | 40 | 17 | 27 | 5 | 23 | 26 | 24 | 32 |
| IE | | 18 | 12 | | 46 | 4 | 3 | | | 46 |
| IT | 7 | 16 | 4 | 5 | 13 | 10 | 3 | 4 | 2 | 50 |
| LT | 2 | 67 | 17 | 13 | 56 | 17 | 33 | 17 | 7 | 7 |
| LU | | 35 | 29 | 22 | 14 | 4 | 17 | 18 | 9 | 35 |
| LV | 4 | 47 | 11 | 5 | 27 | 1 | 11 | 14 | 7 | 38 |
| MT | 20 | 80 | 30 | 10 | 10 | 25 | 5 | 40 | 20 | 45 |
| NL | 7 | 16 | 10 | 2 | 82 | 14 | 9 | 9 | 5 | 28 |
| PL | 4 | 38 | 32 | 7 | 29 | 5 | 12 | 26 | 10 | 14 |
| PT | 1 | 56 | 33 | 5 | 84 | 11 | 18 | 33 | 11 | 7 |
| RO | 45 | 54 | 91 | 9 | | 20 | | 20 | | 40 |
| SE | 19 | 50 | 15 | 31 | 27 | 7 | 7 | 7 | 7 | 14 |
| SI | | 17 | 25 | 25 | 17 | 32 | 8 | 16 | 45 | 18 |
| SK | | 39 | 6 | 17 | 17 | 13 | 9 | | 17 | 56 |
| UK | 2 | 24 | 15 | | 37 | 27 | | 13 | | 33 |

Source: Eurostat.

Denmark, Estonia, Spain, Greece, Ireland, Netherlands and Portugal). Another reason frequently mentioned by older population is lack of adequate skills. This reason was listed as one of the most important for young population only in Lithuania. But, certainly, lack of skills is something that deserves policy attention and could be addressed by further government actions as IT training programs are highly important for promoting use of e-government services by elderly population (Lee & Porumbescu, 2019).

There are also notable differences between perception on the availability of e-government services between the young and the old. Although this could be attributed to the actual place a person resides in (youth being more mobile and more likely to reside in vibrant communities), it could also imply that in some cases citizens are not aware of the availability of e-government services. If this is the case, policy actions aimed towards raising awareness could lead to increased adoption of e-government services.

In the next section, we specifically seek the answer to the question whether there are differences between the younger and older population in the factors contributing to e-government non-adoption. We focus on the issue of form-submission because it assumes the highest interaction between governments and citizens.

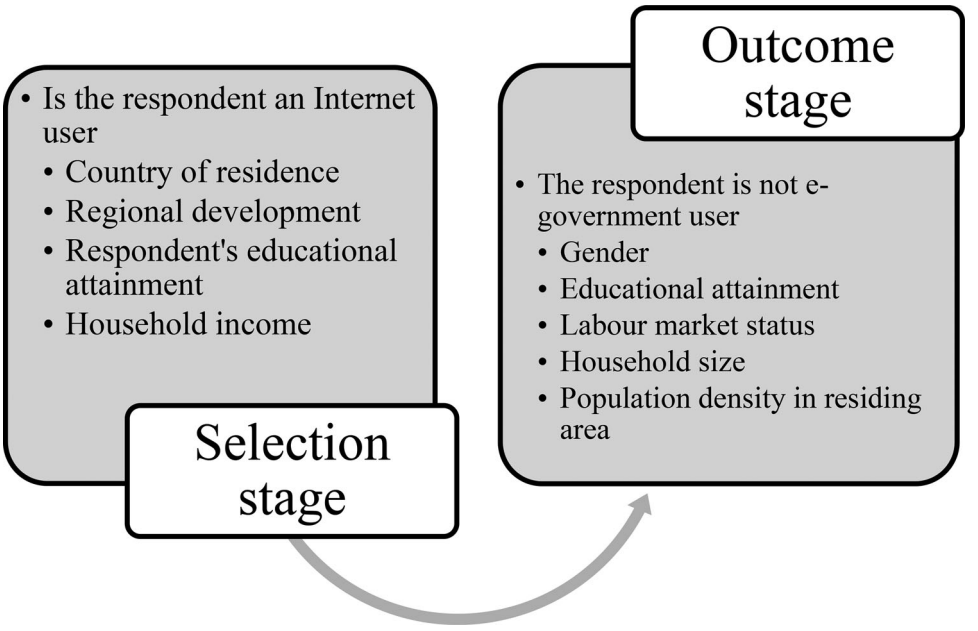


Figure 4. Sample selection process for the probit estimate of the e-government services usage.
Source: authors' illustration.

## 4. Empirical strategy and results

The Survey provides information about the use of e-government services only for those who have been identified as Internet users. For those who are not users, we do not observe their opinion about their potential participation in interaction with government services online. As some of the factors affecting the outcome (i.e., decision not to actively use e-government) may also be the ones affecting the decision to become Internet user, we have a sample selection bias situation. Fortunately, this could be methodologically resolved by relying on the Heckman (1979) procedure.

We have two equations in our empirical strategy: selection equation and outcome equation (Figure 4). In our selection equation, dependent variable is binary variable that takes value 1 if respondent is Internet user. Independent variables include:

- Country dummy variables, aiming to capture the overall Internet infrastructure development level in a country. We subsequently include a set of binary variables taking the value 1 if respondent resides in specific country, omitted country Germany serving as the reference.
- Regional development dummy, aiming to capture the respondents' local living conditions. The assumption is that in more affluent regions within a country, the share of Internet users is higher, i.e., more households will be able to afford having a computer and keeping up with technology advances. It is also more likely that more affluent regions will create higher demand for high-quality services, so the adoption of the new online services could be higher. The data allow for only 3 indicators of the development, so we maintain the less developed and more

developed binary variables in the estimation equation, while the reference value is the average.

- Education level of the respondent corresponds to previous findings in the literature (König et al., 2018) that higher education is positively correlated with higher probability of being an Internet user. This rests on the assumption that educational attainment positively contributes to material and mental resources (Schehl et al., 2019). In this case Survey data allow for 3 categories, so the average serves as the reference, while binary variables for lower and higher educational attainment are included in the estimation.
- Household income is positively correlated with the probability of being an Internet user. As Hargittai et al. (2019) summarise, those with higher income are more likely to have higher Internet skills. Survey stratifies households into quartiles, so for the estimation purpose we assume the lowest quartile to be baseline and include binary variables for other 3 quartiles in the specification.

Outcome equation has dependent binary variable that takes value 1 if respondent did not submit online form to government web site. A set of independent variables include:

- Gender is included following previous literature (Taipale, 2013). We include a binary variable taking value 1 if respondent is female.
- Educational attainment should be correlated with potential lack of skills for performing this task; higher education should alleviate the problem. Again, we take the average level as a baseline, by adding binary variables for lower and higher education in the specification.
- Labour market status could also play important role, as employment creates opportunities for respondent to acquire certain information on e-government usage through interactions at work. Besides employment status, Survey recognises unemployment and inactivity, both of which could be associated with less frequent exposure to new information and technologies. Thus, we include binary variables for unemployment and inactivity in the specification, leaving employment status to be a reference.
- Household size controls for the possible division of work between household members. Namely, in large households, it could be the case that respondent is not expected to interact with government at all, while in smaller households it is more likely that this task will be also performed by respondent. We include a dummy variable that takes value one if the household size is maximally 2.
- Population density respondent resides in does not have straightforward interpretation. It could be the case that in sparsely populated areas, people are more inclined to use e-government services to save time needed for commuting. However, it could also be the case that the usage of e-government services is more widespread in densely populated areas, because of word of mouth and ease of acquiring the knowledge how to adopt the technology. We include two binary variables – densely and sparsely populated areas – in the specification, leaving the average to be the reference.

Estimates for the years 2016 and 2017 are presented in Table 2.

**Table 2.** Digital divided and e-government non-adoption, estimation results.

| | Estimated coefficients (standard errors) | | | |
|---|---|---|---|---|
| | 2017 | | 2016 | |
| Variable | Older population | Younger population | Older population | Younger population |
| **Outcome equation – dependent variable not submitting a form** | | | | |
| Lower education | −0.33*** (0.08) | 0.35*** (0.08) | −0.36*** (0.07) | 0.25* (0.13) |
| Higher education | 0.06 (0.04) | −0.43*** (0.09) | 0.04 (0.04) | −0.39*** (0.04) |
| Unemployment | 0.02 (0.12) | 0.28*** (0.09) | 0.35** (0.18) | 0.19** (0.08) |
| Inactivity | 0.28*** (0.09) | 0.07 (0.09) | 0.27*** (0.07) | 0.04 (0.10) |
| Female | 0.14*** (0.03) | −0.04* (0.02) | 0.17*** (0.02) | −0.01 (0.03) |
| Household size | – | – | 0.03 (0.04) | −0.25*** (0.06) |
| Dense area | −0.06** (0.03) | −0.12*** (0.04) | −0.04 (0.03) | −0.10** (0.04) |
| Sparse area | −0.08*** (0.03) | 0.03 (0.06) | −0.07** (0.03) | 0.01 (0.05) |
| Constant | −0.31*** (0.12) | 0.55*** (0.14) | −0.33*** (0.09) | 0.69*** (0.12) |
| **Selection equation – dependent variable Internet user** | | | | |
| AT | −0.22*** (0.03) | 0.24*** (0.03) | −0.12*** (0.02) | −0.01 (0.02) |
| BE | 0.19*** (0.02) | −0.11*** (0.03) | 0.33*** (0.02) | −0.24*** (0.03) |
| BG | −0.96*** (0.10) | −1.05*** (0.03) | −0.93*** (0.07) | −0.87*** (0.04) |
| CY | −0.28*** (0.03) | −0.39*** (0.03) | −0.32*** (0.03) | −0.18*** (0.02) |
| CZ | – | – | −0.13** (0.06) | −0.65*** (0.07) |
| DK | 1.39*** (0.02) | 0.74*** (0.05) | 1.47*** (0.03) | 4.85*** (0.19) |
| EE | 0.20** (0.10) | 0.81*** (0.03) | 0.40*** (0.07) | 1.03*** (0.05) |
| EL | −0.62*** (0.06) | −0.18*** (0.05) | −0.51*** (0.06) | −0.03 (0.04) |
| ES | 0.15*** (0.03) | 0.07 (0.06) | 0.03 (0.03) | 0.25*** (0.05) |
| FI | 0.69*** (0.02) | 4.71*** (0.21) | 0.72*** (0.02) | 4.83*** (0.18) |
| FR | 0.68*** (0.02) | −0.01 (0.04) | 0.64*** (0.03) | 0.04 (0.04) |
| HR | −0.65*** (0.11) | 0.36*** (0.08) | −0.31*** (0.07) | 0.76*** (0.07) |
| HU | −0.29*** (0.07) | −0.35*** (0.03) | −0.19*** (0.05) | −0.09** (0.05) |
| IE | 0.34*** (0.04) | −0.31*** (0.06) | 0.63*** (0.04) | −0.08* (0.04) |
| IT | 0.10** (0.04) | −0.51*** (0.09) | 0.05 (0.04) | −0.48*** (0.06) |
| LT | −0.33*** (0.10) | 0.29*** (0.06) | −0.34*** (0.07) | 0.62** (0.05) |
| LU | 0.97*** (0.02) | 4.66*** (0.19) | 1.21*** (0.03) | 4.87*** (0.17) |
| LV | −0.19** (0.10) | 0.30*** (0.03) | −0.23*** (0.07) | 0.55*** (0.05) |
| MT | 0.50*** (0.05) | 4.63*** (0.18) | 0.53*** (0.05) | 0.03 (0.10) |
| NL | 1.13*** (0.02) | 0.30*** (0.03) | 1.06*** (0.03) | −0.19*** (0.04) |
| PL | −0.51*** (0.08) | −0.25*** (0.03) | −0.52*** (0.06) | −0.38*** (0.08) |
| PT | 0.07 (0.07) | 0.33*** (0.05) | 0.08 (0.07) | 0.04 (0.05) |
| RO | −0.73*** (0.08) | −0.98*** (0.06) | −0.67*** (0.06) | −1.09*** (0.06) |
| SE | 1.13*** (0.02) | 0.39*** (0.05) | 1.11*** (0.03) | −0.36*** (0.03) |
| SI | −0.34*** (0.05) | 0.24*** (0.08) | −0.43*** (0.04) | 0.12* (0.07) |
| SK | −0.52*** (0.08) | −0.19*** (0.05) | −0.36*** (0.04) | −0.12** (0.06) |
| UK | 0.93*** (0.04) | 0.18** (0.07) | 0.93*** (0.06) | 4.76*** (0.16) |
| Lower education | −0.86*** (0.05) | −0.28** (0.13) | −0.86*** (0.06) | −0.36*** (0.09) |
| Higher education | 0.73*** (0.07) | 0.11 (0.12) | 0.70*** (0.05) | 0.12 (0.15) |
| 2nd quartile income | 0.29*** (0.03) | 0.14** (0.05) | 0.25*** (0.03) | 0.23*** (0.05) |
| 3rd quartile income | 0.55*** (0.04) | 0.44*** (0.13) | 0.52*** (0.05) | 0.49*** (0.08) |
| 4th quartile income | 0.77*** (0.08) | 0.73*** (0.16) | 0.79*** (0.07) | 0.67*** (0.07) |
| Less developed region | −0.10 (0.08) | −0.26*** (0.05) | −0.13* (0.07) | −0.14** (0.06) |
| More developed region | 0.15*** (0.05) | −0.04 (0.06) | 0.15*** (0.02) | 0.18** (0.08) |
| Constant | −0.18*** (0.06) | 2.21*** (0.09) | −0.26*** (0.06) | 2.02*** (0.07) |
| **Diagnostics** | | | | |
| Number of observations | 36667 | 19902 | 35505 | 20883 |
| Selected | 16254 | 19287 | 14827 | 20141 |
| Non-selected | 20423 | 615 | 20678 | 742 |
| Log pseudolikelihood | −26813.07 | −12114.52 | −24853.37 | −12415.51 |
| Rho | 0.87 (0.03) | 0.97 (0.01) | 0.87 (0.03) | 0.97 (0.03) |
| Wald test rho = 0 | 113.02*** | 82.09*** | 155.97*** | 21.56*** |

Source: Authors' estimates.

Notes: estimates obtained by clustering standard errors at the country level. *** denotes significance at 1%, ** at 5% and * at 10%.

**Table 3.** Marginal effects of e-government non-adoption at sample mean.

| | 2017 | | 2016 | |
|---|---|---|---|---|
| Variable | Older population | Younger population | Older population | Younger population |
| Lower education | −0.13*** | 0.11*** | −0.14*** | 0.08** |
| Higher education | 0.02 | −0.14*** | 0.02 | −0.12*** |
| Unemployment | 0.01 | 0.09** | 0.14** | 0.06** |
| Inactivity | 0.11*** | 0.02 | 0.11*** | 0.01 |
| Female | 0.05** | −0.01* | 0.07*** | −0.00 |
| Household size | – | – | 0.01 | −0.08*** |
| Dense area | −0.02** | −0.04** | −0.01 | −0.03** |
| Sparse area | −0.03*** | 0.01 | −0.03** | 0.00 |

Source: Authors' estimates.
Notes: *** denotes significance at 1%, ** at 5% and * at 10%.

The variables in selection equation are in most cases significant and have expected sign. Furthermore, comparison of the estimates for 2016 and 2017 reveal that for the most part the estimated coefficients are of the similar sign and significance (even though the set of variables are not strictly the same). Since the estimates for the year 2016 are based on the more complete dataset, we draw conclusions from the estimates for that year. In order to analyse the differences of the estimated effects between young and the older population, we compare marginal effects at the sample mean – that is average partial effect at the mean of young population and the same effect at the mean of older population (Table 3).

Our results point to three categories of factors, depending on their importance for young and the old:

1. Different factors for the young and the old: gender, household size and population density. While it is more likely that females will not adopt e-government services for older population, there are no such effects for the young. Indeed, estimates for the year 2017 seem to indicate that younger females are slightly more likely to adopt e-government services. So, it could be the case that for the older population group the traditional division of roles within the household still dominates, while such patterns are not detected for the young population. It is interesting to note that for the youth living in small households, it is less likely that they will not adopt e-government services. This might be at odds with descriptive results showing that large proportion of youth relies on others to actively engage in e-government services usage (Table 1). However, it points to the segmentation of youth with respect to their take-up of e-government services. It could be the fact that those living in large households are more likely to rely on others to perform these tasks, while those living in small households (up to 2 persons) are more likely to adopt e-government services. Regarding to the density of population in specific area, older persons are more likely to adopt e-government services in particular in sparsely populated areas. As it is more likely that older population resides in rural and less developed areas, leading to different forms of potential exclusion, this calls for specific policy actions aimed at reducing this risk. Younger people living in densely populated areas are more likely to adopt e-government services, which is in accordance with expectations.

2. Similar factors, but different effects for the young and the old: education. In case of older population, those with lower educational attainment are less likely not to use e-government services. These results are in accordance with the fact that older population to a greater extent believes that they do not have the necessary skills to adopt e-government services. This lack of skills could be more widespread, regardless of the educational attainment, because formal education did not incorporate information technologies in the case of older population. For younger population, the education has expected effect – the higher the education the less likely that person will not adopt e-government services.
3. Similar effects. Economic activity has the same expected effect for the young and the old, although it seems that it is relatively stronger for the older. The attachment to the labour market for the older seems to be positively correlated with the adoption of e-government services. Specifically, unemployed, and inactive are more likely not to adopt e–government. This reveals that longer attachment to the labour market also brings positive spill over effects to other segments of life, such as building potential to prevent exclusion not only in material terms.

These findings in general confirmed relevance of factors such as education and sex for adopting e-government services (Bimber, 1999; Goldfinch et al., 2009). Based on the data for rural Mexico, Martínez-Domínguez and Mora-Rivera (2020) also suggest that women are less likely to use the Internet in relation to e-government, although they seem to be more likely to use it for information searches, communication and social networks. We emphasise that our results confirmed the association between different factors leading to increased social inclusion risk. Being unemployed or inactive diminishes probability that person will be active user of online government services, both in the case of young and the old, although higher effect is estimated for the latter. Thus, employment provides many links to other segment of economic life, which elderly population loses touch with.

The results presented here have certain limitations. The senior citizens focused on in the empirical analysis still belong to the category of younger senior citizens, who are more likely to have better developed Internet skills in general than even older population groups (Hargittai et al, 2019) and are more likely to be Internet users (Seifert et al., 2017). Thus, the problem of digital divide could even be more pronounced in some of the analysed economies. The Survey covers only those citizens living outside institutions, and the assumption is that the population in institutional housing is older and probably even less exposed to e-government services. This is important venue for future research efforts.

We were not able to directly assess the trust in government, which probably differs across the analysed economies, and influences the decision of citizens to adopt e-government services (Alzahrani et al., 2018). We can notice from the data presented in Table 1 that not adopting e-government services due to security issues is of great concern to citizens in some countries. However, it is not *a priori* clear whether younger or older population groups (Alzahrani et al., 2018) will have more trust in e-government services. This issue deserves attention in future comparative research efforts in European economies.

## 5. Conclusions

The paper explores digital divide in e-government adoption across European Union countries. Based on the Eurostat's Community Statistics on Information Society it has been revealed that e-government adoption patterns differ not only between countries, but also when it comes to digital divide. In some countries the results are in accordance with the overall digital divide expectations – youth are more likely to adopt new technologies (Slovakia, Slovenia and Estonia in the case of obtaining information from government web sites). However, in other countries it is the older who lead in e-government services adoption (Ireland, Luxembourg and Portugal in case of obtaining information from government web sites).

Our empirical results lead to potentially important policy recommendations. What could be considered a common sense argument – that special attention should be given to older population in sparsely populated areas – is confirmed on the aggregate EU level, even after taking into account for different stages of Internet penetration development across Europe. This implies that actions towards preventing exclusion of older population in sparsely populated areas should be a joint EU effort, to prevent the risk of further gap increase.

Skill deficiencies for the older population have been proven important deterring factor for e-government adoption, regardless of the formal educational attainment. This suggests that specialised learning activities should be developed for older EU citizens. Training programs designed to improve ICT skills of older population can in general help them to overcome concerns and doubts related to new technology. Managers of government agencies should be advised to design senior citizens friendly services.

Finally, we have identified that for older population, women are less likely to adopt e-government services. Thus, additional efforts should be given to promote inclusion of older women in learning activities. Managers of government agencies could be given advice to specifically target promotion activities towards female senior citizens. Additional effort is also required in promoting e-government services and benefits of their use especially in lagging countries.

This study did not include factors related to motivation and expected benefits associated to e-government use by elderly or younger population, neither the issue of general trust in government. This is one of the limitations that is worth exploring in future research. Future studies should also consider differences among age groups within older and younger population, as both are highly heterogeneous. To gain better insights future studies can focus on other aspects of e-government, with the aim to address the issue of the quality of services provided.

Another important limitation is related to the time required for the comparable European micro data to become available for the analysis. We acknowledge the fact that many governments have improved the services offered to their citizens since 2017, in particularly during the outburst of the COVID-19 pandemics. This again supports the need for the quality research data to be available for the analysis as soon as possible, as only than it could be appropriately directed towards relevant policy recommendations.

## Notes

1. More information on the Survey can be found on following link https://ec.europa.eu/eurostat/web/microdata/community-statistics-on-information-society. While the latest data on aggregate Internet use are publicly available for year 2019, we use data for 2016 and 2017 for which we have access to micro data. Micro data consists of anonymised Survey data for all EU countries. The same questionnaire is administered in all the countries, thus enabling comparative approach. Anonymised individual responses are used in the analysis, without any imputation methods used to account for item non-response.
2. Following reviewers' suggestion, our aim was to report the estimates based on the most recent available dataset. However, the micro data for the Czechia were not available for 2017, thus we opted for presentation of the results in two consecutive years.
3. For brevity not shown here but could be available from the authors upon request.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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## Appendix

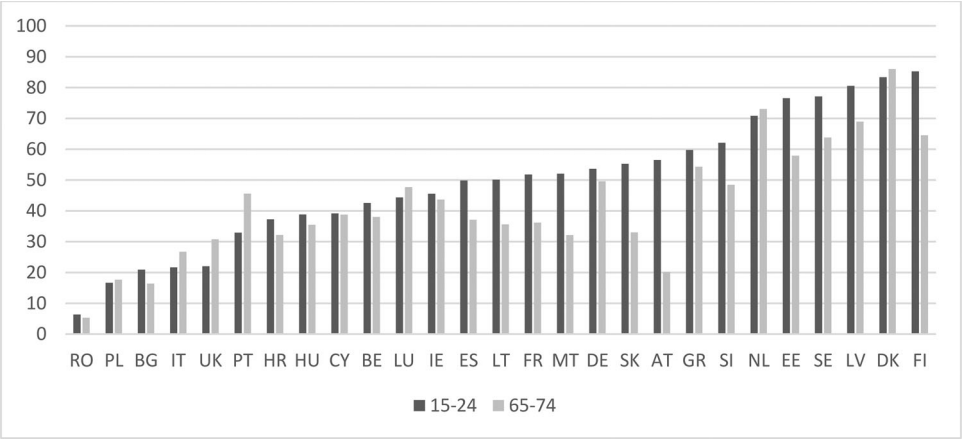


**Figure A1.** Obtaining information from web sites, 2017.
Source: Eurostat.

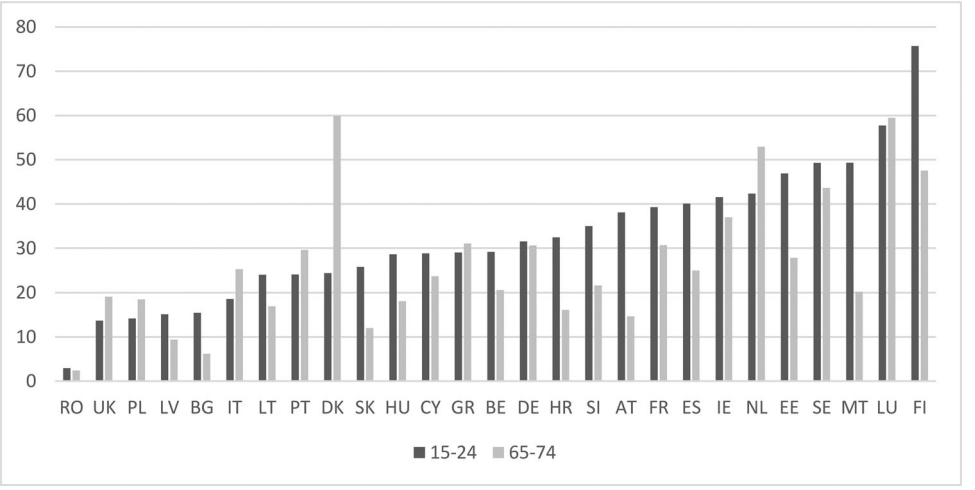


**Figure A2.** Downloading official forms, 2017.
Source: Eurostat.

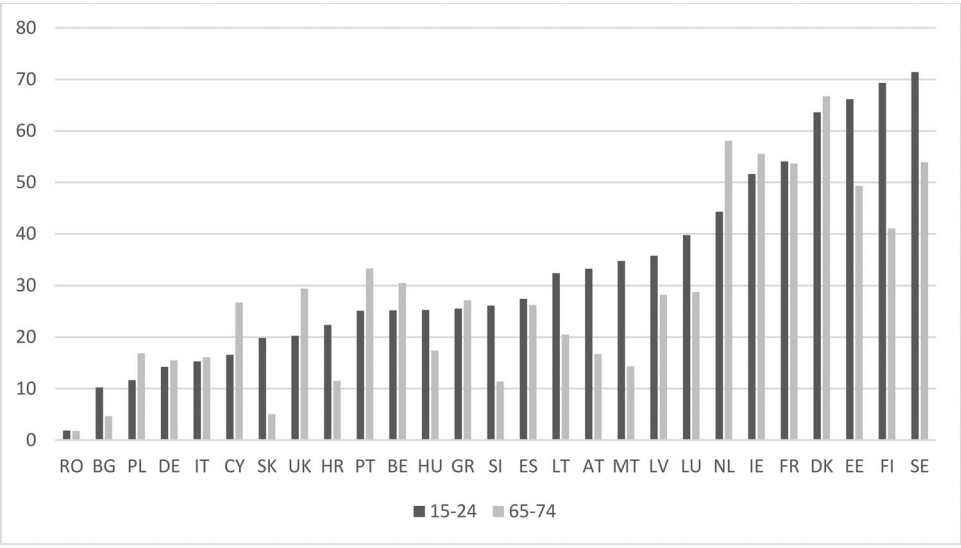


**Figure A3.** Submitting completed forms, 2017.
Source: Eurostat.

**Table A1.** Reasons for not submitting completed form – percentage of respondents, 2017.

| | Older | | | | | Younger | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No service | Lack of skills | Security concerns | Electronic signature problems | Another person | No service | Lack of skills | Security concerns | Electronic signature problems | Another person |
| AT | 15 | 36 | 23 | | 26 | 4 | 13 | 21 | | 47 |
| BE | 1 | 24 | 12 | 6 | 54 | 6 | 9 | 6 | 4 | 54 |
| BG | 6 | 28 | 17 | 22 | 6 | 53 | 6 | 10 | 14 | 12 |
| CY | 0 | 53 | 18 | 9 | 10 | 33 | 10 | 41 | 18 | 15 |
| DE | 13 | 35 | 46 | | 9 | 40 | 5 | 20 | | 12 |
| DK | 1 | 12 | 9 | 6 | 20 | 3 | 3 | 9 | 1 | 49 |
| EE | 7 | 29 | 4 | 4 | 0 | 0 | 33 | 0 | 0 | 0 |
| EL | 0 | 18 | 4 | 1 | 5 | 1 | 5 | 2 | 0 | 12 |
| ES | 4 | 39 | 19 | 24 | 22 | 22 | 14 | 20 | 27 | 48 |
| FI | 9 | 53 | 20 | 11 | 34 | 20 | 20 | 20 | 13 | 40 |
| FR | 1 | 44 | 32 | | 84 | 5 | 8 | 15 | | 77 |
| HR | 3 | 33 | 3 | 17 | 33 | 22 | 33 | 22 | 11 | 22 |
| HU | 7 | 38 | 41 | 26 | 38 | 6 | 21 | 27 | 26 | 36 |
| IE | 0 | 17 | 15 | | 23 | 3 | 18 | 5 | | 38 |
| IT | 9 | 17 | 7 | 6 | 66 | 13 | 4 | 3 | 3 | 55 |
| LT | 5 | 57 | 14 | 4 | 5 | 19 | 35 | 4 | 4 | 8 |
| LU | 5 | 27 | 29 | 14 | 55 | 5 | 9 | 19 | 14 | 53 |
| LV | 1 | 53 | 7 | 4 | 11 | 2 | 18 | 10 | 16 | 29 |
| MT | 12 | 68 | 24 | 15 | 18 | 18 | 23 | 23 | 27 | 23 |
| NL | 10 | 27 | 22 | 6 | 21 | 28 | 13 | 9 | 4 | 28 |
| PL | 1 | 33 | 26 | 9 | 12 | 3 | 14 | 15 | 7 | 13 |
| PT | 1 | 54 | 35 | 9 | 4 | 7 | 19 | 25 | 4 | 7 |
| RO | 0 | 50 | 17 | 0 | 17 | 10 | 20 | 80 | 40 | 0 |
| SE | 3 | 24 | 15 | 18 | 9 | 10 | 20 | 0 | 10 | 10 |
| SI | 20 | 20 | 0 | 0 | 40 | 34 | 10 | 16 | 26 | 26 |
| SK | 3 | 31 | 28 | 0 | 56 | 11 | 3 | 8 | 11 | 57 |
| UK | 6 | 12 | 18 | | 24 | 0 | 0 | 22 | | 22 |

Source: Eurostat.