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\* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

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# **Euro area consumers' payment behaviour and banking digitalisation<sup>1</sup>**

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## **Abstract**

This paper contributes to understanding consumers' payment behaviour and digitalisation in personal finances. We study individuals' payment choices, the availability of cashless payments in everyday situations and the use of banking apps in the euro area. Using the European Central Bank (ECB) Consumer Expectations Survey (CES), we find that most people prefer to use only one payment instrument, mostly cash, partly due to supply constraints in accepting non-cash payments. We also find substantial cross-country heterogeneity. Our results highlight the prominent role of demographic factors in choosing non-cash payment options and app-based tools in managing personal finances. While mobile banking is already popular among euro area consumers, using smart (device) payment methods remains very limited.

*Keywords:* Consumer Payment Behaviour; Banking Digitalisation; Consumer Expectations Survey (CES)

*JEL-classifications:* D12; C13; O33

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## 1. Introduction

This paper focuses on consumers' payment choices in the euro area and app-based tools for daily (offline) purchases involving small amounts of money or managing their finances.

Differently from many existing studies, we explore the role of perceived supply constraints in the availability of non-cash payment options. At the same time, we exploit rich cross-country euro area survey data that allows accounting for factors such as financial literacy or risk aversion, on top and beyond the usual background individual and household characteristics. The empirical analysis is based on the ECB Consumer Expectations Survey, a web-based multi-frequency survey that collects data from more than 10,000 consumers from the six largest euro area countries (Belgium, Germany, Italy, France, Spain, and the Netherlands). Most people prefer to use only one payment instrument, mostly cash or debit/credit cards. The perceived presence of supply-side constraints in accepting non-cash payments is a crucial driver of cash usage, even after controlling for demographic and socio-economic characteristics. We also document substantial cross-country heterogeneity, in line with previous studies (e.g. Esselink and Hernández, 2017; ECB, 2022). Belgium and Netherlands stand out as the two countries with the highest fraction of respondents who prefer non-cash payments, whereas on the other side of the spectrum, Germany and Italy lead the countries that use cash the most. In addition, our results highlight a prominent role of demographic factors in choosing non-cash payment options and app-based tools in managing personal finances. The young, the high-earners and the males are more likely to use payment options alternative to cash. Finally, while mobile banking is already popular among euro area consumers, the use of smart (device) payment methods is still minimal, although the recent COVID-19 pandemic seems to have impacted the propensity to transition to these late-generation payment instruments.

Understanding consumer payment patterns and digitalisation in finance is relevant for many reasons and economic agents. Firstly, making payments and managing personal finances is a substantial part of consumers' daily life. The outbreak of the COVID-19 pandemic has imposed unprecedented restrictions on people's movements, while goods kept being delivered at almost an average pace. As Lagarde (2020) posed, *"As our lives have suddenly gone digital, so have our payments: there has been a surge in online payments and a shift towards contactless payments in shops."* (Lagarde, 2020). Secondly, how payments in the retail market are made is very relevant for commercial banks. The rapidly growing role of fintech and big-tech firms in the past decades has increased the competition with traditional financial institutions in the payment field and posed new challenges to the banking sector in the supply of payment instruments. Thirdly, monitoring payment behaviour matters for

central banks, too, due to their role in providing access to money for citizens (ECB, 2022). The relevance of consumer payment choices is confirmed by the surge and maintenance of several payment surveys, by ongoing debates about the issuance of central bank digital currencies (CBDCs) and the withdrawal of cash from circulation (Sweden and Norway are underway to become fully cash-free, while the ECB (2023) Eurosystem cash strategy offers an opposite view to ensure that cash remains widely available and accepted as both a means of payment and a store of value), by the development of a single set of tools and standards that make cross-border payments in a particular currency as easy as national payments (e.g. the EU SEPA or the US FED Now). The rise of new digital payment services, associated operational risks, and increased global trade and electronic commerce have also reinforced the need to understand, regulate, and re-think the design of resilient payment systems.

On the one hand, research finds that "*cash does not seem to be going away*" (Shy, 2022). On the other hand, many observers of the payment sector have recently hypothesised about cash being marginalised by alternative payment options in light of rapid technological change. If anything, this public perception has only strengthened through the experience of the COVID-19 pandemic. Nevertheless, similar claims were made three decades ago (Carow and Staten, 1999). Similar to recent studies, we find that cash remains a widespread payment method among euro area consumers (ECB, 2022) while smart payment options stay at an early stage. We address what type of consumers use non-cash payment methods and fintech (smart payments and banking apps) and who still refrains from using such tools.

The remainder of the paper is organised as follows. Section 2 places the paper in the related literature. Section 3 presents the dataset and summarises the research questions and methodology. Section 4 describes and discusses the main empirical results. Section 5 concludes the paper.

## 2. Related literature

This paper relates to at least three distinct strains of a growing literature on consumer payments and technology adoption in finance. Reviewing this vast literature in its entirety is beyond the scope of this paper.<sup>2</sup> Instead, we focus on contributions most closely related to the questions we address.

The first strain of the literature focuses on potential drivers of observed payment patterns and consumer payment preferences. These studies show that demographic factors and peculiar characteristics of a

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<sup>2</sup> For a recent comprehensive review of the economics of cash usage, see Shy (2022) and for a summary of recent work on euro area payment behaviour more generally, see Jonker et al. (2022).

particular payment method play an important role in payment behaviour. On the one hand, cash usage increases with age and decreases with education and income levels, as well as with the involved transaction amounts (Jonker, 2007; Klee, 2008; Wang and Wolman, 2016; Stavins, 2021; Kajdi, 2022). Similar factors are also related to being underbanked (Ampudia and Ehrmann, 2017). On the other hand, prices and financial incentives have a steering effect on non-cash usage (Borzekowski *et al.*, 2008; Bolt *et al.*, 2010; Ching and Hayashi, 2010; Carbó-Valverde and Liñares-Zegarra, 2011; Stavins, 2018).

Moreover, the use of cards is enhanced by their features, such as user-friendliness (Jonker, 2007; van der Crujsen and Plooi, 2018) and perceived safety (Kosse, 2013). The contribution of our paper to this literature consists of a detailed analysis of the role of perceived supply constraints for consumers' choices between cash and non-cash payment methods.<sup>3</sup> We build on earlier work by Bagnall *et al.* (2016), who explore the role of perceived acceptance of cash relative to cards in a study based on a diary survey conducted in seven countries in different years.<sup>4</sup> However, we deviate from that study as we look at a comparable measure of non-cash acceptance across countries and field the questions simultaneously in all countries. We also build on DNB (2020), which highlights a potential role for cash supply constraints in the Netherlands due to merchants' reactions during the outbreak of the COVID-19 pandemic. We add to this by not only analysing the Netherlands but the six largest euro area economies. More recently, Moracci (2022) illustrates in a calibrated model how limited acceptance of non-cash payment methods and uncertainty about the size of future purchases might explain consumers' cash holdings due to a precautionary motive. Our study further supports such findings by highlighting the role of perceived non-cash payment constraints on payment attitudes.

The second literature strain consists of contributions on the effect of large exogenous shocks on payment habits, such as the surge of the fintech/big-tech industry at large and the outbreak of the COVID-19 pandemic. Over the past few decades, fintech and big-tech companies have developed new technologies and devices (cloud technology, advanced data analytics tools and blockchain), enabling radical innovations in financial processes and leading to the development of various new (digital) financial products, such as mobile payments (Brits *et al.*, 2021 among others). In emerging economies, the entrance of fintech and big-tech companies seems to be driven by an unmet demand of consumers and small enterprises for payments and other financial services by traditional banks. As a consequence,

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<sup>3</sup> While especially during the COVID-19 pandemic perceived acceptance of cash in shops might have been an important topic (Tamele *et al.*, 2022) we do not collect direct information on this. Instead, we infer from a survey run by the ECB in 2021 that during times of the then still ongoing COVID-19 pandemic acceptance of cash by merchants was 96 percent while it might have not been the preferred means of payment by customers (ECB, 2022).

<sup>4</sup> The seven diary surveys were conducted in 2009 (Canada), 2010 (Australia), 2011 (Austria, France, Germany, and the Netherlands), and 2012 (the United States).

they have started to offer (mobile) payment services to un(der)banked people and small enterprises to boost financial inclusion (Demirguc-Kunt *et al.*, 2022, among others).

More recently, the COVID-19 pandemic has abruptly impacted individual daily activities, including the way to shop and pay. This relatively recent literature shows that during the COVID-19 pandemic, consumer payment behaviour shifted towards cashless forms of payment (Kotkowski and Polasik, 2021; Kotkowski, 2023, among others). Fu and Mishra (2022) estimate that the spread of COVID-19 and related government lockdowns have led to a 24 and 32 percent increase in the relative rate of daily downloads of finance mobile applications in the 74 countries sampled. While COVID-19 has had disproportionate adverse economic effects on micro, small, and medium-sized enterprises and poor households, fintech providers were essential in mitigating these effects, notably in Asia (Beirne *et al.*, 2022).

The third strain of the literature collects studies on the process of payment digitalisation and the role of central bank digital currencies (CBDCs) as a payment or savings instrument.<sup>5</sup> While this field is relatively new, surveys have been used to assess the potential uptake of CBDCs via self-reported intention to use retail CBDC as a new means of payment. Using Dutch data, Bijlsma *et al.* (2021) identify trust in banks as a critical factor in facilitating adoption. Subsequent work for Austria by Abramova *et al.* (2022) shows that technology-savviness increases consumers' willingness to adopt CBDC. In turn, using complementary methods such as mobile payments could be an essential indicator of the potential adoption rate of CBDC. Relying on revealed preferences for different payment technologies, Li (2023) uses a structural model to estimate likely CBDC demand based on US consumers' cash and demand deposits allocation. Our study contributes to this evolving literature by enhancing the understanding of consumers' frontier payment choices using mobile devices and the use of smart technologies in managing personal finances.

### **3. Research questions, dataset, and methodology**

This paper poses three main research questions:

1. What are the latest developments and the main drivers of using different payment options for daily purchases?
2. What is the role of perceived supply-side constraints in people's payment attitudes?

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<sup>5</sup> See, for instance, Zamora-Pérez *et al.* (2022) for a review of the recent retail CBDC literature.

3. What are the determinants of using relatively new payment instruments based on the most advanced financial technologies, such as mobile banking applications and smart devices?

We use the European Central Banks' Consumer Expectations Survey (CES) to address these questions. The survey has been conducted monthly since April 2020 by the ECB. This panel survey on consumer expectations and behaviour collects data from more than 10.000 consumers via the internet from the six largest euro area countries (Belgium, Germany, Italy, France, Spain, and the Netherlands), accounting for more than two-thirds of the euro area population. ECB (2021) and Georgarakos and Kenny (2022) provide a detailed review of the survey's methodology. Notably, a large share of the respondents is recruited randomly from the euro area population of consumers older than 18.

The survey's relatively large sample size, detailed individual and household background characteristics and overall representativity make the CES particularly suitable for analysing changes in population attitudes towards new technologies. The surveys' online nature allows the CES to address topical issues, such as the changing landscape of payment methods in Europe during the COVID-19 pandemic, other than to elicit consumer expectations on various aspects.<sup>6</sup>

Our analysis exploits two special-purpose questions fielded in two waves of the survey's pilot (May and December 2020), covering more than 9,000 responses in each wave. About 70 percent of respondents provide answers in both survey rounds, highlighting a substantial panel component.

To elicit consumers' self-reported behaviour when faced with different payment options, we ask consumers about their openness to other modes of payment in day-to-day retail transactions. Cash remains an essential means of payment in the euro area, with 96% of companies accepting cash (ECB, 2022b). To ensure comparability across payment means, we limit the amount in the hypothetical scenario to €20. In addition, according to a survey run by the ECB (2020), the average transaction value was only marginally below a value of €20 before the outbreak of the COVID-19 pandemic. In the euro area, contactless payment limits have traditionally been relatively low for most countries. In the six surveyed euro area countries, this limit has ranged between €20 and €30 during 2019.<sup>7</sup> The €20 might thus be particularly relevant for consumers unaware of the broad-based increase to €50 in 2020.<sup>8</sup> Finally, using a rounded amount makes it easier for consumers to conceptualise the scenario.

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<sup>6</sup> Updates about the survey, sample questionnaires, further methodological details and recent results are available on the ECB webpage: [https://www.ecb.europa.eu/stats/ecb\\_surveys/consumer\\_exp\\_survey/html/index.en.html](https://www.ecb.europa.eu/stats/ecb_surveys/consumer_exp_survey/html/index.en.html).

<sup>7</sup> In particular, the limit for contactless card payments without pin in the euro area has been €30 in France; €25 in Belgium, Germany, Italy, the Netherlands and €20 in Spain. The latter serving as upper bound for the awareness in early 2020 about limits.

<sup>8</sup> While in 2020 this limit has been increased this increase has not happened synchronous across countries and payment card issuers.



For this purpose, in two CES survey rounds, a question on payment choices was fielded that reads as "*Which of the following payment options do you use to pay for an amount of €20 for a day-to-day transaction (e.g. at a supermarket)*". The answer categories are cash; debit or credit card (excluding contactless); contactless debit or credit card; smartphone (mobile payment); retailer card with a payment function; bitcoin or other crypto-asset; other (e.g. food voucher). Respondents may report multiple choices, so the payment options are not mutually exclusive. From this question, we consider the first four categories, as the last three categories amount to a small fraction of the overall sample (see Table 1 – Payment choices).

Cash – paper money and coins: is one of the most common ways to pay for purchases. Cash has the advantage of being immediate but likely not the safest nor the cheapest form of payment. In our initial sample, cash is, on average, chosen by about 56 percent of consumers.

Contactless and non-contactless debit/credit cards: Paying with a debit card implies that the money is directly taken from the buyer's account; paying with a credit card temporarily defers the buyer's bill. In the case of a credit card, the buyer pays off their bill to the credit card company rather than paying the seller directly. Debit and credit cards can be used for online purchases and at physical retailers. They can be used by inserting a PIN code (non-contactless method) or tapping the card on a payment device (contactless method). In our sample, non-contactless and contactless debit/credit card is used by 32 percent and 47 percent of consumers, respectively.

Smart devices include banking apps, QR codes and digital wallets: Payment is made for a product or service through a portable electronic device such as a tablet or cell phone. They are typically considered easy to use, low-cost and convenient, and do not require a PIN. Their main disadvantages are limited availability, security and/or privacy concerns. In our sample, smart devices are used by 14 percent of consumers.

In addition, to dive into the level of digitalisation in public payment habits, in each of the two survey rounds, we ask a question that reads, "*Banks offer the possibility to arrange banking affairs by smartphone. You can manage your accounts and execute payments by using a special app provided by your bank. Do you use this type of app?*" Answer categories are "Every day", "At least once a week", "At least once a month", "Less often than once a month", and "Never".<sup>9</sup>

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<sup>9</sup> The wording of the question has been adopted in large parts from the DNB Household Survey conducted by Centerdata.

### 3.1. The dependent variables

The question described above allows building the following dependent variables: the **number of payment methods** respondents report preferring and the **particular type of payment method** that respondents report using for a €20 transition; the **use of new financial technologies**, namely smart devices and banking apps.

The summary statistics relative to each of these variables for the pooled sample (May and December 2020) are reported in Table 1 – Aggregated.

*Table 1 about here*

#### Number and type of payment options

The reported choices range between 1 and 4 distinct types of payment methods. Despite the increased availability of payment options through recent decades, the average respondent prefers less than two, with the median consumer using a single payment instrument. Cash is favoured by 33 percent of the respondents in combination with some other forms of payment and by 24 percent of the sample as the sole payment method. Non-cash payment methods are reported by 42 percent of consumers as the only payment options (see Table 1 – Aggregated).

Figure 1 shows the structure of different payment modes for the pooled sample. We observe that most consumers (some 60 percent) prefer only one payment type. The most preferred ones are cash and contactless card, both counting for about 20 percent. In comparison, pin cards and smartphones are chosen by a marginal fraction of individuals (about 10 and 5 percent, respectively). A third uses two payment options: cash and contactless card, cash and pin card, and another. Some 10 percent prefer three payment options, whereas only 3 percent prefer a blend of 4 payment options. These findings relate to previous literature that shows that consumers typically use only a few payment instruments (Bagnall *et al.*, 2016; Boston Consulting Group, 2020, among others). It is also notable that cash appears in all the reported mixed payment options.

*Figure 1 about here*

Interestingly, cash is negatively and significantly correlated to other payment forms (see Table 2), suggesting a substituting role of cash. This finding contrasts Fujiki (2022), who documents that the frequency of cash payments is unlikely to decrease despite using cashless payment methods. In contrast, mobile apps are positively and significantly correlated with other non-cash payment methods, suggesting a complementarity role of this more recently introduced form of payment. Some

literature documents that the share of cash payments in many countries has decreased over recent years and more markedly during the COVID-19 pandemic (Coyle *et al.*, 2021; Tamele *et al.*, 2021, among others).

*Table 2 about here*

It is a well-known fact that payment habits and preferences differ substantially among countries in the euro area (see Esselink and Hernández, 2017, among others). Our data show (see Table 3) that cash is the most used option in Germany and Italy (30 percent and 28 percent, respectively, both above the average of 24 percent for the pooled sample of countries) as well as in Spain (23 percent). In addition, cash is the second most preferred option in France (18 percent), even if cash appears in the top position in combination with contactless cards (26 percent). In the Netherlands, only 10 percent of consumers claim cash as their most preferred option, while in Belgium, cash does not appear in the top three payment preferences.

*Table 3 about here*

Another way to address country differences is to distinguish between cash only, non-cash only and a mix of cash/non-cash payment methods. Figure 2 reports the percentage of consumers for each of these subgroups. Belgium and Netherlands stand out as the two countries with the highest fraction of individuals who prefer non-cash only payment methods, being six times as large as the fraction who prefer cash only and doubling the fraction of the individuals who prefer a mix of cash and non-cash payment options.

*Figure 2 about here*

### Use of new financial technologies

The third dependent variable considered in this paper consists of the individuals who reported using smart payment devices (e.g. smartphones or wearables) and those who reported using mobile **banking applications** for managing their finances. On average, 14 percent of consumers use smart devices and 60 percent use banking apps.<sup>10</sup>

Figure 3 reports the percentage of consumers who report using new financial technologies by country. Euro area countries are relatively homogeneous in the use of such payment forms, with mobile banking being the most preferred by large in all countries (Spain and the Netherlands lead with around 65

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<sup>10</sup> While we acknowledge that differences in magnitudes might be partly due to the different question mode (multiple vs. single choice), we cross-validated our results against data from the DNB Household Survey for the Netherlands and obtain for the year 2020 comparable results in terms of the adoption of mobile banking applications.

percent of consumers; France and Germany are at the end of the spectrum with about 55 percent) and smart only payments being the least preferred in all countries (with a fraction of respondents no higher than 5 percent).

*Figure 3 about here*

The time dimension of the database allows for computing the fraction of individuals who have chosen cash exclusively in both May and December 2020 and the fraction who had never chosen any mobile banking applications. Figure 4 shows that the highest fraction of people never adopting non-cash payment instruments is highest in Italy (20 percent) and lowest in Belgium (4 percent). The figure also highlights that the fraction of consumers who reported never using mobile banking applications is highest in Belgium and France (33 and 30 percent, respectively) and lowest in Spain (19 percent).

In our subsequent analysis, we exploit the time dimension by analysing the determinants of the **adoption of smart devices** between May and December 2020.

*Figure 4 about here*

### 3.2. The explanatory variables

In our basic regressions, we also include several background and socio-economic characteristics, whose summary statistics are reported in Table A1 of Appendix 1. In particular, we control for age (in class dummies), gender (female indicator), education level (university diploma indicator), households' financial situation, income and wealth (employed indicator; yearly net household income in quartiles; homeownership indicator), household composition and size (presence of partner indicator; the number of household members; the presence of child indicator), country of residence (Belgium, Germany, Spain, France, Italy and Netherlands indicators), degree of urbanisation (high, middle and low indicators).

In addition, we control for financial literacy (1-4 scale score of correct answers), hand-to-mouth consumption (dummy), trust in people (0-10 scale score), risk attitude (in dummies)<sup>11</sup> and COVID-19 health concerns (0-10 scale score). Financial literacy has been measured following the well-established

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<sup>11</sup> The reason to include measures of trust in people and risk attitude is the idea that the choice of cash may be positively correlated with more defensive personality traits that prevent individuals to adopt technological devices in view of their potential leak of personal data (by inserting a PIN or downloading an app on the personal mobile).

concept of the “big 3” questions developed by Lusardi and Mitchell (2011) and one more advanced question (see Appendix 2 for details on the question wording).

An important aspect we want to explore is the presence of perceived supply-side constraints in (non-cash) payments which might shed light on the circular relationship between consumers' adoption of payment technologies and merchants' acceptance (ECB, 2022c). For this purpose, the following question was asked in December 2020:

*Thinking about the stores where you shop most frequently, how many offer the possibility to pay by card or other electronic means?*

Answers categories were "All stores", "Most stores", "Around half of the stores", "Few stores", and "None".

From this question, we construct a binary variable that takes value one, if not all stores offer the possibility to pay non-cash. On average, 61 percent of consumers report that not all stores give them that possibility.<sup>12</sup>

It is interesting to see how supply constraints are perceived across the country. Figure 5 shows that the Netherlands has the highest fraction of individuals who report that all stores accept non-cash payments (55 percent). The lowest percentage refers to Germany (31 percent), where the highest fraction of respondents declare that most stores accept electronic payments (56 percent).

*Figure 5 about here*

Finally, we analyse the role of household age differentials in adopting frontier payment technologies. By including the age difference of the individual respondent compared to other household members, computed as the respondent's age minus the average age of the household members, we explore the possibility of spillover from younger generations to older generations.

*Table A1 about here*

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<sup>12</sup> We acknowledge that this variable may potentially suffer from endogeneity. We partly address this issue by splitting the sample in the regression analysis by levels of urbanization. The idea is that in rural areas there may be less possibility for the consumer to choose among stores that allow for a larger set of alternative payment options if compared to the consumer who lives in urban areas. If this is true, we should find a different role of the supply side constraints by urbanization level. In addition, we are currently exploring the possibility to repeat a similar question in a comparable setting that avoids this potential issue.

### 3.3. The empirical models

We start the empirical analysis by looking for the main determinants of diversification in payment preferences. For this purpose, we estimate a Poisson model on the sum of payment options used:

$$\sum_j Y_{j,i,t} = \exp(\alpha + \beta * X'_i + \nu * Z'_{i,t} + \delta_t + \gamma_c + \varepsilon_{i,t}), \quad (1)$$

where  $Y_{j,i,t}$  denotes the use of payment method  $j$  (cash, pin debit/credit card, contactless debit/credit card, smart devices) reported by respondent  $i$  at time  $t$  (May, December 2020);  $X'_i$  is a vector of time-invariant demographic variables;  $Z'_{i,t}$  is a vector of time-varying economic characteristics;  $\delta_t$  is a fixed-effect vector of time dummies that allows accounting for shifts in the overall macroeconomic environment between May and December 2020;  $\gamma_c$  denotes a set of country-fixed effects that captures any country-specific factors;  $\varepsilon_{i,t}$  is a residual component.

Next, we focus on each group of payment methods (mixed payment methods, cash only, non-cash only) and the use of digital tools (smart, mobile banking apps) separately to characterise the "typical" users better and to inspect how much these alternative options overlap. For this purpose, we estimate a linear probability model on each payment method and the use of banking applications as follows:

$$M_{i,t} = \alpha + \beta * X'_i + \delta_t + \gamma_c + \varepsilon_{i,t}, \quad (2)$$

where  $M_{i,t}$  is one of three aggregated payment methods chosen by consumers (mixed, cash only or non-cash only).<sup>13</sup> Firstly, mixed payment methods are an indicator variable that takes the value one if, in either May or December 2020, the respondent reports using cash and non-cash for their daily purchases. Secondly, cash only is a dummy variable that takes value one if the respondent reports using only cash in either May or December 2020. Thirdly, non-cash only is an indicator variable that takes the value one if, in either May or December 2020, the respondent reports using only non-cash payment methods.

We continue our empirical analysis by focussing on the dynamics of payment methods. For this purpose, we classify the respondents as (permanent) refusers of non-cash payment methods and mobile banking applications and estimate a model akin to (2). Throughout, standard errors are clustered on the individual level.

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<sup>13</sup> For brevity, since the objective is not forecasting probabilities and for ease of interpretation, we only present results from the linear probability model. However, results from assuming a specific non-linear relationship and using a probit model are qualitatively comparable. Results of partial effects from the probit are available upon request.

## 4. Empirical results

In this section, we review and discuss the main empirical results related to how people diversify their daily purchases (section 4.1), to the type of payment instruments used, in particular cash versus non-cash (section 4.2), and to the use of new financial technologies, namely smart devices and mobile banking applications (section 4.3).

### 4.1. Payment diversification

The estimation results from the model (1) are visualised in Figure 6, where the marginal effects and the 95% confidence intervals are reported. Demographic factors like age, being female and having a spouse are negatively and significantly associated with payment diversification. Being a homeowner and a hand-to-mouth consumer are also negatively and significantly associated with more payment instruments. In contrast, financial literacy, employment, and higher incomes are positively and significantly associated with payment diversification. We also observe significant country effects: Spain, France, and Italy diversify less than Germany.

*Figure 6 about here*

### 4.2. Cash vs non-cash payment methods: drivers and role of perceived supply-side constraints

The marginal effects from model (2) estimation are reported in Table 4a and visualised in Figure 7. For each of the alternative payment methods (mixed cash/non-cash, cash only and non-cash only), two specifications are estimated: one with the time dummy for December 2020 and no control for supply constraints, to be found in columns (1), (3) and (5) of Table 4, and one without the time dummy but that controls for the presence of perceived supply constraints, to be found in columns (2), (4) and (6) of Table 4a.<sup>14</sup>

The first thing to notice is that cash and non-cash payments have roughly the same determinants but with opposite signs. Cash is significantly (at the 1-percent level) less used by the respondents who reported trusting other people (at the 1-percent level) and by those with a high level of financial literacy. Non-cash is, in contrast, significantly more used by individuals with higher financial literacy

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<sup>14</sup> Since the supply constraint variable is collected in December 2020 only, the number of observations for the latter specification is lower.

scores. The surge of the COVID-19 pandemic significantly (at the 1-percent level) reduced the use of cash in favour of non-cash payments, likely due to concerns about the safety of cash through a possible risk of infection (Tamele *et al.*, 2022).

Our data also show a significant (at the 1-percent level) age gradient: the use of cash is monotonically increasing with age, with marginal effects going from some 3 percent for the 35-49-year-olds to some 6 percent for the 65+-year-olds. Conversely, the use of non-cash is less frequent in the older population compared to the very young, aged less than 34 years old.

The highly educated sample respondents are significantly (at the 1-percent level) more likely to adopt non-cash types of payment for their daily purchases. In contrast, there is no significant difference in the use of cash.

The household composition is another significant (at the 1-percent level) determinant of using cash or non-cash instruments in opposite directions. Larger households are more likely to rely on cash and less likely on non-cash; the presence of a partner is negatively correlated with the use of cash and positively so with the use of non-cash; the presence of a child in the household significantly increases the probability to adopt a non-cash payment and decreases the likelihood to use cash.

The use of cash is monotonically decreasing with income, whereas the use of non-cash payments is monotonically increasing with income. A plausible explanation of this finding is that low earners think that cash is a better monitoring and budgeting tool than non-cash payment channels (Hernández *et al.*, 2017).

Our estimation results also confirm the previously documented heterogeneity in payment preferences across countries. Cash is significantly (at the 1-percent level) less likely to be used in any other country than Germany, and non-cash is significantly (at the 1-percent level) more likely to be used in any other country than Germany.

In addition, hand-to-mouth respondents are significantly (at the 1-percent level) more likely to use cash, in line with Hernández *et al.* (2014), who document that liquidity-constrained individual use cash for budget control purposes. However, their use of non-cash is not significantly different from those that do not face liquidity constraints. Similarly, being employed significantly (at the 1-percent level) decreases the use of cash but does not significantly affect the use of non-cash.

The use of mixed payment methods has less significant determinants than the use of cash and non-cash methods. Risk-averse respondents are significantly (at the 5-percent level) less likely to adopt mixed payments than the risk-neutral ones and significantly (at the 1-percent level) less likely in less



urbanised areas. One interesting result is that for hand-to-mouth and employed respondents, the use of mixed payments is opposite to the use of cash. The former group is significantly (at the 1-percent level) less likely to use mixed payments than unconstrained respondents; the latter group is significantly (at the 1-percent level) more likely to adopt mixed payments than the unemployed. Income does not significantly affect the adoption of mixed payments. Still, we observe significant (at the 1-percent level) country effects: Germany is the country where most likely the use of mixed payment methods occurs.

*Table 4a and Figure 7 about here*

The presence of non-cash supply constraints non surprisingly is significant (at the 1-percent level) and positively correlated with the use of cash and negatively with the use of non-cash methods. This finding is consistent with some literature showing that the decline in using cash as a payment instrument results from increased acceptance of non-cash payment channels (Arango-Arango and Suárez-Ariza, 2020, among others). To address the potential endogeneity issue (i.e. consumers might self-select into stores that allow their most preferred payment option), we split the sample by the degree of urbanisation and run the same regression. The rationale behind this strategy is to see whether the marginal effect of the supply side constraints changes between rural and urban areas since, in less urbanised areas, there may be a lower opportunity to find stores that allow all kinds of payment methods to choose from, therefore making the supply side constraints more binding than in non-rural areas. Table 4b shows that this is not the case for the cash and the non-cash options. However, we find that for mixed payment instruments, the supply side constraints are significantly (at the 5-percent level) more likely to be binding in areas with a medium level of urbanisation and insignificant for both the rural and the non-rural areas.

*Table 4b about here*

### **4.3. New financial technologies: smart devices and mobile banking applications**

In the past few years, the market for retail payments has known an unprecedented innovation trend, resulting in a change in consumer preferences and habits. This paper focuses on innovations in two front-end devices: smartphones and banking applications. Table 5 reports their main drivers estimated by the linear probability model (2) for the pooled sample (columns 1 to 3). In addition, the repeated question about the use of smart devices allows for analysing the dynamic aspect of adopting smart

devices between May and December 2020. For this purpose, a similar model to model (2) is estimated, with a considerable drop in the number of observations (from 15,021 to 5,172) due to the limited panel component. The corresponding results are reported in column (4).

Two main findings can be extrapolated from Table 5. Firstly, smart devices and banking applications are complementary payment instruments. As shown in Table 2, the two payment instruments are significantly (at the 1-percent level) and positively correlated. Using banking applications increases the probability of using some smart devices by 19 percentage points. Secondly, using smart devices and banking applications has very similar determinants. Both payment methods are significantly (at the 1-percent level) less likely to be used in non-urban areas, by females, by the older population, and by hand-to-mouth respondents.

Conversely, the two payment methods are significantly (at the 1-percent level) more likely to be used by the respondents who report trusting other people, those with children, the employed, and those with higher income levels. These findings suggest that payment instruments based on new financial technologies might not be very inclusive and may exacerbate the gap between specific population subgroups, particularly along the gender, age, and income dimensions. In the Netherlands, for instance, millions of Dutch struggle to get to grips with digital payments (DNB, 2023a, 2023b and 2023c).

The dynamic analysis confirms the previous results. Not only the use of banking apps in May 2020 significantly (at the 1-percent level) increases the adoption of smart devices for payment in December 2020, but again females and older individuals are significantly (at the 1-percent level) less likely to start using smart devices. In addition, households with children, the employed and the respondents with higher income are again more likely to adopt smart devices in December 2020.

*Table 5 about here*

To better understand the role of children (therefore of a younger person in the household, more prone to catch up with technological progress in daily activities), we dive into the use of smart devices for purchases purposes and regress it on the individual age as well as on the difference between the personal age and the average age of the household members.<sup>15</sup> Table 6 reports the results for single households, couples and households with 3 and 4 members. The individual age is always significantly (at the 1-percent level) and negatively correlated with using smart devices, but the age difference is significantly (at the 1-percent level) and positively correlated. This finding confirms the role of

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<sup>15</sup> We performed the same analysis for banking applications and the results were comparable suggesting more general technology related effects.

younger members in the household in inducing older members to catch up with the technology developments, suggesting a "keeping up with the young" narrative.

*Table 6 about here*

## **5. Discussion, concluding remarks and future work**

This paper focuses on three specific aspects of the digitalisation process in the payment landscape in the euro area. The first aspect is how much consumers diversify their payment instruments when dealing with daily purchases that involve small amounts. The paper, therefore, focuses on the market for retail payments that in recent years has been characterised by the entrance of incumbent financial firms, increasing the competition with more traditional suppliers of payment methods, namely the banking sector. We distinguish between cash, non-cash, and mixed payment channels. The second aspect of the ongoing digitalisation process in consumer payments addressed in this paper is the role of supply-side constraints that may restrict the choice set of payment options and therefore be responsible for a mismatch between individual preferences and actual behaviour. While unable to match our survey data with administrative data from banks or stores, we collect information about supply-side constraints from the consumers directly. This way, we ultimately deal with consumer perceptions of such restrictions. Finally, we study the extent to which consumers use new financial technologies for retail payments by focusing on the self-reported usage of smart devices and banking applications for managing personal finances.

The main findings can be summarised as follows. Consumer payment behaviour is heterogeneous across countries as well among individuals. There is evidence of relatively little diversification in daily payments. The two major payment options are cash and cards (both with pin and contactless), often competing with each other but sometimes also used in combination. Cash may not be an unchallenged "king" (Panetta, 2021), especially in certain countries like the Netherlands, but it is still present in daily purchases. The main drivers of consumer payment choices are demographic characteristics, personality traits and supply-side factors. Consumers still perceive the imperfect availability of cashless payment options, which drives the prominent use of cash in countries where these supply-side constraints are perceived more strongly. We also find somewhat limited use of smart devices and banking apps, especially for some subgroups: the old, the low-educated and the low-earners. At the same time, the paper shows some signs of willingness to adopt these new payment devices during the COVID-19 pandemic.

Based on our results, we see several future avenues for further research in this area. Firstly, the role of supply-side factors could be identified in an alternative way if transaction data from banks and stores become accessible to researchers. High-frequency transaction level data would allow combining payment choices with purchases exploring heterogeneity in different market segments based on the amount of money involved and allowing for empirical identification using, for instance, exogenous (regulatory) variation in payment limits at the point of sale. Secondly, to better understand the role of the COVID-19 pandemic on payment attitudes and its impact over time, questions of a similar kind, as used in this study, could be fielded in future survey waves. Collecting the same information for a more significant number of countries offers the possibility to explore further country heterogeneity, which shapes the European payment landscape. The possibility of adding a more extended time dimension to the data would considerably improve the analysis of the dynamics of using several payment options. In particular, to better study the adoption of more digitalised forms of payments among heterogeneous groups of consumers in a rapidly changing technological environment. Both aspects can, already today, be partly addressed by using complementary studies like the SPACE survey conducted by the ECB, which records payment diary information and acceptance levels at the point of sale for a specific period. All these possible extensions are left for future research.

**Tables and Figures**

Table 1: Description of key variables

Variable	Description	Mean	SD	Min	Max	N
<b>Payment choices</b>						
Cash	Binary (1=cash payment; 0=else)	0.56	0.50	0	1	19383
Contactless card	Binary (1=contactless card payment; 0=else)	0.47	0.50	0	1	19383
Pin card	Binary (1=pin card payment; 0=else)	0.32	0.47	0	1	19383
Smartphone	Binary (1=smartphone payment; 0=else)	0.14	0.34	0	1	19383
Retailer card	Binary (1=retailer card payment; 0=else)	0.06	0.23	0	1	19383
Bitcoin	Binary (1=bitcoin payment; 0=else)	0.01	0.11	0	1	19383
Other (incl. food voucher)	Binary (1=other payment method; 0=else)	0.04	0.19	0	1	19383
<b>Aggregated (omitting: retailer card, bitcoin, and other payment methods)</b>						
Nr. of payment methods	Count (number of payment methods chosen)	1.54	0.75	1	4	18864
Mixed payment methods	Binary (1=mixed payment; 0=else)	0.33	0.47	0	1	18864
Cash (only)	Binary (1=cash payment only; 0=else)	0.24	0.43	0	1	18864
Non-cash (only)	Binary (1=non-cash payment only; 0=else)	0.42	0.49	0	1	18864
<b>Banking applications</b>						
Banking app user	Binary (1= using mobile device banking apps; 0=else)	0.60	0.49	0	1	19192

Note: Statistics based on the population-weighted and pooled May 2020 and December 2020 samples. This table

Describes the basic properties of the primary dependent variables used in the regressions. The number of observations

might vary in the empirical section depending on the covariates available in the regressions.

Respondents that *only* report *retailer card*, *bitcoin* or *other (incl. food voucher)* (<3% of the sample) are excluded

from the analysis.

Table 2: Cross-correlations of payment methods

	Banking app	Cash	Pin card	Contactless	Smartphone
Banking app	-				
Cash	-0.134	-			
Pin card	0.051	-0.088	-		
Contactless	0.127	-0.233	-0.215	-	
Smartphone	0.310	-0.089	0.007	0.025	-

Source: ECB – Consumer Expectations Survey, pooled and weighted May 2020 and December 2020 data.

Note: Variables are all coded as binary. All Pearson correlations are significant at the 1-percent level.

Table 3: Country-specific payment choices

Rank	1	2	3
Average	<i>Cash (24%)</i>	Contactless card (20%)	Contactless card & cash (12%)
BE	Pin card (25%)	Contactless card (20%)	Pin & contactless card (12%)
DE	<i>Cash (29%)</i>	Contactless card & <i>cash</i> (15%)	Contactless card (12%)
ES	<i>Cash (23%)</i>	Contactless card (18%)	Pin card (14%)
FR	Contactless card & <i>cash</i> (26%)	<i>Cash (18%)</i>	Pin card (13%)
IT	<i>Cash (28%)</i>	Contactless card (24%)	Pin card (12%)
NL	Contactless card (27%)	Pin card (15%)	<i>Cash (9%)</i>

Source: ECB – Consumer Expectations Survey, pooled and weighted May 2020 and December 2020 data.

Table 4a: Drivers of different payment method usage

Dep. var.:	Mixed payment methods (binary)		Only cash (binary)		Only non-cash (binary)	
	(1)	(2)	(3)	(4)	(5)	(6)
Risk averse	-0.027** (0.01)	-0.029** (0.01)	0.008 (0.01)	0.012 (0.01)	0.019* (0.01)	0.017 (0.01)
Risk loving	-0.009 (0.01)	-0.001 (0.01)	0.014 (0.01)	0.016 (0.01)	-0.005 (0.01)	-0.015 (0.01)
Trust in people	0.004** (0.00)	0.002 (0.00)	-0.006*** (0.00)	-0.004** (0.00)	0.002 (0.00)	0.002 (0.00)
Financial literacy	0.007* (0.00)	-0.009* (0.01)	-0.021*** (0.00)	-0.019*** (0.00)	0.013*** (0.00)	0.028*** (0.01)
COVID-19 health concerns	-0.001 (0.00)	-0.004** (0.00)	-0.005*** (0.00)	-0.007*** (0.00)	0.006*** (0.00)	0.011*** (0.00)
Non-cash supply constraints		0.022** (0.01)		0.061*** (0.01)		-0.083*** (0.01)
Low urbanisation	-0.034*** (0.01)	-0.045*** (0.01)	0.014 (0.01)	0.019* (0.01)	0.020* (0.01)	0.026** (0.01)
High urbanisation	0.014 (0.01)	0.019 (0.01)	-0.006 (0.01)	-0.012 (0.01)	-0.007 (0.01)	-0.007 (0.01)
Women	-0.017** (0.01)	-0.016 (0.01)	0.009 (0.01)	0.008 (0.01)	0.007 (0.01)	0.008 (0.01)
Age: 35-49	-0.009 (0.01)	0.005 (0.01)	0.029*** (0.01)	0.031*** (0.01)	-0.020 (0.01)	-0.036** (0.01)
Age: 50-64	-0.015 (0.01)	0.003 (0.01)	0.039*** (0.01)	0.035*** (0.01)	-0.024* (0.01)	-0.038** (0.01)
Age: 65+	-0.067*** (0.02)	-0.037* (0.02)	0.060*** (0.02)	0.050*** (0.02)	0.007 (0.02)	-0.013 (0.02)
Education: Bachelor and above	-0.022*** (0.01)	-0.022** (0.01)	-0.016** (0.01)	-0.009 (0.01)	0.039*** (0.01)	0.032*** (0.01)
Household size	0.008* (0.00)	0.009 (0.01)	0.017*** (0.00)	0.017*** (0.01)	-0.025*** (0.01)	-0.026*** (0.01)
Partner in household	-0.036*** (0.01)	-0.040*** (0.01)	-0.027*** (0.01)	-0.030*** (0.01)	0.063*** (0.01)	0.070*** (0.01)
Child in household	0.005 (0.01)	0.010 (0.01)	-0.044*** (0.01)	-0.045*** (0.01)	0.039*** (0.01)	0.035** (0.01)
Homeowner	-0.022*** (0.01)	-0.030*** (0.01)	0.011 (0.01)	0.007 (0.01)	0.011 (0.01)	0.024** (0.01)
Hand-to-mouth	-0.038*** (0.01)	-0.052*** (0.01)	0.055*** (0.01)	0.065*** (0.01)	-0.017* (0.01)	-0.013 (0.01)
Employed	0.031*** (0.01)	0.045*** (0.01)	-0.047*** (0.01)	-0.065*** (0.01)	0.017* (0.01)	0.020* (0.01)
Income: 2 <sup>nd</sup> quartile	0.018 (0.01)	0.009 (0.01)	-0.040*** (0.01)	-0.022* (0.01)	0.022* (0.01)	0.013 (0.01)
Income: 3 <sup>rd</sup> quartile	-0.000 (0.01)	-0.004 (0.02)	-0.067*** (0.01)	-0.054*** (0.01)	0.067*** (0.01)	0.058*** (0.02)
Income: 4 <sup>th</sup> quartile	0.002 (0.01)	-0.003 (0.02)	-0.091*** (0.01)	-0.075*** (0.01)	0.089*** (0.02)	0.078*** (0.02)
Belgium	-0.081*** (0.02)	-0.119*** (0.02)	-0.216*** (0.01)	-0.212*** (0.01)	0.297*** (0.02)	0.331*** (0.02)
Spain	-0.096*** (0.01)	-0.128*** (0.02)	-0.086*** (0.01)	-0.083*** (0.01)	0.182*** (0.01)	0.211*** (0.02)
France	-0.074*** (0.01)	-0.131*** (0.02)	-0.109*** (0.01)	-0.102*** (0.01)	0.183*** (0.01)	0.233*** (0.02)
Italy	-0.125*** (0.01)	-0.180*** (0.02)	-0.026** (0.01)	-0.015 (0.01)	0.151*** (0.01)	0.195*** (0.02)
Netherlands	-0.106*** (0.02)	-0.124*** (0.02)	-0.194*** (0.01)	-0.175*** (0.02)	0.300*** (0.02)	0.300*** (0.02)
Dec-20	0.001 (0.01)		0.008 (0.01)		0.009 (0.01)	
Number of observations	15,910	9,037	15,910	9,037	15,910	9,037
R-2	0.02	0.04	0.07	0.07	0.06	0.08
Joint significance (p-values)						
Age categories	0.001	0.163	0.000	0.007	0.099	0.031
Urbanisation categories	0.000	0.000	0.123	0.034	0.081	0.052
Income categories	0.347	0.675	0.000	0.000	0.000	0.000
Country dummies	0.000	0.000	0.000	0.000	0.000	0.000

Standard errors clustered at the individual level, significance levels: \*\*\* p<.01, \*\* p<.05, \* p<.1. Constant estimated but not included. The baseline group for the country dummies is Germany.



Table 4b: Supply constraint effect heterogeneity with urbanisation

Dep. var.:	Mixed payment methods (binary)			Cash (only) (binary)			Non-cash (only) (binary)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Urbanisation:	<i>Low</i>	<i>Medium</i>	<i>High</i>	<i>Low</i>	<i>Medium</i>	<i>High</i>	<i>Low</i>	<i>Medium</i>	<i>High</i>
Non-cash supply constraints	0.015 (0.02)	0.037** (0.01)	0.006 (0.02)	0.054*** (0.02)	0.047*** (0.01)	0.081*** (0.01)	0.069*** (0.02)	0.084*** (0.02)	0.084*** (0.02)
Number of observations	2,118	4,033	2,886	2,118	4,033	2,886	2,118	4,033	2,886
R-2	0.03	0.04	0.04	0.12	0.07	0.06	0.12	0.09	0.07

Standard errors clustered at the individual level, significance levels: \*\*\*  $p < .01$ , \*\*  $p < .05$ , \*  $p < .1$ .

Constant estimated but not reported. All baseline demographics and economic characteristics are included. Country dummies are included. The level of urbanisation is defined as low = a village or rural area, Middle = a city with 100,000 to 500,000 inhabitants or a small city with less than 100,000 inhabitants, a big city with more than 500,000 inhabitants or a suburb or outskirts of a big city.

Table 5: Drivers of using new financial technologies

Dep. var.	Smart payment (binary)	Banking apps (binary)	Smart payment (binary)	Smart payment adoption (binary)
	(1)	(2)	(3)	(4)
Banking app usage			0.194*** (0.00)	
Banking app usage (May-20)				0.065*** (0.01)
Risk averse	0.000 (0.01)	-0.022** (0.01)	0.005 (0.01)	-0.010 (0.01)
Risk loving	0.018* (0.01)	0.021* (0.01)	0.014 (0.01)	0.005 (0.01)
Trust in people	0.007*** (0.00)	0.017*** (0.00)	0.004*** (0.00)	0.002 (0.00)
Financial literacy	-0.006* (0.00)	0.014*** (0.00)	-0.004 (0.00)	0.013*** (0.00)
COVID-19 health concerns	0.002 (0.00)	0.005*** (0.00)	0.001 (0.00)	-0.002 (0.00)
Low urbanisation	0.025*** (0.01)	0.064*** (0.01)	-0.014* (0.01)	-0.014 (0.01)
High urbanisation	0.015* (0.01)	0.017* (0.01)	0.012 (0.01)	0.010 (0.01)
Women	0.058*** (0.01)	0.057*** (0.01)	0.047*** (0.01)	0.025*** (0.01)
Age: 35-49	0.041*** (0.01)	0.079*** (0.01)	0.026*** (0.01)	-0.026** (0.01)
Age: 50-64	0.094*** (0.01)	0.183*** (0.01)	0.058*** (0.01)	0.048*** (0.01)
Age: 65+	0.127*** (0.01)	0.247*** (0.02)	0.078*** (0.01)	0.068*** (0.02)
Education: Bachelor+	0.003 (0.01)	-0.008 (0.01)	0.006 (0.01)	0.008 (0.01)
Household size	-0.003 (0.00)	-0.002 (0.00)	-0.003 (0.00)	-0.003 (0.00)
Partner in household	-0.001 (0.01)	0.011 (0.01)	-0.003 (0.01)	-0.007 (0.01)
Child in household	0.015 (0.01)	0.038*** (0.01)	0.008 (0.01)	0.017 (0.01)
Homeowner	0.001 (0.01)	-0.015 (0.01)	0.004 (0.01)	-0.008 (0.01)
Hand-to-mouth	-0.013* (0.01)	-0.023** (0.01)	-0.009 (0.01)	0.001 (0.01)
Employed	0.028*** (0.01)	0.057*** (0.01)	0.018*** (0.01)	0.024*** (0.01)
Income: 2 <sup>nd</sup> quartile	0.021** (0.01)	0.013 (0.01)	0.018** (0.01)	0.004 (0.01)
Income: 3 <sup>rd</sup> quartile	0.034*** (0.01)	0.048*** (0.01)	0.026*** (0.01)	0.024** (0.01)
Income: 4 <sup>th</sup> quartile	0.069*** (0.01)	0.077*** (0.01)	0.054*** (0.01)	0.044*** (0.01)

	-		-	-
Belgium	0.032*** (0.01)	0.100*** (0.02)	0.053*** (0.01)	0.062*** (0.02)
Spain	0.000 (0.01)	0.120*** (0.01)	-0.023** (0.01)	0.054*** (0.01)
France	0.051*** (0.01)	-0.004 (0.01)	0.051*** (0.01)	0.061*** (0.01)
Italy	0.031*** (0.01)	0.135*** (0.01)	0.060*** (0.01)	0.090*** (0.01)
Netherlands	-0.015 (0.01)	0.149*** (0.02)	0.046*** (0.01)	0.055*** (0.02)
Number of observations	15,910	16,197	15,775	5,287
R-2	0.04	0.08	0.11	0.05
Joint significance (p-values)				
<i>Age categories</i>	0.000	0.000	0.000	0.000
<i>Urbanisation categories</i>	0.000	0.000	0.000	0.059
<i>Income categories</i>	0.000	0.000	0.008	0.003
<i>Country dummies</i>	0.000	0.000	0.000	0.000

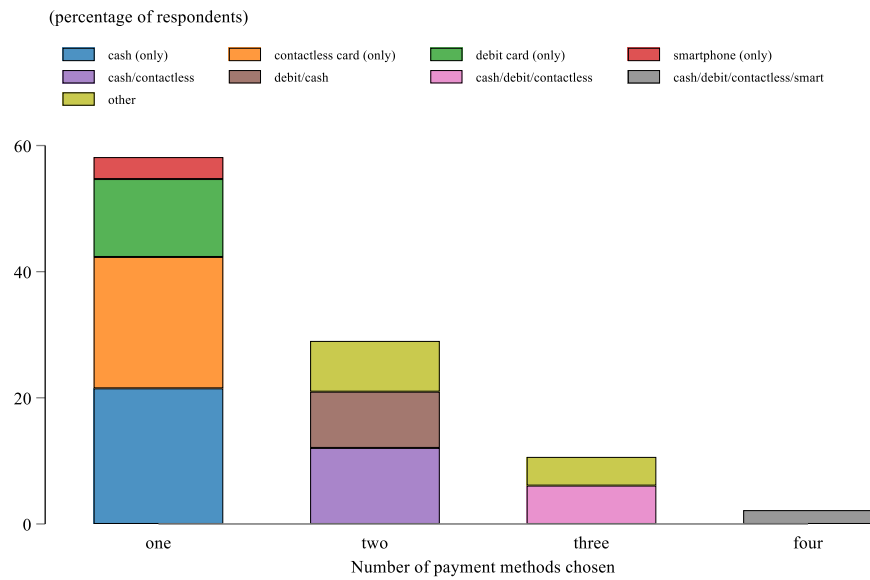
Standard errors clustered at the individual level, significance levels: \*\*\* p<.01, \*\* p<.05, \* p<.1. Constant estimated but not reported. The baseline group for the country dummies is Germany. Columns (1), (2) and (3) include a December 20 dummy. Column (4) compares adopters of smart payments to non-adopters (i.e., permanent users are not included in column (4)).

Table 6: Smart payment usage and within household age differences

Dep. var.:	Smart payment (0/1)			
Household size:	Singles	Couples	Three persons	Four persons (or more)
Individual age	-0.003*** (0.00)	-0.004*** (0.00)	-0.004*** (0.00)	-0.006*** (0.00)
Individual age – household average age		0.003*** (0.00)	0.001** (0.00)	0.002** (0.00)
Number of observations	3,201	4,916	4,112	5,216
R-2	0.05	0.05	0.04	0.04

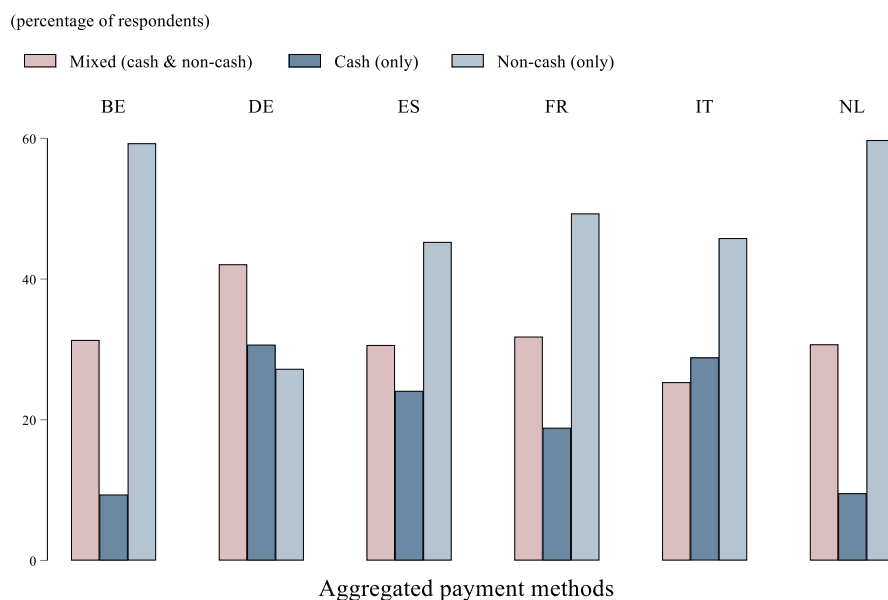
Standard errors clustered at the individual level, significance levels: \*\*\* p<.01, \*\* p<.05, \* p<.1. Constant estimated but not reported. The regressions also include age, gender, education, homeownership, hand-to-mouth type, employment situation, income quartiles and country dummies. Columns (3) and (4) also include separate binary variables for children or a partner being present in the household.

Figure 1: Diversification in payment options



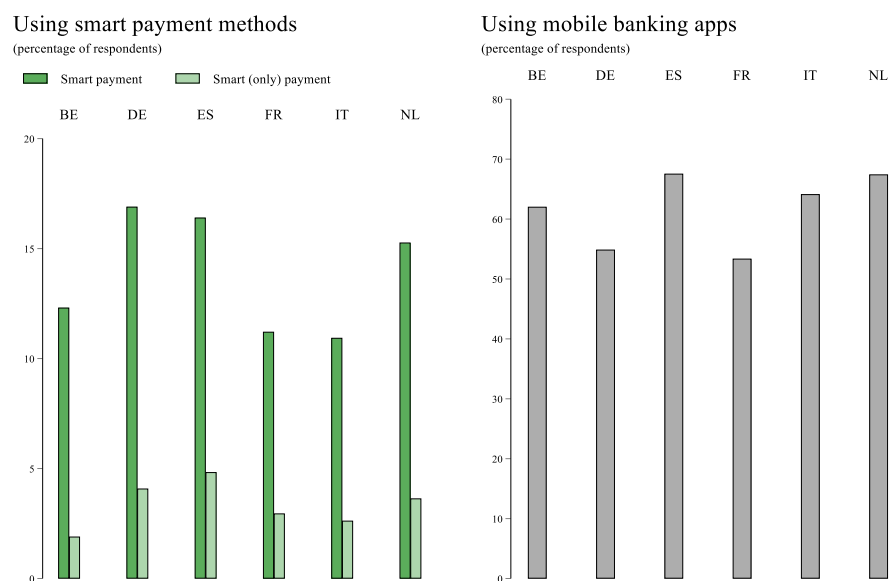
Source: ECB – Consumer Expectations Survey, pooled and weighted May 2020 and December 2020 data.

Figure 2: Population payment choices by country



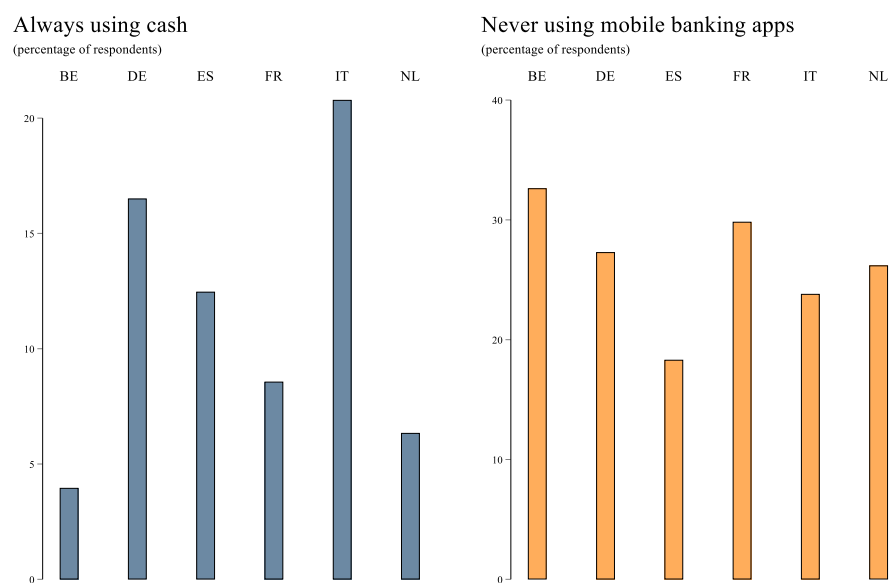
Source: ECB – Consumer Expectations Survey, pooled and weighted May 2020 and December 2020 data.

Figure 3: Usage of new financial technologies by country



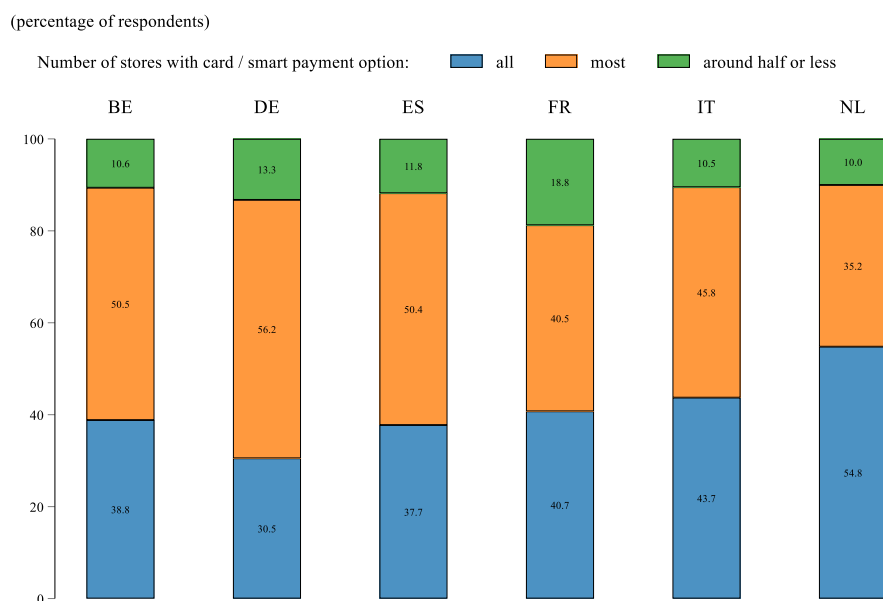
Source: ECB – Consumer Expectations Survey, pooled and weighted May 2020 and December 2020 data.

Figure 4: Share always choosing cash (only) or never using mobile banking in 2020 by country



Source: ECB – Consumer Expectations Survey, pooled and weighted May 2020 and December 2020 data.

Figure 5: Perceived availability of in-store non-cash payment options



Source: ECB – Consumer Expectations Survey, weighted December 2020 data.

Figure 6: Diversification of payment choices

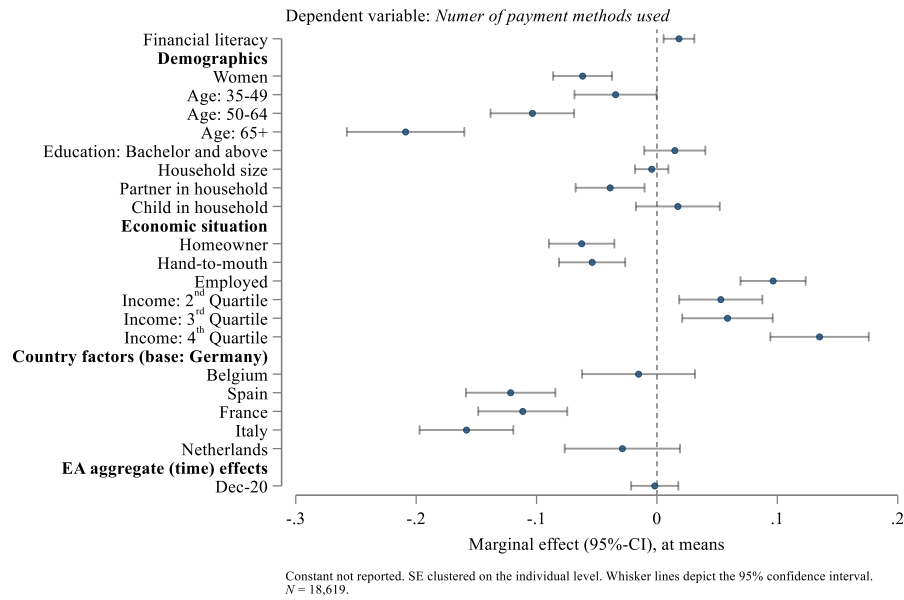
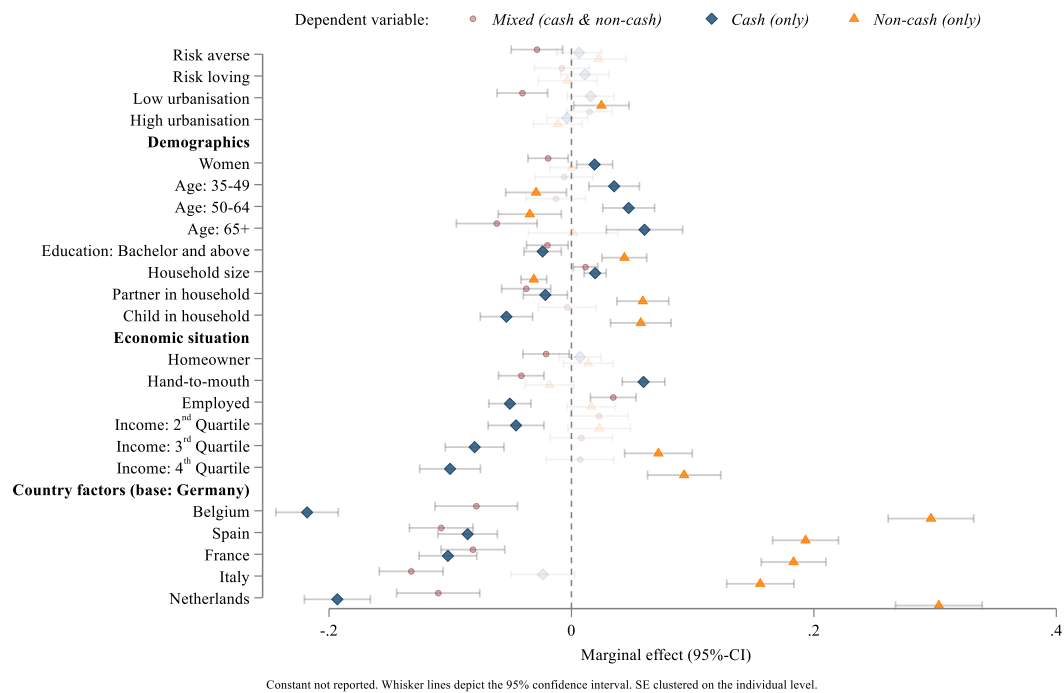


Figure 7: Drivers of different payment method usage



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## Appendix 1 – Tables and Figures

Variable	Description	Mean	SD	Min	Max	N	
<b>Main dependent variables</b>							
Number of different payment options	Count (1 to 4; the number of payment methods chosen)	1.54	0.75	1.00	4.00	18,864	
Mixed payment methods	Binary (1=cash and non-cash payment; 0=else)	0.33	0.47	0.00	1.00	18,864	
Cash (only)	Binary (1=cash payment only; 0=else)	0.24	0.43	0.00	1.00	18,864	
Non-cash (only)	Binary (1=non-cash payment only; 0=else)	0.42	0.49	0.00	1.00	18,864	
Banking app user	Binary (1=using mobile banking (apps); 0=else)	0.60	0.49	0.00	1.00	19,192	
Never adopting non-cash	Binary (1=not using non-cash in May-20 and Dec-20; 0=else)	0.14	0.35	0.00	1.00	6,774	
Never adopting mobile banking apps	Binary (1=not using mobile banking in May-20 and Dec-20; 0=else)	0.26	0.44	0.00	1.00	6,994	
<b>Individual characteristics</b>							
Age (in year bands)							
	between 18 and 34	Binary (1=age between 25 and 34; 0=else) – <i>reference group</i>	0.24	0.43	0.00	1.00	18,864
	between 35 and 44	Binary (1=age between 35 and 44; 0=else)	0.17	0.37	0.00	1.00	18,864
	between 45 and 54	Binary (1=age between 45 and 54; 0=else)	0.18	0.39	0.00	1.00	18,864
	between 55 and 64	Binary (1=age between 55 and 64; 0=else)	0.18	0.39	0.00	1.00	18,864
	65 and older	Binary (1=age 65 and older; 0=else)	0.22	0.42	0.00	1.00	18,864
<b>Gender</b>							
	women	Binary (1=women; 0=men)	0.51	0.50	0.00	1.00	18,864
<b>Education</b>							
	university education	Binary (1=university education, bachelor or above; 0=else)	0.53	0.50	0.00	1.00	18,864
<b>Income and wealth</b>							
	Employed	Binary (1=employed, 0=else)	0.54	0.50	0.00	1.00	18,864
	Household (net) income	Quartiles (1 to 4; based on yearly net household income)	-	-	-	-	18,864
	Homeowner	Binary (1=owner of place of residence; 0=else)	0.63	0.48	0.00	1.00	18,864
<b>Household size</b>							
	Partner	Binary (1=partner living in household; 0=else)	0.63	0.48	0.00	1.00	18,864
	Number of household members	Count (1 to 5; the number of individuals in the household; censored at 5)	2.54	1.18	1.00	5.00	18,864
	Child in household	Binary (1=child in household; 0=else)	0.28	0.45	0.00	1.00	18,787
<b>Country of residence</b>							
	BE	Binary (1=Belgium, 0=else)	0.04	0.19	0.00	1.00	18,864

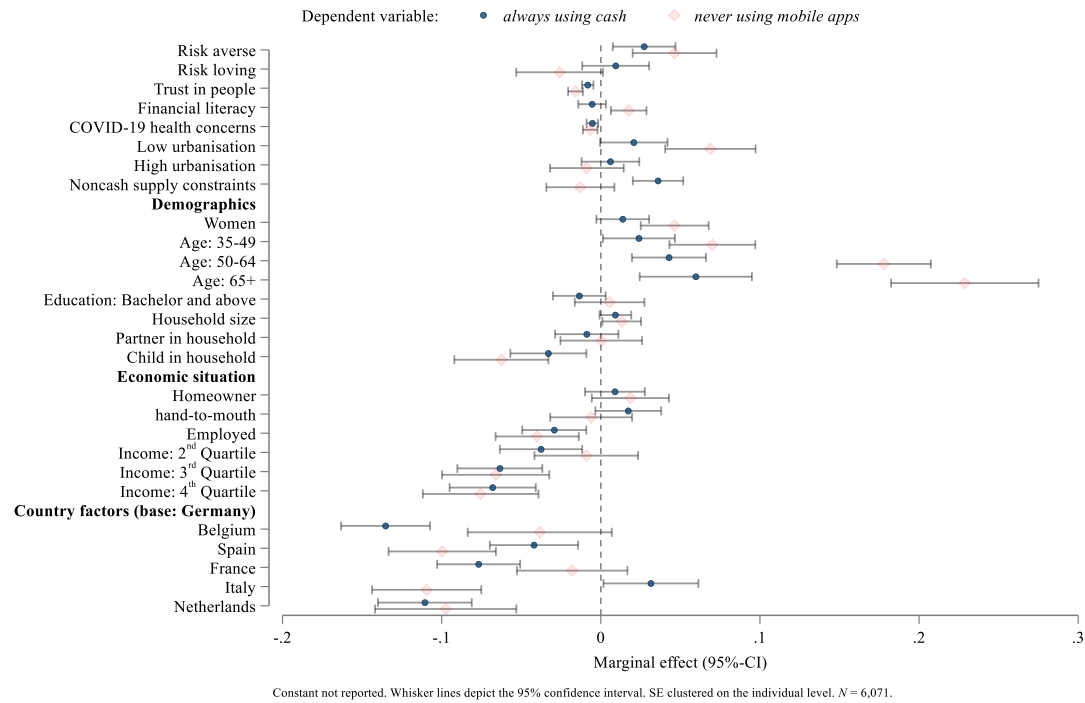
<b>Degree of urbanisation</b>	DE	Binary (1=Germany, 0=else) – <i>reference group</i>	0.29	0.46	0.00	1.00	18,864
	ES	Binary (1=Spain, 0=else)	0.17	0.37	0.00	1.00	18,864
	FR	Binary (1=France, 0=else)	0.22	0.41	0.00	1.00	18,864
	IT	Binary (1=Italy, 0=else)	0.22	0.41	0.00	1.00	18,864
	NL	Binary (1=Netherlands, 0=else)	0.06	0.24	0.00	1.00	18,864
	High	Binary (1=large city or suburb; 0=else)	0.31	0.46	0.00	1.00	16,598
<b>Additional variables</b>	Middle	Binary (1=city or small city; 0=else) – <i>reference group</i>	0.46	0.50	0.00	1.00	16,598
	Low	Binary (1=village or rural area; 0=else)	0.23	0.42	0.00	1.00	16,598
	Financial literacy	Count (1 to 4 score based on the number of correct responses)	2.50	1.02	1.00	4.00	18,619
	Hand-to-mouth consumer	Binary (1=liquidity constrained; 0=else)	0.28	0.45	0.00	1.00	18,864
	Trust in people	Count (0=no trust; 10=complete trust)	5.47	2.37	0.00	10.00	18,864
	Risk averse	Binary (1=risk averse; 0=else)	0.46	0.50	0.00	1.00	18,493
	Risk loving	Binary (1=risk loving; 0=else)	0.32	0.47	0.00	1.00	18,493
	COVID-19 health concerns	Count (0=not concerned;10=very concerned)	6.63	2.56	0.00	10.00	18,683
	Supply constraints in mobile payments	Binary (1=not all shops offer cashless payments,0=else)	0.61	0.49	0.00	1.00	10,066
	Age difference in household (Age-Mean hh age)	Continuous (winsorised at the most extreme 2 percentiles)	6.41	15.85	-36.00	36.00	15,547

Table A2: Transitions in payment preferences during the pandemic

		May-20							
		Cash		Non-cash		Smart		Banking app	
		<i>nonuser</i>	<i>user</i>	<i>nonuser</i>	<i>user</i>	<i>nonuser</i>	<i>user</i>	<i>nonuser</i>	<i>user</i>
<b>Dec-20</b>	<i>nonuser</i>	27.47	13.96	14.12	9.99	78.53	8.05	25.69	15.13
	<i>user</i>	15.00	43.57	11.07	64.81	7.45	5.97	14.27	44.91

Note: The table shows population-weighted transitions based on the balanced sample.

Figure A1: Drivers always choosing cash payment methods



## Appendix 2 – Selected Survey Questions

### Financial literacy

Respondents are asked the following financial literacy questions (“big 3”) and one more advanced question (correct answers are highlighted in bold):

- 1) Suppose you had €100 in a savings account and the interest rate was 2% per year. After five years, how much do you think you would have in the account if you left the money to grow? (**more than 102€**; exactly 102€; less than 102€; Do Not Know).
- 2) Imagine that the interest rate on your savings account was 1 % per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account? (more than today; exactly the same; **less than today**; Do Not Know).
- 3) Do you think the following statement is true or false? Buying shares in a single company usually provides a safer return than buying shares in a mutual fund. (True; **False**; Do Not Know).
- 4) Suppose you owe €1,000 on a loan and the interest rate you are charged is 20% per year, compounded annually. If you didn't pay anything off, at this interest rate, how many years would it take for the amount you owe to double? (years: <2; [**2,5**], [5,10), >=10; Do Not Know).

### Hand-to-mouth (liquidity constraints)

Respondents who answer “no” to the below question are classified as hand-to-mouth consumers:

Please think about your available financial resources, including access to credit, savings, loans from relatives or friends, etc. Suppose that you had to make an unexpected payment equal to one month of your household income. Would you have sufficient financial resources to pay for the entire amount?

### Trust in people in general

Respondents are asked about their trust in people in general:

Generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people? Please indicate your level of trust on a scale from 0 to 10, where 0 means that “you can't be too careful” and 10 means that “most people can be trusted”.

### Risk attitude

Respondents are asked a sequence of the following questions in which they are presented with choices at 10€ increments:

Imagine you are playing a game of chance by flipping a coin. If the coin comes up heads, you win €60, but if it comes up tails you win nothing. Would you rather play this game or alternatively receive the amount shown below for sure? (I would prefer to play the game; I would rather receive this amount for sure)

We classify respondents who choose 10€ or 20€ as relatively risk-averse, those choosing 30€ (the expected value) as risk-neutral and those choosing 40€, 50€ or would always play the game as rather risk-loving.

COVID-19 health concerns

Respondents are asked the following question capturing their level of health concerns:

How concerned are you about the impact of the coronavirus (COVID-19) on your own health or the health of the members of your household (scale from 0 – “Not concerned at all” to 10 – “Extremely concerned”; Do Not Know).



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