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Linda Hirt-Schierbaum
Maryna Ivets

You *Can* Win by Losing! Using Self-Betting as a Commitment Device: Evidence from a Weight Loss Program

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#881

Imprint

Ruhr Economic Papers

Published by

RWI – Leibniz-Institut für Wirtschaftsforschung
Hohenzollernstr. 1-3, 45128 Essen, Germany

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Ruhr Economic Papers #881

Responsible Editor: Wolfgang Leininger

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ISSN 1864-4872 (online) – ISBN 978-3-96973-020-1

The working papers published in the series constitute work in progress circulated to stimulate discussion and critical comments. Views expressed represent exclusively the authors' own opinions and do not necessarily reflect those of the editors.

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Bibliografische Informationen der Deutschen Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at **http://dnb.dnb.de**

RWI is funded by the Federal Government and the federal state of North Rhine-Westphalia.

http://dx.doi.org/10.4419/96973020
ISSN 1864-4872 (online)
ISBN 978-3-96973-020-1

Linda Hirt-Schierbaum and Maryna Ivets[1]

You *Can* Win by Losing! Using Self-Betting as a Commitment Device: Evidence from a Weight Loss Program

Abstract

In this paper we investigate the influence of financial incentives on agents' commitment success who use a self-bet mechanism to overcome their self-control problems. We use results from the theoretical model developed in Hirt-Schierbaum and Ivets (2020) that allows for heuristic bias in agents' expectations of their future self-control costs and future payoffs, and test its conclusions with data from the online weight loss program DietBet. Our empirical results suggest that financial incentives incorporated into the self-bet mechanism encourage commitment and weight loss. More specifically, by placing higher wagers on themselves and participating in games with larger pots, agents can increase their chances of successful commitment and lose more weight. Additionally, we explore heterogeneity of the results by agents' type based on how accurately they predict their future self-control costs and future payoffs.

JEL-Code: C93, D01, D84, D90, D91, I12

Keywords: Weight loss; financial incentive; self-bet; commitment device; self-control; heuristic bias; overconfidence; underconfidence; optimism; pessimism

November 2020

1 Linda Hirt-Schierbaum, RGS Econ and TU Dortmund; Maryna Ivets, RGS Econ, CINCH, and UDE . *– We thank WayBetter Inc. for their cooperation and support; Katharina Blankart and Wolfgang Leininger for support, helpful comments and discussions. Special thanks to Stephan Sommer for his detailed comments and valuable remarks. We thank Daniel Avdic for comments on an earlier draft. We also would like to thank the participants at various seminars and conferences for their constructive comments and suggestions. All remaining errors are ours. Financial support by the RGS Econ, German Ministry of Education (BMBF grant number 01 EH1602A) and the RAG Stiftung is gratefully acknowledged.* *- All correspondence to: Maryna Ivets, University of Duisburg-Essen, Germany, e-mail: Maryna.Ivets@wiwinf.uni-due.de*

1 Introduction

Excessive weight is considered an increasingly global problem, as obesity and overweight are no longer only problems of high-income countries but have been on the rise in low- and middle-income countries as well.[1] Overall, 13% of the adult population worldwide, including 11% of men and 15% of women, are obese (WHO, 2016a).[2]

Obesity is associated with the substantial increase in the disease risk for hypertension, type 2 diabetes, stroke and coronary heart disease, and reduced life expectancy (Thompson *et al.*, 1999; Kopelman, 2007). Moreover, its impacts go beyond the individual. For example, several approaches have been utilized to illustrate obesity's economic impacts. Thompson *et al.* (1999) find that medical costs for the overweight increase by 20% and for the obese by 50% compared to nonobese peers. For the U.S., Cawley and Meyerhoefer (2012) estimate that obesity (compared to nonobese) can raise individual care costs by $2,741 (in 2005 USD) annually. Notably, these studies only consider obesity's *direct* costs. *Indirect* costs like productivity and human capital costs are not included. Nonetheless, the direct costs alone clearly indicate that individuals and policymakers have a significant economic rationale to reduce obesity-related externalities.

At the same time, 63% of US adults have seriously tried to lose weight at least once and 17% have never succeeded losing a significant amount of weight despite trying (Gallup, 2011). This example demonstrates the consequences of a behavior that is said to result from self-control problems: people seek to reach a target, but are not always successful in following through with their intentions.

In Hirt-Schierbaum and Ivets (2020) - henceforth HSI - we develop a theoretical model that aims to understand what is driving such behaviors in agents with self-control problems and preferences for commitment, and suggest a commitment strategy – an investment-payoff mechanism (a self-bet) – that can help incentivize normatively-preferred behavior.

We incorporate a heuristic bias about agents' expected future self-control costs and payoffs into the model. Based on our assumption about *how accurately* the agents' predict their expected future self-control costs and payoffs, we distinguish different types of agents: sophisticates (who are completely aware of their self-control issues and accurately predict their future self-control costs and payoffs), naifs (who are not aware of their self-control issues and of any changes in their future self-control costs, and overestimate their future payoffs), and partially naive agents (who are aware of their self-control issues but under- or overestimate the severity of their problem and over- or under-

[1] Obesity and overweight are defined as abnormal or excessive fat accumulation that may impair health (WHO, 2016a).

[2] For overweight these numbers are: 39% of adult population worldwide, including 39% of men and 40% of women, are overweight (WHO, 2016a).

estimate their future payoffs) further separated into naive optimists and naive pessimists, respectively.

In this paper we apply the model to the weight loss setting – an area where agents tend to experience self-control issues (Harris and Bruner, 1971; Will Crescioni *et al.*, 2011). The theoretical predictions from HSI indicate that a self-bet – where agents place a wager on their future behavior – is a helpful commitment device. To test the conclusions of our theoretical model, we use data from December 2011 until April 2017 from the online weight loss program *DietBet*, where players bet on the percentage of body weight they will lose in a certain amount of time.[3,4] The results from the current analysis can be used to inform individual decision-making and have implications for public health policy.

More specifically, we find evidence that the bet mechanisms can help naive and partially naive agents of the optimistic type to follow through with their intentions (as exemplified by January and male bettors), and can increase chances of successful commitment for sophisticated and partially naive agents of the pessimistic type (as exemplified by pre-Christmas bettors). We also find that naive optimists benefit from participation in games with larger pots due to overestimation of their future payoffs.

Regarding public health policy, these results can be used by policymakers to improve the effectiveness of public policy interventions aimed at encouraging positive behavioral changes. In a broader context, the results can also provide insights to the discussion about introduction, reimbursement and assessment of new digital health technologies that focus on improvement of patients' health behaviors in contemporary healthcare markets.

The remainder of the paper is organized as follows. Section 2 gives an overview of related literature and discusses the contribution of this paper. Section 3 presents the main findings from HSI, sets them in relation to the bet mechanism used in *DietBet*, and states the hypotheses we draw from the theory. Section 4 describes the data. Sections 5 and 6 present the empirical method and results, respectively. Section 7 provides discussion and Section 8 concludes.

2 Placement in Existing Literature

In this section we review three main strands of literature to which we aim to contribute: commitment devices, financial incentives in weight loss, and heuristic biases and behavior.

[3]*DietBet* has a parimutuel betting set up where players chose a monetary wager and join a game with other players. At the end of the game the players who lost their targeted weight split the pot, while the players who did not lose their wagers.

[4]Reassuring for the self-bet mechanism in question used by *DietBet*, Leahey and Rosen (2014) have analyzed data from December 2012 to July 2013 and have found promising 4-week weight loss results.

2.1 Commitment Devices

Our theoretical model incorporates an investment-payoff mechanism in the form of a self-bet as a commitment device that should help agents overcome their self-control problems. Therefore, we review empirical and experimental literature on related commitment devices.

There is a proliferation of commitment devices on the market.[5] This indicates that people are (to some extent) aware of their self-control problems. It also suggests that there is a demand for external devices that help people commit to their normatively-preferred choices.

Commitment contracts are common examples of such external devices. A commitment contract is a binding agreement between an agent and a third party (a referee). To ensure the agent follows through with his normatively-preferred choices (pre-specified goals) he has to put something on the line, e.g. money, which he will get back in case of success or lose in case of failure. However, evidence shows that commitment contracts often have low take up rates and increase desired behavior only to a small margin (Giné *et al.*, 2010). Therefore, other commitment mechanisms have been developed and tested recently, such as self-bet mechanisms.

Burger and Lynham (2010) use data from the UK bookmaker William Hill from 1993 to 2006 to analyze a real-world weight loss betting market. They find that only 20% of bettors who spent money betting on their own behavior won their bets. However, due to its small sample size (51 observations) it provides only limited insights into the mechanism. Lusher (2016) applies a parimutuel bet market to education[6] and shows that the mechanism proves effective in helping students achieve their educational goals. He distinguishes loss aversion as the main principal contributor to the effectiveness of the mechanism. Woerner (2018) has applied a matched bet[7] to exercise behavior. He finds that offering a matched bet has significant positive effect on gym attendance. Both papers (Lusher, 2016 and Woerner, 2018) test the effectiveness of bets as commitment devices in experimental settings. While both forms of bets have the advantage of being cost-efficient, the matched bet has the disadvantage of needing a planner in order to match players. This might work well in experimental settings, but could potentially be difficult for policymakers to implement in real life.

To sum up, this literature documents the effectiveness of commitment devices, such as commitment contracts and self-bets, which have been mainly

[5]Some examples include *Save More Tomorrow* (SMT) (Thaler and Benartzi, 2004); *Save, Earn, Enjoy Deposits* (SEED) (Ashraf *et al.*, 2006); *Commitment Action to Reduce and End Smoking* (CARES) (Giné *et al.*, 2010); `Beeminder.com`, `CollegeBetter.com`, `HealthWage.com`, `LazyJar.com`, `StikK.com` and `WayBetter.com`.

[6]In a parimutuel betting market, participants' stakes are put together in a pool that is later shared by all winners. Lusher (2016) offered a bet with modest bet stakes ($10 and $20) and without matching.

[7]In a matched bet, a planner matches participants with equal ability levels, so that every player in a group has similar chance of winning.

tested with the help of lab or field randomized control trials (RCTs). While internally valid, the evidence on external validity of commitment mechanisms is still largely missing. Thus, we intend to add to this literature by analyzing data from *DietBet*, a real-world weight loss program. Additionally, we also take a closer look into contributing factors of the self-bet mechanism, i.e. loss aversion and response to monetary rewards. While loss aversion has been previously named as a main contributor of the mechanism's success (see, e.g., Lusher, 2016), the role of and response to financial rewards have been understudied.

2.2 Monetary Incentives in Weight Loss

The commitment mechanism used in our theoretical model is based on a (possibly monetary) self-bet that is applied in the weight loss setting. Therefore, we review empirical and experimental literature on monetary incentives in weight loss.

Since obesity and overweight are linked with worse health (e.g., Hammond and Levine, 2010) and also with increased societal cost burden (e.g., Thompson *et al.*, 1999; Cawley and Meyerhoefer, 2012), researchers are constantly looking for potential solutions that can instigate positive behavioral changes to reduce the problem.

Recent literature suggests the use of financial incentives as a potential way to address obesity and overweight (see, e.g., Finkelstein *et al.*, 2007; Volpp *et al.*, 2008; Cawley and Price, 2011; John *et al.*, 2011; Relton *et al.*, 2011; Augurzky *et al.*, 2012; Cawley and Price, 2013).[8] The evidence comes from observational studies and randomized experiments. There are two main types of financial incentives that have been used to incentivize weight loss: deposit contracts[9] and financial cash rewards.

With deposit contracts, people are asked to deposit a certain monetary amount at the beginning of the program and are reimbursed at the end if they reach their target weight, otherwise the deposit is forfeited. With financial cash rewards, people are offered various financial rewards to encourage them to lose and maintain weight. They are given the reward if they reach their target weight or maintain it.[10]

This literature indicates that financial incentives *can* encourage people to lose weight – with some being more effective than others. For example, deposit contracts have been shown to be more successful than cash rewards (Jeffery,

[8]Related literature looks at incentivizing habit formation in exercise rather than weight loss (see, e.g. Charness and Gneezy, 2009; Royer *et al.*, 2015).

[9]Deposit contracts are a special case of commitment contracts.

[10]Notably, a self-bet mechanism includes elements of both, deposit contracts and financial rewards. Specifically, the initial bet serves a similar purpose to a deposit contract, while splitting of the pot among winners at the end of the game serves a similar purpose to financial rewards (though the exact final payoff is uncertain, but is equal to or greater than the amount bet). Thus, a self-bet simultaneously evokes loss aversion and instills a taste for gains.

2012) with larger deposits being associated with greater likelihood to reach weight loss goals (Jeffery *et al.*, 1984). However, the take up rates for deposit contracts are usually lower and decrease with larger deposits (Jeffery *et al.*, 1978, 1983). There is also evidence of diminishing marginal returns to the efficacy of larger deposits (Jeffery *et al.*, 1983). Cash rewards usually have higher take up rates and can also produce significant weight loss results (Finkelstein *et al.*, 2007; Augurzky *et al.*, 2012). However, higher rewards are found to be associated with only small increases in weight loss, indicating diminishing marginal returns to the reward size.[11,12]

Overall, these studies suggest that people react to monetary incentives encouraging them to lose weight. Generally, they find that larger deposits and financial rewards are associated with a higher likelihood of reaching weight loss goals. However, this literature also documents diminishing marginal returns of weight loss to financial incentives and some gender differences in responses.

2.3 Heuristic Biases and Behavior

Our theoretical model allows for agent bias regarding their expected future self-control costs and payoffs, and demonstrates that this bias can influence choices and outcomes. Therefore, we review empirical and experimental literature on heuristic biases and how they influence human behavior.

Current economic literature that documents heuristic biases in expectations and perceptions is limited but growing.[13] For example, in an experimental set up, Camerer and Lovallo (1999) explore whether overconfidence in one's relative ability can explain excessive business entry that leads to the high business failure rates. They find that when the payoff depends on a subject's own abilities, individuals tend to overestimate their relative chances of success and enter the market more frequently (compared to when the payoff does not depend on skill), confirming the overconfidence hypothesis. Merkle and Weber (2011) experimentally test two possible explanations for the better-than-average effect that describes people's tendency to perceive their skills and virtues as above

[11] Augurzky *et al.* (2012) find that the higher reward (€ 150 vs. € 300) was associated with very modest increase in weight loss and caused only obese women to lose more weight, indicating also that there are gender differences in response to financial incentives.

[12] For policymakers one of the biggest concerns is to not only understand how to make these interventions effective, but also to address their cost-effectiveness. More importantly, consideration should be given to the appropriate size of the financial incentives. A literature review on financial incentives for weight loss by Paul-Ebhohimhen and Avenell (2008) finds that there are no studies that justify the choice of the amount of the financial incentives, which underlines the importance of testing an elasticity of weight loss to financial incentives.

[13] Alternatively, in the field of psychology there is an ample literature on the well-studied psychological bias known as overconfidence (for an overview see, e.g. Glaser *et al.*, 2004). Generally, overconfidence can be defined as an error in people's judgement or decision-making that leads to *overestimation* of one's abilities, performance or knowledge, and/or *underestimation* of skills, knowledge or abilities of one's opponents, difficulty of the task or possible risks.

average. They find that these beliefs are inconsistent with rational information processing, but are in accord with the psychological bias of overconfidence. In an empirical study, d'Uva *et al.* (2017) find evidence of prediction bias in longevity expectation among older Americans: they predict their longevity very inaccurately and underestimate their chances of surviving to 75. Kinari (2016) studies expectation biases by examining how participants forecast the NIKKEI 225 over three forecasting horizons and finds that participants hold overconfident beliefs for all three horizons.

There is also limited but growing literature that links heuristic biases to various behaviors and economic choices. For example, Spinnewijn (2015) empirically finds that the unemployed overestimate how quickly they will find work. Consequently, they search too little for work, save too little for unemployment, and deplete their savings too rapidly when unemployed. Arni *et al.* (2020) study the relationship between bias in health perception and risky health behaviors. They find that people who overestimate their health are less likely to exercise and sleep enough, and are more likely to eat unhealthily and drink alcohol daily. Harris (2017) finds that people who overestimate their physical activity levels consume more calories. A study by Spitzer and Shaikh (2020) finds that people's misconceptions about their health (either over- or underestimation) can lead to less or more health care utilization and out-of-pocket spending. Comin *et al.* (2018) look at the role of misperceptions (optimistic and pessimistic) in adaption and use of health technologies. They find that providers who are overly optimistic about their own skills are more likely to adapt new technologies earlier and have higher utilization rates. Bertoni *et al.* (2020) look at researchers' self-assessment of their productivity and research grant application behavior. They find that low-productivity researchers are more likely to overestimate their own productivity and are more likely to apply for grants, while the opposite is true for the high-productivity researchers. Puri and Robinson (2007) link perception bias to a series of significant work- and life-related choices. They find that optimistic and pessimistic expectations play an important role in individual decision-making.

It should be noted that some of this literature documents gender differences in heuristic biases and related behaviors and finds that in uncertain situations, men tend to be more overconfident in self-assessment of their performance than women. For example, this literature documents that males offer overly positive performance assessments more often than females, despite equivalent performance. This difference between males and females in performance evaluation is especially pronounced on masculine tasks, where women also tend to exhibit lower accuracy in self-assessments of their performance. (Deaux and Farris, 1977; Beyer, 1990; Beyer and Bowden, 1997). Niederle and Vesterlund (2007) suggest that one of the reasons why equally-able women shy away from competition while men embrace it is that men are more overconfident than women about their relative performance. Barber and Odean (2001) document that men engage in more frequent trading of common stock, and this overtrading substantially reduces their returns relative to women, confirming the male overconfidence hypothesis. Thus, this evidence indicates that we can expect to see gender differences in behavior.

To sum up, there is a growing economic literature that documents that people tend to experience various heuristic biases in different domains and how these biases influence individuals' behavior and decision-making, and also highlights gender differences.

2.4 Our Contribution

In HSI we develop a theoretical model, which will be called *Self-Commitment Decision Model* hereon. In this model, agents face a given menu and are tempted by an item from that menu. Whenever it is not in their own best interest to choose the tempting item, agents need to exert self-control in order to resist temptation. Commitment mechanisms are needed when agents lack sufficient self-control to resist.

In economic theory, agents' failure to follow through with their normative intentions is usually modeled by assuming that agents experience preference reversal. Our model offers an alternative explanation for this behavior with respect to self-control problems and introduces a commitment device that utilizes an investment-payoff combination (in the form of a self-bet) to overcome them. More specifically, our model allows for a heuristic bias in agents' expectations of their future self-control costs and payoffs and provides insights on the mechanism's helpfulness in self-commitment based on agent type.

In the current study, we use the hypotheses drawn from the *Self- Commitment Decision Model* and apply them to the data from *DietBet*. Thus, we contribute to the three strands of literature: commitment devices; financial incentives in weight loss; heuristic biases and behavior. We show that the (parimutuel) bet mechanism can help different agent types follow through with their weight loss goals. Moreover, our proposed mechanism is superior to any kind of subsidy or other financial intervention due to its cost efficiency. The mechanism's helpfulness is based on the observations that people tend to avoid losses more than they strive to obtain gains (Kahnemann and Tversky, 1979), and that people tend to overestimate the likelihood of positive unlikely events (here, their future payoff) (Kahneman and Tversky, 1984).

Additionally, we use real-world data as opposed to experimental investigations. Therefore, when testing our theoretical model's conclusions that distinguish between different agent types, we utilize real-world observations of human behavior (observation about infamously unsuccessful New Year's resolutions and gender differences in overconfidence and response to financial incentives).

Finally, our study indicates that the self-bet mechanism can be used outside the RCT setting. This fact supports the mechanism's external validity and shows that it could easily be adopted by policymakers.

3 Main Theoretical Results and Adaptation

In this section we present the main findings of the *Self-Commitment Decision Model* developed in HSI and set them in relation to the current paper.

HSI develop a theoretical two-period decision model based on Gul and Pesendorfer (2001). An agent is facing a given menu over lotteries, A, and has to exercise self-control in period two in order to make the normatively-preferred choice, rather than succumb to temptation. His decision is highly dependent on his (random) time-variant degree of motivation, $\delta_i,\ i = 1, 2$, which directly influences the cost of self-control he is facing.

HSI also introduce a self-commitment mechanism based on an investment-payoff combination that can help agents commit successfully to their normatively-preferred choices.

Definition 1 (Investment-Payoff Combination (HSI))**.** An *investment-payoff combination* is a self-commitment device where an investment is made before the action is taken. After the action is taken, a pre-defined payoff, at least the size of the investment, is rewarded if the pre-defined goal is reached. The investment is lost in the case of failure.

Definition 2 (Investment-Payoff Mechanism (HSI))**.** An *investment-payoff mechanism* is a self-commitment mechanism that utilizes an investment-payoff combination as a commitment device.

Agents have to choose a commitment in period one, *before* they face the actual temptation in period two. Thus, agents have to anticipate their future motivation and therefore their future costs of self-control. Based on *how accurately* the agents predict their future costs of self-control, the *Self-Commitment Decision Model* distinguishes four types of agents: sophisticated, naive optimists, naive pessimists,[14] and naive agents.

HSI first develop a basic model with a constant degree of motivation $\delta \in (0, 1)$ and extend that model further to analyze an agent facing a random degree of motivation. Here, $\delta_i,\ i = 1, 2$ is distributed on $(0, 1)$. Suppose this distribution is well behaved and denote its CDF $F(\cdot)$, with support $\text{supp}(F) = [0, 1]$. The degree of motivation is revealed at the beginning of each period, so that agents know their period one motivation, but not their period two motivation.

As we will stick to the latter case in the following analysis, we will present the theoretical results for a random degree of motivation, when agents choose a commitment in period one.

The period one utility function for $|A| \geq 2$ is given by

$$\mathbb{E}U_A(wp) := \mathbb{E}\left[\max_{x \in A}\left(u(x) - (\frac{1}{\delta_2} - 1)(v(y^M) - v(x)) + s(-w + \lambda p_2(x) - k)\right)\right], \quad (1)$$

[14]Naive optimists and pessimists are two types of partially naive agents.

where wp is the chosen investment-payoff combination (w, p_w).
The *normative utility* u is a von Neumann-Morgenstern utility, which describes the agent's normative preferences. The *temptation utility* v is a von Neumann-Morgenstern utility and describes how tempting an agent finds a lottery. The difference $\max_{y \in A} v(y) - v(x)$ describes the cost of self-control, where y is the most tempting item on the given menu A, and x is the chosen item from that menu. Following Gul and Pesendorfer (2001) it is assumed that players are only tempted by the most tempting item on the menu. The *perceived (future) cost of self-control* $(\frac{1}{\mathbb{E}(\delta_2)} - 1)(\max_{y \in A} v(y) - v(x))$ is influenced by the random future (period two) degree of extrinsic motivation $\delta_2 \in (0, 1)$. Based on *how accurately* the person perceives these future costs we can distinguish different types of agents.

Let $s : \mathbb{R} \to \mathbb{R}$ be *well behaved*, i.e. it is defined, strictly monotonic, and twice continuously differentiable. With $s(-w) < 0$ for all $w > 0$ and $s(0) = 0$, defined over the investment w, the effort cost k and period two payoff p_2, which will be paid at the end of the period, and is discounted by $\lambda \in [0, 1]$. s is upward-sloped; i.e. $s'(x) > 0$ for all $w \neq 0$ and $s'(0) = 0$. Furthermore, $s''(0) = 0$ and $s'''(0) \neq 0$; i.e., s is a (asymmetric) sigmoid function with reference point $s(0) = 0$. The payoff p_2 that is paid at the end of period two is defined as follows:

$$p_2(x) = \begin{cases} 0 & \text{if } x_2^* = y^M \neq x^M, \\ p_w & \text{if } x_2^* = x^M, \end{cases}$$

with $x^M := \arg\max_{x \in A} (u(x) + v(x))$ the normatively-preferred choice, $y^M := \arg\max_{y \in A} v(y)$ the most tempting item of the menu, and x_2^* the actual choice in period two. For example, if the agent succumbs to temptation his payoff is 0, and p_w otherwise.

In order to choose a welfare-enhancing and resistance-inducing commitment, period one agent has to solve the following equation:

$$u(y^M) - u(x^M) + (\frac{1}{\hat{\delta}_2} - 1)(v(y^M) - v(x^M)) < s(\lambda p_w - w - k). \tag{2}$$

Note that $\hat{\delta}_2$ – the biased expected future degree of motivation – differs for different types of agents, i.e. $\hat{\delta}_2$ is not necessarily equal to $\mathbb{E}(\delta_2)$. Based on *how accurately* these agents make these predictions, introduces heuristic bias into the model and allows us to distinguish between four different types of agents. Sophisticated agents, for example, *accurately* predict their future degree of motivation ($\hat{\delta}_2 = \mathbb{E}(\delta_2)$) and their future costs of self-control. Naive agents, on the other hand, are completely *unaware* of their self-control problems ($\hat{\delta}_2 = 1$) and are unaware of any changes in their future degree of motivation and self-control costs. Partially naive agents of the optimistic type (naive optimists) neglect the possibility of a negative shock ($\hat{\delta}_2 > \mathbb{E}(\delta_2)$) and *underestimate* their future costs of self-control. They are considered to be overconfident about their future self-control. Lastly, there are partially naive agents of the pessimistic type (naive pessimists) who underestimate the possibility of a positive shock ($\hat{\delta}_2 < \mathbb{E}(\delta_2)$) to their motivation and therefore *overestimate* their future costs of self-control. They are considered to be underconfident about their future self-control.[15]

The main results from the model with random degree of motivation can be summarized by Proposition 1 (for proof see HSI). If $00 := (0, p_0)$ stands for not investing; i.e. no commitment, then:

Proposition 1 (Investment Effect - Dynamic Model (HSI))**.**

i) An agent who chooses an investment-payoff combination $wp > 00$ has a dominant investment strategy, given his beliefs.

ii) A sophisticated agent uses an investment-payoff mechanism successfully as a commitment device.

iii) An optimistic agent is more likely to undercommit when choosing an efficient investment-payoff combination, given his belief. The higher the period one motivation, the more likely the undercommitment.

iv) A pessimistic agent is more likely to overcommit when choosing an efficient investment-payoff combination, given his belief. The lower the period one motivation, the more likely the overcommitment.

v) Naive agents fail to use an investment-payoff mechanism as a commitment device, but might commit successfully by coincidence.

vi) Without an investment-payoff mechanism, an agent with self-control problems is more likely to succumb to temptation.

In order to bring the theory closer to the data, we now consider an adapted version of the model.

Take a closer look at the settings of the game: *DietBet* players join a parimutuel bet in order to lose weight. This means the set over lotteries, A, consists, for example, of consumption choices or choices regarding exercise behavior (e.g., go to the gym; workout at home; watch TV) or a combination of both. All players set the same wager and the pot is split between winners at the end of a game. Contrary to what we assume in the theoretical model, players do not know their period two payoff in advance and, more importantly, cannot choose it. The pot size changes with every player that joins the game, so players can only observe the current pot size when joining the game, but they have no information how that is going to change afterwards.

[15] For further details see HSI.

Participants of open games do not know their fellow players, so there is no possible way to know or make an educated guess about other players' types (i.e. sophisticated, (partially) naive). On this basis, it is impossible to draw conclusions on their anticipated failure or success and therefore on the payoff an agent receives at the end of period two in case of success. This is why we stick to our former approach and analyze an agent's choice problem independently of what the other players actually do and incorporate only a dependence on the likelihood of winning that agents attribute to other players.[16]

We consider a version of the model where players can only choose an investment (wager) w and build a belief about their future payoff, dependent on their own (biased) expected motivation.

Definition 3 (Degree of Naiveté)**.** Let ν be the *degree of naiveté* defined by

$$\nu := |\mathbb{E}(\delta_2) - \hat{\delta}_2|,$$

where $\mathbb{E}(\delta_2)$ is the (true) expectation of period two degree of motivation and $\hat{\delta}_2$ is the biased expected period two degree of motivation depending on an agent's type.

We make use of the direction of bias:[17].

Definition 4 (Sign-dependent Degree of Naiveté)**.** Let $\tilde{\nu}$ be the *sign-dependent degree of naiveté* defined by

$$\tilde{\nu} := \hat{\delta}_2 - \mathbb{E}(\delta_2).$$

Following Kahnemann and Tversky (1979), Weinstein (1980), Gouveia and Clarke (2001), and Mansour *et al.* (2006), we assume that naive optimists tend to overestimate the expected value of their possible future payoff, while naive pessimists[18] underestimate it. Sophisticates correctly estimate that the chance of winning is 50% and that their expected period two payoff is given by $2 \cdot w$.

We use the sign-dependent degree of naiveté as a weight that influences the likelihood an agent attributes to himself and other players of winning a game. Equation (1) then changes to

$$\mathbb{E}U_A(w) := \mathbb{E}\left[\max_{x \in A}\left(u(x) - (\frac{1}{\delta_2} - 1)(v(y^M) - v(x)) + s(-w + \lambda\hat{p}_2(x) - k)\right)\right], \quad (3)$$

[16]A game theoretic approach analyzing interdependent decisions of players might be an interesting approach for future research. This can, for example, model private games – where players might have information about their fellow players.

[17]I.e. sophisticates do not have a bias ($\hat{\delta}_2 = \mathbb{E}(\delta_2)$); optimists overestimate their expected future motivation ($\hat{\delta}_2 > \mathbb{E}(\delta_2)$); pessimists underestimate their expected future motivation ($\hat{\delta}_2 < \mathbb{E}(\delta_2)$); naifs do not realize they are not fully motivated

[18]We follow Abel (2002) in the notion that a pessimistic bias in individual beliefs is related to an underestimation of the probability of good outcomes and an overestimation of the probability of bad outcomes.

with

$$\hat{p}_2(x) = \frac{n}{(1+\tilde{v}) + (n-1)(1-\tilde{v})} \cdot \mathbb{E}(p_2(x))$$
$$= \begin{cases} 0 & \text{if } x_2^* = y^M \neq x^M, \\ \frac{2nw}{(1+\tilde{v})+(n-1)(1-\tilde{v})} & \text{if } x_2^* = x^M, \end{cases}$$

with n being the number of players in period one, when the agent joins the game.[19] For details on the definition of $\hat{p}_2(x)$ see Appendix A.

From the adapted model we can draw the following conclusions:

Proposition 2 (Bet Effect)**.**

i) An agent who chooses to join a bet with a wager $w > 0$ has a dominant investment strategy, given his beliefs.

ii) A sophisticated agent uses a bet successfully as a commitment device.

iii) If the pot size is perceived as exogenous constant, players are more likely to commit successfully when playing games with larger pot sizes.

iv) In a game with more than two players an optimistic agent

  a) is more likely to undercommit[20] when choosing an efficient wager given his belief. The higher the period one motivation, the more likely the undercommitment.

  b) profits from his biased expectation about the payoff, which decreases that effect.

v) In a game with more than two players a pessimistic agent

  a) is more likely to overcommit[21] when choosing an efficient wager, given his belief. The lower the period one motivation, the more likely the overcommitment.

  b) suffers from his biased expectation about the payoff, which increases that effect.

vi) Naive agents fail to use a bet as a commitment device, but might commit successfully by coincidence.

[19] This number might change after the player made his investment decision, which he can observe before he makes his choice in period two.

[20] An agent *undercommits* when his wager is not large enough to induce a binding commitment.

[21] An agent *overcommits* when his wager is larger than necessary to induce a binding commitment.

vii) Without a bet an agent with self-control problems is more likely to succumb to temptation.

Proof. See Appendix A. □

We use the results from the *Self-Commitment Decision Model* in HSI and the adapted version of the model as a theoretical basis for our empirical analysis. The main theoretical findings suggest that using a bet mechanism as a commitment device can increase the likelihood to resist temptation and can help agents to commit successfully to their predefined goals. Furthermore, it indicates that the likelihood of success depends heavily on an agent's sophistication/(partial) naiveté. We directly derive the following hypotheses:

Hypothesis 1. Agents that place higher wagers on themselves should be more successful in their commitments (win the games) and their weight loss.

Hypothesis 2. Subgroups with larger shares of naive and overconfident agents (naive optimists) should still have a positive effect from placing higher wagers[22], but the effect size should be smaller because they are more likely to underinvest.

Hypothesis 3. Subgroups with larger shares of sophisticated and underconfident agents (naive pessimists) should have a positive effect from placing higher wagers[23], but the effect size should be larger because they are more likely to overinvest.

Hypothesis 4. Agents that participate in games with larger pots should be more successful in their commitments (win the games) and their weight loss.

Hypothesis 5. Subgroups with larger shares of naive and overconfident agents (naive optimists) should have a positive effect from playing games with larger pot sizes, but the effect size should be larger because they are more likely to overestimate their future payoff.

Hypothesis 6. Subgroups with larger shares of sophisticated and underconfident agents (naive pessimists) should have no or a positive effect from playing games with larger pot sizes, but the effect size should be the same or smaller because they are more likely to estimate accurately or underestimate their future payoff.

Finally, given our theory and hypotheses, another related and relevant question one might have is whether (partially) naive agents are able to learn about their naiveté from their past behavior and update their believes. We do not cover this topic with our theoretical model, but we present some suggestive preliminary empirical evidence in subsection 6.4 that provides insights into future research.

[22]By placing higher wagers optimistic (and naive) agents can "accidentally" commit themselves.

[23]By placing higher wagers pessimistic and sophisticated agents will increase their chances of successful commitment.

4 DietBet Data

4.1 WayBetter Inc. and DietBet

In this study we use data from WayBetter Inc. The company was founded in 2011 and provides an online platform that offers people commitment opportunities in the form of self-bets to help them engage in healthier behaviors. The first type of bet it introduced was *"DietBet"*, followed by *"StepBet"* in 2016, and *"RunBet"* in 2017.

This study utilizes data from DietBet program that offers self-bets as a commitment to promote weight loss. During enrollment, players bet money and join a game. The size of the game pot thus depends on the amount of the initial bet and the number of players in a game. Players can join an existing game that has not yet started or can create their own game. If a player creates her/his own game s/he can choose whether to make it open – anyone can join – or closed – by invitation only.

Players submit their initial weight within 48 hours of the game's start. After the game is over, players have to submit their final weight within 48 hours.[24] During the game, players have the possibility to socially interact in a game-specific forum to encourage each other and discuss exercise routines and dieting tips.

Since the launch of DietBet, several types of weight loss bets have been introduced. In this study, we focus on the *Kickstarter Bet*, where players bet to lose 4% of their initial body weight within 4 weeks (28 days). At the end of the 4-week period weight loss is verified via official weigh-ins. Within each game all winners (players who lose at least 4% of their initial weight) split the pool of money. Thus, there could be multiple winners. If no one lost 4% of their initial body weight, then a player who lost the most weight in percentage is rewarded the pool of money.[25]

DietBet adheres to the 'No Lose Guarantee' principle, which ensures that players who win DietBet will not lose money. For example, in a situation when a game has an unusually high percentage of winners, the company will forfeit their cut in order to ensure that nobody loses money. Thus, in the worst case scenario, the players will lose weight for free. Figure 1 below illustrates the screenshot of a game example a potential player could join.

[24] For more information on the photo-based weight verification process and referee review please refer to the DietBet website: `https://www.dietbet.com/faq`.

[25] Before paying the players, DietBet takes a portion of the initial gross money pool to cover their expenses. Thus, the players who do not win do not have to pay additional fees. The amount that is retained by DietBet depends on the amount of the initial bet. For more information please refer to the DietBet website: `https://www.dietbet.com/faq`.

Figure 1: Screenshot of a game example (taken on December 12$^{\text{th}}$ 2019)

4.2 Descriptive Analysis

One of the implications of our theoretical model (see Proposition 2) is that agents make their investment decision (choose a wager) based on the expectation of their future degree of motivation (future self-control costs). Thus, depending on how accurately they predict it, they either fail to commit, commit successfully, or under/over commit.

The other implication relates to the expectation about their future payoff (based on pot size). Here again, depending on how accurately they predict it, it can either have no effect on their commitment success (for sophisticates), increase their chances of successful commitment (for naifs and naive optimists), or increase their chances of successful commitment, but to a lesser degree (for naive pessimists).

To test these predictions, we use data from *Kickstarter Bet* from December 2011 until April 2017. Given that our theoretical results provide different implications for different types of agents regarding the mechanism's helpfulness in commitment, we need to distinguish them in our data. Since we are working with real-world data and not a survey or a RCT, where agents' sophistication and naiveté can be measured with the help of survey questions, we rely on real-world observations about human behaviors.

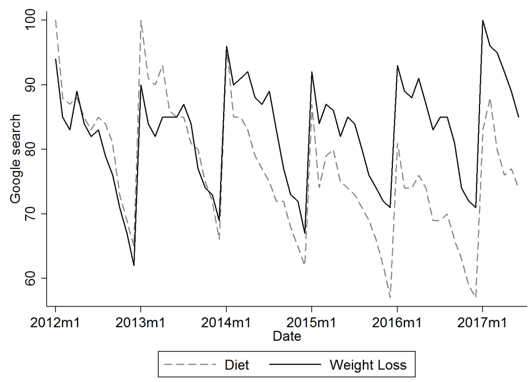
In particular, we use an observation about the infamously unsuccessful New Year's resolutions[26] and the fact that every year millions of people make New Year's resolutions, but many of them fail. Google trends (see Figure 2)

[26]Dieting/eating healthier, exercising more, and weight loss consistently appear as the top three New Year's resolutions (i.e., https://www.statista.com/chart/16500/top-us-new-years-resolutions/).

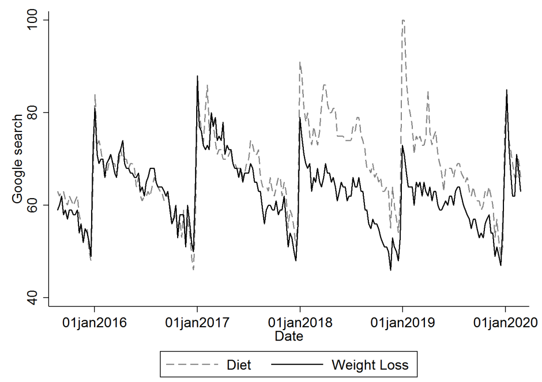
also show that there is a spike in interest in dieting and weight loss right after the New Year.[27]

Figure 3 is based on our data and shows the number of bets played by months. We see that the most bets per month take place in January. At the same time, Figure 4c shows that January bettors are, on average, heavier than bettors in other months, but their betting stakes (Figure 4a) are similar to the average bets placed in other months (except December). Thus, we expect that a large share of January players are driven by their New Year's resolutions and we therefore assume that these games contain a larger share of naive and partially naive players of the optimistic type.

In Figures 2 and 3 we also observe that December is the month with the least bets and the lowest interest in weight loss and dieting.[28] Therefore, we expect that people who participate in the games before Christmas are those who would like to commit themselves ahead of the holidays. Thus we expect that before Christmas, games contain larger share of sophisticated and partially naive agents of pessimistic type. This is also supported by Figure 4 where we see that December players place higher bets (Figure 4a), while their initial weight, on average, is lower than that of January players (Figure 4c).



(a) Monthly searches (2012-2017)



(b) Weekly searches (2015-2020)

Figure 2: Data from worldwide Google trends for terms "diet" and "weight loss" (collected on August 8th 2020).

[27]Numbers represent search interest relative to the highest point on the chart for the given time. A value of 100 is the peak popularity for the term; a score of 50 means the term was half as popular as the peak.

[28]Notably, the lowest point in Google trend searches is achieved just before Christmas (see Figure 2b).

[29]The figure is based on bets placed from January 2012 until January 2017 in order to ensure comparability between months.

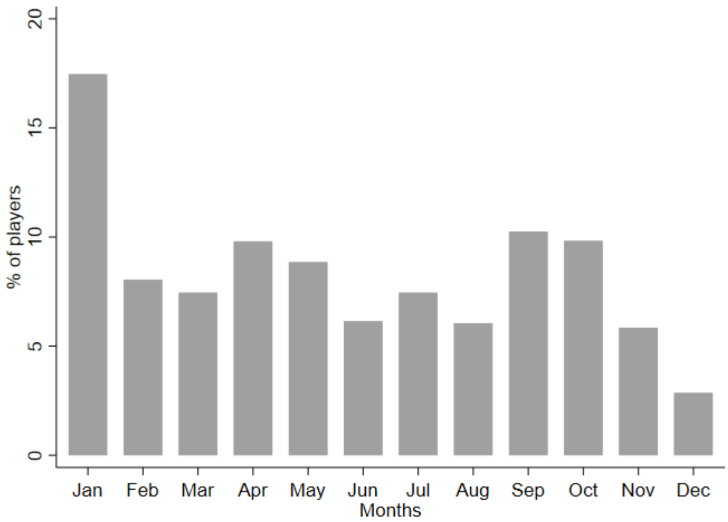
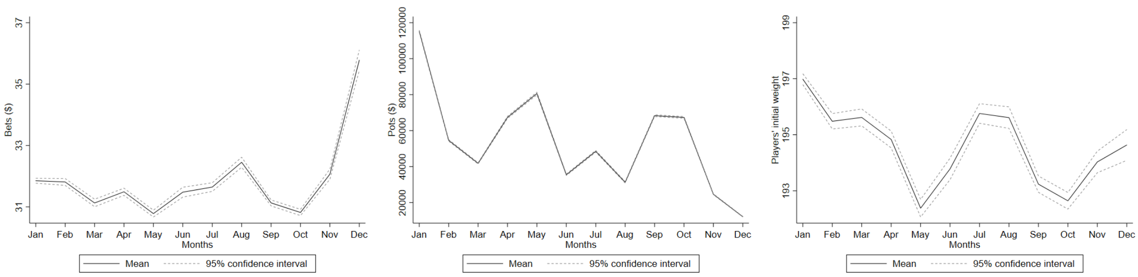


Figure 3: Bets by Month.[29]



(a) Bets (b) Pots (c) Player's weight

Figure 4: Average Bets, Pots and Players' Starting Weight by Month.

Another insight about agents' sophistication and naiveté comes from the literature on gender differences and overconfidence. Generally, this literature finds that men tend to be more overconfident in self-assessment of their performance than women (as discussed in subsection 2.3), indicating that we would expect a larger share of men to be of the naive optimist type about their future self-control. Additionally, we can also expect to find gender differences in responses to gains.[30]

We start by conducting a descriptive analysis. Table 1 presents summary statistics for the overall DietBet sample. There are 21,077 games containing 912,737 players (user/game combinations).[31] Of these, 84% are female play-

[30]See, e.g. Croson and Gneezy (2009) for an overview of gender differences in preferences.

[31]The DietBet example shows that there is a demand for commitment: over five-year period almost 430,000 people used the program as a self-imposed commitment to lose weight.

ers[32] and 16% are male players. 44% are closed games and 56% are open games. 50.7% of all players were considered winners in their games. The average age of players is 35 years. On average, an individual participates in 2.14 games. The number of players per game ranges significantly – while on average there are 45.1 players per game, there are small games (only 1 player) and large games (14,448 players).

The average bet amount is $31.6 (USD), with the lowest bet being $1 and highest bet being $500. It is notable that winners on average bet more than nonwinners ($33.5 vs. $29.7). On average winners won $64.1, but the winning amounts range from $2 to $1,283.

The average initial weight of the player is 194.9 lb (88.4 kg). The final weight is 189.7 lb (86 kg). On average, players lost 5.2 lb (2.4 kg). Winners lost 9.13 lb (4.14. kg) on average, while nonwinners lost 1.16 lb (0.53 kg) on average.[33] A total of 64.5% of players completed an official weigh-in at the end of the game.

We examine whether player characteristics differ between the groups of completers and noncompleters. For this purpose, we use analysis of variance and chi-square tests. Table 12 in Appendix B presents the results from the comparison of completers to noncompleters. Here we see that the groups differ significantly between each other on a number of characteristics: there are more males among completers, completers have a lower baseline weight and bet more money. Moreover, completers finish more weigh-ins and are more socially engaged.[34]

Since noncompleters did not submit their final weight, we make an assumption that people who did not submit the official final weigh-ins did not lose any weight. On average, players lost 2.7% (sd 2.3) of their initial weight, and the weight loss is statistically different between completers and noncompleters (4.2% vs. 0.0% ($P<0.00$)).

We use both completers and noncompleters in our analysis, but in order to account for noncompletion and the assumption we make about players' weight loss in that case, we always control for it in our analysis by including a dummy variable equal to one if a person is a completer and zero otherwise.[35]

Figure 5 shows the percent of bets placed by size. Here we see that the most popular bets are $30, $35, and $25 bets. This is not surprising since DietBet offers many default bets for these amounts and they tend to attract a lot of people. Moreover, people are less willing to participate in the games where

[32]The fact that women represent the overwhelming majority of players is not surprising, i.e. Cawley and Price (2013) document that women were over represented as participants in workplace weight loss programs.

[33]Some players did not complete a final, verified weigh-in (we refer to them as "Noncompleters"). By not completing their final game weigh-in, noncompleters forfeit their wager.

[34]During the game, players have a possibility submit unofficial weigh-ins to track their progress and to share their participation on Facebook, share photos, add comments and likes.

[35]We also repeat the analysis on the sample of completers only. The results stay qualitatively and quantitatively similar (available upon request).

Table 1: Descriptive Statistics I: Full Sample.

	Obs	Mean	SD	Min	Max
		Game Characteristics			
Pot Amount, $	21077	1470.6	9757.8	2	442140
N Players in Games	21077	45.1	306.0	1	14448
N Winners in Games	21077	22.0	157.4	0	8777
Closed Game	21077	0.44	0.50	0	1
		User Characteristics			
N Games per User	426609	2.14	2.87	1	102
Male	426609	0.16	0.37	0	1
Age	233007	35.0	9.39	18	86.8
		Player Characteristics			
Bet Amount, $	912737	31.6	17.3	1	500
Amount Won, $	912737	32.5	37.6	0	1282.5
Share of Winners	912737	0.51	0.50	0	1
Start Weight, lb	912737	194.9	43.3	121.2	334.6
Final Weight, lb	912737	189.7	42.6	107.8	335
Weight Loss, lb	912737	5.20	4.61	-0.50	17.2
Weight Loss, %	912737	2.70	2.29	-0.41	11.9
Social Engagement	912737	0.93	10.0	0	261
N Weigh-ins in Game	912737	4.66	3.49	1	31
Male	912737	0.16	0.37	0	1
Completer	912737	0.64	0.48	0	1
		Player Characteristics: Winners			
Bet Amount, $	462791	33.5	19.8	1	500
Amount Won, $	462791	64.1	27.5	2	1282.5
Start Weight, lb	462791	193.3	42.6	121.2	334.6
Final Weight, lb	462791	184.2	40.8	107.8	329
Weight Loss, lb	462791	9.13	2.38	0.10	17.2
Weight Loss, %	462791	4.74	0.80	0.057	11.9
Social Engagement	462791	1.12	11.5	0	261
N Weigh-ins in Game	462791	5.85	3.73	1	31
Male	462791	0.19	0.40	0	1
		Player Characteristics: Nonwinners			
Bet Amount, $	449946	29.7	13.9	1	500
Start Weight, lb	449946	196.5	43.9	121.2	334.6
Final Weight, lb	449946	195.4	43.7	116.6	335
Weight Loss, lb	449946	1.16	2.25	-0.50	13.2
Weight Loss, %	449946	0.60	1.12	-0.41	3.99
Social Engagement	449946	0.73	8.27	0	261
N Weigh-ins in Game	449946	3.44	2.74	1	30
Male	449946	0.13	0.33	0	1

they have to put more money on the line as was also observed for deposit contracts.[36]

Notably, people tend to choose bets that are multiplicative of 5, which corresponds with observed bet clustering at $5, $10, $15, $20, 25$, $30, $35, $40, $50, $100, and $150 values. There is a greater clustering of bets under $50 with the next prominent cluster being at $100. In Figure 5 we see that people make greater differentiation between smaller bets (i.e. bets under $50), but there is no such differentiation for bets between $50 and $100 or above $100. This is consistent with the idea of cognitive biases and anchoring effect in pricing first identified by Tversky and Kahneman (1974). Here we can distinguish two anchors: $50 and $100 bets that serve as natural reference points. For people who prefer lower bets, a $50 bet serves as an anchor (upper bound of their willingness to pay) with bets under that amount being seen as more attractive.[37] Similarly, a $100 bet is seen as an anchor by people who prefer higher bets. More specifically, this anchor attracts bettors who are either willing to bet more than $50 or those willing to bet more than $100.[38]

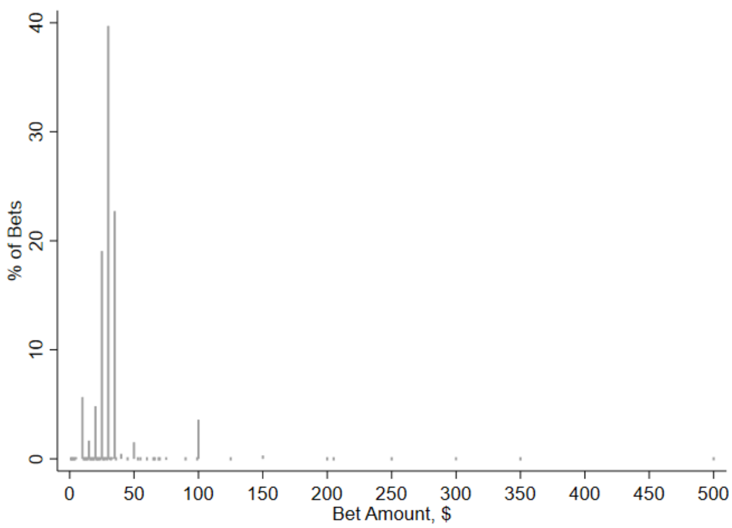


Figure 5: Percent of Bets by Size

We are interested in the effects of the bets on the probability of winning and weight loss. Figure 6 presents scatter plots of shares of winners and aver-

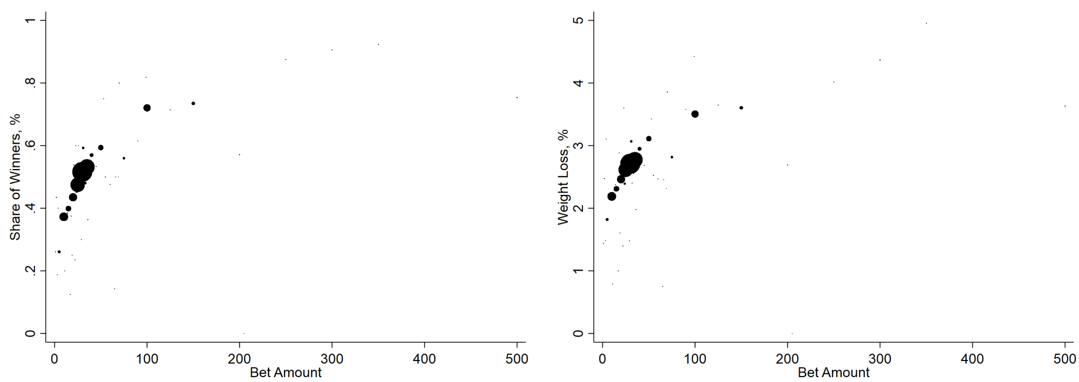
[36]It is not unusual that the majority of people choose to participate in smaller bets, i.e. the evidence from weight loss literature on deposit contracts shows that enrollment rates drop significantly for higher deposits (e.g. 30% less people agreed to participate in $300 deposit commitment as compared to $30 one (Jeffery, 2012)).

[37]This is also supported by the fact that there is no clustering at $45.

[38]Overall, about 5% of all bets are bets $100 and over.

age weight losses (in %) for each bet size (weighted by the number of observations). Here we see that this relationship is nonlinear and exhibits diminishing marginal returns. More specifically, we see that there is a positive relationship between the size of the bet and the share of winners and weight losses. At the same time, this relationship starts to exhibit diminishing marginal returns for higher bet stakes (i.e. around $100). We plot the marginal effects of bets on our outcomes in order to examine this relationship in more detail (see Figure 7). The figure shows marginal effects for probability of winning and weight loss (%) from a quadratic fit. Here we see that at first the marginal effects of higher bets are steep, but then exhibit diminishing marginal returns. The maximum is reached around $225.

In our analysis we split bets into higher and lower stakes. We implement this split at the $100 mark. The idea for this comes from psychology of pricing research since betting/paying a three-digit bet/price would be considered as breaking a mental barrier of a two-digit bet/price. It also relates to the anchoring effect of the $100 bet and prospect theory with loss aversion (Tversky and Kahneman, 1974; Kahnemann and Tversky, 1979). It suggests that people react more strongly to losses and given that people might perceive bets of $100 and over more costly than even the bets just under $100, they can therefore exert extra effort to commit themselves.[39]

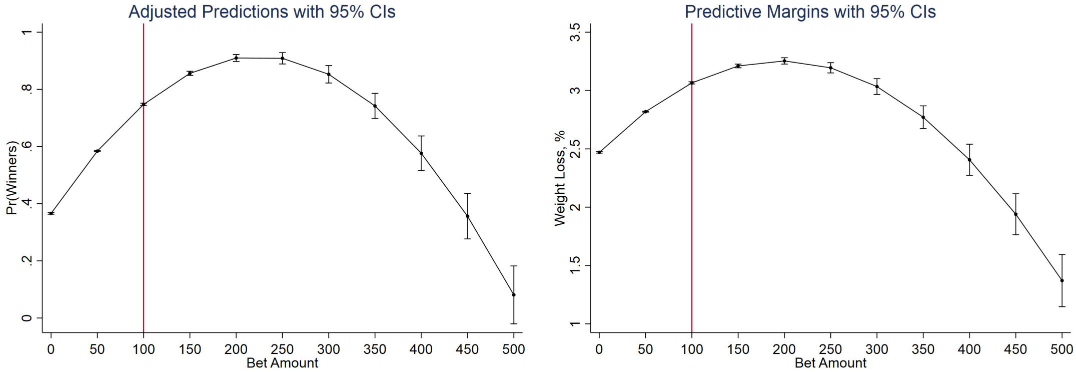


(a) Share of Winners

(b) Weight Loss (%)

Figure 6: Scatter plot of share of winners and weight loss (%) per bet amount (weighted by the number of observations).

[39] Additionally, for any game where the bets are over $100, DietBet requires video weigh-ins for all players.



(a) Probability of Winning

(b) Weight Loss (%)

Figure 7: Marginal effects of bet amount on probability of winning and weight loss.

5 Empirical Method

In our empirical analysis we explore within-person variation and therefore use a multi-level structure of the data where individuals participate in multiple games.[40] Using within-person variation allows us to get rid of any game-invariant heterogeneity between people.

The hypotheses 1, 2 and 3 state that people who bet more on themselves should be more successful in their commitments. We can test this by examining whether people who place high-stake bets ($100 or more) are more likely to win and lose weight. Thus, we specify the following model:

$$Y_{ig} = \alpha_i + \beta\, HighStakes_{ig} + X_{ig}\Gamma + Z_g\Theta + \epsilon_{ig} \tag{4}$$

where Y_{ig} is either probability of winning the game or weight loss in percent:

$$Y_{ig} := \begin{cases} Pr(Win) \\ \text{Weight Loss}(\%) \end{cases} \tag{5}$$

for player i in game g. $HighStakes_{ig}$ is equal to one if the wager of player i in game g is $100 or more; and zero otherwise. α_i is player i's unobserved game-invariant characteristics that also include his initial degree of motivation (δ_{1i}). X_{ig} and Z_g represent other individual and game characteristics, respectively.

[40] One might argue that the selected sample of people participating more than once might differ from the overall population of people who try to lose weight. However, polls indicate that people usually attempt multiple times to lose weight (i.e. on average adults try to lose weight 5.3 times in their life (women vs. men: 7 vs. 3.6 times) (Gallup, 2011)). Moreover, we repeat the analysis on the full sample and find very similar results (see Table 22), indicating that the results are not sample specific.

Controls include game's pot size, player's starting weight, social engagement, number of weigh-ins, an indicator whether the game is closed, and a categorical variable for game order to control for participation experience. ϵ_{ig} is the error term that also contains player i's random motivation in period two, δ_{2ig}.

The coefficient of interest is β. It captures the difference in probability of winning and weight loss (%) for a person who places a high-stake wager vs. low-stake wager. Potential concern here is that δ_{1i} and other game-invariant unobservables are correlated with the variable of interest, $HighStakes_{ig}$. For this reason we estimate the model with fixed effect regression. We cluster standard errors at the individual level.

We are also interested in looking at marginal effects of bets. Therefore, we also specify the following model:

$$Y_{ig} = \alpha_i + \beta_1\, Inter_{\geq \$100} + \beta_2\, Bet_{<100\$,ig} + \beta_3\, Bet_{\geq \$100,ig} + X_{ig}\Gamma + Z_g\Theta + \epsilon_{ig}. \tag{6}$$

Here, we utilize a linear spline regression to allow for different slopes for bets under and over \$100, since marginal effects of betting differ between high and low stakes (see, e.g. Figures 6 and 7). $Inter_{\geq \$100}$ is the spline-specific intercept for bets of \$100 and more, which is equal to one if a bet is \$100 or more and zero otherwise; $Bet_{<\$100,ig}$ and $Bet_{\geq \$100,ig}$ are linear splines defined according to equations (7) and (8):

$$Bet_{<\$100,ig} = \begin{cases} Bet_{ig}, & \text{if } Bet_{ig} < \$100 \\ 99, & \text{otherwise} \end{cases} \tag{7}$$

$$Bet_{\geq \$100,ig} = \begin{cases} Bet_{ig} - 99, & \text{if } Bet_{ig} \geq \$100 \\ 0, & \text{otherwise} \end{cases} \tag{8}$$

The coefficients of interest are β_2 and β_3 for the marginal effects of bets under and over \$100, respectively.

In the next step we test hypotheses 4, 5 and 6. They state that participation in games with larger pots should also have different implications for different types of agents. We test this by looking at people who participate in games with pot sizes above and below the sample median. We estimate the following model:

$$Y_{ig} = \alpha_i + \beta\, HighPots_{ig} + X_{ig}\Gamma + Z_g\Theta + \epsilon_{ig} \tag{9}$$

where Y_{ig} is either probability of winning the game or weight loss in percent for player i in game g. $HighPots_{ig}$ is equal to one if a game pot is above the sample median and zero otherwise.[41] X_{ig} and Z_g represent individual and game char-

[41] The median pot size in the panel sample is \$24,200.

acteristics, respectively. Controls include bet size and bet size squared, player's starting weight, social engagement, number of weigh-ins, an indicator whether the game is closed and a categorical variable for game order to control for participation experience.

The coefficient of interest is β. It captures the difference in probability of winning or weight loss (in %) for a person who participates in games with higher vs. lower pot sizes. ϵ_{ig} is an error term. We again cluster standard errors at the individual level.

Before we move to our results we should note that we expect that being a completer is associated with higher probability of winning the game and greater weight loss, since completing a final weigh-in is a precondition for being a winner, given our assumption that people who did not submit their final weigh-ins did not lose any weight. If we do not account for this in our analysis we expect to identify an upper bound of the effect of bets on our outcomes, since completers bet more than noncompleters and noncompleters are automatically considered nonwinners by default. In order to account for this, we always include a dummy for being a completer in our main analysis and thus identify a lower effect bound.[42]

6 Results

6.1 Overall Effect of High-Stake Bets and High Pot Sizes

We conduct our main analysis on the panel subsample of players who participate in more than one game.[43,44] By doing so we explore a within-player variation of bet stakes on probabilities of winning and weight loss (%) by utilizing fixed effects regression according to Eqs. (4) and (6). The results are found in Table 2.

The results from columns (2) and (4) show that the relationship between the high-stake bets ($100 or more) and probability of winning and weight loss is positive and statistically significant. More specifically, high-stake bets are associated with 5.3 percentage points (pp) higher likelihood of winning and 0.14 pp higher weight loss. Regarding the effect size, the increase in winning probability of 5.3 pp for high-stake bets corresponds to an increase of 10.6% with respect to winning probability for bets under $100 (5.3/49.8). Similarly, 0.14 pp higher weight loss for high-stake bets corresponds to 5.2% increase with respect to weight loss for bets under $100 (0.14/2.66).[45]

[42] We repeat the analysis without controlling for completer status in Tables 14 and 15.

[43] The descriptive statistics for this sample can be found in Table 13 in Appendix B.

[44] Some players participated in more than one game at once. In Table 21 in Appendix B we check the robustness of the results by only looking at games that were played sequentially.

[45] It should be noted that these effect sizes represent a lower bound since we control for the completion status. If we do not control for it, the effect sizes for probability of winning and

Table 2: Effect of High-Stake Bets and Marginal Effects of Bets on Probability of Winning and Weight Loss (%).

	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
High-Stake Bet	0.0504***	0.0530***	0.1302***	0.1389***
	(0.0016)	(0.0016)	(0.0062)	(0.0063)
	(1)	(2)	(3)	(4)
Bet Amount under $100	0.0020***	0.0017***	0.0061***	0.0050***
	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Bet Amount over $100	0.0001*	-0.0000	0.0004**	0.0001
	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Add. controls	No	Yes	No	Yes
N	643,916	643,916	643,916	643,916
N (clust)	157,788	157,788	157,788	157,788

Dependent variables: probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, pot size, and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * $p<0.1$ ** $p<0.05$ *** $p<0.01$

With respect to marginal effects we find that betting \$10 more in bets under \$100 is associated with 1.7 pp higher probability of winning and 0.05 pp more weight loss (as also evident from Figure 7). However, the marginal effect of betting more money on probability of winning and weight loss is not significant once the person is a high-stake bettor. Thus, agents that place high-stake bets are more likely to win and lose more weight, but once they place such a bet, betting marginally more does not increase their likelihood of success.

Table 3 presents the results from participation in games with larger pots. Here we see that, on average, agents who participate in games with above median pot sizes are significantly more likely to win the game and lose more weight.[46] This supports our hypothesis 4 which suggests that agents who participate in games with larger pots should be more successful in their commitments (win the games) and their weight loss. The implication of this hypothesis is that people expect larger payoffs when participating in games with larger pots, conditional on the bet stake and other player and game characteristics.

The results from Tables 2 and 3 add insights to the discussion about the relative importance of loss aversion and response to monetary rewards as contributing factors of the bet mechanism's success. Here we can observe that the effect size from high-stake bets is much larger than from higher pot sizes (0.053 vs. 0.014 and 0.139 vs. 0.047 for probability of winning and weight loss, respectively). However, the latter is still statistically significant. This indicates that while loss aversion does seem to be the main contributor to the mechanism's success, agent's response to monetary rewards can still provide an additional incentive and amplify the effect of the bet.

6.2 Sophistication and Naiveté

Our theoretical model allows for uncertainty regarding the beliefs agents hold about their future costs of self-control. This can have an important impact on behavior. There are two extreme types of agents: sophisticates, who accurately predict their future costs of self-control, and naifs, those who do not. In between, there are partially naive agents, who realize that they are prone to changes in motivation and self-control costs but underestimate or overestimate the extent of these changes.

In this subsection we test our second and third hypotheses. Here we rely on the observations from the real world and our data discussed in subsection 4.2. More specifically, we expect that January games contain a larger share of naive

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weight loss are 0.105 pp and 0.425 pp (corresponding to 21.1% and 16% increase relative to bets under \$100), respectively (see Table 14 in Appendix B).

[46]Regarding the effect size, this corresponds to 2.9% and 2% (0.014/0.48 and 0.05/2.63) increase with respect to probability of winning and weight loss, respectively, for players in game with below median pot sizes. This, again, represents a lower bound. Table 15 in Appendix B presents the results without controlling for completion status. The effect sizes for probability of winning and weight loss are 0.019 pp and 0.075 pp (corresponding to 4% and 2.9% increase relative to below median pots), respectively.

Table 3: Effect of High Game Pots on Probability of Winning and Weight Loss (%).

	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
High Pot Size	0.0167***	0.0137***	0.0566***	0.0468***
	(0.0008)	(0.0008)	(0.0029)	(0.0029)
Add. controls	No	Yes	No	Yes
N	643,916	643,916	643,916	643,916
N (clust)	157,788	157,788	157,788	157,788

Dependent variables: probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). High Pot Size is a dummy variable equal to one if pot size is larger than the sample median ($24,200), and zero otherwise. All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, bet and bet squared, and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * p<0.1 ** p<0.05 *** p<0.01

and partially naive players of the optimistic type. Thus, January bettors are expected to be less successful in their commitments compared to people who bet in other months during the year. However, we still expect high-stake January bettors to be more successful in their commitments than low-stake January bettors.[47] Table 4 presents the results from the fully interacted model.

Table 4: Heterogeneity Analysis of New Year's Resolutions on Probability of Winning and Weight Loss (%).

	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
High-Stake Bet	0.0550***	0.0546***	0.1461***	0.1432***
	(0.0018)	(0.0018)	(0.0067)	(0.0068)
High-Stake Bet × NY Bet	-0.0222***	-0.0128***	-0.0730***	-0.0382***
	(0.0035)	(0.0036)	(0.0141)	(0.0142)
	(1)	(2)	(3)	(4)
Bet Amount under $100	0.0019***	0.0017***	0.0058***	0.0050***
	(0.0001)	(0.0001)	(0.0003)	(0.0003)
Bet Amount over $100	-0.0000	-0.0001*	0.0002	-0.0000
	(0.0001)	(0.0001)	(0.0003)	(0.0003)
Bet Amount under $100 × NY Bet	-0.0000	-0.0000	-0.0006	-0.0002
	(0.0002)	(0.0002)	(0.0006)	(0.0006)
Bet Amount over $100 × NY Bet	0.0002**	0.0002	0.0001	-0.0001
	(0.0001)	(0.0001)	(0.0004)	(0.0004)
Add. controls	No	Yes	No	Yes
N	643,916	643,916	643,916	643,916
N (clust)	157,788	157,788	157,788	157,788

Dependent variables: probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, pot size and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * $p<0.1$ ** $p<0.05$ *** $p<0.01$

As anticipated, we see that people who participate in January games are on average less successful compared to players in other months. Although the high-stake January bettors are still more successful than low-stake January bettors[48], the effect of high-stake January bets remains much smaller compared to

[47]Figure 10 in Appendix B shows the percent of bets by size placed in each months.

[48]For high-stake January bettors the effect is 0.042 for probability of winning and 0.105 for weight loss, significant at 1% significance level.

other months. The marginal effects for January bets are not significantly different from marginal effects of bets placed in other months. Overall, the results indicate that even naive and partially naive agents of the optimistic type can increase their chances of commitment and achieve greater weight losses by placing high-stake bets.

Conversely, we look at the bets made in December before Christmas. As illustrated in section 4.2, we expect that these games contain larger shares of sophisticated and partially naive agents of the pessimistic type. Table 5 contains the results from the fully interacted model.

Table 5: Heterogeneity Analysis of Before Christmas Bets on Probability of Winning and Weight Loss (%).

	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
High-Stake Bet	0.0501***	0.0527***	0.1297***	0.1383***
	(0.0016)	(0.0017)	(0.0063)	(0.0064)
High-Stake Bet× Before Xmas Bet	0.0272***	0.0153**	0.1023***	0.0577**
	(0.0074)	(0.0074)	(0.0283)	(0.0283)
	(1)	(2)	(3)	(4)
Bet Amount under $100	0.0020***	0.0017***	0.0060***	0.0050***
	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Bet Amount over $100	0.0001	-0.0000	0.0004*	0.0000
	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Bet Amount under $100 × Before Xmas Bet	0.0009**	0.0007	0.0049***	0.0032**
	(0.0004)	(0.0004)	(0.0015)	(0.0016)
Bet Amount over $100 × Before Xmas Bet	-0.0001	-0.0000	0.0001	0.0007
	(0.0003)	(0.0004)	(0.0010)	(0.0012)
Add. controls	No	Yes	No	Yes
N	643,916	643,916	643,916	643,916
N (clust)	157,788	157,788	157,788	157,788

Dependent variables: probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, pot size and a categorical variable for game order to control for participation experience. 'Before Xmas Bet' is a dummy equal to 1 if a bet take place from December 1st until December 24th, and 0 otherwise. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * p<0.1 ** p<0.05 *** p<0.01

In Table 5 we see that the high-stake pre-Christmas bettors are more successful than low-stake pre-Christmas bettors.[49] We also see that pre-Christmas high-stake bettors are, on average, more successful compared to high-stake bettors in other months. For weight loss, the marginal effects for bets under $100 are also positive and significantly different from marginal effects of bets placed in other months. This indicates that even sophisticated and partially naive agents of the pessimistic type can increase their chances of commitment by placing higher bets.

As a Placebo test we run the same regression for all other months. There are other holidays during the year that can influence people's preferences and incentives to lose weight. For example, April and November bets could be influenced by Easter and Thanksgiving holidays.[50] During this time some people might be seeking commitment before the holiday in order to avoid overconsumption, while others might be driven by the desire to lose extra weight gained during the holiday. Moreover, Madden (2017) documents a seasonality in weight loss contemplations with peaks in winter and summer. Indeed, Figures 2 and 3 show that there is an increase in interest in weight loss during summer, which peaks in July. It is suggested that the summer interest could be driven by the difference between winter and summer clothing since some surveys have indicated that appearance is among second or third most popular motives to lose weight (O'Brien *et al.*, 2007; Gallup, 2014).[51] Given this, people who participate in May and June bets could be seen as forward-looking because they start losing weight earlier and ahead of summer holidays.

People who participate in September and October games tend on average to weigh less (see Figure 4c). This time period is usually thought to be the best to start weight loss because most people are at their lowest weight in the beginning of the fall making it easier to lose weight than right after the holidays. After October body weight begins to increase into early January due to holiday festivities. At the same time some agents participating in February games could be driven by their failed initial attempts to lose weight in January as part of their New Year's resolution.[52] Overall, however, it is difficult to conclude which types of agents dominate in any of these months in particular. The results can be found in Tables 16 and 17 in Appendix B. Here we see that in most of these months the players are not different from players in other months of the year with respect to their commitment successes. This supports

[49]For high-stake pre-Christmas bettors the effect is 0.068 for probability of winning and 0.196 for weight loss, significant at 1% significance level.

[50]Helander *et al.* (2016); Yanovski *et al.* (2000) document that people tend to gain weight after certain holidays – the most prominent weight gains happen around Christmas, Thanksgiving and Easter holidays.

[51]Notably, in Figure 4c we see that the average initial weight of individuals participating in July and August games increases, indirectly supporting this proposition.

[52]Figure 2b shows that there is an increase in interest in weight loss in the second half of February which coincides with the time when most people fail their first initial attempts in New Year's resolutions.

our assumption that there are larger shares of naive/sophisticated agents participating in January/pre-Christmas games, respectively.[53]

In the next step we investigate our hypotheses 5 and 6. The results from the fully interacted model can be found in Table 6. Here we see that high-pot January and pre-Christmas players are more successful than low-pot January[54] and pre-Christmas[55] players. We also see that players who participate in games with higher pots in January are more successful in their commitments, while players who participated in games with larger pots before Christmas are not significantly different in their commitment successes from high-pot players in other months. The results are in line with our hypotheses, where we suggest that naifs and naive optimists would benefit more from participating in games with larger pots due to their overestimation of future payoffs, while sophisticates and naive pessimists would not benefit or would do so to a lesser extent. Table 18 shows the results of larger pot sizes from the Placebo test by bet months.[56]

6.3 Gender Differences

We extend our analysis further and look at gender differences in behavioral responses.[57] We test this by conducting a heterogeneity analysis by gender. Following literature on gender differences in overconfidence (e.g. Deaux and Farris (1977); Lichtenstein *et al.* (1982); Beyer (1990); Lundeberg *et al.* (1994); Beyer and Bowden (1997); Barber and Odean (2001); Niederle and Vesterlund (2007)) we expect larger shares of men to be of the naive optimist type about their future self-control, implying that male bettors should be less successful in their commitments compared to female bettors. However, we still expect high-stake male bettors to be more successful than low-stake male bettors. The results can be found in Tables 7 and 8 (fully interacted).

Here we see that men participating in high-stake bets are more successful than men participating in low-stake bets (Table 7), but they are on average less successful in their commitments compared to high-stake female players (Table 8). These results are consistent with the expectation that there is a larger share of agents overconfident about their future self-control among men. It should be noted that this result is consistent with greater risk and loss aversion

[53]The coefficient on high-stake bets is positive and significant for April and July bets. This could be driven by Easter holidays and people trying to lose weight during the summer.

[54]0.0181 for probability of winning and 0.0601 for weight loss, significant at 1% significance level

[55]0.0201 for probability of winning and 0.0749 for weight loss, significant at 1% significance level

[56]Figure 11 in Appendix B shows the distribution of pot sizes in each months.

[57]Though gender differences in naiveté are hard to cover in the theoretical approach due to potential asymmetry in naiveté (i.e. when agents' prediction accuracy differs for their future self-control costs and payoffs), we still think that it is worth looking at them more closely empirically.

Table 6: Heterogeneity Analysis of New Year's Resolutions and Participation in Before Christmas Games with High Pot Sizes on Probability of Winning and Weight Loss (%).

	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
High Pot Size	0.0121***	0.0101***	0.0479***	0.0339***
	(0.0009)	(0.0009)	(0.0031)	(0.0031)
High Pot Size × NY Bet	0.0074***	0.0079***	0.0167**	0.0262***
	(0.0020)	(0.0021)	(0.0070)	(0.0071)
	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
High Pot Size	0.0171***	0.0128***	0.0518***	0.0424***
	(0.0008)	(0.0008)	(0.0029)	(0.0029)
High Pot Size × Before Xmas Bet	0.0068	0.0073	0.0306	0.0325
	(0.0069)	(0.0069)	(0.0247)	(0.0249)
Add. controls	No	Yes	No	Yes
N	643,916	643,916	643,916	643,916
N (clust)	157,788	157,788	157,788	157,788

Dependent variables: probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). High Pot Size is a dummy variable equal to one if pot size is larger than the sample median ($24,200), and zero otherwise. All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, bet and bet squared, and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * p<0.1 ** p<0.05 *** p<0.01

Table 7: Probability of Winning and Weight Loss (%) with Larger Bets: Male Sample.

	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
High-Stake Bet	0.0258***	0.0264***	0.0718***	0.0759***
	(0.0025)	(0.0025)	(0.0103)	(0.0104)
	(1)	(2)	(3)	(4)
Bet Amount under $100	0.0010***	0.0009***	0.0031***	0.0029***
	(0.0001)	(0.0001)	(0.0005)	(0.0005)
Bet Amount over $100	0.0000	-0.0000	0.0005*	0.0002
	(0.0001)	(0.0001)	(0.0003)	(0.0003)
Add. controls	No	Yes	No	Yes
N	87,992	87,992	87,992	87,992
N (clust)	19,591	19,591	19,591	19,591

Dependent variables: probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, pot size, and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * p<0.1 ** p<0.05 *** p<0.01

Table 8: Heterogeneity Analysis by Gender on Probability of Winning and Weight Loss (%) with Higher Bets.

	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
High-Stake Bet	0.0580***	0.0612***	0.1497***	0.1603***
	(0.0020)	(0.0021)	(0.0077)	(0.0078)
High-Stake Bet × Male	-0.0313***	-0.0339***	-0.0777***	-0.0840***
	(0.0031)	(0.0032)	(0.0126)	(0.0127)
	(1)	(2)	(3)	(4)
Bet Amount under \$100	0.0022***	0.0018***	0.0067***	0.0053***
	(0.0001)	(0.0001)	(0.0003)	(0.0003)
Bet Amount over \$100	0.0001	0.0000	0.0003	-0.0001
	(0.0001)	(0.0001)	(0.0003)	(0.0003)
Bet Amount under \$100 × Male	-0.0012***	-0.0009***	-0.0034***	-0.0023***
	(0.0002)	(0.0002)	(0.0006)	(0.0006)
Bet Amount over \$100 × Male	-0.0001	-0.0000	0.0003	0.0004
	(0.0001)	(0.0001)	(0.0004)	(0.0004)
Add. controls	No	Yes	No	Yes
N	643,916	643,916	643,916	643,916
N (clust)	157,788	157,788	157,788	157,788

Dependent variables: probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, pot size, and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * p<0.1 ** p<0.05 *** p<0.01

of women that has been documented in the literature[58] and that is sometimes attributed to gender differences in overconfidence.[59]

In the next step we look at behavioral gender differences in response to higher game pots.[60] Tables 9 and 10 present the results. Here we see that males have a positive effect from participation in games with larger pots (Panel A in Table 9), but this effect is smaller than for females (Panel B in Table 9 and Table 10). One possible explanation for the observed result is that, even though a larger share of men are naive optimists about their future self-control costs, a larger share of women are naive optimists with regard to their expected future payoff (i.e. overestimate their expected payoff). It should be noted that this result can be attributed to greater responsiveness of women to financial incentives (i.e. by having a steeper s-shaped utility curve that is associated with higher utility from a given expected payoff). This indicates that there is a potential asymmetry in naive optimistic expectations relating to future self-control costs and expected future payoffs. Notably, this result is consistent with the literature on behavioral response of weight loss to cash rewards, where women are found to be more responsive to the prospect of larger rewards (Augurzky *et al.*, 2012).

6.4 Learning Effect

In this subsection we would like to investigate a learning effect.[61] It has been theorized in the literature that agents are able to learn in the short run from their own behavior about their naiveté (Le Yaouanq and Schwardmann, 2019). In the current setting, it is natural to suggest that some agents might learn from their failure and about their own behavior after unsuccessful commitment. They can then apply this self-knowledge in the next game.

We can investigate this by looking at agents' betting behavior and outcomes in their next game after they lost their previous game.[62] More specifically, we are interested to see whether the agents adjust their betting stakes conditional on their previous failure and whether this adjustment has a positive effect on their commitment success. This adjustment, i.e. an increase in betting stakes, can be interpreted as a learning effect where agents raise their betting stakes

[58]Studies that examine gender differences in risk attitudes over monetary gambles find that women are either more risk averse than men (Gächter *et al.*, 2007; Schmidt and Traub, 2002; Rieger *et al.*, 2011) or that there are no gender differences (Byrnes *et al.*, 1999; Eckel and Grossman, 2008).

[59]Figures 8b and 8c in Appendix B show the percent of bets by size placed by males and females.

[60]Figures 9b and 9c in Appendix B show the distribution of pot sizes for male and female samples.

[61]While this is not the focus of the current investigation, the insights on this can provide grounds for future research.

[62]Conversely, one can also look at the betting behavior and changes in outcomes after the agents won their first game. The initial win can increase overconfidence in (partially) naive agents and lead to worse outcomes as the result.

Table 9: Probability of Winning and Weight Loss (%) with Larger Pots for Males and Females.

	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
Panel A: Male Sample				
High Pot Size	0.0042***	0.0039**	0.0129**	0.0149**
	(0.0016)	(0.0016)	(0.0062)	(0.0062)
Add. controls	No	Yes	No	Yes
N	87,992	87,992	87,992	87,992
N (clust)	19,591	19,591	19,591	19,591
	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
Panel B: Female Sample				
High Pot Size	0.0188***	0.0151***	0.0638***	0.0511***
	(0.0010)	(0.0010)	(0.0033)	(0.0033)
Add. controls	No	Yes	No	Yes
N	543,352	543,352	543,352	543,352
N (clust)	134,564	134,564	134,564	134,564

Dependent variables: probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). High Pot Size is a dummy variable equal to one if pot size is larger than the sample median ($22,590 for Panel A and $24,675 for Panel B), and zero otherwise. All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, bet size, bet squared, and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * $p<0.1$ ** $p<0.05$ *** $p<0.01$

Table 10: Heterogeneity Analysis by Gender on Probability of Winning and Weight Loss (%) with Larger Pots.

	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
High Pot Size	0.0192***	0.0152***	0.0653***	0.0516***
	(0.0010)	(0.0010)	(0.0033)	(0.0033)
High Pot Size × Male	-0.0154***	-0.0113***	-0.0537***	-0.0376***
	(0.0018)	(0.0018)	(0.0067)	(0.0067)
Add. controls	No	Yes	No	Yes
N	643,916	643,916	643,916	643,916
N (clust)	157,788	157,788	157,788	157,788

Dependent variables: probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). High Pot Size is a dummy variable equal to one if pot size is larger than the sample median ($24,200), and zero otherwise. All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, bet size, bet squared, and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * $p<0.1$ ** $p<0.05$ *** $p<0.01$

in order to help themselves to commit. This can be expressed by the following model:

$$Y_{ig} = \alpha_i + \beta\, SecondGame_{ig} + X_{ig}\Gamma + Z_g\Theta + \epsilon_{ig} \tag{10}$$

$$Y_{ig} := \begin{cases} Bet_{ig} \\ Pr(Win) \\ \text{Weight Loss}(\%) \end{cases} \tag{11}$$

where Bet_{ig} is individual $i's$ betting stake in game g; $SecondGame_{ig}$ is equal to 1 if it is a second game and 0 if it is the first game.[63] We estimate Equation 10 using fixed effects regression on a subsample of the first two games the agents played, conditional that they lost their first game. A positive sign on β for all three outcomes can be interpreted as a learning effect. The results are presented in Table 11.

Table 11: Learning Effect (Lost First Game).

	Bet Size		Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)	(5)	(6)
Second Game	2.3354***	2.1886***	0.2504***	0.2432***	0.5868***	0.5545***
	(0.0704)	(0.073)	(0.0015)	(0.0015)	(0.0052)	(0.0052)
Add. controls	No	Yes	No	Yes	No	Yes
N	115,516	115,516	115,516	115,516	115,516	115,516
N (clust)	57,758	57,758	57,758	57,758	57,758	57,758

Dependent variables: Bet size (estimated by OLS); probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, pot size, bet and bet squared (in columns (4) and (6)). Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * p<0.1 ** p<0.05 *** p<0.01

Here we see that, after losing their first game, agents tend to bet more in their second game and are also more likely to win the second game and lose more weight. The results from columns (2), (4) and (6) could be interpreted as an indication of agents' learning about their naiveté. Notably, the results from columns (4) and (6) show that agents are more likely to win and lose more weight in their second game even after holding betting stakes constant. This

[63]We concentrate on the first two games in order to capture the initial learning effect from the first experience with the mechanism.

could indicate that they learn about their self-control and adapt their behavior accordingly.

6.5 Robustness Check

One potential concern with respect to our model is that players' socioeconomic characteristics could be correlated with the betting stakes and their weight loss success. For example, agents with higher income can afford to place higher wagers and can also afford to buy better quality food, consult a nutritionist, and go to the gym with a personal trainer. If these socioeconomic status characteristics stay constant between games, then the fixed effects regression should eliminate them. However, if there is actually a change in these unobserved variables, they will contribute to the omitted variable bias. Therefore, we address this concern by focusing only on bets placed by the agents within one calendar year. The assumption here is that education and income are unlikely to change within one year. The results are presented in Tables 19 and 20 in Appendix B. The results stay qualitatively the same, therefore, we conclude that this is not a concern.

Additionally, another concern could be that some agents participate in more than one game at once.[64] In this case, our identifying assumption that the initial motivation (δ_{1i}) is game-invariant might not hold since the wager in the first game can influence motivation in the parallel game. To address this concern we exclude parallel games and concentrate only on games that were played sequentially without overlap. The results stay qualitatively the same (see Table 21 in Appendix B).

We also check the sensitivity of our results to using logit model instead of LPM for the probability of winning as an outcome. Logit model produces qualitatively similar results.[65]

Finally, we repeat the main estimation of the bet and pot size effect on the full sample (i.e. also including people who only played once) in order to check that our results are not specific to our panel sample. The results can be found in Tables 22 and 23 in Appendix B. Here we see that the results are very similar to our panel sample, indicating that they are not sample-specific.

7 Discussion

The results from our empirical analysis concur with the theoretical predictions from Hirt-Schierbaum and Ivets (2020) and show that a self-bet is a promising mechanism that can help different types of agents overcome their self-control problems. More specifically, we find that when agents bet more money they

[64] DietBet allows participation in up to three Kickstarter games at once: `https://waybetter.com/dietbet/faq`.

[65] The results are available upon request.

are more likely to win the game and lose more weight. We also find that agents benefit from participation in games with larger pots.

Our theoretical model uses the observation from behavioral economics that loss aversion is a significant motivator of human behavior (Kahneman and Tversky, 1979). Additionally, the mechanism also utilizes agents' taste for gains and rewards by providing a payoff in case of successful commitment and the observation that people tend to overestimate the likelihood of unlikely events (here, the size of future payoff) (Kahneman and Tversky, 1984).[66] The findings are also consistent with the evidence from several behavioral weight loss programs involving deposit contracts and financial incentives.[67]

7.1 Policy Relevance

In this section we discuss the results with respect to their policy relevance and provide outlook for future research.

Certain challenges should be highlighted related to the provision of self-bets as commitment devices in the market. One of them is the public policy concern of potential exploitation of (partially) naive agents. Naive and partially naive agents of the optimistic type may be inefficiently served. Naive agents will not demand commitment per se, while naive optimists will overestimate their chances of successful commitment. This implies that intervention by policymakers would be necessary, e.g. by protecting them through regulation, to prevent their exploitation by the market and to allow for successful commitment.

In order to avoid exploitation of (partially) naive agents in the market, benevolent policymakers can alternatively implement this mechanism in the public health policy context. A potential application can be a public program offered by policymakers to instigate positive health behaviors among overweight/obese individuals or smokers. The program participation can be framed as a challenge in order to avoid the negative connotation of betting and gambling.[68]

[66]Studies that compare the effectiveness of financial incentives structured as rewards vs. as deposit contracts find that there is a higher take up for the reward options, but the deposit-based programs lead to greater behavioral change (Halpern *et al.*, 2015). The self-bet mechanism includes both features: while participants put their own money on the line and therefore evoke loss aversion, there is also a chance to be rewarded in case of successful commitment which could increase interest in the program compared to simple commitment or deposit contracts.

[67]Jeffery *et al.* (1983, 1984); Volpp *et al.* (2008); John *et al.* (2011), and Finkelstein *et al.* (2007); Augurzky *et al.* (2012) find that deposit contracts and financial incentives yield significant weight losses. Moreover, greater baseline deposits and cash rewards are associated with higher likelihood to reach weight loss goals (Jeffery *et al.*, 1984; Finkelstein *et al.*, 2007; Augurzky *et al.*, 2012). However, both types of financial incentives are found to exhibit diminishing marginal returns (Jeffery *et al.*, 1983; Finkelstein *et al.*, 2007; Augurzky *et al.*, 2012).

[68]Although it is possible that the motivation for betting on weight loss is associated with enjoyment of gambling, risk-seeking, or profit-making, there are a number of reasons to believe

Prior to the start of the program, policymakers should prescreen[69] and identify naifs and agents overconfident about their self-control (naive optimists) and educate them on their probabilities of default in order to increase their commitment chances. More specifically, policymakers should encourage naive and partially naive agents of the optimistic type to bet more than they originally planned to bet based on their perception of future costs of self-control. Hereby, policymakers can assist these agents to commit successfully and allow for a random negative change in motivation.[70] Moreover, (partially) naive agents should be encouraged by policymakers to participate in games with larger pots since this increases their chances of successful commitment. Finally, policymakers should use the information from previous bets (e.g. bet size and outcome) in order to advise individuals who are interested to participate in the program more than once.

Policymakers should also consider an important observation that emerged from the analysis – many people seek commitment in January, more than any other month of the year. At the same time, these people are significantly less likely to commit successfully. This represents a critical period and an opportunity for policymakers to intervene and help those who seek commitment by providing information and guidance. It is also important to target men as they seem to be less willing to participate, have a high prevalence of obesity and smoking (Flegal *et al.*, 2010; WHO, 2016b), are more likely to be overconfident about their future self-control and less responsive to monetary incentives, and, therefore, are also at a higher risk of default on their commitments.

Another concern regarding the effectiveness of the mechanism is that some people who participate in the program and initially lose weight might be unsuccessful in maintaining it in the longer term and later regain it back. These people then try to lose this regained weight by starting a new weight loss cycle. This weight cycling problem is usually known as a yo-yo effect.

We look at the changes in players' initial weight between the games in order to check whether this concern stands. Results can be found in Table 24 in Appendix B. Here we look at the initial weight changes between first and second, second and third, third and fourth or higher order games. We see that the initial weight in the second game is lower than that of the first, indicating that people participating in these games have lost and not regained weight. The same holds true for other higher order games: the initial weight between the games is on average lower meaning that on average people lose and do

that bettors are using bets to tackle self-control problems – there are significant costs for the bettors that make weight bets different from standard gambles. The obvious costs include the cost of losing weight and submitting weigh-ins.

[69]For example, with the help of a survey about their motivation, self-control issues, subjective expectations, and past behaviors.

[70]Of course, some of these agents might not take the higher bets, but this is not necessarily welfare decreasing since these naive and partially naive agents of the optimistic type would have likely lost their original bets. However, if they do take higher bets they will increase their probability of success.

not regain weight.[71] However, we can observe diminishing marginal returns to weight loss between the games. This indicates that the mechanism is helpful for weight loss even when used several times, however its effectiveness diminishes with higher order attempts.

It is important to note that weight loss is only part of the process associated with positive behavioral change, while another important concern is weight maintenance over the longer run. Here, we suggest that a different incentive structure should be introduced that puts healthy habit formation in focus.

To address concerns that program participants might attempt to lose weight with unhealthy strategies, policymakers can provide information on healthy ways to achieve weight loss, monitor and reach out to the participants that exhibit rapid weight loss, and exceed the targeted goal.

Another question that could be raised by some critics is the concern about manipulation of weigh-in data and potential gaming of the system. This is hypothetically possible, but is highly unlikely since these agents still need to exert effort to lose weight, submit weigh-ins, and face the uncertain final net payoff when they succeed.[72] Even when assuming that a certain percentage of players have joined the game for the wrong reason, we expect them not to participate more than once after they learn that the net payoff is not worth the effort. Moreover, we do not expect these players to appear in our main analysis since we only look at players who participated more than once.

An argument towards sustainability and cost-effectiveness of such programs is the fact that DietBet has been offered by a private company since 2011 and continues to survive on the marketplace.

Finally, the main insights from our study can also be used in a broader context, i.e. when introducing and assessing new digital health technologies in contemporary healthcare markets. For example, some countries have already introduced digital health applications with one of the focuses being improvement of patients' health behaviors.[73] Our results indicate that introduction of loss aversion can improve the effectiveness of the devices aimed at encouraging positive behavioral changes. For example, introducing a co-pay instead of providing digital health apps free of charge could improve their behavioral health effects. This co-pay can later be reimbursed in case of successful com-

[71] Notably, the results without controls (columns (3) & (5)) indicate that there a weight gain, but after we include controls and, especially, when we control for the time between the games, the results indicate towards weight loss (columns (4) & (6)).

[72] In fact, this conclusion is supported by the descriptive statistics: 49.3% of all players fail; the average amount bet is \$31.62 while the average amount won is \$32.52 (see Table 1), indicating a very small net payoff.

[73] One example is a recently-enacted Digital Healthcare Act that came into effect on December 19th 2019 in Germany and introduced "apps on prescription" as part of the care provided to statutory health insurance (SHI) patients. This program allows patients to receive healthcare through digital health apps that can be prescribed by physicians or psychotherapists and are reimbursed by health insurers. In order to be eligible for reimbursement digital health apps should be approved by the Federal Institute for Drugs and Medical Devices (BfArM). Part of this assessment is examining the evidence of their positive healthcare effect.

mitment. Thus, these considerations should be factored in by the governmental agencies involved in effectiveness assessment and price negotiation of such devices. Moreover, to ensure that patients, providers, and payers make well-informed decisions, the digital health app directory provides comprehensive information on the device. Thus, the insured person could also be informed about their probabilities of default and the importance of co-pay to increase their likelihood of commitment.

7.2 Outlook for Future Research

In the current investigation the primary focus lies on the short-term applicability and success of the bet mechanism: theoretically, we develop a two-period model and empirically we examine a 4-week program. The natural next steps would be to look into applicability of the bet mechanism – in theory and application – in the longer term.[74] For the empirical analysis, data from 6-month- and 12-month-long games called *Transformer* and *Maintainer Bets* provided by WayBetter Inc. can be examined.

In order to investigate the optimal bet size that can ensure commitment for different types of agents a RCT targeting overweight/obese people or smokers who are interested in the mechanism[75] should be conducted. In the RCT we can measure agents' self-reported expectations (perception biases) about their likelihoods of default and expected size of future payoffs, motivation levels and self-control problems with the help of a survey, and test how they influence the bet choice and the likelihood of success.[76] Special attention should be given to gender differences since we find some indication that men and women estimate their future self-control costs and expected payoffs differently.

Finally, in the cases that policymakers would identify as needing intervention (i.e. for naive and partially naive agents of the optimistic type) it is also important to determine the investments that these agents are willing to make and that ensure resistance as well (i.e. take up rate of higher bets and the increase in the likelihood of success in that cases).

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[74]Here, for example, we can extend the theoretical model to allow for development of motivation over time; asymmetry in naiveté with regard to future costs of self-control and payoffs (as exemplified by gender differences in responses); agents learning from their previous experiences with the commitment mechanism and updating their beliefs; and healthy habit formation.

[75]Taking into consideration that any future interventions are likely to be optional, the program participation should be voluntary, and, therefore, self-selection would be present. However, outcomes among self-selected participants would still be relevant since we are analyzing a *self*-commitment mechanism and this does, by nature, applies to agents who are aware of their problem and are willing to do something about it.

[76]Moreover, we can introduce a questionnaire for noncompleters. In the current setting we assume they did not lose any weight, but in reality they might have lost up to 3.9% and not submitted their final weigh-in because they anticipate to lose the bet anyway. However, these players might nevertheless perceive themselves as successful (with regard to weight loss) since they did lose weight after all, just not enough to win their money back.

8 Conclusion

Obesity is a growing problem throughout the developed and developing world. Despite the fact that our collective knowledge and understanding of nutrition and exercise has never been greater, obesity rates continue to increase at an alarming speed. It is imperative to attack this problem on every level, including innovations that can incentivize positive behavioral changes. Digital technology offers a new set of solutions in this respect, with apps focused on nutrition, diet, and behavioral change. Our paper investigates the use of a financial incentive weight-loss app as a novel way to combat the problem.

In this paper, we empirically test the conclusions from the theoretical *Self-Commitment Decision Model* from HSI where we develop a theoretical model that provides an alternative explanation to the observed behavior usually attributed to preference reversal. The model explains *why* certain agents with a preference for commitment might fail. According to the *Self-Commitment Decision Model*, agents with self-control problems can use the self-bet mechanism in order to help themselves follow through with their normatively-preferred choices. The model also allows for heuristic biases in agents' decision-making and for heterogeneity in agent types, with different conclusions arising from this regarding their abilities to use the bet mechanism successfully.

Here, we apply the model in the weight loss setting – an area where agents are usually thought to experience self-control issues. In our analysis we use real-world data from DietBet. We confirm the hypotheses derived from the theoretical model and uncover that betting more money is associated with a significantly higher probability of losing more weight, and thus winning the bet. In particular, participation in a high-stake bet increases the likelihood of winning the game by 5.3 - 10.5 pp (0.14 - 0.43 pp greater weight loss);[77] betting $10 more is associated with an increase of 1.7 - 2.9 pp in probability of winning the bet (0.05 - 0.12 pp higher weight loss) for bets under $100; while marginal effects for high-stake bets ($100 and over) are not significant – implying diminishing marginal returns. Thus, we suggest that by placing higher wagers on themselves (and simultaneously evoking higher loss aversion) agents can increase their likelihood of successful commitment.

We also find that agents benefit from participation in games with larger pots (respond to the monetary reward part of the bet) due to overestimation of their future payoffs. This effect is much smaller, than that of the high-stake bet, therefore, implying that loss aversion is the main contributor to the mechanism's success. However, agents' response to the prospective monetary reward is still significant and amplifies the bet effect.[78] Furthermore, the low take up rates of commitment and deposit contracts (which use loss aversion as the only

[77]Overall, this corresponds to around 10.6 - 21.1% increase from the baseline probability of winning of 49.8% for bets under $100 in the full sample.

[78]For example, if we combine both bet and pot effects together the total effect from self-bet mechanism will be 6.7 - 12.44 pp increase in the probability of winning the bet (0.19 - 0.5 pp higher weight loss), corresponding to around 13.5 - 25% increase from the baseline probability

contributor to the commitment mechanism) and the large number of players that join DietBet can indicate that the monetary reward is an important factor for people to choose this commitment mechanism.

Moreover, our empirical results corroborate the theoretical predictions from HSI that the bet mechanism can help different types of agents who seek commitment to follow through with their normative intentions. More specifically, we find evidence that the bet mechanism can help naive and partially naive agents of the optimistic type follow through with their commitments (as exemplified by January bettors), and can increase chances of successful commitment for sophisticated and partially naive agents of the pessimistic type (as exemplified by pre-Christmas bettors). Finally, we also document behavioral differences in gender responses.

of winning of 49.8% for bets under $100 in the full sample (or 7.1 - 19% increase in weight loss from the baseline weight loss of 2.66% for bets under $100 in the full sample).

Appendices

A Theoretical Extension

In our main model we consider an investment-payoff combination that is generally-defined and is not context-specific. Here, we specify the case of a monetary unmatched bet as is observed in the context of the online dieting program. In this case an agent can observe how many players joined the bet before him. Let n be the number of players after the agent joined the game. $g \leq n$ of these players will win the bet. The possible payoff from the bet is then defined by $p_w = \frac{n*w}{g}$; i.e., the pot is split equally amongst winners. This implies that the monetary payoff that winners receive is financed by all players and the bet is thus budget-balanced.

Proposition 3 (Budget Balancedness)**.** If the pot of an unmatched bet with n players, $g \leq n$ winners and bet amount $w > 0$ is split equally among winners, the bet is budget-balanced.

Proof. The value of the pot is $n * w$, each winner receives the payoff $p_w = \frac{n*w}{g}$. Thus, the net value of the pot is $n * w - g * p_w = 0$. □

Generally, players cannot foresee how many players will win the bet and g is unknown in advance. Therefore, at the beginning of periods one and two players have to maximize their utility given their believes about other players' motivation and the overall number of players, $\hat{g}$. If we were analyzing a matched bet, players with equal motivation would have been matched in one bet. In our case, however, players are not matched and therefore face a heterogeneous group of people. And since players do not have any information about the other participants of the bet, it is valid to assume that all players are equally likely to win or lose (i.e., $g = \frac{1}{2} \cdot n$).[79]

The true expected payoff at time t=1 is given by

$$\mathbb{E}(p_2(x)) = \frac{n \cdot w}{\sum_{i=1}^{n} \mathbb{E}(\mathbb{1}_i)}, \qquad \mathbb{1}_i = \begin{cases} 1 & \text{if } x_2^* = x^M, \\ 0 & \text{if } x_2^* = y^M \neq x^M. \end{cases}$$

Given that the probability of winning is $\frac{1}{2}$, $\mathbb{E}(\mathbb{1}_i) = \frac{1}{2} \cdot 1 + \frac{1}{2} \cdot 0$. This yields

$$\mathbb{E}(p_2(x)) = \frac{n \cdot w}{\frac{1}{2} \cdot n} = 2 \cdot w.$$

[79] Also, our data shows that on average players win 50% of their bets (see Table 1), which consolidates this assumption.

We follow Weinstein (1980), Abel (2002), Shepperd *et al.* (2002), and Mansour *et al.* (2006) in the assumption that an agent attributes a certain likelihood to himself and others winning the bet. Sophisticates correctly anticipate that their chances are 50:50. Naive optimists (pessimists) overestimate (underestimate) their own motivation and their own likelihood of winning the bet ($\frac{1}{2} \cdot (1+\tilde{v})$). At the same time, they underestimate (overestimate) the motivation of other players and their respective likelihood of winning ($\frac{1}{2} \cdot (1-\tilde{v})$).[80]

We use the sign-dependent degree of naiveté as a distortion (weight) of the true winning probability and receive the following result for the biased expected payoff $\hat{p}_2(x)$ in case $x_2^* = x^M$:

$$\hat{p}_2(x) = \frac{n \cdot w}{\underbrace{\frac{1}{2}(1+\tilde{v}) \cdot 1 + \frac{1}{2}(1-\tilde{v}) \cdot 0}_{\text{distorted probability that agent wins}} + \sum_{i=1}^{n-1} [\underbrace{\frac{1}{2}(1-\tilde{v}) \cdot 1 + \frac{1}{2}(1+\tilde{v}) \cdot 0}_{\text{distorted probability that other players win}}]}$$

$$= \frac{n \cdot w}{\frac{1}{2}(1+\tilde{v}) + \frac{1}{2}(n-1)(1-\tilde{v})} = \frac{2 \cdot n \cdot w}{(1+\tilde{v}) + (n-1)(1-\tilde{v})}.$$

Note that $\hat{p}_2(x) \in (w, nw)$ is bound by $\tilde{v} \in (-1, 1)$. We assume that the agent assigns reversed probability distributions to himself vs. other players, so if he is an optimist he assumes other players to perform worse than himself and if he is a pessimist vice versa. Sophisticates are assumed to have a degree of naiveté of $\tilde{v} = 0$, which yields $\hat{p}_2(x) = \mathbb{E}(p_2(x))$. This then results in naive optimists to overestimate their possible future payoff and naive pessimists to underestimate it.

Given their beliefs and following HSI agents only bet if ($\hat{8}$) from HSI is satisfied for $\hat{p}_2(x)$, i.e., if the expected payoff from investing is welfare-enhancing compared to not investing and it induces resistance in expectation:

$$\underbrace{u(y^M) - u(x^M) + (\frac{1}{\hat{\delta}} - 1)(v(y^M) - v(x^M))}_{\widetilde{LHS}}$$
$$\leq \underbrace{s(\lambda \frac{n \cdot w}{\frac{1}{2}(1+\tilde{v}) + \frac{1}{2}(n-1)(1-\tilde{v})} - w - k)}_{\widetilde{RHS}}. \qquad (\tilde{8})$$

Definition 5 (Efficient Bet)**.** A wager is *efficient*, given a player's belief, whenever it induces equality in ($\tilde{8}$).

Before we start with the proof of Proposition 2 we need to consider an important factor. In case of parimutuel betting in general, players often receive information about the bet amount and current pot size. It is up to them to draw conclusions on how many players are involved in the game (pot size/wager).

[80] See, for example, Shepperd *et al.* (2002) for optimism in comparative risk judgments.

Although this seems like an easy mathematical task, the authors assume that there might be a range of players that will not do calculations like these and just ignore the fact that a larger pot size comes with a larger amount of players. These type of players might simply associate a larger pot size with a higher expected payoff - in the (wrong) assumption the pot size was an exogenously given constant.[81]

In the special case of DietBet players are actively informed about how many players are in the game (see, e.g., Figure 1), which should make this kind of ignorance a lot harder. But, given that we assume partially naive players to have a biased expectation about their own and other players' ability to win the bet we can still see a positive effect from a larger pot size (larger number of players in a game) on the biased expected payoff - see calculations below.

We leave the conclusion whether players realize the connection between pot size and number of players up to psychologists and simply observe that in both cases the expected payoff depends positively on the pot size/number of players:

1. the agent considers the pot size to be an exogenous constant, ρ. Then, $\frac{\partial \hat{p}_2(x)}{\partial \rho} = \frac{2}{(1+\tilde{v})+(n-1)(1-\tilde{v})} > 0$.
2. the agent considers the pot size to be dependent on the number of players. Then, $\frac{\partial \hat{p}_2(x)}{\partial n} = \frac{\partial \hat{p}_2(x)}{\partial \rho(n)} \cdot \frac{\partial \rho(n)}{\partial n}$

Just the size of this effect varies, but it is of no special interest in this theoretical approach.

Proof Proposition 2.

i) This follows from the fact that agents only bet if ($\tilde{8}$) is satisfied.

ii) Sophisticates will solve their true problem and will only bet if resistance is induced and welfare is enhanced.

iii) This follows directly from the calculation above. $\frac{\partial \hat{p}_2(x)}{\partial \rho} = \frac{2}{(1+\tilde{v})+(n-1)(1-\tilde{v})} > 0$. So, the larger the potsize, the larger the expected payoff. This holds true independently of naiveté.

iv) a) Recall that naive optimists face $\tilde{v} > 0$. Now compare ($\tilde{8}$) with (8) from HSI (called (8_{HSI}) here, to avoid confusion):

$$\underbrace{u(y^M) - u(x^M) + (\frac{1}{\mathbb{E}\delta_2} - 1)(v(y^M) - v(x^M))}_{LHS} \leq \underbrace{s(\lambda 2w - w - k)}_{RHS} \tag{8_{HSI}}$$

[81] Psychologists find that concerning lotteries people rather concentrate on the pot size than on the probability of winning and generally more people play when the pot size is larger (Griffiths and Wood, 2001).

For convenience we label the left-hand sides (right-hand sides) of inequalities ($\tilde{8}$) and (8_{HSI}) with $\widetilde{LHS}$ and LHS ($\widetilde{RHS}$ and RHS), respectively.

Given his belief, the monotonicity of s and for $n > 2$ we receive $\widetilde{LHS} < LHS$ and $RHS < \widetilde{RHS}$. Both of these relations follow directly from $\tilde{\nu} > 0$. If we assumed there was no naiveté about the expected payoff, the agent solved $\widetilde{LHS} = RHS$, i.e., he bets efficiently given his belief about his future degree of motivation while he estimates the expected payoff correctly (has no bias about his and his fellow players' likelihood to win), then $\widetilde{LHS} = RHS < LHS$. This implies he is more likely to undercommit. Due to the fact that he can only choose the efficient wager with respect to his expected motivation there is always the possibility that the random shock is positive and of such force that his actual motivation is even larger than his biased expected motivation ($\delta_2 > \hat{\delta}_2 > \mathbb{E}(\delta_2)$) which would imply that the commitment was binding.

b) If we include naiveté about the expected payoff it is possible that he ends up with $\widetilde{LHS} = RHS < LHS < \widetilde{RHS}$. This means, given the same wager his biased expectation would cancel out his undercommitment and he would win the bet nevertheless.

v) a) Analogously to iii) compare ($\tilde{8}$) and (8_{HSI}). Keep in mind that naive pessimists face $\tilde{\nu} < 0$ which reverses the relations stated above (for $n > 2$): $\widetilde{LHS} > LHS$ and $RHS > \widetilde{RHS}$.

Again, if we assume that there was no naiveté about the expected payoff, an agent would falsely choose the wager that solves $\widetilde{LHS} = RHS$. With $LHS < \widetilde{LHS} = RHS$ this implies he is more likely to overcommit in the sense that his bet is not efficient wrt. his true expected motivation. Due to the fact that he can only choose the efficient wager wrt. his expected motivation there is still the possibility that the random shock is negative and of such force that his actual motivation is smaller than his biased expected motivation ($\delta_2 < \hat{\delta}_2 < \mathbb{E}(\delta_2)$), which would imply that the commitment was not binding.

b) As above, include naiveté about the expected payoff. Generally, since $\widetilde{RHS} < RHS$ if he chose $\widetilde{LHS} = RHS$ he might end up with $LHS < \widetilde{RHS} < \widetilde{LHS} < RHS$ or $\widetilde{RHS} < LHS < \widetilde{LHS} < RHS$. This implies that, given the same bet amount, the distorted expectation about the pot size lets the chosen wager seem too small. To cancel this effect out (solving $\widetilde{LHS} = \widetilde{RHS}$) the agent would have to bet even more, which would make his overcommitment more severe.

vi) As in the proof of proposition 1 v) (see HSI) naive agents are not aware that they have a self-control problem. They neglect their true motivation and the possibility of external shocks. This type of agent has then the same maximization problem as in the basic model. So either a naive agent does not commit at all or maximizes the net-payoff of the investment, which is the most binding choice he can make, given his endowment. In this case he might unintentionally commit successfully to a choice.

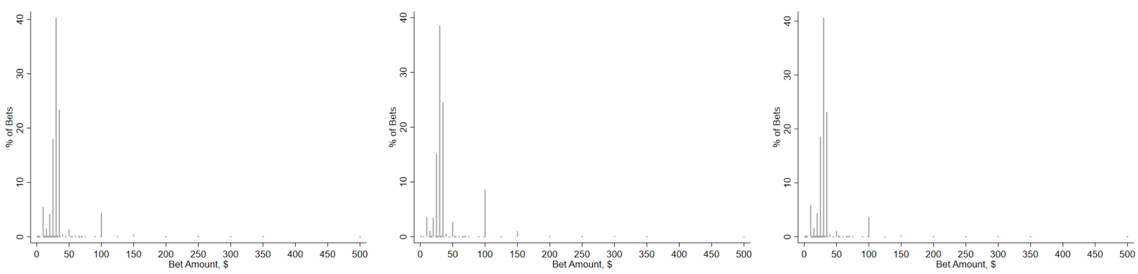
vii) This follows directly from ii)-v).

□

B Empirical Appendix

Table 12: Completers vs. Noncompleters.

	Completers		Noncompleters		P value
Male, N (%)	100937	(11.1)	45113	(4.9)	<0.000
Start Weight lb, Mean (SD)	193.6	(42.7)	197.3	(44.2)	<0.000
Bet Amount USD, Mean (SD)	32.4	(18.6)	30.2	(14.4)	<0.000
N Weigh-ins in Game, Mean (SD)	5.7	(3.6)	2.8	(2.3)	<0.000
Social Engagement, Mean (SD)	1.1	(11.3)	0.6	(7.3)	<0.000
Weight Loss (%), Mean (SD)	4.2	(1.4)	0.0	(0.0)	<0.000
N	588315		324422		



(a) Panel Sample (b) Male Panel (c) Female Panel

Figure 8: Percent of Bets by Size.

Table 13: Descriptive Statistics II: Panel Sample.

	Obs	Mean	SD	Min	Max
		Game Characteristics			
Pot Amount, $	17572	1675.2	10489.9	2	442140
N Players in Games	17572	51.2	329.4	1	14448
N Winners in Games	17572	25.0	169.2	0	8777
Closed Game	17572	0.40	0.49	0	1
		User Characteristics			
N Games per User	157788	4.08	4.04	2	102
Male	157788	0.15	0.35	0	1
Age	105648	34.7	9.00	18	86.3
		Player Characteristics			
Bet Amount, $	643916	32.5	18.5	1	500
Amount Won, $	643916	37.4	37.9	0	1050
Share of Winners	643916	0.58	0.49	0	1
Start Weight, lb	643916	195.3	42.8	121.2	334.6
Final Weight, lb	643916	189.5	42.0	108.7	335
Weight Loss, lb	643916	5.81	4.54	-0.50	17.2
Weight Loss, %	643916	3.00	2.23	-0.41	11.9
Social Engagement	643916	0.92	9.86	0	261
N Weigh-ins in Game	643916	5.03	3.68	1	31
Male	643916	0.16	0.36	0	1
Completer	643916	0.70	0.46	0	1
		Player Characteristics: Winners			
Bet Amount, $	375305	34.0	20.4	1	500
Amount Won, $	375305	64.2	27.4	3	1050
Start Weight, lb	375305	194.0	42.4	121.2	334.6
Final Weight, lb	375305	184.9	40.6	108.7	321
Weight Loss, lb	375305	9.12	2.35	0.10	17.2
Weight Loss, %	375305	4.71	0.77	0.057	11.9
Social Engagement	375305	1.04	10.8	0	261
N Weigh-ins in Game	375305	5.97	3.84	1	31
Male	375305	0.19	0.39	0	1
		Player Characteristics: Nonwinners			
Bet Amount, $	268611	30.4	15.1	1	500
Start Weight, lb	268611	197.1	43.2	121.2	334.6
Final Weight, lb	268611	195.9	43.0	116.6	335
Weight Loss, lb	268611	1.18	2.26	-0.50	13
Weight Loss, %	268611	0.60	1.12	-0.41	3.99
Social Engagement	268611	0.76	8.31	0	261
N Weigh-ins in Game	268611	3.71	2.96	1	30
Male	268611	0.11	0.31	0	1

Table 14: Effect of High-Stake Bets and Marginal Effects of Bets on Probability of Winning and Weight Loss (%)–Not Controlling for Completer Status.

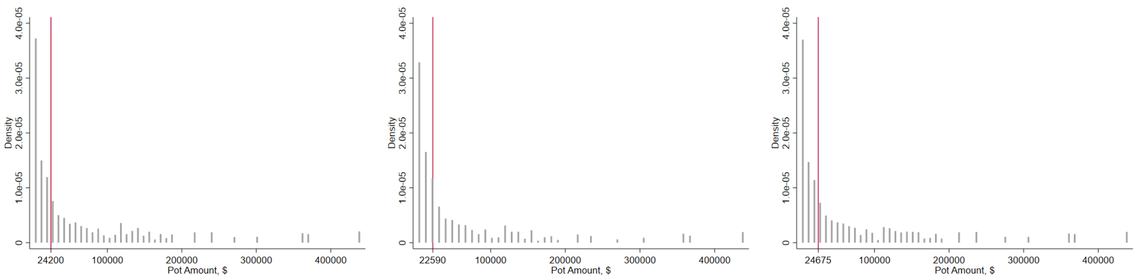
	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
High-Stake Bet	0.1068***	0.1052***	0.4297***	0.4246***
	(0.0028)	(0.0027)	(0.0133)	(0.0126)
	(1)	(2)	(3)	(4)
Bet Amount under $100	0.0028***	0.0029***	0.0103***	0.0117***
	(0.0001)	(0.0001)	(0.0005)	(0.0004)
Bet Amount over $100	0.0004***	-0.0001	0.00191***	-0.0005
	(0.0001)	(0.0001)	(0.0005)	(0.0004)
Add. controls	No	Yes	No	Yes
N	643,916	643,916	643,916	643,916
N (clust)	157,788	157,788	157,788	157,788

Dependent variables: probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). All regressions include individual fixed effects. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, pot size, and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * $p<0.1$ ** $p<0.05$ *** $p<0.01$

Table 15: Effect of High Game Pots on Probability of Winning and Weight Loss (%)–Not Controlling for Completer Status.

	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
High Pot Size	0.0126***	0.0189***	0.0350***	0.0752***
	(0.0013)	(0.0012)	(0.0059)	(0.0053)
Add. controls	No	Yes	No	Yes
N	643,916	643,916	643,916	643,916
N (clust)	157,788	157,788	157,788	157,788

Dependent variables: probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). High Pot Size is a dummy variable equal to one if pot size is larger than the sample median (24,200$), and zero otherwise. All regressions include individual fixed effects. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, bet and bet squared, and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * p<0.1 ** p<0.05 *** p<0.01



(a) Panel Sample (b) Male Panel (c) Female Panel

Figure 9: Distributions of Pot Sizes with Sample Median.

Table 16: Placebo Test: Probability of Winning.

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
High-Stake Bet	0.0527***	0.0530***	0.0517***	0.0530***	0.0519***	0.0533***	0.0529***	0.0535***	0.0535***	0.0524***
	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0017)
High-Stake Bet × X	-0.0010	-0.0021	0.0158***	-0.0023	0.0159***	-0.0053	0.0015	-0.0059	-0.0079	0.0078
	(0.0046)	(0.0052)	(0.0054)	(0.0063)	(0.0059)	(0.0051)	(0.0052)	(0.0052)	(0.0056)	(0.0053)
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Bet Amount under $100	0.0019***	0.0019***	0.0019***	0.0019***	0.0019***	0.0019***	0.0019***	0.0019***	0.0019***	0.0019***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Bet Amount over $100	0.0000	-0.0000	-0.0000	-0.0000	0.0000	-0.0000	-0.0000	0.0000	-0.0000	0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Bet Amount under $100 × X	-0.0002	-0.0003	-0.0001	0.0001	-0.0004	-0.0005**	-0.0008***	-0.0001	0.0002	-0.0001
	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)
Bet Amount over $100 × X	-0.0002	0.0001	-0.0001	-0.0000	-0.0005	0.0002	0.0002	-0.0007*	0.0002	-0.0005
	(0.0002)	(0.0002)	(0.0001)	(0.0004)	(0.0004)	(0.0002)	(0.0004)	(0.0004)	(0.0003)	(0.0005)
Add. controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	643,916	643,916	643,916	643,916	643,916	643,916	643,916	643,916	643,916	643,916
N (clust)	157,788	157,788	157,788	157,788	157,788	157,788	157,788	157,788	157,788	157,788

Dependent variable: probability of being a winner in the game (estimated by LPM). All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, pot size and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * p<0.1 ** p<0.05 *** p<0.01

Table 17: Placebo Test: Weight Loss (%).

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
High-Stake Bet	0.1337***	0.1393***	0.1360***	0.1389***	0.1364***	0.1418***	0.1370***	0.14175***	0.1395***	0.1391***
	(0.0066)	(0.0066)	(0.0065)	(0.0064)	(0.0065)	(0.0065)	(0.0065)	(0.0065)	(0.0065)	(0.0065)
High-Stake Bet × X	0.0332*	-0.0101	0.0358*	-0.0052	0.0419*	-0.0396*	0.0250	-0.0358*	-0.0102	0.0015
	(0.0184)	(0.0194)	(0.0205)	(0.0230)	(0.0227)	(0.0202)	(0.0197)	(0.0206)	(0.0209)	(0.0205)
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Bet Amount under $100	0.0057***	0.0057***	0.0057***	0.0056***	0.0057***	0.0058***	0.0058***	0.00572***	0.0055***	0.0056***
	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0002)
Bet Amount over $100	0.0002	0.0000	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0000	0.0001
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Bet Amount under $100 × X	-0.0001	-0.0017**	-0.0004	0.0001	-0.0009	-0.0022***	-0.0026***	-0.0014*	0.0016*	0.0007
	(0.0007)	(0.0008)	(0.0007)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0010)
Bet Amount over $100 × X	-0.0006	0.0012	-0.0004	-0.0002	-0.0008	0.0004	0.0024	-0.0024	0.0022*	-0.0008
	(0.0005)	(0.0011)	(0.0005)	(0.0013)	(0.0014)	(0.0009)	(0.0017)	(0.0018)	(0.0012)	(0.0017)
Add. controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	643,916	643,916	643,916	643,916	643,916	643,916	643,916	643,916	643,916	643,916
N (clust)	157,788	157,788	157,788	157,788	157,788	157,788	157,788	157,788	157,788	157,788

Dependent variable: weight loss in % (estimated by OLS). All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, pot size and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * p<0.1 ** p<0.05 *** p<0.01

Table 18: Placebo Test: Probability of Winning and Weight Loss (%) for Games with Higher Pot Sizes.

	Winner									
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
High Pot Size	0.0146***	0.0142***	0.0148***	0.0136***	0.0138***	0.0147***	0.0142***	0.0141***	0.0138***	0.0136***
	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)
High Pot Size × X	-0.0086***	-0.0086***	-0.0113***	0.0006	-0.0035	-0.0130***	-0.0090***	-0.0070**	-0.0014	0.0014
	(0.0025)	(0.0028)	(0.0028)	(0.0029)	(0.0034)	(0.0029)	(0.0032)	(0.0028)	(0.0028)	(0.0032)
	Weight Loss (%)									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
High Pot Size	0.0504***	0.0493***	0.0497***	0.0462***	0.0472***	0.0509***	0.0486***	0.0474***	0.0472***	0.0455***
	(0.0031)	(0.0030)	(0.0030)	(0.0030)	(0.0030)	(0.0030)	(0.0030)	(0.0030)	(0.0030)	(0.0030)
High Pot Size × X	-0.0363***	-0.0378***	-0.0297***	0.0025	-0.0157	-0.0611***	-0.0348***	-0.0187**	-0.0035	0.0108
	(0.0086)	(0.0096)	(0.0096)	(0.0102)	(0.0121)	(0.0102)	(0.0111)	(0.0095)	(0.0100)	(0.0113)
Add. controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	643,916	643,916	643,916	643,916	643,916	643,916	643,916	643,916	643,916	643,916
N (clust)	157,788	157,788	157,788	157,788	157,788	157,788	157,788	157,788	157,788	157,788

Dependent variable: probability of winning and weight loss in % (estimated by OLS). High Pot Size is a dummy variable equal to one if pot size is larger than the sample median (24,200$), and zero otherwise. All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, gender, social engagement, N of weigh-ins, indicator whether the game is closed, bet and bet squared, and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * p<0.1 ** p<0.05 *** p<0.01

Table 19: Probability of Winning by Year.

	2012	2013	2014	2015	2016	2017
	(1)	(2)	(3)	(4)	(5)	(6)
High-Stake Bet	0.1615	0.0591***	0.0699***	0.0415***	0.0418***	0.0185***
	(0.1218)	(0.0104)	(0.0053)	(0.0034)	(0.0026)	(0.0040)
	2012	2013	2014	2015	2016	2017
	(1)	(2)	(3)	(4)	(5)	(6)
Bet Amount under $100	0.0016**	0.0015***	0.0017***	0.0015***	0.0009***	0.0013***
	(0.0008)	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0003)
Bet Amount over $100	-0.0012	0.0001	0.0000	-0.0003**	-0.0002	-0.0000
	(0.0008)	(0.0001)	(0.0003)	(0.0002)	(0.0002)	(0.0003)
Add. controls	Yes	Yes	Yes	Yes	Yes	Yes
N	2,856	65,697	87,311	140,154	183,860	49,435
N (clust)	1,094	20,161	28,459	42,452	54,197	18,300

Dependent variable: probability of being a winner in the game (estimated by LPM). All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, pot size and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * p<0.1 ** p<0.05 *** p<0.01

Table 20: Weight Loss (%) by Year.

	2012	2013	2014	2015	2016	2017
	(1)	(2)	(3)	(4)	(5)	(6)
High-Stake Bet	0.1885	0.0907***	0.1712***	0.1153***	0.1117***	0.0651***
	(0.5177)	(0.0351)	(0.0189)	(0.0128)	(0.0010)	(0.0162)
	2012	2013	2014	2015	2016	2017
	(1)	(2)	(3)	(4)	(5)	(6)
Bet Amount under $100	0.0048	0.0044***	0.0062***	0.0047***	0.0025***	0.0032***
	(0.0030)	(0.0006)	(0.0007)	(0.0005)	(0.0004)	(0.0009)
Bet Amount over $100	0.0003	0.0001	0.0006	-0.0000	-0.0004	-0.0006
	(0.0036)	(0.0003)	(0.0011)	(0.0006)	(0.0006)	(0.0010)
Add. controls	Yes	Yes	Yes	Yes	Yes	Yes
N	2,856	65,697	87,311	140,154	183,860	49,435
N (clust)	1,094	20,161	28,459	42,452	54,197	18,300

Dependent variable: weight loss in % (estimated by OLS). All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, pot size and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * p<0.1 ** p<0.05 *** p<0.01

Table 21: Weight Loss (%) by Year–Not Parallel Games.

	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
High-Stake Bet	0.0682***	0.0751***	0.1754***	0.2004***
	(0.0025)	(0.0025)	(0.0093)	(0.0093)
	(1)	(2)	(3)	(4)
Bet Amount under $100	0.0024***	0.0021***	0.0075***	0.0062***
	(0.0001)	(0.0001)	(0.0003)	(0.0003)
Bet Amount over $100	0.0003***	0.0001	0.0011***	0.0005
	(0.0001)	(0.0001)	(0.0004)	(0.0004)
Add. controls	No	Yes	No	Yes
N	455,428	455,428	455,428	455,428
N (clust)	140,347	140,347	140,347	140,347

Dependent variables: probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, pot size and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * p<0.1 ** p<0.05 *** p<0.01

Table 22: Effect of High-Stake Bets on Probability of Winning and Weight Loss (%): Full Sample.

	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
High-Stake Bet	0.0504***	0.0530***	0.1302***	0.1389***
	(0.0016)	(0.0016)	(0.0062)	(0.0063)
	(1)	(2)	(3)	(4)
Bet Amount under $100	0.0020***	0.0017***	0.0061***	0.0050***
	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Bet Amount over $100	0.0001*	-0.0000	0.0004**	0.0001
	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Add. controls	No	Yes	No	Yes
N	912,737	912,737	912,737	912,737
N (clust)	426,609	426,609	426,609	426,609

Dependent variables: probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, pot size and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * $p<0.1$ ** $p<0.05$ *** $p<0.01$

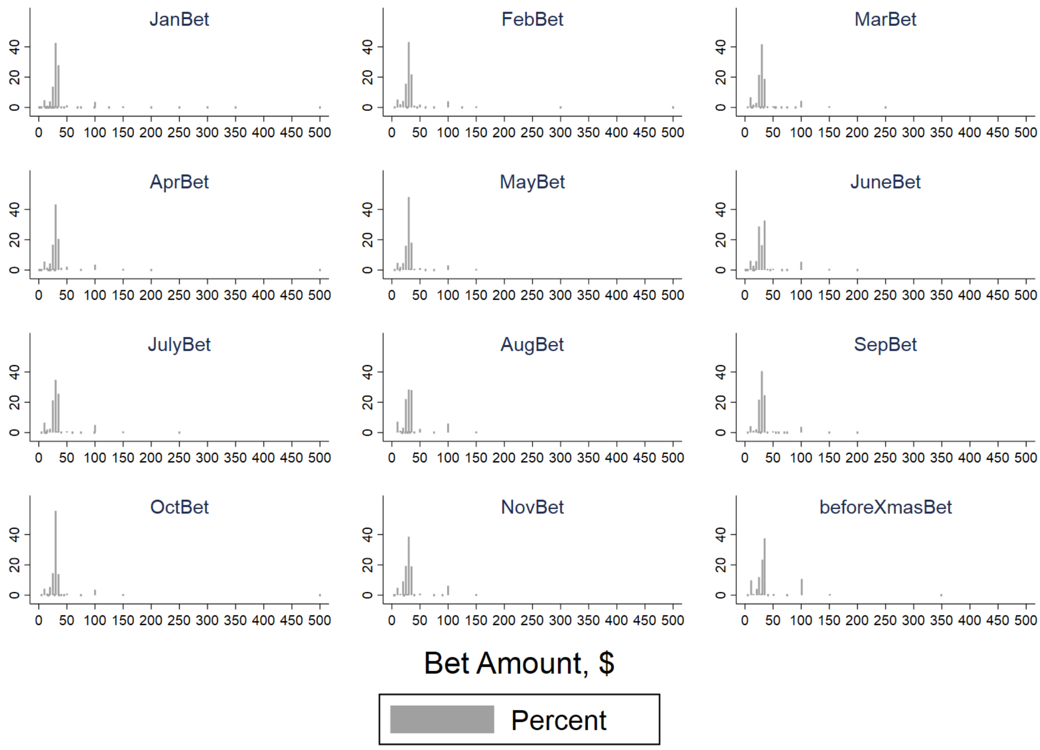


Figure 10: Percent of Bet Sizes by Month

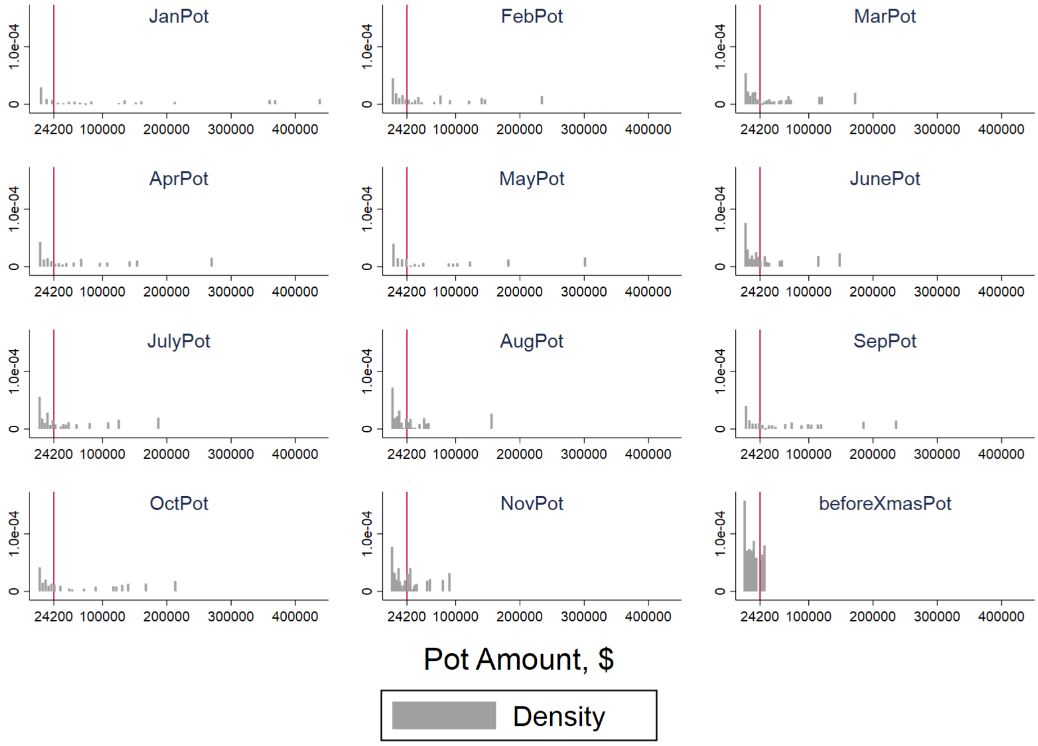


Figure 11: Density of Pots by Month

Table 23: Effect of High Game Pots on Probability of Winning and Weight Loss (%): Full Sample.

	Winner		Weight Loss (%)	
	(1)	(2)	(3)	(4)
High Pot Size	0.0169***	0.0138***	0.0571***	0.0471***
	(0.0008)	(0.0008)	(0.0029)	(0.0029)
Add. controls	No	Yes	No	Yes
N	912,737	912,737	912,737	912,737
N (clust)	426,609	426,609	426,609	426,609

Dependent variables: probability of being a winner in the game (estimated by LPM); and weight loss in % (estimated by OLS). High Pot Size is a dummy variable equal to one if pot size is larger than the sample median (22,855$), and zero otherwise. All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, bet and bet squared, and a categorical variable for game order to control for participation experience. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * p<0.1 ** p<0.05 *** p<0.01

Table 24: Change in Player's Initial Weight Between 1^{st} and 2^{nd}, 2^{nd} and 3^{rd}, 3^{rd} and 4^{th} or Higher Order Games.

	Initial Game Weight					
	1^{st}-2^{nd} Game		2^{nd}-3^{rd} Game		3^{rd}-4^{th} or Higher Game	
	(1)	(2)	(3)	(4)	(5)	(6)
2^{nd}, 3^{rd} or 4^{th} Game	-0.9100***	-3.6653***	0.7941***	-2.2190***	2.1535***	-1.3825***
	(0.0316)	(0.0352)	(0.04628)	(0.0568)	(0.0939)	(0.1153)
Add. controls	No	Yes	No	Yes	No	Yes
N	241,232	241,232	98,504	98,504	34,682	34,682
N (clust)	120,616	120,616	49,252	49,252	17,341	17,341

Dependent variable: initial weight (in lb) in the beginning of each game (estimated by OLS). All regressions include individual fixed effects and an indicator for being a completer. Controls include players' starting weight, social engagement, N of weigh-ins, indicator whether the game is closed, bet and bet squared, pot size and the games' starting dates to control for a number of days between the games. 2^{nd}, 3^{rd} or 4^{th} Game represent three dummy variables. Columns (1)-(2) estimate the effect of 2^{nd} Game which is equal to one if it is a 2^{nd} game and zero if it is the 1^{st} game. Columns (3)-(4) estimate the effect of 3^{rd} Game is equal to one if it is a 3^{rd} game and zero if it is the 2^{nd} game. Columns (5)-(6) estimate the effect of 4^{th} and higher Game is equal to one if it is a 4^{th} or higher game and zero if it is the 3^{rd} game. Sample includes only nonparallel games that were played sequentially. Standard errors in parentheses, clustered at the individual level. The stars represent significance at the following p-values: * $p<0.1$ ** $p<0.05$ *** $p<0.01$

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