Financial Knowledge, Risk Preferences, and the Demand for Digital Financial Services

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Abstract

Financial knowledge and risk preferences explain a large part of the variation in important financial decisions of households such as stock holdings, personal debt, retirement savings, or the adoption of financial innovations. Based on a survey among more than 1,700 customers of a German retail bank, we find that both financial knowledge and risk tolerance are significantly positively correlated with the likelihood to use digital financial services. As in previous studies, gender, age, and education additionally influence this decision. Moreover, individuals preferring the traditional banking solution require a higher compensation to switch to a digital service provider than customers of a digital service provider require to switch back to the retail bank, which we interpret as further evidence for the central role of financial knowledge and risk preferences. Our results have implications for both traditional banks and providers of digital financial services.

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1 Introduction

Financial technology start-ups providing lean online consumer financial products and services (hereafter: "Fintechs") have seen massive growth rates recently, threatening the more cost-intensive business models of traditional retail banks. Goldman Sachs (2015) estimates that almost US$5 trillion of the revenues of traditional financial institutions might potentially be taken over by Fintechs, thereby transferring almost US$500 billion in profits to the new providers. As an example, the assets under management (AUM) of Betterment, a US-based digital provider of investment advice, have exhibited double-digit growth rates over the last years; the company currently has more than US$5 billion of AUM. Similarly, in Germany, Scalable Capital has seen substantial growth in AUM, which now amount to more than US$200 million. Fintechs usually transfer traditional banking services from banks to digital platforms on the internet. Importantly, they disaggregate the personnel-intensive processes operated by traditional banks and offer technology-based solutions, thereby exploiting savings opportunities in each process step. In this way, they often succeed in providing low-cost solutions compared to traditional banks' cost-intensive services.[1] Fintechs are part of a larger development in which traditional banking services are increasingly being provided in digital form. Financial advice provided through online communities, loans granted via peer-to-peer lending platforms, and digital payment services are among the most prominent fields in which providers of digital financial services compete against traditional banks.

Since providers of digital financial services usually replace in-person advice with software-based solutions, their customers face a higher degree of individual responsibility compared to the traditional provision of financial products in a physical bank office when using these services. As there is ample evidence that both financial literacy and risk attitudes are significantly related to financial outcomes in situations in which customers need to act more autonomously, we analyze whether financially knowledgeable and risk tolerant consumers are also more likely to use digital financial services.

Our analysis is based on a unique dataset with 1,752 survey responses provided by current clients of a traditional German retail bank. This focus and the fact that our sample is representative of the bank's total customer group are key advantages of our study as they allow us to study the potential switching behavior of actual banking clients from an incumbent to the new digital service providers. We obtain a sample of banking clients with a large variation in financial knowledge, risk preferences, and demographic variables compared to, e.g., a sample comprised of students. The

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[1]Regarding regulatory requirements such as a banking license, most Fintechs cooperate with traditional banks as they are usually not able to fulfill the requirements on their own. In spite of such cooperations, Fintechs and the cooperating banks typically have distinct product offerings such that they potentially compete for the same clients; due to the offering of e.g. white-label products, the cooperation is not necessarily visible to the client.

survey is specifically designed to test for the interrelation of financial knowledge and risk preferences on the one hand and the readiness to adopt digital financial services in three important domains of retail banking (investment advice, loans, and payment services) on the other hand.

Previous research suggests that many individuals lack the knowledge required to cope with an increased degree of responsibility and autonomy in financial decision-making. Investing in the stock market, taking out a loan, or planning retirement savings are examples of core financial decisions which are significantly correlated with individuals' financial literacy (Lusardi and Tufano; 2015; van Rooij et al.; 2007, 2011; von Gaudecker; 2015). In addition to financial literacy, risk attitudes are usually found to be related to the likelihood of holding stocks and the speed at which individuals adopt financial innovations (Bauer and Hein; 2006; van Rooij et al.; 2007). Missing from the previous research is, however, an analysis of the connection between financial literacy, risk preferences, and the demand for digital financial services. Our study fills this gap by investigating the role of self-assessed financial knowledge (as a proxy for financial literacy) and self-assessed financial risk tolerance (as a proxy for risk preferences in the financial domain) for the adoption of digital financial services.

We first find that financial knowledge is significantly and positively correlated with the likelihood to use digital financial services. For each level of self-assessed financial knowledge (measured from 1, lowest, to 5, highest), the likelihood to use a digital service offering increases by about 3.3 percentage points (pp). Second, higher financial risk tolerance is accompanied by a higher likelihood to adopt these new technologies. For each level of self-assessed risk tolerance (measured from 1, lowest, to 5, highest), the likelihood to choose the services of a digital service provider increases by about 3.9 pp. In addition to our main findings, our analyses suggest that men, younger individuals, and clients with a higher level of education are significantly more likely to use digital financial services.

Furthermore, we are interested in the level of compensation required by individuals to be willing to switch to the provider of financial services they do *not* choose in the survey. As expected, individuals preferring the traditional retail bank require a substantially higher relative compensation to consider switching to the digital service provider than do individuals opting for the digital service provider in order to switch to the traditional provider. As more financially knowledgeable and risk tolerant individuals are better able to assess the benefits of switching and more willing to approach digital service providers without a proven track record, we interpret this asymmetry as further evidence for the central role of both parameters in the decision to use digital financial services.

In-person services as provided by traditional banks appear to be especially relevant for financially unsophisticated and risk averse customers. As customers with high financial literacy are often clients with a higher income (and are thus potential high-value customers), our results have important

implications for the providers of digital financial services as well as for traditional retail banks. While the former need to develop ways to attract less financially knowledgeable and more risk averse clients (if this clientele fits their business model), the latter need to find a suitable strategy to cater to their financially literate and well-educated high-value customers in order to retain them.

This study contributes to the existing literature in several ways. First, we extend the broader research on financial literacy and risk preferences by examining the role of self-assessed financial knowledge and risk tolerance for the adoption of financial services offered by digital service providers. We relate both measures to outcomes in the domain of household finance which have not yet been investigated from this point of view. Second, considering the potential importance of the current digital revolution in the retail banking market, there is surprisingly little work on the drivers and potential future outlook of this development. Our results add to this strand of research and provide avenues for future projects.

The remainder of this paper is organized as follows: In Section 2, we review the related literature. In Section 3, we develop a model of the demand for digital financial services. Section 4 describes the setup of our survey, states our predictions, and contains the descriptive statistics of the dataset. Our main results are presented in Section 5, along with an analysis of heterogeneity and several robustness checks. Section 6 discusses our results and concludes.

2   Review of Related Literature

Our study is primarily related to the research on the influence of financial literacy and risk preferences on consumers' financial decisions. We also contribute to the research investigating the interaction between financial literacy and risk preferences.

The research on financial literacy focuses on the influence of individuals' financial sophistication on their decisions in various financial domains. As pointed out by van Rooij et al. (2011), higher individual autonomy in several important domains of household finance continuously increases the need for households to have sufficient financial knowledge. Individuals with insufficient financial knowledge could substitute financial expertise with advice by more knowledgeable individuals (von Gaudecker; 2015). Importantly, higher financial literacy is usually found to lead to increased participation in the stock market (van Rooij et al.; 2007, 2011) and to more reasonable stock market behavior such as better diversified portfolios (von Gaudecker; 2015) or smaller investment mistakes such as the disposition effect and risky share inertia (Calvet et al.; 2009). In the domain of personal debt, previous findings show that financial literacy decreases the degree of indebtedness (Lusardi

and Tufano; 2015) and leads to more thoughtful debt behavior: as an example, Agarwal et al. (2016) show that mortgage borrowers with higher financial sophistication refinance their mortgages at better interest rates and with better timing. Several studies argue that financial literacy is positively related to the extent of (retirement) savings and wealth (Bernheim and Garrett; 2003; Bernheim et al.; 2001; Lusardi and Mitchell; 2007a,b, 2008; van Rooij et al.; 2007). Stango and Zinman (2009) relate financial sophistication to both, debt and wealth, and confirm earlier findings that more sophisticated individuals save more and borrow less. We contribute to this strand of research by examining the role of financial sophistication for the likelihood to use the services offered by digital service providers. Since these providers leave their clients with a higher degree of autonomy and a relatively lower degree of (personal) financial advice, financial knowledge could be a key driver of the adoption of such services.

In this study, we ask respondents to self-assess their financial knowledge, which has the advantage of being simple and cost-efficient (van Rooij et al.; 2011). However, as pointed out by Lusardi and Mitchell (2014), self-assessed financial knowledge and financial literacy as measured with tasks related to numeracy and financial concepts might not be perfectly correlated; some studies report that respondents are rather confident of their financial knowledge and tend to overestimate their actual knowledge (Bucher-Koenen et al.; 2016; Lusardi; 2011; Lusardi and Mitchell; 2014). However, van Rooij et al. (2011) find that subjective and objective measures of financial literacy are positively correlated, and several studies (e.g., van Rooij et al. (2007) and Allgood and Walstad (2016)) show that both types of measures have the ability to predict financial outcomes.

Acquiring the necessary information and knowledge to deal with unfamiliar financial services might be costly. Using the example of the stock market, Haliassos and Bertaut (1995) argue that households not holding stocks may be discouraged from investing in the stock market by information costs; such costs might for example be related to the acquisition of information about institutional aspects, about the skills of different advisors, and about the stock investment process. Similarly, increasing financial literacy might come at a cost. Jappelli and Padula (2013) argue that time and money need to be invested to accumulate financial knowledge, which creates a trade-off between the benefits and costs of higher financial knowledge. Similarly, Lusardi et al. (2017) assume costs of accumulating financial knowledge; they model the cost function as a convex function. In sum, there may be optimal levels of information and financial knowledge which might differ between households; in addition, these differences may be rational from the perspective of the individual household (see also the related discussion in Hastings et al. (2013)).

Risk attitudes also play an important role for two reasons. First, as with financial literacy, risk

preferences have a direct impact on individual financial decisions and the likelihood to use unfamiliar financial products, which are often assessed as being more risky than more familiar products. As an example, van Rooij et al. (2007) find that risk preferences influence the choice of the retirement scheme; in a sample of Dutch households not accustomed to defined contribution retirement plans with a higher degree of individual responsibility, more risk tolerant individuals are more likely to choose the unfamiliar defined contribution scheme instead of the widespread defined benefit plan, which requires much less autonomous decision-making. In addition, comparably to the domain of financial literacy, higher risk tolerance increases the share of stocks in their sample's retirement savings portfolios. Second, risk attitudes are usually found to be correlated with the willingness to use new technologies and related to the readiness to adopt new banking technologies. Bauer and Hein (2006) show that individuals with higher risk tolerance are more likely to use internet banking, for example. A potential interpretation is that households deem innovative banking services more risky than traditional services. Due to the important role of risk preferences for the use of unfamiliar financial products and financial innovations, it seems natural to investigate their role for the adoption of digital financial services. Our study adds this aspect to the research on risk preferences. Similarly to financial literacy, we ask respondents to self-assess their risk tolerance in the financial domain. Dohmen et al. (2011) and Lönnqvist et al. (2015) show that this type of self-assessment accurately predicts actual risk-taking behavior.

Adding to the points made above, previous research suggests that financial literacy and risk attitudes in financial matters might be interrelated. First, using several experiments, Heath and Tversky (1991) find that ambiguity is related to competence (see also the related discussions in Tversky and Kahneman (1992), Camerer and Weber (1992), or Fox and Tversky (1995)). Individuals who feel more competent with respect to a specific decision situation are found to exhibit lower ambiguity aversion. Second, several studies report that risk aversion and ambiguity aversion are positively correlated (Dean and Ortoleva; 2016; Kocher and Trautmann; 2013). Combining these insights, competence and risk preferences are potentially related. In a banking context, this conclusion suggests that clients with higher financial literacy might be less risk averse than clients with less financial knowledge. We contribute to this strand of research by investigating decision situations in a banking context in which risk aversion and financial competence or knowledge might both influence the decision to adopt a novel product offering.

3 A Model of the Demand for Digital Financial Services

To give a formal intuition for our research question, we adapt the model suggested by Bauer and Hein (2006) for the adoption of internet banking technologies and transfer it to the domain of digital financial services. In the model, x represents the banking services used by a banking client, and clients exhibit the utility function $f(x)$ with respect to traditionally provided banking services to which they add digital financial services. Since providers of digital financial services such as Fintechs usually offer selected services instead of the full range of services as provided by a traditional bank, their clients typically use basic banking services of traditional banks in addition to the services provided by the digital service providers (e.g., a checking account at a traditional bank). n different digital financial services are offered. In contrast to traditional channels, clients' utility derived from novel digital financial services is uncertain, i.e., it can increase or decrease total utility with the marginal function $h(x)$.

There are two sources of uncertainty regarding the use of digital financial services: First, clients might be unsure regarding security issues related to the disclosure of sensitive data when choosing a digital financial service. Second, clients might face uncertainty with respect to the capabilities and knowledge required to use a specific service. Hence, clients do not know with certainty the outcome when using digital financial services. There are k uncertain outcomes to which each client attributes a probability p_j. Importantly, the outcome $j = 1$ is the outcome in which no sensitive data is lost and clients possess all capabilities required to use digital financial services.

In sum, clients' total expected utility derived from a traditional bank account combined with digital financial services can be written as in Equation (1), where δ_i represents a dummy variable for the ith digital financial service.

$$U(x) = f(x) + \sum_{j=1}^{k} p_j \sum_{i=1}^{n} \delta_i h_{ij}(x) \tag{1}$$

With $\phi(x)$ representing the cost of the traditional bank account (such as fees related to the provision of a checking account), $\gamma_i(x)$ denoting the cost of digital financial services, including mental costs to develop the necessary skills (if these are not yet available) as well as potential costs for technical equipment, and m referring to the total costs of traditional and digital banking services, Equation (1) can be maximized using the following condition:

$$\phi(x) + \sum_{i=1}^{n} \delta_i \gamma_i(x) = m \tag{2}$$

Since $\sum_{j=1}^{k} p_j = 1$, $U(x)$ can be simplified to

$$U(x) = f(x) + \sum_{i=1}^{n} \delta_i h_{i1}(x) + \pi \tag{3}$$

with

$$\pi = \left(\sum_{j=2}^{k} p_j \sum_{i=1}^{n} \delta_i h_{ij}(x) \right) - \left((1 - p_1) \sum_{i=1}^{n} \delta_i h_{i1}(x) \right) \tag{4}$$

Importantly, π denotes the risk premium, which contains the marginal utility function of digital financial services, $h(x)$, and the perceived probabilities of uncertain outcomes, p_j. The first term in brackets in Equation (4) refers to all outcomes except for the optimal outcome $j = 1$.

π is a crucial aspect of a client's decision to choose a digital financial service. More specifically, a client evaluates if

$$\max \left[\sum_{i=1}^{n} \delta_i h_{ij}(x) \right] > \pi \tag{5}$$

to consider using a digital financial service.

In sum, both financial knowledge and risk tolerance influence clients' decisions to choose digital financial services. Banking services requiring advanced financial knowledge increase the (mental) costs of digital financial services, thereby influencing $\gamma_i(x)$; services involving sensitive data or uncertainty about the skills required to use them impact the risk premium π. Depending on the respective nature of the digital financial service (e.g., investment advice, credit, or payment services), clients' individual cost function related to the digital financial service, $\gamma_i(x)$, and risk premium, π, can differ. The more complex the service and the lower a client's knowledge in this domain, the higher the associated costs. The more sensitive the data and the higher the uncertainty regarding the own ability to use a service, the higher the risk premium. In the next section, we will use these insights to derive detailed predictions of how financial knowledge and risk preferences are likely to influence the use of digital financial services in the domains of investment advice, credit, and payment services.

Note that the model is able to account for the interplay of financial knowledge and risk attitudes described in Section 2. The more financially knowledgeable or experienced clients are, the lower should be their uncertainty regarding the ability to use a specific digital financial service, thereby reducing the risk premium.

4   Methodology and Data

This section describes the setup of our survey (Section 4.1), explains our predictions (Section 4.2), and presents the main summary statistics of our dataset (Section 4.3).

4.1   Survey Setup

A survey approach is especially well suited to investigate the role of financial knowledge and risk preferences for the adoption of digital financial services. In particular, the two parameters can be assessed without relying on proxies, and the preferences for traditional banks or providers of digital financial services (e.g., Fintechs) can be directly elicited.

To study potential switching behavior from the traditional to the new providers and its determinants, the survey has been conducted with private clients of a retail bank based in Northern Germany and was implemented as an online survey.[2] The bank has more than 100,000 customers and approximately 500 employees. The link to the survey was available on the bank's website; repeated participation of the same respondent was not possible. The median time respondents needed to complete the survey was between eight to nine minutes. To compensate respondents for their participation in the survey, several prizes were randomly allocated to respondents who fully completed the survey.[3]

Since the survey has been conducted in cooperation with a specific bank and implemented as an online survey, one might expect a selection bias to be potentially present in the data 1) if the clients of the cooperating bank behave systematically differently from the average banking client, 2) if clients choosing to participate in the survey differ systematically from the average client, and 3) if clients using online banking are more likely to participate in the survey.

Regarding 1), the cooperating bank belongs to a type of bank which covers up to about one fourth of the German market in its largest business segments, thereby representing a substantial share of the total market. Thus, we consider it unlikely that the clients of the bank do not behave like the average banking client in the German market.

As for 2), while some of the demographic details of the survey respondents provided below indicate that our sample of respondents closely matches average numbers reported for the German population (e.g., with respect to age), other aspects appear to be different from usual averages (such as the relatively high fraction of respondents with a university degree or Northern Germany as the

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[2]As pointed out by van Rooij et al. (2007), an online survey which can be completed at home has the advantage that respondents are under no time pressure and remain fully anonymous.

[3]The prizes were an iPad Air, a gift certificate of € 200, and tickets for an ice hockey match.

place of residence for virtually all respondents). However, determining the direction of a potential bias is hardly possible for these variables ex ante.

With respect to 3), we repeat our main analyses reported below using a Heckman correction in which we assume that clients who actively use online banking services are more likely to participate in the survey. We find that our results remain robust to this correction, indicating that our data is not biased by banking clients which differ systematically from other clients regarding the role of financial knowledge and risk preferences due to their likelihood to use online banking.

Moreover, since the respondents are current clients of a traditional bank, the likelihood to prefer a bank to a provider of digital financial services is potentially higher compared to a sample of clients of a direct bank and other forms of non-traditional banking. This could potentially lead to an underestimation of the market potential of digital financial services. Importantly, clients who prefer the digital service provider might already have switched to such a provider and no longer have an account at the cooperating bank, thereby increasing the potential underestimation.

We use three scenarios, corresponding to the core services of a retail bank, to take into account that people might choose their provider differently depending on whether they want to invest in stocks, take out a loan, or carry out a payment transaction. Following a short description of the respective scenario, respondents have to choose whether they prefer to use the services of a traditional retail bank (which corresponds to the cooperating bank) or a digital service offering in each of the three scenarios.[4]

Scenario 1 (S1): Investment advice In this scenario, respondents are asked to assume that they want to invest a monthly amount of € 200 in a savings plan. With respect to the advice on how to best invest the money, they can choose between the advisor of a traditional retail bank and the members of an online community. While the former provides advice in a face-to-face conversation, the latter is an online network of private members who exchange investment ideas on the internet. The financial expertise in the online community varies between beginner and expert; if required, anonymity is guaranteed.

Scenario 2 (S2): Credit The second scenario puts respondents in the hypothetical situation of wanting to take out a loan to finance a new car. In this scenario, respondents can choose between a traditional retail bank and a peer-to-peer online lending platform.[5] While the traditional bank provides the loan after a face-to-face conversation, several individual private lenders offer the loan

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[4]The exact wording of the survey questions is provided in Appendix A.

[5]The described platform is similar to those discussed in Duarte et al. (2012) and Lin et al. (2013).

via the website of the lending platform without providing personal advice. The user's name and address are not visible to other users of the online platform.

Scenario 3 (S3): Payment services In the third scenario, respondents are asked to decide between using a credit card or an application on their smartphone to pay for a new TV. The credit card is assumed to be linked to the respondent's checking account held at a traditional retail bank. By contrast, payments with the smartphone app are made by holding the phone close to a reading device; a specified bank account is then used to make the payment.

While all three scenarios represent digital financial services, S2 and S3 are most closely related to the concept of Fintechs. An online community such as the one described in S1 might be different from the online lending platform described in S2 and the payment services of S3 in that it might also be offered by nonprofit organizations.

Besides asking respondents about their preferred provider of financial services in the three scenarios, we assess their willingness to switch to the provider they do *not* choose in each domain. In each of the three scenarios, we elicit the relative compensation which the non-chosen provider would need to provide in order for the respondent to alter his or her choice. This provides a rough measure of how definite our respondents' choices in a specific scenario are. In all scenarios, we provide pre-specified value ranges in seven steps, which are provided in Appendix A.[6] In S1, respondents are required to state how much higher the (expected) investment return offered by the non-chosen provider compared to the chosen provider would have to be to consider a switch. The required return difference is measured in pp.[7] In S2, we ask for the required interest rate difference in favor of the non-chosen provider, i.e., how much lower the interest rate on the loan offered by the non-chosen provider would have to be compared to the rate offered by the preferred provider, also measured in pp. In S3, respondents are asked to state the required cost advantage of the non-chosen provider compared to the chosen provider when offering payment services, measured in EUR per transaction.

After going through the scenarios, respondents answer a questionnaire in which they are asked to provide a self-assessment of their financial knowledge and risk tolerance in the financial domain.

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[6]The value ranges were developed based on the cooperating bank's experiences and estimations regarding the behavior of the average customer.

[7]The non-chosen provider might offer higher returns at no additional risk in two ways. First, if the current provider holds an inefficient portfolio, a new provider might offer higher returns at the same level of risk when holding a more efficient portfolio. Second, the non-chosen provider might have lower costs than the current provider such that the return after costs is higher than the return offered by the current provider. The exact way in which higher returns might be realized is not described in the question.

Since risk preferences have been shown to vary over different domains of household decision-making, it is crucial to elicit risk tolerance in financial matters when assessing its role for the adoption of digital financial services (Charness et al.; 2013).

Several demographic characteristics are also included in the questionnaire.

4.2 Predictions

Based on the results of the previous research summarized above and our model of the demand for digital financial services, we derive two main predictions and expected outcomes for the three survey scenarios.

P1: Financial knowledge and digital financial services The likelihood to use digital financial services is higher for individuals with a high degree of financial knowledge in domains in which financial decisions are complex. In such domains, financial knowledge can reduce the (mental) costs of using digital financial services. Since financial literacy has been found to increase the participation of individuals in environments in which a higher degree of household autonomy is required, we expect respondents with higher self-assessed financial knowledge to be more likely to choose the digital financial service in domains in which individuals need to implement complex financial decisions.

P1a: Financial knowledge and investment advice Regarding investment advice, a relatively high degree of financial knowledge is required to meaningfully interpret the advice provided by the online community and to implement the recommendations, while the advisor of a traditional retail bank usually implements the recommendations for the client in a traditional banking context. Consequently, respondents might feel more comfortable in using the digital service for stock investment advice if they feel financially knowledgeable, in particular regarding the stock market which might exhibit a relatively high degree of ambiguity for inexperienced investors. We thus expect self-assessed financial knowledge to positively influence the demand for the digital financial service in S1 by reducing $\gamma_i(x)$.

P1b: Financial knowledge and credit As for credit decisions, the information provided on peer-to-peer online lending platforms requires careful consideration and interpretation by borrowers and lenders. With similar arguments as for investment advice, respondents might be more likely to prefer the digital financial service provider when taking out a loan if they consider themselves knowledgeable in this domain and hence capable of dealing with the relatively high degree of ambiguity in this

decision situation. We therefore expect self-assessed financial knowledge to positively affect the demand for the peer-to-peer credit in S2 by reducing $\gamma_i(x)$.

P1c: Financial knowledge and payment services Payment services appear simple and straightforward without requiring advanced financial knowledge. Self-assessed financial knowledge should not significantly impact the demand for the smartphone payment service in S3.

P2: Risk tolerance and digital financial services The likelihood to use digital financial services is higher for individuals with a high degree of risk tolerance in domains in which security issues are involved or in which there is high uncertainty regarding the skills required to use these services.

P2a: Risk tolerance and investment advice No severe security issues are involved in the investment advice scenario in which respondents only obtain advice without necessarily disclosing sensitive information. Risk tolerance should therefore not influence the demand for investment advice provided by an online community as far as data security is concerned in S1; it might only play a role if respondents are unsure about the required skills to implement the advice, which would increase the risk premium π.

P2b: Risk tolerance and credit Taking out a loan on a peer-to-peer lending platform usually requires the disclosure of sensitive information related to income and occupation and further personal data, thereby increasing π; in addition, respondents might be unsure about the capabilities which are required to handle a peer-to-peer loan. The decision to use an online lending platform in S2 should thus be driven by risk tolerance.

P2c: Risk tolerance and payment services Payment services typically involve the use of sensitive information such as checking account data or credit card data, which increases π; respondents' uncertainty as to which skills are needed to use the app should rather not substantially influence the decision since the process is simple and straightforward, but might additionally raise the risk premium. The likelihood to use the smartphone app should thus increase with risk tolerance in S3.

Table 1 summarizes these predictions.

Table 1: Predictions by Survey Scenario

This table summarizes the predictions regarding the influence of self-assessed financial knowledge and risk tolerance on the decision to choose the digital service provider or the traditional retail bank in the three survey scenarios. *x* denotes an expected significant influence.

	Scenario 1: Investment advice	Scenario 2: Credit	Scenario 3: Payment services
Financial knowledge	x	x	
Risk tolerance	(x)	x	x

These predictions should have direct implications for individuals' willingness to leave their currently preferred provider and choose the respective other provider as the willingness to switch will depend on the drivers derived in this section.

First, since investment advice provided by the digital service provider requires relatively higher financial knowledge and at least the same degree of risk tolerance, individuals with higher self-assessed financial knowledge should be more likely to choose the digital service provider. While these individuals might achieve comparable outcomes with traditional banks, the reverse does not necessarily hold if individuals with lower financial knowledge choosing the traditional bank switch to a digital service provider. As an example, further service components might be required to actually realize the investment recommendations provided by the digital service provider or the bank, and such services might be less relevant for individuals with higher financial knowledge who might be able to complete some of these services on their own. Individuals preferring the digital service provider should thus be relatively more willing to switch than individuals preferring the traditional provider and therefore require a lower premium to switch.

Second, as derived above, borrowers choosing the peer-to-peer credit can be expected to exhibit higher self-assessed financial knowledge and risk tolerance in financial matters; individuals choosing the traditional provider might not possess the necessary financial knowledge and be afraid of disclosing sensitive data. While the former might thus be more willing to switch to the traditional provider, the latter might be more reluctant to choose the digital service provider.

Third, paying with the smartphone app requires higher risk tolerance than using the traditional payment channel. Individuals preferring the digital payment service might thus be more willing to switch to the traditional bank and require a lower premium than individuals preferring the traditional way of paying; the latter might not exhibit the required risk tolerance to be willing to rely on the digital payment service.

Table 2: Summary Statistics of Respondents

This table displays the summary statistics of the survey respondents. *Male* is a dummy variable equal to one if a respondent is male; *Age* is denoted in years; *University degree* is a dummy variable equal to one if a respondent has a university degree; *Financial knowledge* is the self-assessed financial knowledge score, measured on a five-point scale where 1 denotes no significant financial knowledge and 5 represents very high knowledge; *Risk tolerance* is the self-assessed risk tolerance score in the financial domain, measured on a five-point scale where 1 denotes very low risk tolerance and 5 represents very high risk tolerance.

	Mean	Median	SD	Min	Max
Male	0.58	1.00	0.49	0.00	1.00
Age	44.45	45.00	15.35	18.00	85.00
University degree	0.39	0.00	0.49	0.00	1.00
Financial knowledge	2.96	3.00	1.00	1.00	5.00
Risk tolerance	2.44	2.00	1.07	1.00	5.00
N	1,752				

4.3   Data Description

After eliminating respondents with incomplete sets of answers, we are left with 1,752 respondents who completed the survey in January and February of 2015.[8] Table 2 displays respondents' summary statistics. Almost 60% of respondents are male, and about 40% possess a university degree. The average age equals about 45 years (median: 45).[9] The values of the demographic variables reported here are consistent with the average values of the bank's full customer base (not disclosed); our sample can thus be considered representative of the bank's total customer group. The mean self-assessed financial knowledge, measured on a scale from 1 to 5 (where 1 denotes no significant financial knowledge and 5 represents very high financial knowledge) equals 2.96 (median: 3). The mean self-assessed risk tolerance in financial matters, measured on a scale from 1 to 5 (with 1 representing very low risk tolerance and 5 denoting very high risk tolerance) equals 2.44 (median: 2). Respondents choose among the full range of financial knowledge and risk tolerance levels; the actual values provided in the survey range between 1 and 5 for both measures.[10]

The Spearman correlation between self-assessed financial knowledge and risk tolerance in the financial domain equals 0.29 and is significant at the 1% level. This indicates that both measures are positively related and is consistent with the findings regarding the interplay of competence and risk preferences cited above. Respondents deeming themselves more financially knowledgeable consider themselves more risk tolerant in financial matters on average.

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[8]About 800 respondents started the survey but aborted it while about 650 respondents finished the survey but chose the option *"No answer"* when asked for their preferred provider in at least one scenario, for their levels of financial knowledge and risk tolerance, or for demographic variables. We exclude those 1,450 respondents from our analyses.

[9]Since respondents are asked to provide their year of birth, age is computed as the difference between 2015 and the year of birth.

[10]Appendix B contains additional summary statistics related to respondents' demographic background.

Table 3: Choice of Provider in Three Survey Scenarios

This table displays the summary statistics of respondents' provider choices. *S1* denotes Scenario 1 (investment advice); *S2* represents Scenario 2 (credit); *S3* denotes Scenario 3 (payment services); *Number of decisions in favor of digital service provider* is the number of scenarios in which respondents choose the digital service provider, ranging from 0 to 3; *Digital service provider chosen at least once* is a dummy variable equal to one if the digital service provider is chosen in at least one of the three scenarios.

	Mean	SD	Min	Max
S1 (Advice): Final decision for digital service provider	0.12	0.33	0.00	1.00
S2 (Credit): Final decision for digital service provider	0.11	0.32	0.00	1.00
S3 (Payment): Final decision for digital service provider	0.11	0.31	0.00	1.00
Number of decisions in favor of digital service provider	0.34	0.65	0.00	3.00
Digital service provider chosen at least once	0.26	0.44	0.00	1.00
N	1,752			

5   Results

In this section, we first present the main results regarding the correlations of financial knowledge and risk preferences with the adoption of digital financial services (Section 5.1) and discuss heterogeneity across different types of services (Section 5.2). We then provide further evidence for the important role of both parameters by examining respondents' likelihood to switch between providers (Section 5.3).

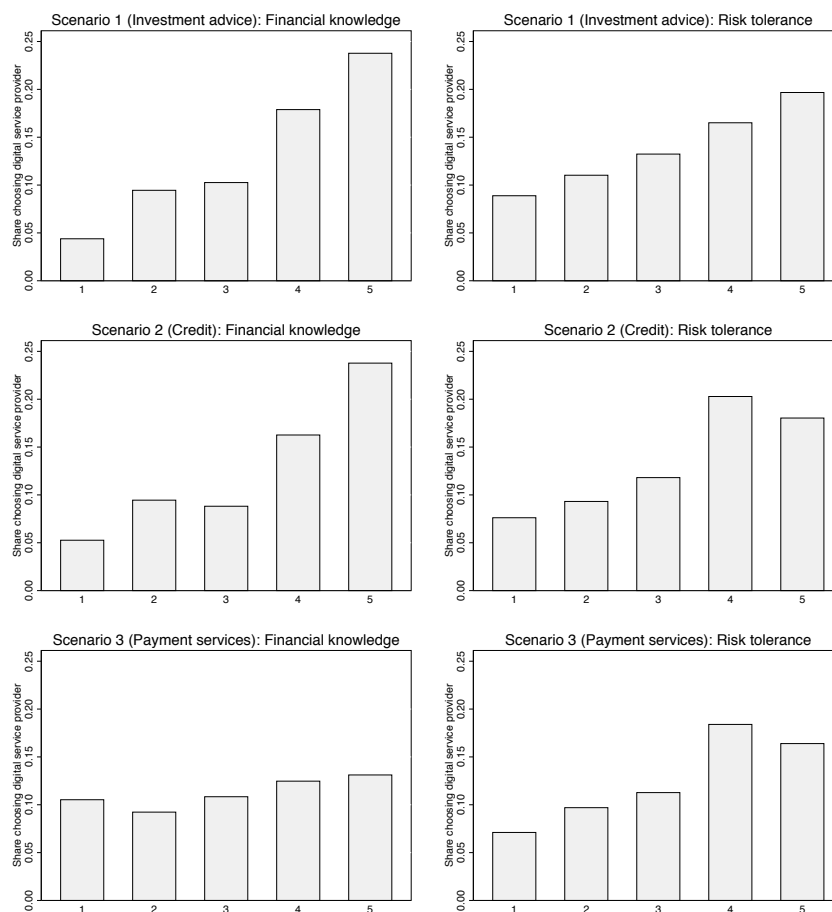## 5.1   Financial Knowledge, Risk Preferences, and Choice of Provider

As a first step, we examine respondents' choices between the digital service provider and the traditional retail bank in the three survey scenarios. Table 3 contains the summary statistics regarding the choice of a provider of financial services. In all three scenarios used in the survey, the share of respondents choosing the digital service provider is slightly above 10%. Although the traditional retail bank seems to be strongly favored, there is no scenario in which all respondents uniformly choose it. Out of the three choices between the traditional retail bank and the digital service provider, 0.34 decisions are made in favor of the digital service provider and 2.66 are made in favor of the traditional bank. 30 respondents choose the digital service provider in all three scenarios, while 26% of respondents choose the digital service provider in at least one of the three scenarios.[11]

As a second step, we investigate the correlates of respondents' choices between the two providers of financial services. Figure 1 depicts the shares of respondents choosing the digital service provider across levels of self-assessed financial knowledge and risk tolerance in the three scenarios. In all three scenarios, respondents with higher financial knowledge and higher risk tolerance are more likely to

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[11]Further descriptive statistics related to respondents' provider choices are provided in Appendix B.

Figure 1: Financial Knowledge, Risk Tolerance, and Choice of Provider in Three Scenarios

This figure displays the fraction of respondents choosing the digital service provider across levels of financial knowledge and risk tolerance, grouped by the three scenarios. *Financial knowledge* is the self-assessed financial knowledge score, measured on a five-point scale where 1 denotes no significant financial knowledge and 5 represents very high knowledge; *Risk tolerance* is the self-assessed financial risk tolerance score, measured on a five-point scale where 1 denotes very low risk tolerance and 5 represents very high risk tolerance.

prefer the digital service provider than respondents with lower financial knowledge and lower risk tolerance.

Table 4 displays the marginal effects of a probit regression with robust standard errors in which the dependent variable is equal to one if the digital service provider is chosen in at least one of the three scenarios. We thus include one observation for each survey respondent. In addition to the variables described in Tables 2 and 3, we include the occupation and the zip code of the area of residence of a respondent, both coded as dummy variables, as further control variables. Since the cooperating bank is located in Northern Germany, the zip code dummy equals one if the zip code

starts with 2, the usual first digit of zip codes in Northern Germany, and zero otherwise.[12] Column 1 of Table 4 reveals that for each additional level of self-assessed financial knowledge, the likelihood to choose the digital service provider in at least one scenario increases by about 5 pp. In line with P1, individuals with higher financial knowledge are significantly more likely to choose the digital service provider as a provider of financial services. Column 2 shows that when risk tolerance in financial matters increases by one point, the likelihood to choose the digital service provider at least once increases by about 6 pp. As predicted by P2, we thus observe that individuals with a higher willingness to take financial risks are more likely to choose the digital service provider. Combining both variables in Column 3, we find that the marginal effects of both remain strongly significant, although slightly smaller in absolute size.[13]

Adding several covariates in Columns 4 to 6 does not substantially alter these results. Male respondents are significantly more likely than female respondents to choose the digital service provider at least once. Age is negatively and significantly related to choosing the digital service provider at least once; older respondents are less likely to choose the digital service provider, thereby confirming earlier results (Bauer and Hein; 2006; van Rooij et al.; 2007). A university degree significantly increases the likelihood of choosing the digital service provider.[14] Controlling for respondents' occupation and area of residence (Column 7) does not change the sign and significance of our results: in the full model, each level of financial knowledge and risk tolerance is associated with an increase in the likelihood to choose the digital service provider at least once by about 3.3 pp and 3.9 pp, respectively.

Note that the pseudo R^2 is relatively low in all columns of Table 4. I.e., although there is a significant relationship between financial knowledge, risk tolerance, and the preference for the digital service provider or the traditional bank, potential predictions based on our model exhibit a relatively lower degree of precision compared to models with higher values of the pseudo R^2. Predictions should thus be made with caution. In spite of these concerns, the interpretation of the significant explanatory variables such as financial knowledge and risk tolerance does not change.

In sum, traditional providers of financial services are still favored over digital service providers by

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[12]Including more digits of the zip code would substantially reduce the number of observations since many zip codes with low numbers of observations perfectly predict the regression outcome.

[13]Table 4 shows that multicollinearity should not be a problem since the coefficients of both parameters are only slightly changed in size and unchanged in sign and significance when included without the respective other parameter (see Columns 1 and 2). Moreover, the calculation of the variance inflation factors (VIFs) for the explanatory variables of the model reveals that all VIFs are significantly lower than 10, which is usually considered to indicate that multicollinearity is not a problem in a regression model.

[14]Table 7 in Appendix B shows the summary statistics of Table 2 split by respondents choosing the digital service provider at least once and respondents who never choose the digital service provider.

Table 4: Digital Service Provider Chosen at Least Once

This table contains the marginal effects of a probit regression (z-statistics in parentheses) with robust standard errors in which the dependent variable is equal to one if the digital service provider is chosen in at least one of the three scenarios. *Financial knowledge* is the self-assessed financial knowledge score, measured on a five-point scale where 1 denotes no significant financial knowledge and 5 represents very high knowledge; *Risk tolerance* is the self-assessed financial risk tolerance score, measured on a five-point scale where 1 denotes very low risk tolerance and 5 represents very high risk tolerance; *Male* is a dummy variable equal to one if a respondent is male; *Age* is denoted in years; *University degree* is a dummy variable equal to one if a respondent has a university degree; *Occupation* denotes the current occupation of a respondent; *Zip code* is a dummy variable which is equal to one if the first digit of the five-digit zip code of the current area of residence of a respondent equals 2. *, **, and *** denote significance at the 10%, the 5%, and the 1% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Financial knowledge	0.048***		0.034***	0.043***		0.032***	0.033***
	(4.55)		(3.04)	(3.99)		(2.87)	(2.92)
Risk tolerance		0.057***	0.049***		0.049***	0.041***	0.039***
		(5.83)	(4.71)		(4.80)	(3.90)	(3.67)
Male (d)				0.106***	0.097***	0.091***	0.087***
				(5.00)	(4.51)	(4.17)	(3.97)
Age				-0.004***	-0.004***	-0.004***	-0.004***
				(-5.56)	(-5.36)	(-5.58)	(-4.37)
University degree (d)				0.058***	0.060***	0.056**	0.057**
				(2.65)	(2.73)	(2.54)	(2.52)
Occupation	No	No	No	No	No	No	Yes
Zip code	No	No	No	No	No	No	Yes
N	1,752	1,752	1,752	1,752	1,752	1,752	1,752
Pseudo R^2	0.01	0.02	0.02	0.04	0.04	0.05	0.05

current clients of this traditional retail bank, and both financial knowledge and risk tolerance in the financial domain are significantly correlated with this choice. These observations are consistent with our predictions outlined above and suggest that if there is a causal link between financial knowledge and risk preferences on the one hand and financial decisions on the other hand, face-to-face advice as offered by traditional retail banks still seems valuable to customers with low self-assessed financial knowledge and risk tolerance.[15]

5.2   Scenario Heterogeneity

In this section, we extend our results by examining potential heterogeneity in respondents' choices in the three scenarios.

Since we employ three different scenarios in our survey, it is not clear whether financial knowledge

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[15]We resume the discussion on the direction of causality in Section 6. In unreported regressions (available from the authors upon request), we provide several tests of robustness. First, we compute an OLS, a tobit, and a binomial model in which the dependent variable is the number of decisions in favor of the digital service provider. Second, we analyze a probit model in which the dependent variable is equal to one if the digital service provider is chosen at least *twice*. Third, we run our main regression in Table 4 and exclude those 25% of respondents who completed the survey in 6.5 minutes or less, the lowest quartile of time needed to complete the survey. Fourth, we specify financial knowledge and risk tolerance as dummy variables in our main analysis. In all four cases, our main findings are not substantially changed.

Table 5: Choice of Provider in Three Survey Scenarios

This table contains the marginal effects of a probit regression (z-statistics in parentheses) with robust standard errors in which the dependent variable is equal to 1 if the digital service provider is chosen as the preferred provider in the respective survey scenario. *Financial knowledge* is the self-assessed financial knowledge score, measured on a five-point scale where 1 denotes no significant financial knowledge and 5 represents very high knowledge; *Risk tolerance* is the self-assessed financial risk tolerance score, measured on a five-point scale where 1 denotes very low risk tolerance and 5 represents very high risk tolerance; *Male* is a dummy variable equal to one if a respondent is male; *Age* is denoted in years; *University degree* is a dummy variable equal to one if a respondent has a university degree; *Occupation* denotes the current occupation of a respondent; *Zip code* is a dummy variable which is equal to one if the first digit of the five-digit zip code of the current area of residence of a respondent equals 2. *, **, and *** denote significance at the 10%, the 5%, and the 1% level, respectively.

	S1: Advice	S2: Credit	S3: Payment
Financial knowledge	0.038***	0.028***	0.002
	(4.81)	(3.51)	(0.31)
Risk tolerance	0.009	0.020***	0.021***
	(1.22)	(2.77)	(2.98)
Male (d)	0.033**	0.040**	0.064***
	(2.09)	(2.55)	(4.48)
Age	-0.001*	-0.001	-0.003***
	(-1.75)	(-1.07)	(-5.68)
University degree (d)	0.032*	0.023	0.019
	(1.93)	(1.47)	(1.26)
Occupation	Yes	Yes	Yes
Zip code	Yes	Yes	Yes
N	1,752	1,752	1,752
Pseudo R^2	0.05	0.04	0.07

and risk tolerance are correlated with respondents' choices in a consistent way over all three scenarios. To this end, we use separate probit regressions for all three scenarios in which the dependent variable is equal to one if the digital solution is chosen. All specifications include the full set of control variables described in Section 5.1 (which we use in Column 7 of Table 4) and use robust standard errors. The results are displayed in Table 5.

As for the impact of self-assessed financial knowledge, S1 and S2 drive the results; the marginal effect of our financial knowledge measure is significantly positive in these two scenarios (Columns 1 and 2; 1% level) and insignificant in the third scenario (Column 3). While financial knowledge seems to affect the provider choice in the domains of investment advice and credit, there is no significant correlation in the domain of payment services, which is consistent with our predictions derived above.

Columns 2 and 3 reveal that S2 and S3 are mainly responsible for the findings related to the impact of self-assessed risk tolerance; while the marginal effect is significantly positive in the last two scenarios (1% level), it is insignificant in the first one. Whereas risk tolerance seems to be relevant in the context of credit and payment services, it does not significantly affect the choice of a provider of investment advice. While the prediction regarding the influence of risk tolerance in S1 was not straightforward, the results indicate that the absence of data security issues from the

scenario is probably responsible for the insignificant role of risk tolerance; respondents' uncertainty regarding the required skills to implement the advice obtained does not seem to play a role. The results regarding the role of risk tolerance for Scenarios 2 and 3 are in line with our predictions. As predicted, taking out a loan involves data security issues and may be demanding with respect to financial knowledge; payment services mainly involve security aspects from clients' point of view while not requiring deeper financial knowledge.

Regarding the interrelation of financial knowledge and risk preferences, the significant role of financial knowledge in S1 and S2 indicates that higher financial knowledge reduces observed risk aversion in these scenarios; respondents with higher financial knowledge might feel more comfortable using the services of digital service providers with respect to investment advice and credit. Thus, they may be better suited to deal with the considerable degree of ambiguity when using these services. The insignificant role of financial knowledge in S3 might suggest that payment services are perceived as less ambiguous by many respondents, thereby not necessarily requiring a higher level of financial knowledge.

In sum, we find that no single scenario is fully responsible for our findings in the cross-section, i.e., there is no single scenario that drives our results by itself.[16]

5.3 Implications for Switching Behavior

The previous sections show that respondents preferring the digital service provider deem themselves more financially knowledge and risk tolerant on average. In this section, we investigate the implications of these results regarding the likelihood to switch to the respective non-chosen provider. As we argue in the following, similar to the provider choice discussed in the previous sections, the switching likelihood is correlated with both financial knowledge and risk tolerance.

Besides eliciting respondents' preferred provider of financial services in the three scenarios as discussed above, we assess their willingness to switch to the provider they do *not* choose in the respective domain. For this purpose, we ask them to provide the required relative advantage of the non-chosen provider compared to the preferred provider in the three scenarios. In other words, respondents choosing the traditional bank provide the required compensation to make them favor the digital service provider, and vice versa.

About 1,000 to 1,300 respondents actually state a required relative advantage (depending on the scenario), and the following analyses are based on this subset of respondents. Due to potential

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[16]These observations increase our confidence in the data since the distinct patterns in each scenario reduce the possibility that respondents simply "clicked through" the survey without putting considerable cognitive effort into their decisions.

concerns of a selection bias, the results in this section should thus be considered as indicative evidence.[17]

In S1, the median required additional investment return provided by the non-chosen provider of those respondents who choose the digital service provider is 1 pp to 1.25 pp while the median response of those who choose the traditional bank equals 1.26 pp to 1.50 pp.[18] The required interest rate difference (i.e., lower cost of credit) in favor of the non-chosen provider in S2 is 1 pp to 1.25 pp for respondents who favor the digital service provider, compared to 1.26 pp to 1.50 pp for those who opt for the traditional bank. In S3, respondents choosing the digital service provider require a cost advantage of € 0.21 to € 0.25 per transaction, whereas respondents opting for the traditional bank need an advantage of € 0.30 or higher. Wilcoxon rank-sum tests reveal that the differences in required advantages between the two groups of respondents are highly significant (1% level) in all three scenarios.[19]

Table 6 shows the results of an interval regression in which the dependent variable is equal to the range of the required relative advantage. The independent variables are dummy variables representing respondents' provider choice in the respective scenario. The coefficients of the decisions in favor of the digital service provider are significantly negative in all three scenarios and range between 0.105 and 0.281, indicating that respondents preferring the digital service provider in a given scenario require a lower relative advantage than the advantage required by respondents preferring the traditional retail bank; the required additional return is by about 0.28 pp lower, the credit interest rate difference is by about 0.28 pp lower, and the required cost advantage is by about € 0.11 lower for the first group of respondents. These results are in line with our predictions derived above. Respondents with higher financial knowledge and risk tolerance are more likely to choose the digital service provider; due to their higher financial knowledge and risk tolerance, switching back to the traditional bank would not be as problematic as switching to the digital service provider would be for respondents preferring the traditional bank.

In sum, these results indicate that clients do not only base their provider choice on pricing aspects but on further criteria. If price were the only dimension considered, the required relative

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[17]In unreported analyses (available from the authors upon request), we find that the subsets of respondents used in this section do not significantly differ from the full sample of respondents in terms of their demographic characteristics.

[18]As discussed in Section 4.1, the non-chosen provider might offer additional returns if the current provider holds an inefficient portfolio or if the non-chosen provider has lower costs than the current provider. The channel that is actually assumed by the survey respondents is not clear. However, the fact that 1,242 respondents stated a relative advantage in S1 (compared to 1,280 and 1,014 in S2 and S3, respectively) indicates that this issue did not discourage respondents from stating a relative advantage in S1. Moreover, conditional on choosing the digital service provider, the level of self-assessed financial knowledge does not determine the required relative advantage; the same is true conditional on choosing the traditional bank.

[19]Histograms of the stated required relative advantages are provided in Appendix C.

Table 6: Drivers of Switching Likelihood

This table contains the coefficients of an interval regression (z-statistics in parentheses) with robust standard errors in which the dependent variable is the required relative advantage to be offered by the non-chosen provider to make respondents change their provider choice. Intervals for Scenario 1 (investment return difference, measured in pp): < 0.25; $0.25 - 0.50$; $0.51 - 0.75$; $0.76 - 1.00$; $1.01 - 1.25$; $1.26 - 1.50$; > 1.50; Intervals for Scenario 2 (interest rate difference, measured in pp): < 0.25; $0.25 - 0.50$; $0.51 - 0.75$; $0.76 - 1.00$; $1.01 - 1.25$; $1.26 - 1.50$; > 1.50; Intervals for Scenario 3 (cost advantage, measured in EUR per transaction): < 0.05; $0.05 - 0.10$; $0.11 - 0.15$; $0.16 - 0.20$; $0.21 - 0.25$; $0.26 - 0.30$; > 0.30. The explanatory variables are dummy variables equal to one if a respondent chooses the digital service provider in a given survey scenario. *, **, and *** denote significance at the 10%, the 5%, and the 1% level, respectively.

	S1: Advice	S2: Credit	S3: Payment
S1 (Advice): Final decision for digital service provider	-0.281*** (-5.52)		
S2 (Credit): Final decision for digital service provider		-0.277*** (-4.63)	
S3 (Payment): Final decision for digital service provider			-0.105*** (-5.75)
Constant	1.464*** (60.95)	1.459*** (55.26)	0.374*** (37.12)
N	1,242	1,280	1,014
sigma	0.63	0.71	0.20

advantages should be close to zero. However, both for clients preferring the digital service provider and clients preferring the traditional bank, the median values reported above are significantly higher than zero, suggesting that both groups of clients consider aspects other than pricing. Moreover, the asymmetry between both client groups is instructive: the significantly higher advantages required by clients preferring the traditional bank indicate that this group of clients focuses on non-pricing aspects to a greater extent than the group of clients preferring the digital service provider.

The asymmetry documented above has an additional link to our results on the role of financial knowledge. Based on our finding that respondents with higher financial knowledge are more likely to choose the digital service provider than respondents with lower financial knowledge, there is a potential further reason why this type of switching behavior is observed. Since respondents choosing the traditional bank deem themselves less financially knowledgeable on average, they might underestimate the long-term effect of small return or interest rate differences, especially if compounding effects are involved (Stango and Zinman; 2009) and thus require relatively higher return and interest rate differences for switching in S1 and S2. Further support for this explanation is provided by the above-mentioned finding that in all three scenarios, a relatively large number of respondents chooses the option *"No answer"* when asked to state the relative advantages. Presumably, these respondents face difficulties in answering this question as it could be computationally demanding. χ^2 tests reveal that the fraction of respondents choosing not to provide an estimate is significantly higher among the

respondents choosing the traditional bank than among those opting for the digital service provider in each scenario (significance at the 1% level in all three scenarios).

Overall, the asymmetry in respondents' switching likelihood can be interpreted as further evidence for the central role of financial knowledge and risk tolerance in the decision to use the services offered by a digital service provider.

6   Discussion and Concluding Remarks

Providers of digital financial services in traditional retail banking segments have seen strong growth in the last years and are expected to further increase their market shares in the next years; Fintechs providing financial products and services online constitute the most prominent group among these new providers of financial services.

Digital financial services are offered in all relevant domains of personal finance, in particular investment advice, credit, and payment services. Many of the new providers transfer a high degree of responsibility to their customers, who need to make more autonomous decisions than in a traditional retail banking relationship. The drivers of customers' adoption of their services are, however, not yet well understood. In this study, we investigate the influence of financial knowledge and risk tolerance on the likelihood to use digital financial services. Intuitively, financial sophistication and risk aversion influence the way in which customers of banking services adopt new service offerings in which their own responsibility is relatively higher and outcomes might appear comparatively risky. Since both characteristics have been found to substantially influence various domains of personal financial decision-making in traditional retail channels in previous research, it is likely that both contribute to the adoption of digital financial services.

Our analysis is based on 1,752 survey responses provided by a representative sample of customers of a traditional German retail bank, which enables us to study a sample of respondents with a relatively high degree of heterogeneity in financial knowledge, risk preferences, and demographic variables. The survey approach allows for the elicitation of financial knowledge, risk tolerance, and the preferences for traditional banks or digital service providers in a simple setup and in different areas of retail banking.

We obtain two major results. First, financial knowledge is positively correlated with the likelihood to use digital financial services. The likelihood to use the services offered by digital service provider increases by about 3.3 pp for each level of self-assessed financial knowledge. Second, higher risk tolerance is also positively correlated with the readiness to use digital financial services. The

likelihood to choose a digital service provider increases by about 3.9 pp for each level of self-assessed risk tolerance. In addition to these findings, gender, age, and education are identified as further correlates, with female, less educated, and older respondents more strongly preferring the traditional bank to the digital service provider. We also find that individuals preferring the traditional bank require a relatively higher compensation in order to switch to a digital service provider than individuals opting for a digital service provider require to switch (back) to a retail bank. This asymmetry is likely to be caused by the lower degree of financial sophistication and risk tolerance in the group of respondents preferring the traditional banking solution and supports our results regarding the central importance of these two parameters for the use of digital financial services. For individuals with low financial knowledge, the advantages of switching might be difficult to evaluate. Also, turning to an unfamiliar provider of financial services is unpopular among individuals with low risk tolerance in financial matters.

These results imply that digital service providers would need to offer higher relative advantages compared to traditional banks in terms of investment returns, credit interest rates, and service costs to attract clients that currently prefer the traditional bank than traditional banks would need to offer to clients of digital service providers. 1.26 pp to 1.50 pp higher investment returns, 1.26 pp to 1.50 pp lower credit interest rates, and service cost advantages of at least € 0.30 per transaction as required by the respondents preferring the traditional bank seem hard to achieve for any financial institution. Importantly, in view of the current interest rate level, higher returns and lower credit interest rates such as the ones stated by the respondents should be virtually impossible to offer. In addition, due to their lower size compared to most traditional banks, digital service providers can usually profit less from economies of scale.

Our results are therefore relevant for both traditional providers of financial services and digital financial service providers. On the one hand, they suggest that a high priority for digital service providers should be to find ways to attract customers with relatively low financial knowledge and risk tolerance. Transparency and education about digital service providers might be promising ways in order to achieve that. Since the required relative advantages on the digital service providers' side are relatively high in order to attract switchers, financial education might seem a more promising avenue than the costly attraction of new clients by return and cost advantages. The latter would need to be relatively high and might render the digital service providers' services unprofitable. On the other hand, traditional banks need to clearly understand why the most educated and risk tolerant customers are most likely to leave them and develop ways to attract or regain this high-value clientele. Since these customers require relatively lower relative advantages on the traditional banks' side in

order to switch back, even rather small differences in returns, interest rates, and transaction costs might help to regain these clients. In addition, retail banks might want to consider the introduction of digital service offerings themselves, integrating some approaches successfully developed by Fintechs into their traditional business models.

Taken together, our results imply that financially illiterate and risk averse individuals still seek financial services that are catered on a personal level. Traditional banks should thus find ways to offer face-to-face advice in a way that is especially suited to this particular clientele and less costly to provide than today. Digital service providers need to be aware that many customers might be hard to attract without increasing their level of financial education. However, depending on the business model of a given digital service provider, attracting clients with low financial education and/or low risk tolerance might not be in the digital service provider's interest. Instead, many digital service providers' business models might rely on financially knowledgeable and risk tolerant customers exclusively, and other customers than these might be too costly to attract, to serve, and to retain. For this reason, digital service providers should carefully evaluate whether the attraction of less educated and risk tolerant customer groups is desirable.

Similarly to previous studies on the role of financial literacy and risk preferences in the context of financial decision-making, the direction of causality has to be interpreted with caution. As an example, it is not clear whether higher self-assessed financial knowledge leads individuals to prefer the digital service provider or whether the use of the services provided by a digital service provider increases the financial sophistication of an individual. The empirical analysis of our study focuses on correlations between the two parameters and personal financial decisions. We are thus cautious with deriving a specific direction of causality. However, previous research has mainly identified a clear direction of cause – financial literacy influences economic behavior (see e.g. van Rooij et al. (2011) and the summary provided in Lusardi and Mitchell (2014); moreover, it has been shown that the effect of financial literacy on economic behavior is more likely to be underestimated when simple regression frameworks without instruments are used). For this reason it is well possible that higher financial knowledge and risk tolerance increase the likelihood to use digital financial services.

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Appendices

A Survey Questions

(Translation of the German original.)

A.1 Scenarios

Note that the role of the traditional retail bank in the actual survey questions was assumed by the cooperating bank. For reasons of anonymity, the name of the bank is not provided in the following list of questions.

Scenario 1

Please assume you want to invest a monthly amount of € 200 in a savings plan. However, you are uncertain as to how to invest the money. To receive advice, you can either consult your bank advisor or the members of an online community. The bank advisor provides advice in a face-to-face conversation. The online community is an online network of private members who exchange investment ideas on the internet. The financial expertise in the online community varies between beginner and expert. If required, anonymity is guaranteed in the community.

1. Which provider do you choose?
   ☐ Bank advisor
   ☐ Online community
   ☐ No answer

2. Based on your response to the preceding question: Which additional investment return (at constant risk) would the non-chosen provider need to offer so that you would favor the non-chosen provider?
   ☐ $< 0.25pp$
   ☐ $0.25pp - 0.50pp$
   ☐ $0.51pp - 0.75pp$
   ☐ $0.76pp - 1.00pp$
   ☐ $1.01pp - 1.25pp$
   ☐ $1.26pp - 1.50pp$
   ☐ $> 1.50pp$
   ☐ No answer

Scenario 2

Please assume you need to take out a loan to finance a new car. You can take out the loan either with your retail bank or with a peer-to-peer online lending platform. The traditional bank provides the loan after a face-to-face conversation. At the online lending platform, you need to publicly describe the project to be financed so that several individual private lenders can offer a loan. The platform acts as an intermediary and is responsible for the legal aspects of the transaction. Your name and address are not visible to other users of the online platform.

1. Which provider do you choose?
   ☐ Bank
   ☐ Online platform
   ☐ No answer

2. Based on your response to the preceding question: How much lower would the interest rate charged on the loan of the non-chosen provider need to be so that you would favor the non-chosen provider?
   ☐ $< 0.25pp$
   ☐ $0.25pp - 0.50pp$
   ☐ $0.51pp - 0.75pp$
   ☐ $0.76pp - 1.00pp$
   ☐ $1.01pp - 1.25pp$
   ☐ $1.26pp - 1.50pp$
   ☐ $> 1.50pp$
   ☐ No answer

Scenario 3

Please assume you want to purchase a new TV. Since you do not have sufficient cash with you, you can either pay with your credit card or use an application on your smartphone. The credit card is linked to your checking account held at your bank. To pay with the smartphone application you need to hold the phone close to a reading device; a specified bank account is then used to make the payment.

1. Which provider do you choose?
   ☐ Bank (credit card)
   ☐ Smartphone application
   ☐ No answer

2. Based on your response to the preceding question: How high would the cost advantage per transaction of the non-chosen provider need to be in order for you to favor the non-chosen provider?
   ☐ < € 0.05
   ☐ € 0.05−€ 0.10
   ☐ € 0.11−€ 0.15
   ☐ € 0.16−€ 0.20
   ☐ € 0.21−€ 0.25
   ☐ € 0.26−€ 0.30
   ☐ > € 0.30
   ☐ No answer

A.2　Questionnaire

1. How do you rate your personal financial knowledge?
   ☐ 1 (lowest)
   ☐ 2
   ☐ 3
   ☐ 4
   ☐ 5 (highest)
   ☐ No answer

2. What is your year of birth?
   Year: ☐☐☐☐☐☐

3. What is your gender?
   ☐ Male
   ☐ Female

4. Please provide the zip code of your area of residence
   Zip code: ☐☐☐☐☐

5. What is your highest educational achievement?
   ☐ No graduation from school
   ☐ Certificate of secondary education
   ☐ General certificate of secondary education
   ☐ Higher education entrance qualification
   ☐ Apprenticeship
   ☐ Graduation from university of applied sciences
   ☐ Graduation from university
   ☐ PhD
   ☐ No answer

6. What is your occupation?
   ☐ Employee
   ☐ Officer
   ☐ Self-employed
   ☐ Freelancer
   ☐ Worker
   ☐ Retiree

☐ Student
☐ Other
☐ No answer

7. How do you rate your risk tolerance in financial matters?
☐ 1 (lowest)
☐ 2
☐ 3
☐ 4
☐ 5 (highest)
☐ No answer

B Additional Summary Statistics

B.1 Demographic Variables

Figure 2 displays the distribution of respondents' age. As shown in Section 4, respondents are on average 45 years old.

Figure 2: Age of Respondents

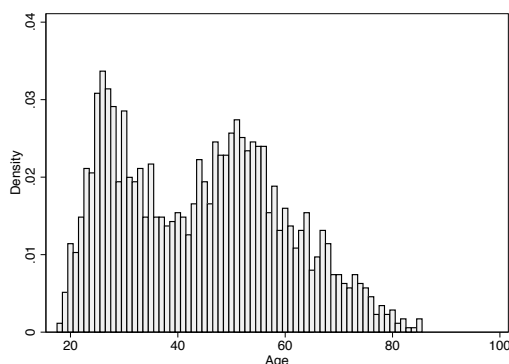This figure displays the distribution of respondents' age, measured in years.

Table 7 contains the summary statistics of the survey respondents, split by their choice of a financial services provider.

Table 7: Summary Statistics of Respondents (Split by Provider Choice)

This table displays the summary statistics of the survey respondents, split by their provider choices. *Male* is a dummy variable equal to one if a respondent is male; *Age* is denoted in years; *University degree* is a dummy variable equal to one if a respondent has a university degree; *Financial knowledge* is the self-assessed financial knowledge score, measured on a five-point scale where 1 denotes no significant financial knowledge and 5 represents very high knowledge; *Risk tolerance* is the self-assessed risk tolerance score in the financial domain, measured on a five-point scale where 1 denotes very low risk tolerance and 5 represents very high risk tolerance.
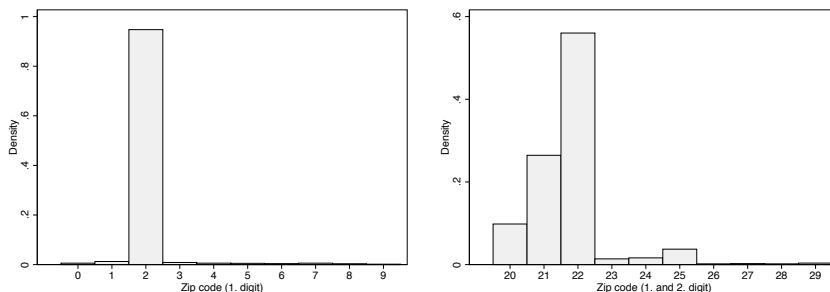
	Digital service provider chosen at least once					Digital service provider never chosen				
	Mean	Median	SD	Min	Max	Mean	Median	SD	Min	Max
Male	0.68	1.00	0.47	0.00	1.00	0.54	1.00	0.50	0.00	1.00
Age	41.88	40.00	14.22	19.00	85.00	45.36	46.00	15.64	18.00	85.00
University degree	0.45	0.00	0.50	0.00	1.00	0.36	0.00	0.48	0.00	1.00
Financial knowledge	3.15	3.00	1.03	1.00	5.00	2.89	3.00	0.99	1.00	5.00
Risk tolerance	2.70	3.00	1.12	1.00	5.00	2.35	2.00	1.04	1.00	5.00
N	458					1,294				

The distribution of the first two digits of respondents' zip codes is shown in Figure 3. The left-hand panel displays the distribution of the first digit. Since the cooperating retail bank is located in Northern Germany, virtually all respondents live in areas with a zip code starting with 2. The

right-hand panel shows the first and the second digits for all zip codes starting with 2. As the cooperating bank has its primary customer focus in the city of Hamburg, the zip codes starting with 20, 21, and 22, which represent all Hamburg zip codes, are the most frequent.

Figure 3: Zip Codes of Respondents

The left-hand panel of this figure displays the distribution of the first digit of the zip codes of respondents' current area of residence. The right-hand panel shows the distribution of the first and the second digit of the zip codes of respondents' current area of residence for all zip codes starting with 2.
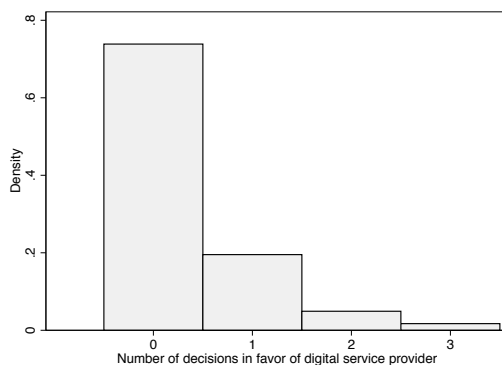

B.2 Provider Choice

Figure 4 shows the distribution of the number of decisions in favor of the digital service provider. Due to the use of three scenarios in the survey, the possible values of the variable range between 0 and 3. As discussed in Section 5, the mean number equals 0.34.

Figure 4: Decisions in Favor of Digital Service Provider

This figure displays the distribution of respondents' decisions in favor of the digital service provider.
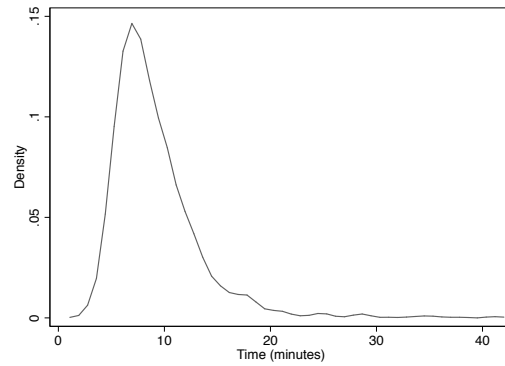
B.3   Survey

Figure 5 shows the distribution of the time it took respondents to complete the survey. The median time equals between eight and nine minutes.

Figure 5: Time to Complete Survey

This figure displays the distribution of the time it took respondents to complete the survey, measured in minutes.

C   Distribution of Required Relative Advantages

Figure 6 shows histograms of the stated required relative advantages, split by respondents choosing the digital service provider and respondents deciding in favor of the traditional bank.

Figure 6: Distribution of Required Relative Advantages of Non-Chosen Provider

This figure displays the distributions of the required relative advantages of the respective non-chosen provider in the three survey scenarios. In S1 (top panel), respondents have to state the required difference in investment return, denoted in pp. In S2 (middle panel), respondents have to assess the required difference in the interest rate on loans. In S3 (bottom panel), the required cost difference per transaction needs to be stated in EUR.