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Is Financial Knowledge Really Declining? Randomized Evidence on the Effects of Smartphone Responses [1]

Jeremy Burke,[2] Carly Urban,[3] and Olivia Valdes[4]

Abstract

Measured financial knowledge declined by 15 percent in the U.S. between 2009 and 2021. We propose one possible explanation: an increase in smartphone responses on web-based surveys. Using within-individual variation in device type in a representative internet panel, we first observe that when respondents use smartphones, they are more likely to choose "don't know" and less likely to answer questions correctly than when responding on a desktop, laptop, or tablet. We then conduct an experiment where respondents are randomized to complete a survey on a smartphone or another device and find remarkably similar results. Leveraging randomized question placement, we find that the smartphone penalty is larger when questions appear later in the survey. We find similar results for a set of general knowledge questions. Back-of-the-envelope calculations suggest that at least 23 percent of the decline in financial knowledge can be attributable to expanded smartphone use when taking surveys.

JEL Classification Codes: D83, D14, G53, C83
Keywords: Financial Literacy, Mobile Phones, Survey design

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1 INTRODUCTION

The 2007 global financial crisis left many households reeling (Bernanke, 2023). Countries subsequently constructed regulatory guardrails and developed national financial literacy strategies (OECD, 2015; International Monetary Fund, 2018*a*). Surveys worldwide began consistently measuring financial literacy using the same five questions commonly referred to as the Big 5 or a subset, referred to as the Big 3 (Lusardi and Mitchell, 2007, 2014*a*).[5] More recently, hundreds of fintech and online platforms that provide financial education and measure financial literacy have proliferated in the marketplace.[6] Understanding how changes in measured financial literacy reflect actual knowledge changes is critical for accurately assessing the changes in population-level financial sophistication and the effectiveness of interventions, like financial education.

Two stylized facts come from U.S.-representative data measuring financial knowledge. First, despite the expansion of high school financial education (shown to be effective along multiple dimensions) from 2009 to 2025,[7] measured financial literacy has nevertheless declined. The National Financial Capability Study (NFCS), an internet-based survey of U.S. households, has shown steady declines in measured financial literacy from 2009 through 2021 (Figure 1). Second, the number of "don't know" (DK) responses to financial literacy questions has steadily increased over the same time frame.

We propose one potential explanation for these patterns: an increase in the use of

[5] See, for example Boisclair, Lusardi and Michaud (2017) in Canada, Bucher-Koenen and Lusardi (2011) in Germany, Fornero and Monticone (2011) in Italy, Sekita (2011) in Japan, Van Rooij, Lusardi and Alessie (2011) in the Netherlands.

[6] See Gargano and Rossi (2024) for a goal-setting fin-tech pilot.

[7] For example, see Burke, Collins and Urban (Forthcoming); Stoddard and Urban (2020); Mangrum (2022); Harvey (2019); Urban et al. (2020); Lee et al. (2024); **?**.

smartphones to answer survey questions. While only 35 percent of US adults had a smartphone in 2011, 85 percent owned one ten years later. Beyond adoption rates, smartphones themselves have evolved.[8] With higher-speed internet, greater power, and larger screens, smartphones have become an increasingly common way to answer web surveys (Gummer et al., 2023). Within the NFCS, the rate of mobile phone responses has risen from 0 percent in 2009 to 55 percent in 2021 (Figure 2). This paper estimates the causal effect of using mobile phones, compared to desktops, laptops, or tablets, on correct and DK financial knowledge responses.

Across the four biggest nationally representative internet-based surveys that have both data on the Big 3 financial literacy questions and the type of device used when responding, those answering on a smartphone score lower than those who do not (Figure 3).[9] Naturally, this correlation between smartphone responses and measured financial knowledge does not point to causality. There is clear selection into device type: younger respondents, respondents with lower levels of education, respondents with lower household incomes, and Black and Hispanic respondents are more likely to respond to surveys on a smartphone than their respective counterparts in simple regression models predicting mobile use on surveys (Figure 4).[10]

We overcome selection into device type using two methods. First, we examine respondents in the nationally representative Understanding America Survey (UAS) who answer the same financial literacy questions multiple times but vary in the type of device on which

[8] Figure A.1 depicts the most popular cell phone from 2009 through 2021.

[9] All of these differences in means are statistically different from zero at the one percent level overall and across each individual survey year. The difference is similar in magnitude and remains statistically different from zero whether or not we use survey weights.

[10] These characteristics similarly predict smartphone survey response across all survey years since 2014 in the UAS data, where we have data on device type.

they respond. Second, we conduct a pre-registered randomized experiment in the same panel (Burke, Urban and Valdes, 2024). Participants who had access to both a smartphone and another web-connected device were randomly assigned to complete the survey either on their smartphone or on another device;[11] the link to the survey was unavailable if they logged in on the wrong device.

In the randomized experiment, we find that individuals assigned to use their smartphones answer 0.117 fewer financial literacy questions correctly, representing a 3 percent reduction in knowledge scores, and respond DK 0.083 more times, an 11 percent increase relative to the mean level. We find remarkably similar results from our observational variation in the UAS panel. The primary mechanism is that respondents in the smartphone condition were 50 percent more likely to engage in rapid guessing—answering at least one of the questions in an implausible three seconds or less.

Figure 3 also reveals that where questions are placed on the survey may be important—knowledge scores are consistently lower in surveys where the financial literacy questions appear near the end of the questionnaire. This observation is consistent with work by Brown et al. (2025) on cognitive endurance in standardized tests. In our experiment, half of participants were randomly assigned to see the financial literacy questions near the beginning of the survey while the other half saw the questions near the end. We find that the negative effects of smartphone assignment on responses to financial literacy questions are stronger among individuals who saw the questions late in the survey. Across all findings, we find similar results for a general knowledge test, suggesting that our findings are not confined to financial literacy.

[11] They were allowed to use a desktop, laptop, or a tablet.

Beyond device effects, the expansion of smartphones may have increased and altered the population willing to respond to internet surveys. To investigate this possibility we lifted the device restriction at the conclusion of our experiment and allowed any remaining individuals who had not yet completed the survey to do so on their device of choice (smartphone or desktop, laptop, or tablet).[12] Our survey response rate increased from 72 percent to 81 percent, with marked differences between compliers in the other device condition and individuals who were only willing to respond on their smartphone. Participants who were only willing to respond on their smartphone had lower education levels, lower income, and financial literacy scores that were 22 percent lower than compliers in the other device condition.

To examine how much of the observed decline in measured financial literacy may be due to increased smartphone use, we conduct two counterfactual exercises. First, we assume that all NFCS respondents who completed the survey on a smartphone in 2021 would have also responded in 2009 using another device, since smartphone participation was not an option at the time. This implies any observed effects would be entirely attributable to the device used, and our estimates suggest smartphone expansion would explain 23 percent of the observed reduction in measured financial knowledge. Conversely, if none of the participants responding on a smartphone in 2021 would have participated in 2009, implying that smartphones brought a new population of survey takers, then the expansion of smartphones accounts for 83 percent of the observed reduction in measured financial knowledge.

Our evidence consistently points to our central finding—individuals perform worse

[12] We find consistent results from intent-to-treat style analyses that incorporate the additional (negatively selected) sample that was allowed to complete on their device of choice after the experiment concluded.

on financial knowledge questions when responding on their smartphones. This presents challenges to fintechs and web-based surveys attempting to measure financial knowledge. Failing to adjust for differences in smartphone use and the position of questions across surveys may lead to inaccurate policy conclusions. We discuss potential strategies to mitigate this problem and develop a database that corrects for differences in survey implementation when making cross-survey comparisons in Section 6.

We make contributions to the large and growing literature on financial literacy (Lusardi and Mitchell, 2014*b*; van Rooij, Lusardi and Alessie, 2012; Lusardi, Maarten van Rooij and Alessie, 2011; Lusardi and Mitchell, 2023), where we are the first to examine how survey responses may in themselves plague estimates.[13] We also contribute to a small survey methods literature on the data-quality impacts of smartphone use on surveys, which finds few meaningful effects on responses when survey participants are answering questions about themselves (Couper, Antoun and Mavletova, 2017; Tourangeau et al., 2018; Antoun, Couper and Conrad, 2017).[14] No large-scale studies have examined the causal effects of smartphones on responses to knowledge questions.[15]

[13](Bertola and Prete, 2025) use an individual-level panel to understand measurement error in financial literacy DK responses, but they assume that no one who knows the answer responds DK; we are able to relax that assumption.

[14]Antoun, Couper and Conrad (2017) has respondents complete a web-based survey on both a PC and smartphone to assess data quality.

[15]In an experiment with less than 80 respondents, Ilany-Tzur and Fink (2019) show that cognitively demanding tasks may result in poorer performance when assessed on mobile phones when compared to laptops.

2 OBSERVATIONAL EVIDENCE FROM TWO DATASETS

In this section, we present observational evidence on the gap in financial knowledge and DK responses between respondents using smartphone and non-smartphone devices. We begin with suggestive evidence from the Federal Reserve Board's Survey of Household Economics and Decisionmaking (SHED), comparing smartphone and non-smartphone respondents who were randomly assigned to either receive or not receive DK response options to the Big 3 questions (Lusardi and Mitchell, 2014*a*).We then leverage the panel structure of the UAS to compare financial literacy and DK response patterns within individuals who switched the device type used to respond to the survey over time.

2.1 SHED Data

The SHED annually examines the economic well-being of households in nationally representative samples of the U.S. Importantly for our study, the 2021 and 2022 waves of the SHED: (1) randomized whether respondents were presented with DK response options for the Big 3 questions, and (2) included a variable capturing the device type participants used to respond to the survey. We classify participants into smartphone and non-smartphone (i.e., tablets, laptops, and desktops) respondents.

In Table 1, we show the extent to which financial literacy scores differ across those who respond on smartphones versus non-smartphone devices. We separately examine those who were (Columns 1–2) and were not (Columns 3–4) provided DK as response options to the Big 3 questions. Among respondents shown DK, those on smartphones answer 0.34 fewer questions correctly than their non-smartphone counterparts, with this gap falling to 0.14 fewer questions after adjusting for observable characteristics correlated

with both smartphone use and financial knowledge. Compared to the sample average, the gap closes by 41 percent, though it remains large at roughly 7 percent.

Among respondents not provided the DK option, the raw difference is 0.18 fewer questions correct for smartphone users than non-smartphone users (47 percent lower than the smartphone/non-smartphone gap for the group that didn't get the DK option). The difference falls to 0.065 fewer questions after adjusting for observable characteristics tied to smartphone use. The device gap falls to 2.6 percent. This evidence is consistent with descriptive cross-survey trends in Figure 3, where the smallest smartphone/non-smartphone gap is seen in the survey that does not include the DK option (the CFPB survey).

While these data do not allow us to account for all observable and unobservable characteristics that influence selection into the use of smartphones, the results point to two suggestive patterns: (1) people responding on a smartphone display lower measured financial knowledge, and (2) when DK is available as a response option, smartphone users choose it much more frequently than non-smartphone users.

2.2 UAS Data

The UAS is a nationally representative panel of U.S. adults maintained by the Center for Economic and Social Research at the University of Southern California. Given its internet panel structure, the UAS provides a unique environment for studying the effects of device type on financial knowledge scores. Further, the UAS allows respondents to answer surveys using their device of choice: a smartphone or another device (laptop/tablet/desktop). We rely upon within-person changes in device type to determine if someone using a smartphone, compared to another device, is more likely to say DK and less likely to answer

knowledge questions correctly. Since smartphone usage expanded over this time period, we rely upon technological change to drive the change in device type, not a change in financial literacy. Further, we expect that since smartphone usage became more common in later survey years, the fact that individuals are more likely to use a smartphone later in the sample period—after they have already seen the questions once—will likely bias us against finding an effect, as respondents may have already looked up the questions' answers.

From 2014 through 2021, the UAS regularly asked financial literacy questions as part of its nationally-representative core survey content.[16] Using data from 5,046 individuals who responded, we first document that there is selection into using a smartphone to complete surveys. We run a regression of characteristics on smartphone use and report regression coefficient estimates and 95 percent confidence intervals in Figure 4. Two particular findings stand out: older respondents and more educated respondents are much less likely to use a smartphone to complete the survey than their younger and less educated counterparts. Compared to those under 30, respondents over 55 are more than 20 percentage points less likely to respond on a smartphone. Further, those with a college degree or more are nearly 20 percentage points less likely to respond on a smartphone than those with a high school diploma or less. Individuals with above-median household incomes, greater than $75,000 per year, are also less likely to respond on a smartphone than their counterparts. While females are more likely to respond on a smartphone than males, and Hispanic and Black respondents are more likely to respond on smartphones than White respondents or respondents of other races/ethnicities, the magnitude of these difference is

[16]We do not include the UAS samples that are specific to certain populations, such as the one for Los Angeles County only, one for Native Americans only, and one for California only.

much smaller than the gaps by age and education.[17]

To overcome the selection into smartphone use, we rely upon the panel nature of the UAS, wherein many individuals have answered financial literacy questions more than once. We draw upon 1,678 people who answered the financial literacy questions twice and 3,368 individuals who did so three times. Among those with repeat financial literacy observations, 30 percent have used two different types of devices when answering the UAS survey. Of those who have used multiple devices, 76 percent used a laptop, tablet, or desktop in an earlier year, and later used a smartphone, and the remainder used a smartphone in an earlier year, and later another device.

2.3 Methods

To examine how smartphone use influences responses, we estimate Equation 1, where Y_{it} is alternatively the number or likelihood of DK or correct responses to four of the Big 5 Financial Literacy measures (Lusardi and Mitchell, 2014*a*) for individual i in survey year t.[18] Mobile equals one for individual i in survey year t if the individual completed the survey on a smartphone and zero otherwise. We include individual-level fixed effects (δ_i) and survey year fixed effects (γ_t) in our model. Thus, all identification comes from within person changes in outcomes when a person switches to or from a mobile device in completing the survey. This method does not take into account *why* that person switched devices.

[17] These relationships hold for every survey year in the UAS, beginning in 2014. We cannot test whether this selection is similar in the 2012 NFCS data, though the survey data providers did report that no NFCS 2009 respondents answered on a smartphone.

[18] The UAS core surveys do not ask respondents the Big 5 question focused on mortgages.

$$Y_{it} = \alpha_0 + \alpha_1 \text{Mobile}_{it} + \delta_i + \gamma_t + \varepsilon_{it} \quad (1)$$

2.4 Results

Table 2 shows the estimates for $\hat{\alpha}_1$. Among respondents who used multiple devices, when using their smartphone to answer they answer 0.111 fewer questions correctly than when that same person uses a non-smartphone device (Panel A)—a 4 percent decrease. We also see an increase in the use of DK, with respondents answering DK 0.115 more times on their smartphone (Panel B)—a 17 percent increase. Notably, the decrease in correct responses (and increase in DK) is driven by fewer correct answers to the questions our sample found most difficult—the bond and diversification questions—and to a lesser degree, by the question on inflation.

3 THE EXPERIMENT

To account for possible selection into device use and to examine mechanisms through which smartphones may reduce measured knowledge, we conducted an experiment that randomized the type of device respondents were required to use to complete a survey. Specifically, 5,200 UAS panelists who previously reported owning both a smartphone and a laptop, desktop, or tablet were randomly assigned to complete the survey using either their smartphone or another web-connected device. Per standard UAS procedures, participants were informed via email that they were invited to complete a new survey. In the survey invitation, we highlighted that respondents could only complete the survey on the

type of device to which they were assigned. When participants logged into their UAS homepage, the link to the survey was only available if they were currently using their assigned device type, where detection was based on an analysis of the browser user agent string using the Mobile Detect library (`http://mobiledetect.net`). If they were logged in using an unassigned device, they were asked to log out and log back in using an assigned device type.[19] Figure 8 and Figure 9 display screenshots of the survey on a smartphone and laptop, respectively.[20]

Table 3 presents balance across baseline characteristics. In total, 2,580 participants were assigned to use a smartphone ("Mobile Device") and 2,620 participants were assigned to complete the survey using either a desktop, laptop, or tablet ("Other Device"). The average age in the sample is 50 years old, and approximately 60 percent of invited participants were female. Our invited sample is somewhat higher educated and higher income than the population at large. More than half the sample has a bachelor's degree or an annual household income above $75,000—though this is not unexpected given that invitations were only sent to randomly selected panelists who own both a smartphone and another web-connected device. Over half the sample is married, and three-quarters are White. Consistent with valid randomization, differences across conditions for each baseline characteristic are small and not statistically significant.

[19]During the experiment, 18 people assigned to the other device condition evaded our enforcement mechanisms and responded using a smartphone, while 61 people assigned to the smartphone condition responded on another device. This was most likely accomplished by logging into the UAS portal on their assigned device type, then switching to an unassigned device after the survey link appeared in their account. It is also possible that a respondent may have evaded our detection techniques by using desktop mode on their smartphone, though we assess this as unlikely as it results in UAS surveys appearing very small on the screen.

[20]The survey looks similar on an Android and an iPhone.

3.1 The Survey

Participants were invited to respond to a survey that would take approximately six minutes to complete. The survey measured financial literacy using the Big Five Financial Literacy questions and solicited general knowledge with five questions on a range of topics including the scientific method, the current Chief Justice of the United States, and what it means if a website uses cookies. We randomized the order in which respondents completed the two sets of questions: half of participants were first presented with financial literacy questions, and half were first presented with general knowledge questions. Between the two blocks of questions, participants were presented with a lengthy attention check question. At the end of the survey, participants who answered DK to any of the financial literacy questions were asked the same questions without the DK option. All participants were then asked if they experienced any interruptions while completing the survey and one factual question about themselves. The survey opened on September 12, 2024, and closed on November 24, 2024. The complete survey instrument is in Appendix C.

3.2 Estimation

Overall, 72 percent of invited participants completed the survey. Compliance with assigned condition was high—98 percent of participants who completed did so on their assigned device type. Completion rate was higher in the smartphone condition (74 percent) than in the other device condition (70 percent). Individuals who completed using a smartphone were, on average, two years younger and 5.7 percentage points less likely to hold a bachelor's degree than those who completed using a different device (Table 3). Given the differences in response rates and observable characteristics, we control for baseline

covariates in all specifications below, though we explore various methods of accounting for differential attrition in Section 4.4.

To estimate the effect of random assignment to answer the survey on a smartphone relative to the other device types, we estimate intent-to-treat specifications of the following form:

$$Y_i = \alpha + \beta \text{Mobile}_i + \gamma \text{X}_i + \varepsilon_i \tag{2}$$

where Y_i captures an outcome of interest (e.g., number or likelihood of correct or DK responses to the financial literacy questions), Mobile captures random assignment to the smartphone condition, and X_i is a vector of baseline characteristics, including age, gender, bachelor's degree or more, annual household income over $75,000, married, and whether the respondent is White.

4 Experimental Results

Table 4 contains results from our primary specification. We find that, on average, assignment to the smartphone condition results in answering 0.12 fewer financial literacy questions correctly, a 3.2 percent reduction relative to the sample mean of 3.6 questions answered correctly. The decline is largely attributable to an increased rate of responding "don't know." Assignment to the smartphone condition increased the number of DK responses by 0.08 questions (an 11 percent increase relative to the sample mean of 0.75 DK responses), and increased the likelihood of responding DK to at least one of the five questions by 3.6 percentage points (an 8 percent increase relative to the sample mean of

45 percent responding DK to one or more questions).

Table 5 examines treatment effects for each of the questions separately. The overall results are primarily driven by fewer correct answers and more DK responses to the questions measuring knowledge of bond prices and diversification, the two questions our sample had most difficulty answering. Only 36 percent of respondents correctly indicated that bond prices will fall if interest rates rise, while 72 percent correctly identified that mutual funds usually provide safer returns than a single company's stock. In comparison, between 80 and 90 percent of respondents correctly answered the interest, inflation, and mortgage questions.

Random assignment to the smartphone condition reduced the likelihood of correctly answering the question about bond prices by 4.4 percentage points, and the question about diversification by 3.6 percentage points. We observe marginally significant effects on measured knowledge about inflation, reducing the likelihood of a correct response by 2.0 percentage points. There are no observable effects on the questions about interest or mortgages, though point estimates are negative for each of the five questions. Similar to the results for aggregate knowledge, reductions in correct answers are largely driven by increases in DK responses. The smartphone condition increased the likelihood of selecting DK to the bond question by 3.0 percentage points and the diversification question by 3.3 percentage points. Other estimated effects are not statistically different from zero, though all estimated coefficients are directionally indicative of more DK responses. Our results are similar if we remove demographic controls (Table B.1). The pattern of results also remain when we account for week fixed effects, (the week in which respondents took the survey) which account for potential differences across the smartphone and other device

groups in the week of response (Table B.2).

4.1 Survey Placement

Following work on cognitive endurance (Brown et al., 2025), we additionally randomized the order in which the survey questions were presented. Half of respondents received the financial literacy questions at the beginning of the survey, while the other half received the questions near the end of the survey (approximately three minutes later, on average). This randomization occurred within the survey. Accordingly, respondent observable characteristics are well balanced across survey placement, both for the overall sample (Table A.1) and within the smartphone and other device conditions (Table A.2).

We examine whether respondents assigned to the smartphone condition perform comparatively worse on the financial literacy questions when the questions are placed later in the survey. Particularly, we augment equation 2 by interacting random assignment with survey placement:

$$Y_i = \alpha + \beta_1 \text{Mobile}_i \times \text{Early}_i + \beta_2 \text{Mobile}_i \times \text{Late}_i + \phi \text{Late}_i + \gamma \text{X}_i + \varepsilon_i \tag{3}$$

Early_i and Late_i capture whether respondents saw the financial literacy questions at the beginning or end of the survey, respectively. The remainder of the equation mimics Equation 2.

Table 6 presents these results.[21] We find little evidence that respondents randomly assigned to the smartphone condition perform worse on the financial literacy questions than those assigned to another device type when the questions are placed early in the

[21] These results are robust to removing demographic controls in Table B.3.

survey—point estimates are not statistically different from zero at the 10 percent level. In contrast, we find larger differences when the questions are placed near the end of the survey. Respondents assigned to the smartphone condition answer 0.17 fewer questions correctly, select DK 0.14 more times, and are 5.1 percentage points more likely to say DK to at least one of the questions relative to respondents in the other device condition when financial literacy questions appear late in the survey. This device by survey placement interaction is significant for DK responses. Interestingly, the coefficients on our Late variable indicate that respondents in the other device condition improve their performance on the financial literacy questions when exposed to them later in the survey. However, individuals in the smartphone condition do not experience any such improvements, contributing to the device-by-survey placement interaction.

4.2 Mechanisms

The evidence thus far points to smartphone respondents answering fewer financial literacy questions correctly, due in part to increased DK responses. We next try to understand why. Table 7 tests potential mechanisms.

First, we consider that those responding on smartphones may encounter more distractions. We test this in two ways. We ask an attention check question midway through the survey (between the financial and general knowledge questions).[22] We also ask in the last question of the survey whether the respondent was interrupted or experienced a distraction while taking the survey. In both cases, we see no difference in distractions or attention across smartphone and non-smartphone groups in terms of either economic or statistical

[22] See Appendix C.

magnitude.

Second, we examine who spends more time thinking about the questions: smartphone or non-smartphone respondents. Here the findings suggest that those answering on their smartphone spend 4.4 fewer seconds (4 percent less) on the financial knowledge questions than those who complete the survey on their desktops, laptops, or tablets. Other research has found that respondents on smartphones take longer due to distractions (Couper and Peterson, 2017). We find no evidence to support that in our setting; in fact, we find that respondents seem to be answering more quickly on their smartphones.

Third, we take the evidence on survey completion time and push this a bit further to examine whether responding on smartphones leads to more rapid guessing. Following the survey effort literature (Wise, 2017), we denote rapid guesses as responses made in three seconds or less, an implausibly short amount of time for providing considered answers to the financial literacy questions.[23] We find that respondents on smartphones are 4.2 percentage points more likely to rapidly guess on at least one of the five questions, a 49 percent increase relative to the sample mean. In Table 8 we show that the questions with more rapid guessing generally correspond to the questions with increased don't knows from Table 5.

Fourth, we consider whether individuals are less likely to be paying attention by seeing if they correctly respond to questions about themselves. Our finding here is consistent with other research in survey methodology (Couper, Antoun and Mavletova, 2017), where people responding on smartphones and non-smartphones are equally likely to answer questions about themselves correctly. Column (4) shows that individuals select their birth year

[23] A literature exists studying effort in low-stakes standardized tests (Gneezy et al., 2019; Zamarro, Hitt and Mendez, 2019; Borghans, Diris and Tavares, 2025).

correctly at the same rate across device types.

Fifth, we test whether those answering on smartphones simply enjoy completing the survey less than those answering on other devices. The UAS asks respondents after each survey how interesting they found it on a scale from 1 - Very Interesting to 5 - Very Uninteresting. We see no differences across the two groups (Column (5)).

Taken together, these findings suggest that smartphone respondents spend less time answering the financial literacy questions and are more likely to engage in rapid guessing on these questions.

4.3 General Knowledge

This paper so far has explored the role of smartphones in explaining a decline in measured financial knowledge, but are the findings unique to the financial literacy domain? Duquennois (2022) finds that math questions related to finance on standardized tests are less likely to be answered correctly among students from low-income backgrounds, suggesting finance questions themselves harm disadvantaged students. We thus seek to understand whether our results extend to general knowledge questions.

We chose five questions that have been asked previously asked in other large-scale surveys to capture knowledge in science, math word problems, the Chief Justice of the Supreme Court, trade agreements, and web literacy (cookies).[24] Table 9 shows that the mean number of correct and DK responses are similar in magnitude to the financial literacy questions. Our experimental results are overall consistent with our findings on financial knowledge. Those assigned to the smartphone group answer 0.14 (or 4 percent)

[24]Unfortunately, not all have been asked consistently over time, which precludes us from graphing a trend.

fewer questions correctly than those assigned to the non-smartphone condition. Again, this comes largely from an increase in DK responses, with those in the smartphone group providing 0.09 more DK responses (or 11 percent greater than the sample mean) and being 4 percentage points more likely to indicate DK to one or more questions (9 percent greater than the sample mean) relative to those in the non-smartphone condition. Table B.4 shows that the questions with the greatest decreases in knowledge and increases in DK are those asking (1) who is the Chief Justice of the Supreme Court (SCOTUS), (2) which trade agreement was replaced by the United States-Mexico-Canada Agreement (Trade), and (3) the math word problem (Math). We further verify this pattern in our early versus late analysis using our general knowledge measure in Table B.5.

4.4 Accounting for Differential Attrition

Table 3 shows that those assigned to the smartphone condition were 4.9 percentage points more likely to respond to the survey than those in the other device condition. Moreover, completers in the smartphone condition were younger, less educated, and had directionally lower incomes. We apply two methodologies to examine the robustness of our results to the differential attrition we observe—inverse probability weighting and generalized Lee bounds Semenova (Forthcoming).

Inverse probability weighting assumes that selection into survey completion can be explained by our vector of covariates. In essence, this method models the probability of completing the survey and reweights observations in the data so that weighted average characteristics of those completing in the smartphone condition are similar to those in the other device condition. Table B.6 demonstrates that using inverse probability weighting

yields nearly identical estimated treatment effects to those obtained in Table 4.

The assumption that baseline observable characteristics can explain attrition is strong. Another common method to investigate robustness to differential attrition is to estimate potential bounds for the treatment effect under less restrictive assumptions about who fails to complete the survey. A common approach is to estimate bounds proposed in Lee (2009). However, Lee bounds rely on a critical assumption of monotonicity, namely that treatment (weakly) affects attrition in the same direction for everyone in the sample. This assumption is highly unlikely to be satisfied in our setting. In particular, it is likely that older adults were less likely to complete the survey if they were assigned to the smartphone condition, while younger adults were more likely to complete if assigned to use their smartphone.

Instead, we follow Semenova (Forthcoming), who relaxes the monotonicity assumption and instead imposes conditional monotonicity, allowing the effect of random assignment on attrition to differ across groups based on pre-treatment covariates. Applied to our setting, this would permit random assignment to the smartphone condition to increase completion rates among, for example, low-income younger respondents, and decrease rates among high-income older respondents. Semenova (Forthcoming) represents the bound as a ratio of two semiparametric moments and permits continuous covariates for both defining the subspaces and tightening the bounds. We modify Semenova (Forthcoming)'s replication code to estimate generalized Lee bounds in our setting.

Figure 5 presents the results for measured financial literacy. We partition our sample along age (in years), income (16 categories ranging from less than $5,000 per year to $150,000 or more per year), and education categories (16 categories ranging from less than 1st grade to doctorate degree), and their interactions, as these are the dimensions

on which we found at least suggestive evidence of differential attrition.[25] In all cases, the estimated lower bound indicates that smartphones lead to large possible reductions in measured financial literacy, on the order of 0.4 fewer questions answered correctly (11 percent of the mean score). Upper bounds are considerably smaller, and negative when we partition on income, or education and income. We achieve our tightest bound when using income in isolation, with the treatment effect bounded between -0.06 points and -0.37 points.

4.5 Expanding the Sample

The previous sections present evidence of device effects—measured financial literacy is lower when individuals use smartphones to complete the assessment. However, the increased proliferation of smartphones may have also changed the population who respond to web-based surveys. In particular, there may be a subpopulation who is only willing (or able) to respond to surveys using their smartphones. If this subpopulation differs substantially from individuals willing (or able) to respond using another web-connected device, expanded access to smartphones may have changed measured financial literacy in part by altering the composition of who is included in the measurement.

To investigate this possibility,[26] after the experiment closed, we requested additional funding to extend the survey period and allow people who had not yet responded to complete the survey on any device.[27] A total of 460 participants completed the survey after

[25] Adding additional covariates does not substantially change the results.

[26] We note that everyone invited to participate in our experiment had previously indicated having both a smartphone and another web-connected device (i.e., desktop, laptop, or tablet) that they can use to respond to UAS surveys. Thus, we interpret differences in this section as a result of willingness to respond on different device types, rather than ability to do so.

[27] Because this change was made after the experiment closed, this is not part of our pre-registration plan.

the device restriction was lifted: 181 people who were initially assigned to the smartphone condition (170 of whom completed on a desktop, laptop, or tablet) and 279 who were assigned to the other device condition (264 of whom completed on a smartphone). We also included 18 respondents who, during the original experiment, were assigned to the other device condition but evaded our enforcement mechanisms and responded using a smartphone, and 61 people who were assigned to the smartphone condition but responded on another device.

Table 10 shows the characteristics of completers, including our expanded sample, by randomly assigned device and the device they used to respond. Columns 1 and 2 present characteristics of individuals who were randomly assigned to complete on their smartphone and completed on another device (column 1) or complied with the assignment (column 2). Individuals who were only willing to respond on a desktop/laptop/tablet were older, more likely to be White, and had higher measured financial literacy than compliers in the smartphone condition (all differences are statistically significant). Of greater interest to this exercise is the comparison between columns 3 and 4 — how does the sample change when a requirement to complete the survey on desktop/laptop/tablet is relaxed and people are able to complete on a smartphone? We find that those only willing to respond on a smartphone are younger, more likely to be female, less likely to be married, less likely to be white, and substantially less likely to have high incomes or a bachelor's degree or more education than compliers in the other device condition (all differences are statistically significant). Importantly, those only willing to complete on a smartphone have markedly lower measured financial literacy than compliers in the other device condition, on the order of 0.8 fewer questions answered correctly.

We also use this expanded sample to perform a robustness check on our main results. In the face of differential attrition, one typically employs bounding exercises that make assumptions about the outcome variable for the differential attriters who were not observed. Here, we are able to get measures of our outcomes of interest directly—albeit from a selected sample who (predominately) used an unassigned device. Since more than 90 percent of the additional sample are non-compliers who did not complete on their randomly assigned device, their inclusion in the sample will attenuate any device effects we observe, resulting in a lower bound for our estimates.

Table 11 presents a balance table merging participants across the two enrollment regimes—the first where we enforced the device type restriction and the second in which it was relaxed. Notably, in this merged (and selected) sample, we observe no differences in response rates or observable characteristics across the two randomly assigned groups. Table 12 conducts an intent-to-treat analysis on the appended sample.[28] As expected, our estimates are attenuated, though our pattern of results persists. We find that random assignment to the smartphone condition results in 0.07 fewer financial literacy questions answered correctly, 0.07 more DK responses, and a 2.9 percentage point increase in responding DK to at least one of the questions. Moreover, we find similar patterns with respect to the smartphone survey placement interaction (Table 13). Effects are concentrated almost entirely among the sample that answered the financial literacy questions late in the survey, and the interaction effect is statistically significant for measured financial knowledge and total DK responses.

[28]We do not include covariates in this regression, as the sample is now balanced. If we do include covariates, our results become marginally insignificant but similar in magnitude in our overall specification, and our survey placement and mobile interactions remain similar in significance and magnitude.

5 COUNTERFACTUAL TRENDS

How much of the downward trend in financial knowledge can be explained by the use of smartphones to complete surveys? To glean some evidence on this, we carry out two counterfactual exercises in Figure 6. The plot shows the measured mean financial knowledge weighted to be nationally representative (FK Observed) and the mean 2009 financial knowledge level as a marker for the level of the first year of the trend (2009 FK), represented by a horizontal line. Recall that in 2009, no one answered the survey on a smartphone.

We then construct two comparison groups that allow us to bound the contributions to the trend. First, we plot the mean financial knowledge among people who answer on non-smartphone devices (FK Observed Non-Mobile Users) in the two years for which we have these data (2018 and 2021).[29] The difference between the 2009 overall financial knowledge level and the level for 2021 non-smartphone users is less than 0.07 questions. If we assume that everyone who responded on a smartphone in 2021 will *only* respond on a smartphone (i.e., would not respond if smartphones were unavailable), then our counterfactual is that measured financial knowledge in 2021 would be captured by FK Observed for Non-Mobile Users. Under this assumption, smartphone expansion explains 83 percent of the decline in measured financial knowledge.[30]

Second, we construct a counterfactual scenario by taking a weighted average of the non-smartphone responses and an adjusted level of financial knowledge for the smartphone

[29] We use the survey weights for the means, but the results are consistent if we do not.

[30] We cannot rule out that people overall are becoming less attentive in general over time, which means the true decline in knowledge may actually be flat—or that knowledge could have increased.

users based on the results from our experiment (FK Counterfactual).[31] We scale up the average smartphone response scores by our estimate and then create a weighted average of the adjusted smartphone response scores and non-smartphone response users. If everyone who responded in 2021 would have also responded in 2009 (i.e., the sample population remains unchanged, but some respondents used smartphones to respond in 2021), then our estimate of the impacts of the introduction of smartphones on measured financial knowledge is only the smartphone penalty (FK Counterfactual − FK Observed), which explains 23 percent of the observed decline from 2009 to 2021. This is a conservative estimate that assumes that the proliferation of smartphones in no way changed the pool of respondents who responded to the NFCS over time, only the manner in which they responded.

6 IMPLICATIONS

Our findings show that when respondents use smartphones, they are less likely to correctly answer knowledge-based questions. These results leave us with the question: what can we do? At a minimum, we acknowledge the trade-off: while allowing smartphones increases DK responses to knowledge-based questions, it also allows people to respond to surveys who may not otherwise participate. Having data on this population is crucial for informed policymaking. Given this reality, we compiled a database cataloging the datasets that measure the Big 3 or Big 5 worldwide, along with key survey details.[32] We code important elements of the survey design, including: (1) the placement of FK questions within the survey, (2) the survey modality, (3) the population assessed (e.g., nationally representative,

[31] We use the estimate that captures the mobile × late effect (-0.16), as financial knowledge questions are asked at the very end of the NFCS.

[32] The data are at: `https://papers.carlyurban.com/AllDatasetsBig3Big5_v1.xlsx`.

older adults, etc.), (4) the country, and (5) the survey year. This allows researchers to correct for the mobile penalty when making cross or within-country comparisons.

We next outline four ways to potentially alter surveys going forward and discuss the trade-offs.

One option to reduce the smartphone penalty is to remove the DK option. When we do this in our experimental context—asking those who responded DK to any financial knowledge question to respond again without providing a DK response option—the smartphone penalty falls by 35 percent (Table 14), which is largely consistent with but smaller in magnitude than the descriptive evidence from the SHED data. Some research, however, suggests that there is information about confidence within the DK responses (Bucher-Koenen et al., 2024).[33] Luskin and Bullock (2011) find that DK responses in the political realm reflect genuine ignorance, suggesting that removing the option won't actually change most measured knowledge, at least outside the financial literacy realm. Cziriak, Bucher-Koenen and Alessie (2024) consider a strategy to remove the DK option but ask a follow-up question to assess whether the respondent guessed in order to parse out the differences between knowledge and confidence.[34]

A second option would be to financially incentivize responses, as in Gneezy et al. (2019) with students completing the PISA exam. In low-stakes standardized tests, implementing incentives is feasible (at least in some settings). However, in large web-based

[33]In related work, Iriberri and Rey-Biel (2021) show that women are less likely to guess on multiple choice questions in standardized tests. Griselda (2024) further show that multiple choice questions themselves reduce women's performance on standardized tests. Tranfaglia, Lloro and Merry (2024) find that removing the DK option reduces the FK gender gap.

[34]Hospido, Iriberri and Machelett (2024) show that an informational intervention reduces DK responses among women, though this was a very tailored intervention regarding the FK gender gap and may not be generalizable to other settings.

surveys, this is not feasible. In practice, Hospido, Iriberri and Machelett (2024) show that financial incentives (albeit small) do not reduce DK responses. Further, incentivizing respondents to look up the answers to web-based surveys may severely misrepresent actual knowledge.

A third option is to—where possible—move the financial knowledge questions to the beginning of surveys in which responding on a smartphone is allowed, which may lessen the penalty. However, depending on the other questions asked, this approach can have some trade-offs, including reducing the quality of other responses, particularly since finance questions can be triggering for disadvantaged respondents (Duquennois, 2022).

A fourth option would be to introduce prompts and instructions to encourage careful and deliberate responses. Conrad et al. (2017) find that interactive prompts targeting respondents displaying speeding behaviors in real-time can successfully decrease speeding without increasing survey break-offs. Less targeted approaches show more mixed results (Blazek and Siegel, 2024).[35]

7 CONCLUSION

While some research points to the decline in financial knowledge over time as an indictment of financial education (Kim, Lee and Hanna, 2022), we show that this decline is likely due, at least in part, to measurement changes. In this study, we use observational data and a randomized experiment to show that answering knowledge questions on smart-

[35] Asking respondents to commit to answering carefully can increase engagement but may not reduce nonresponse or increase time spent; encouraging feelings of obligation or commitment requires rigorous pilot testing as some approaches can actually decrease survey interest; and providing preemptive warnings about data quality detection checks are generally found to reduce survey satisficing but may trigger psychological resistance in some respondents, resulting in problematic response patterns.

phones reduces correct responses while increasing DK responses, with the effect notably larger when knowledge questions appear later in the survey. We also find that the expansion of smartphones may explain a large portion of the observed reduction in financial knowledge—we estimate that smartphone expansion explains at least 23 percent and at most 83 percent of the decline in measured financial knowledge from 2009 to 2021.

When comparing across countries, time periods, and populations, the way the surveys are conducted matters. As policymakers track within-country changes to assess the effectiveness of financial literacy initiatives and make cross-country comparisons to explore the efficacy of various financial education strategies, keeping these measures consistent is critical. At the same time, the way people take surveys continues to evolve, and mobile responses may continue to increase. To help the field create comparable measures, we construct a database of datasets that contain the Big 3 and Big 5 financial knowledge measures worldwide, providing details on how they are elicited across surveys. The database also provides correction factors based on our estimated smartphone penalties that researchers and policymakers can use to make more accurate cross-country and longitudinal comparisons.

As more large-scale surveys move from face-to-face or telephone to online, how smartphones influence both answers to knowledge questions and the composition of respondents will become increasingly important issues. Further technological advances, such as the ease of using AI-enhanced search engines to look up answers may further complicate knowledge measurements. Future research should innovate ways to measure knowledge, taking into account smartphone effects and the impacts of other increasingly sophisticated technologies.

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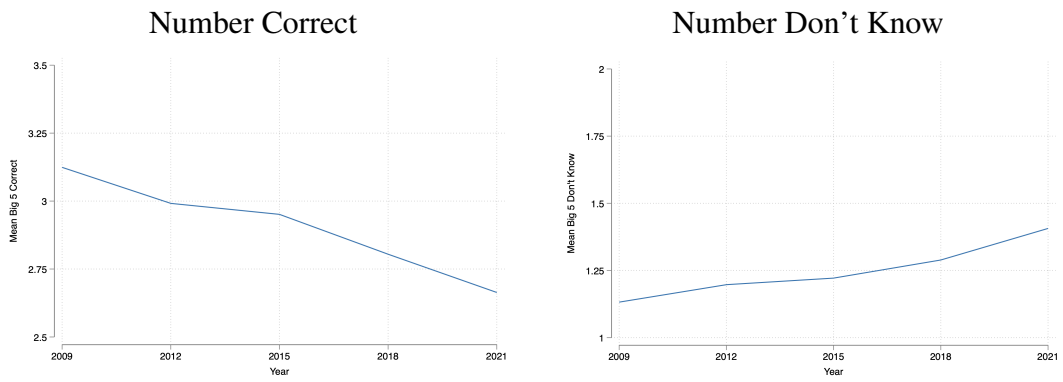
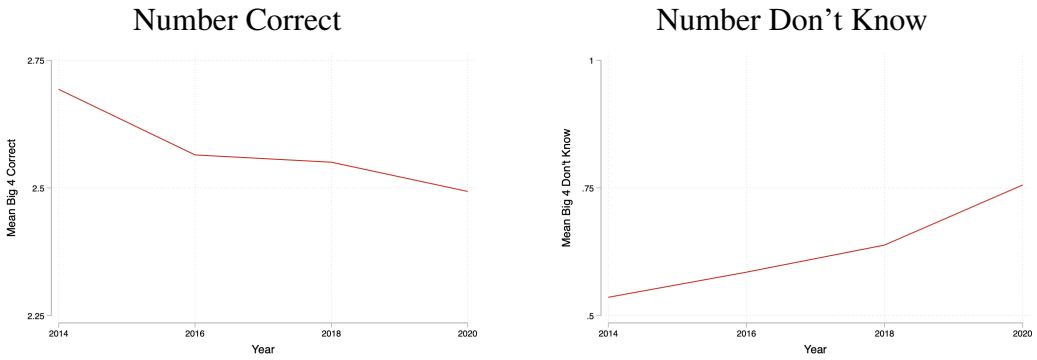
8 FIGURES

Figure 1: Financial Knowledge over Time

NFCS Big 5

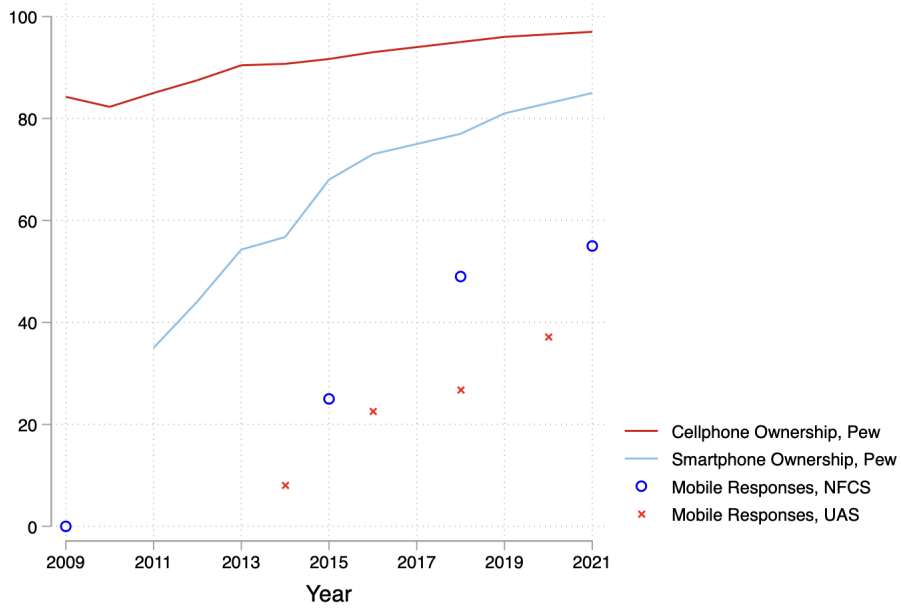


UAS Big 4



Notes: Data from 2009, 2012, 2015, 2018, and 2021 NFCS; 2014–2021 UAS. Means reported. The Big 5 questions are five questions regarding financial literacy (Lusardi and Mitchell, 2014*a*) that cover interest, inflation, the relationship between interest rates and bond prices, interest payments across types of mortgages, and diversification. The four questions on the UAS remove the mortgage question.

Figure 2: Smartphone Ownership and Usage on Surveys Increased Dramatically since 2009

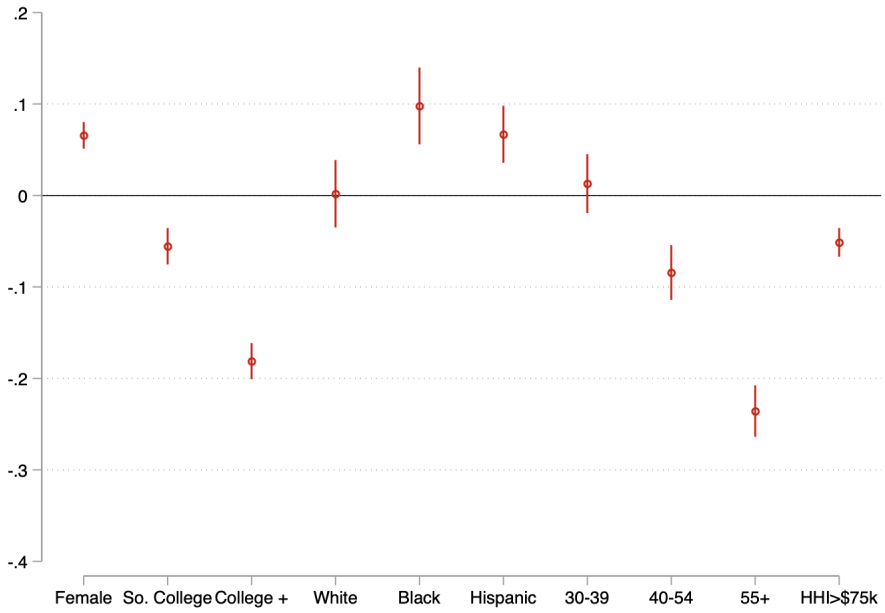


Notes: Data from Pew (cellphone and smartphone ownership), NFCS (2009, 2015, 2018, and 2021), and UAS (2014–2021). Means reported. There is no data on the fraction of smartphone respondents in the 2012 NFCS

Figure 3: Smartphone use and Financial Literacy

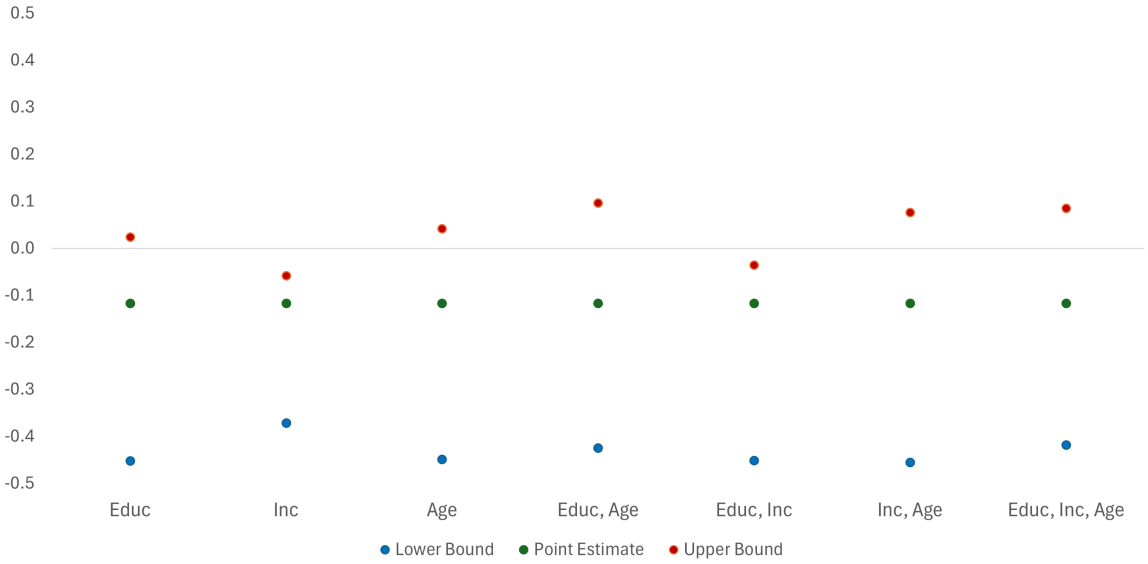
Notes: Data from CFPB (2016), NFCS (2018 and 2021), SHED (2018–2022), and UAS (2014, 2016, 2018, 2022). Means reported. Each mean is statistically different across the mobile and non-mobile group at the one percent level. The means across mobile and non-mobile groups are statistically different at the one percent level in every single year of each individual survey, regardless of whether survey weights are used. In the 2021 and 2022 SHED surveys, we include only the respondents who were randomly assigned to receive the don't know option in order to have cross year consistency in measures.

Figure 4: Who uses Smartphones to Answer Surveys?



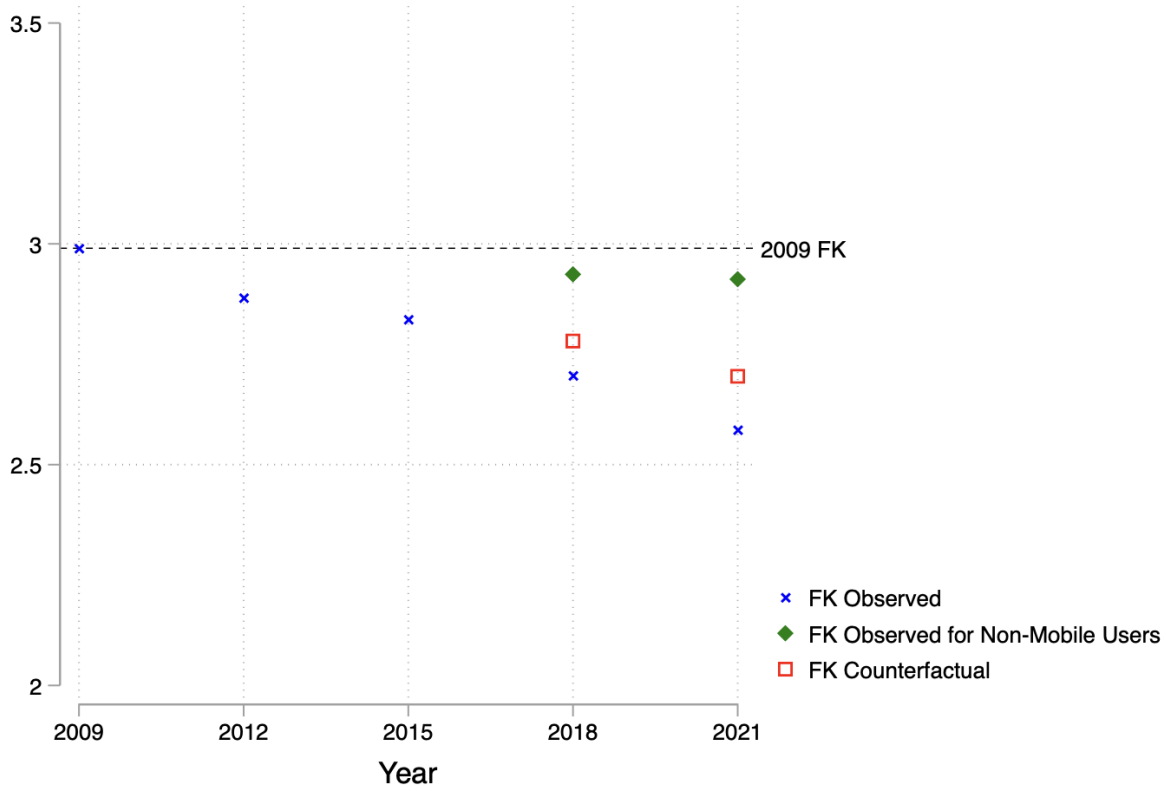
Notes: Regression coefficient estimates and 95 percent confidence intervals reported from a regression where the dependent variable is a dummy variable that equals one if the respondent used a smartphone for the survey and the independent variables are all covariates reported. Excluded groups include male, high school diploma or less education, other race/ethnicity, age 18-29, household income under $75k per year.

Figure 5: Generalized Lee Bounds for Measured Financial Literacy



Notes: The figure presents estimates of generalized Lee bounds following Semenova (Forthcoming). The x-axis describes the set of covariates used to partition the sample.

Figure 6: Counterfactual Trends in Financial Knowledge



Notes: FK Observed is the mean financial knowledge in each survey year. The mean level of financial knowledge in 2009 is 2.99, depicted in the dashed horizontal line. FK Observed for Non-Smartphone Users is the mean level of financial knowledge among respondents who answered on a laptop or tablet in the two survey years where this information exists (2018 and 2021, though we know there were no smartphone respondents in 2009). FK Counterfactual is computed by taking a weighted average of the non-smartphone response scores and an adjustment of the smartphone users' scores, where we increase the mean FK by the amount of the Mobile $\times$ Late penalty from Table 6.

9 TABLES

Table 1: Descriptive Evidence from the SHED: Removing the Don't Know Option Reduces the Mobile/Other Device Gap

	DV= # Correct Big 3 FL Questions			
	Had DK Option		No DK Option	
	(1)	(2)	(3)	(4)
Mobile	-0.337***	-0.143***	-0.181***	-0.065***
	(0.020)	(0.018)	(0.014)	(0.014)
Female		-0.391***		-0.152***
		(0.018)		(0.013)
White		0.110***		0.083***
		(0.033)		(0.025)
Black		-0.367***		-0.256***
		(0.043)		(0.034)
Hispanic		-0.158***		-0.097***
		(0.041)		(0.032)
Married		0.112***		0.019
		(0.019)		(0.014)
HHI $>$ 75k		0.407***		0.192***
		(0.020)		(0.015)
Bachelors		0.573***		0.315***
		(0.019)		(0.014)
Age		0.006***		0.005***
		(0.001)		(0.000)
N	11,753	11,753	11,788	11,788
Mean DV	1.91	1.91	2.49	2.49

Notes: Data come from the 2021 and 2022 SHED. In these years, respondents were randomly assigned to either see or not see the the don't know option on the Big 3 financial literacy questions. Columns (1)-(2) include respondents that had the don't know option. Columns (3)-(4) looks at respondents that did not have the don't know option. HHI >75k is equal to one if household income is reported as being $75,000 a year or higher. Bachelors equals one if the respondent has a bachelors degree or more education. Results remain consistent if we instead look at age in dummies, in categories, or by including a quadratic in age. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Quasi-Experimental Evidence from the UAS Panel: Measured Financial Knowledge is Lower when Respondents use a Smartphone

Panel A: Correct Responses					
	(1)	(2)	(3)	(4)	(5)
	# Big 4 Correct	Q1-Int	Q2 - Inf	Q3 - Bond	Q4 - Div
Mobile	-0.111***	-0.015	-0.022*	-0.037***	-0.035***
	(0.025)	(0.011)	(0.012)	(0.012)	(0.013)
N	13,381	13,381	13,381	13,381	13,381
Mean DV	2.55	0.88	0.74	0.29	0.64
Panel B: Don't Know Responses					
	(1)	(2)	(3)	(4)	(5)
	# Big 4 DK	Q1-Int	Q2 - Inf	Q3 - Bond	Q4 - Div
Mobile	0.115***	0.007	0.039***	0.031**	0.037***
	(0.025)	(0.006)	(0.009)	(0.013)	(0.013)
N	13,381	13,381	13381	13,381	13,381
Mean DV	0.66	0.037	0.094	0.25	0.28

Notes: Robust standard errors clustered at the individual level are in parentheses. Models include individual-level fixed effects and survey year fixed effects. Data from the nationally-representative UAS surveys from 2014 through 2021. We report estimates of α_1 in Equation 1.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Sample Characteristics and Randomization Balance

	Randomized Sample			Completed Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
	Other Device	Mobile Device	Univariate Difference	Other Device	Mobile Device	Univariate Difference
Age	50.190	50.141	-0.049	52.361	50.164	-2.197***
	(16.550)	(16.704)	(0.462)	(16.598)	(16.222)	(0.537)
Female	0.616	0.600	-0.016	0.589	0.598	0.008
	(0.487)	(0.490)	(0.014)	(0.492)	(0.490)	(0.016)
Bachelors	0.531	0.541	0.010	0.592	0.535	-0.057***
	(0.499)	(0.498)	(0.014)	(0.492)	(0.499)	(0.016)
HHI $>$ \$75k	0.540	0.552	0.012	0.581	0.557	-0.024
	(0.498)	(0.497)	(0.014)	(0.494)	(0.497)	(0.016)
Married	0.551	0.555	0.004	0.566	0.570	0.004
	(0.497)	(0.497)	(0.014)	(0.496)	(0.495)	(0.016)
White	0.743	0.750	0.006	0.765	0.750	-0.015
	(0.437)	(0.433)	(0.012)	(0.424)	(0.433)	(0.014)
N	2,620	2,580	5,200	1,822	1,920	3,742

Notes: Means reported with standard deviations in parentheses. Invited sample characteristics at baseline in Columns (1)-(3); Sample characteristics among completers in Columns (4)-(6). Differences are mobile minus other device. Bachelors captures whether the respondent has a bachelor's degree (or more education) and HHI $>$ \$75k captures whether annual household income exceeds \$75,000.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Randomized Smartphone Respondents have Lower Measured Financial Literacy

	(1)	(2)	(3)
	Fin Lit	Total DKs	Any DKs
Mobile	-0.117***	0.083***	0.036**
	(0.036)	(0.031)	(0.015)
N	3,742	3,742	3,742
Mean DV	3.639	0.745	0.449
R-squared	0.243	0.179	0.157

Notes: Fin Lit captures the number of the Big 5 financial literacy questions answered correctly, Total DKs denotes number of don't know responses, and Any DKs is an indicator variable capturing whether a respondent answered don't know to at least one of the five questions. Each specification includes the baseline characteristics in Table 3. Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Randomized Smartphone Respondents Correct and Don't Know Responses Question-by-Question

Panel A: Correct Responses					
	(1)	(2)	(3)	(4)	(5)
	Q1 - Int	Q2 - Inf	Q3 - Bond	Q4 - Mort	Q5 - Div
Mobile	-0.001	-0.020*	-0.044***	-0.016	-0.036***
	(0.010)	(0.012)	(0.015)	(0.011)	(0.013)
N	3,742	3,742	3,742	3,742	3,742
Mean DV	0.897	0.814	0.363	0.850	0.715
R-squared	0.057	0.110	0.075	0.071	0.184
Panel B: Don't Know Responses					
	(1)	(2)	(3)	(4)	(5)
	DK1 - Int	DK2 - Inf	DK3 - Bond	DK4 - Mort	DK5 - Div
Mobile	0.006	0.012	0.030**	0.002	0.033**
	(0.005)	(0.008)	(0.015)	(0.009)	(0.013)
N	3,742	3,742	3,742	3,742	3,742
Mean DV	0.029	0.068	0.323	0.081	0.244
R-squared	0.033	0.061	0.071	0.064	0.151

Notes: Columns capture whether respondents correctly answered (Panel A) or answered don't know (Panel B) to each of the Big 5 Financial Literacy questions, respectively. Q1-Interest tests interest rates; Q2-Inf tests inflation; Q3-Bond tests the relationship between interest rates and bond prices; Q4-Mort tests the difference in 30 and 15 year mortgages; Q5-Div tests diversification. Each specification includes the baseline characteristics in Table 3. Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Randomized Mobile Respondents and Survey Placement Affects Measured Financial Literacy

	(1) Fin Lit	(2) Total DKs	(3) Any DKs
Mobile × Early	-0.066	0.020	0.021
	(0.051)	(0.045)	(0.022)
Mobile × Late	-0.166***	0.142***	0.051**
	(0.049)	(0.043)	(0.021)
Late	0.141***	-0.118***	-0.047**
	(0.051)	(0.044)	(0.021)
N	3,742	3,742	3,742
Mean DV	3.639	0.745	0.449
R-squared	0.245	0.180	0.159

Notes: Fin Lit captures the number of financial literacy questions answered correctly, Total DKs denotes number of don't know responses, and Any DKs is an indicator variable capturing whether a respondent answered don't know to at least one of the five questions. Early denotes seeing the financial literacy questions at the beginning of the survey, Late denotes seeing the questions near the end. Each specification includes the baseline characteristics in Table 3. Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Potential Mechanisms

	(1) Attn Check	(2) Was Distracted	(3) Fin Lit Seconds	(4) Rapid Guess	(5) Birth Year Correct	(6) Interesting
Mobile	-0.013	-0.006	-4.366**	0.042***	0.003	0.010
	(0.014)	(0.013)	(2.070)	(0.009)	(0.005)	(0.026)
N	3,742	3,740	3,661	3,661	3,738	3,739
Mean DV	0.732	0.212	99.963	0.085	0.976	4.109
R-squared	0.050	0.005	0.070	0.046	0.006	0.017

Notes: Attn Check captures whether the responded correctly answered the attention check question; Was Distracted denotes whether the respondent indicated they experienced a distraction while taking the survey; Fin Lit Seconds captures the (winsorized) total number of seconds spent answering the financial literacy questions; Rapid Guess captures whether respondents answered at least one of the questions in three seconds or less; Birth Year Correct indicates whether the respondent selected their correct birth year; and Interesting captures how interesting the respondent said the survey was. Each specification includes the baseline characteristics in Table 3. Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Impact of Smartphone use on Rapid Responses, Question by Question

	(1) Q1 - Int	(2) Q2 - Inf	(3) Q3 - Bond	(4) Q4 - Mort	(5) Q5 - Div
Mobile	0.006	0.017***	0.014***	0.019***	0.009
	(0.004)	(0.005)	(0.005)	(0.006)	(0.007)
N	3,702	3,724	3,731	3,731	3,733
Mean DV	0.016	0.028	0.029	0.033	0.044
R-squared	0.008	0.024	0.026	0.029	0.033

Notes: Columns capture whether responded to each question in less than three seconds to each of the Big 5 Financial Literacy questions, respectively. Q1-Interest tests interest rates; Q2-Inf tests inflation; Q3-Bond tests the relationship between interest rates and bond prices; Q4-Mort tests the difference in 30 and 15 year mortgages; Q5-Div tests diversification. Each specification includes the baseline characteristics in Table 3. Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Impact of Smartphone use on Measured General Knowledge

	(1) Gen Knowledge	(2) Total DKs	(3) Any DKs
Mobile	-0.139***	0.087***	0.041***
	(0.040)	(0.030)	(0.015)
N	3,744	3,744	3,744
Mean DV	3.452	0.792	0.474
R-squared	0.240	0.168	0.156

Notes: Gen Knowledge captures the number of the five general knowledge questions answered correctly, Total DKs denotes number of don't know responses, and Any DKs is an indicator variable capturing whether a respondent answered don't know to at least one of the five questions. Each specification includes the baseline characteristics in Table 3. Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Sample Characteristics Extended Sample, Relaxing Device Assignment

Device Assigned: Device Responded:	Mobile Oth Device	Mobile Mobile	Oth Device Mobile	Oth Device Oth Device
Age	61.70	49.66	48.30	52.30
Female	0.537	0.597	0.716	0.587
Bachelors	0.554	0.539	0.312	0.594
HHI $>$ \$75k	0.532	0.560	0.369	0.583
Married	0.580	0.573	0.461	0.569
White	0.814	0.748	0.699	0.767
Fin Lit	3.853	3.541	2.926	3.753
N	231	1870	282	1819

Notes: After our main sample period ended, we opened up our survey for respondents to complete on any device type. This table shows the mean characteristics of those who completed by device type assigned and the one they responded on. Bachelors captures whether the respondent has a bachelor's degree (or more education) and HHI $>$ \$75k captures whether annual household income exceeds \$75,000. Fin lit is the number correct on the Big 5.

Table 11: Balance Table Among Completers - Extended Sample

	(1) Other Device	(2) Mobile	(3) Univariate Difference
Age	51.764	50.986	-0.778
	(16.478)	(16.464)	(0.508)
Female	0.604	0.591	-0.013
	(0.489)	(0.492)	(0.015)
Bachelors	0.556	0.540	-0.016
	(0.497)	(0.498)	(0.015)
HHI $>$ \$75k	0.554	0.557	0.002
	(0.497)	(0.497)	(0.015)
Married	0.554	0.574	0.019
	(0.497)	(0.495)	(0.015)
White	0.757	0.755	-0.002
	(0.429)	(0.430)	(0.013)
N	2,101	2,101	4,202

Notes: Means reported with standard deviations in parentheses. Completed sample characteristics at baseline including respondents who answered the survey after the device type restriction was removed. Differences are mobile minus other device. Bachelors captures whether the respondent has a bachelor's degree (or more education) and HHI $>$ \$75k captures whether annual household income exceeds \$75,000. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Impact of Smartphone use on Measured Financial Literacy - Extended Sample

	(1) Fin Lit	(2) Total DKs	(3) Any DKs
Mobile	-0.067*	0.065**	0.029*
	(0.039)	(0.033)	(0.015)
N	4,202	4,202	4,202
Mean DV	3.609	0.757	0.453
R-squared	0.001	0.001	0.001

Notes: Each specification includes respondents who completed the survey after the device type restriction was removed. Fin Lit captures the number of the Big 5 financial literacy questions answered correctly, Total DKs denotes number of don't know responses, and Any DKs is an indicator variable capturing whether a respondent answered don't know to at least one of the five questions. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13: Impact of Smartphone use on Measured Financial Literacy
Survey Placement Interaction - Extended Sample

	(1) Fin Lit	(2) Total DKs	(3) Any DKs
Mobile × Early	0.000	-0.017	0.009
	(0.057)	(0.048)	(0.022)
Mobile × Late	-0.133**	0.144***	0.047**
	(0.054)	(0.045)	(0.021)
Late	0.161***	-0.158***	-0.054**
	(0.056)	(0.045)	(0.022)
N	4,202	4,202	4,202
Mean DV	3.609	0.757	0.453
R-squared	0.003	0.004	0.002

Notes: Each specification includes respondents who completed the survey after the device type restriction was removed. Fin Lit captures the number of the Big 5 financial literacy questions answered correctly, Total DKs denotes number of don't know responses, and Any DKs is an indicator variable capturing whether a respondent answered don't know to at least one of the five questions. Early denotes seeing the financial literacy questions at the beginning of the survey, Late denotes seeing the questions near the end. Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 14: Forced Responses

	(1) Fin Lit	(2) Forced Fin Lit
Mobile	-0.117***	-0.076**
	(0.036)	(0.031)
N	3,742	3,742
Mean DV	3.639	3.980
R-squared	0.243	0.181

Notes: Fin Lit captures the number of financial literacy questions answered correctly, while Forced Fin Lit replaces Don't Know responses with respondents' answers to the questions when the Don't Know option is removed. Each specification includes the baseline characteristics in Table 3. Each specification includes the baseline characteristics in Table 3. Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

APPENDIX A: DESCRIPTIVE STATISTICS

Figure A.1: Most Popular Cell Phones Over Time

Table A.1: Sample Characteristics and Randomization Balance - Question Placement

	(1) Early	(2) Late	(3) Univariate Difference
Age	51.208	51.258	0.050
	(16.350)	(16.528)	(0.538)
Female	0.588	0.599	0.012
	(0.492)	(0.490)	(0.016)
Bachelors	0.570	0.557	-0.013
	(0.495)	(0.497)	(0.016)
HHI $>$ \$75k	0.571	0.566	-0.004
	(0.495)	(0.496)	(0.016)
Married	0.577	0.561	-0.016
	(0.494)	(0.496)	(0.016)
White	0.756	0.758	0.002
	(0.430)	(0.428)	(0.014)
N	1,800	1,942	3,742

Notes: Means reported with standard deviations in parentheses. Baseline characteristics across the question placement randomization conditions. Early denotes seeing the financial literacy questions at the beginning of the survey, Late denotes seeing the questions near the end. Differences are late minus early. Bachelors captures whether the respondent has a bachelor's degree (or more education) and HHI $>$ \$75k captures whether annual household income exceeds \$75,000. For more on randomization of question placement based on randomization into device type, see Appendix Table A.2.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.2: Sample Characteristics and Randomization Balance - Question Placement Conditional on Smartphone Condition

	Assigned to Mobile			Assigned to Non-mobile		
	(1)	(2)	(3)	(4)	(5)	(6)
	FL	FL	Univariate	FL	FL	Univariate
	Early	Late	Difference	Early	Late	Difference
Age	50.024	50.292	0.268	52.437	52.290	-0.147
	(16.114)	(16.326)	(0.741)	(16.511)	(16.688)	(0.778)
Female	0.589	0.606	0.017	0.587	0.592	0.005
	(0.492)	(0.489)	(0.022)	(0.493)	(0.492)	(0.023)
Bachelors	0.539	0.532	-0.006	0.602	0.583	-0.020
	(0.499)	(0.499)	(0.023)	(0.490)	(0.493)	(0.023)
HHI $>$ \$75k	0.550	0.563	0.014	0.592	0.570	-0.023
	(0.498)	(0.496)	(0.023)	(0.492)	(0.495)	(0.023)
Married	0.577	0.564	-0.013	0.576	0.557	-0.019
	(0.494)	(0.496)	(0.023)	(0.494)	(0.497)	(0.023)
White	0.749	0.751	0.002	0.763	0.767	0.003
	(0.434)	(0.433)	(0.020)	(0.425)	(0.423)	(0.020)
N	917	1,003	1,920	883	939	1,822

Notes: Means reported with standard deviations in parentheses. Baseline characteristics across the question placement randomization conditions for individuals assigned to complete the survey on their smartphone (Columns (1)-(3)) and individuals assigned to complete the survey on a device other than a cellphone (Columns (4)-(6)). Early denotes seeing the financial literacy questions at the beginning of the survey, Late denotes seeing the questions near the end. Differences are late minus early. Bachelors captures whether the respondent has a bachelor's degree (or more education) and HHI $>$ \$75k captures whether annual household income exceeds \$75,000.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

APPENDIX B: ROBUSTNESS CHECKS

Table B.1: Impact of Smartphone use on Measured Financial Literacy, No Demographic Controls

	(1) Fin Lit	(2) Total DKs	(3) Any DKs
Mobile	-0.206***	0.148***	0.064***
	(0.041)	(0.034)	(0.016)
N	3,742	3,742	3,742
Mean DV	3.639	0.745	0.449
R-squared	0.007	0.005	0.004

Notes: Fin Lit captures the number of the Big 5 financial literacy questions answered correctly, Total DKs denotes number of don't know responses, and Any DKs is an indicator variable capturing whether a respondent answered don't know to at least one of the five questions. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.2: Impact of Smartphone use on Measured Financial Literacy, Including Week Fixed Effects

	(1) Fin Lit	(2) Total DKs	(3) Any DKs
Mobile	-0.115***	0.083***	0.038**
	(0.036)	(0.031)	(0.015)
N	3,742	3,742	3,742
Mean DV	3.639	0.745	0.449
R-squared	0.245	0.180	0.162

Notes: Fin Lit captures the number of the Big 5 financial literacy questions answered correctly, Total DKs denotes number of don't know responses, and Any DKs is an indicator variable capturing whether a respondent answered don't know to at least one of the five questions. Each specification includes the baseline characteristics in Table 3 and weekly fixed effects. Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.3: Impact of Smartphone use on Measured Financial Literacy Survey Placement Interaction, No Demographic Controls

	(1) Fin Lit	(2) Total DKs	(3) Any DKs
Mobile × Early	-0.168***	0.094*	0.053**
	(0.058)	(0.049)	(0.023)
Mobile × Late	-0.243***	0.199***	0.075***
	(0.056)	(0.047)	(0.023)
Late	0.115**	-0.099**	-0.039*
	(0.058)	(0.049)	(0.023)
N	3,742	3,742	3,742
Mean DV	3.639	0.745	0.449
R-squared	0.008	0.006	0.005

Notes: Fin Lit captures the number of financial literacy questions answered correctly, Total DKs denotes number of don't know responses, and Any DKs is an indicator variable capturing whether a respondent answered don't know to at least one of the five questions. Early denotes seeing the financial literacy questions at the beginning of the survey, Late denotes seeing the questions near the end. Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.4: Impact of Smartphone use on Correct and Don't Know General Knowledge Questions
Question-by-Question

Panel A: Correct Responses					
	(1)	(2)	(3)	(4)	(5)
	Q1 - Sci	Q2 - Math	Q3 - SCOTUS	Q4 - Trade	Q5 - Cookies
Mobile	-0.001	-0.033**	-0.062***	-0.040***	-0.003
	(0.015)	(0.015)	(0.015)	(0.014)	(0.011)
N	3,744	3,744	3,744	3,744	3,744
Mean DV	0.682	0.649	0.602	0.648	0.871
R-squared	0.087	0.137	0.155	0.159	0.039
Panel B: Don't Know Responses					
	(1)	(2)	(3)	(4)	(5)
	Q1 - Sci	Q2 - Math	Q3 - SCOTUS	Q4 - Trade	Q5 - Cookies
Mobile	-0.003	0.006	0.042***	0.038***	0.004
	(0.009)	(0.006)	(0.014)	(0.014)	(0.008)
N	3,744	3,744	3,744	3,744	3,744
Mean DV	0.079	0.043	0.272	0.338	0.059
R-squared	0.034	0.027	0.144	0.146	0.016

Notes: Columns capture whether respondents correctly answered (Panel A) or answered don't know (Panel B) to each of the five general knowledge questions, respectively. Each specification includes the baseline characteristics in Table 3. Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B.5: Impact of Smartphone use on Measured General Knowledge
Survey Placement Interaction

	(1) Gen Knowledge	(2) Total DKs	(3) Any DKs
Mobile × Early	-0.133**	0.143***	0.057***
	(0.057)	(0.043)	(0.022)
Mobile × Late	-0.144***	0.034	0.026
	(0.055)	(0.042)	(0.021)
Late	-0.008	0.057	0.041*
	(0.057)	(0.043)	(0.022)
N	3,744	3,744	3,744
Mean DV	3.452	0.792	0.474
R-squared	0.240	0.169	0.157

Notes: Gen Knowledge captures the number of financial literacy questions answered correctly, Total DKs denotes number of don't know responses, and Any DKs is an indicator variable capturing whether a respondent answered don't know to at least one of the five questions. Early denotes seeing the general knowledge questions near the end of the survey, Late denotes seeing the questions at the beginning. Each specification includes the baseline characteristics in Table 3. Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

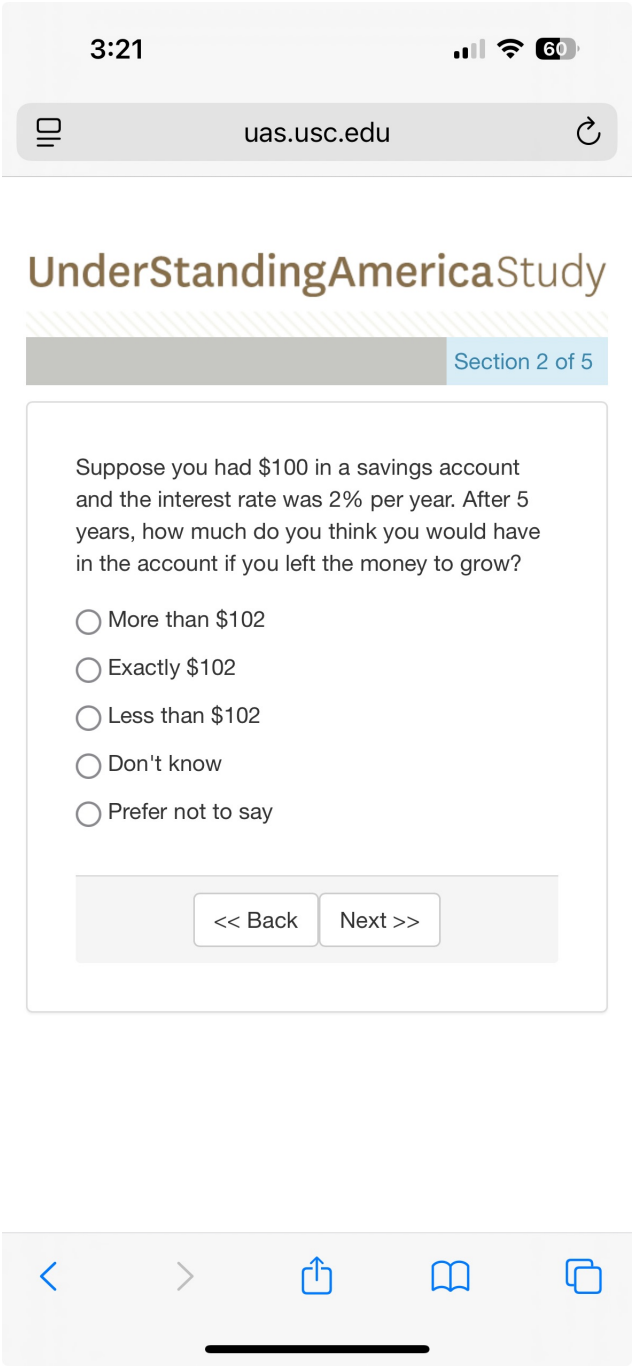
Table B.6: Adjusting for Attrition using Inverse Probability Weighting Yields Similar Results

	(1) Fin Lit	(2) Total DKs	(3) Any DKs
Mobile	-0.118***	0.084***	0.036**
	(0.036)	(0.031)	(0.015)
N	3,744	3,744	3,744
Mean DV	3.639	0.745	0.449

Notes: The table presents treatment effect estimates from inverse probability weighting specifications using all covariates in 3. Fin Lit captures the number of the Big 5 financial literacy questions answered correctly, Total DKs denotes number of don't know responses, and Any DKs is an indicator variable capturing whether a respondent answered don't know to at least one of the five questions.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

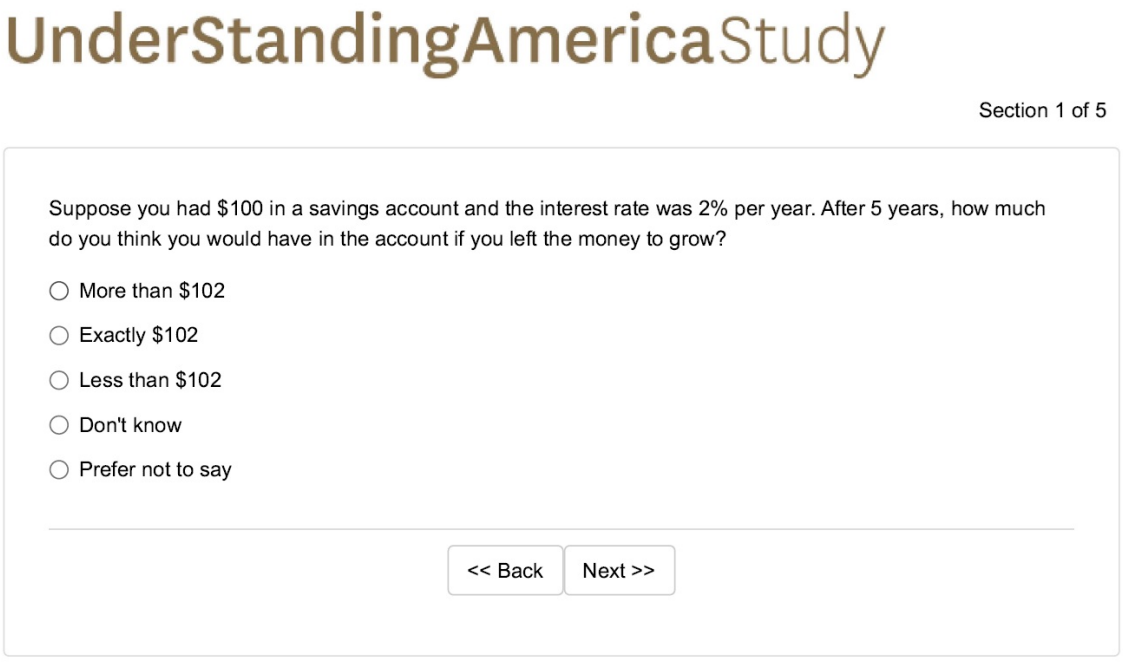
APPENDIX C: THE SURVEY

Figure 8: Survey on a Mobile Phone



Notes: Survey when viewed on a mobile device.

Figure 9: Survey on a Laptop



Notes: Survey when viewed on a laptop.

Survey Instrument

Introduction:

This survey will ask you questions about general knowledge topics and a few financial questions.

{Randomize: ½ sample begin with Block 1, ½ with Block 2}

Start Block 1

1) 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?

A) More than $102
B) Exactly $102
C) Less than $102
D) Don't know
E) Prefer not to say

2) Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

A) More than today
B) Exactly the same
C) Less than today
D) Don't know
E) Prefer not to say

3) If interest rates rise, what will typically happen to bond prices?

A) They will rise
B) They will fall
C) They will stay the same
D) There is no relationship between bond prices and the interest rate
E) Don't know
F) Prefer not to say

4) A 15-year mortgage typically requires higher monthly payments than a 30-year mortgage, but the total interest paid over the life of the loan will be less.

A) True
B) False
C) Don't know
D) Prefer not to say

5) Buying a single company's stock usually provides a safer return than a stock mutual fund.

A) True
B) False
C) Don't know
D) Prefer not to say#

End Block 1

1) We would like to get a sense of your general preferences.

Most modern theories of decision making recognize that decisions do not take place in a vacuum. Individual preferences and knowledge, along with situational variables can greatly impact the decision process. To demonstrate that you've read this much, just go ahead and select both red and green among the alternatives below, no matter what your favorite color is. Yes, ignore the question below and select both of those options.

What is your favorite color? {check all that apply}

White, Black, Green, Blue, Red, Pink, Other

Start Block 2

1) *A scientist is conducting a study to determine how well a new medication treats ear infections. The scientist tells the participants to put 10 drops in their infected ear each day. After two weeks, all participants' ear infections had healed. No one who used the ear drops experienced any side effects. Which of the following changes to the design of this study would most improve the ability to test if the new medication effectively treats ear infections?*
    a. *Create a second group of participants with ear infections who do not use any ear drops*
    b. *Create a second group of participants with ear infections who use 15 drops a day*
    c. *Have participants use ear drops for only 1 week*
    d. *Have participants put ear drops in both their infected ear and healthy ear*
    e. *Don't know*
    f. *Prefer not to say*
2) *A car travels at a constant speed of 40 miles per hour. How far does the car travel in 45 minutes?*
    a. *30 miles*
    b. *25 miles*
    c. *35 miles*
    d. *40 miles*
    e. *Don't know*
    f. *Prefer not to say*
3) *Who is the current Chief Justice of the United States?*
    a. *Amy Coney Barrett*
    b. *John Roberts*
    c. *Clarence Thomas*
    d. *Ketanji Brown Jackson*
    e. *Don't know*
    f. *Prefer not to say*
4) *The United States – Mexico – Canada Agreement (USMCA) is a trade agreement that replaces which previous trade agreement?*
    a. *NAFTA*
    b. *AUKUS*
    c. *KORUS*
    d. *IMF*
    e. *Don't know*
    f. *Prefer not to say*

5) *If a website is using cookies, it means that the site…*
    a. *Can see the content of all the files on the device you are using*
    b. *Is not a risk to infect your device with a computer virus*
    c. *Will automatically prompt you to update your web browser software if it is out of date*
    d. *Can track your visits and activity on the site*
    e. *Don't know*
    f. *Prefer not to say*

End Block 2

Intro: We are going to repeat a few questions for which you answered "Don't Know." This time, please give us your best guess.

[Repeat Block 1 questions with DK responses]

1) *In what year were you born?*
    a. *Year dropdown*
2) *While you completed this survey did you experience any interruptions (e.g. doorbell, phone call, text message, someone speaking to you, moving from one place to another) or did you complete the survey without interruption?*
    a. *I was interrupted while completing the survey*
    b. *I was not interrupted while completing the survey*