▎Mobile payment usage in Germany

Mobile payments have gained a foothold in Germany in recent years. The Bundesbank's representative studies on payment behaviour in Germany, which are carried out at regular intervals, show that this is true of both smartphone payments at the point of sale (POS) and mobile payments between individuals (peer-to-peer, or P2P). In the Bank's most recent study, 5,870 people were asked by telephone about their use of payment instruments and their attitudes towards these. 4,197 of the respondents subsequently filled out a three-day payments diary.

The survey responses reveal that around 3% of transactions at the POS and 3% of P2P payments were made by smartphone in 2021. This means that mobile payments are still lagging far behind cash and debit and credit cards. However, multiple factors in the study suggest that mobile payments could gain traction in the future. These include, amongst other things, socio-demographic characteristics such as age, as well as respondents' attitudes towards paying with cash and their online purchasing behaviour, for example. In addition, provider-side market developments such as the availability of near-field communication (NFC) technology for retailers and customers, coupled with regulatory changes, are also likely to boost the uptake of mobile payments.

This article complements the analysis of data from the payment behaviour study with an assessment of the regional prevalence of mobile payments at the POS across German federal states. This aspect merits further investigation as these payments become more widespread. A comparison with other euro area countries shows that Germany has been slower so far in adopting mobile payment methods than most of these countries.

Efforts to establish instant payments as an integral component of European payments in future open up additional potential for the expansion of mobile payment methods. This is because instant payments, combined with state-of-the-art wallet solutions, could provide the basis for attractive service enhancements in mobile payments at the POS, in e-commerce and in P2P transactions. The Bundesbank therefore welcomes pan-European private market initiatives such as the European Payments Initiative (EPI). In addition, the insights into user behaviour and preferences can also yield important findings that will enrich discussions surrounding the design of a potential digital euro.

Introduction: Increasing use of mobile payment methods in Germany

The rapid proliferation of smartphones and wearables[1] worldwide and the increasing digitalisation of society and the economy mean that the global market for mobile payments has seen very dynamic growth in recent years.[2] Asia, especially, has witnessed the emergence of "super apps" – solutions that aim to combine not just payments but also a wide range of everyday services on a single platform. But Germany, too, is experiencing marked growth in mobile payments, albeit from a low starting level.

Mobile payments are payments initiated by smartphone or wearable. In principle, they can be used in different payment situations, such as at the POS or in peer-to-peer (P2P) payments.[3]

The Bundesbank publication "Payment behaviour in Germany in 2021" provides an overview of the use of mobile payment methods in Germany, amongst other things.[4] This study saw the market research institute forsa conduct telephone interviews with 5,870 people on behalf of the Bundesbank about their payment behaviour and attitudes towards various means of payment between 8 September and 5 December 2021. 4,197 of the respondents subsequently filled out a three-day payments diary. The sample is representative of the German-speaking population aged 18 and over in the Federal Republic of Germany in terms of the respondents' age, gender, level of education and place of residence. The mobile payment methods covered by this study included Apple Pay and Google Pay, banks' own payment apps, Payback Pay and chain store payment apps. PayPal and the giropay/Kwitt[5] payment app offered by the German banking industry were also included, but only for P2P payments.

Many of these mobile payment methods can be used for e-commerce, which sometimes makes it difficult to clearly distinguish them from the general use of e-payment methods.[6] This has led many studies, and this article, too, to define mobile payments as payments made at physical locations (i.e. at the POS) and as P2P payments.[7]

An earlier article has already demonstrated that, in addition to the growing importance of e-commerce and thus the proliferation of specialised e-payment methods, broader smartphone use has also spurred the development of new solutions for paying at the POS.[8] In 2021, according to the Bundesbank's most recent payment behaviour study, 38% of respondents making mobile payments at the POS utilised Apple Pay, followed by banks' and savings banks' payment apps (25%) and Google Pay (18%).[9] Mobile payment methods can often also be used for P2P payments. Study participants mostly turned to PayPal or giropay/Kwitt for this purpose.[10]

Mobile payments slowly gaining traction in Germany

The increasing uptake of mobile payments at the POS is reflected in the Bundesbank's previous surveys on payment behaviour: in 2017, only 2% of respondents stated that they had already paid by smartphone at least once in a

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1 These include, for example, fitness wristbands and smart watches. Some of these devices support NFC-enabled payments.
2 The Bundesbank illuminated trends and developments in payments most recently in its September 2012, December 2013 and June 2019 Monthly Reports. See Deutsche Bundesbank (2012, 2013, 2019).
3 E-commerce payments do not count as mobile payments, even where the online purchase is made via smartphone. P2P payments are money sent via an app to family, friends or acquaintances.
4 See Deutsche Bundesbank (2022a).
5 The P2P payment solution Kwitt is being incorporated into the giropay payment service offered by German banks and savings banks.
6 Examples include PayPal, Klarna/Sofort (Pay now) and the German banking industry's giropay/paydirekt service.
7 Unless stated otherwise, the figures and statistics provided in this article are taken from the latest Bundesbank study on payment behaviour. The shares of turnover and transactions accounted for by individual means of payment as well as the importance of payment locations were calculated on the basis of the entries in the payments diaries. The other data are based on respondents' assessments as derived from the questionnaires. See Deutsche Bundesbank (2022a).
8 See Deutsche Bundesbank (2019).
9 See Deutsche Bundesbank (2022a).
10 See Deutsche Bundesbank (2022a).

store; by 2020, this figure had risen to 11% within the space of three years. In 2021, 15% of all respondents were already reporting that they had utilised this payment method at least once.[11] Growth was evident, too, in the shares of mobile payment methods used for the transactions and turnover at the POS recorded in the payments diaries (see the adjacent chart): while they were still too small to be visible in 2017, 2% of all transactions and turnover at the POS were already being settled using mobile payment methods in 2020. In 2021, their market share grew to around 3%.[12]
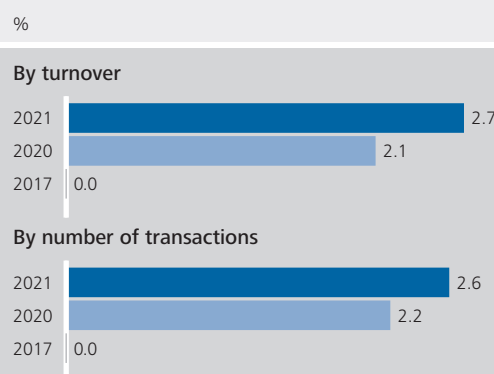
With regard to P2P payments by smartphone, 5% of all respondents stated in the Bundesbank's 2017 payment behaviour study that they had already sent or received money using an app at least once. In 2020 and 2021, that figure had already increased to 27% and 28%, respectively.[13] However, these high percentages are not yet reflected in the payments diaries, with a mere 3% of P2P transactions and turnover being settled using a mobile app in 2021.

Factors influencing the use of mobile payment methods

2021 payment behaviour study used as basis for present evaluation

This article now turns to the factors influencing the use of smartphone payments at the POS and the use of P2P payment methods, drawing on respondents' feedback to qualitative questions in the 2021 payment behaviour study described above.[14] The first step is to present the individual impact of socio-demographic characteristics as well as certain personal attitudes and respondent behaviours, before using a regression approach to test the results. The following section begins by studying the persons who indicate that they have already paid by smartphone at the POS.[15] Next, those who have made P2P payments are considered.

Share of mobile payments in Germany at the point of sale (POS)*

%

By turnover

2021	2.7
2020	2.1
2017	0.0

By number of transactions

2021	2.6
2020	2.2
2017	0.0

* Relative share of turnover and transactions accounted for by mobile payment methods at the POS (day-to-day retail purchases and retail purchases of durable goods, payments at petrol stations and pharmacies).

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Descriptive analysis of survey results

Possible explanatory factors behind using a smartphone for payment

The respondents were asked whether they had already made at least one mobile payment at the POS, to which they could answer either "yes" or "no". The next step was to investigate how far the following factors were useful in explaining the respondents' behaviour: gender, age, level of school education, employment and the financial situation of the respondent's household (the possible answers for the latter being "very good", "good", "not so good" and "bad"). This investigation was also based on how the respondents had answered the questions on behaviour and preferences, such as

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11 See Deutsche Bundesbank (2018, 2021, 2022a). In the 2020 and 2021 payment behaviour studies, the subsample is all smartphone owners (84% and 89% of respondents, respectively). Based on this subsample, 13% (2020) and 17% (2021) of smartphone owners state that they have already used mobile payments at the POS at least once.
12 This corresponds to 236 mobile payments at the POS, as recorded in the payments diary, with a total value of €7,638.
13 See Deutsche Bundesbank (2018, 2021, 2022a). Sample: all respondents.
14 On account of the methodology used, the data in the following analyses are not weighted to make them representative of the population. Individual percentages may therefore differ from the weighted values presented in the Bundesbank's payment behaviour studies.
15 A total of 932 respondents stated that they had paid by smartphone at the POS at least once before.

concerning (1) how frequently they make internet purchases, (2) their use of online banking, (3) their trust in certain companies to handle personal data responsibly, (4) concerns about how personal data could be used, and (5) their preference for cash versus non-cash means of payment.

Indicators for mobile payment methods at the POS

The table on p. 79 provides a comprehensive overview of the surveyed behaviours and preferences as well as the attributes used. Column "*N*" shows how many study participants answered the questions listed above (a total of 5,119 persons), while the "Total" column lists the shares of respondents who agree with the attributes of the variable in question or to whom they apply. For example, 5,113 people answered the question of which means of payment they prefer to use at the POS if the choice is theirs. Of these respondents, a total of 24% favour cash, while 47% prefer to pay by card or another non-cash means of payment.

The next columns, "Users" and "Non-users", show the differences in responses between individuals who use a mobile device for POS payments and those who do not. In this case, 9% of mobile payers ("users") prefer cash and 71% favour cards or other non-cash means of payment. By contrast, 28% of those who have never used mobile payment methods ("non-users") show a preference for cash, while 42% prefer to use cards or other non-cash means of payment. The deviation of the mean values in the responses of these two groups (the "Difference" column) and the *t*-values[16] in the last column shows the extent to which the variable in question has an impact on mobile payments at the POS, if at all. In this exercise, the aforementioned determinants are considered independently of each other.

Mobile payments more frequent among card users, internet buyers and online banking customers

On balance, people who (1) favour cards or non-cash means of payment, (2) make internet purchases once a week or more, and (3) bank online are particularly inclined to use their smartphones or wearables to pay at the POS. Other important factors for mobile payments

at the POS are whether respondents (4) work full-time, (5) have a higher-grade school leaving certificate, and (6) are 35 to under 45 years of age. Moreover, (7) the option to use cash is not important at all or not so important to them. By contrast, non-users of such means of payment comprise somewhat more women and persons aged 65 and older, as well as those respondents who rarely shop online, prefer to use cash at the POS and consider cash usage to be very important.

Another factor associated with mobile payments is whether respondents trust technology companies to handle personal data responsibly. The proliferation of Apple and Google's mobile payment methods is presumably important in this regard. Overall, female respondents tend to trust technology companies less (difference of 6 percentage points between the genders). In addition, respondents who have already bought or paid with crypto-tokens have more of a tendency to make mobile payments than those who are planning to neither purchase nor use them. Here, this factor is interpreted as an indicator of participants' willingness to adopt new technology. That said, only 5% of respondents actually reported owning crypto-tokens or using them as a means of payment. Due to the small size of the reporting sample, though, the statistical estimation is less robust, meaning that the actual influence of this factor merits further investigation. The same holds for the concern that money could be stolen from an account as a result of data misuse.

Trust in technology companies and willingness to adopt new technology could also influence use of mobile payments

For all the other factors considered in the table on p. 79, there is little difference between the mean values of the two groups, with the result that they cannot independently explain the use of mobile payment methods at the POS, even if the *t*-test values are significant in some cases. The statistical analysis presented further below aims to shed more light on this matter.

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16 The more the *t*-value differs from zero, the more likely it is that the examined variable in isolation has an impact on the use or non-use of mobile payments.

Mobile payments at the point of sale (POS)

Variable[1]	N[2]	Mean			Difference[6]	t-value[7]
		Total[3]	Users[4]	Non-users[5]		
Mobile payments at the POS	5,119	0.182	.	.	.	.
Online purchases	5,020	.	.	.	.	.
Weekly[8]	.	0.207	0.399	0.164	0.236	13.79***
Monthly[8]	.	0.496	0.503	0.494	0.009	0.48
Yearly[8]	.	0.166	0.074	0.187	− 0.113	10.71***
Less frequently	.	0.045	0.012	0.053	− 0.041	8.18***
Never	.	0.086	0.012	0.102	− 0.091	15.29***
Online banking	5,000	0.789	0.957	0.751	0.206	21.60***
Crypto-tokens	5,016	.	.	.	.	.
Purchased/paid with	.	0.050	0.134	0.031	0.103	8.83***
Purchase/use planned	.	0.040	0.070	0.034	0.036	4.06***
Purchase/use not planned	.	0.871	0.779	0.892	− 0.112	7.66***
Never heard of them	.	0.039	0.017	0.044	− 0.027	5.10***
Responsible handling of payment data						
Technology companies	2,465	0.172	0.274	0.150	0.124	5.45***
Start-ups/fintech firms	2,151	0.158	0.234	0.141	0.093	4.10***
Own bank/savings bank	2,532	0.934	0.938	0.933	0.004	0.35
Other bank/savings bank	2,385	0.832	0.890	0.819	0.071	4.09***
Data concerns						
Used for criminal acts	2,539	0.582	0.559	0.587	− 0.028	1.10
Who will use data for what purpose	2,549	0.713	0.667	0.723	− 0.056	2.31**
Who will save data	2,545	0.685	0.643	0.694	− 0.051	2.08**
Money stolen from account	2,554	0.477	0.384	0.497	− 0.113	4.47***
Blackmail	2,553	0.272	0.276	0.271	0.005	0.019
Put at a disadvantage	2,544	0.364	0.355	0.366	− 0.011	0.44
State authorities	2,546	0.300	0.253	0.311	− 0.058	2.54**
Preference	5,113	.	.	.	.	.
Cash	.	0.242	0.091	0.275	− 0.184	15.71***
Card/non-cash	.	0.470	0.708	0.417	0.291	17.34***
Unclear	.	0.288	0.201	0.308	− 0.107	7.12***
Option to use cash	5,117	.	.	.	.	.
Very important	.	0.350	0.200	0.383	− 0.184	12.16***
Fairly important	.	0.311	0.232	0.329	− 0.097	6.21***
Not so important	.	0.262	0.367	0.239	0.129	7.55***
Not important at all	.	0.077	0.201	0.049	0.151	11.18***
Female	5,119	0.497	0.332	0.533	− 0.202	11.70***
Age groups	5,119	.	.	.	.	.
18 to under 25 years	.	0.096	0.161	0.081	0.080	6.25***
25 to under 35 years	.	0.098	0.155	0.085	0.069	5.51***
35 to under 45 years	.	0.172	0.279	0.148	0.131	8.34***
45 to under 55 years	.	0.132	0.117	0.136	− 0.019	1.59
55 to under 65 years	.	0.219	0.159	0.232	− 0.073	5.38***
65 years and older	.	0.284	0.130	0.318	− 0.188	14.29***
Level of school education	5,116	.	.	.	.	.
Student/no school leaving certificate	.	0.010	0.011	0.010	0.001	0.25
Primary/lower secondary education	.	0.151	0.071	0.169	− 0.098	9.58***
Higher secondary education	.	0.320	0.241	0.338	− 0.098	6.17***
University of applied sciences entrance diploma	.	0.097	0.124	0.091	0.033	2.83***
Upper secondary school leaving certificate	.	0.422	0.554	0.393	0.161	8.99***
Employment	5,113	.	.	.	.	.
Full-time	.	0.364	0.512	0.331	0.181	10.12***
Part-time	.	0.135	0.113	0.140	− 0.027	2.34**
Other	.	0.066	0.063	0.067	− 0.003	0.35
Student	.	0.051	0.080	0.044	0.035	3.74***
Unemployed	.	0.015	0.010	0.016	− 0.006	1.57
Retired/unable to work	.	0.298	0.141	0.333	− 0.192	14.18***
Self-employed	.	0.072	0.082	0.070	0.012	1.18
Financial situation	5,116	.	.	.	.	.
Very good	.	0.215	0.285	0.199	0.086	5.37***
Good	.	0.676	0.630	0.686	− 0.057	3.26***
Not so good	.	0.850	0.066	0.089	− 0.024	2.59***
Bad	.	0.024	0.019	0.025	− 0.006	1.08

1 All the variables shown are dummy variables, i.e. if the respective characteristic applies, they take on the value of 1; otherwise they take on the value of 0. **2** Number of persons who answered the question. **3** Mean value for all N to whom the respective characteristic applies, i.e. the variable takes on the value of 1. **4** All N who indicated in the questionnaire that they use their smartphone to make mobile payments at the POS. **5** N who do not use their smartphone to make mobile payments at the POS. **6** Difference in the mean values of the user and non-user groups. **7** The t-value refers to a test of whether the calculated difference is significantly different from 0. The calculation of the t-test statistic values takes into account unequal variances between users and non-users. ***/** indicates significance at the 1% and 5% levels. **8** Online purchases at least once per week/per month/per year.

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Indicators for use of mobile payment methods in P2P transactions

The same analytical approach and factors as above can be applied to explain the use of mobile devices for P2P payments. The distinction between "users" and "non-users" in this case is based on whether respondents have already utilised an app to send money to family, friends or acquaintances at least once, which, as above, is asked as a "yes"/"no" question. Overall, the results presented in the table on p. 81 are broadly in line with the remarks on mobile payments at the POS.

Reports from other countries such as Sweden[17] and China show that people who have had positive experiences with mobile P2P methods are more likely to be willing to employ mobile payments at the POS as well. If a similar mechanism plays out in Germany, too, this could lead to mobile payments at the POS gaining in importance in future. After all, 34% of respondents who own a smartphone and are familiar with PayPal or giropay/Kwitt reported that they have already used these at least once to send money to friends or family. Yet the uptake of mobile payments at the POS has been lower to date, with only 18% of respondents owning a smartphone and being familiar with at least one mobile payment method reporting that they have already used these to pay at the POS.

Regression analysis of factors for mobile payments at the POS and in P2P transactions

To gain a clearer picture of how the determinants investigated so far affect smartphone payments at the POS on the one hand and P2P payments on the other, a logistic regression model was estimated in each case.[18] For ease of interpretation, the average marginal effects relative to the relevant reference group are studied in the following. These are presented separately for POS and P2P in the chart on p. 82 for four main factors with the following reference groups: (1) frequency of internet purchases: at least once per week, (2) use of

crypto-tokens: already purchased or paid with crypto-tokens, (3) importance of option to use cash: not so important, and (4) age group: 45 to under 55 years.[19]

As already suggested by the descriptive statistics on smartphone payments at the POS and on the use of P2P payments, the probability of use decreases in both cases as online activity declines. Compared with respondents who make internet purchases at least once a week (reference group), the probability of making mobile payments at the POS and of using P2P payment methods is consistently significantly lower for individuals who shop online less frequently. For those who make online purchases at least once a month, the probability is 10 percentage points lower than that of the reference group in both cases, for example. By contrast, banking online is associated with a 10 and 11 percentage point higher probability of making mobile POS and P2P payments, respectively.[20]

There therefore appears to be a positive mediating effect between familiarity with the online world and mobile payment applications. Such mediating effects have also been documented for other countries, such as the United States,[21] China[22] and India.[23] Furthermore, the data can be interpreted as indicating that willingness to adopt new technology has a positive impact on the use of mobile devices in payments. That hypothesis is also supported by the observed rela-

Internet purchases and use of online banking increase probability of use of mobile payment applications

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17 See Sveriges Riksbank (2022).
18 For an overview of the logistic regression analysis, see Amemiya (1981) and McFadden (1984).
19 The evaluation included effects that are statistically significant at the 1% and 5% levels. The marginal effect indicates the magnitude of the difference in the probability of use of the dependent variable (in this case, mobile payment at the POS or P2P) of a person with the observed characteristic (e.g. 18 to under 25 years of age) compared with the reference group (e.g. 45 to under 55 years of age). The mean of the differences in the probability of use across all observations in the dataset then gives the average marginal effect.
20 As this is a dummy variable (reference group: non-use of online banking), it was omitted from the chart.
21 See Garrett et al. (2014).
22 See Su et al. (2018).
23 See Singh and Srivastava (2020).

Smartphone payments between individuals (P2P)

Variable[1]	N[2]	Mean			Difference[6]	t-value[7]
		Total[3]	Users[4]	Non-users[5]		
P2P use	4,958	0.323	.	.	.	.
Online purchases	4,880	.	.	.	.	.
Weekly[8]	.	0.212	0.363	0.139	0.224	16.64***
Monthly[8]	.	0.502	0.549	0.479	0.070	4.59***
Yearly[8]	.	0.166	0.076	0.210	− 0.134	13.75***
Less frequently	.	0.043	0.006	0.061	− 0.055	11.88***
Never	.	0.076	0.006	0.111	− 0.105	18.14***
Online banking	4,859	0.799	0.942	0.729	0.213	21.89***
Crypto-tokens	4,859	.	.	.	.	.
Purchased/paid with	.	0.051	0.116	0.021	0.095	11.15***
Purchase/use planned	.	0.041	0.072	0.027	0.045	6.28***
Purchase/use not planned	.	0.872	0.796	0.907	− 0.111	9.75***
Never heard of them	.	0.036	0.017	0.045	− 0.028	5.80***
Responsible handling of payment data						
Technology companies	2,380	0.172	0.223	0.148	0.075	4.30***
Start-ups/fintech firms	2,087	0.160	0.230	0.126	0.104	5.65***
Own bank/savings bank	2,441	0.934	0.944	0.929	0.015	1.42
Other bank/savings bank	2,311	0.834	0.896	0.804	0.092	6.12***
Data concerns						
Used for criminal acts	2,449	0.584	0.548	0.601	− 0.052	2.44**
Who will use data for what purpose	2,457	0.716	0.713	0.718	− 0.005	0.25
Who will save data	2,454	0.687	0.681	0.690	− 0.009	0.43
Money stolen from account	2,463	0.480	0.414	0.512	− 0.098	4.58***
Blackmail	2,462	0.271	0.262	0.275	− 0.013	0.66
Put at a disadvantage	2,453	0.362	0.359	0.364	− 0.005	0.26
State authorities	2,456	0.298	0.278	0.307	− 0.029	1.47
Preference	4,952	.	.	.	.	.
Cash	.	0.238	0.138	0.286	− 0.148	12.74***
Card/non-cash	.	0.474	0.617	0.406	0.210	14.19***
Unclear	.	0.288	0.246	0.308	− 0.062	4.65***
Option to use cash	4,955	.	.	.	.	.
Very important	.	0.348	0.245	0.397	− 0.151	11.07***
Fairly important	.	0.309	0.257	0.333	− 0.077	5.63***
Not so important	.	0.265	0.359	0.220	0.138	9.91***
Not important at all	.	0.079	0.140	0.050	0.090	9.50***
Female	4,958	0.495	0.430	0.526	− 0.096	6.39***
Age groups	4,958	.	.	.	.	.
18 to under 25 years	.	0.099	0.198	0.052	0.146	13.67***
25 to under 35 years	.	0.101	0.200	0.054	0.146	13.60***
35 to under 45 years	.	0.176	0.294	0.120	0.174	13.70***
45 to under 55 years	.	0.135	0.129	0.137	− 0.008	0.82
55 to under 65 years	.	0.222	0.126	0.268	− 0.141	12.52***
65 years and older	.	0.268	0.054	0.370	− 0.316	31.40***
Level of school education	4,955	.	.	.	.	.
Student/no school leaving certificate	.	0.010	0.011	0.009	0.002	0.75
Primary/lower secondary education	.	0.147	0.056	0.190	− 0.134	15.06***
Higher secondary education	.	0.320	0.215	0.369	− 0.155	11.70***
University of applied sciences entrance diploma	.	0.097	0.121	0.086	0.035	3.69***
Upper secondary school leaving certificate	.	0.427	0.597	0.346	0.251	17.03***
Employment	4,953	.	.	.	.	.
Full-time	.	0.372	0.517	0.303	0.214	14.47***
Part-time	.	0.138	0.153	0.131	0.022	2.03**
Other	.	0.067	0.080	0.061	0.019	2.34**
Student	.	0.052	0.103	0.027	0.076	9.33***
Unemployed	.	0.015	0.013	0.015	− 0.002	0.58
Retired/unable to work	.	0.283	0.061	0.389	− 0.328	31.71***
Self-employed	.	0.073	0.073	0.073	− 0.001	0.06
Financial situation	4,955	.	.	.	.	.
Very good	.	0.217	0.255	0.199	0.056	4.34***
Good	.	0.676	0.657	0.685	− 0.028	1.96**
Not so good	.	0.084	0.064	0.093	− 0.029	3.72***
Bad	.	0.023	0.024	0.023	0.001	0.32

1 All the variables shown are dummy variables, i.e. if the respective characteristic applies, they take on the value of 1; otherwise they take on the value of 0. **2** Number of persons who answered the question. **3** Mean value for all *N* to whom the respective characteristic applies, i.e. the variable takes on the value of 1. **4** All *N* who indicated in the questionnaire that they have used an app to send money to family, friends or acquaintances (P2P). **5** *N* who have not used an app for P2P payments. **6** Difference in the mean values of the user and non-user groups. **7** The *t*-value refers to a test of whether the calculated difference is significantly different from 0. The calculation of the *t*-test statistic values takes into account unequal variances between users and non-users. ***/** indicates significance at the 1% and 5% levels. **8** Online purchases at least once per week/per month/per year.

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Average marginal effects on the probability of paying by smartphone*

Percentage points
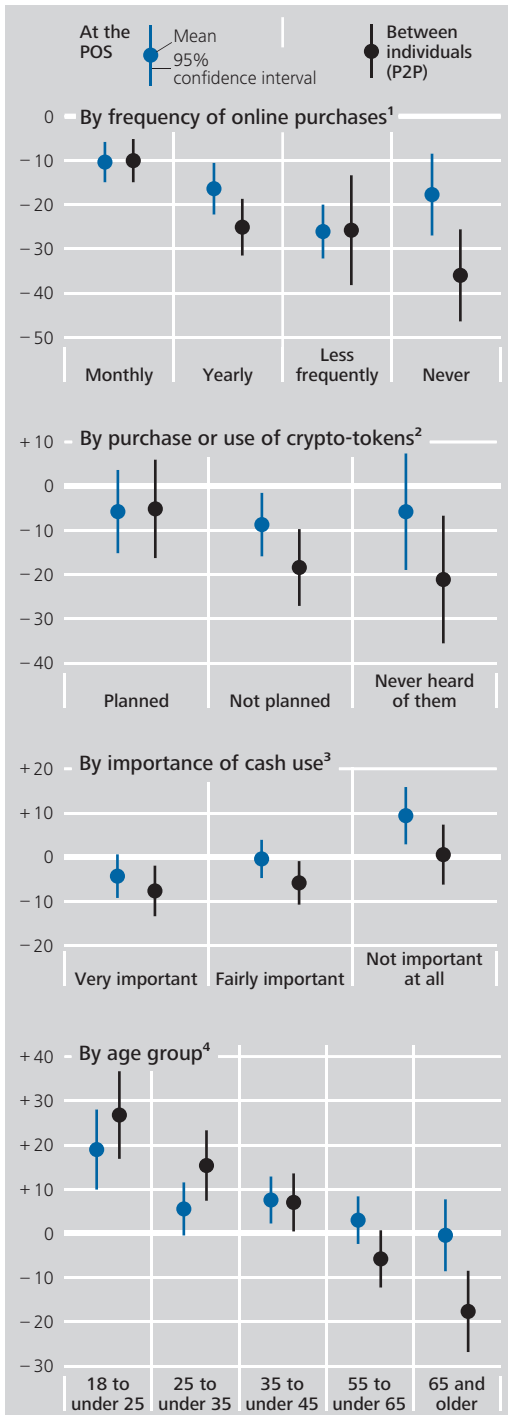
* The marginal effect indicates the magnitude of the difference in the probability of use of a person with the observed characteristic compared with the reference group (e.g. a person who makes online purchases on a monthly basis compared with persons who make online purchases on a weekly basis). The mean of the differences in the probability of use across all observations in the dataset then gives the average marginal effect. **1** Reference group: persons who make online purchases at least once per week. **2** Reference group: persons who have already purchased or paid with crypto-tokens. **3** Reference group: option to use cash not so important. **4** Reference group: 45 to under 55 years.

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tionships between the attitude towards crypto-tokens and the use of mobile payment methods. Another possible indication is that the probability of using mobile payments at the POS is 6 percentage points higher among the respondents who believe that personal data are being handled responsibly by technology companies. Incidentally, the significance of the willingness to adopt new technology was also borne out by a qualitative study drawn up for the Eurosystem in 2022 in connection with the digital euro project.[24]

The attitude towards cash is another significant indicator for the use of mobile payment applications. Respondents who prefer to pay with cash at the POS are 15 percentage points less likely to turn to mobile payment methods. Where respondents have no clear preference for either cash or non-cash means of payment, the probability of them using mobile payment methods decreases by 6 percentage points. For P2P payments, meanwhile, the preferred means of payment holds no relevance.[25] An analysis of the importance of cash use yields similar insights. For example, the probability of making payments via mobile devices drops by 5 (POS) and 8 percentage points (P2P) for respondents for whom cash use is very or fairly important.

An analysis by age group shows that the probability of paying with a mobile device is up to 19 (POS) and 27 percentage points (P2P) higher for the younger age group (18 to under 45 years) than for the reference group (45 to under 55 years). For P2P payments, furthermore, the probability of use for respondents in the higher age groups (65 years and older) is up to 18 percentage points lower compared with the reference group, whereas for mobile payments at the POS, no significant effect is discernible with increasing age. This means that the probability of making P2P payments decreases with age across all groups; in the

Younger age groups more likely to use mobile payment applications

24 See Kantar (2022).
25 As the effects for P2P payments are not significant, they were omitted from the chart.

case of mobile POS payments, this can only be observed up to the reference group age. The negative correlation between age and use of mobile payment applications is also well documented in the literature.[26]

The opinion that technology companies handle personal data responsibly is associated with a 6 percentage point higher probability of using mobile payments at the POS. Where P2P payments by app are concerned, the probability of use decreases by 9 and 7 percentage points, respectively, among respondents with a lower or higher secondary school leaving certificate compared with the reference group (upper secondary school leaving certificate).

In summary, it is evident that above all experience with internet applications, a willingness to try out new technology, attitudes towards cash and age are good indicators of the use of mobile payments at the POS and in P2P transactions. The empirical analysis was therefore able to confirm the findings of the previous descriptive study.

Geographical proliferation of mobile payments at the POS in Germany and Europe

The next step is to add a geographical dimension to this analysis of the key determinants of mobile payments at the POS.

Regional comparison at federal state level

Use of mobile payment methods at the POS varies across regions

The chart on p. 84 is based on transaction data taken from the payments diaries completed as part of the latest payment behaviour study, according to which 2.6% of transactions at the POS in Germany were made using mobile payment methods in 2021. Broken down by federal state, the distribution is fairly heterogeneous, with Rhineland-Palatinate, Hesse and the northern federal states – except for Ham-

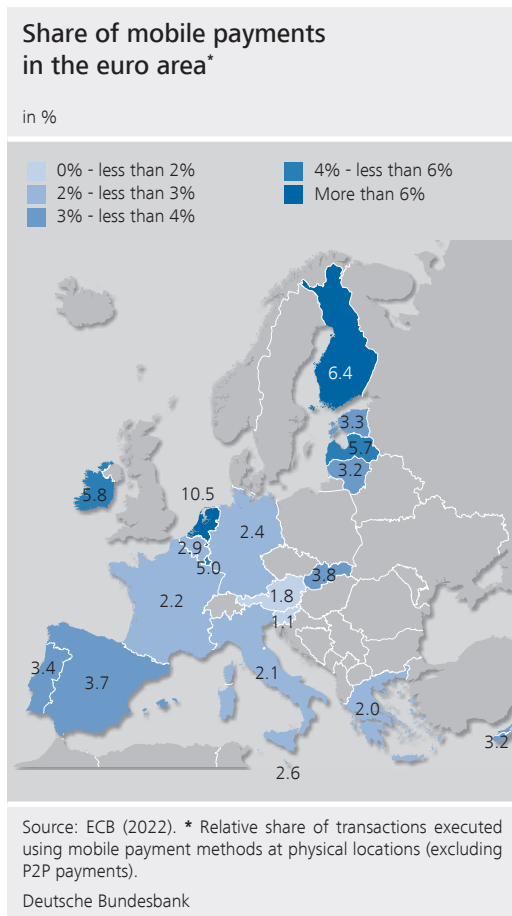**Share of mobile payments at the point of sale (POS) by federal state***
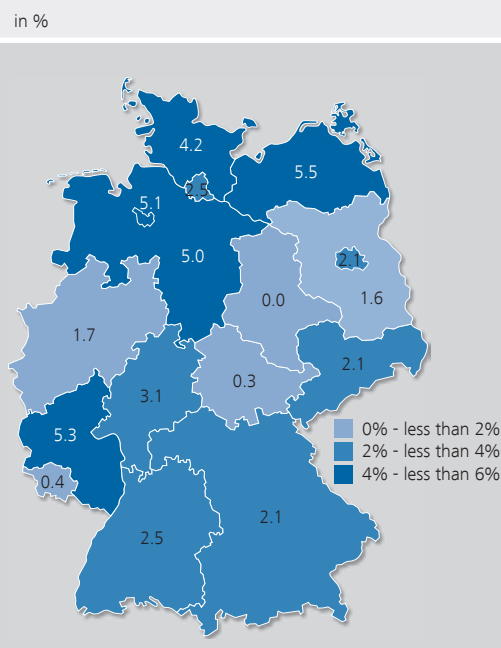
in %

* Relative share of transactions executed using mobile payment methods at the POS (day-to-day retail purchases and retail purchases of durable goods, payments at petrol stations and pharmacies).

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burg – accounting for an above-average number of mobile payments. Mecklenburg-West Pomerania leads this group with a share of 5.5%. All the other federal states fall short of the average, with Hamburg and Baden-Württemberg coming in just below that level, at 2.5% each. The number of mobile payments is particularly small in Saxony-Anhalt, Thuringia and Saarland. As the number of transactions at the federal state level is still relatively small in absolute terms, an empirical analysis of the causes of these differences would not yet be meaningful. Future Bundesbank payment behaviour studies, however, could permit a more detailed analysis of regional differences as the volume of mobile POS payments continues to rise.

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26 See Garrett et al. (2014), Li et al. (2020) and Kantar (2022).

Share of mobile payments in the euro area*

in %

0% - less than 2%
2% - less than 3%
3% - less than 4%
4% - less than 6%
More than 6%

Source: ECB (2022). * Relative share of transactions executed using mobile payment methods at physical locations (excluding P2P payments).

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Comparison across euro area countries

Mobile payments in the euro area particularly popular in Finland and the Netherlands

To get a better idea of where Germany stands with regard to smartphone payments, it is worth looking at how the country shapes up relative to its euro area peers in the SPACE study prepared by the European Central Bank (ECB).[27] Just like the Bundesbank's payment behaviour study, the SPACE study looks at people's payment habits and attitudes towards the available means of payment as well as trends in payment transactions, but does so throughout the euro area. To this end, the market research institute Kantar conducted a representative survey among a total of 50,000 persons in all euro area countries (except Germany and the Netherlands) by telephone and online, and had the respondents complete a payments diary. The study was rounded out by incorporating data from the national payment behaviour surveys conducted in Germany and the Netherlands.

The average share of mobile transactions at physical payment locations excluding P2P payments is 3% in the euro area. The adjacent chart shows the results for all the euro area countries. Eleven countries are above this level and eight below it. Of particular note are the high percentages in Finland (6.4%) and the Netherlands (10.5%), the latter percentage reflecting the strong popularity of Apple Pay and Google Pay in the Netherlands. Card payments at the POS reached a very high level as well (80%), with the vast majority being contactless or smartphone/wearable transactions.[28] Ireland and Latvia are also well above the euro area average at just below 6%, possibly reflecting a relative openness to technology and advances in digitalisation in these countries. The same could also be said about the other Baltic States and Slovakia, where the shares of mobile transactions lie between 3.2% and 3.8%. The above-average percentages in Spain and Portugal, meanwhile, could be attributable, at least in part, to the national mobile payment systems Bizum and MB Way. At a share of 2.4%[29] for mobile payments, Germany occupies a mid-table position in Europe, albeit below the euro area average. This raises the question of why developments in Germany in this respect have so far been rather lacking in momentum.

Possible reasons for the low uptake of mobile payments in Germany so far

The still moderate growth overall of mobile payments in Germany can be traced back to various economic and technological factors as well as market-specific growth paths that are always affected to a degree by whether the network effects needed in payments have been achieved or not. Originally, efforts were made

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27 See European Central Bank (2022).
28 See De Nederlandsche Bank and Dutch Payments Association (2021).
29 This differs from the value reported in the Bundesbank's payment behaviour study owing to a different methodological definition.

in Germany to use optical methods such as bar-codes or QR codes for mobile payments. These first initiatives were set in motion either by retailers or mobile telephone operators, rather than originating in the banking industry. One early QR code-based payment solution was Yapital, a subsidiary of the Otto group.[30] However, due to an insufficient number of users, operations were discontinued back at the beginning of 2016.

Solutions that are still in the market are QR code-based POS payment methods such as Payback Pay – which is an enhancement to the well-known multi-partner bonus programme – and the chain store payment apps.

Card schemes rely on NFC

NFC technology, by contrast, is used in a form of mobile payment method that is employed by both the German girocard and international contactless card schemes.[31] While girocard has only been rolled out in bulk with the contactless function since 2017,[32] Mastercard and Visa already came equipped with an NFC chip several years earlier. However, acceptance among retailers was slow, which limited the spread of contactless payments. Things only changed when the two card schemes forced their retailer customers to use NFC-enabled terminals by no later than 2020.

Mobile credit cards available for some time now, but less widespread among general public

Initially, it was only possible to use the credit cards issued by international card schemes – but not girocard, which is widespread in Germany. However, according to the payment behaviour study, only 54% of respondents currently have a credit card. Of these, 32% have added that card to a payment app. By contrast, according to the study, almost all respondents own debit cards, most of which are girocards, but only 23% have registered their card in a payment app.

Evidently, the application landscape for mobile payments is still highly fragmented by smartphone operating system and centred around international card schemes: in general, NFC payments using credit and debit cards issued by international schemes are possible via Apple Pay and Google Pay, provided they cooperate with the card-issuing bank. Android generally allows the NFC interface to be used by bank-owned payment apps – including with giro-card. On iOS devices, on the other hand, the NFC interface was long the reserve of Apple Pay. To add girocard to Apple Pay, additional technical modifications need to be made to facilitate payment processing, alongside the appropriate contractual agreements. Thus, the ability to use NFC in mobile payments at the POS depends on the available card, the card-issuing bank and the smartphone's operating system. The amendments to Section 58a of the German Payment Services Oversight Act[33] as well as the EU's Digital Markets Act[34] are designed to facilitate access to the NFC interface. This might increase the use of girocard for mobile payments, which, given their popularity and proliferation among the general public, could help to fuel further growth in mobile payments.[35]

As mentioned above, card issuers generally need to cooperate with wallet providers in order to use digital wallets outside of bank-owned payment apps. Savings banks and credit cooperatives spent a long time focused on enabling girocard to be integrated into third-party wallets such as Apple Pay in the same way as it is in the bank's own apps.[36] Only since the end of 2019 have customers of both types of banks been able to use Apple Pay in combination with their credit card. And since the third quarter of 2020, it has been possible to add giro-

Cooperation is necessary to add payment cards to third-party wallets

30 See De la Motte (2015) and Streit (2015).
31 See the box on how mobile payments work at the point of sale on p. 86.
32 See Association of German Banks (2018).
33 Amongst other things, Section 58a of the Payment Services Oversight Act *(Zahlungsdiensteaufsichtsgesetz)* governs access to technical infrastructure services (e.g. on a smartphone) in the provision of payment services or conduct of electronic money business.
34 Regulation (EU) 2022/1925 of the European Parliament and of the Council of 14 September 2022 on contestable and fair markets in the digital sector (Digital Markets Act), OJ L 265, 12 October 2022, pp. 1-66, http://data.europa.eu/eli/reg/2022/1925/oj
35 See also Baumgartner (2020).
36 See Benkelberg (2019).

How mobile payments work at the point of sale

Two factors are usually required for mobile payments at the point of sale (POS): the customer needs a smartphone or wearable that comes with a payment function, plus a debit or credit card that is stored virtually on that device in a suitable wallet. Technically speaking, then, mobile payments at the POS are generally contactless card payments initiated from the mobile device.[1] That device is scanned over the payment terminal to allow the payment app to exchange the payment information with the POS terminal via the smartphone or wearable's NFC (near-field communication) antenna. In a smartphone payment, authentication – i.e. verification of the user's identity – takes place either with the aid of biometric verification methods such as a fingerprint or face scan or – as in the case of wearable payments – by entering the device's PIN.[2] The payment messages exchanged via NFC are processed via the infrastructure of the respective card scheme, as with payments by physical card.

To reduce fraud risks, payment details are stored not on the device's operating system, which is where the bulk of other data is kept, but either provisioned into a secure element built into the mobile device (e.g. a chip embedded in the device's SIM card) or stored remotely on cloud servers operated by a suitable provider (a configuration known as host card emulation, or HCE).[3]

One key difference between contactless card payments and mobile payments concerns the nature of the information exchanged between device and terminal. Whilst a contactless payment made using a physical card involves the direct transfer of the associated card information, in a mobile payment only tokenised payment details are stored and transferred. In this context, tokenised means that a designated technical service provider – the token service provider – generates one or more new virtual card numbers, known as payment tokens, from an existing card number.[4] These are placed, or provisioned, into a smartphone's or wearable's wallet when the device connects to the internet. Third parties such as retailers are unable to match the payment token with a physical card. Payment tokens are each virtual cards in their own right and are time-limited and, in some cases, domain and purpose-specific. For the most part, they can only be used for a single transaction. This means that if the device is hacked or stolen, the information on it is only usable for a limited amount of time and money. To add a further layer of security for mobile payments, the digital wallet generates a dynamic cryptogram that is sent to the terminal together with the payment token. Without that cryptogram the payment token is useless.

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1 See Payment Systems Regulator (2018). Some providers, such as Payback Pay, or the payment apps operated by some chain stores take a different approach, settling the payment by debiting the amount directly from the payer's bank account. Likewise, payments made via the PayPal app or website are not a card-based mobile payment method but a transfer of electronic money, because the virtual card is used only to charge the user's electronic money account with PayPal, not for the payment transaction itself. See Göbel (2021).
2 See Baumgartner (2019a), Oppong (2020) and Deutsche Bundesbank (2022a). Depending on the device and payment app used, it is also sufficient to enter the PIN once (e.g. by scanning the smartwatch).
3 See Payment Systems Regulator (2018) and Roland (2022).
4 See Payment Systems Regulator (2018), Baumgartner (2019a, 2019b) and Roland (2022).

card to Apple Pay, but only if that card was issued by a savings bank.[37]

Card issuers may incur additional fees that could lower earnings

In addition, there are reports from the market that the cooperating institutions are required to pay a fee of up to 0.15% of the transaction value for each Apple Pay payment when a credit card is added and 0.05% for debit cards.[38] This reduces card issuers' earnings. For them, an interchange fee, or "authorisation fee" in the case of girocard – payable by the retailer per transaction – is an important source of income. Interchange fees generally amount to 0.3% of the transaction value for credit cards and 0.2% for debit cards issued by the international schemes.[39] According to the latest survey conducted by the EHI Retail Institute in spring 2022, authorisation fees for girocard payments averaged 0.17% of the transaction value, and came to 0.14% on average for large enterprises.[40] In view of these costs paid to third-party wallet providers, issuing cards could make less and less commercial sense for the banks concerned. This is probably one of the reasons why girocard has so far only been partially integrated into the wallet products offered by major technology providers.

On top of the reasons cited so far for the as yet low uptake of NFC payments at the POS using a smartphone, users are concerned that mobile payments might entail security risks. For example, 42% of respondents in the payment behaviour study stated that they did not make mobile payments because they seemed too insecure. Many consumers still appear to be unaware of the additional level of security provided by tokenisation compared with a physical card payment.[41]

◼ Outlook

Demographic developments and growth in online shopping could help to increase mobile payments

This analysis has shown that the use of smartphones to make payments at the POS or to send money P2P is above-average among younger age groups in particular. Demographic developments thus make it likely that the use of mobile payment methods will increase in the future. Moreover, buyers are more inclined to make mobile payments when they are familiar with shopping and banking online. If the general public's uptake of mobile internet services evolves as it has done in recent years,[42] and online shopping and banking therefore continue to grow, this could also help spread the use of mobile payments.

Furthermore, a certain degree of openness to technological trends is likely to boost the willingness to pay by smartphone at the POS or in P2P transactions, as is the growing trend towards preferring non-cash means of payment at the POS.[43]

Experience has shown that for an innovative – and therefore also mobile – payment method to succeed, it needs to offer consumers an additional benefit in the form of greater convenience, such as in how long the payment process takes. Two recent studies show that payments by smartphone or wearable are fastest compared with other means of payment, taking an average of 11 and 14 seconds, respectively.[44]

The reasons for the low prevalence of mobile payments in Germany to date were the late availability of the infrastructure needed to settle NFC-based payments and the cautious cooperation of banks and savings banks with third-party providers. However, these barriers are gradually being removed – including through appropriate regulation. In particular, the prospect of being able to use any girocard regardless of the issuing institution in the relevant digital wallets is likely to boost smartphone payments.

Legal changes could also further strengthen mobile payments, …

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37 See Baumgartner (2020) and Göbel (2021).
38 See Klotz (2015) and Baumgartner (2019a, 2020).
39 For more information on the capping of interchange fees, see European Commission (2015).
40 See Rüter (2022).
41 See Deutsche Bundesbank (2022a) and the box on p. 86.
42 See Initiative D21 e. V. (2022).
43 See Deutsche Bundesbank (2022b).
44 See Deutsche Bundesbank (2022b) and girocard (2022).

Alongside banks and savings banks, PayPal is also looking to capitalise on its popularity and broad user base[45] in online and P2P payments to expand into the POS business field, where payments can be made using a QR code or – in conjunction with Google Pay and Mastercard – via NFC. To date, Bluecode has been a niche product for making payments at the POS. It works on the basis of an optical code and is part of the European Mobile Payment Systems Association (EMPSA). The main purpose of this association is to link payment apps in different European countries so that they can be used seamlessly across multiple countries.[46] An alternative approach is the creation of a completely new pan-European mobile payment method based on instant payments and QR codes to initiate payment. This is currently being discussed by various European banks, especially in France, Germany, Belgium and the Netherlands, under the acronym EPI. In Germany, the initiative is supported by large parts of the banking industry.

ments market still fragmented – as is also evident from the analysis of mobile payments at physical locations in the euro area[47] – the Bundesbank believes that the opportunity should be taken to establish a pan-European mobile payment method based on instant payments, as is envisaged with EPI, for example. The planned European regulation of instant payments may support this process.[48] At the same time, the existing insights into payment behaviour could be leveraged to examine – as part of the Eurosystem's work on the topic – the design features that a digital euro would need to have in order to be perceived as an attractive means of payment.[49]

Overall, the uptake of mobile payment methods is likely to increase significantly over the next few years. However, it remains to be seen how quickly the factors identified here will pick up momentum and how regulatory developments will affect payments in the coming years.

… such as the EU's commitment to use instant payments

Instant payments in particular have the potential to form the basis for mobile POS, e-commerce and P2P payment applications in the future. In the past, successful mobile payment solutions have been developed in some European countries, such as Sweden, Denmark and Spain, that focused initially on P2P payments before being gradually expanded to e-commerce and the POS. With Europe's pay-

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45 45% (91%) of respondents in the payment behaviour study report they usually use this method for online purchases (P2P payments). See Deutsche Bundesbank (2022a).
46 See Pirkner (2020) and Schneider (2019).
47 See the chart on p. 84.
48 See COM (2022) 546 final, Proposal for a Regulation of the European Parliament and of the Council of 26 October 2022 amending Regulations (EU) No 260/2012 and (EU) 2021/1230 as regards instant credit transfers in euro.
49 For more information on the digital euro, see https://www.bundesbank.de/en/tasks/payment-systems/digital-euro/digital-euro-frequently-asked-questions

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