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The Impact of Socio-Economic and Demographic Factors on the Use of Digital Access to Financial Services*

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Abstract

This paper investigates which socio-economic and demographic factors influence the demand for digital access to financial services. For this purpose, customer data from all public savings banks in Germany are linked with socio-economic and demographic data at regional level. As a result, attributes can be identified that promote a so-called informational divide. The risk of such a divide is comparatively high in rural, sparsely populated areas with a high average age of the population and in regions with a relatively low average formal education level. Here, people could lose access to basic financial services as a basis for economic and social participation as a result of ongoing digitisation.

JEL-Classification: G21, L32, L38, L86, O33, R12, R20, R51

Keywords: financial services, digitalisation, digital divide, informational divide, savings banks, regional comparison

I. Introduction

"Germany's banks are increasing the pace of branch closures. In the past two years, 2,200 locations have been closed. A key driver is digitisation, which has fully gripped the banking market. New competitors, new technologies and changing customer requirements are shaping the change in competitive conditions" (*Schwartz et al.* 2017, p. 1).

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Regarding customer requirements, literature shows that internet use and online banking penetration have increased, but depend on socio-economic and demographic characteristics of consumers (e. g. *Königsheim et al.* 2017; *Kleine/Jolms* 2016). This corresponds to digital access and internet usage. The acceptance and usage of new digital technologies is still heterogeneous within the German society. Heterogeneity with respect to digital access or internet usage may lead to a digital or informational divide. The digital divide represents the divergence in access to information and communication technologies (ICT) among groups, regions or countries, which may be related to the internet availability (wired or mobile), the network quality and the usage costs. The broader concept of an informational divide describes divergence in the use of ICT due to heterogeneous socio-economic conditions: it depends on the digital divide and other factors, such as economic (affordability), social (education, internet literacy, urbanisation, culture) and demographic characteristics (*Hong et al.* 2016, p. 28).

With increasing access to the internet in developed economies, the issue of digital access divide has lost importance, while the concern of digital usage divide has grown (*Akhter 2015*, p. 209). The use of the internet and mobile devices is becoming increasingly important for social participation. For those who might be excluded due to an information divide face economic and social disadvantages or even exclusion (for the USA see e. g. *Rice/Katz* 2003; *Goldfarb and Prince* 2008).

Against this background, the question arises whether the reduction of physical access to financial services due to closures of bank branches can be compensated by sufficient access to online services or internet services. A further question that comes into focus is whether a digital divide will arise, since those who find it difficult to obtain physical access to bank branches (e. g. older people in peripheral regions) might also excluded from internet access (e. g. little internet-literacy or insufficient network qualitiy). *Conrad et al.* (2018) examined digital access to financial services in Germany on the basis of data from savings banks and cooperative banks. The study has identified the quality of digital access and its regional discrepancies in Germany. However, the determinants of using digital access to financial services are not yet well understood.

Even if digital access is provided on a high quality level, online banking may not be used by all consumers because of heterogeneity in motivation or competence to use digital offers (informational divide). In this context, the results of the study D21 Digital Index are of interest: 16 million Germans are digitally offside, i. e. a quarter of Germans does not participate in the digital world. Almost a third feel overwhelmed by digitization (*Handelsblatt* 2018).

This paper examines the influence of socio-economic and demographic factors on the use of digital access to financial services. It contributes to the literature on the use of online banking by linking for the first time customer data

from all public-sector savings banks in Germany to various data sets on socio-economic and demographic characteristics at regional level (business areas of savings banks). We examine common socio-economic and demographic characteristics that have already been studied in literature (income, age, education, financial knowledge). Beyond that, we include a measure of customers' financial wealth (savings deposits), an approximation for internet literacy and distance, measured by average travel time to the nearest bank branch.

The paper is structured as follows. Section II. provides an overview of related literature. On that basis, section III. derives the corresponding hypotheses. Section IV. presents the data and estimation approach. Section V. discusses the regression results, evaluation of hypotheses and limitations. Section VI. concludes with an outlook.

II. Review of Related Literature

A representative sample of customers of a German retail bank based on more than 1,700 survey responses in 2015 shows that the likelihood to use digital financial services (investment advice, loans, payment services) is related to financial knowledge, risk tolerance, gender, age and education (*Königsheim et al.* 2017). The use of online banking services increases with financial knowledge, financial risk tolerance and educational level. Men are more likely than women to use digital service providers and older consumers are less likely to do so than younger ones. The positive correlation of risk tolerance and the negative correlation of age with the use of internet banking confirms earlier results for the US (*Bauer/Hein* 2006). Controlling for occupation and area of residence does not change these results. Customers preferring traditional banks with physical access require a relatively higher compensation to switch to online banking providers than customers preferring digital providers require to switch back to a traditional retail bank. This indicates that financially illiterate and risk averse individuals have a relatively high preference for physical access with personal advice.

A nationwide survey of bank customers aged 14+ in Germany shows that regular personal contact with the bank is less important or dispensable, especially for online banking customers, which are younger and wealthier, demand more banking products and are interested in more complex and riskier products than offline customers. The use of digital access is positively correlated with income or assets (*Berger/Gensler* 2007). However, in a more recent survey conducted in 2015 among young people (14–24 years) in Germany, only 5 % fully agreed, but 49 % completely disagreed with the statement "Banks no longer need a branch these days – you can handle all financial services including advice online" (*Bankenverband* 2015, p. 33).

For all bank customers, it is evident that both access routes are used. Almost half of all bank customers first inform themselves online, but conclude the purchase of a financial product in a branch. Banks are increasingly offering multi-channel distribution in which physical and digital offerings complement each other (*Ornau* 2017, p. 52). In a 2016 private customer survey, 53 % of respondents were multi-channel customers (*Mihm/Frank* 2016). Also wealthy internet savvy investment customers in Germany have been found to be hybrid, using both digital and personal asset management services and products. Although they are highly satisfied with personal services from traditional providers, they show significant demand for innovative digital banking/brokerage/advice products. "Ultimately, research gives strong evidence for a high need for personal advice and human guidance" (*Altenhain/Heinemann* 2018, p. 343). The use of online banking depends on the financial service demanded. In the standardised consumer credit and deposit business, the physical presence of the bank is likely to be less important or irrelevant. For example, private banking with Robo-Advice or automatic sales manages without physical advice (*Ornau* 2017).

A representative survey of 2,000 adults in Germany finds that security concerns in the form of data tapping (65 %) and fraud (54 %) are cited as the biggest hurdle for the use of online banking. In addition, 35 % of respondents prefer personal contact. The use of online banking increases with income and educational level and is very pronounced in the age group 25–39. 15 % of customers are pure online users, 52 % are hybrid customers using both online and offline banking services, while 33 % are offline users. Among the latter, 17 % are digital refusers (*Kleine/Jolms* 2016).

Lambrecht/Seim (2006) find consumer heterogeneity with respect to both online banking adoption (measured by online banking authorisation) and usage (measured by number of logins and number of transactions into online banking) by customers, using internal data of a large German retail bank. They show a nonlinear influence of income on internet adoption: consumers with low or high incomes adopt online banking more often than those with medium income. The relationship of online banking use with income is ambiguous. On the one hand, low-income customers log into online bank accounts more often than higher-income customers, possibly to avoid paying overdraft interest. On the other hand, the number of transactions increases with income, suggesting higher demand for banking services among richer customers. Men accept internet banking more often than women.

The correlation between online banking adoption and age is non-linear: customers between the ages of 20 and 40 are more likely to opt for online banking than customers under the age of 20 or 40+. However, older customers use online banking more actively than younger ones, which could be explained by lower opportunity costs of time or a more complex financial profile.

The probability of adopting online banking increases with internet availability. It is the higher the lower the local branch density of the bank, which is a proxy for high transport costs when visiting a bank branch. It is positively correlated with the local branch density of competing banks, probably because banks' efforts to attract customers with online banking services increase with intensity of competition. The use of online banking increases with transport costs, measured in terms of bank's branch density and car ownership around the consumer's location as proxy for time spent to conduct offline banking (*Lambrecht/Seim* 2006).

A survey of residents in one Midwestern city in the US shows that the use of online banking does not only depend on socio-economic and demographic variables, being negatively correlated with age and positively correlated with income, but also on the psychological constructs of internet usage comfort (i. e. feeling of ease in accessing the Internet and managing social and personal interaction) and internet technical comfort (i. e. feeling of ease in being able to resolve computer-related problems), which both have significant and positive effects (*Akhter* 2015).

In addition to physical access to financial services, *Conrad et al.* (2018) consider digital access both quantitatively in terms of the proportion of inhabitants with a broadband connection and/or mobile access to the network and qualitatively in terms of connection speed. On the basis of these results, conclusions have been drawn on the existence or risk of a digital divide in Germany.

We contribute to this strand of research by investigating the impact of socio-economic variables on the use of online banking measured by the share of online bank accounts in all retail customer accounts of savings banks in Germany. As in previous studies, we include customers' income, age, education and financial knowledge.

Beyond that, we examine the customers' financial wealth (savings deposits), an approximation of financial and internet literacy and the average travel time to the nearest bank branch as possible determinants of online banking usage in relation to a possible informational divide.

III. Hypotheses

With regard to the state of research, in particular *Königsheim et al.* (2017), *Kleine/Jolms* (2016), *Hong et al.* (2016), *Akhter* (2015) and *Lambrecht/Seim* (2006), the following hypotheses can be derived:

(H1) There is an informational divide with respect to demographic characteristics (age, population density, place of residence).[5]

We assume that (H1.1) the effect of age is inversely U-shaped, i. e. that the informational divide first decreases with age and increases again from a certain age.[6] With regard to the population density of the federal state or community, two opposing hypotheses can be formulated: On the one hand, a positive influence of population density on the use of online banking services can be expected (H1.2), because more densely populated regions are likely to be exposed to higher competitive pressure on banks which should result in a progressive supply of digital banking services (which leads to a higher rate of online bank accounts). On the other hand, a negative influence can be expected (H1.3), since cost pressure is particularly high in sparsely populated areas and the physical withdrawal from unprofitable areas (mostly rural areas) (cf. *Conrad et al.* 2018) has contributed to a higher penetration of online bank accounts.

The relation between physical access to bank branches and the proximity to the place of residence could also have an effect: It can be assumed that the share of online bank accounts increases with the distance to the nearest branch (H1.4).

Based on *Kleine/Jolms* (2016), *Akhter* (2015), *Berger/Gensler* (2007) and *Lambrecht/Seim* (2006), we postulate:

(H2) There is an informational divide with regard to economic factors (income, savings assets).[7]

We assume that the number of online bank accounts is positively correlated with income (H2.1) and savings assets (H2.2).

Following *Königsheim et al.* (2017), *Kleine/Jolms* (2016) and *Akhter* (2015), we postulate:

(H3) There is an informational divide in terms of social factors (level of school education, financial and media literacy).

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[5] The state of research also shows that gender may be relevant as a demographic characteristic. In tests to determine data set quality, however, the variable gender has been found to be highly distorted and is therefore not further included in the analysis. The reason for the distortion is the way in which the existing data are converted from the district or municipality level to the level of the savings bank areas.

[6] Including different age groups, there should be a positive influence on the share of online bank accounts for young groups and a negative influence for older groups.

[7] With regard to the state of research, the inclusion of the unemployment rate would also be appropriate – in this case, it would be expected that this variable has a negative effect on the share of online bank accounts. However, the correlation analyses show (as expected) a high negative correlation between income and unemployment. Therefore, only income is taken into account. Cf. Table 6 in the appendix.

We expect that the level of education has a positive effect on the number of online bank accounts. The level of education is subdivided into school education (H3.1), financial literacy (H3.2), and media literacy which is further subdivided into the frequency of internet use (H3.3) and internet literacy (H3.4).

IV. Data and Estimation Approach

1. Data Set

The data set is composed of several subsets. The first subset includes all business areas of public savings banks in Germany (except Stuttgart, Braunschweig and Berlin). The second subset contains survey results of online banking user behavior as well as internet literacy. These data sets are combined with socio-economic and demographic attributes. As far as possible, the data is gathered at municipal level or is transformed from the aggregate to municipal level using appropriate proxies (level of education and age structure).

Finally, the municipalities are assigned to the business areas of the respective savings banks.[8] A limitation that might weaken the significance of the results is based on the data structure: Some socio-economic and demographic data are only available for the year 2011 at municipal level, while information on online bank accounts and internet literacy refer to the year 2017. Information on the data used are summarised in the following:

- Population density (inhabitants per km^2): *Census* 2011, municipal level
- Average age or different age groups: *Census* 2011, municipal level
- Unemployment rate: *Federal Statistic Office of Germany* 2015, municipal level
- Average income (available income per inhabitant): *Federal Statistic Office of Germany* 2015, municipal level
- Savings assets (share of savings deposits in all customer deposits) as a proxy for financial wealth: *Savings Banks Ranking List* 2017, business area level of savings banks in Germany
- Total assets of savings banks: *Savings Banks Ranking List* 2017, business area level of savings banks in Germany
- School degree (1 = without degree, 2 = low formal education, 3 = medium formal education, 4 = high formal education): *Census* 2011, municipal level
- Level of education (from 1 = low to 4 = high): *Census* 2011, municipal level

[8] The terms savings bank business area and region are used synonymously in the following.

- Average internet usage time (average usage time per day in hours by age group): *Initiative D21* 2017, federal level
- Internet literacy (weighted survey results on internet access, literacy, usage hours/day and affinity for internet applications): *Initiative D21* 2017, Germany, transformed from federal to municipal level
- Financial education (ING survey, all persons who have not received financial education): *ING DiBa* 2017, transformed from federal to municipal level
- Financial knowledge (BdB survey, from 2 = good to 5 = bad): *Federal Association of German Banks (BdB)* 2017, transformed from federal to municipal level
- Average travel time (to nearest bank branch): *Conrad et al.* (2018), municipal level
- Online banking rate (share of online bank accounts in all private accounts): *DSGV – German Association of savings banks* 2017, business area level of savings banks in Germany

2. Measurement of Financial and Internet Literacy

The test of the third hypothesis (H3) includes the level of school education and financial and internet literacy. While the level of school education is well classified for each municipality within the census data 2011, there is no granular data set for internet and financial literacy at the municipality level. The only available data sets are based on representative surveys at aggregate level by Eurostat and the Federal Government in Germany (D21-index).

In order to include these variables in a regression analysis, the survey data are transformed at municipal level. To generate a proxy for financial and internet literacy at municipal level, a distribution key is required that links the survey results at the federal level with the granular census data at municipal level. In this context the age structure and school education level seem to be appropriate proxies.

The aggregated survey results show strong correlations between education level ($\rho = 0.99$)/age structure ($\rho = -0.94$) and internet literacy (with regard to financial literacy: educational level ($\rho = -0.93$)/age structure ($\rho = -0.49$).

The data structure of internet literacy reveals that the internet affinity of individuals between 20 and 29 years ("digital natives") is the highest in comparison to other age groups. Furthermore, the distribution among the older generations shows a linear decline with higher age (distribution is right-skewed). The approximation of the internet literacy structure on the basis of the age structure follows slightly better normality conditions than the age structure itself (normality of residuals in direct OLS with online bank accounts).

Additional explanatory power might be disclosed when implementing the approximation of internet literacy. Similar observations hold true for financial literacy. However, a strong limitation of this approximation comes along with the fact that financial and internet literacy themselves are influenced by other variables. The survey results state that the affinity for the use of internet-based services is influenced by age, education, gender and trust in data security or risk tolerance.

This means that no conclusions can be drawn from the exact constellation or weighting of the influencing factors, which requires a further study. However, the D21-Index survey reveals that the "digital natives" (age group 20 – 29) have a higher affinity to internet-based services. But even in this age group, differences in education and gender are observed. Therefore, the financial and internet literacy in this study can only be measured and interpreted as an approximation.

A further limitation that arises from the data structure is the time discrepancy between the census data of 2011 and the online banking rate in 2017. A discussion follows in section V.3.

3. Descriptive Statistics

Tables 1 and 2 show descriptive statistics of the collected data set. The variables in Table 1 are subdivided into three groups with high, medium and low share of online bank accounts. The classification of the regions (business areas of the savings banks) is based on the normal frequency distribution (z-value = +/– 0.675).

It is noticeable that all mean differences between the extreme positions (highest minus lowest share of online bank accounts) differ statistically significantly from 0. On average, it can be observed that individuals in regions with a comparatively high share of online bank accounts live in more densely populated regions (in line with H1.2 and contradictory to H1.3), are younger (in line with H1.1), have a higher per capita income (in line with H2.1), are embedded in a higher branch density in their region (in line with H1.4), have a more profound financial knowledge (in line with H3.2), use the internet more frequently (in line with H3.3) and have a higher internet literacy (in line with H3.4). Contrary to our expectations (H3.1), individuals in regions with a relatively low share of online bank accounts have a significantly higher general education than individuals in regions with a comparatively high share of online bank accounts. In contrast to what was expected in (H2.2), the savings assets (ratio of savings deposits to customer deposits) show a negative influence on the share of online bank accounts.

Table 2 shows a comparison of the data between the regions of the new and old states[9]. All differences in mean values between the old and new states panels are statistically significantly different from 0. On average, regions (and their citizens) in the old states have a higher share of online bank accounts, have fewer savings assets, are younger, less frequently unemployed, have higher per capita income, are embedded to a higher branch density in their region, have a more profound financial knowledge, use the internet more frequently and have a higher internet literacy. Hence, it can be assumed that there is an East-West disparity or the risk of an informational divide between old and new states. In this respect, the following multivariate analyses take East/West differences into account.[10]

[9] "New states" are the states that emerged from the GDR, while "old states" refers to the western states of the old federal republic.

[10] The data were also differentiated according to population density. With the exception of the educational level, significant differences between regions of high and low population density are observed for all considered factors.

Table 1

Descriptive Statistics for the Data Set – Subdivision by Share of Online Bank Accounts

	Density $\left(\frac{EW}{km^2}\right)$	*Savings assets (%)*	*Age (Years)*	*Income (KEUR)*	*Education (Index)*	*Distance (min)*	*F-Index (Index)*	*Internet (h)*	*Internet (Index)*
Regions with the highest share of online bank accounts ≥ 53 % (n = 88)									
Mean	487.7	0.32	48.1	22.7	2.11	9.1	3.83	1.95	58.4
Min	73.5	0.12	45.8	19.1	1.94	2.9	3.81	1.87	56.9
Q1	170.7	0.26	47.5	21.3	2.02	6.0	3.82	1.93	57.9
Median	270.4	0.31	48.0	22.7	2.09	8.9	3.83	1.95	58.4
Q3	564.7	0.38	48.7	23.8	2.17	11.1	3.83	1.96	58.7
Max	3.668.7	0.49	50.2	29.4	2.46	19.7	3.85	2.02	60.0
Regions with medium share of online bank accounts 44 % < x < 53 % (n = 221)									
Mean	336.9	0.34	48.6	21.8	2.08	9.2	3.83	1.94	58.0
Min	34.9	0.08	45.0	16.8	1.85	2.6	3.81	1.84	54.5
Q1	119.9	0.27	47.9	20.5	2.02	6.2	3.82	1.92	57.6
Median	203.1	0.33	48.6	21.7	2.05	8.9	3.83	1.93	58.0
Q3	360.8	0.40	49.3	23.1	2.12	11.3	3.83	1.95	58.5
Max	2.726.9	0.55	53.6	35.6	2.44	22.6	3.86	2.06	60.6
Regions with lowest share of online bank accounts ≤ 44 % (n = 81)									
Mean	269.8	0.40	49.9	19.6	2.16	11.0	3.83	1.90	57.2
Min	32.4	0.10	45.8	16.2	1.86	2.9	3.81	1.83	55.4
Q1	74.0	0.34	48.4	17.9	2.04	7.8	3.82	1.85	56.2
Median	107.6	0.42	50.0	18.9	2.18	11.4	3.83	1.89	57.1
Q3	163.8	0.48	51.4	21.5	2.25	13.4	3.83	1.94	58.1
Max	3.017.5	0.61	52.5	24.4	2.37	21.6	3.86	1.98	60.3
Difference of averages: Panel highest share ./. Panel lowest share of online bank accounts									
Difference	217.9	–0.08	–1.79	3.0	–0.05	–1.93	0.005	0.05	1.17
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.002)	(0.000)	(0.000)	(0.000)

Notice: Density = population density; Savings assets = share of savings deposits in customer deposits; Age = average age; Income = average income; Education (1 = low to 4 = high); Education = Level of education (1 = low to 4 = high); Distance = Distance to nearest savings bank branch; F-index = Financial knowledge (2 = good to 5 = bad); Internet (hours) = period of use; Internet (index) = internet literacy; Mean = arithmetic mean, Q1/Q3 = first/third quartile.

Source: own calculation and presentation.

Table 2

Descriptive Statistics for the Data Set – Subdivision According to Business Areas in East and West

	Account (%)	*Savings assets* (%)	*Age* (Years)	*Income* (KEUR)	*Education* (Index)	*Distance* (min)	*F-Index* (Index)	*Internet* (h)	*Internet* (Index)
Regions old states (n = 329)									
Mean	50.3	0.33	48.4	22.1	2.07	9.2	3.83	1.94	58.1
Min	34.1	0.08	45.0	16.2	1.85	2.6	3.81	1.84	54.5
Q1	47.0	0.26	47.7	20.9	2.02	6.1	3.82	1.92	57.7
Median	50.2	0.33	48.4	22.1	2.05	9.0	3.83	1.94	58.1
Q3	53.3	0.39	49.0	23.3	2.13	11.4	3.83	1.96	58.6
Max	67.4	0.55	53.6	35.6	2.46	22.6	3.86	2.06	60.6
Regions new states (n = 61)									
Mean	40.2	0.44	50.7	18.3	2.26	11.6	3.82	1.87	56.7
Min	26.6	0.25	48.0	16.7	2.16	3.5	3.81	1.83	55.4
Q1	36.5	0.39	50.0	17.7	2.20	8.4	3.82	1.85	56.1
Median	40.7	0.45	50.8	18.2	2.24	11.8	3.82	1.86	56.7
Q3	43.2	0.50	51.7	18.9	2.30	13.9	3.82	1.89	57.2
Max	51.7	0.61	52.5	19.9	2.44	21.6	3.85	1.99	58.6
Difference of averages: Panel regions old states ./. Panel regions new states									
Difference	10.1	−0.11	−2.3	3.8	−0.18	−2.4	0.005	0.07	1.6
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notice: Account = share of online bank accounts ; Savings assets = share of savings deposits in customer deposits; Age = average age; Income = average income; Education (1 = low to 4 = high); Education = Level of education (1 = low to 4 = high); Distance = Distance to nearest savings bank branch; F-index = Financial knowledge (2 = good to 5 = bad); Internet (hours) = period of use; Internet (index) = internet literacy; Mean = arithmetic mean, Q1/Q3 = first/third quartile.

Source: own calculation and presentation.

4. Heatmap of Informational Divide

Figure 1 shows the share of online bank accounts as a proxy for the risk of an informational divide in the business areas of the savings banks in the sense of a 'heatmap'. As already illustrated quantitavely in Tables 1 and 2 the discrepancy between new and old states is obvious and leads to the assumption that the informational divide in the new states is more severe.

5. Regression Models

In a first step, the variables have been included in a correlation matrix and eliminated if necessary (cf. table 6 in the appendix). In a second step, the variables "income" and "population density" have been standardised using natural logarithm. Finally, the variables have been included stepwise in a linear cross-sectional regression model which culminated in following equations:

(M1:) Percentage of online bank accounts$_i$ = α_i + $\beta_1$ln(Density)$_i$ + $\beta_2$ln(Income)$_i$ + β_3Education$_i$ + β_4Age$_i$ + β_5East-West$_i$ + u_i

(M2:) Percentage of online bank accounts$_i$ = α_i + $\beta_1$ln(Density)$_i$ + $\beta_2$ln(Income)$_i$ + β_3Education$_i$ + β_4Age$_i$ + β_5Total assets$_i$ + β_6Savings assets$_i$ + β_7East-West$_i$ + u_i

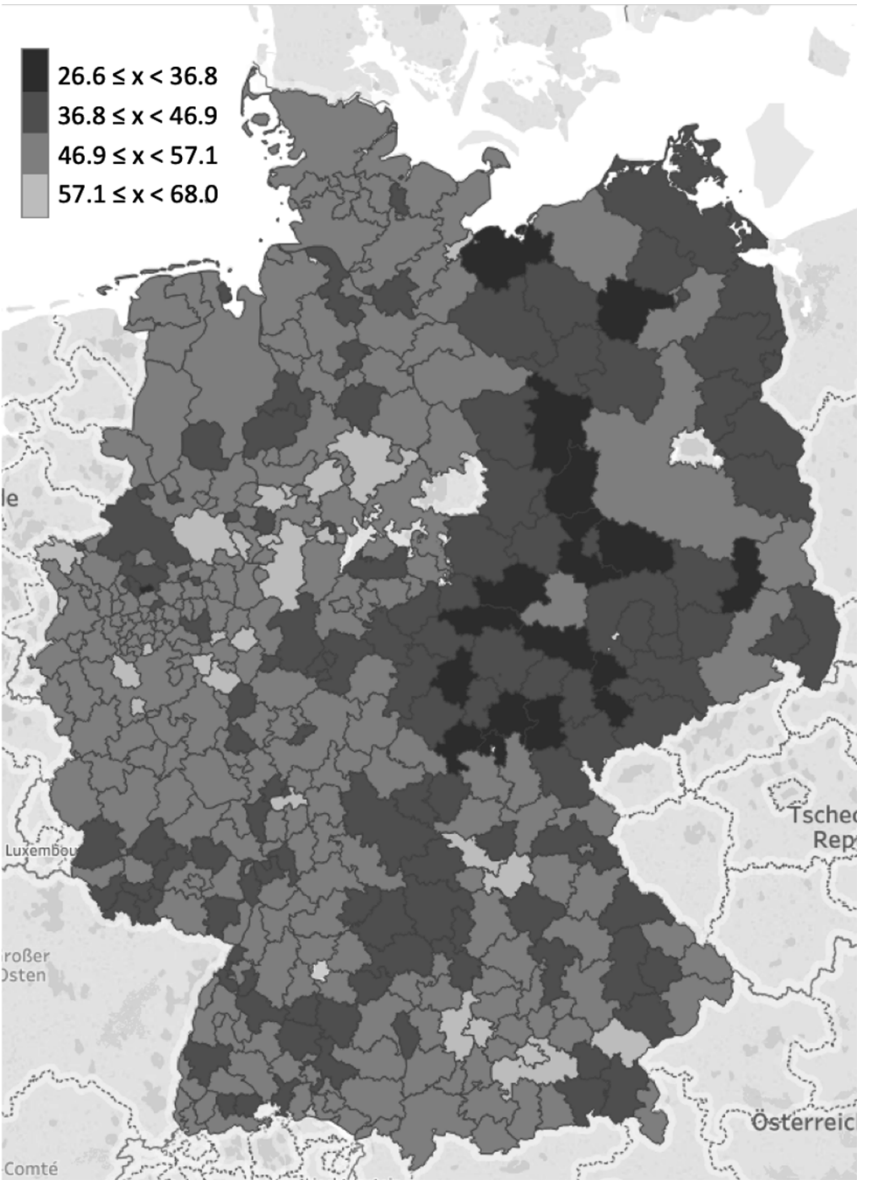
(M3:) Percentage of online bank accounts$_i$ = α_i + $\beta_1$ln(Density)$_i$ + $\beta_2$ln(Income)$_i$ + β_3Education$_i$ + β_4BdB-Index$_i$ + β_5ING-Index$_i$ + β_6Internet competency$_i$ + β_7Internet usage$_i$ + β_8East-West$_i$ + u_i

V. Results

1. Regression Results

All regressions that have been conducted are in line with the Gauss-Markov assumptions. The residuals are normally distributed and show no multicollinearity or heteroscedasticity. The regression results of the three models are documented in Table 3 and show that the variables – measured by R^2 – can explain a maximum of 41 % of the dispersion of the dependent variable (share of online bank accounts).

Model (M1) reveals that population density has a significantly positive and age a significantly negative influence on the share of online bank accounts. No reliable conclusion can be interpreted for the influence of income and education: the statistical significance of the income effect is lost depending on the inclusion or omission of various variables and the effect of education changes



Source: Own calculation and presentation.

Notice: Business areas of the savings banks with a share of online bank accounts in percentage terms.

Figure 1: Heatmap Informational Divide in %

when excluding the East-West dummy. Additional analyses of the influence of age supports the non-linear (inversely U-shaped) correlation as already revealed in *Kleine/Jolms* (2016) and *Lambrecht/Seim* (2006). If the variable average age is replaced by age groups in the estimation model, a corresponding significance is found for classes 16 to 24 (+), 55 to 74 (–) and for 75 (–). Hence, the share of online bank accounts is higher in those regions that have a comparatively high number of young people and a relatively small number of older and very old people (cf. Table 7 in the appendix).

By including control variables in the models (M2) and (M3), the following results are observed: population density has a (weak) significant positive influence on the share of online bank accounts and seems to be distorted by total assets and internet literacy. The educational level has a (strong) significant positive influence on the share of online bank accounts when implementing the East-West dummy. Income on the other hand seems to be highly influenced by the education level.

Furthermore, no signficant influence can be interpreted for total assets and savings assets. The approximations for financial education (BdB-index and ING-index) in model (M3) have a highly negative and significant influence when generated on the basis of the education level. If the proxies are generated with the age structure, no significant influence can be observed for financial knowledge. This observation is not very surprising since the correlation of financial literacy and age structure is on an intermediate level. Similar results are revealed for the approximations of internet literacy and internet usage: When the approximations are based on education level, a highly positive influence can be investigated and still a high influence when based on age structure.

With regard to the coefficient of determination, these control variables add further explanatory power to the dispersion of the share of online bank accounts when generated on education level by one percentage point (R^2) and no further explanatory power when based on the age structure. For the East-West dummy, a significant negative influence is observed in all model variations. The share of online bank accounts is significantly lower in regions of the new states. This is a clear indication of a structural break, which will be examined in more detail below by partitioning between the regions of the new and old states (cf. Tables 4 and 5).

For the regions of the old states, it becomes obvious that population density, income and education (and related financial and internet literacy) have a significant positive influence on the share of online bank accounts. In contrast to the analysis of all regions in this cluster, no significance is observed for age. The same applies to the control variables in model (M2). However, the statistically significant variables only result in a low explanatory content of approx. 7 %.

Table 3

Regression Results – All Regions

	Dependent Variable: Percentage of Online Bank Accounts			
Scenario	(1)	(2)	(3)	(4)
Model (M1)				
Const.	***–81.97 (31.32)	–18.71 (30.96)	–25.24 (31.74)	2.94 (32.67)
ln(Density)	***1.33 (0.28)	**0.58 (0.29)	***0.91 (0.27)	**0.62 (0.28)
ln(Income)	***18.58 (2.60)	4.70 (3.29)	***9.94 (2.88)	4.90 (3.28)
Education	**–11.64 (5.03)	***25.59 (7.01)		***22.32 (7.17)
Age	***–1.09 (0.20)		***–0.59 (0.21)	**–0.44 (0.22)
East-West		***–10.84 (1.32)	***–6.03 (1.00)	***–9.47 (1.48)
Corr. R^2	0.34	0.39	0.38	0.40
RMSE	5.04	4.82	4.85	4.80
Model (M2)				
Const.	**–82.70 (32.80)	–7.31 (33.37)	2.87 (32.74)	–8.08 (33.50)
ln(Density)	***1.18 (0.29)	0.48 (0.30)	**0.62 (0.29)	0.47 (0.30)
ln(Income)	***17.89 (2.68)	5.05 (3.27)	4.90 (3.28)	5.05 (3.28)
Education	***–13.67 (5.30)	***20.11 (7.32)	***22.42 (7.37)	***20.57 (7.47)
Age	***–0.96 (0.21)	–0.35 (0.22)	**–0.44 (0.22)	–0.35 (0.23)
ln(Assets)	0.34 (0.33)	0.45 (0.31)		0.47 (0.31)
Savings assets	–4.01 (2.84)		0.15 (2.75)	0.88 (2.82)
East-West		***–9.51 (1.48)	***–9.49 (1.54)	***–9.65 (1.54)
Corr. R^2	0.33	0.40	0.40	0.40
RMSE	5.07	4.79	4.81	4.89
Model (M3)				
Const.	**375.23 (158.99)	*86.83 (47.98)	–31,51 (31.34)	–36.42 (31.47)
ln(Density)	***0.86 (0.27)	**0.68 (0.28)	0.39 (0.31)	0.42 (0.31)
ln(Income)	**7.63 (3.00)	4.55 (3.35)	***7.90 (2.91)	***7.95 (2.91)
Age	**–0.51 (0.22)	**–0.47 (0.22)	**–0.45 (0.22)	**–0.46 (0.22)
BdB-Index	**–99.12 (38.57)			
ING-Index		***–112.40 (36.27)		
Int.-lit.			***0.47 (0.14)	
Int.-use.				***0.38 (0.11)
Corr. R^2	0.40	0.40	0.41	0.41
RMSE	4.82	4.81	4.79	4.79

Notice: n = 390; Density = population density; Income = income per capita; Education = education; Age = average age; Assets = total assets; Savings assets = share of savings deposits in customer deposits; BdB-Index = financial knowledge; ING-Index = financial education; Int.-lit. = internet literacy; Int.-use. = internet usage; Corr. R^2 = corrected R^2; RMSE (Root Mean Square Error) is a measure that represents the difference between the forecast and the historical data – the lower the RMSE, the better the adjustment of the model; statistical significance levels *** = 1 % ** = 5 % * = 10 %; (p-value).

Source: Own calculation and presentation.

Table 4

Regression Results – Business Areas of Old States

	Dependent Variable: Percentage of Online Bank Accounts			
Scenario	(1)	(2)	(3)	(4)
Model (M1)				
Const.	–20.82 (33.72)	–32.44 (31.45)	–43.03 (32.57)	
ln(Density)	**0.63 (0.30)	**0.62 (0.30)	**0.83 (0.29)	
ln(Income)	**6.59 (3.35)	**6.56 (3.35)	***10.48 (2.92)	
Education	**17.20 (7.37)	**18.61 (7.22)		
Age	–0.22 (0.23)		–0.33 (0.23)	
Corr. R^2	0.07	0.07	0.05	
RMSE	4.97	4.79	4.79	
Model (M2)				
Const.	–33.01 (34.82)	–29.82 (34.58)	–21.89 (33.82)	
ln(Density)	0.50 (0.31)	0.52 (0.31)	**0.63 (0.30)	
ln(Income)	**6.78 (3.35)	**6.74 (3.35)	**6.60 (3.35)	
Education	**16.63 (7.68)	**15.40 (7.53)	**18.17 (7.60)	
Age	–0.13 (0.24)	–0.14 (0.24)	–0.23 (0.23)	
ln(Assets)	0.44 (0.33)	0.37 (0.32)		
Savings assets	2.48 (3.04)		1.56 (2.97)	
Corr. R^2	0.07	0.07	0.07	
RMSE	4.79	4.79	4.80	
Model (M3)				
Const.	*295.93 (163.40)	44.66 (49.83)	–45.66 (32.26)	–49.80 (32.34)
ln(Density)	***0.83 (0.29)	**0.69 (0.30)	0.40 (0.32)	0.43 (0.32)
ln(Income)	***8.62 (3.04)	*6.29 (3.41)	***8.72 (2.96)	***8.75 (2.96)
Age	–0.27 (0.23)	–0.25 (0.23	–0.24 (0.23)	–0.25 (0.23)
BdB-Index	**–83.98 (39.68)			
ING-Index		**–87.95 (37.42)		
Int.-lit.			***0.38 (0.14)	
Int.-use.				***0.32 (0.11)
Corr. R^2	0.07	0.07	0.08	0.08
RMSE	4.80	4.80	4.78	4.78

Notice: n = 329; Density = population density; Income = income per capita; Education = education; Age = average age; Assets = total assets; Savings assets = share of savings deposits in customer deposits; BdB-Index =financial knowledge; ING-Index = financial education; Int.-lit. = internet literacy; Int.-use. = internet usage; Corr. R^2 = corrected R^2; RMSE (Root Mean Square Error) is a measure that represents the difference between the forecast and the historical data – the lower the RMSE, the better the adjustment of the model; statistical significance levels *** = 1 % ** = 5 % * = 10 %; (p-value).

Source: Own calculation and presentation.

Table 5

Regression Results – Business Areas of New States

	Dependent Variable: Percentage of Online Bank Accounts			
Scenario	(1)	(2)	(3)	(4)
Model (M1)				
Const.	180.35 (147.79)	155.65 (151.38)	142.34 (157.52)	
ln(Density)	–0.26 (1.08)	–0.93 (1.06)	*1.77 (0.91)	
ln(Income)	–15.04 (15.81)	–21.34 (15.94)	0.27 (16.03)	
Education	***90.07 (29.66)	***121.08 (26.21)		
Age	**–1.27 (1.27)		***–2.23 (0.57)	
Corr. R^2	0.31	0.27	0.21	
RMSE	4.41	4.53	4.72	
Model (M2)				
Const.	122.50 (146.33)	168.10 (154.46)	154.91 (150.16)	
ln(Density)	–1.13 (1.11)	–0.83 (1.11)	–0.35 (1.08)	
ln(Income)	–12.62 (15.51)	–16.20 (15.56)	–12.69 (16.00)	
Education	**72.16 (29.79)	**78.49 (29.92)	***88.21 (29.73)	
Age	–0.76 (0.64)	*–1.06 (0.62)	*–1.12 (0.63)	
ln(Assets)	**2.26 (1.06)	*1.76 (1.02)		
Savings assets	–12.12 (7.63)		–7.31 (7.52)	
Corr. R^2	0.35	0.34	0.31	
RMSE	4.28	4.34	4.41	
Model (M3)				
Const.	990.42 (1011.39)	**524.07 (198.14)	8.70 (155.33)	–16.48 (158.53)
ln(Density)	0.99 (1.30)	–0.09 (1.07)	–0.01 (1.05)	0.09 (1.04)
ln(Income)	–7.72 (18.62)	–18.24 (16.37)	–5.43 (15.22)	–5.94 (15.26)
Age	**–1.77 (0.79)	**–1.51 (0.59)	–0.48 (0.81)	–0.49 (0.81)
BdB-Index	**–205.70 (242.29)			
ING-Index		***–424.08 (146.15)		
Int.-lit.			***2.19 (0.76)	
Int.-use.				***1.88 (0.66)
Corr. R^2	0.21	0.31	0.31	0.31
RMSE	4.73	4.44	4.45	4.45

Notice: n = 61; Density = population density; Income = income per capita; Education = education; Age = average age; Assets = total assets; Savings assets = share of savings deposits in customer deposits; BdB-Index = financial knowledge; ING-Index = financial education; Int.-lit. = internet literacy; Int.-use. = internet usage; Corr. R^2 = corrected R^2; RMSE (Root Mean Square Error) is a measure that represents the difference between the forecast and the historical data – the lower the RMSE, the better the adjustment of the model; statistical significance levels *** = 1 % ** = 5 % * = 10 %; (p-value).

Source: Own calculation and presentation.

Looking at Table 5 it becomes clear that education has a significant positive influence on the share of online bank accounts in the regions of the new states. Age in combination with education level has a significant negative influence on the share of online bank accounts in the new states. The inclusion of total assets seems to distort the age/education relation. The positive significant influence of total assets shows that larger institutions have a higher share of online bank accounts. This may indicate an urbanisation effect. Financial and internet literacy and internet usage seem to have an even stronger effect than in the old states.

2. Evaluation of the Hypotheses

In relation to the hypotheses formulated in section III., the following conclusions can be drawn:

- Hypothesis (H1) is mainly supported by the results. In general the share of online bank accounts decreases with average age (H1.1) and increases with population density (H1.2). In addition, the inverted U-shaped relationship between age is supported (H1.1). However, the age effect plays a greater role within the new states whereas the population density effect plays a greater role within the old states of Germany.[11] In this respect, a higher risk of an informational divide can be expected for peripheral, sparsely populated areas, which have a comparatively high average age and a longer travel time to the nearest branch.
- Hypothesis (H2) is only partially supported by the results. The income[12] (H2.1) has – with regard to the entire federal territory – only a weak statistical significance. The effect increases when considering only the old states. Moreover, the savings assets (H2.2) included as a control variable shows neither a clear (with regard to the direction of effect) nor a significant influence on the share of online bank accounts, regardless of the location in the new or old states. In this respect, there is only limited evidence that the risk of an informational divide is higher in economically weak regions (compared to economically strong regions).
- Hypothesis (H3) cannot be rejected. The level of education (H3.1) is a reliable indicator for having an online bank account. This interpretation is also reflected in the analysis of the old and new states. The approximations of financial or internet literacy seem to add slightly more explanatory power when

[11] Regarding population density, no evidence can be observed in support of H1.4. The travel time has no influence on the share of online bank accounts in this study.

[12] In alternative model specifications, the unemployment rate, which is highly negatively correlated with income, was included instead of income, and again: no stable significant influence on the share of online bank accounts was found.

based on education level (H3.2, H3.3, H3.4), whereas the relevance in the new states (comparing to old states) is likely to be higher. In general it can be concluded that the risk of an informational divide should be higher in regions with comparatively low average educational attainment and in those regions where media literacy is comparatively low.

No clear identification of the effect of financial and internet literacy can be found in this study. Therefore, the influence of financial and internet literacy on online bank accounts can only be interpreted in combination with the survey results on an aggregated level[13]. While the "digital natives", represented by the age group between 20 and 29 years, have the highest internet literacy, individuals in the age group between 30 and 49 years are the most active group in using e-commerce and online banking services (with a share of 41 %).

Our regressions reveal a very similar result: the level of education seems to be the most important factor for having an online bank account. Financial and internet literacy seem to have only a side effect or to be determined by other variables such as education, income, age, gender, trust in data security and/or risk tolerance. A more comprehensive study is needed to investigate the exact causality.

3. Limitations

A limitation results from the discrepancy between the 2011 census data and the online bank account data in 2017 for the business areas of savings banks in Germany. On the one hand, there is no current data set with a similar granular data structure at municipal level as the 2011 census data. On the other hand, time inconsistencies can lead to distortions in multivariate analysis. In order to elaborate this potential bias, we analysed the population development between 2011 and 2017. The population data for the respective municipalities is gathered from the statistical offices of the respective federal states. Distortion effects can occur especially in the different age structures due to urbanisation effects between 2011 and 2017.

The correlation between the average population age of the savings bank areas and population development is -0.67 (for internet literacy: 0.70). This is an indication of a progressive urbanisation effect. In addition, an auxiliary regression is conducted, which includes population change (in %) as the dependent variable. The independent variables are the different population developments in dif-

[13] Financial literacy: *Bundesverband deutscher Banken* (2017) and *ING-DiBa* (2017); Internet literacy and Internet usage: *D21-Digital-Index* (2017), *Eurostat survey* (2017).

ferent municipality sizes (village < 1,500; 1,500 ≤ rural community < 5,000; 5,000 ≤ small town < 20,000; 20,000 ≤ city < 100,000; large city > 100,000).

In addition, the variables age, population density and the east/west dummy are included stepwise. With the exception of the variable "village", all variables are statistically significant at a 5 % level. Furthermore, the regression has a coefficient of determination of around 0.81. The variables age, new states and small town appear to have the strongest effects on population development. However, this auxiliary regression is only used as an indicator and is therefore not documented.

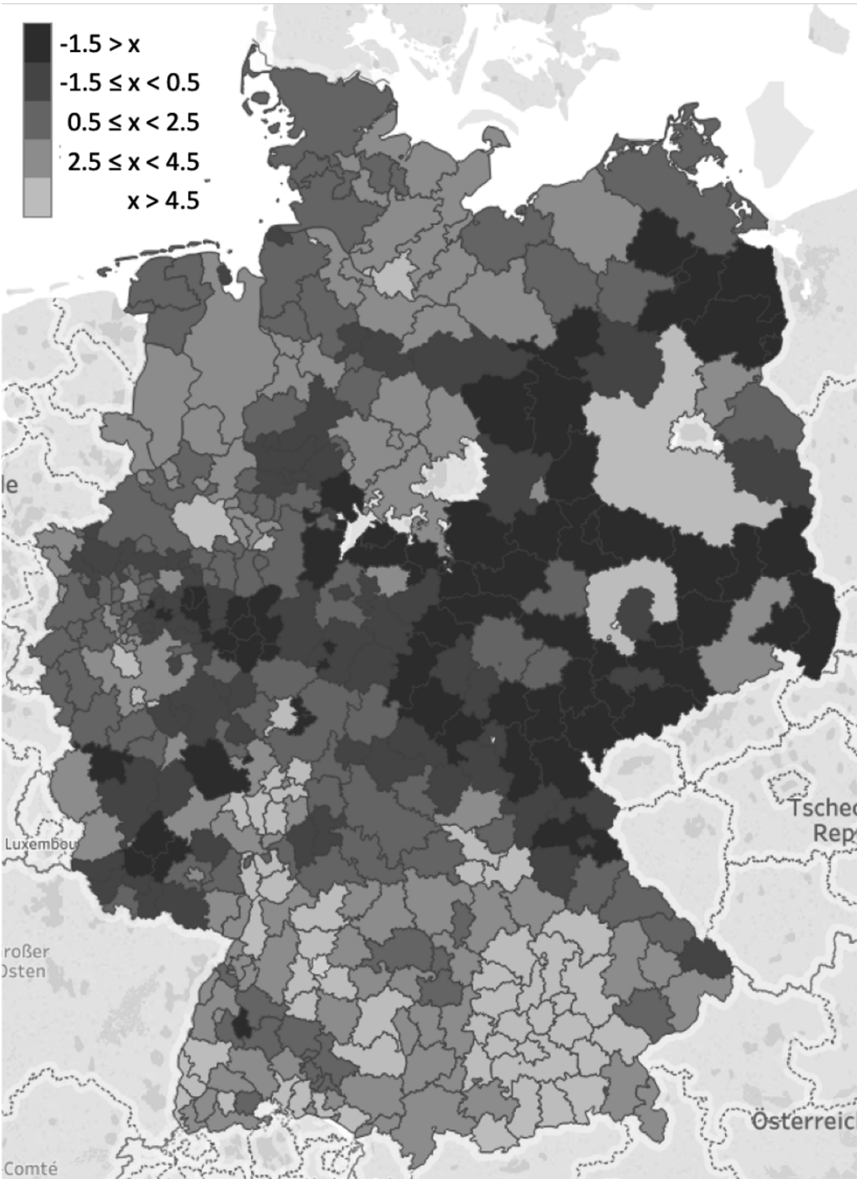
A further indicator is provided by the inclusion of the population development variable as an independent variable in the model (M1). The population development is statistically significant only in the old states at a 10 % significance level.

The correlation between the urbanisation effect and the online account rate can be seen graphically by comparing Figure 1 and 2. The Federal Institute for Research on Building, Urban Affairs and Spatial Development[14] provides additional support in the form of a graphical representation of the population development of the municipalities since 2011.

It can be concluded that the urbanisation effect has continued to increase on average between 2011 and 2017. The high negative correlation with age and the results of the auxiliary regression seem to corroborate that especially young people tend to increase the urbanisation effect. Thus, we cannot eliminate a potential bias which arisis from the data time discrepancy but we can conclude that this bias is negligibly small for this study. However, the flow of refugees from 2015 to 2017 in Germany might also lead to additional distortion in the analyses of the population development. Since most refugees are not included in the statistics we cannot measure this distortion.

Furthermore, the data includes only online bank accounts from savings banks in Germany which is a distortion itself. A study from mm1 Consulting (2017) substantiate this bias. According to mm1 Consulting (2017) the market share of the approximately 1,500 savings banks and credit unions in Germany still amounts to more than 80 % among older teenagers. However, between the early 20s and mid-30s, the rate gradually declines to only 50 %. This phenomena seems to be caused by account fees charged by savings banks and credit unions when no more discounts are granted at a certain age level (e. g. study, apprenticeship).

[14] Bundesinstitut für Bau-, Stadt- und Raumforschung: https://bit.ly/2GGL1HX.



Source: Own calculation and presentation.

Notice: Figure 2 shows the population development in the business areas of savings banks between 2011 and 2017 in percentage terms.

Figure 2: Population Development Between 2011 and 2017 (in %)

In addition, there is a trend towards app-based banking, which also led to a decline in the number of customers. As soon as there is a demand for real estate loans or private pension provision, the number of customers is rising again in the age group of 40 years and older. Therefore, the business model of individual banks seems to play a role in customer acquisition. However, these elements can only be discussed in an interbank study.

VI. Conclusions and Outlook

This study investigates the impact of socio-economic and demographic factors on the use of online banking, measured by the share of online bank accounts in all retail customer accounts of savings banks in Germany. The socio-economic factors age, income, savings assets and education are available at the municipal level whereas financial and internet literacy are transformed from aggregated survey results to the respective savings bank areas.

In general the probability of using an online bank account increases with the level of education, income, financial and internet literacy and population density while it decreases with age or shows an inversely U-shaped relationship with age. People in the age between 30 and 49 years use internet banking most often. The results are consistent with survey results on the influence of age, income, education and financial knowledge on the use of digital financial services (*Königsheim et al.* 2017; *Akhter* 2015; *Kleine/Jolmes* 2016; *Berger/Gensler* 2007; *Lambrecht/Seim* 2006). Differences in the relevance and significance of these factors can be seen in the comparison of East and West Germany. In the new states of the East the influence of education, financial literacy, internet literacy and age is particularly significant. In the business areas of the old states, the population density and income are highly significant. In general it can be concluded that older people, people in rural, sparsely populated regions and those with a low level of education are exposed to a higher risk of an informational divide. Hence, these people face the risk of being left behind as the digitalisation of banking services becomes more progressive and of losing access to basic financial services.

In a less static view, internet literacy seems to be a crucial factor for the probability of an informational divide and is highly correlated with the educational level. Therefore, individuals with a lower formal level of education may acquire greater competence and motivation to use digital access via training, thus reducing the risk of being left behind.

Two limitations arise from the data sets used in this study. On the one hand, the data refer only partially to the same period, which distorts the results. On the other hand, a small share of online bank accounts may be a poor indicator for the existence or risk of an informational divide, because the share of online

bank accounts does not provide any information about whether this online account is actively used.

The use of online banking could also be a matter of avoiding costs, since online bank accounts often involve lower account fees or even (in response to competition from direct banks) no fees at all. More powerful indicators (if available) could be used in subsequent studies: Indicators on the use of online banking or home banking software, or on the use of banking apps, data on online transactions, or the frequency or likelihood of having completed or being able to complete a banking transaction online. In addition, further econometric analyses could be conducted, i. e. neighborhood effects and more non-linear relationships.

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Appendix

Table 6

Correlation Matrix

	OA	*E/W*	*Bal.*	*Sav.*	*Density*	*Alt.*	*Income*
OA	1.00						
E/W	–0.58	1.00					
Ass.	0.20	–0.06	1.00				
Sav.	–0.29	0.40	–0.26	1.00			
Density	0.31	–0.32	0.36	–0.19	1.00		
Age	–0.45	0.59	–0.28	0.33	–0.19	1.00	
Income	0.47	–0.62	0.11	–0.34	0.18	–0.43	1.00
School	–0.04	0.42	0.23	–0.01	0.21	0.10	–0.11
Edu.	–0.16	0.59	0.24	0.02	0.01	0.20	–0.06
Dist.	–0.18	0.19	–0.18	0.03	–0.44	0.12	–0.09
I.-use.	0.45	–0.61	0.28	–0.30	0.26	–0.92	0.37
I.-lit.	0.43	–0.55	0.32	–0.34	0.23	–0.99	0.41
ING-I	0.36	–0.40	0.44	–0.35	0.34	–0.90	0.32
BdB-I	0.24	–0.25	0.38	–0.21	0.31	–0.66	0.10
	School	*Edu.*	*Dist.*	*I.–use.*	*I.–Kp.*	*ING–I*	*BdB–I*
School	1.00						
Edu.	0.86	1.00					
Dist.	–0.14	–0.03	1.00				
I.-use.	–0.12	–0.25	–0.15	1.00			
I.-lit.	–0.04	–0.13	–0.14	0.91	1.00		
ING-I	0.14	0.05	–0.18	0.87	0.93	1.00	
BdB-I	0.16	0.04	–0.15	0.84	0.69	0.82	1.00

Notice: OA = share of online bank accounts; E/W = East-West; Ass. = total assets of the savings bank; Sav. = savings assets; Density = population density; Age = average age; Income = average income per capita; School = school Degree; Edu. = educational level (1 = low to 4 = high); Dist. = distance to next savings bank branch; I.-use. = internet usage; Int.-lit. = internet literacy; ING-I = index financial education; BdB-I = index financial knowledge; n = 390.

Source: Own calculation and presentation.

Table 7

Influence of Age on the Share of Online Bank Accounts

Age groups	*Multivariate Regression*
All Regions	
Age group 16 to 24	**68.81
Age group 25 to 54	9.65
Age group 55 to 74	**–36.95
Age group 75 and older	*–44.22
Regions old States	
Age group 16 to 24	33.95
Age group 25 to 54	2.05
Age group 55 to 74	–25.53
Age group 75 and older	–23.10
Regions new States	
Age group 16 to 24	**194.59
Age group 25 to 54	60.16
Age group 55 to 74	–59.68
Age group 75 and older	**–135.85

Notice: Results of the adjusted model estimation (M1). The average age is replaced by age groups; statistical significance levels *** = 1 % ** = 5 % * = 10 %.

Source: Own calculation and presentation.