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

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Financial literacy in the DNB Household Survey: Insights from innovative data collection*

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Abstract

This paper surveys what we have learned on financial literacy and its relation to financial behavior from data collected in the Dutch Central Bank (DNB) Household Survey, a project done in collaboration with academics. A pioneering survey fielded in 2005 included an extensive set of financial literacy questions and questions that can serve as instruments for financial literacy in regression analyses to assess the causal effect of financial literacy on behavior. We describe how this survey spurred a series of research papers demonstrating the crucial role of financial literacy in stock market participation, retirement planning, and wealth accumulation. This inspired various follow-up studies and experiments based on new data collections in the DNB Household Survey. Researchers worldwide have used these data for innovative studies, and other surveys have included similar questions. This case study exemplifies the essential role of data in empirical research, showing how innovative data collections can inspire new research initiatives and significantly contribute to our understanding of household financial decision-making.

JEL Codes: G53, D14, D12, C81.

Key words: financial literacy, consumer financial decision-making, household finance, survey methodology, data collection methods, empirical analysis.

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1. Introduction

Data is a crucial tool for deepening our understanding of household financial decision-making. By collecting information and analyzing data, researchers can gain new insights, which in turn generate new questions and may lead to further data collections. This process is essential for advancing the frontier of knowledge in the field.

In this paper, we review the pioneering financial literacy data collection initiative by the Dutch central bank (DNB) and the work based on those data. Two decades ago, data on financial literacy was basically non-existent. Financial literacy was often approximated using years of education or financial behavior related to how people handle finances, but these variables are very crude proxies. Lusardi and Mitchell (2011a) were given the opportunity to devise a special module in the 2004 US Health and Retirement Study (HRS) on financial literacy, albeit for a limited set of questions and a specific subpopulation (i.e., older respondents). Shortly thereafter, Van Rooij, Lusardi and Alessie (2011a) were able to field a much broader set of questions in a population-representative survey. This was a collaboration between De Nederlandsche Bank (DNB), i.e., the central bank of the Netherlands, and a team of academics. This project became the starting point of a successful and enduring collaboration from which we learned a great deal. It led to several new initiatives and fostered financial literacy research worldwide.

Starting in 2003, the Dutch central bank has sponsored the DNB Household Survey, an annual data collection project conducted through Centerpanel, an internet panel of over 2,000 households, representative of the Dutch population. In addition to the recurring core questions, researchers could run ad hoc modules on topical subjects. The ability to design surveys and to merge these data with other modules tailored to specific research questions and answered by the same respondents as well as to follow the respondents over time, underpin the pioneering work on financial literacy conducted in the DNB Household Survey. Moreover, over the years the annual and ad hoc surveys have covered a very broad range of topics and the collected data have enabled researchers worldwide to investigate various aspects of household decision-making, including studies on health (Kapteyn et al. 2007), risk preferences (Von Gaudecker et al. 2011), monetary policy (Van der Cruijsen et al. 2015), work and pensions (Vermeer et al. 2016), saving and retirement (De Bresser, 2024), housing (Christelis et al. 2021) and consumption (Coibion et al. 2023), to name a few examples.

As we will showcase in this paper, the survey design and capacity to add new questions has been instrumental for the groundbreaking role of the DNB data in studying financial literacy. In conjunction with the international research community's access to the collected data, it has spurred a wide variety of studies on the relationship between financial literacy and several important economic outcomes (see e.g., Bucher-Koenen et al. 2024; Deuflhard et al. 2019; Von Gaudecker 2015; Van Rooij et al. 2011a, 2012). Specifically, studies have shown that financial literacy is crucial for financial decision-making related to saving, borrowing, investment decisions and retirement planning (see

Lusardi and Mitchell (2014, 2023) for an overview). Given these findings, it is not surprising that financial literacy also proves to be an important determinant of wealth accumulation and financial resilience.

The contribution of these studies is not limited to deepening our knowledge of financial literacy and how it differs across different groups in the population and our understanding of the effect of literacy on financial decision-making. The impact of the research work extends to methodological contributions as well. For instance, multiple survey experiments were conducted to better understand the measurement of financial literacy and the role of confidence in explaining gender differences in financial knowledge. Moreover, new survey modules have included questions designed to serve as instruments for financial literacy to both alleviate endogeneity concerns and to enable stronger causal inference in regression analyses. The panel component of different surveys has also helped address potential endogeneity concerns.

In addition to reviewing existing studies, we also make use of panel data on financial literacy over a long time period. A comparison of four waves of data spanning from 2005 to 2018 show no discernible improvement of financial literacy over time. Combined with the overwhelming evidence of the crucial role of financial literacy in financial decision-making, this finding underscores the need to step up the effort to improve the levels of financial literacy in the population, starting with the young.

The remainder of this paper is structured as follows. In Section 2, we provide a brief history of the data collection initiative. In Section 3, we describe new experiments and other innovative steps taken over the years. In Section 4, we summarize the main findings and their implications based on both own research and other studies using the Dutch data. In Section 5, we provide descriptive statistics on the evolution of financial literacy over time. Section 6 concludes.

2. A brief history of financial literacy measurement in the DNB Household Survey

Earlier on, there were a handful of studies that can be considered as pioneering in pointing out whether consumers are knowledgeable about basic financial concepts and able to handle day-to-day money management. In particular, Bernheim (1994, 1995) recognized the importance of financial literacy for financial decision-making, in particular for saving, and emphasized that there is a role to play for public policy. A group of researchers at the Federal Reserve Board developed a set of true/false questions to measure understanding of day-to-day financial management and documented a strong association between financial knowledge and financial behavior (Hilgert et al. 2003).

Shortly thereafter, in 2004, three financial literacy questions were added to a new module in the HRS. These questions were designed by Annamaria Lusardi and Olivia Mitchell and focused on the understanding of three basic financial concepts: compound interest, inflation, and stock risk and have become known as the Big Three (for an overview, see Lusardi and Mitchell, 2014 and 2023). The numerous financial literacy studies conducted since then have shown that these questions are highly effective in measuring basic knowledge and how that knowledge impacts financial decision-making.

While the addition of these three questions in HRS was an important step for financial literacy research, it was based on a small set of questions and fielded on a specific subset of the population, i.e., the older population (aged 50 and older). Inspired by that initial work, we devised a much larger set of questions and fielded them in 2005 on an internet panel that was representative of the Dutch population. The Netherlands is an ideal country to study financial literacy and its importance for the well-functioning of the economy. For example, historically the Netherlands has been characterized by well-developed financial markets that offered consumers a wide range of (complex) financial products that require a certain degree of financial sophistication; for example, mortgages are often combined with investment and insurance products. Retirement planning and pension products, another area of increasing importance in the Netherlands, also require basic financial knowledge.

Two financial literacy indices, one for basic financial literacy and one for more advanced financial literacy, were developed and added to the DNB Household Survey. The first index aimed to measure basic financial knowledge. It was based on five questions measuring numeracy, the understanding of interest compounding, inflation, time value of money, and money illusion. The advanced index was based on eleven questions measuring knowledge of more advanced concept related to workings of stocks, bonds, and mutual funds, the functioning of financial markets and concepts such as risk diversification and the relationship between risk and return. Box 1 and Box 2 show the exact wording of the questions (see Van Rooij et al. (2011a, 2011b, 2012) for a detailed analyses of these questions).

[Insert Box 1 and Box 2 around here]

Not only the questions include the Big Three financial literacy questions from the HRS module, but they follow the same methodology: they are multiple choice questions, but respondents are also allowed to say that they do not know the answer (or can refuse to answer). The factor analysis used to construct the financial literacy indices takes into account both correct and incorrect answers and also do not know answers (see Van Rooij et al. (2011a) for details).

The 2005 financial literacy survey questions were asked to the household member who was responsible for the household finances and are, therefore, most likely to have the better financial knowledge within the household.[1] We observe substantial heterogeneity in literacy across households. First, only 4 in 10 respondents were able to answer all five basic literacy questions correctly and the

[1] The statistics reported in the next paragraphs are taken from Van Rooij et al. (2011a). The sample consists of 1508 respondents with an average age of 49.6 years. Slightly more than half of the respondents are men. About a third has a college degree, which means they have a degree from an academic university or higher vocational training. Regarding employment status, 4 percent of respondents is self-employed, 11 percent is unemployed or disabled and 18 percent is retired. Even though the Centerpanel is designed to be representative of the Dutch population, we report weighted statistics to correct for any remaining differences in the sample composition with respect to the distribution of net household income (10 deciles) and homeownership (renters versus homeowners).

percentages are much lower for the more complex questions: 5 percent of respondents answered all eleven questions correctly, while 8 percent did not provide any correct answers.

Van Rooij et al. (2011a, 2011b, 2012) document how these indices vary across socio-demographic characteristics, which serves also as a validation test for the quality of the data. The descriptive analysis shows a strong association between literacy and formal education levels. But notably, while 43.4 percent of respondents with an academic university degree are in the highest advanced literacy quartile, there are also highly educated consumers with low financial literacy scores and low educated consumers who display high levels of financial literacy (6.0 percent of respondents with an academic university degree are in the lowest advanced literacy quartile and 9.5 percent of respondents without a degree other than primary school are in the highest advanced literacy quartile). Thus, financial literacy cannot be taken for granted even among those who have high levels of schooling and some learning seems to be acquired outside of formal school education (perhaps via experience or practice).

There is also a notable a hump-shaped profile across age with literacy levels increasing at younger ages and declining later in life. Respondents between 51 and 60 years have the highest financial literacy score. Consumers with higher income display higher levels of literacy which may be related to more opportunities to learn from a wider variety of financial decisions. A finding that has been very persistent in these data and across studies is that women display lower levels of financial literacy than men (12.1 percent of women are in the highest advanced literacy quartile compared to 37.2 percent of men). This finding has inspired a lot of research studies investigating the possible causes of these gender differences, including measurement issues (Bucher-Koenen et al. 2017, 2024).

3. Experiments and methodological innovations

Flexible data collection provides opportunities for experimental studies and innovative research questions. This section provides information on the Centerpanel that forms the basis for the literacy surveys, on the measurement of financial literacy, the role of the "do not know" option, how to deal with endogeneity in regression analyses and the development of financial literacy scales targeted at specific topics, e.g., debt literacy.

3.1 The Centerpanel: DHS and ad hoc surveys

The 2005 survey on financial literacy was fielded in the Centerpanel as a module of the DNB Household survey (DHS).[2] The Centerpanel is a representative internet panel of over 2,000 households. It is run by Centerdata, a survey agency affiliated with Tilburg University. The panel is designed for

[2] The panel is representative of the Dutch population. Participants are recruited via a random probability sampling design and the first contact is made by letter, followed by a first interview either face-to-face or over the phone. Once interviewees have agreed to participate in the household panel, they are explained that surveys are done over the internet and that they are provided with replacement equipment if they do not have access to the internet already. For more info on the use and the methodological aspects of the Centerpanel and the DHS see Teppa and Vis (2012).

academic research and developed in close cooperation with the scientific community. Having the ability to track respondents over time offers many advantages. The attrition rate typically ranges between 15 and 20 percent per year (Teppa and Vis, 2012). To maintain the panel size and ensure the representativeness of the Centerpanel, refreshment samples are regularly drawn. In addition, the annual DHS data includes household weights (based on net household income and homeownership) and, upon request, Centerdata provides individual weights (based on age, gender, income and education) that researchers can use in their analyses to make the sample representative of the population of interest.

A potential disadvantage of panel data is that participation in past surveys may influence responses to current surveys. For example, respondents might become more interested in economic and financial news after repeatedly answering literacy questions, which could affect their answers over time. However, after looking at the evidence for the Big Three, Alessie et al. (2011a) did not find evidence of any learning effect.

While DHS modules are fielded each year ad hoc modules can also be fielded throughout the year and participants can be recontacted multiple times within a relatively short time period. Depending on the survey length and topic, response rates vary between 70 and 85 percent. Researchers can design their survey questions tailored at their specific research questions and information can be merged with data from other surveys fielded among the same respondents. This makes it possible to do many projects, including follow-ups on specific topics, and data is made available to all researchers. These features of the data have been exploited extensively following the pioneering literacy survey collected in 2005.

3.2 The measurement of financial literacy

Several contributions were made to the measurement of financial literacy in the 2005 survey. As discussed in the previous section, while the survey included the Big Three, a more elaborate set of questions were added to module, allowing researchers to better differentiate between basic and advanced financial knowledge. Another novel feature of the survey is the experimentation with the wording of the questions (van Rooij et al. 2011a). Given the low level of financial literacy documented by the Big Three, one may worry whether respondents have problems in interpreting the questions and the relevance of guessing.

In our work, we experimented with the wording of the questions. For three questions, we consider two different versions by shifting the order of the question as follows:[3] We asked (1a) “Stocks are normally riskier than bonds. True or false?” versus (1b) “Bonds are normally riskier than stocks”; (2a) “Buying a company stock usually provides a safer return than a stock mutual fund. True or false?” versus (2b) “Buying a stock mutual fund usually provides a safer return than a company stock. True or false?”; (3a) “If the interest rate falls, what should happen to bond prices: rise/fall/stay the same/none

[3] The results discussed below are taken from Van Rooij et al. (2011a).

of the above?" versus (3b) "If the interest rate rises, what should happen to bond prices: rise/fall/stay the same/none of the above?"

While for the stocks versus bonds questions the number of correct answers to both variants of the question were almost the same: 61 versus 60 percent (for version 1a and 1b respectively)[4], we observed statistically and economically meaningful differences in the response patterns in the other two questions. In particular, the stock mutual fund versus company stock questions (one of the Big Three financial literacy questions) was answered correctly by 63 versus 32 percent of respondents, for version 2a and 2b respectively. For the question asking for the impact of interest rate changes on bond prices the number of correct answers varied from 31 to 19 percent of respondents (for version 3a and 3b respectively). Thus, question wording does matter, in particular for questions measuring complex topics.

There are several take aways from these experiments with the wording of financial literacy questions. First, we take this evidence as additional proof of low financial literacy among the population. Second, it is important to pay attention to the wording of questions and make sure that the formulation is clear. Third, in panel analyses it is important to use exactly the same wording over time as minor variations can lead to different response patterns. Fourth, when doing cross country comparisons, one should pay attention to the proper translation of the financial literacy questions, which may contribute to differences in answer patterns (for such a cross country comparison see, e.g., Lusardi and Mitchell, 2011c, or Demertzis et al. 2024).

3.3 The role of "do not know" answers

Another recurring topic regarding the measurement of financial literacy is the interpretation and treatment of the "do not know" (or DK) answers". All financial literacy questions are multiple choice questions featuring a correct answer, incorrect answer(s) and a DK answer. The central question is whether and how much a DK answer reflects a lack of knowledge with respect to an incorrect answer. While many studies group incorrect answers together with DK answers, other approaches have also been used in the literature. For example, Lusardi and Mitchell (2011a, b) use this information in their regression analyses to differentiate among degrees of financial knowledge. Van Rooij et al. (2011a, 2011b, 2012) take into account the differences among correct, incorrect and DK responses in the factor analysis underlying their advanced literacy scale. Von Gaudecker (2015) assigns a value to DK answers that corresponds to the probability of randomly selecting a correct answer.

Bucher-Koenen et al. (2024) designed an experiment to examine whether DK answers reflect lack of knowledge or lack of confidence. They devised a two-wave experiment in the Centerpanel as follows: in the first wave respondents answer the original Big Three questions, which include the DK option; six weeks later, in the second wave, respondents were given the same financial literacy

[4] Response patters did not differ significantly on the 5% level. Differences were significant on the 10% level though which was the result of somewhat larger differences in the proportion of do not know answers: 27 versus 22 percent.

questions, but this time without the DK option and followed by a question asking how confident respondents are about their answer. This study has several interesting findings. First, respondents answering DK in wave 1 often report the correct answer when answering the question (which does not include a DK option) in wave 2. The hypothesis that these respondents are random guessing the correct answer is statistically rejected for all questions. Second, women are disproportionately more likely to answer DK to the financial literacy questions and some of that is due to their lack of confidence. Third, there is information in the DK answers and Bucher-Koenen et al. (2024) advise to include both the number of correct answers and the number of |DK answers in regression analyses that include financial literacy.

3.4 Dealing with endogeneity in regression analyses

A significant concern when assessing the impact of financial literacy on financial behavior nis the issue of endogeneity. Moreover, biases may arise from measurement error, omitted variables or reverse causality. Several approaches have been used to tackle these concerns. As mentioned earlier, Bucher-Koenen et al. (2024) address measurement error by using the standard financial literacy questions and including the number of DK responses in the regression analyses as an additional control variable. Van Rooij et al. (2011a, 2012) regress stock market participation, retirement planning and household wealth on a measure advanced financial literacy, while controlling for basic financial literacy. The latter is a measure of ability, which is often an omitted variable in many other studies.

Another strategy is to use instrumental variables (IV) estimation. The challenge in this case is to find suitable instruments. Bucher-Koenen et al. (2024) and Van Rooij et al. (2012) use economics education as an instrument, i.e., the extent to which respondents were exposed to economic subjects during high school. The identifying assumption is that this exposure is exogeneous and boosts the accumulation of financial knowledge and skills but has no impact on retirement planning or stock market participation other than via the increased levels of financial literacy. This instrument is strong: the first stage suggests a positive and statistically significant relationship between economics education and financial literacy.

Van Rooij et al. (2011a) and Alessie et al. (2011a) use a different set of questions that were designed to serve as instruments for the financial literacy questions. Specifically, they use information on the financial understanding of parents and the financial situation of the oldest sibling. The identifying assumption is that experiences of siblings and parents are exogenous but that respondents can learn from their situation and experiences. The first stage regression shows a strong and negative relationship, suggesting that negative experiences of family members improve the financial knowledge of respondents. These papers provide examples of how surveys can be used to design instruments for financial literacy.

Repeat information from household panels can be used to overcome the omitted variable problems arising from unobserved individual heterogeneity. Alessie et al. (2011a) apply this strategy

using data from Centerpanel surveys in 2005 and in 2010 to study the impact of the Big Three on retirement planning.

3.5 Targeted financial literacy scales

The original Big Three questions designed by Lusardi and Mitchell aimed to understand the knowledge of basic concepts, such as interest compounding, inflation and risk diversification. These questions inspired other measures of financial literacy. As mentioned earlier, the 2005 advanced financial literacy scale developed by Van Rooij et al. (2011a, 2011b, 2012) focused on more complex concepts, including the workings of financial markets. A measure for pension literacy was also developed, focused on the accrual and pay out phase of the basic state pension in the Netherlands.[5] In 2010, a measure of debt literacy was fielded in the Centerpanel and used to study the relation to mortgage decisions (Van Ooijen and Van Rooij, 2016).[6] Findings from these studies confirm that the level of knowledge of these difference concepts is low in the population and it does affect financial decisions.

4. What insights have we gained on financial literacy and financial behavior?

The last two decades of research have yielded many insights into the effect of financial literacy on financial decision-making. Many of these studies utilize the data initially collected in the DNB Household Survey, and other data collection efforts have followed, often inspired by that original work. For example, the extensive set of financial literacy questions that were designed for the DNB Household inspired data collection in US household panels, specifically the RAND American Life Panel (ALP) and the Understanding America Study (UAS), which included many of the questions pioneered in the DHS Survey (see Lusardi and Mitchell, 2017; Angrisani and Kapteyn, 2024). Advances in the measurement of financial literacy made it possible to document the levels of financial knowledge within a broad population and dig into differences across socio-demographic groups. Importantly, this type of data made it possible to study the relationship between financial literacy and a variety of financial decisions, from retirement planning to saving and investment decisions, to debt management. By now, it has been shown that financial literacy is an important determinant of financial decision-making. Lusardi and Mitchell (2014, 2023) provide an overview addressing many findings from US studies and abroad.

Since the first survey in 2005, studies using financial literacy measures and data from the Centerpanel and the DNB Household survey have made useful contributions to the literature. Van Rooij et al. (2011a) have shown that financial literacy has a statistically significant and economically meaningful impact on the likelihood of investing in the stock markets. This study contributes to

[5] These questions and the results are documented (in Dutch) by Van Rooij, Alessie and Lusardi in an article published in ESB entitled "Pensioenakkoord verist financieel inzicht", 19 August 2011.
[6] The debt literacy scale was taken from Lusardi and Tufano (2015).

explaining the so-called stock market participation puzzle, i.e., the fact that while economic models indicate it is normally beneficial for a very large majority of households to have at least some part of their wealth invested in the stock market, many households shy away from stocks (Haliassos and Bertaut, 1995). Van Rooij et al. (2011a) show that consumers do not have much knowledge of the workings of the stock market and are unfamiliar with basic asset pricing. Lack of financial literacy raises the costs of gathering and collecting information on stock investments and these information costs introduce a barrier to invest in stocks. Indeed, higher financial literacy increases the likelihood of stock market participation both in the OLS and IV regressions that use information on the financial situation of siblings and the financial understanding of parents as instruments (Van Rooij et al. 2011a).

Using data from the DNB survey, Van Rooij et al (2011b) highlight the positive association between financial literacy and retirement planning in the Netherlands, which confirms the findings for the US documented by Lusardi and Mitchell (2007). Alessie et al. (2011a) analyze whether there it a causal impact of financial literacy on retirement planning, using IV estimation. Using information on siblings and parents and running fixed effects regressions on the 2005 and 2010 DNB data, they find that respondents with higher financial literacy are more likely to plan for retirement.

Similar results have been obtained using other measures of retirement preparation. For instance, a study for the US has shown that financial literacy goes hand in hand with concrete actions by workers, for instance whether they have tried to calculate how much they need to save for retirement and whether they actually developed a saving plan for retirement (Lusardi and Mitchell, 2008). Using a similar measure, Van Rooij et al. (2012) were also able to document that financial literacy has a causal impact on the likelihood of retirement preparation. Moreover, studies in the US and the Netherlands show the importance of this first step in the retirement planning process, since those who make these calculations often do come up with a savings plan for retirement and in many cases were able by and large to stick to these savings plans.

The positive relationship between literacy and retirement planning is because a high level of financial knowledge can reduce the costs associated with planning, i.e., higher literacy reduces barriers to acquire information, do calculations and develop a plan. These barriers can be economic, for instance related to the time and effort needed to gather information and to devise concrete plans, or they can be psychological, for instance perceived hurdles to initiate the search for information and estimate retirement saving needs. This is confirmed by the finding that households who are relatively overconfident in their financial literacy are also more likely to try and calculate saving needs (Van Rooij et al. 2012).

The crucial role of financial literacy on retirement preparation is further highlighted in a study by Alessie et al. (2011b), which examines expected retirement ages and replacement rates. This study shows that Dutch employees hold overly optimistic expectations regarding pension replacement rates and are quite confident of achieving these high replacement rates. However, employees with higher levels of financial literacy are more likely to have more realistic pension expectations and anticipate

significantly lower replacement rates and acknowledge that these expectations come with a significant amount of uncertainty.

Given the observed relationships between financial literacy and retirement planning and stock investments, one would expect that financial knowledge also plays a role in wealth holdings. Van Rooij et al. (2012) test this hypothesis and run IV regressions using the DNB data. They find a strong positive effect of financial literacy on wealth accumulation. This effect is statistically significant and economically meaningful. This is illustrated by comparing the predicted difference in net worth between households at the 25th percentile and those at the 75th percentile in the distribution of financial literacy, keeping all other characteristics constant. The difference in net worth between these low-literacy and high-literacy households amounts to approximately 80,000 euro, or roughly three and a half times the median net household income. Similar calculations for the predicted differences in the likelihood of planning for retirement and investing in the stock market suggest that households with (moderately) high levels of literacy are respectively 30 and 17 percentage points more likely to engage in these financial behaviors than households with (moderately) low levels of financial literacy.

The relationship between financial literacy and financial behavior is not limited to retirement planning and stock market participation but extends to many other financial decisions. For instance, Deuflhard et al. (2019) show that financial literacy is also an important determinant of other and simpler financial decisions, such as choosing saving accounts. Using the 2005 financial literacy measure from Van Rooij et al. (2011a, 2011b, 2012), these authors document that more financially literate households earn higher interest rates on their saving accounts. They link the survey data on financial literacy and the detailed information on all individual bank accounts from the DHS - i.e., the amount deposited on each account, the name of the bank offering the account and the specific name of this bank account - to administrative data on interest rates on all bank accounts. Their findings show that higher financial literacy is associated on average with a 29 basis points higher interest rate on saving accounts. The paper argues that familiarity with new technologies, i.e., the use of online bank accounts, is a potential explanation for achieving higher returns on savings accounts. More broadly, the evidence show that higher literate households are better able to detect bank accounts offering higher interest rates out of the large variety of available bank saving accounts.

Von Gaudecker (2015) also builds upon the 2005 financial literacy measure to study the effect of financial literacy on portfolio diversification. For this purpose, he links the data available in the DHS to the historical time series of returns on stocks and mutual funds. This allows the calculation of risk-return characteristics of households' portfolios. Many households are found to hold under diversified investment portfolios. The expected return loss is highest for households with low levels of financial literacy, in particular those who do not seek advice and trust their own decision making capabilities. Compared to other groups, the low literacy investors who do not use advice have on average 50 basis points lower annual investment returns as a result of poor portfolio diversification. Von Gaudecker (2015) suggests that the losses resulting from underdiversification in this group are an indication of

overconfidence in their financial literacy. The other low financial literacy group who achieves effective investment risk-return outcomes does so either because they turn to others for financial advice or because they choose a very low level of risk.

A study on mortgage decisions by Van Ooijen and Van Rooij (2016) reports similar findings. They document that households with lower levels of debt literacy more often choose traditional mortgages, for instance annuity or mortgages that are based on a gradual repayment of the loan principal. Households with higher levels of debt literacy often hold riskier loans with higher loan-to-value and loan-to-income ratios and mortgages that have an interest-only or investment-based component. Interestingly, when low debt literate households consult mortgage brokers, they too tend to hold riskier mortgages. Note that this study does not take a stand on optimal mortgage decision-making, but more risky mortgages are often set-up to take advantage of tax benefits. What we can take away from this study is that low literate households tend to shy away from complex financial products unless they consult advisors.

Not just decisions involving large amounts of money like mortgages, but even the capacity of dealing with small shocks highlights the importance of financial literacy. Wiersma et al. (2020) examine how households cope with financial emergencies, such as sudden expenses like a refrigerator breakdown. Specifically, they ask respondents whether they would be able to come up with €2,000 within a month if faced with an unexpected need. They show a strong link between financial literacy and financial fragility. Respondents with low levels of literacy are less likely able to come up with €2,000 within a month. If they manage to do so, they often resort to multiple coping strategies and are more inclined to rely on informal sources such as family and friends.

In summary, the available empirical evidence from many studies looking at a variety of financial decisions shows the important role that financial literacy plays in household decision-making.

5. Development of financial literacy over time

After reviewing the findings from the set of studies based on the financial literacy surveys conducted since 2005, a natural next question is: how has financial literacy evolved over time? Given that financial literacy has been surveyed multiple times in the DHS, and these surveys have consistently included the Big Three financial literacy questions, we are well-positioned to investigate the evolution of financial literacy. Table 1 presents the findings for financial literacy across four survey years for each individual question and for the overall literacy score. The results are based on an unbalanced panel with respondents who are 25 years and older and are responsible for the finances in their household. We use weights (based on net household income and homeownership) to make sure that results are representative of Dutch households. Note that we are able to only use half of the original 2005 sample since the risk diversification question in that survey year was offered either using either the original

wording of the Big Three literacy questions (we use this sub-sample) or using a slightly different wording (we delete this sub-sample).

[Insert Table 1 around here]

The percentage of correct answers to the interest rate question remains relatively consistent over the years, ranging between 87.6% and 90.5%. These percentages show that the interest rate question is the simplest question of the Big Three. However, about 1 in 10 respondents either provides an incorrect answer, indicates that they do not know the answer, or prefers not to answer. While this proportion is relatively low, it is important to note that these responses come from the respondent who manages the household finances.

The percentages of correct answers to the inflation question range from 81.5% to 83.6%. While the number of correct answers is lower than in the interest rate question, the percentages of incorrect answers, DK answers and refusals are all higher. The number of do not answers is by and large comparable to the number of incorrect answers. Typically, the number of refusals is very low, as is the case for all Big Three questions. The findings on inflation literacy are not only imported for consumer welfare but also of great interest for central banks with a price stability mandate.

The third and most difficult question on risk diversification shows somewhat larger differences across waves with a minimum of 56.8% in 2010 to a maximum of 63.4% in 2005. Noticeably, in all survey years the DK responses outnumber the incorrect responses indicating that respondents do not feel knowledgeable regarding diversification in stock investments.

In summary, the patterns for the Big Three are strikingly similar across years and show neither a clear upward nor a clear downward trend. The OECD (2015) reports that countries worldwide have implemented initiatives and established institutional programs to promote financial education and improve the general level of financial knowledge among the population. The Netherlands designed and implemented a national strategy for financial literacy as early as 2007. The results in Table 1 demonstrate that, despite the increased attention among policymakers and the growing body of research on financial literacy, levels of financial sophistication in the population have remained stubbornly stable.

Since the Big Three are regularly asked in large American panel surveys as well, we can compare the literacy outcomes for the Netherlands with results for the United States. Specifically, we base the comparison on Angrisani et. al (2023) who report the findings for the Big Three in the 2012 and 2018 ALP and Angrisani and Kapteyn (2024) who report the findings for four different waves fielded between 2014 and 2023 in the UAS. Dutch respondents display a somewhat higher level of understanding of the interest rate question; the percentage of correct answers in the four waves between 2005 and 2018 varies between 88 to 91 percent as compared to 86-88 percent in ALP and 83-86 percent

in UAS.[7] Dutch respondents show higher levels of knowledge of the inflation question, with 82-84 percent providing the correct answer vis-à-vis 76 percent in ALP and 67-73 percent in UAS. However, for the risk diversification question the patterns are different. The percentage of correct answers in the Dutch sample varies from 57 to 63 percent, which is below the percentage of correct answers provided by ALP respondents (62-67 percent) and comparable to UAS respondents (57-61 percent). Overall, the differences for the Big Three between the Netherland and the US are not large and in both countries there is no evidence of increasing levels of knowledge over time.

While the actual level of financial literacy has not witnessed meaningful changes, policy awareness and publicity campaigns may have moved self-consciousness among the public of their actual levels of financial knowledge. Insights on this can be taken from the level of confidence that respondents have in their own answers to the Big Three literacy questions. Table 2 (panel A) presents results for overall financial literacy, that is for the Big Three taken together. Across all years, the average number of correct answers to the 3 questions is equal to 2.31, the average number of DK-responses and refusals is 0.42 and the average number of incorrect answers is 0.27. The summary measures confirm that, across the survey years, the averages of the number of correct questions, the number of incorrect questions and the number of DK responses are relatively stable and show neither an upward nor a downward trend. The number of DK responses can be interpreted as a proxy for confidence and thus the summary results show that over time there have not been meaningful changes there as well.

[Insert Table 2 around here]

We also have information on how many questions respondents believe they have answered correctly. Since 2010, respondents are asked the following question (after having answered the three literacy questions): *The last three questions were about returns on savings accounts and stock investments. How many questions do you think you answered correctly? (i) None; (ii) One; (iii) Two; (iv) All three; (v) Do not know; (vi) Refusal*. Table 2 (Panel B) shows that this number of self-assessed correct literacy questions is remarkably stable and equal to on average 2.19 or 2.20 correct questions for each survey wave.

This measure cannot be directly compared to the average number of correct questions for all respondents because some respondents choose the DK option when asked for the expected number of correct questions. Therefore, we calculate the difference between the actual number of correct questions and the estimated number of correct questions (for all individuals who gave an answer to the question on the self-assessed number of correct questions). The average respondent appears to be underconfident and provided on average 0.2 more correct answers to the three literacy questions than they estimated

[7] Please recall that these comparisons need to be interpreted carefully given that subtle differences in wording due to translations from Dutch the English may not be innocuous. Also, keep in mind that the Dutch data refer to the person in the household responsible for finances.

themselves (Table 2, panel B). While this number differs somewhat across waves, there is again not a clear upward or downward trend. Recall that Bucher-Koenen et al. (2024) found that women, in particular, tend to be underconfident. When we delve further into the differences between men and women, we find that the discrepancy between the actual number of correct answers and the self-assessed number of correct answers also shows a gender difference. Women exhibit higher levels of underconfidence compared to men, in line with the findings of Bucher-Koenen et al. (2024).

In summary, both actual knowledge and self-assessed knowledge have not changed much over time.

6. Concluding remarks

Data collection provides the foundation for empirical analyses upon which theories and hypotheses are formulated, tested, and refined. We have been able to design surveys and run experiments in the DNB Household Survey through a collaborative effort between researchers from the Dutch central bank and academia. This pioneering data collection on financial literacy enables us to address research questions that were difficult to tackle with existing datasets.

In this paper, we have documented how the first data collection in 2005/2006 which included an extensive new set of financial literacy questions and questions that can serve as instruments for financial literacy led to many studies assessing the level of financial literacy and how literacy impacts financial decisions. These early investigations delivered new insights and inspired numerous follow-up studies and new experiments. Not only have researchers worldwide used these datasets, but many other major surveys now include financial literacy modules, including many new surveys started by central banks. These modules most often encompass the Big Three literacy questions and also more extensive sets of questions inspired by those designed for the first survey run in the DNB Household Survey. Financial literacy modules with the same questions over time are important because they enable comparisons and new research studies that contribute to a more comprehensive understanding of household behavior, ultimately informing policies and interventions that better address household needs.

Beyond the methodological contributions, one of the major findings reported in this paper is that financial literacy is crucial for important financial decisions such as saving, borrowing, investing, and planning for retirement. Additionally, financial literacy impacts wealth holdings and financial fragility.

We also presented an analysis of how financial literacy has evolved since 2005. These data demonstrate that overall financial literacy levels among the Dutch population have remained stable since the first survey, despite numerous initiatives by the government and the private sector The Netherlands has had a national strategy since 2007 to improve financial knowledge and awareness in the Dutch population, leading to the establishment of the Money Wise Platform (OECD, 2015) where government and industry partners collaborate to promote better financial knowledge and preparedness

for the Dutch population. High levels of financial literacy remain an important objective as the financial landscape continuously and rapidly changes with new financial products, digitalization, and technological advancements, altering the characteristics of financial decisions and the required skills to navigate the choices on how much to spend, borrow, invest, save precautionary or set aside for retirement.

The lack of improvements in financial literacy indicate that more work is needed. There are two large initiatives in the Netherlands to increase financial literacy and help consumers in financial decision-making. One is the Money Wise Platform which was launched by the Ministry of Finance where partners from government agencies, the financial industry, NGO's and academic institutes collaborate in a wide variety of projects. The second is the work of the National Institute for Family Finance Information (Nibud), an independent foundation in the Netherlands with the mission to contribute to family wellbeing by promoting sound money management.[8] Future research studies and new data collection initiatives may inform these policies and lead to interventions that prove successful in raising financial literacy across the population.

[8] For more information, see their websites: https://www.wijzeringeldzaken.nl/english/ and https://www.nibud.nl/about-nibud/

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Box 1. Basic Literacy Questions

1) Numeracy

Suppose you had €100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow? (i) More than €102; (ii) Exactly €102; (iii) Less than €102; (iv) Do not know; (v) Refusal.

2) Interest compounding

Suppose you had €100 in a savings account and the interest rate is 20% per year and you never withdraw money or interest payments. After 5 years, how much would you have on this account in total? (i) More than €200; (ii) Exactly €200; (iii) Less than €200; (iv) Do not know; (v) Refusal.

3) Inflation

Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account? (i) More than today; (ii) Exactly the same; (iii) Less than today; (iv) Do not know; (v) Refusal.

4) Time value of money

Assume a friend inherits €10,000 today and his sibling inherits €10,000 3 years from now. Who is richer because of the inheritance? (i) My friend; (ii) His sibling; (iii) They are equally rich; (iv) Do not know; (v) Refusal.

5) Money illusion

Suppose that in the year 2010, your income has doubled and prices of all goods have doubled too. In 2010, how much will you be able to buy with your income? (i) More than today; (ii) The same; (iii) Less than today; (iv) Do not know; (v) Refusal.

Box 2. Advanced Literacy Questions

6) *Which of the following statements describes the main function of the stock market?* (i) The stock market helps to predict stock earnings; (ii) The stock market results in an increase in the price of stocks; (iii) The stock market brings people who want to buy stocks together with those who want to sell stocks; (iv) None of the above; (v) Do not know; (vi) Refusal.

7) *Which of the following statements is correct? If somebody buys the stock of firm B in the stock market:* (i) He owns a part of firm B; (ii) He has lent money to firm B; (iii) He is liable for firm B's debts; (iv) None of the above; (v) Do not know; (vi) Refusal.

8) *Which of the following statements is correct?* (i) Once one invests in a mutual fund, one cannot withdraw the money in the first year; (ii) Mutual funds can invest in several assets, for example invest in both stocks and bonds; (iii) Mutual funds pay a guaranteed rate of return which depends on their past performance; (iv) None of the above; (v) Do not know; (vi) Refusal.

9) *Which of the following statements is correct? If somebody buys a bond of firm B*: (i) He owns a part of firm B; (ii) He has lent money to firm B; (iii) He is liable for firm B's debts; (iv) None of the above; (v) Do not know; (vi) Refusal.

10) *Considering a long time period (for example 10 or 20 years), which asset normally gives the highest return*? (i) Savings accounts; (ii) Bonds; (iii) Stocks; (iv) Do not know; (vi) Refusal.

11) *Normally, which asset displays the highest fluctuations over time*? (i) Savings accounts; (ii) Bonds; (iii) Stocks; (iv) Do not know; (v) Refusal.

12) *When an investor spreads his money among different assets, does the risk of losing money:* (i) Increase; (ii) Decrease; (iii) Stay the same; (iv) Do not know; (v) Refusal.

13) *If you buy a 10-year bond, it means you cannot sell it after 5 years without incurring a major penalty. True or false*? (i) True; (ii) False; (iii) Do not know; (iv) Refusal.

(14) *Stocks are normally riskier than bonds*. True or false? (i) True; (ii) False; (iii) Do not know; (iv) Refusal.

(15) *Buying a company stock usually provides a safer return than a stock mutual fund. True or false?* (i) True; (ii) False; (iii) Do not know; (iv) Refusal.

(16) *If the interest rate falls, what should happen to bond prices*? (i) Rise; (ii) Fall; (iii) Stay the same; (iv) None of the above; (v) Do not know; (vi) Refusal.

Table 1. Responses to the big-3 financial literacy questions across years

	Years				
	2005	2010	2015	2018	All
Interest rate question					
More than 102 euro	***90.5***	***87.6***	***90.1***	***88.3***	***89.0***
Exactly 102 euro	3.0	2.9	4.1	4.2	3.6
Less than 102 euro	2.6	1.4	1.8	2.3	2.0
Refuse to answer	0.3	0.8	0.3	0.5	0.5
Do not know	3.7	7.2	3.7	4.8	4.9
Inflation question					
More	1.6	1.7	2.5	3.6	2.5
Exactly the same	7.6	5.8	5.5	5.7	6.0
Less	***82.2***	***81.5***	***83.6***	***82.4***	***82.5***
Refuse to answer	0.5	1.0	0.3	1.0	0.7
Do not know	8.1	10.0	8.1	7.2	8.3
Risk question					
True	12.3	10.9	14.5	14.7	13.3
False	***63.4***	***56.8***	***61.0***	***58.4***	***59.6***
Refuse to answer	0.3	1.2	0.4	0.5	0.6
Do not know	24.0	31.1	24.1	26.4	26.5
Number of observations	753	1,113	1,424	1,356	4,646

Notes: The table shows weighted percentages for responses to the big-3 financial literacy questions from 4 ad hoc modules in the DNB household survey. The question wording is "Suppose you had €100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?" (Interest rate question), "Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?" (Inflation question), and "Buying a company stock usually provides a safer return than a stock mutual fund. True or false?" (Risk question). The correct answer categories are highlighted in bold and italics.

Table 2. Overall financial literacy and self-assessed literacy across years

	Years				
	2005	2010	2015	2018	All
Panel A: Financial literacy, overall					
Number of correct answers	2.361	2.259	2.347	2.291	2.312
	(0.841)	(0.925)	(0.838)	(0.892)	(0.877)
Number of incorrect answers	0.270	0.226	0.283	0.304	0.273
	(0.558)	(0.480)	(0.549)	(0.560)	(0.539)
Number of DK responses/refusals	0.368	0.515	0.370	0.405	0.415
	(0.696)	(0.853)	(0.709)	(0.753)	(0.759)
Number of observations	753	1,113	1,424	1,356	4,646
Panel B: Self-assessed financial literacy					
Self-assessed number of correct answers		2.204	2.194	2.193	2.197
		(0.840)	(0.849)	(0.858)	(0.849)
Difference: # correct -/- # self-assessed correct		0.169	0.231	0.202	0.203
		(0.716)	(0.746)	(0.751)	(0.739)
Number of observations		1,035	1,338	1,254	3,627

Notes: The table shows weighted means for the total number of correct responses, the total number of incorrect responses and the total number of do not know (DK) responses to the big-3 financial literacy questions taken from 4 ad hoc modules in the DNB household survey. Standard deviations are reported in parentheses. Panel B reports fewer observations compared to panel A. The reason is that some respondents answer do not know to the question on the self-assessed number of correct questions (which question was introduced in 2010).

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