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The Timing of a Warning Message on Effectively Debiasing Herd Behavior in Financial Decisions

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Abstract

Herd behavior, characterized by individuals imitating the actions of others, poses significant challenges in financial decision making. However, previous literature has not been able to successfully debias herding. This study proposed that timing may be a crucial factor in determining the effectiveness of debiasing interventions. The present study experimentally investigated the influence of the timing of a warning message on mitigating herd behavior in retirement savings decisions. A total of 192 participants were randomly assigned to different conditions in a retirement savings choice set. These conditions included: (1) peer information including a prior warning message, (2) peer information followed by a warning message after making an initial choice, and (3) no peer information or warning. The peer information successfully elicited herd behavior, but this study did not find a significant difference between the two timings of the warning message. However, the limitations of this study may have contributed to these insignificant results. Nevertheless, the warning message provided after the initial choice, and possibly the warning provided before, have shown effectiveness in mitigating herd behavior. While no significant results were observed for the timing, this paper serves as a foundation for highlighting the significance of timing in enhancing decision making processes.

Keywords: herd behavior, debiasing, timing, warning message, financial decision making, retirement savings

Contents

Chapter 1: Introduction

Herd behavior, a phenomenon discussed in economic works as early as Keynes (1936), is deeply rooted in human instinct and continues to be observed. Herd behavior refers to individuals' tendency to "imitate each other's actions and/or base their decisions upon the actions of others" (Spyrou, 2013, p. 175). The phenomenon of herd behavior in economic and financial decision making presents significant challenges and can lead to inefficiencies, market bubbles, and can even contribute to financial crises. Addressing the issue of herding bias can be done by introducing a debiasing technique that enables decision makers to make unbiased choices even in the presence of peer information (Larrick, 2004). One such technique is providing participants with a warning message, which has been employed in various attempts to counteract different biases. Previous research has shown that herd behavior can be elicited by providing peer information, but efforts to debias this behavior have yielded no results (Compen, Pitthan, Schelfhout, & De Witte, 2022).

This research presents a novel contribution by addressing the unresolved issue of effectively debiasing herd behavior. A new theory is proposed in this study to explain the varying levels of effectiveness among different debiasing techniques. Specifically, when comparing studies that successfully employed a warning message for debiasing with those that were unsuccessful, a key distinction emerges regarding the timing of the message. Providing the warning message before an initial choice is made appears to yield greater efficiency compared to delivering it afterwards. This discrepancy can potentially be attributed to the anchoring and adjustment bias (Tversky and Kahneman, 1974), where the initial estimate serves as an anchor that may not be sufficiently adjusted in response to the warning message, thereby limiting its effectiveness. Another contributing factor may be the choice-supportive bias, whereby individuals tend to perceive their previously chosen option as more favorable than it was initially (Lind, Visentini, Mäntylä, & Del Missier, 2019).

This research builds upon the work of Compen et al. (2022). The weaknesses and limitations of their study are identified, which include the potential influence of the compromise effect and the framing effect. Building upon these insights, this research aims to improve their experimental design and make a new attempt at mitigating herd behavior.

The findings of this paper can be used by policymakers or other administrators to encourage individuals to make informed decisions in various domains. Additionally, it lays the foundation for further research on the optimal timing for providing information or advice. Looking into enhancing the utilization of advice through manipulating timing, might be interesting as there is a gap in the literature on when advice should be given (Kämmer, Choshen-Hillel, Müller-Trede, Black, & Weibler, 2023).

The key objective of this thesis is to investigate the significance of timing in the process of debiasing herd behavior within a financial context. To achieve this objective, the following research question will be addressed:

To what extent does the timing of a warning message affect the ability to debias herd behavior in the context of choosing a retirement savings plan?

The research question will be answered by analyzing the data of an experimental design. The experimental design focusses on several treatment conditions, where the provision of peer information and a warning message are manipulated. The collected data will be analyzed using two logistic regression models and a McNemar's test.
The findings of this thesis revealed that peer information influenced decisions and led to herd behavior. However, no significant difference was found between providing the warning message before or after making an initial choice. Limitations may have affected the study's ability to capture the full potential of the warning message provided beforehand. But the warning provided after was significantly effective in reducing herd behavior.

The thesis will be structured as follows: Chapter 2 serves to define and explain important concepts, establishing the theoretical groundwork for the subsequent research. Chapter 3 outlines the research methodology, encompassing the data collection process, the sample description, and a discussion of data analysis methods. Building upon this, Chapter 4 presents the actual data analyses, concluding the results section. Moving forward, Chapter 5 begins by discussing and summarizing the results, followed by an acknowledgment of the limitations.
After addressing the limitations, the chapter then explores the implications of the results, discussing their significance and potential applications. Additionally, chapter 5 suggests further research directions to build upon the findings and overcome the identified limitations.

Chapter 2: Theoretical Framework

2.1 Preceding Research

This research closely follows the recent paper by Compen, Pitthan, Schelfhout, and De Witte (2022), thus it is useful to first analyze the article critically. Their article aimed to explore the conditions under which herd behavior occurs and to make a pioneering attempt to debias it. The authors used decision support systems (DSS), which essentially are computer program applications designed to help decision makers make informed decisions (Alavi & Joachimsthaler, 1992). Their study focused on two financial contexts: retirement savings and disability insurance. Within the DSS, individuals were presented with a set of options based on their personal information. In the experimental groups, one option included peer information presented as "Chosen by x%". After making their initial choice, the experimental groups received a warning regarding the potential presence of herding bias and clarifying that the percentage was randomly generated. Participants were then allowed to revise their decision. Herd behavior was successfully provoked when the peer information mentioned exceeded 50%. However, the attempt to debias herd behavior through the warning message did not yield desired results.

The use of decision support systems (DSS), personalized options, and participants' active interest in obtaining specific plans were significant strengths of their study that cannot be replicated in this research. However, their research design had certain limitations. For instance, providing participants with three options where the middle option had peer information attached to it may have led to the compromise effect (Chang & Liu, 2008). Additionally, the labeling of this option as "Premium" might have created a perception of superiority, leading to the framing effect (Levin, Schnittjer, & Thee, 1988). These factors likely contributed to the popularity of the option even in the control group, making it challenging to fully assess the impact of herding bias. This paper will use these points to improve the experimental design and make a new attempt at mitigating herd behavior.

2.2 Herd Behavior: Understanding the Phenomenon

2.2.1 Definition of Herd Behavior

Herding is not limited to a single area and can be observed across multiple domains, including sociology, psychology, and zoology. For instance, animals exhibit herd behavior as they form groups for protection or to obtain resources. Similarly, in a social context, high school students often engage in herding behavior by for example frequenting the same stores or adopting similar fashion trends. In economical or financial context herd behavior generally refers to the tendency of economic agents to mimic the actions of others or make decisions based on the actions of others (Spyrou, 2013). Bikhchandani and Sharma (2000) differentiate between two types of herd behavior: *spurious herding* and *intentional herding*. *Spurious herding* occurs when individuals make similar decisions due to

sharing similar information sets and responding to changes in circumstances in similar manners. On the other hand, *Intentional herding* refers to individuals deliberately imitating the actions of others. This paper will specifically focus on *Intentional herding* since understanding the underlying motivations and decision-making processes behind intentional imitation allows for targeted interventions and strategies to mitigate the negative effects of herd behavior.

2.2.2 Reasons for Engaging in Herd Behavior

Understanding the reasons behind why individuals engage in herd behavior is crucial to comprehending its occurrence. However, the reason for herding among economists is subject to debate, with varying viewpoints on its rationality. Some economists see herding as a rational phenomenon while others attribute it to be irrational behavior. One of the key circumstances that lead individuals to rationally engage in herd behavior is when they believe the crowd to be better informed than they are (Baddeley, Curtis & Wood, 2004). In this case, Individuals will incorporate the herd's opinions into their prior information set leading to the emergence of herding tendencies.

Moreover, Scharfstein and Stein (1990) propose that in uncertain situations, managers might disregard their private information and instead choose to follow the herd to protect their reputation. Any negative consequences resulting from the decision are then shared among managers. This perspective suggests that herding can be seen as a form of insurance against underperformance for managers (Rajan, 2006). In this case, the behavior can be considered rational, however by ignoring private information, it may lead to inefficient outcomes.

Other economic literature suggests that herd behavior may irrationally arise from psychological stimuli and constraints, such as social pressure or conformity to social norms. Keynes (1936), for example, offers such a compelling perspective, suggesting that herd behavior is influenced by sociological factors. According to Keynes, individuals may engage in herding when they are concerned about how others will perceive their ability to make sound judgments.

Understanding the reasons behind herd behavior is crucial, although it is subject to debate in the literature. These previously mentioned reasons, only conclude a small scope of the literature on why herding occurs. However, this general understanding of why the phenomenon may occur helps in comprehending the concept, which is necessary to eliminate the effect of herding bias.

2.2.3 Consequences of Herd Behavior

Apart from protecting reputations and earning social validation, herd behavior can offer various other potential advantages. For instance, governments could encourage herd behavior as a means of nudging the population to behave in a more desirable way (Benartzi, 2017). Policymakers can shape societal behavior by using social norms and collective behavior to influence them to align with broader objectives and aspirations. Herding can also be beneficial when the costs of acquiring information are

high (Ali, 2018). For example, an individual might opt to choose the same health insurance plan as a coworker, when it is costly to learn more about these plans (Sorenson, 2006).

However, herd behavior is popularly known to have more drawbacks than benefits. As previously mentioned, inefficiencies tend to arise because individuals ignore crucial private information when blindly following the herd (Banerjee, 1992). This can among other things stagnate innovation, as it may discourage independent analysis and critical thinking. Herding is especially harmful, when the consensus opinion is based on other objectives and/or incomplete or inaccurate information (Baddeley, 2013). Herd behavior can also lead to market bubbles, where asset prices do not reflect their underlying value, which potentially can result in market crashes (Bekiros, Jlassi, Lucey, Naoui, & Uddin, 2017). Thus, herd behavior can amplify market volatility and contribute to inefficient market pricing. In addition, similarly to how the government can nudge the population to adopt a desirable behavior, companies can manage cues to improve purchases and create value, therefore misleading their customers (Ding & Li, 2019).

2.2.4 Real-Life Cases Caused by Herding

In the following part, real-life case studies will be examined that illustrate the detrimental economic consequences of herd behavior. These examples provide insights into how following the crowd can lead to market bubbles, financial crises, and inefficient resource allocation.

The first documented occurrence of a market bubble caused by herd behavior is the *Tulip Mania*, a tulip bulb trading frenzy that occurred during the Dutch Golden Age as a result of herd investing. Tulips, when newly introduced, became highly sought-after luxury items among the Dutch elite, driving their prices to extraordinary heights. With the professional traders and even the general population joining in the speculation. However, the bubble eventually burst, causing significant losses for investors. One year later, the tulip bulb prices had returned to normal, illustrating the consequences of speculative and herd behavior. (Xu, 2023)

A more modern case is the dotcom bubble of the late 1990s and early 2000s. With the introduction of the World Wide Web, the dotcom companies experienced exponential growth, attracting significant capital and investor enthusiasm. The investors disregarded the lack of solid business plans and profits. The market became inflated, with exaggerated valuations and unrealistic forecasts. However, when investors realized the unsustainable nature of these investments, the bubble burst, causing significant financial losses. (Patterson & Sharma, 2007)

In these two examples, the bursting of the market bubbles only caused the investors to lose money, without detrimental consequences for the financial systems. However, when a bigger market bursts it can potentially cause a financial crisis.

The global financial crisis of 2008 was among other things caused by herd behavior in the housing market. During the so-called housing boom, investors and financial institutions shared a collective belief that housing prices would rise indefinitely. Which resulted in financial institutions behaving in risky lending practices and them disregarding the quality of mortgage loans. However, when the housing market eventually declined, the market rates began to rise. This pushed investors to rapidly sell their properties, causing asset prices to decrease and confidence in the financial system to be lost. This crisis had deteriorating consequences, for instance, bank failures, stock market declines, and a worldwide economic downturn. (Hott, 2012)

As illustrated, Herd behavior has been having negative consequences since at least the 17th century. These real-life case studies illustrate how following the crowd can lead to market bubbles, which when they burst can in the most extreme cases lead to financial crises. These examples show the importance of caution and independent thinking to mitigate the risks associated with herd behavior.

2.2.5 Eliciting Herd Behavior

To be able to research herd behavior in an experimental setting, it is crucial to elicit it effectively. Previous research has successfully elicited herd behavior by providing information on the behavior of others in various settings. For instance, when making online book purchases, selecting insurance, or deciding on a retirement savings plan (Chen, 2008; Liu, 2015**;** Compen et al., 2022). Looking specifically at retirement savings decisions, herd behavior has been induced by using peer information interventions (Compen et al., 2022). Typically, this peer information intervention involves mentioning the preferred option chosen by others and the corresponding percentage of individuals who opted for it.

However, Beshears, Choi, Laibson, Madrian, and Milkman (2015) had deviating results when using a peer information intervention in this format. They found that when employees were provided with information about the high savings rates of their colleagues, individuals with lower savings deviated from the peer norm and decreased their savings. This outcome was attributed to the discouragement experienced by low-income employees upon realizing that higher-income individuals tended to have higher savings rates. To address this potential issue, an anonymous peer information intervention is incorporated into the experimental design in this paper. By ensuring anonymity, the aim is to minimize any discouragement that may arise from income-based comparisons. Participants will receive peer information without specific identification, thereby reducing the impact of income disparities and personal comparison, allowing them to solely focus on the informative aspects of the peer data.

Additionally, Compen et al. (2022) conducted research to determine the most effective percentage of peer information in eliciting herding behavior. Their findings revealed that the range of 50-89% successfully triggered herd behavior, with the highest effectiveness observed within the 70-89% range. This research will focus on provoking herd behavior based on the findings mentioned. Thus, it is

expected that herd behavior can be elicited in the same way, which leads to the first hypothesis of this paper:

Hypothesis 1 (H1): Disclosing peer information induces herd behavior, leading individuals to choose the most popular retirement savings plan more frequently.

2.3 Debiasing: Countering Herd Behavior

As previously explained, herd behavior, referring to individuals imitating the actions of others, in economic and financial decision making presents significant challenges. The following subchapter focuses on debiasing to address herd behavior and mitigate its negative consequences.

2.3.1 Debiasing and Techniques

Debiasing refers to the process of reducing or eliminating the influence of cognitive biases and irrational tendencies in decision making. It involves identifying and mitigating biases that can distort judgment and lead to suboptimal outcomes. The general goal of debiasing is to improve decision making quality, enhance accuracy, and reduce the influence of cognitive shortcuts or social pressures that can lead to errors or irrational behavior. (Larrick, 2004)

Over the years several effective debiasing techniques have been identified. Soll, Milkman, and Payne (2015) have divided these techniques into two separate categories, according to them you can either modify the environment or modify the decision maker. Modifying the environment can be done by providing incentives or changing the choice architecture. Modifying the decision maker can be achieved by educating, using cognitive strategies, or by making the decision makers base their answers on specific models. This paper will focus on modifying the decision maker through education. Fischhoff (1982) described four debiasing techniques, varying in intensity and effort required, which can be viewed as educational tools for decision makers. These techniques include: (1) presenting a warning message about the potential for bias; (2) providing a description of the specific bias and its direction; (3) providing personalized feedback on the individual's behavior; and (4) participating in an extensive training program.

The debiasing technique used in this paper will be a warning message. The main reason for using a warning message over any of the other techniques mentioned is firstly the ease of implementation. Secondly, because of how time-and-cost effective it is, especially compared to the extensive training technique. And even though a simple warning message might be less effective than any other technique, it can potentially improve the decision making of several individuals without any major disadvantages. Thus, when initially addressing a new bias, it may be intuitive to begin by testing the effectiveness of a straightforward technique, such as implementing a warning message. If the desired results are not

achieved, then it becomes necessary to progress towards more intensive or demanding debiasing techniques.

2.3.2 Warning Message

Several researchers have tried to reduce the influence of cognitive biases by warning decision makers about the possibility of biases distorting their answers, some less successful than others. For example, by using a warning message, the influence of overconfidence, hindsight bias, the outcome effect, and the framing effect has been effectively decreased (Block & Harper, 1991; Reimers & Butler, 1992; Clarkson, Emby, & Watt, 2002; Cheng & Wu, 2010). While others have been unsuccessful to debias the anchoring and adjustment bias and herding bias using a similar method (George, Duffy & Ahuja, 2000; Compen, et al., 2022). This paper proposes a possible reason for the discrepancies in the studies focusing on the debiasing effect of warnings.

The difference between these two groups of studies can be found in the timing of the provision of the warning message. All discussed studies that effectively mitigated the bias, warned the participants before they initially made a decision. While the other authors warned their subjects after they had already made their initial decision, allowing them to revise their answer after being warned. Possible explanations for why the timing would matter are the anchoring and adjustment bias and the choice-supportive bias (Tversky and Kahneman, 1974; Lind, Visentini, Mäntylä, & Del Missier, 2017).

The anchoring and adjustment bias refers to individuals anchoring to an initial piece of information when making a choice and adjusting based on that anchor (Tversky & Kahneman, 1974). This bias can cause individuals to be strongly influenced by an anchor and fail to adequately adjust their choices. In the context of retirement savings decisions, the respondents' initial choice may act as an anchor that is not properly adjusted in response to a warning message provided after the choice is made.

Similarly, the choice-supportive bias leads individuals to remember and emphasize the positive aspects of their choices while downplaying the negatives (Lind, Visentini, Mäntylä, & Del Missier, 2019). This bias can cause individuals to perceive their initial choice as more favorable and resist changing it, even when presented with a warning message.

Hence, these biases can collectively or independently lead to the limited effectiveness of a warning message when it is provided after an initial choice is made. Based on this, the second hypothesis of the study is proposed:

Hypothesis 2 (H2): Providing the warning message before choosing a retirement savings plan is more effective in reducing herd behavior compared to providing it after the initial choice is made.

2.3.3 Timing of the Warning Message

The current literature lacks research on the timing of debiasing techniques, particularly concerning the provision of information, which can be regarded as offering advice. Therefore, it is crucial to broaden the scope of the literature search to address this area and extend the novelty of this study. In the research conducted by Rader, Soll, and Larrick (2015), they explored the timing of advice provision and identified a phenomenon known as the *push-away effect.* This effect describes participants' tendency to choose an estimate far away from the advice given, only when the advice is provided before making an initial choice. However, this push-away is not expected to be found in this research, as it stems from overconfidence, while individuals in our context are likely to feel less informed than the crowd. Except for this single article, there is a research gap regarding the optimal timing for providing (financial) advice (Kämmer et al., 2023).

2.3.4 Design of the Warning Message

While timing offers a plausible explanation for the utilization of a message, other factors can also influence its effectiveness. One such factor is the design of the experiment, including the contents and prompt of the warning message. George, Duffy, and Ahuja (2000) first studied the design of a warning message, they found that simply instructing or warning the respondent about the potential of the bias effect was only weakly effective, while a strongly worded message had significant results. This has been further investigated by Cheng and Wu (2010), who have found a *weak* warning message to be less effective than a *strong* one. Where the weak message warned the respondents about the potential bias and asked the respondents to be conscious of its influence. The strong message explained the potential bias and aimed to urge the participants to reflect on the information provided. Therefore, an effective warning message should be of similar intent to the strong message described.

Chapter 3: Methodology

3.1 Data

The research question of this study aims to examine the impact of the timing of a warning message on mitigating herd behavior in the decision-making process of selecting a retirement savings plan. To address this research question, primary data was collected through an experimental approach using a questionnaire.

3.1.1 Experimental Design

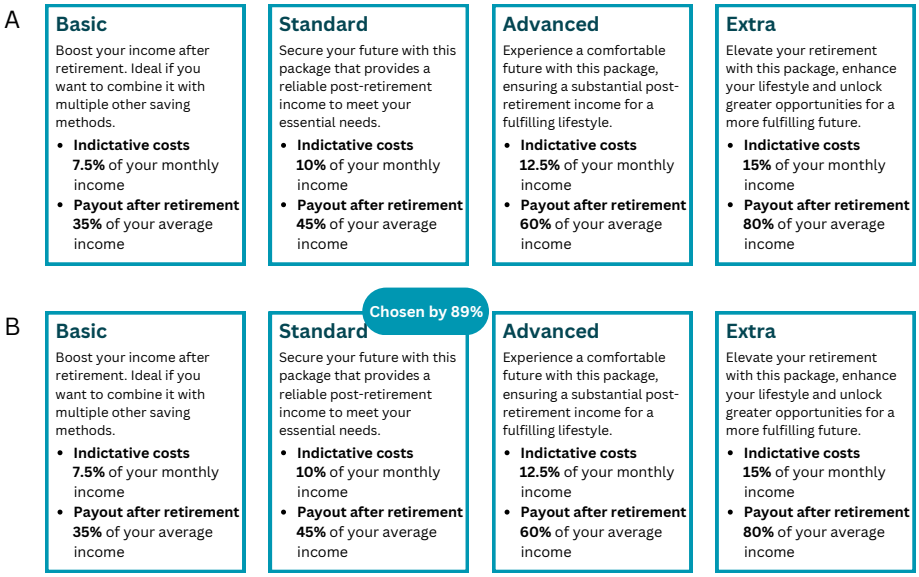
The experimental design of this study, inspired by the research conducted by Compen et al. (2022), involved presenting participants with four retirement savings plans. Before the retirement savings options were presented, the participants were asked to answer some demographical questions regarding their age, gender, ethnicity, highest education level (either attained or currently working on), employment status, and monthly gross income.

The second part of the survey focused on two treatments: (1) the peer information intervention, and (2) the timing of the warning message. The experiment consisted of three treatment groups: the control group, the ex-post experimental group, and the ex-ante experimental group. The participants were randomly allocated to one of these three groups when starting the survey.

The goal of the peer information intervention was to elicit herd behavior. The peer information intervention, which takes the form of "Chosen by 89%" as inspired by Compen et al. (2022), is visually represented in Figure 1. This percentage was determined based on the findings of Compen et al. (2022) regarding the effective elicitation of herd behavior. The retirement savings plan options, as reflected in Figure 1, were loosely based on a basic cumulative interest rate calculation adjusted downward to reflect the current risks more accurately. The plans contained details regarding the monthly contributions and the post-retirement payouts.

Figure 1

Peer information Intervention



Note. Row A shows the options as how they were presented to the respondents in the control group. Row B shows the options presented to the experimental groups, including the peer information intervention for the Standard option.

The timing of the warning message differed between the ex-post and ex-ante experimental group, with the former receiving the warning message after their initial choice and the latter being exposed to the message simultaneously with the options. The control group, on the other hand, did not receive any peer information or a warning message. The warning message used in this study followed the format of the strong message employed by Cheng and Wu (2010) and stated "Warning! The peer information presented above may affect your preference towards the plan. Thus, please be aware that the peer information may have influenced your final judgment." in bold lettering.

An overview of the differences between the treatment groups is visualized in Figure 2. In summary, the control group made their choice without any peer information intervention or warning message. The ex-ante experimental group received the choice set, which included both the peer information intervention and the warning message simultaneously, before making their choice. On the other hand, the ex-post experimental group made their initial choice after receiving the choice set with peer information. Following their initial choice, they received a warning message and then proceeded to make their final choice.

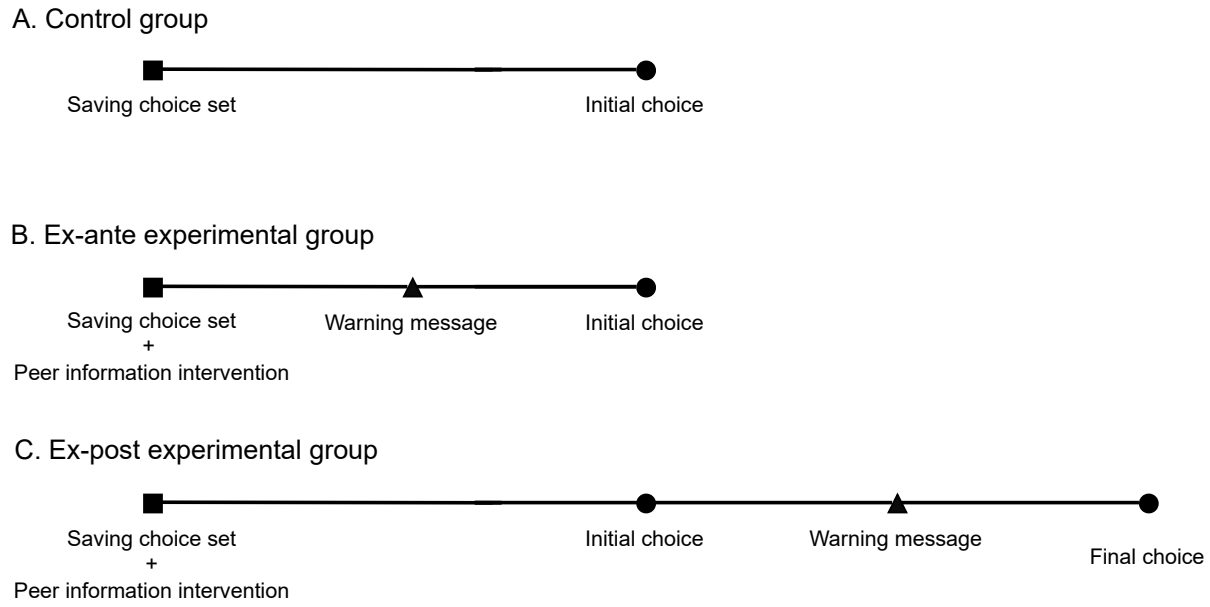


Figure 2

Overview of the Experimental Design per Condition

3.1.2 Participants

The sample contained a total of 192 participants, who were recruited through the distribution of anonymous links using convenience sampling. The participants were evenly distributed among the three groups, with each group comprising 64 participants. Table 1 presents the average characteristics of the participants, divided by treatment group. From the descriptive statistics, it can be observed that the average age of participants in the overall sample is 32. Ethnic groups with 5 or fewer observations were included in the "Other or preferred not to say" group, ethnic groups included in this subgroup are the "Black or African" group and the "Middle Eastern or Arab" group. This is done to simplify the analysis, improve statistical robustness, and reduce the impact of potential imbalances caused by small numbers. However, doing this introduces potential limitations, for example, detailed information could be lost and important variations within the data could be obscured.

Table 1

Descriptive statistics

Characteristics	Control (1)	Ex-post (2)	Ex-ante (3)	Full Sample (4)
Age	33.656 [13.267]	32.172 [14.953]	32.438 [15.664]	32.755 [14.599]
Gender				
Female	0.609	0.516	0.641	0.589
Ethnicity				
White	0.859	0.812	0.750	0.807
Asian	0.062	0.062	0.094	0.073
Mixed	0.031	0.031	0.078	0.047
Other or preferred not to say	0.047	0.094	0.078	0.073
Monthly Gross Income				
Less than €1,000	0.312	0.328	0.312	0.318
€1,000 - €2,500	0.219	0.234	0.312	0.255
€2,500 - €4,000	0.203	0.234	0.172	0.203
€4,000 - €5,500	0.125	0.094	0.094	0.104
More than €5,500	0.141	0.109	0.109	0.120
Employed	0.703	0.594	0.656	0.651
Higher Education	0.672	0.641	0.625	0.646
Number of observations	64	64	64	192

Note. The table displays the average characteristics of 192 participants (64 for each condition) with column 1 representing the control group, column 2 the ex-post experimental group, and column 3 the ex-ante experimental group. Column 4 shows the average characteristics of the entire sample. All variables, except for *Age*, are presented as dummy variables, indicating the proportion of participants that align with the variable category (e.g., *Employed* = 0.651, indicating that 65.1% of the sample is currently employed, including those who are self-employed. The variable *Higher Education* represents the proportion of participants that are currently working on or already obtained a bachelor's degree (HBO or WO). The standard deviations are indicated in parentheses.

Figure 3 displays the proportion of participants that chose the herded option. Where the herded option is defined as the plan with the peer information intervention attached to it, hence the "Standard package". In the control option, thus without any manipulations, the herded option was chosen one out of four times, which is proportionate as there are four plans in total.

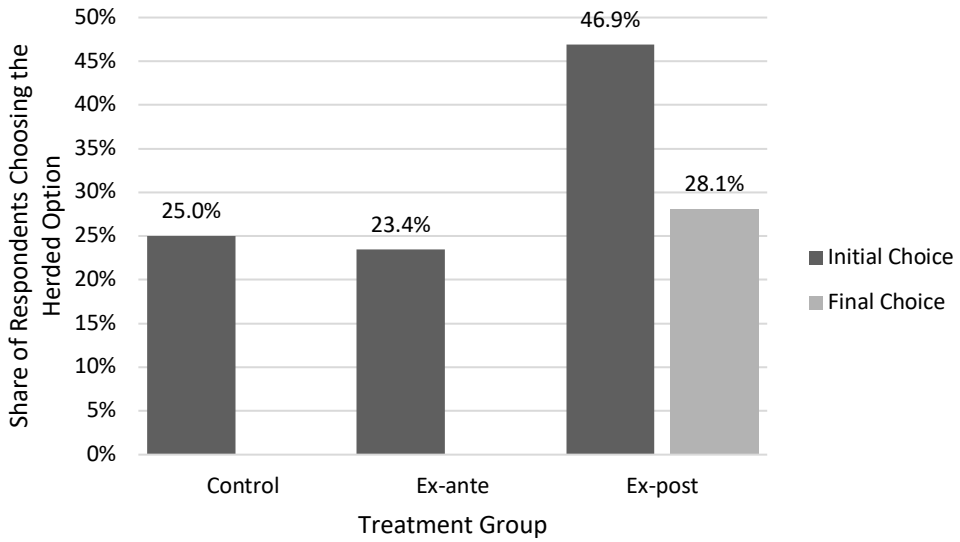


Figure 3

Share of Respondents Choosing the Herded Option per Treatment Group

Note. N = 192, n = 64 per group. For the Ex-post experimental group, the left bar (dark gray) reflects the initial choice, made before being warned and the right bar (left gray) reflects the final choice, made after warning.

3.2 Methods

3.2.1 Sample Composition Analysis

To ensure the validity of the statistical tests conducted to investigate the hypotheses, it is crucial to assess the success of randomization. This was accomplished by conducting a balance test, which compared the characteristics across different groups. Multiple independent t-tests were conducted to examine whether the means of each characteristic differed significantly among the groups. Specifically, the means of the demographic characteristics of the control group were compared to those of the ex-post experimental group, which is relevant to the first hypothesis. Additionally, a comparison was made between the ex-post experimental group and the ex-ante experimental group, which is essential for the second hypothesis. For completeness, the control group was also compared to the ex-ante experimental group. These sample composition analysis tests provide valuable insights into the comparability of participant demographics across the experimental groups. If the groups are balanced as expected, it provides greater confidence that the later observed differences in the outcome variables are attributable to the treatments, rather than pre-existing differences between groups.

3.2.2 Hypotheses Testing

To investigate the effectiveness of the peer information intervention in inducing herd behavior and the effect of the timing of a warning message on debiasing herd behavior, firstly two binary logistic regression models were employed and secondly, an additional McNemar's chi-test was conducted. The resulting odds ratios from the logit models provided insights into the effects of the provision of peer information and the timing of the warning message on the respondents' preference for the option with the peer information. By examining the odds ratios, insight was gained into how these factors influenced the likelihood of selecting the herded option in comparison to the alternatives.

The assumptions for using logit models are likely to hold for the comparisons between groups. The first assumption states that the dependent variable should be binary (Moore, McCabe, Alwan, & Craig, 2016). Which in the two following models is *Herded Option*, which was created to indicate whether the participant chose the option containing peer information, assigned a value of 1 if chosen and 0 otherwise. Furthermore, the independence of observations assumption assumes that the observations in the dataset are independent of each other. This is likely to hold as the survey was distributed through anonymous links and it was encouraged to take the survey independently and only one observation per participant was used.

The first logit model was used to investigate the first hypothesis stating that including the peer information intervention induces herd behavior. The treatment in this model, *Peer Information*, represents whether the participant was exposed to the peer information intervention, assigned a value of 1 for exposed and 0 otherwise. The choices made by participants in the control group, thus with no peer information, are compared to the initial choices made by the ex-post experimental group, after peer information but before the warning. This comparison will allow for analyzing the effect of the peer information intervention on choosing the herded option. The logistic regression model was estimated using the following equation, where the error term is denoted by ε:

$$Herded\ option = \beta_0 + \beta_1 Peer\ Information + \varepsilon$$

Assuming the hypothesis is correct, it is expected that the *Peer Information* coefficient is significant and positive. This will be tested using the null hypothesis of no significant relationship between receiving peer information and choosing the herded option. Which is represented in the following:

$$H_0: \beta_1 = 0 \qquad \text{vs.} \qquad H_a: \beta_1 > 0$$

Additionally, another logit model was used to test the second hypothesis, stating that providing a warning message before making an initial choice is more effective in mitigating herd behavior, than

providing it afterwards. The dependent variable again being *Herded Option*, reflects whether the herded option was chosen over an alternative. The independent or treatment variable, *Timing*, is the timing variable taking value 1 if the warning message was received before making an initial decision and 0 if the warning was received afterwards. The final answers of the ex-post experimental group were compared to the answers of the ex-ante experimental group. Concluding the following estimation of the logit model, wherein the error term is again denoted as ε:

$$Herded\ option = \beta_0 + \beta_1 Timing + \varepsilon$$

In line with the hypothesis, it is expected that the coefficient of *Timing* is negative, meaning that the before warning decreased the frequency of the herded option chosen more than the after warning. Therefore, the null hypothesis states that there is no difference in the frequency of choosing the herded option based on the timing of the warning message provided. More specifically, the following hypothesis was tested:

$$H_0: \beta_1 = 0 \qquad \text{vs.} \qquad H_a: \beta_1 < 0$$

Furthermore, the effectiveness of providing the warning message after the initial choice was made was evaluated, to assess its impact on mitigating herd behavior in the ex-post experimental group. When using a logistic regression model, the independence of observations assumption should hold. However, to analyze the effectiveness of the warning provided afterwards, the initial choice of the participants would be compared to the final choice of the same group of participants. Thus, repeated measures of the same participants will be compared, which violates the independence of observations assumption. Therefore, the logistic regression model is not ideal in this scenario.

An alternative test is the McNemar's chi-test, which does allow for the analysis of paired binary data. Another, advantage of this test is that it is robust even for small sample sizes, which is ideal as only the answers of the ex-post experimental group were analyzed. (Fisher, Marshall, & Mitchell, 2011)

The McNemar's test examines whether there is a significant change in the distribution of responses before and after participants receive a warning message. The categorical dependent variable is the retirement savings choice, with two categories: the herded option and the non-herded option chosen. The independent variable is the warning message, where the initial choice was compared to the final choice, thus before versus after receiving the warning.

The assumptions for this test are likely to hold as there is a categorical dependent variable with two categories and one categorical independent variable with two observations. Additionally, the two retirement savings options, herded and non-herded, were mutually exclusive, meaning that the

participants were only able to select one option. Furthermore, each participant made a retirement savings choice twice, satisfying the assumption of dependent responses.

Table 2 shows a summary of the paired responses, presenting the frequencies of participants who made specific choices before and after receiving the warning message. This contingency table equals the input for the McNemar's test.

Table 2

Contingency table: Before and After Warning

	After Warning Message		
Before Warning Message	**Herded**	**Non-Herded**	**Total**
Herded	18	12	30
Non-herded	0	34	34
Total	18	46	64

Note. The table shows the paired choices of 64 participants before and after they received a warning message. Herded reflects that the herded retirement savings plan was chosen and non-herded means an alternative was chosen. The (Herded, Non-Herded) cell means that the participant chose the herded option before and changed their answer after the warning.

It is expected that the herded option was chosen less after the warning message was received. Consequently, this McNemar's chi-test aims to test the following null hypothesis: no difference in the change of the distribution of the paired choices before and after receiving the warning message. The alternative hypothesis proposes a significant positive difference in the proportion of discordant pairs before and after the treatment, indicating that fewer participants chose the herded option after receiving the warning.

The conducted statistical analyses help answer the research question regarding the extent to which the timing of a warning message affects the ability to debias herd behavior in the context of choosing a retirement savings plan. By first analyzing the effects of the peer information intervention on herd behavior, it can be investigated if herd behavior can be provoked and observed in retirement savings decisions. Moreover, the attempt to debias this provoked herd behavior, using manipulated timings helped answer the research question by analyzing the effect of timing. Additionally, the extra test to study the efficiency of the warning message provided afterwards helps strengthen the previous analyses focusing on timing. These tests provided a careful analysis that directly addressed the research question and contributed to a better understanding of the impact of timing on herd behavior in the context of retirement savings plan choices.

Chapter 4: Results

4.1 Balance Test

To assess the effectiveness of randomization, independent t-tests were conducted to examine the comparability of participants across the three treatment groups. Table 1 presents the means of various characteristics for each group. Subsequently, Table 3 displays the differences between these means and indicates the significance of each pairwise comparison. Table 3 shows that all differences were found to be statistically insignificant, suggesting that randomization was successful in achieving group comparability. Consequently, the concern of the results being compromised by underlying differences is minimized.

Table 3

Assessing Balance, independent t-tests

	Control vs. Ex-post (1)	Control vs. Ex-ante (2)	Ex-post vs. Ex-ante (3)
Age	-1.484	-1.219	-0.266
	(0.554)	(0.636)	(0.922)
Gender			
Female	-0.094	0.031	-1.125
Ethnicity			
White	-0.047	-0.109	0.062
Asian	0.000	0.031	-0.031
Mixed	0.000	0.047	-0.047
Other or preferred not to say	0.047	0.031	0.016
Monthly Gross Income			
Less than €1,000	0.016	0.000	0.016
€1,000 - €2,500	0.016	0.094	-0.078
€2,500 - €4,000	0.031	-0.031	0.062
€4,000 - €5,500	-0.031	-0.031	0.000
More than €5,500	-0.031	-0.031	0.000
Employed	-0.109	-0.047	-0.062
Higher Education	-0.031	-0.047	0.016

Note. The table compares the average characteristics of participants in different treatment groups with each other, using independent t-tests. Column 1 compares the characteristics of the control group and the ex-post experimental group. Column 2 compares the control group with the ex-ante experimental group. And column 3 compares the two experimental groups. Thus, each comparison consists of 128 participants. The standard deviations are indicated in the brackets. *P<0.10; **P<0.05; ***P<0.01.

4.2 Eliciting Herd Behavior (H1)

The logistic regression results presented in Table 4 assess the impact of disclosing peer information on herd behavior, specifically the frequency of choosing the herded option in the context of retirement savings plans. Hypothesis 1 (H1) suggests that disclosing peer information induces herd behavior, leading individuals to choose the most popular retirement savings plan more frequently when being exposed to peer information. Figure 3 provides preliminary support for H1, as it shows that when participants received the peer information intervention, the herded option was chosen over 20% more often compared to when no peer information was provided. To further investigate this relationship, a binary logistic regression model was created, which is represented in Table 4. With the independent variable being a binary variable measuring whether peer information was provided and the dependent binary variable measuring if the herded option was chosen.

The results in Table 4 reveal that the coefficient of the peer information intervention is 0.973 and is significant against the 5% significance level. Thus, this model shows that the peer information intervention increased the frequency that the herded option was chosen. The corresponding odds ratio is equal to 2.646. This means that the likelihood of choosing the herded option is 2.646 times higher when being presented with the peer information intervention, compared to when not being exposed to it. Based on the data, receiving peer information comes with an expected increase between 23 to 470% in the odds of choosing the herded option. Based on this analysis of the data, the null hypothesis that disclosing peer information does not induce herd behavior is rejected. These findings support the first hypothesis that disclosing peer information causes participants to choose the herded option.

Table 4

Logit model: Effectiveness of Peer Information Intervention on Choosing the Herded Option

Variables	**β**	**SE β**	e^{β} **(odds ratio)**
Peer information	0.973**	0.382	2.647
Constant	-1.097***	0.333	NA
Pseudo R^2	0.040		
N	128		
x^2	6.440		
P > x^2	0.011		

Note. The dependent variable is a binary variable that indicates 1 if the herded option is chosen and 0 if an alternative is chosen. The Independent variable *Peer Information* is 1 for the ex-post experimental group, that received peer information and 0 for the control group that did not receive the peer information intervention. NA means not applicable. **P*<0.10; ***P*<0.05; ****P*<0.01.

4.3 Timing Warning Message (H2)

Another logistic regression analysis was conducted to test the second hypothesis, which predicted that providing the warning message before would be more effective in reducing the frequency of choosing the herded option compared to providing the warning message afterwards. The dependent variable in the analysis was the binary variable indicating whether the herded option was chosen. The independent variable was a binary variable indicating the timing of the warning message relative to the first choice, coded as 1 for before and 0 for after. The results of this analysis, displayed in Table 5, show that the coefficient for the timing variable was estimated to be -0.246, which indicates a negative relationship between receiving the warning message beforehand and the likelihood of choosing the herded option, which is in line with the second hypothesis. However, the coefficient for the timing variable was not statistically significant at the 5% level. This lack of significance indicates insufficient evidence to support the second hypothesis. Although the coefficient is in line with the alternative hypothesis, we cannot reject the null hypothesis of no differences in timing due to the nonsignificant results.

Table 5

Logit model: Effectiveness Timing Warning Message

Variables	β	SE β	e^{β} (odds ratio)
Timing	-0.246	0.405	0.782
Constant	-0.938***	0.278	NA
Pseudo R^2	0.0025		
N	128		
x^2	0.370		
P > x^2	0.003		

Note. The dependent variable is a binary variable that indicates 1 if the herded option is chosen and 0 if an alternative is chosen. The Independent variable *Timing* is 1 for the ex-ante experimental group, which received the warning before making a choice, and 0 for the ex-post experimental group which received the warning after making an initial choice. NA means not applicable. **P*<0.10; ***P*<0.05; ****P*<0.01.

However, these results do not make any inference about the effectiveness of the warning messages. Consequently, a McNemar's chi-test was conducted to analyze the effectiveness of the warning message for the ex-post experimental group. The McNemar's test analyzes whether there is a significant change in the distribution of responses before and after receiving a warning message. Thus, it is tested if the warning message caused participants to move away from the herded option. The dependent variable in this test is the retirement savings plan choice, comparing the frequency of the herded option chosen

with the frequency of the non-herded option chosen. The contingency table (table 2) presents the variables and frequencies used in the test.

The results in Table 6 indicate that the McNemar's test statistic is 0.188 with 1 degree of freedom. The coefficient is statistically significant at the 5% significance level, suggesting a significant difference in choices before and after the warning. Thus, the warning message had a significant impact on whether participants chose the herded option over the alternatives. These findings provide evidence that the warning message influenced participants' choices, leading to a notable shift away from the herded option. The results highlight the effectiveness of providing the warning message after making an initial choice in debiasing herd behavior.

Table 6

McNemar's Chi-test: Before and After Warning

Test Statistic	Degrees of Freedom	P-value
0.188	1	0.000

Note. This table presents the results of the McNemar's Chi-square test conducted to analyze the relationship between choices made before and after the warning message intervention. The table provides the test statistic, degrees of freedom, and the corresponding p-value.

Chapter 5: Discussion and Conclusion

5.1 Discussion Results

This paper aimed to effectively elicit herd behavior and then tried to mitigate the herd behavior using a warning message at different timings in the context of retirement savings decisions. First, an attempt to elicit herd behavior was made by using a peer information intervention. Then this elicited herd behavior was attempted to be debiased using a warning message. The warning message was provided before making an initial choice and after making the initial choice, depending on the participant's treatment group.

After analyzing the results, it was concluded that herd behavior was effectively elicited, which matches the expectations and previous research by Compen et al. (2022). Thus, the first hypothesis of this study is accepted. Meaning that herd behavior can be effectively provoked by providing peer information in the context of retirement savings decisions.

However, the initial analysis did not support the second hypothesis, which proposed that providing the warning message before making an initial choice is more effective in mitigating herd behavior compared to providing it afterwards. Nevertheless, further analysis revealed that the after-warning message was indeed effective in decreasing the herding bias. This finding contradicts the results reported by Compen et al. (2022), where providing the warning message after was not found to be effective. It is possible that the adjustments made in this study, such as changing the prompt of the warning message and the choice options, contributed to this discrepancy.

Considering that the after-warning message was effective and there was no significant difference observed between the two timings, it suggests that both warnings were effective in reducing herd behavior. Additionally, it is worth noting that there is a suspicion that the before-warning message may potentially be more effective. This suspicion arises from the negative coefficient observed in the difference between the before and after timings in terms of the amount of herding (as shown in Table 5). Although this difference was not statistically significant, it indicates that the before-warning did decrease herd behavior in this sample. The reason for the lack of significance could be attributed to the small sample size and the popularity of the herded option, even in the control group. For instance, the control group chose the herded option 16 times, the ex-ante group initially chose it 30 times and 18 times after receiving the warning, while the before group chose it 15 times. This suggests that the before-warning message was effective in decreasing herd behavior but may not have had the opportunity to distinguish itself from the other conditions, due to the small sample size and the popularity of the herded option even in the control group. However, this is just speculation and cannot be tested using the data from this experiment.

5.2 Limitations

This research has multiple limitations that should be solved or controlled for in further research. First of all, the experimental design has several limitations. For instance, the participants had no incentive to accurately consider the options presented and to choose the one most accurately reflecting their preferences. Which similar DSS research was oppositely able to achieve (George et al., 2000; Compen et al., 2022). Additionally, the ex-post experimental group made two choices, while the ex-ante and control group only made one initial choice. This makes the comparability of the two groups questionable. Thus, the answers of both groups might not be fully comparable. However, it was thought to be confusing for the participants to be asked if they wanted to reevaluate their answer, without any changes in the set.

Besides there are some limitations due to time and funding constraints. For example, the sample size is small which might have affected the statistical power and the ability to detect small effects. As discussed earlier, having a bigger sample size potentially could have made sure to get significant results for the difference between the timing of the warning message. Moreover, the sample was obtained through convenience sampling, thus the composition of the groups likely does not reflect the population accurately. The excluded individuals might have traits that cause them to respond differently to the treatments, thus limiting the generalizability of the results. The generalizability is also limited due to the treatments and the context being very specific. Thus, these results might not be directly usable by policymakers or administrators.

5.3 Implications

Nevertheless, the results can provide policymakers or administrators with a general idea of how herd behavior can be provoked and mitigated. The findings can inform policymakers, employers, and retirement plan administrators on effective strategies to encourage individuals to make informed decisions about their retirement savings or even other personal finance decisions. Understanding the effects of warning messages can help design interventions and communication strategies that effectively address herd behavior and improve retirement outcomes. This knowledge can potentially enhance the design and implementation of retirement savings plans, such as providing more timely and targeted warnings or educational materials to participants. While the study focuses specifically on retirement savings plans, the insights can be generalized to other contexts, for example, consumer behavior or public policy interventions. For instance, the government could use warning messages to encourage people to make informed and individual decisions.

Other implications are of academic or theoretical nature. The suspected effect of the timing of a debiasing technique has not been studied in this context before. Researchers can further analyze the

timing. And if found significant, timing can be incorporated into several experimental designs that aim to debias or even change the participant's behavior. Which can prove to be useful in research focusing on behavioral sciences.
To summarize, warning messages could be used in several settings to nudge individuals to make more efficient choices. And even though further research is required, the timing of the warning message can also be incorporated in various situations.

5.4 Further Research Directions

Further research could focus on fixing the limitations of this research**.** For example, a DSS could be used instead so that the participants consist of individuals who are actively looking for a retirement savings plan. This would make their answers more reliable and making the results more accurate in reflecting real-life decisions. To solve the problem of lacking comparability due to only one group being asked to reevaluate their answer, another condition could be added. In this condition, participants would not receive a warning message, but they would still have the opportunity to change their initial answer. By including this condition, the isolated impact of the warning message could have been assessed, separate from the combined effect of offering the opportunity to change the decision and the warning message. New research should also focus on obtaining a larger sample that more accurately reflects the general population.

In addition to solving the limitations, similar research could also focus on other contexts outside of personal finance, to analyze if herd behavior is also observed and if it is possible to debias. More research should focus on the circumstances that affect the effectiveness of debiasing techniques like the warning message, for example, the design of the debiasing technique like timing and prompt, or what characteristics of individuals affect debiasing. These implications could help designing the most efficient debiasing techniques.

5.5 Conclusion

In conclusion, this thesis investigated how the timing of a warning message impacts herd behavior in the decision making process of selecting a retirement savings plan. The findings revealed that peer information influenced individuals' decisions and led to herd behavior. However, the study did not find a significant difference in the effectiveness of debiasing herd behavior between providing the warning message before or after making an initial choice. It is worth noting that this study might not have captured the potential efficiency of the warning before due to its limitations, as discussed earlier.

The implications of this research are relevant to both theoretical and practical domains. While this study has certain limitations, it serves as a starting point for future research to explore the role of timing and other interventions in various decision making contexts.

By shedding light on the factors that influence herd behavior and the potential effectiveness of interventions, this research aims to promote more independent and informed decision making, benefiting individuals, financial institutions, and policymakers. Overall, the study did not find a significant difference in debiasing herd behavior between the two timings investigated, but it lays the groundwork for further investigation into this area.

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