Socioeconomic Status and Learning from Financial Information*

Camelia M. Kuhnen†

Andrei C. Miu‡

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Abstract

We investigate the role of socioeconomic status (SES) on people's ability to learn from information in financial markets. In an experimental setting we find that low SES participants, relative to medium or high SES ones, form more pessimistic beliefs about the distribution of outcomes of financial investments when, objectively, these investments are likely to be good. This pessimism bias regarding risky investments that is induced by coming from a low SES environment is particularly strong if participants are actively investing, rather than passively learning, and if financial losses are possible. These results suggest that SES shapes in predictable ways people's perception of financial news, which in turn may help explain differences in households' propensity to participate in financial markets.

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†University of North Carolina, Kenan-Flagler Business School, Finance Area, 300 Kenan Center Drive, MC #4407, Chapel Hill, NC 27599, USA. E-mail: camelia_kuhnen@kenan-flagler.unc.edu. (Corresponding author)

‡Babes-Bolyai University, Department of Psychology, Republicii St. #37, Cluj-Napoca 400015, Romania. E-mail: andreimiu@psychology.ro.

I. Introduction

Does people's socioeconomic status change the way they perceive financial information and make investment decisions? Recent evidence suggests that encountering economic adversity has a significant influence on how people make economic choices, in particular by changing the way they learn from new information and form beliefs about future outcomes.

Chronic poverty and bad economic shocks have been shown to be detrimental to cognitive performance (Hackman and Farah (2009), Mani et al. (2013)). Early-life adversity in particular has long-lasting effects on brain development and function, for example by changing the brain's response to stress or by diminishing memory function (Evans and Schamberg (2009)). Poverty causes stress and negative affective states (Haushofer and Fehr (2014)), which may lead to suboptimal choices such as underinvestment in education, undersaving, or overborrowing (Banerjee and Duflo (2007), Shah et al. (2012))

Aside from impeding decision-making in general, economic adversity seems to also induce a pessimism bias in how people view the distribution of future outcomes they can attain. Living through bad economic times or experiencing sequences of negative financial outcomes leads people to have more pessimistic beliefs about future returns of risky investments (Malmendier and Nagel (2011), Kuhnen (forthcoming)). Survey data indicates that people with lower socioeconomic status, as measured by their education, have more pessimistic expectations about aggregate business conditions (Souleles (2004)).

In this paper, we use a controlled experimental setting to examine whether indeed people's socioeconomic background changes the way they learn from new financial information and make investment decisions. We find that low SES participants, relative to medium or high SES ones, form more pessimistic beliefs about the distribution of outcomes of financial investments when, objectively, these investments are likely to be good. This pessimism bias regarding risky investments that is induced by coming from a low SES environment is particularly strong if participants are actively investing, rather than passively learning, and if financial losses are possible.

To investigate whether learning from new information depends on people's socioeconomic background, participants from a top public university in Romania were invited to a financial decision making study, for which we used the same experimental design as in Kuhnen (forthcoming). We ran the experiment at that university because there we can observe a large amount of variation in the socioeconomic status of the participant population, and, at the same time, a high degree of homogeneity in terms of scholastic achievement. Two institutional details lead to these features of our experimental setting: first, all students at this university must pass a stringent exam to be admitted; second, the Romanian government provides full scholarships to all students who need financial assistance for covering the cost of attending this university.

The study required each participant to complete two financial decision making tasks. In the Active task subjects made sixty decisions, split into ten separate blocks of six trials each, to invest in one of two securities: a stock with risky payoffs coming from one of two distributions (good and bad), one which was better than the other in the sense of first-order stochastic dominance, and a bond with a known payoff. In each trial, participants observed the dividend paid by the stock, after making their asset choice, and then were asked to provide an estimate of the probability that the stock was paying from the good distribution. Therefore, the stock dividend history seen by each participant does not depend on whether or not they chose the stock. In other words, the asset choice did not change the learning problem faced by participants. In the Passive task subjects were only asked to provide the probability estimate that the stock was paying from the good distribution, after observing its payoff in each of sixty trials, which were also split into ten separate learning blocks of six trials each. In either task, two types of conditions - gain or loss - were possible. In the gain condition, the two securities provided positive payoffs only. In the loss condition, the two securities provided negative payoffs only. Subjects were paid based on their investment payoffs and the accuracy of the probability estimates provided.

Importantly, the learning problem faced by subjects was exactly the same, irrespective of their socioeconomic status. Hence, people's estimate regarding the probability that the stock was paying from the good dividend distribution, namely that distribution where the high outcome for that condition was more likely to occur than the low outcome, should not depend on whether a participant has encountered more or less economic adversity in life.

However, we find that low SES participants form subjective estimates for the likelihood that the stock is paying from the good distribution that are 2.86% lower than those of mid/high SES participants, in situations where objectively the stock is likely to be the good one. If subjects are actively investing and they are in loss condition trials, this wedge in beliefs becomes 4.70%. These results are robust to multiple approaches by which the low SES versus mid/high SES groups are constructed. This pessimism bias induced by low SES is not driven by differences in risk preferences or finance-relevant knowledge, but rather, by differences updating from new information. In particular, we find that when high stock dividends are revealed, low SES participants update their beliefs less, by 3% to 5%, relative to mid/high SES participants. That is, lower SES participants are less likely to pay attention to good news about the available financial assets. Finally, we show that while participants on average improve over time their ability to correctly estimate the probability that the stock is paying from the good distribution, the rate of improvement is slower for the low SES group relative to the others.

The results in this paper could help shed light on the empirical pattern documented by Campbell (2006) and Calvet et al. (2007), namely, that U.S. and European households with lower education, income or wealth are less likely to participate in the stock market. A potential driver of this pattern could be that lower SES households have more pessimistic beliefs about the possible outcomes of risky investments, as observed in the experimental setting studied here. Thus, incorrect, overly pessimistic beliefs about risky asset returns may help explain why lower SES households are less likely to invest in equities.

We describe the experimental design in Section II. The main result, as well as the robustness checks and tests of alternative explanations, are presented in Section III. In Section

IV we discuss the implications of the pessimism bias induced by encountering economic adversity for underinvestment in the context of household finance, corporate finance and developmental economics, and suggest avenues for further research building on this finding.

II. Experimental design

The 203 participants in the study (53 males, 150 females, mean age 21.3 years, 2 years standard deviation) were recruited via on-campus flyers at the Babes-Bolyai University, which is a top higher-education institution in Romania, with more than 10,000 undergraduate and graduate students. Participants gave written informed consent, as required by human subjects protection rules. The study was conducted during October - December 2012. All payments to participants for their performance in the experiment were provided in RON, which is the local currency. (1 RON is approximately equal to 0.3 USD.)

Following the same experimental protocol as in Kuhnen (forthcoming), each participant completed two financial decision making tasks, referred to as the Active task and the Passive task, during which information about two securities, a stock and a bond, was presented. Whether a participant was presented with the Active task first, or the Passive task first, was determined at random.

Each task included two types of conditions: gain or loss. In the gain condition, the two securities provided positive payoffs only. The stock payoffs were +10 RON or +2 RON, while the bond payoff was +6 RON. In the loss condition, the two securities provided negative payoffs only. The stock payoffs were -10 RON or -2 RON, while the bond payoff was -6 RON.

In either condition, the stock paid dividends from either a good distribution or from a bad distribution. The good distribution is that where the high outcome occurs with 70% probability in each trial, while the low outcome occurs with 30% probability. The bad distribution is that where these probabilities are reversed: the high outcome occurs with

30% probability, and the low outcome occurs with 70% probability in each trial.

Each participant went through 60 trials in the Active task, and 60 trials in the Passive task. Trials are split into "learning blocks" of six: for these six trials, the learning problem is the same. That is, the computer either pays dividends from the good stock distribution in each of these six trials, or it pays from the bad distribution in each of the six trials. At the beginning of each learning block, the computer randomly selects (with 50%-50% probabilities) whether the dividend distribution to be used in the following six trials will be the good or the bad one.

There are ten learning blocks in the Active task, and ten learning blocks in the Passive task. In either task, there are five blocks in the gain condition, and five blocks in the loss condition. The order of the blocks is pseudo-randomized. An example of a sequence of loss or gain learning blocks the a subject may face during either the Active task or the Passive task, as well as a summary of the experimental design, are shown in Table I.

In the Active task participants made 60 decisions (six per each of the ten learning blocks) to invest in one of the two securities, the stock or the bond, then observed the stock payoff (irrespective of their choice) and provided an estimate of the probability that the stock was paying from the good distribution. Figure 1 shows the time line of a typical trial in the Active task, in either the gain and or the loss conditions (top and bottom panel, respectively).

In the Passive task participants were only asked to provide the probability estimate that the stock was paying from the good distribution, after observing its payoff in each of 60 trials (split into ten learning blocks of six trials each, as in the Active task). Figure 2 shows the time line of a typical trial in the Passive task, in either the gain or the loss conditions.

In the Active task participants were paid based on their investment payoffs and the accuracy of the probability estimates provided. Specifically, they received one tenth of accumulated dividends, plus ten cents for each probability estimate within 5% of the objective Bayesian value. In the Passive task, participants were paid based solely on the accuracy of the probability estimates provided, by receiving ten cents for each estimate within 5% of the correct value. Information regarding the accuracy of each subject's probability estimates and the corresponding payment was only provided at the end of each of the two tasks. This was done to avoid feedback effects that could have changed the participants' strategy or answers during the progression of each of the two tasks.

This information was presented to participants at the beginning of the experiment, and is summarized in the participant instructions sheet included in the Appendix. The experiment lasted 1.5 hours and the average payment per person was 28.69 RON.

The value of the objective Bayesian posterior that the stock is paying from the good distribution can be easily calculated. Specifically, after observing t high outcomes in n trials so far, the Bayesian posterior that the stock is the good one is: $\frac{1}{1+\frac{1-p}{p}*(\frac{q}{1-q})^{n-2t}}$, where $p = 50\%$ is the prior that the stock is the good one (before any dividends are observed in that learning block) and $q = 70\%$ is the probability that a good stock pays the high (rather than the low) dividend in each trial. The Appendix provides the value of the objective Bayesian posterior for all $\{n, t\}$ pairs possible in the experiment. This Bayesian posterior is my benchmark for measuring how close the subjects' expressed probability estimates are from the objectively correct beliefs.

For each participant we also obtained measures of their financial literacy and risk aversion. We obtained these two measures by asking subjects two questions regarding a portfolio allocation problem, after they completed the Active and Passive investment tasks. These questions are described in the Appendix. Briefly, the first question asked how much of a 10,000 RON portfolio the participant would allocate to the stock market and how much to a savings account. This answer provides a proxy for their risk preference, measured outside of the financial learning experiment. The second question asked the person to calculate the expected value of the portfolio they selected, and through multiple-choice answers could detect whether people lacked an understanding of probabilities, of the difference between net and gross returns, or of the difference between stocks and savings accounts. This yielded a financial knowledge score of 0 to 3, depending on whether the participant's answer showed an understanding of none, one, two or all three of these concepts.

Participants also completed an 11-item numeracy questionnaire as in Peters et al. (2006), which measured their ability to do simple algebraic calculations and use information about probabilities.

Our main measure of socioeconomic status for this sample of young adults is obtained as in Ensminger et al. (2000) by aggregating information we obtain from each participant regarding their parents' income and education, their family size, and closeness of family ties. We split the overall group of 203 participants into a low SES subsample (67 individuals), and a mid/high SES subsample (136 individuals), based on whether their aggregate SES score is in the low third or the upper two thirds of the SES scores distribution. As a second way to measure of SES, we split the sample depending on whether the parental income is below or above 1000 RON/month (approximately $300), which is the minimum full-time wage in the country this experiment was conducted. As a third way to measure of SES, we split the sample based on whether the participants' subjective assessment of whether they rank in society on a scale from 1 to 10 is below 5. Finally, as a fourth way to measure of SES, we split the sample in based on whether neither of the participants' parents have a college degree.

III. Empirical Findings

A. *Main result*

We find that low SES participants, relative to medium or high SES ones, form more pessimistic beliefs about the distribution of outcomes of financial investments when, objectively, these investments are likely to be good. This effect is shown in the simple univariate analysis in Figure 3, where we present the average subjective probability estimate that the stock is paying from the good distribution, for each level of the objective Bayesian posterior probability, separately for low SES participants, and for mid/high SES ones.

As the figure shows, there is no significant difference in subjective posteriors of low SES individuals relative to the rest of the sample, in situations where the objective posterior that the stock is the good one is below 50%. However, when, objectively, the stock is likely to be the good one, we document that low SES participants have a significantly more pessimistic assessment of the quality of this stock, for every level of objective probability equal to or higher than 50%.

We also conduct regression analyses, as shown in Table II, where we estimate the effect of the low SES indicator on subjective probability estimates, while controlling for participants' gender and age, and including fixed effects for the level of the objective posterior probability. Standard errors in these regressions and throughout the rest of the analysis are clustered by participant.

In Table II we replicate the main result shown in Figure 3. We find that low SES participants have beliefs that are 2.86% ($p < 0.05$) more pessimistic relative to the mid/high SES participants, regarding the likelihood that the stock is paying from the good distribution, when the objective probability that this is the good stock is greater or equal to 50%. When objectively the stock is unlikely to be the good one, there is no SES difference in subjective probabilities.

Moreover, the regressions in the leftmost four columns in Table II show that the pessimism bias regarding risky investments that is induced by coming from a low SES environment is particularly strong if participants are actively investing, rather than passively learning, and if financial losses are possible. In these types of trials (i.e., in the Active task, in loss condition blocks), the beliefs expressed by low SES participants are on average 4.70% ($p < 0.05$) more pessimistic than those of mid/high SES participants. Unsurprisingly, we also find that men have more optimistic assessments of the quality of the stock, relative to women, in most of the sample splits done in the analysis in Table II.

To check whether these findings are robust to our measure of low SES, in Table III we conduct the same type of regression analyses as in Table II using the other three ways to measure SES discussed in Section II. For ease of comparison, we present the coefficient estimates for our main low SES measure (obtained in Table II) in Panel A of Table III. We then assign participants to low socioeconomic status based on parental income (Panel B), subjective socioeconomic status evaluation (Panel C), or parental education (Panel D). The low SES measures in Panels A, B and C have similar effects: lower SES participants, categorized this way using either of these three approaches, have more pessimistic beliefs regarding the quality of the stock. However, if SES is assessed solely based on whether or not neither parent of a participant got a college education, we no longer observe a significant pessimism bias in the low SES participants (i.e., those whose parents do not have college degrees). This suggests an possibility that needs investigation in further work, namely, that pessimism in assessing financial investments may be triggered by aspects of SES related to low income or financial difficulties, and not necessarily by a lack of formal higher education in one's family.

The evidence in Figure 3 and Tables II and III indicates that low SES form pessimistic posterior beliefs about the likelihood that the stock they are presented with is paying dividends from the good distribution. A natural question is why these posterior beliefs are more pessimistic for the low SES group. All participants were carefully instructed that at the beginning of each learning block of 6 trials, the probability that the stock would pay from the good distribution, not the bad one, was 50%. Thus, by the design of the experiment, the priors were set to 50%, for all participants, no matter their socioeconomic status. Therefore, the observed SES-related difference in posterior beliefs needs to be driven by the process by which individuals from different SES levels update their beliefs about the quality of the stock, after observing its dividends.

In the regressions in Table IV we find that indeed there is a difference in how low SES participants and the mid/high SES ones update beliefs after observing the stock outcome in a given trial. In particular, in the first column in the table we document that low SES participants' subjective probability estimates are 3.15% ($p < 0.06$) less sensitive relative to those of mid/high SES participants, to the presentation of high stock dividends. The second column in the table shows that updating after seeing low dividends does not significantly differ by SES level.

A particularly informative setting in which updating can be studied is that of the first trial in each of the 10 learning blocks completed by each person. In the first trial of each learning block, everybody's prior that the stock is the good one is set to 50%, by experimental design. In that first trial, the stock dividend is either high or low. If low SES participants update less from high dividends, we should observe that their subjective probability estimates after that first dividend in the learning block is revealed to be high will be lower than the estimates produced by mid/high SES participants who observe the same high dividend. The results in the third column of Table IV present evidence consistent with this prediction: after seing a high dividend in the first trial of a new learning block, low SES participants produce subjective probability estimates that are 4.53% ($p < 0.08$) lower than those of their mid/high SES counterparts. The last column in the table shows that when the first dividend in a new learning block is low, there is no significant difference in the posterior beliefs of participants, depending on their SES level.

Therefore, the evidence in Table IV suggests a possible mechanism through which low SES participants become pessimistic regarding the quality of the financial assets available to them: they do not update as much as the higher SES participants from news that would indicate that these assets are in fact of good quality. That is, low SES participants may have a skewed view of the financial investments surrounding them: more of a view akin to "the glass half-empty" rather that "the glass is half-full".

Aside from being more pessimistic in their beliefs regarding the stocks presented during the experiment, low SES participants also differ from the mid/high SES ones in terms of the rate at which they improve their probability estimation performance over time. Specifically, while participants improve their probability estimation over time, during the 20 blocks of the experiment, the rate of improvement is lower among low SES individuals, compared to mid and high SES individuals. Figure 4 shows that for low SES subjects, probability estimates are on average 31.87% away from Bayesian posteriors in the first learning block they encounter. These subjects estimation errors decrease at an average rate of 0.2% per block. For mid or high SES subjects, probability estimates are on average 31.18% away from Bayesian posteriors in the first learning block they encounter. These subjects estimation errors decrease at an average rate of 0.35% per block. The rate of improvement in probability estimation for low SES participants is significantly lower than that for mid or high SES participants ($p < 0.05$).

B. *Alternative explanations*

While the evidence so far suggests that low SES participants form opinions about the quality of investment opportunities differently from mid/high SES participants, it is possible that there are other SES-related factors, unrelated to updating, that would lead to these differences in subjective probability estimates in the low SES versus mid/high SES group. For example, it could be that low SES participants are not more pessimistic in how they update their view about investments, but they have lower levels or finance-related knowledge that would allow them to do well in this learning task. We find that this is not the case in our sample. We use four measures of finance-relevant knowledge: the subjects' scores on the financial knowledge questions detailed in Section II, their numeracy score calculated as in Peters et al. (2006), the type of college major they pursued (technical or not), and the average confidence they reported when expressing their probability estimate every trial.

Table V presents averages of these four variables related to the subjects understanding of finance-relevant concepts, separately for the low SES subsample, and the mid & high SES subsample. We find that neither one of these four dimensions of finance-relevant knowledge differs significantly across the two subsamples, as shown by the p-values in the last column in the table.

Another potential explanation for our main effect is that perhaps low SES participants are more risk averse than the mid/high SES participants, and their subjective probability estimates reflect their increased risk aversion, and not pessimism related to actual beliefs. We analyze four measures of risk aversion to see whether they are different for the low SES group relative to the rest of participants.

First, for each person we calculate the frequency with which they chose the stock, rather than the bond, in the first trial in each learning block. In this trial the choice is solely driven by risk preferences and not by new information, since no dividend of the stock has yet been observed, and thus participants only know the 50% prior that the stock is the good one. As shown in the first row of Table VI, the difference in the propensity to chose the stock in the first trial between the low SES group and the other participants is not significantly different from 0 at conventional levels. Second, we compare the amount (out of a hypothetical 10,000 *RON* endowment) that subjects would invest in the stock market rather than an investment account, for the low SES group and the mid/high SES group, and again find no significant difference, as shown in the second row of the table. The third and four measures of risk attitudes shown in the bottom two rows of Table VI are given by subjects' scores on two surveys used widely in the psychology literature, the State-Trait Anxiety Inventory (Spielberger et al. (1983)) and the Behavioral Inhibition Scale (Carver and White (1994)). We do not find any differences between the low SES and the mid/high SES groups on these anxiety-related proxies for risk avoidance.

IV. Conclusion

We present experimental evidence that socioeconomic status influences the way people perceive and use financial information. We find that low SES participants are more pessimistic about the possible payoffs of available investment opportunities, in particular when they have more money at stake and when losses are possible. These results are robust to several ways of measuring one's socioeeconomic standing. Moreover, these SES-related differences in beliefs do not arise from difference in risk preferences or finance-relevant knowledge. Rather, we document that low SES participants are less likely to update their beliefs about the quality of the investments available to them when the outcome of these investments are high. Finally, we also show that low SES participants improve at slower rates their ability to correctly estimate the quality of risky investments.

These findings are important for understanding the low rates of stock market participation observed among low SES households (Campbell (2006) and Calvet et al. (2007)). It is possible that coming from a background characterized by high economic adversity induces people to view financial matters through a pessimistic, "glass is half-empty", lens, rather than in an unbiased manner. If so, then low SES people would underestimate the possible returns to investment in risky assets such as the stock market, or perhaps to investments in human capital. Further studies need to examine whether this pessimism bias induced by low SES replicates in other samples, and if so, whether there exist interventions that can help reduce this bias in people's beliefs about the distribution of future outcomes of such investments.

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APPENDIX

A. Participant Instructions (English Translation)

Welcome to our financial decision making study!

In this study you will work on two investment tasks. In one task you will repeatedly invest in one of two securities: a risky security (i.e., a stock with risky payoffs) and a riskless security (i.e., a bond with a known payoff), and will provide estimates as to how good an investment the risky security is. In the other task you are only asked to provide estimates as to how good an investment the risky security is, after observing its payoffs.

In either task, there are two types of conditions you can face: the GAIN and the LOSS conditions. In the GAIN condition, the two securities will only provide POSITIVE payoffs. In the LOSS condition, the two securities will only provide NEGATIVE payoffs.

Details for the Investment Choice and Investment Evaluation Task:

Specific details for the GAIN condition:

In the GAIN condition, on any trial, if you choose to invest in the bond, you get a payoff of 6 RON for sure at the end of the trial. If you choose to invest in the stock, you will receive a dividend which can be either 10 RON or 2 RON.

The stock can either be good or bad, and this will determine the likelihood of its dividend being high or low. If the stock is good then the probability of receiving the 10 RON dividend is 70% and the probability of receiving the 2 RON dividend is 30%. The dividends paid by this stock are independent from trial to trial, but come from this exact distribution. In other words, once it is determined by the computer that the stock is good, then on each trial the odds of the dividend being 10 RON are 70%, and the odds of it being 2 RON are 30%. If the stock is bad then the probability of receiving the 10 RON dividend is 30% and the probability of receiving the 2 RON dividend is 70%. The dividends paid by this stock are independent from trial to trial, but come from this exact distribution. In other words, once it is determined by the computer that the stock is bad, then on each trial the odds of the dividend being 10 RON are 30%, and the odds of it being 2 RON are 70%.

Specific details for the LOSS condition:

In the LOSS condition, on any trial, if you choose to invest in the bond, you get a payoff of -6 RON for sure at the end of the trial. If you choose to invest in the stock, you will receive a dividend which can be either -10 RON or -2 RON.

The stock can either be good or bad, and this will determine the likelihood of its dividend being high or low. If the stock is good then the probability of receiving the -10 RON dividend is 30% and the probability of receiving the -2 RON dividend is 70%. The dividends paid by this stock are independent from trial to trial, but come from this exact distribution. In other words, once it is determined by the computer that the stock is good, then on each trial the odds of the dividend being -10 RON are 30%, and the odds of it being -2 RON are 70%. If the stock is bad then the probability of receiving the -10 RON dividend is 70% and the probability of receiving the -2 RON dividend is 30%. The dividends paid by this stock are independent from trial to trial, but come from this exact distribution. In other words, once it is determined by the computer that the stock is bad, then on each trial the odds of the dividend being -10 RON are 70%, and the odds of it being -2 RON are 30%.

In both GAIN and LOSS conditions:

In each condition, at the beginning of each block of 6 trials, you do not know which type of stock the computer selected for that block. You may be facing the good stock, or the bad stock, with equal probability.

On each trial in the block you will decide whether you want to invest in the stock for that trial and accumulate the dividend paid by the stock, or invest in the riskless security and add the known payoff to your task earnings.

You will then see the dividend paid by the stock, no matter if you chose the stock or the bond.

After that we will ask you to tell us two things: (1) what you think is the probability that the stock is the good one (the answer must be a number between 0 and 100 - do not add the % sign, just type in the value) (2) how much you trust your ability to come up with the correct probability estimate that the stock is good. In other words, we want to know how confident you are that the probability you estimated is correct. (answer is between 1 and 9, with 1 meaning you have the lowest amount of confidence in your estimate, and 9 meaning you have the highest level of confidence in your ability to come up with the right probability estimate)

There is always an objective, correct, probability that the stock is good, which depends on the history of dividends paid by the stock already. For instance, at the beginning of each block of trials, the probability that the stock is good is exactly 50%, and there is no doubt about this value.

As you observe the dividends paid by the stock you will update your belief whether or not the stock is good. It may be that after a series of good dividends, you think the probability of the stock being good is 75%. However, how much you trust your ability to calculate this probability could vary. Sometimes you may not be too confident in the probability estimate you calculated and some times you may be highly confident in this estimate. For instance, at the very beginning of each block, the probability of the stock being good is 50% and you should be highly confident in this number because you are told that the computer just picked at random the type of stock you will see in the block, and nothing else has happened since then.

Every time you provide us with a probability estimate that is within 5% of the correct value (e.g. correct probability is 80% and you say 84% , or 75%) we will add 10 cents to your payment for taking part in this study.

Throughout the task you will be told how much you have accumulated through dividends paid by the stock or bond you chose up to that point.

Details for the Investment Evaluation Task:

This task is exactly as the task described above, except for the fact that you will not be making any investment choices. You will observe the dividends paid by the stock in either the GAIN or the LOSS conditions, and you will be asked to provide us with your probability estimate that the stock is good, and your confidence in this estimate. In this task, therefore, your payment only depends on the accuracy of your probability estimates.

You final pay for completing the investment tasks will be:

27 RON + 1/10 * Investment Payoffs + 1/10 * Number of accurate probability estimates,

where Investment Payoffs = Dividends of securities you chose in the experiment, in both the GAIN and the LOSS conditions.

Please note: cell phones must be off. No drinks, food or chewing gum are allowed during the experiment. Thank you!

B. Objective Bayesian Posterior Beliefs

The table below provides all possible values for the objectively correct Bayesian posterior that the stock is paying from the good dividend distribution, starting with a 50%-50% prior, and after observing each possible dividend history path in a learning block. Every trial a new dividend (high or low) is revealed. There are six trials in each learning block.

The objective Bayesian posterior that the stock is the good one, after observing t high outcomes in n trials so far is given by: $\frac{1}{1+\frac{1-p}{p}*(\frac{q}{1-q})^{n-2t}}$, where $p = 50\%$ is the prior that the stock is good (before any dividends are observed in that learning block) and $q = 70\%$ is the probability that a good stock pays the high (rather than the low) dividend in each trial.

n trials so far	t high outcomes so far	Probability{stock is good | t high outcomes in n trials}
1	0	30.00%
1	1	70.00%
2	0	15.52%
2	1	50.00%
2	2	84.48%
3	0	7.30%
3	1	30.00%
3	2	70.00%
3	3	92.70%
4	0	3.26%
4	1	15.52%
4	2	50.00%
4	3	84.48%
4	4	96.74%
5	0	1.43%
5	1	7.30%
5	2	30.00%
5	3	70.00%
5	4	92.70%
5	5	98.57%
6	0	0.62%
6	1	3.26%
6	2	15.52%
6	3	50.00%
6	4	84.48%
6	5	96.74%
6	6	99.38%

C. Measures of Financial Literacy and Risk Preferences

To get measures of financial literacy and risk preferences, each participant was asked the following questions after the completion of the experimental tasks: "Imagine you have saved 10 RON,000. You can now invest this money over the next year using two investment options: a stock index mutual fund which tracks the performance of the stock market, and a savings account. The annual return per dollar invested in the stock index fund will be either +40% or -20%, with equal probability. In other words, it is equally likely that for each RON you invest in the stock market, at the end of the one year investment period, you will have either gained 40 cents, or lost 20 cents. For the savings account, the known and certain rate of return for a one year investment is 5%. In other words, for each RON you put in the savings account today, for sure you will gain 5 cents at the end of the one year investment period. We assume that whatever amount you do not invest in stocks will be invested in the savings account and will earn the risk free rate of return. Given this information, how much of the 10 RON,000 will you invest in the stock index fund? Choose an answer that you would be comfortable with if this was a real-life investment decision. The answer should be a number between 0 and 10,000 RON."

After each participant wrote their answer to this question, they were asked the following: "Let's say that when you answered the prior question you decided to invest x RON out of the 10,000 RON amount in the stock index fund, and therefore you put $(10,000 - x)$ RON in the savings account. Recall that over the next year the rate of return on the stock index fund will be +40% or -20%, with equal probability. For the savings account, the rate of return is 5% for sure. What is the amount of money you expect to have at the end of this one year investment period? Please choose one of the answers below. If you choose the correct answer, you will get a 5 RON bonus added to your pay for this experiment. [A]. 0.5 (0.4 x - 0.2 x) + 0.05 (10,000 - x); [B]. 1.4 x + 0.8 x + 1.05 (10,000 - x); [C]. 0.4 (10,000 - x) - 0.2 (10,000 - x) + 0.05 x; [D]. 0.5 [0.4 (10,000 - x) - 0.2 (10,000 - x)] + 0.05 x; [E]. 0.4 x - 0.2 x + 0.05 (10,000 - x); [F]. 0.5 (1.4 x + 0.8 x) + 1.05 (10,000 - x); [G]. 1.4 (10,000 - x) + 0.8 (10,000 - x) + 1.05 x; [H]. 0.5 [1.4 (10,000 - x) + 0.8 (10,000 - x)] + 1.05 x."

The correct answer to this question is [F]. The actual choices (if other than [F]) made by participants indicate three different types of errors that can occur when calculating the expected value of their portfolio holdings: the lack of understanding of statements regarding probabilities (answers [B], [C], [E], [G]); the lack of understanding of the difference between net and gross returns (answers [A],[C], [D] and [E]); and confusing the stock versus risk-free asset investments (answers [C], [D], [G] and [H]). Therefore, a financial knowledge score varying between zero and three can be constructed, based on the number of different types of errors contained in the answer provided by each participant (i.e., zero errors for answer [F], one error for answers [A], [B] and [H], two errors for answers [D], [E] and [G], and three for answer [C]). Hence a financial knowledge score of 3 indicates a perfect answer, while a score of 0 indicates that the participant's answer included all three possible types of errors. Of the 87 participants, 45 made no errors, 24 made one type of error only, 17 made two types of errors, and 1 person made all three possible types of errors.

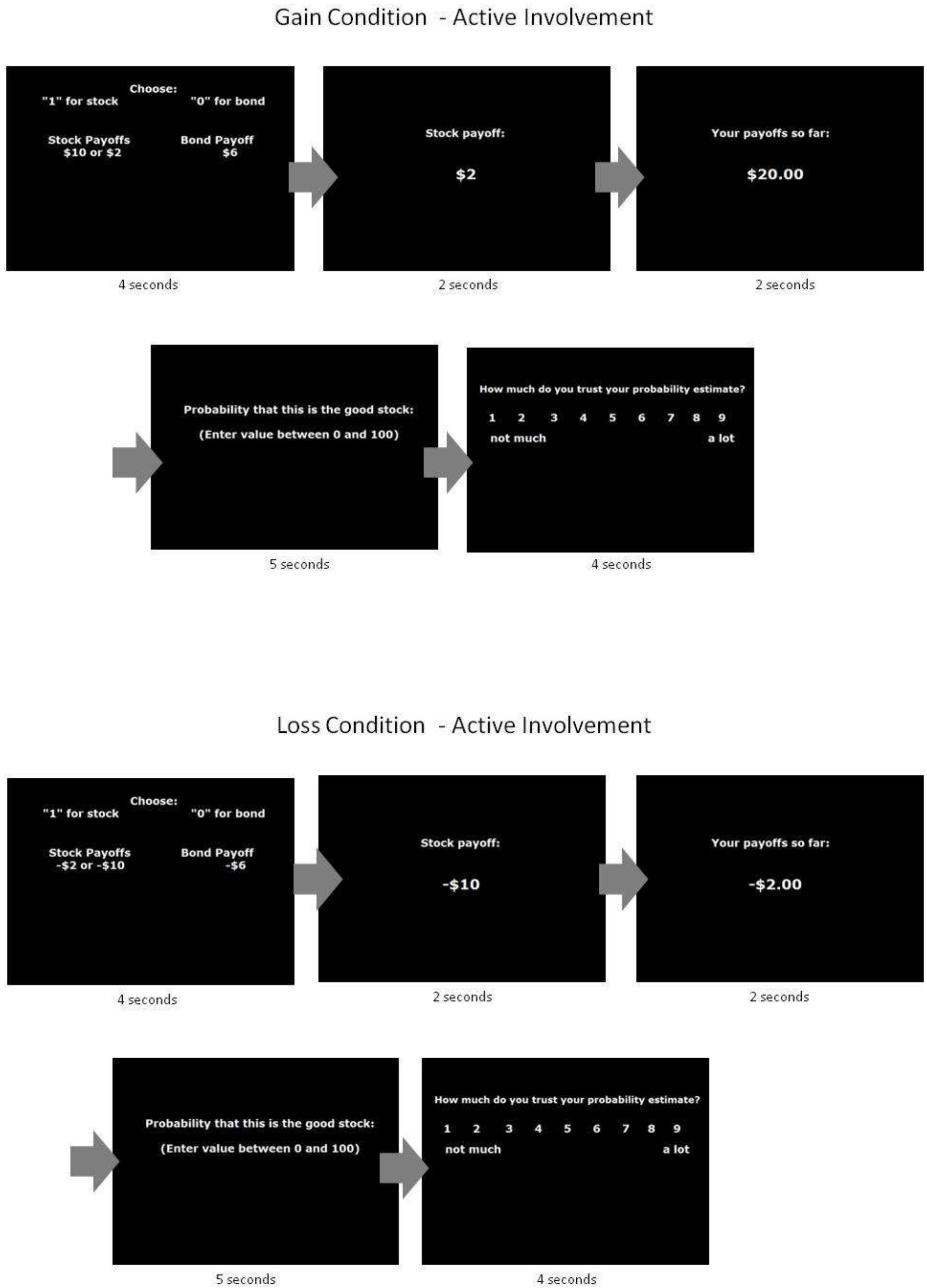

Figure 1: Active task: An example, translated in English, of a gain condition trial (top panel) and a loss condition trial (bottom panel). In either type of trial, subjects first choose between the stock and the bond. Then they observe the dividend paid by the stock that trial, no matter which asset they chose, and then are reminded of how much they have earned so far from the payoffs of the assets chosen so far in the Active investment task. Lastly, they are asked to provide an estimate for the probability that the stock is paying from the good dividend distribution, and their confidence in this estimate.

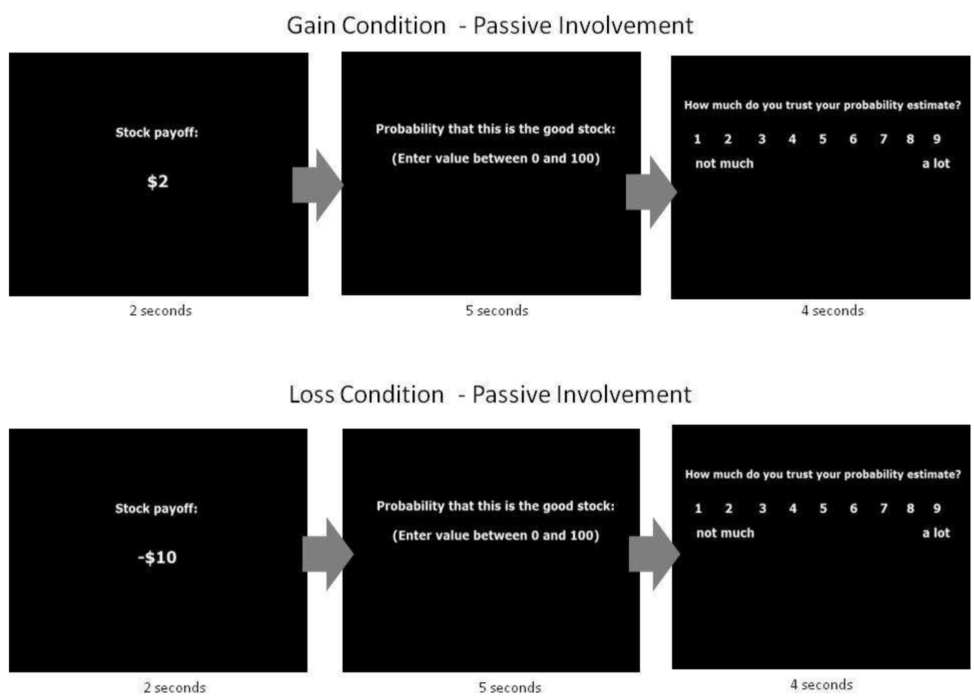

Figure 2: Passive task: An example, translated in English, of a gain condition trial (top panel) and a loss condition trial (bottom panel). In either type of trial, subjects observe the dividend paid by the stock that trial. Then they are asked to provide an estimate for the probability that the stock is paying from the good dividend distribution, and their confidence in this estimate.

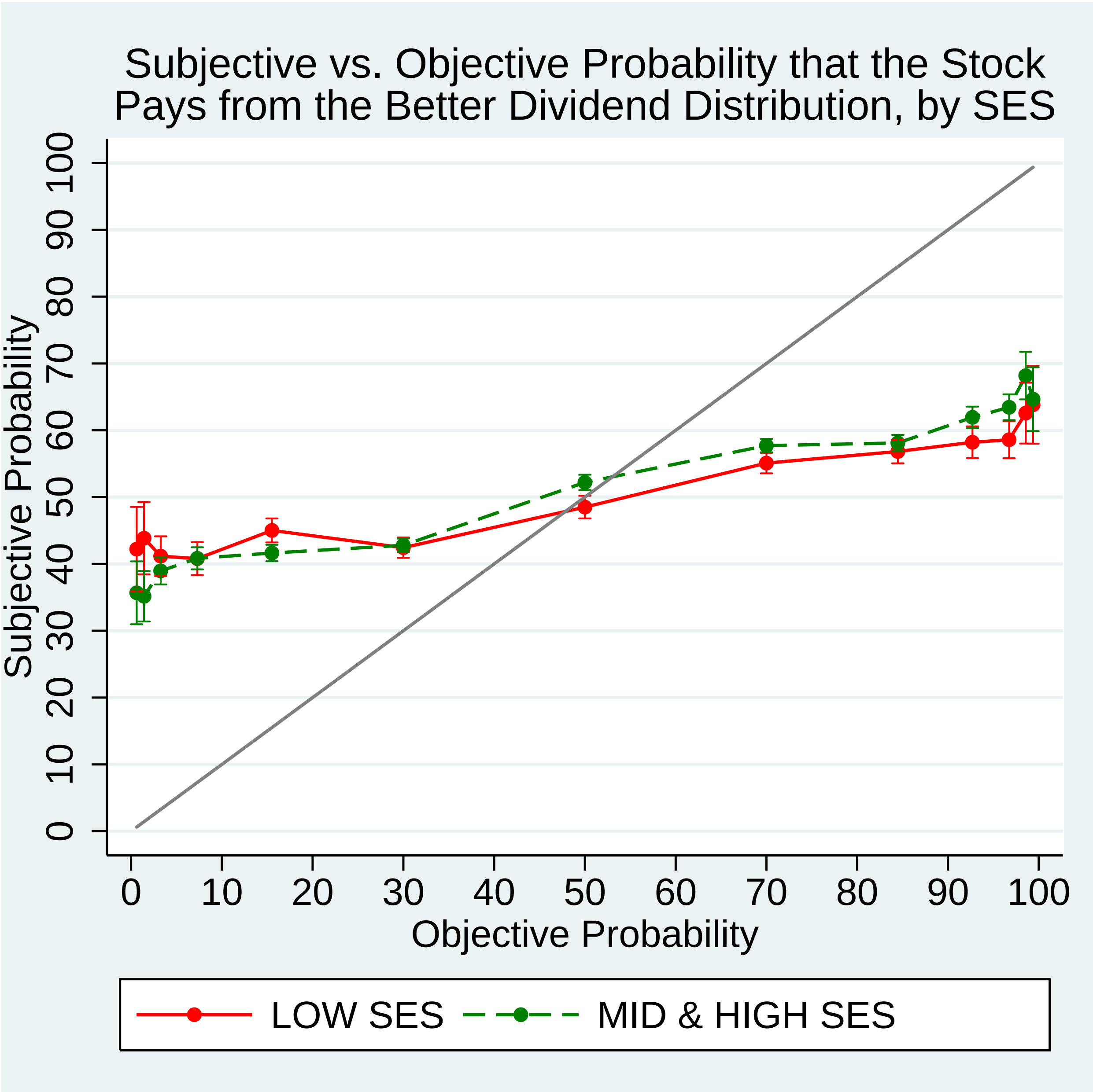

Figure 3: Average subjective estimates for the probability that the stock is paying from the good dividend distribution, as a function of the objective Bayesian probability. The objective Bayesian posteriors that the stock is good which are possible in the experiment are listed in the Appendix, together with the various combinations of high and low outcomes observed during a learning block that lead to such posteriors. If subjective posteriors were Bayesian, they would equal the objective probabilities and thus would line up on the grey 45° line. Subjective probability estimates provided by participants for each level of the objectively correct Bayesian posterior are shown in red for low SES participants (i.e., those in the bottom third of the SES score distribution), and in green for medium and high SES participants.

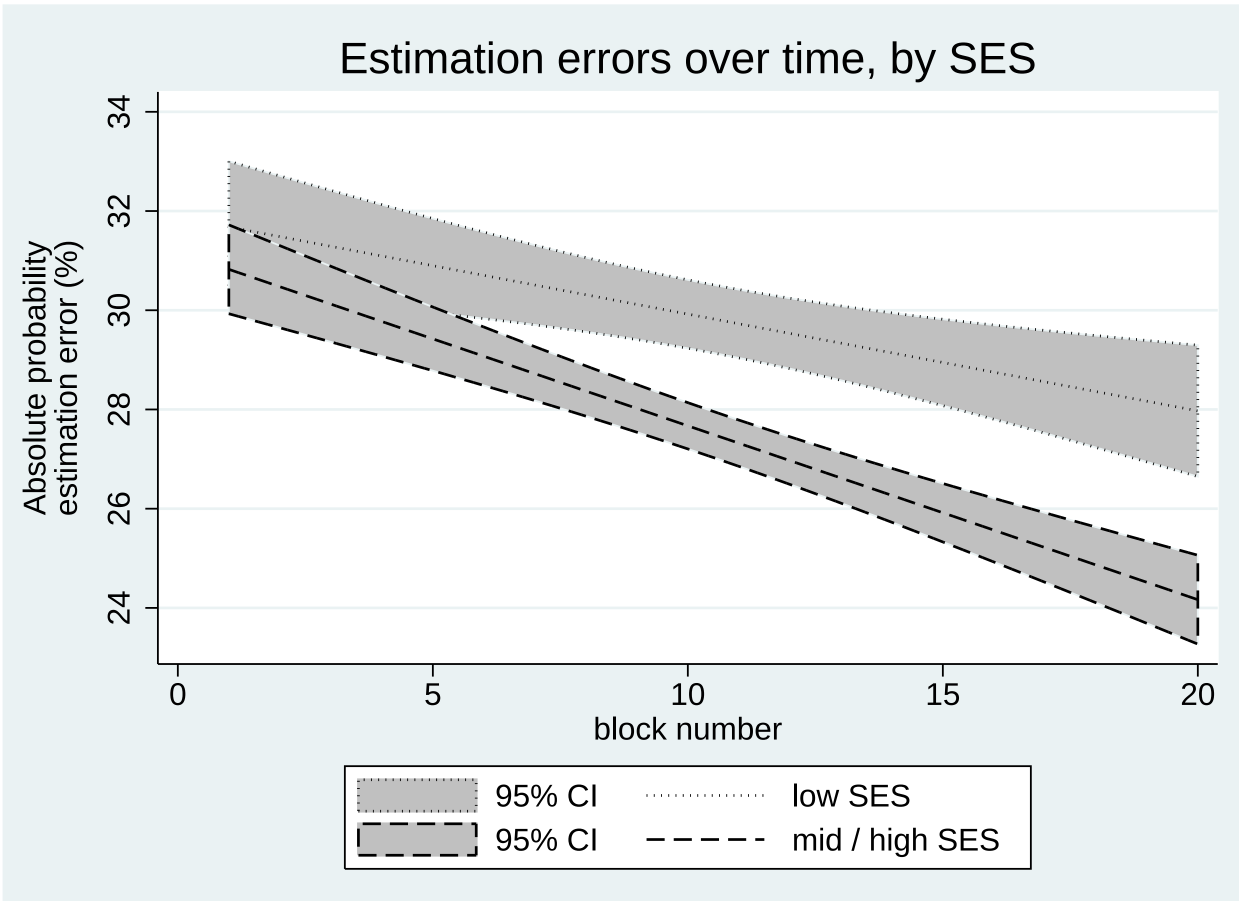

Figure 4: Absolute probability estimation errors, over the 20 learning blocks played by each subject (10 active and 10 passive learning blocks), by SES level. For low SES subjects, probability estimates are on average 31.87% away from Bayesian posteriors in the first learning block they encounter. These subjects' estimation errors decrease at an average rate of 0.2% per block. For mid or high SES subjects, probability estimates are on average 31.18% away from Bayesian posteriors in the first learning block they encounter. These subjects' estimation errors decrease at an average rate of 0.35% per block. The rate of improvement in probability estimation for low SES participants is significantly lower than that for mid or high SES participants ($p < 0.05$).

Table I: Experimental design. Each participants goes through 60 trials in the Active task, and 60 trials in the Passive task. Whether the participant does the Active task first, or the Passive task first, is determined at random. Trials are split into "learning blocks" of six: for these six trials, the learning problem is the same. That is, the computer either pays dividends from the good stock distribution in each of these six trials, or it pays from the bad distribution in each of the six trials. The good distribution is that where the high dividend occurs with 70% probability in each trial, while the low outcome occurs with 30% probability. The bad distribution is that where these probabilities are reversed: the high outcome occurs with 30% probability, and the low outcome occurs with 70% probability in each trial. At the beginning of each learning block, the computer randomly selects (with 50%-50% probabilities) whether the dividend distribution to be used in the following six trials will be the good or the bad one. There are ten learning blocks in the Active task, and ten learning blocks in the Passive task. In either task, there are five blocks in the gain condition, and five blocks in the loss condition. The order of the blocks is pseudo-randomized. An example of a sequence of loss or gain blocks that a participant may face is shown below.

Active Task	See Figure 1 for examples of trials	Condition
Block 1	Trial 1; Trial 2; Trial 3; Trial 4; Trial 5; Trial 6	Loss
Block 2	Trial 1; Trial 2; Trial 3; Trial 4; Trial 5; Trial 6	Gain
Block 3	Trial 1; Trial 2; Trial 3; Trial 4; Trial 5; Trial 6	Gain
.	.	.
.	.	.
.	.	.
Block 9	Trial 1; Trial 2; Trial 3; Trial 4; Trial 5; Trial 6	Gain
Block 10	Trial 1; Trial 2; Trial 3; Trial 4; Trial 5; Trial 6	Loss

Passive Task	See Figure 2 for examples of trials	Condition
Block 1	Trial 1; Trial 2; Trial 3; Trial 4; Trial 5; Trial 6	Gain
Block 2	Trial 1; Trial 2; Trial 3; Trial 4; Trial 5; Trial 6	Loss
Block 3	Trial 1; Trial 2; Trial 3; Trial 4; Trial 5; Trial 6	Gain
.	.	.
.	.	.
.	.	.
Block 9	Trial 1; Trial 2; Trial 3; Trial 4; Trial 5; Trial 6	Loss
Block 10	Trial 1; Trial 2; Trial 3; Trial 4; Trial 5; Trial 6	Loss

Table II: Probability estimates and the SES aggregate score

The dependent variable in the OLS regressions in the table is *Probability Estimate*$_{it}$, which is the subjective estimate for the probability that the stock pays from the good dividend distribution, given the dividend history seen by participant i up to and including trial t. The variable *Low SES*$_i$ is an indicator equal to 1 for participants in the bottom third of the aggregate SES score distribution. Control variables *Male*$_i$ and *Age*$_i$ indicate the gender and age of participant i. Also included as controls are fixed effects for each level of the objective Bayesian posterior probability that the stock pays from the good distribution, given the 50% prior and the history of stock dividends observed by participant i up to and including trial t (*Objective Probability*$_{it}$). Standard errors are robust to heteroskedasticity and are clustered by subject.

Dependent variable	*Probability Estimate*$_{it}$					
	Objective Probability <50%	Objective Probability ≥50%	Objective Probability ≥50% Passive Task	Objective Probability ≥50% Active Task	Objective Probability ≥50% Active Task Gain Condition	Objective Probability ≥50% Active Task Loss Condition
Low SES$_i$	1.65	–2.86	–1.71	–4.07	–3.17	–4.70
	(0.92)	(–1.98)**	(–0.94)	(–2.28)**	(–1.71)*	(–1.98)**
Male$_i$	1.31	5.39	4.96	5.87	2.08	10.10
	(0.66)	(3.79)***	(3.02)***	(3.32)***	(1.12)	(4.12)***
Age$_i$	–0.38	0.50	0.54	0.42	0.49	0.40
	(–0.94)	(2.18)**	(1.70)*	(1.58)	(1.27)	(1.15)
Objective Probability$_{it}$ FEs	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.004	0.033	0.027	0.039	0.043	0.048
Observations	10135	13669	6813	6856	3476	3380

Table III: Probability estimates and different measures of socioeconomic status
The regressions in the four panels of the table are estimated as in Table II. A different measure of socioeconomic status is used in each panel. The dependent variable in the OLS regressions in the table is $Probability\ Estimate_{it}$, which is the subjective estimate for the probability that the stock pays from the good dividend distribution, given the dividend history seen by participant i up to and including trial t. The variable $Low\ SES_i$ is an indicator equal to 1 for participants in the bottom third of the SES score distribution. The variable $Low\ Parental\ Income_i$ is an indicator equal to 1 for participants whose parents have a combine income of less than 1000 RON (approx. $300) per month. The variable $Low\ SSS_i$ is an indicator equal to 1 if the person's subjective assessment of their socioeconomic status is less than 5, on a scale from 1 to 10. The variable $Low\ Parental\ Education_i$ is an indicator equal to 1 for participants for whom neither parent has a college degree. Standard errors are robust to heteroskedasticity and are clustered by subject.

Dependent variable	$Probability\ Estimate_{it}$					
	Objective Probability <50%	Objective Probability ≥50%	Objective Probability ≥50% Passive Task	Objective Probability ≥50% Active Task	Objective Probability ≥50% Active Task Gain Condition	Objective Probability ≥50% Active Task Loss Condition
Panel A						
$Low\ SES_i$	1.65	–2.86	–1.71	–4.07	–3.17	–4.70
	(0.92)	(–1.98)**	(–0.94)	(–2.28)**	(–1.71)*	(–1.98)**
Panel B						
$Low\ Parental\ Income_i$	1.69	–5.39	–5.03	–5.83	–4.58	–6.66
	(0.70)	(–2.58)**	(–1.80)*	(–2.21)**	(–1.81)*	(–2.20)**
Panel C						
$Low\ SSS_i$	–1.00	–3.28	–3.52	–3.11	–2.65	–3.54
	(–0.59)	(–2.29)**	(–2.04)**	(–1.85)*	(–1.45)	(–1.52)
Panel D						
$Low\ Parental\ Education_i$	0.46	–0.95	–1.54	–0.32	2.02	–3.34
	(0.27)	(–0.69)	(–0.94)	(–0.19)	(1.13)	(–1.50)

Table IV: SES and differences in probability updating after high and after low dividends. The dependent variable in the OLS regressions in the table is $Probability\ Estimate_{it}$, which is the subjective estimate for the probability that the stock pays from the good dividend distribution, given the dividend history seen by participant i up to and including trial t, in the Active version of the task. The variable $Low\ SES_i$ is an indicator equal to 1 for participants in the bottom third of the SES score distribution. Control variables $Male_i$ and Age_i indicate the gender and age of participant i. Also included as a control in the first two columns is the subjective probability, expressed in trial $t-1$, that the stock pays from the good distribution. The regressions in the last two columns include only data from the first trial in each learning block (i.e., 10 trials per subject), for which the prior belief that the stock is the good one is 50%, as indicated to subjects in the experimental instructions. That is, for observations in the last two columns, $Probability\ Estimate_{it-1}$=50% by experimental design. Standard errors are robust to heteroskedasticity and are clustered by subject.

Dependent variable	$Probability\ Estimate_{it}$			
	High dividend in trial t	Low dividend in trial t	High dividend in 1^{st} trial	Low dividend in 1^{st} trial
$Low\ SES_i$	–3.15	0.69	–4.53	0.66
	(–1.95)*	(0.35)	(–1.77)*	(0.23)
$Male_i$	5.67	–0.22	6.29	–0.82
	(3.56)***	(–0.11)	(2.48)**	(–0.25)
Age_i	0.69	–0.47	1.54	–0.60
	(2.26)**	(–1.00)	(3.03)***	(–0.96)
$Probability\ Estimate_{it-1}$				
$Fixed\ Effects$	Yes	Yes		
R^2	0.196	0.122	0.035	0.002
Observations	5864	5866	1027	943

Table V: Finance-relevant knowledge and SES

The table presents averages of four variables related to the subjects' understanding of finance-relevant concepts, separately for the low SES subsample, and the mid & high SES subsample. Neither one of these four dimensions of finance-relevant knowledge differs significantly across the two subsamples, as shown by the *p*-values in the last column.

	Low SES participants (N=67)	Mid & high SES participants (N=136)	p-value for Difference $\neq 0$
Financial knowledge score (0-3 scale) as in Kuhnen (forthcoming)	1.03	1.06	0.83
Numeracy score (0-11 scale) as in Peters et al. (2006)	7.94	8.16	0.45
Technical major (0=No, 1=Yes)	0.48	0.56	0.28
Confidence in subjective beliefs (1-9 scale)	6.42	6.59	0.38

Table VI: Risk aversion and SES

The table presents averages of measures related to the subjects' risk aversion, separately for the low SES subsample, and the mid & high SES subsample. The State Anxiety score, based on the State-Trait Anxiety Inventory (Spielberger et al. (1983)), measures state or current anxiety, whereas the Behavioral Inhibition score (Carver and White (1994)) measures more stable trait anxiety. Neither one of these proxies for risk aversion differs significantly across the two subsamples at conventional levels, as shown by the *p*-values in the last column.

	Low SES participants (N=67)	Mid & high SES participants (N=136)	p-value for Difference $\neq 0$
% trials stock chosen in 1st trial in block	73.48%	78.84%	0.11
% of 10,000 RON invested in stocks	66.11%	47.70%	0.09
State Anxiety score	32.25	31.77	0.70
Behavioral Inhibition Score	19.90	19.99	0.88