Organizational Form with Behavioral Agents

Inauguraldissertation

zur Erlangung des akademischen Grades

Doctor oeconomiae publicae (Dr. oec. publ.)

an der Volkswirtschaftlichen Fakultät

an der Ludwig-Maximilians-Universität München

vorgelegt von

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2017

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Promotionsabschlussberatung: 31. Januar 2018

Acknowledgements

Es ist ein lobenswerter Brauch:
Wer was Gutes bekommt,
Der bedankt sich auch.
It is a good convention:
Whoever gave you help
deserves a grateful mention.

Wilhelm Busch, Translation MB

In the spirit of Wilhelm Busch I want to thank all the people who made this dissertation possible.

First and foremost, I would like to thank my supervisor Florian Englmaier who provided invaluable guidance and continuously nudged me to leave my comfort zone. I grew as a researcher as well as a person over the last four years thanks to him. Andreas Roider and Ingo Weller helped me develop a clear question and challenged me to defend my ideas. Their comments and suggestions were a great help throughout my dissertation.

Second, I am very grateful for the discussions and feedback I received from Matthias Fahn, Yves Le Yaouanq and Marco Schwarz, who took a lot of time to improve my ideas.

Third, I received the privilege to write my dissertation at the LMU through the GRK 1928, funded by the German Science Foundation. I am very grateful for the opportunity and the continued support by the head of the program Carsten Eckel.

Fourth, I would like to thank my co-authors Dominik Fischer and Felix Peterhammer for their patience both with me and our joint project. My colleagues Anne, Else, Katharina and Thomas helped me not to falter when my ideas did not work out and were willing to discuss even my most outlandish claims thoughtfully.

Last but not least, I want to thank my family for supporting me in every way they could. You enabled me to write my dissertation!

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Preface

0.1 Organizations and Human Behavior

Anthropologists estimate that the first humans evolved approximately 2.5 million years ago in Africa. In his history of humankind Yuval Noah Harari points out that "[a]bout 70,000 years ago, organisms belonging to the species *Homo sapiens* started to form even more elaborate structures called cultures."(Harari (2011), p.3). The time difference between human's first appearance and the first signs of culture is humbling from the perspective of the 21st century. We are used to living in functioning societies that are organized through political institutions*, the rule of law protects each individual from transgressions and we work together to further our own interests or a common goal we believe in. Even technological changes are rapidly incorporated into our daily lives as the development of the internet has shown.

While institutions are natural to us, the transfer of knowledge about and the design of institutions has come a long way. Despite developing scripture, the first high cultures, dating back to 4000 b.c.†, relied on knowledge transfer through oral tradition in the form of myths and tales‡. The first philosopher to make human behavior and institutions the object of knowledge was Socrates (470 - 399 b.c.). In contrast to the natural philosophers before him, he "brought philosophy from the sky"(*Socrates autem primus philosophiam*

* Throughout the introduction I use "institutions" and "organizations" as interchangeable. To me both have the same purpose as "means of achieving the benefits of collective action in situations in which the price system fails." (Arrow (1974), p.33). Kenneth Arrow equates both by defining principles of ethics as invisible institutions as well as organizations.

† see Sommer (2013)

‡ The Gilgamesh Epos is the first written record of the interaction between humans and their interaction with nature.

devocavit e caelo, Cicero Tusculanae Disputationes, V 10, 11.). The Socratic turn found its immediate response in Plato and Aristotle, who developed ideas about good behavior (ethics) and the optimal organization of states (polis).

However, rather than designing optimal institutions, that incorporate human strengths and weaknesses, Post-Socratic philosophers worked on ethics as a code of conduct for each individual, that would ensure optimal social outcomes as long as each individual adheres to the code. Even though they were well aware that temptations cause problems for decision maker which made it difficult to follow strict ethics, in their perception it was more important to devise optimal organizations along the line of impeccable behavior.

The idea of individual behavior as solution to problems in collective action carried through till the Enlightenment. Through the work of Adam Smith philosophers became widely aware that most social problems could not be solved through a strong code of ethics. After the French Revolution and with the beginning Industrial Revolution philosophers began to think about the organization of societies and institutions. Not by chance this period marks the birth of sociology, statistics and economics not by chance.

Economists started developing theories of individual rationality based on the liberal tradition that emerged from the Enlightenment. For the best part of the 20th century economics was focused on perfecting the theory of individual rationality. With this theory it became possible for economists to analyze institutions[§].

However, while philosophers underestimated the importance of individual rationality, economists neglected other sources for behavior. When analyzing optimal institutions, be they political, social or business, it becomes clear that both matter: self interest and other motivations of human behavior, like doing the "right thing". With the surge of behavioral economics the old knowledge became fruitful again. Thus, a whole research agenda evolved around the question "how individual behavior plays out in organizations and markets, what [are] the welfare consequences, and how policy should respond to market outcomes" (Kőszegi (2014), p.1075) when psychologically based models of human behavior are used.

[§] Of course, a proud tradition of economists worked on institutions, the rule of law and optimal organizations before. Max Weber and Joseph Alois Schumpeter are well known representatives of the Historical School of Economics.

Of course, even throughout the course of economics in the 20th century prominent economists discussed alternatives (see Simon (1955)). Their ideas and approaches can now be used by researches to venture into new territories. For example, Cyert and March (1963) in their book "Behavioral Theory of the Firm" try to give an extensive assessment of different motives in firms that go beyond self-interest in order to explain observed behavior. Kenneth Arrow in his Fels Lectures "The Limits of Organization" emphasizes the role of non-self interest motives, when he writes:

> the fact that we cannot mediate all our responsibilities to others through prices (...) makes it essential in the running of society that we have what might be called 'conscience'.
> (Arrow (1974), pp.26)

As economists at the beginning of the 21st century we are in the unique position to have a very powerful set of tools (theoretical, experimental, statistical and computational) at our disposal so we can analyze both standard, i.e. self-interested, rationality as well as behavioral factors. With regard to organizations the questions at hand is, how can organizations set optimal incentives if their agents are motivated by more than mere self interest. How should organizations be optimally designed when faced with both types of agents?

0.2 Contribution

My research contributes to the aforementioned question by analyzing how organizations react and optimally should react to behavioral agents. I provide three different angles that are loosely connected by the overarching question of optimal organization as reaction to heterogeneous motives for agents. These three angles try to highlight features of the general question, rather than painting a full picture.

0.2.1 First Chapter: Focusing Attention in Multiple Tasks

The first chapter discusses how optimal incentive schemes should be set, when agents face limited cognitive capacities and react intuitively to complex incentive contracts. Following Arrows claim that "the scarcity of information-handling ability is an essential feature for the understanding of both individual and organizational behavior"(Arrow (1974), p.37), I analyze how increasing complexity can reverse optimal incentives into bad incentives.

Agents face a multitude of different tasks in modern jobs. The increase in complexity is facilitated through new technological possibilities and a shift to flatter hierarchies. Standard contract theory predicts complex contracts, however, actual contracts are simpler. In order to explain this puzzle I propose a model in which agent's limited attention leads to an instinctive focus on tasks with high outcome variation. Therefore agents end up exerting too much effort in those tasks. This provides an explanation of findings in field studies, where the reduction of incentives increases overall productivity or the introduction of new performance measures has negative effects on some tasks.

0.2.2 Second Chapter: On the Dynamics of Prospect Theory

The second chapter is methodological in the sense that it provides an experimental test for a widely used psychological model, Prospect Theory. We are interested in the role Prospect Theory plays for dynamic inconsistent behavior of decision makers.

For Prospect Theory decision makers, there are massive spillovers between sequential choices. The outcomes of early decisions determine whether the decision makers face their subsequent choices from the gain or loss domain, which influences their preferences toward risk. So when it comes to early decisions, their choices can be driven by the anticipations of their own reactions to these domain shifts.

We experimentally investigate the quality of Prospect Theory anticipations for a student subject pool and how individual differences in these anticipations are driven by the subjects' cognitive ability, personality, demographics, and overall stability of Prospect Theory behavior. We find evidence that loss aversion drives dynamic inconsistent behavior. Contrary to our predictions individuals with higher cognitive reflection are not better planners.

Businesses can exploit dynamic inconsistencies by offering sequential lotteries in form of products, e.g. trading card games, sticker albums, fantasy football leagues. In determining the role of Prospect Theory in dynamic inconsistent behavior we provide a angle for policy maker and consumer protection, i.e. organizations that protect behavioral agents from exploitation.

0.2.3 Third Chapter: Unions, Communication, and Cooperation in Organizations

The third chapter seems to be out of line with the previous two, because it does not assume behavioral agents. Rather we use a different perspective on the question how conflict within organizations, in this case firms, can be reduced through the introduction of a union. Unions reduce the cost of communication.

We show that in a relational contracts model with imperfect public monitoring unions can mitigate equilibrium conflict and improve the efficiency of interaction. We modify the standard relational contracts model by assuming asymmetric information regarding the state of the world. Specifically, we assume there are some states of the world in which the firm is hit by an adverse shock, unobservable to the worker, and cannot honor its payment promises. In this situation, the firm always has an incentive to claim that it was hit by the adverse shock and to renege on its promises.

We characterize an equilibrium that has periods of cooperation (high effort and bonus payment) and conflict (low effort and no bonus payments) along the equilibrium path. Though in equilibrium there is always truthful revelation of the state of the world, the conflict phases are needed to sustain cooperation. Unions help to communicate the state of the world and to reduce conflicts.

Thus, we are able to provide a reason for an organization within an organization that helps to reduce conflicts even with purely self interested agents.

Chapter 1

Focusing Attention in Multiple Tasks*

"One of the most puzzling and troubling failures of incentive models has been their inability to account for the paucity of explicit incentive provisions in actual contracts."

Holmström and Milgrom, 1991, p.34

1.1 Motivation

Related to the puzzle by Holmström and Milgrom (1991) is the question why increasingly complex jobs do not involve more complex incentive provisions. My work suggests that the reason for the observed simplicity of incentive provisions is driven by the agents' intuitive response to complexity: focusing too much on tasks, that stand out.

Recently the idea of intuitive focus was modeled by Kőszegi and Szeidl (2013) who use an additional weight in those dimensions with high outcome variance to generate context-dependent preferences. This approach yields a different explanation for simple incentive provisions than Holmström and Milgrom (1991), who assume that the performance in some tasks cannot be measured. In contrast, context-dependent preferences create a negative externality of complex contracts, even and especially when the perfor-

* For helpful comments and discussions I thank Heski Bar-Isaac, Markus Dertwinkel-Kalt, Wouter Dessein, Florian Ederer, Benjamin Enke, Florian Englmaier, Matthias Fahn, Dominik Fischer, Hideshi Itoh, Botond Kőszegi, David Laibson, Yves Le Yaouanq, Rocco Macchiavello, Takeshi Murooka, Emilien Prost, Marco Schwarz and Andrei Shleifer as well as seminar participants in Munich and at the LEOH.

mance of all tasks can be measured.

While focusing has been applied to consumer choice, I believe that it has a natural application to multiple tasks. A short glimpse at job descriptions on online job platforms reveals a variety of different tasks. For example, a retail sales manager needs to organize his staff, control his finances and decide on the product stock. Additionally, multiple tasks are not limited to white collar jobs but can be also found for field workers (e.g. Englmaier et al. (2016)).

The increasing complexity is described in a report issued by the World Economic Forum in 2012. While its main argument is the growing importance of mastering several skills in order to be able to deal with the growing number of challenges on the job[2], these skills become important because jobs are getting more complex.

The aim of this essay is to how optimal incentive provision changes when agents start focusing because of complex incentive schemes. A complex contract with incentives for multiple tasks will divert the agents focus to those tasks that have the highest influence on their compensation, since those stand out relative to the other. The variation in the outcomes influences the agents perception, which in turn leads to higher effort in tasks with higher variation. Therefore an incomplete contract with only one performance measure can increase overall performance. My results not only give a new perspective agent's perception of contracts but also on the optimal use of performance measures. While in the accounting literature Feltham and Xie (1994) additional performance measures never can leave agent nor principal worse of, the externality through complex contracts can reverse the effect.

My main results first show a focusing agent's reaction to a standard contract to build intuition. A standard contract that is *not focusing-proof* induces an effort allocation that can be contrary to the principal's intentions. The first result already provides a good intuition for the externality introduced through focusing.

Second, I describe the optimal contract for a focusing agent, a *focusing-adjusted contract*. As an application of focusing theory (see Kőszegi and Szeidl (2013)) I can show that in order to avoid the wrong effort allocation, the optimal contract will assimilate

[2] For the full report, see http://reports.weforum.org/future-of-jobs-2016/skills-stability/.

incentives. This results in a higher perceived similarity of the different tasks, that takes into account the accuracy of performance measures.

My third result derives boundaries when it is better to use one compound performance measure than several. As long as a single compound performance measure avoids distortions through the agent's focusing it can be optimal to not use the full space of available performance measures. The result can explain why contracts don't become more complex with an increasing number of tasks in work environments, because the efficiency loss through the use of one additional measure is outweighed by the accumulated externalities. Even if all outcomes can be measured, the principal will not condition the optimal contract on all available information.

My results provide insight for findings in field experiments (Manthei and Sliwka (2013) and Englmaier et al. (2016)), how a change in the perception of incentives results can influence effort choices. Especially in Englmaier et al. (2016) the focusing effect is very clear, because worker focus on the task with a high prize and high uncertainty.

The remainder of the paper is organized as follows. Section II reviews the literature in the fields of behavioral contract theory, field experiments in organizational economics and limited attention models. Section III illustrates the main mechanism of distorted effort decisions through a simple example. Section IV introduces the general model for risk neutral agents and derives the main results. Section V concludes.

1.2 Literature

My work contributes to the intersection of organizational economics and behavioral economics. First, with regard to classic contract theory it complements the literature on unintended consequences of incentive contracts. When the objective performance measure is imperfect, an explicit incentive contract can crowd out effort in tasks that are important to the firm but cannot be contracted upon (see Holmström and Milgrom (1991) and Baker et al. (1994)). The result is either fraudulent behavior, e.g. the sales agents deceiving their customers to increase sales, or the neglect of important (but unincentivized) tasks, e.g. the teacher who only cares for his students' test scores and neglects their personal development. These unintended consequences are the result of poor contract design that ignores unmeasurable tasks. Better monitoring or fewer incentives are the proposed remedies, depending on the structure of effort costs. Nonetheless, as long as tasks are measurable, the informativeness principle states that all available information should be considered in the incentive contract. My approach complements this strand of literature by changing the perspective. Instead of the task's observability the agent's reaction to increasing complexity drives the results: the agent simplifies his work by focusing on certain tasks.

Second, in order to model the agent's reaction to complexity, I use recently developed models in behavioral economics. The main idea of these models is that an agent's perception of tasks is influenced by the decision context. These context-dependent preferences provide a simple explanation for a variety of violations of vonNeumann and Morgenstern's Independence Axiom. The decision context influences the agent's perception subconsciously, i.e determining which dimensions it is worth using the limited attention on. Therefore focusing is a fast and intuitive assessment of a given situation, similar to Daniel Kahneman's System 1 (Kahneman (2011)). Economists have started developing focusing models in economic choice that endogenously derive which dimensions stand out and receive more weight in the agents' perception. I follow Kőszegi and Szeidl (2013) who assume that the sensitivity increases with the range of observed values in an attribute. I contribute to this literature through the application to a new field, that hasn't been discussed so far. While the authors already proposed several applications, there has been to the best of my knowledge only one further application by Wisson (2015), who uses focusing agents to study screening in second degree price discrimination.

Third, my application answers to empirical findings from field experiments that raise questions about agent's perception of incentive contracts. Manthei and Sliwka (2013) find that at different bank branches the supervisors' use of objective performance measures can have a detrimental effect in small branches. While in big branches the introduction of an objective performance has a positive effect on all products, in small branches the increased effort on some products is accompanied by a decrease for the major product, customer loans. The authors explain the effect through division of labor that is possible in big but not in small branches. The implication is that when agents face multiple tasks with objective performance measures for each tasks they substitute effort towards one task reducing the overall positive effect of objective performance measures. Englmaier et al. (2016) show that in a setting with two measurable tasks, quantity and quality of harvested lettuce, agents put too much effort in the quality dimension, because it is rewarded by a tournament prize. The high variation of outcomes in the tournaments draws agents attention in comparison to lower variation induced by the piece rate for quantity. These findings suggest another force at work than the observability of outcomes in multiple task models. My approach is able to provide a model that is able to explain the distorted effort decisions as a result of the perceived contracts.

Fourth, in the literature on behavioral contract theory there have been experiments on framing effects in contracts. The research has been focusing on penalty contracts, i.e. contracts that use a loss rather than a gain framing in order to provide agents with additional incentives (Hossain and List (2012), de Quidt (2017), Imas et al. (2016)). Although the contracts are equivalent from a classic contracting perspective, the authors find that the loss frame increases the agents' effort, which is in line with Prospect Theory. A puzzling result both Imas et al. (2016) and de Quidt (2017) find is that subjects select into loss contracts contrary to Prospect Theory. While Imas et al. (2016) claim that this behavior is rational if agents use their loss aversion to overcome other sources of dynamic inconsistent behavior, de Quidt (2017) points out that this explanation is unlikely. He concludes that the higher base wage in loss contracts is perceived as a better deal by the agents. These empirical findings raise the question how the framing of contracts influences the agents' perception and therefore their effort decisions. Outside the field of organizations the empirical evidence on limited attention on decisions has been documented by Chetty et al. (2009) and Finkelstein (2009) in field experiments on non-salient taxes. In both experiments grocery shoppers and drivers are not aware of the taxes they face and don't adjust their behavior accordingly. In a lab experiment Abeler and Jäger (2015) show that in a complex tax system participants adjust too little to new tax rules. They find, that this effects subjects differently on the basis of their ability. While highly able subjects adjust properly to increasing complexity, other subjects disregard the increasing complexity at all.

Last, I provide a new angle on the accounting literature on the usage of performance measures started by Feltham and Xie (1994). Since the variety in performance measures is the driving factor of the focusing model, I use a simplified version of their model. They define necessary and sufficient conditions for additional performance measures to be of use to determine the agents contribution to the principals outcomes. However, additional performance measures can never have a negative effect in their framework. I provide an argument why a multitude of performance measures can have a detrimental effect on firms success and a paucity of performance measures can be optimal.

1.3 Example

To fix ideas how focusing can be modeled and influences effort decisions, I use an example similar to lettuce harvesting by Englmaier et al. (2016). Suppose a risk neutral principal (she) needs a risk neutral agent (he) to exert effort, a, in two distinct tasks $i \in \{1, 2\}$: quantity ($i = 1$) of production and quality ($i = 2$) of the produced goods. The agent's effort in both tasks determines the principals profit $B(a_1, a_2)$.

In order to stay close to the literature I assume that effort allocation and not effort exertion is the problem. Therefore, effort is costless, $c(a_1, a_2) = 0$. The agent only has to choose one dimension in which he will exert high effort: $\langle a_h, a_l \rangle$ or $\langle a_l, a_h \rangle$, with $a_h > a_l$.

The principle sets the reward for quantity as a piece rate $w \cdot a_1$, while for the quality dimension she uses a quality check, that pays a bonus b if the tested products are of high quality and 0 if the product is of low quality. The probability of receiving high quality depends on the effort the agent exerts in the quality dimension, $p(a_2)$ with $p_h = p(a_2 = a_h)$ and $p_l = p(a_2 = a_l)$. The agent receives an outside option of $\bar{U}$ if he doesn't accept the offered contract. His utility function is additively separable in both dimensions:

$$U(a_1, a_2) = u(a_1) + u(a_2) = a_1 w + p(a_2) b$$

I assume that $B(a_1, a_2)$ is maximized with $\langle a_h, a_l \rangle$ and it is socially optimal to employ the agent. The production function $B(a_1, a_2) = t_1 a_1 + t_2 a_2$ fulfills these assumptions for $t_1 > t_2$.

1.3.1 Rational Benchmark

I first establish the solution for a non-focusing agent. The principal maximizes her objective function subject to the agent accepting the contract and choosing the right effort allocation.

$$\max_{w,b,a_1,a_2} B(a_1, a_2) - wa_1 - p(a_2)b \tag{1.1}$$

s.t.

$$(PC)\ wa_1 + p(a_2)b \geq \bar{U} \tag{1.2}$$

$$(ICC)\ \max_{a_1,a_2} wa_1^* + p(a_2^*)b \geq wa_1 + p(a_2)b \tag{1.3}$$

Both the participation constraint (PC) and the incentive compatibility constraint (ICC) have to bind, otherwise the principle would leave a rent to the agent. Therefore the optimal choices for the piece rate w^* and the bonus b^* are given by:

$$w^* = \bar{U} \frac{p_h - p_l}{p_h a_h - p_l a_l} \tag{1.4}$$

$$b^* = \bar{U} \frac{a_h - a_l}{p_h a_h - p_l a_l} \tag{1.5}$$

The optimal bonus payment and the optimal piece rate depend on the difference in outcomes generated through effort in the other task. For example, the piece rate has to increase if effort has a higher impact on the quality test relative to the piece rate.

1.3.2 A focusing agent

In this section I show that if the agent's attention is drawn to the task with the highest variation in pay, the optimal choices for piece rate and bonus payment reverse. The agent is a focusing thinker unbeknownst to the principal. Focus is generated in each task separately and influences the agent's perception of the task. The basic formalization is taken from Kőszegi and Szeidl (2013) with the extension for decisions under risk by Bushong et al. (2015). Each task in the additively separable utility function receives an additional weight that captures how much the agent focuses on the task. The weight is determined by the range of outcomes in this dimension Δ_{a_i} that serves as argument for the weighting function $g(\cdot)$. In line with Kőszegi and Szeidl (2013) I use a convex weighting function. The utility function for the focusing thinker is defined as follows:

$$U^{FT}(a_1, a_2) = g(\Delta_{a_1})u(a_1) + g(\Delta_{a_2})u(a_2) = g(\Delta_{a_1})a_1 w + g(\Delta_{a_2})p(a_2)b \tag{1.6}$$

Since the quantity task does not involve any risk, the definition of its range is straight forward:

$$\Delta_{a_1} = \max_{a_1 \in \{a_h, a_l\}} u(a_1) - \min_{a_1 \in \{a_h, a_l\}} u(a_1) \tag{1.7}$$

Therefore:

$$\Delta_{a_1} = wa_h - wa_l = w(a_h - a_l) \tag{1.8}$$

The second task, however, involves the risk of a bad product being detected and therefore the agent not receiving the bonus b. In order to determine the range under risk Bushong et al. (2015) propose a formulation that considers the expected value E_F as well as the average self-distance S_F for risky prospects, where F denotes the probability distribution:

$$\Delta_{a_2} = \max_{F \in \mathbf{F}}(E_F[u(a_2)] + \frac{1}{2}S_F[u(a_2)]) - \min_{F \in \mathbf{F}}(E_F[u(a_2)] - \frac{1}{2}S_F[u(a_2)]) \tag{1.9}$$

The average self difference is defined as

$$S_F[u(a_2)] = \int \int |u(a_2') - u(a_2)| \, dF(a_2')dF(a_2). \tag{1.10}$$

The intuition for using the average self-distance of a distribution is that in comparison to only using the expected value it also depicts the variation in outcomes in a distribution. The minimum for the focusing range is always given by a_l, whereas the maximum is given by a_h.[3]

Therefore, the range for the product test is given by:

$$\Delta_{a_2} = b[2p_h - p_h^2 - p_l^2] \tag{1.11}$$

The difference in the ranges of both tasks results solely from the higher variation of the quality task through its design as bonus. While my example compares a task without risk to a task with risk, even for two risky reward schemes (e.g. tournament and bonus payment or bonus payments in both tasks) the basic intuition remains the same. The agent will focus on the task with the higher variation in outcomes.

The higher variation of the quality task is also the driving force in the lettuce harvester example. The tournament rewards teams that produce less low quality lettuce, i.e. handle the lettuce with care. A tournament is a source of outcome variation for two reasons. First, outcomes have to be skewed to generate incentives for agents to participate. Second every tournament involves risk through the competition with other agents. Both sources of outcome variation increase the agent's focus on the tournament.

1.3.3 Effort Allocation of a Focusing Agent

For a focusing agent, the perceived contract changes, therefore I introduce a new participation constraint (PC^p) and a new incentive compatibility constraint (ICC^p), that reflect the agents perception. I show that the agent's perception leads him to choose the wrong effort allocation. This provides an explanation for the findings in the field.

[3] See Appendix for the derivation.

$$(PC^p)\ g(\Delta_{a_1})wa_1 + g(\Delta_{a_2})p(a_2)b \geq \bar{U} \tag{1.12}$$

$$(ICC^p)\ \max_{a_1,a_2} g(\Delta_{a_1})wa_1^* + g(\Delta_{a_2})p(a_2^*)b \geq g(\Delta_{a_1})wa_1 + g(\Delta_{a_2})p(a_2)b \tag{1.13}$$

In order to show that a focusing agent will chose an effort allocation contrary to the principal's plan, I use the compensation schemes b^* and w^*, that were optimal for a rational agent, and show that the perceived participation constraint, (ICC^p), results in the opposite behavior to (ICC) for a rational agent. Therefore the perceived utility for effort allocation $\langle a_l, a_h \rangle$ is higher and a focusing thinker will choose it.

For the proof I rearrange (ICC^p):

$$g(\Delta_{a_2})b^*(p_h - p_l)) \geq g(\Delta_{a_1})w^*(a_h - a_l) \tag{1.14}$$

Using the previously optimally chosen w and b as well as the derived ranges for both piece rate and quality test, I can rewrite the violated incentive constraint:

$$\begin{aligned} g(\bar{U}\frac{(a_h - a_l)(2p_h - p_h^2 - p_l^2)}{p_h a_h - p_l a_l})\bar{U}\frac{(a_h - a_l)(p_h - p_l)}{p_h a_h - p_l a_l} > \\ g(\bar{U}\frac{(a_h - a_l)(p_h - p_l)}{p_h a_h - p_l a_l})\bar{U}\frac{(a_h - a_l)(p_h - p_l)}{p_h a_h - p_l a_l} \end{aligned} \tag{1.15}$$

The only difference between LHS and RHS is the range of tasks. Therefore the equation simplifies to

$$(2p_h - p_h^2 - p_l^2) > (p_h - p_l).$$

Rearrangement leads to:

$$p_h + p_l > p_h^2 + p_l^2 \tag{1.16}$$

which is true for all increasing weighting functions $g(\cdot)$.

This result states, that under the optimal compensation scheme for a rational agent, a higher variation in pay for the quality task draws the focusing thinker's attention. Thus, the reward scheme implements the effort allocation $\langle e_l, e_h \rangle$, opposite to the principals intention. In comparison to classic contract theory, the distortion stems entirely from the agent's biased perception of the reward scheme. This result is captured by Lemma 1:

Lemma 1.3.1. *If a work contract is not focusing proof, i.e. it does not account for the agent's perception of different compensation schemes, the agent will choose an effort allocation that is distorted towards tasks with high outcome variation.*

In the specific example it distorts the effort to its opposite $\langle e_l, e_h \rangle$.

1.4 Model

The baseline model generalizes the example in two ways. First, my example uses two different compensation schemes: a piece rate and a quality test. Both compensation schemes represent different combinations of risk and outcome distributions. For the baseline model I follow closely the literature on multiple tasks Holmström and Milgrom (1991) and performance measures (Baker et al. (1994),Feltham and Xie (1994)), where each task's compensation scheme can be represented as a linear sharing rule.

Second, each task generates a signal with the chosen effort being the mean and a normally distributed error term. While focusing in the example was purely driven by variation in outcomes, in this setting it is driven by the noise of performance measures.

I simplify the literature on multiple tasks by introducing risk neutrality for both principal and agent.[4] A risk neutral principal (she) needs a risk neutral agent (he) to perform several distinct tasks $i \in \{1, 2, ..., T\}$. The agent's effort in the different tasks, a_i determines the principals revenue y according to:

$$y = \sum_{i=1}^{T} f_i a_i + \epsilon.$$

Where f_i is the productivity of each task and ϵ is a common shock normally distributed with mean zero and variance of σ_y. The common shock makes it impossible to verify the agents chosen effort before a court.

[4] The results are robust to risk averse agent's. See Appendix A.3

I deviate from the literature on multiple performance measures. While Feltham and Xie (1994) look at compound performance measures, i.e. each performance measure is influenced by several different tasks, I assume that each task has a separate performance measure. The assumption simplifies the problem of Feltham and Xie (1994), because it allows for a direct attribution of each performance measure to the agent's exerted effort.

Thus, the first best solution is possible, whereas compound measures always fall short as long as they are not both precise, i.e. zero noise of performance measure, and congruent, i.e. effort influences the performance measure in the same direction as output. Although the simplification abstracts from the question which compound performance measures a principal should use, it generates clear cut insight into the role of focusing. Since the simplification results in the first best in Feltham and Xie (1994) it is clear that the inefficiency stems solely from focusing and is not driven through the setup of performance measures.[5]

I chose the simplifying assumptions to generate tractable results, where the influence of outcome variation in one task can be determined as the source for the agent's behavior. However each of the assumptions can be relaxed giving rise to additional interesting interactions.

The principal uses multiple performance measures. I assume one performance measure, p_i, for each task i. These measures provide some information on the agent's performance, however entail error term, φ_i, that is normally distributed with mean zero and standard deviation σ_i. The correlation between the different measures is assumed to be zero. The performance measures for each task, i, are defined as follows:

$$p_i = g_i a_i + \varphi_i.$$

The principal has to pay the agent according to a linear sharing rule $w = s + \sum_{i=1}^{N} b_i p_i$.[6] The principal's net payoff is the difference of the revenue and the payment to the agent:

[5] An extension for the role of focusing for the choice of compound performance measures is possible, but not within the reach of the current work.

[6] Risk neutrality and the use of a linear sharing rule make the typical assumption in the literature of additive separability of utility dimensions obsolete.

$\Pi = y - w$. In order to show that the results are not driven by technical assumptions regarding the complementarities in effort costs or production function, all dimensions are assumed to be perfect substitutes. Thus, the cost function is assumed to be $c(a_1, ...a_N) = \frac{1}{2}\sum_{i=1}^{N} a_i^2$. The agent's utility function is given by $U = w - c(a_1, ...a_N)$.

The timing is as follows: First the principal offers an incentive contract to the agent, who decides to either accept or decline. Second, the agent chooses effort in each dimension. Third the shocks are realized which generate in the fourth step the outcome and the performance measures.

1.4.1 Introducing Focusing

In this section I introduce the agent's focusing. Following Kőszegi and Szeidl (2013) I use a concave weighting function for each task. In decisions without risk the weight of each task is determined through the range of maximum and minimum utility obtainable. Since effort decisions involve risk, the weight should also include a measure for the likelihood of differing outcomes. Therefore I use a combination of the first and second moment of the distribution to determine the range. The idea is to capture aspects of decision under risk while remaining tractable for field and laboratory evidence[7].

To model the effect of focusing, I include an additional weighting function, $g(\cdot)$, over the range of each task, Δ_i, in the additive separable utility function:

$$w = s + \sum_{i=1}^{N} g(\Delta_i) b_i p_i a_i. \tag{1.17}$$

A common assumption for $g(\cdot)$ is

$$g'(\cdot) > 0, g''(\cdot) < 0,$$

therefore I use $g(x) = x^\alpha, 0 < \alpha < 1$.

[7] I chose a different formalization than Bushong et al. (2015), because the difference between their measure for average self-distance and variance are small. In addition variance is given by the principal agent models, while average self-distance requires an additional transformation.

The argument of the weighting function, $g(\cdot)$, is the range for each task, Δ_i, that is determined through a linear combination of the expected value and the variation of outcomes. $1 \geq \beta \geq 0$ determines the relative weight put on the expected value. The formula is similar to Bushong et al. (2015) with the exception that instead of their definition for average self-distance I use the variance to increase tractability:

$$\begin{aligned} \Delta_i = &\max_{F \in \mathbf{F}}(\beta E_F(U_i(a_i)) + (1-\beta)V_F(U_i(a_i))) \\ &- \min_{F \in \mathbf{F}}(\beta E_F(U_i(a_i)) - (1-\beta)V_F(U_i(a_i))) \end{aligned}. \tag{1.18}$$

Since the difference in outcomes is not driven by the choice of different lotteries, but through the choice of effort the expected values reduce to:

$$E_F(U_i(a_i)) = b_i g_i a_i + b_i \underbrace{E[\phi_i]}_{=0} = b_i g_i a_i.$$

Similarly, the variance reduces to:

$$V_F(U_i(a_i)) = V(b_i(g_i a_i + \phi_i)) = b_i^2(V(g_i a_i) + V(\phi_i) = b_i^2 \sigma_i^2.$$

For notational simplification, I assume that both the expected value as well as the variance receive the same weight in Δ_i, $\beta = 1 - \beta = \frac{1}{2}$.[8]

$$\Delta_i = \frac{1}{2} b_i g_i a_i + \frac{1}{2} b_i^2 \sigma_i^2 - \frac{1}{2} b_i g_i a_i + \frac{1}{2} b_i^2 \sigma_i^2$$

Thus, the range of each dimension is determined through the quadratic slope of the linear sharing rule b_i and the variance σ_i of the noise ϕ_i of the performance measure.

$$\Delta_i = b_i^2 \sigma_i^2 \tag{1.19}$$

[8] I assume that the agent can exert the same amount of effort in each task, i.e. there are no limitations to the amount of effort. Without this assumption the results do not change, however they are now dependent on exogenous assumptions on the range of effort that can be exerted in each task, since this range drives the agents perception.

The agent's perceived payoff of the offered contract is given by:

$$w = s + \sum_{i=1}^{N} b_i^{2\alpha} \sigma_i^{2\alpha} b_i p_i a_i.$$

Therefore the agent's optimization changes to:

$$\max_a E(w) - c(a) = s + \sum_{i=1}^{N} b_i^{2\alpha} \sigma_i^{2\alpha} b_i p_i a_i - \frac{1}{2} \sum_{i=1}^{N} a_i^2. \quad (1.20)$$

The agent's optimization now contains the additional term $b_i^{2\alpha}\sigma_i^{2\alpha}$ that puts additional weight on dimensions with high variation in outcomes, either through a steep slope b_i or through a noisy performance measure σ_i. The curvature α of the weighting function determines how much the decision maker is influenced by focusing.

For $\alpha > 0$ all tasks that fulfill $b_i * \sigma_i > 1$ will be overvalued by a focusing agent. The perceived utility from a marginal unit of effort is inflated through the focusing. Whereas the tasks with $b_i * \sigma_i < 1$ are undervalued and perceived less valuable than they objectively are. For the special case of $b_i * \sigma_i = 1$, a focusing agent perceives the task the same way a non-focusing agent does.

For $\alpha = 0$ focusing vanishes altogether and the agent is a standard decision maker. In the next section I develop the benchmark contract for a non-focusing agent.

1.4.2 Multiple Performance Measures, Benchmark

Starting with $\alpha = 0$, I can derive the optimal contract for a non-focusing agent. As long as the principal is able to use multiple performance measures, she can condition the contract for each task on those performance measures. Thus, without limited liability and because of risk neutrality, the principal is able to implement the first best.

The agent's choice is given by his utility maximization:

$$\max_a E(w) - c(a) = s + (\sum_{i=1}^{N} b_i g_i a_i) - \frac{1}{2} \sum_{i=1}^{N} a_i^2. \quad (1.21)$$

The optimal choice for each agent is therefore given by

$$a_i^* = g_i b_i. \tag{1.22}$$

The principal takes the agent's choice into account while maximizing the expected total surplus:

$$E(\Pi + U) = E(y) - c(a) = \sum_{i=1}^{T} f_i a_i - \frac{1}{2}\sum_{i=1}^{N} a_i^2 \tag{1.23}$$

s.t.

$$a_i^* = g_i b_i.$$

The optimal choice of b_i is therefore:

$$b_i^* = \frac{f_i}{g_i}. \tag{1.24}$$

The use of multiple performance measures results in the first best result, where the agent exerts effort in each dimension optimally, $a_i^* = f_i$, i.e. marginal return equals marginal costs of effort. Therefore the use of multiple performance measures increases the total expected surplus. Since I ignore the typical tradeoff between risk and incentives, it is not surprising that the first best can be achieved.

1.4.3 Non-Focusing Proof Contracts

As soon as $\alpha > 0$ the agent is a focusing thinker. I first analyze the agent's effort decision in the case where the principal either does not know that the agent is a focusing or she cannot adjust the contract due to institutional constraints or short term contractual rigidity. The perspective on non-focusing proof contracts helps to formalize the findings in the empirical literature (see Manthei and Sliwka (2013) and Englmaier et al. (2016)). When the agent faces several tasks, he will focus on those tasks, that entail higher variation in outcomes.

While multiple performance measures ensure the first best effort allocation, when the agent uses the performance measures as signals in which dimensions it is worth to exert effort, the optimality of complex contracts is not ex ante clear for focusing agents.

As long as the principal does not adjust the contract to account for the agent's focusing towards tasks with high outcome variation, she uses the previously optimally determined slopes for the linear sharing rules:

$$b_i^* = \frac{f_i}{g_i}.$$

However the agent optimizes according to the perceived contract leading to the first order condition:

$$\max_a s + \sum_{i=1}^{N} (\frac{f_i}{g_i})^{2\alpha} \sigma_i^{2\alpha} \frac{f_i}{g_i} g_i a_i - \frac{1}{2} \sum_{i=1}^{N} a_i^2. \tag{1.25}$$

The non-focusing proof contract results in the agent exerting effort in each dimension according to the focusing weight:

$$a_i^{NFP} = f_i b_i^{2\alpha} \sigma_i^{2\alpha}. \tag{1.26}$$

The effort a focusing thinker will exert in a task depends not only on the marginal productivity of effort, but also on the slope of the linear sharing rule. Since the slope moves in the same direction as the marginal productivity, focusing works as an additional incentive for those dimensions where marginal productivity is high and the performance measure p does not overshadow the productivity. However, also the variance of outcomes plays an important role in the determination of the optimal effort. The higher the variance and therefore the noise of the performance measure in a dimension, the more will the focusing thinker be drawn to this dimension. Proposition 1.4.1 captures these results

Proposition 1.4.1. *The effort a focusing thinker will exert is increasing in those dimensions, with steeper slopes in the linear sharing rule and with higher variance in the performance* *measure:*

$$\frac{\partial a_i^{NFP}}{\partial b_i} > 0 \tag{1.27}$$

$$\frac{\partial a_i^{NFP}}{\partial \sigma_i} > 0. \tag{1.28}$$

Proposition 1.4.1 states the influence of focusing on the agent's decision making for non-focusing proof contract. Effort increases with the share the agent receives, i.e. tasks become salient when they are more productive. This result is in line, both with intuition and the principal's interest, because focusing is more pronounced in tasks that are very profitable for her as well.

In addition a focusing thinker's attention is driven by the variance of the performance measure. Noisy performance measures attract the agent's attention resulting in a higher focus and perceived importance of the task. Focusing implies that although the agent is risk neutral the risk involved in the performance measure influences his perception of the tasks. Tasks whose performance measures involve more noise than others become salient and a focusing agent is drawn to them.

For models where instead of performance outcomes in each dimension can be directly measured, it is the variance in outcomes that drives the agent's attention. Section 1.3 builds on this version of the model.

The second result of Proposition 1.4.1 opens up two options. If the principal is constrained in the contract design, the noise of the performance measures can counteract the initially set incentives. However, as long as the principal can choose performance measures and the noise works as additional incentive. So far, I have considered that effort distortions are to the principal's disadvantage, however the exchange of both tasks productivity in the example in Section 1.3 gives rise to a different mechanism.

The additional focus through the higher variation in outcomes in the second task works as additional incentive that allows the principal to reduce the agents performance pay without violating the incentive compatibility and participation constraint. It is straight forward to show that the principal has an incentive to choose noisier performance measures for tasks that are more productive. As long as the principal is free to choose performance measures, she can use them to increase a focusing agents effort in very productive tasks without further costs.

1.4.4 Focusing Adjusted Contracts

In Section 1.4.3 I assumed, that the principal could either not adjust the contract due to external rigidities or was not aware that the agent is a focusing thinker. Now I lift the assumption and analyze the optimal contract that adjusts for focusing agents. The principal's optimization remains the same:

$$E(\pi) = E(y - w) = \sum_{i=1}^{N} f_i a_i - s - (\sum_{i=1}^{N} b_i g_i a_i).$$

However, she anticipates the agent's perception of the contract that changes the agent's individual rational:

$$E(U) = E(w) - c(a) = s + \sum_{i=1}^{N} b_i^{2\alpha} \sigma_i^{2\alpha} b_i p_i - \frac{1}{2} \sum_{i=1}^{N} a_i^2.$$

Since the agent's perception does not influence the objective expected total surplus, it enters only through the agent's distorted effort decisions. Therefore the principals optimization problem looks like the benchmark with the exception of the agent's participation constraint:

$$E(\Pi + U) = E(y) - c(a) = \sum_{i=1}^{T} f_i a_i - \frac{1}{2} \sum_{i=1}^{N} a_i^2$$

s.t.

$$\forall a_i \; a_i = b_i^{2\alpha} \sigma_i^{2\alpha} b_i p_i.$$

The solution to this problem gives the optimal slope for tasks in a focusing proof contract:

$$b_i^{FP} = (\frac{f_i}{p_i}\frac{1}{\sigma_i})^{\frac{1}{2\alpha+1}}. \tag{1.29}$$

In comparison to the optimal slope for non-focusing agents where only the ratio of productivity and influence on the performance measure determined the slope, now the slope is overall flatter, because of the exponent $\frac{1}{2\alpha+1}$ and additionally accounts for the variance of the noise term. To fully understand the behavior of b_i I look at the first and second derivative for both productivity and noise. The results are captured in Proposition 1.4.2 and Proposition 1.4.3.

Proposition 1.4.2. *A focusing-proof contract counteracts the additional attention through the noise within the performance measure. Higher variance results in a decrease of slope. With increasing variance the slope decreases further:*

$$\frac{\partial b_i^{FP}}{\partial \sigma_i} = (\frac{f_i}{g_i})^{\frac{1}{2\alpha+1}}(-1)\frac{1}{2\alpha+1}\sigma_i^{-\frac{2\alpha+2}{2\alpha+1}} < 0 \tag{1.30}$$

$$\frac{\partial^2 b_i^{FP}}{\partial \sigma_i^2} = (\frac{f_i}{g_i})^{\frac{1}{2\alpha+1}}\frac{2\alpha+2}{(2\alpha+1)^2}\sigma_i^{-\frac{4\alpha+3}{2\alpha+1}} > 0. \tag{1.31}$$

Proposition 1.4.2 states that, ceteris paribus, noisier performance measures result in a decrease of slope, b_i. The reduction of slope increases with additional noise.

Proposition 1.4.3. *The optimal linear sharing rule counteracts the additional incentives in a highly productive task $\frac{f_i}{g_i}$. Although it still increases with productivity, the increase becomes slower the higher the productivity is:*

$$\frac{\partial b_i^{FP}}{\partial \frac{f_i}{g_i}} = \frac{1}{2\alpha+1}(\frac{f_i}{g_i})^{-\frac{2\alpha}{2\alpha+1}}(\frac{1}{\sigma_i})^{\frac{1}{2\alpha+1}} > 0 \tag{1.32}$$

$$\frac{\partial^2 b_i^{FP}}{\partial(\frac{f_i}{g_i})^2} = -\frac{2\alpha}{(2\alpha+1)^2}(\frac{f_i}{g_i})^{-\frac{4\alpha-1}{2\alpha+1}}(\frac{1}{\sigma_i})^{\frac{1}{2\alpha+1}} < 0. \tag{1.33}$$

Proposition 1.4.3 states that, ceteris paribus, higher productivity still results in steeper slopes. However, in the benchmark case the increase was linear, while in the focusing proof contract the increase diminishes. Thus the difference between more and less productive tasks decreases in comparison to the benchmark.

Both propositions combined, characterize the principal's ability to set incentives. On the one hand steep incentives will draw a lot of attention. Focusing adjusted contracts allow the principal to reduce the offered marginal product without impeding the incentives. On the other hand the principal needs to counteract the effect of the performance measure. For tasks whose performance measures entail high variation she can reduce incentives. In contrast, tasks with low variation performance measures need additional incentives.

The focusing proof contract induces effort in each task:

$$a_i^{FPC} = f_i \sigma_i^{2\alpha-1}. \tag{1.34}$$

In comparison to the benchmark effort, $a_i^* = f_i$, the effort distortion becomes apparent:

$$a_i^{FPC} > a_i^* \Leftrightarrow \sigma_i^{2\alpha-1} > 1. \tag{1.35}$$

As long as $\alpha > \frac{1}{2}$, i.e. the weighting function is not too concave, a $\sigma_i > 1$ will result in more effort in task i. Even the focusing proof contract will optimally not prevent some degree of focusing. In dimensions with less noisy performance measures the agent will reduce his effort. A $\sigma_i < 1$ results in less effort in task i. Therefore it becomes clear that the noise of the performance measure influences the agent's perception and through this his choice of effort. It is worth noticing that, although the productivity of a task influences the perception of a contract it does not influence the effort choice compared to the benchmark.

1.4.5 Single vs. Multiple Performance Measures

For non-focusing agents clearly the use of multiple performance measures is optimal, because it achieves first best. Therefore it is no surprise that the accounting literature knows examples of the usage of multiple performance measures. Anthony et al. (1992) summarize for example the measures used by McDonald's for their store managers: product quality, service, cleanliness, sales volume, personnel training, and cost control.

It is apparent that most principals do not use multiple performance measures. In cases where incentive pay is provided multiple performance measures are either contracted to a compound measure of success or used in balanced scorecards. Compound measures are commission payments or stock options, that measure the overall success of a firm. Balanced scorecards are used to combine the effort in different dimensions and present the agent with an overall assessment. These incentive schemes are simpler than standard economic theory prescribes.

Therefore I analyze how a single performance measure can be preferable to multiple performance measures if it can avoid the agent's focusing distortions. The setup changes only in one aspect with respect to the use of multiple performance measures. The single performance measure is a compound measure of all different tasks. Therefore the measure measure p provides information on the agent's performance, but entails an error term φ that is normally distributed with mean zero and standard deviation σ. The correlation between the different measures is assumed to be zero.

$$p = \sum_{i=1}^{T} g_i a_i + \varphi.$$

I assume $\varphi = \sum_{i=1}^{N} \varphi_i$, i.e. the joint measure does not have an advantage through the structure of noise terms in comparison to the multiple performance measures.

The linear sharing rule is accordingly, $w = s + bp$.

I assume that the single performance measure does not distort the agent's focus. This assumption captures the most clear cut case, where the principal has a technique to communicate and explain simpler schemes more efficiently. Therefore the principle prevents focusing through the choice of contract design. Thus the optimal choice of slope b is determined through the maximization of the expected total surplus $E(\Pi + U)$ and the agent's optimal decision $\max_a E(U)$ comparable to the non-focusing benchmark.

The agent's choice for a single performance measure (SPM) is given by:

$$\max_a E(w) - c(a) = s + b(\sum_{i=1}^{N} g_i a_i) - \frac{1}{2}\sum_{i=1}^{N} a_i^2. \tag{1.36}$$

The optimal choice for each agent is therefore given by

$$a_i^{SPM} = g_i b. \tag{1.37}$$

In order to determine the optimal slope of the linear sharing rule, b, the principal needs to maximize the expected total surplus subject to the individuals maximization:

$$E(\Pi + U) = E(y) - c(a) = \sum_{i=1}^{T} f_i a_i - \frac{1}{2}\sum_{i=1}^{N} a_i^2 \tag{1.38}$$

s.t.

$$a_i^{SPM} = g_i b.$$

The optimization can be transformed into:

$$E(\Pi + U) = \sum_{i=1}^{T} f_i b_i - \frac{1}{2}\sum_{i=1}^{N} b_i^2. \tag{1.39}$$

The optimal choice of b is therefore as in Feltham and Xie (1994):

$$b^{SPM} = \frac{\sum_{i=1}^{N} f_i g_i}{\sum_{i=1}^{N} g_i^2}. \tag{1.40}$$

The slope of the single performance measure has to balance the influence of the tasks on both the performance measure and principal's outcome.

Using multiple performance measures induces an inefficiency if the principal is confronted with a focusing agent. I assume that a single performance measure avoids these inefficiencies because it prevents the agent to focus on one task. The tradeoff between a single and multiple performance measures is given by the loss of efficiency through a single performance measure in comparison to the loss of efficiency through the agent's focusing by using multiple performance measures.

When comparing multiple and single performance measures, the mentioned tradeoff strengthens the basic intuition: If the number of tasks increases the loss through a single performance measure increases, however the loss of a focusing agent increases at a faster rate. Therefore there exists a cutoff for which it is optimal to switch from multiple to a single performance measure.

As a measure of overall welfare I use the expected total surplus generated through the single as well as multiple performance measures and compare it to the first best, i.e. the use of multiple performance measures for a non-focusing agent.

First, the expected total surplus for a single performance measure:

$$S^{SPM} = E(y - c(a)) = \frac{1}{\sum_{i=1}^{N} g_i^2}[\frac{1}{2}\sum_{i=1}^{N}(f_i g_i)^2 + \sum_{i=1}^{N}\sum_{j \neq i}^{N} f_i g_i f_j g_j]. \tag{1.41}$$

Second, the expected total surplus for multiple performance measures with a focusing agent:

$$S^{FP} = E(y - c(a)) = \sum_{i=1}^{N}(f_i^2 \sigma_i^{2\alpha-1} - \frac{1}{2} f_i^2 \sigma_i^{4\alpha-2}). \tag{1.42}$$

It is straightforward that the expected surplus for multiple performance measures is first best, when the agent is not a focusing thinker, i.e. $\alpha = 0$.

Comparing the expected total surplus of the single performance measure to the contract for the focusing thinker highlights the central tradeoff. While the single performance measure always stays positive, the focusing proof contract can contain tasks (high variation tasks) that have a negative impact on the expected total surplus:

$$f_i^2\sigma_i^{2\alpha-1} - \frac{1}{2}f_i^2\sigma_i^{4\alpha-2} = f_i^2\sigma_i^{2\alpha-1}(1 - \frac{1}{2}\sigma_i^2) < 0 \leftrightarrow \sigma_i \geq \sqrt{2} \tag{1.43}$$

Since the optimal choice of single versus multiple performance measures depends on the tuple (σ_i, g_i, f_i), I simplify the analysis. I assume that all tasks (and all potential tasks) have the same productivity $\forall i \; f_i = f$ and the same influence on the performance measures $\forall i \; g_i = g$. Therefore the expected total surplus of the single performance measure simplifies to

$$S^{SPM} = E(y - c(a)) = \frac{3}{2}\frac{\sum_{i=1}^{N}(fg)^2}{\sum_{i=1}^{N} g^2} = \frac{3}{2}f^2. \tag{1.44}$$

The expected total surplus for multiple performance measures is given by:

$$S^{FP} = E(y - c(a)) = f^2\sum_{i=1}^{N}(\sigma_i^{2\alpha-1} - \frac{1}{2}f^2\sigma_i^{4\alpha-2}) \tag{1.45}$$

Comparing both shows, that an increase in noise, σ_i results in a lower expected total surplus.

$$\frac{3}{2} > \sum_{i=1}^{N}(\sigma_i^{2\alpha-1} - \frac{1}{2}f^2\sigma_i^{4\alpha-2}) \tag{1.46}$$

Assume in addition, that additional performance measures increase in noise terms, i.e. $\forall i \sigma_{i+1} > \sigma_i$. Since the expected total surplus is fixed for the single performance measure, with increasing noise in the performance measures of the multiple performance measures of a focusing agent, there exists a switching point. The inefficiency of the single performance measure is outweighted by the negative externality induced by focusing.

Proposition 1.4.4. *As long as $\forall i \sigma_{i+1} > \sigma_i$ holds, i.e. additional performance measures include increasing noise terms thereby increasing the focusing distortion, there exists a switch-*

ing point of tasks t^* s.t.

$$\frac{3}{2}\sum_{i=1}^{N>t^*} i > \sum_{i=1}^{N>t^*}(\sigma_i^{2\alpha-1} - \frac{1}{2}f^2\sigma_i^{4\alpha-2}) \tag{1.47}$$

Any number of tasks above this switching point increases the negative externality of focusing more than the inefficiency of a single performance measure.

Proposition 1.4.4 implies that with an increasing number of performance measures it becomes optimal to switch from a complex to a simple contract that rewards on the basis of one overall measure. Complete and complex contracts generate a negative externality through the focusing bias. When the tasks increasingly influence the agents perception, then at some point it is socially optimal to switch to a simpler contract. In essence, Proposition 1.4.4 provides a rational for incomplete contracts.

Once I lift the simplification, the result depends on the specific dynamics of the tasks. In general it remains true that increasing variation increases the likelihood of the compound performance measure being more efficient. However, the increase in variation can be offset by an increase in productivity of tasks. Therefore two different empirical predictions arise. First, performance measures with high variation in outcomes should not be empirically observed. This prediction is close to Holmström and Milgrom (1991). Second, the more productive the tasks are individually and the better the performance measures represent this productivity, the more likely are multiple performance measures instead of a compound measure.

1.5 Conclusion

In complex environments classic economic theory predicts similar complex contracts in order to provide the agent with the right incentives. However, if the agent is not fully capable of processing all information, a natural reaction for an agent is to reduce the complexity by focusing his attention. When he focuses on those tasks that have the highest influence on his payoffs, the agent ends up allocating his effort among the tasks contrary to the principal's intention.

Through a combination of a model on multiple tasks with a model on focusing in economic choices, I can derive this result. It provides another argument for the existence of incomplete contracts and the observed paucity of complex incentive schemes. When I compare the choice between a compound performance measure and multiple performance measures, I find that an increasing number of tasks increases the benefits of the compound performance measure. The distortion through focusing increases with the tasks therefore it becomes is optimal for the principal rather than using several different measures to resort to one overall measure of productivity.

My results explain findings of field experiments in organizational economics, where the reduction of incentives increases overall productivity. While I was able to show the distortion for a general multiple task framework, it is an open and interesting question how different contract frames influence the agent's perception and therefore influence his effort choices beyond the financial incentives. The work by Hossain and List (2012), de Quidt (2017) and Imas et al. (2016) is instructive in thinking about the differential effects of contract frames on workers motivation and effort choice.

Chapter 2

On the Dynamics of Prospect Theory - Experimental Evidence*

ita duae voluntates meae, una vetus, alia nova, illa carnalis, illa spiritalis, confilgebant inter se, atque discordando dissipabant animam meam.
"Thus did my two wills, one new, and the other old, one carnal, the other spiritual, struggle within me; and by their discord, undid my soul."

Augustinus, Confessiones VIII, V

2.1 Motivation

Most of us have experienced willed weakness. Augustinus uses a pointed description in his confessions: the old will makes a plan and struggles to follow through with it, because a new will emerges. We research one potential cause for this behavior, the experience of losses on risk taking in sequential lotteries, and test for personality traits that exacerbate or reduce the difficulties to stick to ones plan.

Conventional wisdom helps to circumvent weakness of will by avoiding particular de-

* This chapter is based on joint work with Dominik Fischer (LMU) and Felix Peterhammer (University of Regensburg). The authors want to thank their supervisors Florian Englmaier, Andreas Roider and Klaus Schmidt. For helpful comments we thank Han Bleichrodt, Martin Kocher, Botond Kőszegi, Francesco Pasarelli, Simeon Schudy and Justin Sydnor. For excellent research assistance I thank Michael Hoffmann and Regina Seibel.

cision situations. One particular proverb regarding investing is: 'Never invest money you cannot afford to lose.' Closely related, a common tip for casino trips is to leave your credit card at home. Both suggest that in sequential decisions experiencing a loss will make it harder to follow the initial plan. The decision maker is tempted to change his behavior and to take on more risk in order to 'offset' a loss. Rather than convex preferences the decision maker's inability to restrict himself and accept losses seems to be at the core of the problem.

In the example of casino gambling the dynamics stand out as the cause for increasing risk taking. Sequential lotteries make it harder for the decision maker to follow through with their initial plans. Previously, sequential lotteries were bound to locations, like casinos or racetracks, reducing their availability. Now, through the internet sequential lotteries are easily accessible. On November 15th 2015 the host of 'Last Week Tonight', John Oliver, used a twenty minute segment to educate his viewers about fantasy football leagues. Users build their own fantasy football team, score points and compete for the jackpot. These fantasy leagues are a commonly observed in offices, where they are played over a long period of time. However, the internet leagues take less than a day to be resolved, leaving customers with a row of sequential lotteries.

Although betting and gambling are well known examples, the same underlying idea also influenced product design. Trading cards and stickers are sold in packs, where each pack is a lottery over its content. The desired cards or collections are hard to obtain and without occurring trade would involve substantial costs[2].

The mentioned examples already suggest, that decision maker face difficulties to follow through with plans once they experience losses. While the existence of conventional wisdom indicates that these difficulties are experienced by many, it also opens the question why decision maker enter sequential gambles in the first place. Two explanations come to mind. First, decision makers are not aware that they compare outcomes to a reference point, i.e. they are unaware that their preferences are described by Prospect Theory. It seems highly unlikely that decision makers never experienced losses in their

[2] Sylvain Sardy and Yvan Velenik, two mathematicians from Geneva, calculated the costs of filling one sticker album for soccer with CHF 933.27.

lives up to entering a sequential lottery. Therefore the second explanation seems more plausible: In dynamic situations it is harder to exactly predict the feeling of losses.

How good decision makers are in anticipating their Prospect Theory behavior has been discussed in the literature on penalty contracts (Imas et al. (2016), de Quidt (2017)) and anticipation mistakes have been applied to majority voting by Alesina and Passarelli (2015). Although research on the endowment effect[3] already indicates that decision makers do not correctly anticipate how much giving up an object impacts their utility (see Loewenstein and Adler (1995)), the same has to be proven for dynamic decision situations. In addition, it is an open question if there are personal traits that exacerbate or reduce anticipation mistakes.

The aim of our paper is to inform the theory about what quality of Prospect Theory anticipations is to be expected and to identify potential determinants of individual differences in these anticipations. Therefore, we conducted a controlled laboratory experiment where our participants were asked to plan, commit, and play a sequential investment game and where we elicited summary statistics of their demographics, cognitive abilities, personality traits, and risky choice patterns as potential correlates. We assess the quality of our subjects' anticipations by evaluating their planning and commitment choices based on plan-deviations in their actual play and based on separately elicited Prospect Theory parameters, and we classify them accordingly.

We show that the deviations from plan are driven by loss aversion for subjects whose behavior can be described by Prospect Theory. In addition we observe that the willingness to pay for a commitment increases with the subject's degree of loss aversion, providing suggestive evidence that subjects anticipate their inconsistent behavior. In the analysis of the quality of subjects' plan and commitment decisions, we find that subjects with high scores in agreeableness decide significantly better. In contrast, our prediction that subjects with high scores in the cognitive reflection test or conscientiousness do better has to be rejected.

The remainder of this chapter is structured as follows. Section 2.2 reviews the theoretical and experimental literature on anticipation mistakes and Prospect Theory. Section

[3] Prospect Theory is regarded as a good explanation for the endowment effect.

2.3 presents our predictions. Section 2.4 introduces our experimental design and describes how we conducted the experiment, Section 2.5 presents our data and analysis, and Section 2.6 summarizes the results and provides an outlook on further promising research.

2.2 Literature

In many dynamic decision situations, interactions between individual choices occur, i.e. the optimal decision in one stage can depend on what decisions were taken in other stages. Therefore outcomes for decision makers are crucially driven by their anticipation of own future desires and tradeoffs. However, such anticipation is difficult and people may exhibit systematic errors.

Prominent examples for systematic anticipation errors in decision making are projection bias (Loewenstein et al. (2003)) and naivete with respect to present bias (O'Donoghue and Rabin (1999)). When preferences are state contingent, projection bias describes the tendency to under-appreciate the change of own tastes conditional on changes in the state. For example, preferences over food depend on current hunger, but subjects who are asked right after a meal to choose a snack for a future hungry state systematically underestimate their future desire for unhealthy snacks (Read and van Leeuwen (1998)). Similarly, preferences over clothing, cars, and outdoor movie tickets depend on the weather at time of consumption, but subjects who purchase these items in advance are overly responsive to the weather at time of purchase (Conlin et al. (2007); Busse et al. (2015); Buchheim and Kolaska (2017)). Naivete with respect to present bias describes the tendency to under-appreciate own future desires for immediate gratification. For example, people who sign up for gym memberships underestimate their future laziness and credit card users underestimate their future reluctance to pay off their debt in due time. Firms can exploit such naivete by offering contracts that are tailored to these mistakes (DellaVigna and Malmendier (2004, 2006); Eliaz and Spiegler (2006); Heidhues and Kőszegi (2010)).

Many dynamic decisions involve also risk tradeoffs. However, there are well documented phenomena that cannot be reconciled with Expected Utility Theory, e.g. substantial deviations from risk neutrality in small stakes gambles (Rabin (2000)). Prospect Theory (Kahneman and Tversky (1979); Tversky and Kahneman (1992)), a static model of decision making under risk, can rationalize these choice behaviors and is, therefore, frequently applied also to dynamic choices that involve risk.

Prominent domains of dynamic risky choices where Prospect Theory was fruitfully applied are stock trading, casino gambling, and reactions to advertisements. For specific assumptions about its dynamics, Prospect Theory can help explain equity premiums and the disposition effect in asset trading (Benartzi and Thaler (1995); Barberis and Xiong (2009)), casino gambling strategies and commitment choices (Barberis (2012)), and why "bait-and-switch" strategies and other misleading advertisements of retailers can be effective (Heidhues and Kőszegi (2014); Rosato (2016); Karle and Schumacher (2017)).

However, Prospect Theory decision makers do not only exhibit distinct risk preferences in small stakes gambles, but are subject to massive spillovers between sequential risky choices. As reference points are fixed in the short term, the outcome of one gamble puts Prospect Theory decision makers into the gain or loss domain for their next decision, and they may behave vastly different than they do at the reference point.[4] In particular, for Prospect Theory decision makers a lottery of lotteries is not equivalent to its compound lottery. Therefore, the way decision makers anticipate their future Prospect Theory tradeoffs is a crucial driver of their behaviors in dynamic choices.

For example, investment decisions of stock traders who form reference points for their individual portfolio positions based on the initial purchase prices are crucially driven by Prospect Theory anticipations. If they do not anticipate their future feelings of gains and losses at all, they will trade in stocks and exhibit a disposition effect, i.e. a tendency to sell winning rather than losing stocks because of risk aversion in gains and risk seeking in losses (Odean (1998); Barberis and Xiong (2009)). On the other hand, if they do anticipate their future Prospect Theory behaviors, they either do not trade at all (Hens and Vlcek (2011)) or demand a compensating equity premium (Benartzi and Thaler (1995)).

[4] If reference points would immediately adjust to changes in the environment, they would also immediately adjust to winning or losing a gamble and feelings of gain or loss could never arise.

Another interesting dynamic Prospect Theory application is the usage of own loss aversion as a commitment against self control problems. Koch and Nafziger (2011) assume reference points for the future can be chosen deliberately in advance by setting oneself a goal which allows present biased decision makers to commit their future selves to desired actions by exposing them to losses in case of defection. Clearly, using such a commitment strategy not only requires sophistication about one's own future present bias (i.e. the awareness that the future self might actually misbehave from today's perspective), but also sophistication with respect to one's own future loss aversion (i.e. an understanding how setting a goal will be effective).

Another example has recently emerged in the literature on penalty contracts. Both Imas et al. (2016) and de Quidt (2017) investigate how framing a reward for a contract as either gain or loss influences the agent's effort decision. They find that in accordance with Prospect Theory, the loss frame increases effort provision, presumably because agents want to avoid the sensation of a loss. However contrary to theory, subjects select into the loss contract. Because of this observation Imas et al. (2016) assume that subjects anticipate the sensation of loss and use penalty contracts as commitment device.

Although Loewenstein and Adler (1995) show in a laboratory experiment that subjects do not correctly anticipate the endowment effect, to the best of our knowledge there has never been a test of subject's anticipation of Prospect Theory in dynamic decision situations. Hey and Lotito (2009) provide a full taxonomy of different types of dynamic inconsistent agents through a laboratory experiment. They use choices between lotteries and the equivalent compound lotteries to classify subjects. Although they find a substantial number of naive decision maker, it is impossible to attribute the results to Prospect Theory, because the lotteries used only the gain domain. Andrade and Iyer (2009) conduct a field experiment with a sequence of gambles, that allows for losses. They find that after an actual loss, despite the plan to take less risk, subjects increase the stakes of their bet. While the result is consistent with 'gambling for resurrection', it is only suggestive because the authors did not elicit their subjects' loss aversion.

Our experimental setup is taken from Imas (2016). Alex Imas provides an explanation for the seemingly contradictory findings of both higher risk taking and lower risk taking after a previous loss. Imas introduced the 'realization' as important design element, where subjects increase their risk taking after a not-realized loss, while they become more risk averse after a realization. This finding not only reconciles two strands of the literature on decisions under risk with loss averse agents, but also provides evidence on the relevance of shifts in reference points. Although Imas (2016) incorporates an extension on the subjects anticipation of their own future behavior and finds dynamically inconsistent behavior, the evidence is only suggestive, because he cannot relate the observed behavior to a subject's loss aversion, since he does not elicit Prospect Theory parameters. Therefore, we use the same setup of a four period investment game but include a separate planning stage, elicit our subjects willingness to pay for the plan and their loss aversion according to Abdellaoui et al. (2008). With the elicited parameters, we are able to classify our subjects and provide further insight on how accurate subjects predict their own behavior.

2.3 Predictions

Prospect Theory makes two contrary predictions with regard to risk taking in sequential lotteries: after losses in previous rounds agents invest either more or less. Imas (2016) reconciles both strands of literature through the "realization" effect. Losses that immediately become payoff relevant induce risk averse behavior, while paper losses induce more risk taking in order to offset previous losses.

The increased risk taking in case of paper losses is contrary to the optimal strategy of spreading the risk among all lotteries. Therefore loss aversion creates a wedge between the optimal plan and the decision makers per-round investment decision. This wedge becomes bigger with the decision maker's loss aversion. This results in the first prediction.

Prediction 1. *The deviations from plans increase in the degree of the decision makers loss aversion, because the self control problem becomes stronger:*

$$\frac{\partial deviation}{\partial \lambda} > 0.$$

The second prediction follows directly from the first. The more pronounced the dynamic inconsistency, induced by loss aversion, becomes, the higher a sophisticated agent will value her plan. Thus, for sophisticated agents the willingness to pay for the plan, captured in our experiment through a commitment decision, increases in the level of sophistication and loss aversion. While it is hard to directly assess sophistication, an increase in willingness to pay for plan with increasing loss aversion indicates sophistication.

Prediction 2. *The willingness to pay for the commitment increases with the degree of loss aversion for sophisticated subjects:*

$$\frac{\partial(\textit{actual commitment}|\textit{sophisticated})}{\partial\lambda} > 0.$$

To the best of our knowledge, economic research has either assumed perfect ability to anticipate future behavior or a complete lack thereof. So far nobody tried to identify channels that promote or hinder anticipation. Our experiment allows us to calculate the optimal choice of commitment that equalizes the utility of the plan and the actual investment game:

$$U(\text{plan} - \text{optimal commitment}) = U(\text{investment}).$$

A decision maker who experiences no dynamic inconsistencies should value the commitment at zero, since her behavior will not differ between plan and actual investment decision. In contrast, for each decision maker with dynamic inconsistent behavior the optimal commitment is non-zero. Decision makers who anticipate problems in sticking to their plan are willing to pay for their commitment. The willingness to pay increases with the magnitude of anticipated problems.

Through the difference between optimal and actual commitment decisions we learn about a subjects decision quality and can infer how well she anticipated dynamic inconsistencies:

$$\text{decision quality} = \text{actual commitment} - \text{optimal commitment}.$$

Currently, there is no knowledge on how different personality traits influence the decision quality. Therefore we test for several different traits and try to determine their influence on a subject's decision quality.

$$\frac{\partial \text{decision quality}}{\partial \text{personality trait}} \lesseqgtr 0$$

We follow Kahneman and Frederick (2002) who state that cognitive processes can be partitioned into two different systems, "System 1", intuition, and "System 2", reason. Subjects who are prone to use intuition are more likely to react spontaneously, thereby creating dynamic inconsistencies. A good measure of a decision makers use of System 2 rather than System 1 are cognitive reflection tests (CRT). Our CRT uses three questions for which an answer intuitively springs to mind, but is wrong. To get to the correct answer, one has to show a certain level of reflection and override the System 1 answer with the more deliberate System 2 answer. For example, one of the questions asked is:

> ”A bat and a ball together cost EUR 110. The bat costs EUR 100 more than the ball. How much does the ball cost?”

Frederick (2005) shows that for the question with ball and bat, almost everyone answers either EUR 5, the correct System 2 answer, or EUR 10, the incorrect but intuitive System 1 answer.

We expect a similar positive influence of both the math skills and the personality trait "conscientiousness" that are connected to System 2. Math skills are captured by the A level grade in math. Conscientiousness on the other hand is part of the Big 5 personality test and covers covers questions on how important plans are for the decision maker and how she assesses her ability to stick to plans. Therefore our third prediction links the decision quality to these personality traits.

Prediction 3. *Personality traits that are associated with System 2 allow the agent to better anticipate his future behavior and therefore increase sophistication and decision quality:*

$$\frac{\partial \textit{decision quality}}{\partial \textit{CRT}} > 0.$$

$$\frac{\partial \textit{decision quality}}{\partial \textit{Mathgrade}} > 0.$$

$$\frac{\partial \textit{decision quality}}{\partial \textit{Conscientiousness}} > 0.$$

2.4 Experimental Design and Conduct

Our experiment consisted of a Prospect Theory parameter elicitation task (PTPE), an investment game (IG), and of measurements of potential correlates. Each subject had to show up for two sub-sessions that took place one week apart from each other.

In week 1, we asked our participants for a complete contingent plan for the investment game, elicited their willingness to pay for committing to the plan, conducted a Cognitive Reflection Test (CRT) and a short Big Five personality test, and elicited their Prospect Theory parameters. In week 2, we elicited their Prospect Theory parameters again, played the investment game, and conducted a brief survey required by the lab. The time-line is depicted in Figure 2.4.1.

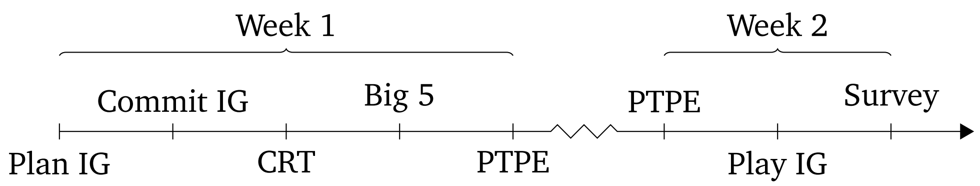

Figure 2.4.1: Time-line of the Experiment

The experiment was conducted in the Regensburg Economic Science Lab (RESL) in November 2016. We did 3 sessions with a total of 66 participants, 64 of whom showed up for both sub-sessions. Subjects were recruited from the RESL subject pool and were mostly students of the University of Regensburg from various backgrounds.

The first sub-session took on average 110 minutes, the second 50 minutes. Our subjects earned on average EUR 28.28, including a show-up fee of EUR 5.00 per week. All payments were made at the end of the second sub-session in week 2. The experiment was programmed in z-tree version 3.4.7 (Fischbacher (2007)) and organized via ORSEE (Greiner (2015)).

2.4.1 Prospect Theory Parameter Elicitation

We elicited Prospect Theory parameters according to the method of Abdellaoui et al. (2008), which has the advantage of requiring only a very limited number of observations and involving only cognitively simple choices.

In line with the usual Prospect Theory notation, we write $(x, p; y)$ for a binary prospect that yields payoff x with probability p and payoff y with probability $1 - p$. Payoffs are relative to the Prospect Theory reference point, which is assumed to remain constant throughout the experiment. If both x and y are positive, the prospect is called a gain prospect G. If both x and y are negative, it is called a loss prospect L. If one of the two payoffs is positive and the other one is negative, the prospect is called a mixed prospect M. We normalize $|x| > |y|$ for gain and loss prospects and $x \geq 0 \geq y$ for mixed prospects.

According to (Cumulative) Prospect Theory, prospects are evaluated as follows.

$$U(G) = w^+(p)v(x) + (1 - w^+(p))v(y)$$
$$U(L) = w^-(p)v(x) + (1 - w^-(p))v(y)$$
$$U(M) = w^+(p)v(x) + w^-(1 - p)v(y)$$

with $w^+(.)$ and $w^-(.)$ the Prospect Theory probability-weighting functions for gains and losses, respectively, and $v(.)$ the Prospect Theory value function. We assume the usual power form of the value function,

$$v(x) = \begin{cases} x^\alpha, & for\ x > 0 \\ -\lambda(-x)^\beta, & for\ x \leq 0 \end{cases}$$

where α and β denote the (curvature) parameters of diminishing sensitivity and λ the loss aversion parameter. Further, we assume the usual power form of the probability weighting functions,

$$w^+(p) = \frac{p^\gamma}{(p^\gamma + (1-p)^\gamma)^{\frac{1}{\gamma}}} \quad \text{and}$$
$$w^-(p) = \frac{p^\delta}{(p^\delta + (1-p)^\delta)^{\frac{1}{\delta}}},$$

where γ and δ denote the shape parameters of the probability weighting functions for gains and losses, respectively.

These parameters can be estimated based on simple choice data of the following three types: certainty equivalents E_G for gain prospects G with probability p_G, certainty equivalents E_L for loss prospects with probability p_L, and offsetting "loss equivalents" E_M for mixed prospects with gain x of probability p_G, where probabilities p_G and p_L add up to one. These equivalents satisfy the following equations.

$$E_G^\alpha = w^+(p_G)x^\alpha + (1 - w^+(p_G))y^\alpha$$
$$-\lambda(-E_L)^\beta = -\lambda w^-(p_L)(-x)^\beta - \lambda(1 - w^-(p_L))(-y)^\beta$$
$$0 = w^+(p_G)x^\alpha - \lambda w^-(p_L)(-E_M)^\beta$$

We set $p_G = 0.5 = p_L$ throughout, which is without loss of generality and reduces the cognitive burden of the task even further compared to any other choice of probabilities, and use a bisection method with 7 iterations for the elicitation of the equivalents instead of directly asking for them.[5]

We elicited certainty equivalents for 7 gain prospects (4 in week 1), 7 loss prospects (4 in week 1), and 5 mixed prospects (3 in week 1, one of them redundant in week 2), which yields 20 observations per subject in total. In each week, we started the elicitation with

[5] See Abdellaoui et al. (2008) for a discussion of these two design features. In the bisection method, participants have to decide between a risky prospect and a safe payment. For the certainty equivalent elicitation, the safe payment of the first iteration is set to be the expected value of the prospect. If a subject chooses the risk, the safe payment for the next iteration is reduced to the average of the current safe payment and the lower payoff of the lottery. If a subject chooses the safe payment, it is increased for the next iteration to the average of the current safe payment and the higher payoff of the lottery. For the loss equivalent elicitation, the loss of the first iteration is minus the gain and the safe payment is zero for all iterations. If a subject chooses the risk, the loss for the next iteration is increased by half of the last loss increment. If a subject chooses the safe amount, the loss for the next round is decreased by half of the last loss increment. The first loss increment is the original loss.

gain lotteries, continued with loss lotteries, and finished with mixed lotteries. Abdellaoui et al. (2008) found that this order is the easiest one for the participants. Table 2.4.1 provides an overview of the lotteries we used and of their timing. For example, lottery G1 offered a payoff x of EUR 1.20 and a payoff y of EUR 0.00, each with probability 50%, and was conducted in week 1.

Lottery	Payoff x	Payoff y	Week
G1	1.20	0.00	1
G2	2.20	0.00	2
G3	2.80	0.00	1
G4	4.40	0.00	1
G5	7.80	0.00	2
G6	7.80	2.80	2
G7	2.80	1.20	1
L1	-1.20	0.00	1
L2	-2.20	0.00	2
L3	-2.80	0.00	1
L4	-4.40	0.00	1
L5	-7.80	0.00	2
L6	-7.80	-2.80	2
L7	-2.80	-1.20	1
M1	-1.20	1.20	1
M2	-2.20	2.20	2
M3	-2.80	2.80	1 & 2
M4	-4.40	4.40	1
M5	-7.80	7.80	2

Table 2.4.1: Lotteries for the Prospect Theory parameter elicitation, payoffs x and y in EUR

We deviated from Abdellaoui et al. (2008) who make use of *"substantial money amounts"* and used money amounts in the range of EUR 1.20 to EUR 7.80 as payoffs for the lotteries. The reasoning behind our design choice is threefold. First, the investment game part of our experiment relies on the assumption that our participants have Prospect Theory value functions with substantial curvature over small amounts, which seems to be confirmed both by Imas (2016) and our own curvature estimates. Second, we want to make inferences about our participants' behaviors in the investment game based on the parameters we elicit in this task and, therefore, use similar amounts to ensure comparability. Third, the very choice of power functions for the functional form of the value function implies that curvature is biggest over small amounts[6].

As usual, only one of all 20 lottery choices was actually played out in order to prevent diversification and hedging[7]. As this task was spread out over two weeks, subjects got to know which lottery was payoff-relevant only in week 2. In order to avoid expectational spillovers regarding payoffs from other parts of the experiment, the uncertainty from this task was resolved only at the very end of the experiment.

2.4.2 Investment Game

We conducted a four-round investment game in week 2 of our experiment which mimics the experiments of Imas (2016) and Gneezy and Potters (1997). Similar to the planning treatment in Imas (2016), we asked our subjects for a complete contingent plan for the investment game before actually playing it. In order to avoid diversification and hedging considerations, only either the plan or the play was payoff-relevant for a subject. The probabilities of implementing the plan respectively the play were individually determined for each subject in a separate commitment task.

In contrast to Imas (2016), we did not ask for the plan right before playing, but one week ahead. This was meant to reduce anchoring effects and any related emotional costs of deviations from the plan such that each choice can be seen as purely instrumental for generating a payoff and its respective Prospect Theory utility. Moreover, our subjects had the opportunity to (stochastically) commit to their plans. All subjects had to participate

[6] In particular, the concern that utility is approximately linear over small amounts should hold only for subjects of the Expected Utility type with wide bracketing, not for subjects of Prospect Theory type with narrow bracketing.

[7] We use the standard assumption of narrow bracketing here, i.e. that subjects make their decisions in each lottery as if it was the only one to be played out instead of viewing their choices as one big compound lottery.

both in the planning and in the playing stages of the investment game, regardless of their commitment choices.

The ultimate purpose of eliciting plan, play, and commitment choices for each subject is to assess the quality of each of these decisions, both by comparing them to one another and by evaluating them according to the separately elicited Prospect Theory parameters.

In the actual play of the investment game in week 2, our subjects faced a sequence of 4 identical investment decisions. In each investment decision, the subjects had to choose what fraction of their per-period endowment of EUR 1.60 to invest in a risky asset, where choices were limited to integer-multiples of EUR 0.20. The risky asset returned seven times the invested amount with probability 1/6 and zero otherwise. The non-invested amount was added one-for-one to the subject's final payoff. The probabilities and multipliers resemble the ones in Imas (2016) and imply that the risky asset has a higher expected value than the safe outside option.

Each randomization was directly realized after the respective investment choice, such that subjects knew in each decision how much they had won and lost in all preceding rounds. In order to facilitate the randomization, each subject had to pick a "success number" between 1 and 6 in each round which was then compared to a die roll. If a subject's success number matched the die roll, her investment was successful and she received seven times her investment on top of the non-invested part of the endowment. If not, the invested amount was forfeited. In each investment round, one participant was randomly selected to manually roll a die and announce the result, which was then typed into the system by one of the experimenters and automatically compared to all subjects' choices.

Furthermore, we replicated the realization treatment of Imas (2016). Therefore, we handed out envelopes to our subjects that contained the total endowment of EUR 6.40 in cash at the beginning of the second sub-session. In two of our three sessions (randomly selected), realization of gains and losses was physically carried out between rounds 3 and 4, i.e. money that was lost in rounds 1 to 3 was taken away from the participants' envelopes and money that was won in rounds 1 to 3 was added to the participants' envelopes.

In week 1, subjects were asked for complete contingent plans for the investment game in week 2. Therefore, the exact procedure of the investment game was already explained to the subjects in week 1. Understanding was ensured by three control questions that had to be filled in correctly before one was able to proceed to the actual planning phase. While planning, subjects saw the complete game-tree on their screens, which they had to fill in line by line. After a line was completed, the payoffs for the next stage's contingencies were calculated and displayed in the interface to help the subjects keep track of each contingency's proceedings. In particular, we allowed our subjects to plan their round 4 investment decisions separately for the contingency of a cash realization after round 3. Subjects were made aware that their plans were to be implemented only stochastically, that their subsequent commitment choices would determine the exact probabilities, and that they had to participate in playing the investment game in any case.

After the planning stage, subjects faced a list of 45 choices between plan implementation plus some (positive or negative) money amount, and play implementation. One of the 45 choices was randomly selected at the end of the second sub-session, and based on the selected choice either the plan became payoff-relevant for that subject, or her week 2 play. The money amounts ranged from EUR -4.80 to EUR +4.80, were arranged in increasing order, and had smaller increments around zero and larger increments towards the boundaries. We enforced single switching points by implementing an error message in case of multiple switching and take each subject's switching point as her individual willingness to pay for commitment to the plan (in case of a negative money amount) respectively for flexibility (in case of a positive money amount). Subjects could completely determine whether their plan or play was to be implemented by not switching at all, but knew that they could not avoid participating in the play by doing so.

The random draw of the relevant choice was facilitated by a computer at the very end of the experiment. For plan-implementations, a subject's winning-and-losing history of her actual play was applied to her planned investment amounts of the respective contingencies.

2.4.3 Correlates Elicitation

Our experiment aims at classifying our participants as naive respectively sophisticated. Taking for granted that such a classification is possible and sensible, it is natural to ask for the drivers of such behavioral differences. Hence, we elicited a series of potential correlates that might explain some of the variation.

Our correlates tests comprise a Cognitive Reflection Test (Frederick (2005)), a short Big Five personality test (Schupp and Gerlitz (2014)), and a brief survey of basic demographics, which was also required by the lab.

The Cognitive Reflection Test (CRT) consists of three short questions that involve basic calculations. Each question lends itself to an intuitive, but incorrect answer and requires some reflection for finding the correct solution. Each correct answer added a point to a subject's CRT score (which, hence, ranges from 0 to 3) and was incentivized by EUR 0.50. We did not impose a time limit, but tracked the response times of our participants.

The short Big Five personality test consisted of 16 questions. Each question contained a personal statement and asked for a 7-points Likert self-assessment of how much it applied to the subject. The incentive for participating in this test was a flat payment of EUR 2.00.

The survey asked for age, gender, and high school math grade. Older subjects might be better in anticipating their own Prospect Theory behavior as they have more experience of life, in particular more experience of gains and losses. The math grade could be a proxy both for cognitive ability and for diligence, which also might improve anticipation.

2.5 Results

In Subsection 2.5.1, we first estimate Prospect Theory parameters for all subjects and for each week individually. Second we distinguish between subjects whose behavior can be described by Prospect Theory. In Subsection 2.5.2 we analyze the causes for subjects' deviation from their plans. In Subsection 2.5.3 we classify our subjects as sophisticated or naive with respect to their anticipation of their own Prospect Theory behaviors along two dimensions: the quality of their complete contingent plans for the investment game, and the quality of their commitment decisions. Further we analyze which personality traits are connected to sophistication and naivete. Since classifying decision maker as sophisticated crucially depends on the Prospect Theory parameters, we provide an extensive discussion of classification and consistency between weeks in Appendix B.2

2.5.1 Prospect Theory Parameter Elicitation

We estimated all Prospect Theory parameters of the usual power-specification introduced in Section 2.4.1 above. These comprise curvature parameters α, β and probability weighting parameters γ, δ for gains and losses, respectively, as well as a loss aversion parameter λ. As only one probability was used in all lotteries ($p = 0.5$), it suffices to estimate probability weights $w^+(0.5)$ and $w^-(0.5)$ instead of γ and δ, as the latter can be derived deterministically from the former.

We followed the overall approach of Abdellaoui et al. (2008) in using a non-linear least squares estimation, but deviated slightly in its specification. Whereas Abdellaoui et al. (2008) separately estimated the gain and loss curvatures α and β from the certainty equivalents of the gain respectively loss lotteries alone and deterministically calculated one λ for each mixed lottery, we used all observations to estimate all parameters simultaneously. In particular, we did not calculate multiple loss aversion parameters to take their median as estimate. Instead, we estimated only one loss aversion parameter and thereby fed the information from the mixed lottery choices also into the estimation of the curvature parameters and probability weights.

For each subject, we collected 20 observations of certainty and loss equivalents of the lotteries listed in Table 2.4.1. Let E jointly denote the elicited certainty equivalents E_G and E_L of the gain and loss prospects, respectively, and the elicited loss equivalents E_M of the mixed prospects. Further, let $\mathbb{1}_j$ for $j \in \{W1, W2, G, L, M\}$ denote the indicator function for an observation being a week 1, week 2, gain, loss, or mixed prospect observation. As all probabilities were $p = 0.5$, we drop the argument of the probability weighting functions in order to reduce notational overload. Then, our regression equations read as

$$
\begin{aligned}
E =& \mathbb{1}_{W1}\Big[\mathbb{1}_G(w_1^+x^{\alpha_1}+(1-w_1^+)y^{\alpha_1})^{\frac{1}{\alpha_1}} - \mathbb{1}_L(w_1^-(-x)^{\beta_1}+(1-w_1^-)(-y)^{\beta_1})^{\frac{1}{\beta_1}} \\
&- \mathbb{1}_M\left(\frac{w_1^+x^{\alpha_1}}{\lambda_1 w_1^-}\right)^{\frac{1}{\beta_1}}\Big] \\
&+\mathbb{1}_{W2}\Big[\mathbb{1}_G(w_2^+x^{\alpha_2}+(1-w_2^+)y^{\alpha_2})^{\frac{1}{\alpha_2}} - \mathbb{1}_L(w_2^-(-x)^{\beta_2}+(1-w_2^-)(-y)^{\beta_2})^{\frac{1}{\beta_2}} \\
&- \mathbb{1}_M\left(\frac{w_2^+x^{\alpha_2}}{\lambda_2 w_2^-}\right)^{\frac{1}{\beta_2}}\Big].
\end{aligned}
$$

The results of the pooled regressions of both weeks separately are summarized in Table 2.5.1.

	Coefficient	Std.Error	t.value	p.value
w_1^+	0.4723	0.0868	5.442	$6.23E-08$
α_1	1.1608	0.2913	3.985	$7.14E-05$
w_1^-	0.3429	0.0899	3.815	$1.43E-04$
β_1	1.5226	0.3828	3.978	$7.35E-05$
λ_1	1.2276	0.1494	8.215	$5.19E-16$
w_2^+	0.3871	0.0376	10.290	$6.61E-24$
α_2	1.5522	0.1769	8.773	$5.50E-18$
w_2^-	0.2247	0.0345	6.522	$1.00E-10$
β_2	1.8660	0.2124	8.785	$4.98E-18$
λ_2	1.6710	0.2035	8.212	$5.28E-16$

Table 2.5.1: Pooled estimation, both weeks separately

In the pooled regression, we find under-weighting both for gains and losses as well as loss aversion, as Prospect Theory suggests. However, we do not find the usual S-shape of the value function, but an inverse S-shape, as our curvature parameters are bigger than 1, not smaller.

Our main focus, however, lies on the individual estimations per subject, as we aim at individually classifying our subjects with respect to the quality of their anticipations. The results of the individual regressions per subject are summarized in Table 2.5.2 for both weeks separately. The complete list of all participants' individual estimations is deferred to Tables A.1 and A.2 in the appendix.

From the table we see, that although the median loss aversion λ is the same in both

Table 2.5.2: Distribution of individual estimates, both weeks separately

	Minimum	25%	Median	75%	Maximum	Average
w_1^+	0.00	0.35	0.48	0.60	0.96	0.46
$(Std.Error)$	(0.00)	(0.13)	(0.20)	(0.31)	(113.42)	(2.00)
$[p.value]$	[0.00]	[0.00]	[0.05]	[0.35]	[1.00]	[0.21]
α_1	0.29	0.82	1.09	1.34	24.00	2.38
$(Std.Error)$	(0.00)	(0.43)	(0.72)	(1.20)	$(1.3E+05)$	$(2.1E+03)$
$[p.value]$	[0.00]	[0.05]	[0.19]	[0.44]	[1.00]	[0.28]
w_1^-	0.00	0.22	0.35	0.50	0.68	0.33
$(Std.Error)$	(0.00)	(0.11)	(0.20)	(0.30)	(599.90)	(9.59)
$[p.value]$	[0.00]	[0.02]	[0.19]	[0.63]	[1.00]	[0.33]
β_1	0.54	1.00	1.46	2.55	19.77	2.97
$(Std.Error)$	(0.00)	(0.47)	(0.95)	(3.77)	$(1.3E+05)$	$(2.1E+03)$
$[p.value]$	[0.00]	[0.05]	[0.20]	[0.45]	[1.00]	[0.29]
λ_1	0.00	0.78	1.30	2.71	$1.9E+11$	$2.9E+09$
$(Std.Error)$	(0.00)	(0.23)	(0.45)	(2.33)	$(1.9E+14)$	$(2.9E+12)$
$[p.value]$	[0.00]	[0.00]	[0.08]	[0.53]	[1.00]	[0.28]
w_2^+	0.00	0.24	0.43	0.53	0.86	0.39
$(Std.Error)$	(0.00)	(0.05)	(0.08)	(0.13)	(1.72)	(0.14)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.10]	[1.00]	[0.17]
α_2	0.42	1.00	1.41	2.40	21.51	2.77
$(Std.Error)$	(0.00)	(0.22)	(0.44)	(1.52)	$(1.0E+03)$	(26.13)
$[p.value]$	[0.00]	[0.00]	[0.01]	[0.11]	[0.99]	[0.17]
w_2^-	0.00	0.03	0.19	0.44	0.56	0.22
$(Std.Error)$	(0.00)	(0.03)	(0.06)	(0.10)	(0.20)	(0.07)
$[p.value]$	[0.00]	[0.00]	[0.07]	[0.71]	[1.00]	[0.31]
β_2	0.77	1.16	1.96	3.64	54.95	5.04
$(Std.Error)$	(0.00)	(0.26)	(0.62)	(3.25)	(910.79)	(33.10)
$[p.value]$	[0.00]	[0.00]	[0.02]	[0.23]	[0.99]	[0.18]
λ_2	0.00	0.95	1.29	5.51	$1.1E+04$	269.38
$(Std.Error)$	(0.00)	(0.14)	(0.50)	(8.06)	$(1.2E+05)$	$(3.1E+03)$
$[p.value]$	[0.00]	[0.00]	[0.04]	[0.63]	[0.99]	[0.28]

weeks, already the 25 and 75 percentiles differ across both weeks. The probability weights w^+, w^- as well as curvature in the gain domain α and in the loss domain β differ substantially.

Therefore the distribution of individual estimates not only shows that there is a difference between the estimated parameters for week 1 and week 2, but also casts doubt on the fit of Prospect Theory for some subjects. Especially the maximum values indicate that for some subjects Prospect Theory has little explanatory power. In order to to account for the quality of fit, we exclude subjects whose parameter estimations cannot be rationalized within Prospect Theory.

We do so by setting upper bounds on acceptable standard errors for estimates. Subjects whose standard error is bigger than 100% of sensible intervals of $[0, 1]$ for probability weights, $[0, 2]$ for curvature parameters, and $[0, 4]$ for loss aversion are classified as "bad fit". In addition subjects whose p-values for estimates exceed 50% are also classified as bad fit. An extended discussion is in Appendix B.2.

Our results show that for 29 subjects Prospect Theory is a bad fit. Since our predictions only work for Prospect Theory behavior, we treat those subjects separately in our further analysis.

2.5.2 Deviation of Actual Investment from Plan

We can test the first predictions from Section 2.3. First, the experience of a non-realized loss makes it harder to stick to the plan. This effect becomes stronger the more loss averse the decision maker is.

As dependent variable we use the mean deviation for each subject:

$$\text{Mean Deviation}_i = \frac{1}{4}\sum_{t=1}^{4}(\text{investment}_{i,t} - \text{plan}_{i,t}).$$

Mean deviation captures both the magnitude of deviation from plan and the overall tendency of either investing less(Mean Deviation$_i < 0$) or more (Mean Deviation$_i > 0$) than planned. Our baseline regression focuses on those subjects who have experienced losses, i.e. subjects that have never won in a round[8]. Additionally, we restrict our sample to those subjects who are consistently estimated by Prospect Theory. We lift these restrictions in later regressions.

The baseline regression uses the Prospect Theory parameter of both weeks as explanatory variables.

$$\text{Mean Deviation}_i = \text{cons} + \gamma_1\alpha 1_i + \gamma_2\beta 1_i + \gamma_3\lambda 1_i + \gamma_4\alpha 2_i + \gamma_5\beta 2_i + \gamma_6\lambda 2_i \qquad (2.1)$$

[8] Every subject that won one round in our experiment always ended up in the gain domain

In column (2) we add demographics. Female is a binary variable that takes value 1 if the subject is female. Age is the subjects age measured in years. Mathgrade is the subjects grade in her math A levels, ranging from 1 to 5, where 1.0 is the best grade. Complex measures how many unique investment choices the subject made in her plan. Plans that contain the same investment in every period receive the lowest number 1. Complex is a proxy for the difficulty to remember the plan after one week. CRT is the number of correctly solved questions in the cognitive reflection test. Columns (3) and (4) are the same regressions as (1) and (2), however we lifted the restriction of subjects in the loss domain. In columns (5) and (6) we drop the restriction that Prospect Theory is a good fit for subjects' behavior. When we include the demographics the variance inflation factors for $\beta 1$ and $\beta 2$ become critical hinting at multicollinearity. Therefore we drop $\beta 1$ and $\beta 2$ when we include the demographics. Table 2.5.3 presents the results.

Table 2.5.3: Drivers of deviation from plan

	(1)	(2)	(3)	(4)	(5)	(6)
$\alpha1$	-0.393	-0.0246	0.0279	-0.118	0.0439	0.0189
	(0.539)	(0.334)	(0.283)	(0.200)	(0.0336)	(0.0161)
$\lambda1$	-0.255*	-0.435**	-0.0129	-0.0354	-0	-0
	(0.144)	(0.156)	(0.106)	(0.111)	(0)	(0)
$\alpha2$	-0.247	-0.250	-0.0933	-0.0957	-0.0242	-0.0119
	(0.155)	(0.145)	(0.171)	(0.170)	(0.0147)	(0.0167)
$\lambda2$	0.162*	0.235**	4.57e-05	0.0228	5.62e-06	6.26e-06
	(0.0893)	(0.0912)	(0.0646)	(0.0696)	(0.000108)	(0.000112)
Female		0.0349		-0.203		-0.116
		(0.191)		(0.182)		(0.120)
Age		0.0145		-0.00511		-0.00364
		(0.0119)		(0.0117)		(0.00708)
Mathgrade		0.0331		0.00868		-0.0172
		(0.0953)		(0.0984)		(0.0646)
Complex		-0.00564		0.0222		0.0264
		(0.0293)		(0.0307)		(0.0230)
CRT		-0.175*		-0.128		-0.0150
		(0.0841)		(0.0922)		(0.0565)
$\beta1$	0.115		-0.0850		-0.0171	
	(0.200)		(0.177)		(0.0252)	
$\beta2$	-0.0941		-0.0887		0.00331	
	(0.106)		(0.119)		(0.00610)	
Constant	0.890*	0.620	0.416	0.642	0.0111	0.0752
	(0.452)	(0.593)	(0.355)	(0.634)	(0.0652)	(0.317)
Observations	26	26	35	35	64	64
R^2	0.305	0.489	0.087	0.198	0.092	0.113

*** 1% significance level; ** 5% significance level; * 10% significance level

We find a significant positive effect for in columns (1) and (2) for loss aversion in week 2. The effect indicates that subjects' deviation from plan is driven by loss aversion rather than complexity of plan or personality traits. The interpretation of our result is additionally strengthened by columns (3), (4), (5) and (6) where it vanishes, when we extend our analysis to subjects who did not experience losses and whose behavior is a bad fit with Prospect Theory.

Columns (1) and (2) show that prediction 1 is correct. Subjects who behave according to Prospect Theory and experience losses invest more than planned in each period with increasing loss aversion in week 2. The effect is significant at the 10% level and the size is 0.16, i.e. an increase in loss aversion by 1 results in a higher investment of EUR 0.16 than originally planned in each round. This effect is 10% of the per round endowment. This is strong evidence that once subjects face a situation of loss, they start investing more because of their loss aversion.[9]

The second observation is not backed by theory, but nonetheless interesting. A higher loss aversion in week 1 induces subjects to invest significantly less than planned. The effect is significant at the 10% level and the size is -0.25, i.e. an increase in loss aversion in week 1 by 1 results in a decrease of investment in comparison to the plan of EUR 0.25 per round. The result suggests that loss averse subjects involve too much risk in their plans and reduce their investment once they receive their endowment.

Unsurprisingly the result for loss aversion in week 2 vanishes once we include subjects who are in the gain domain (columns (3) and (4)). The result for loss aversion in week 1 has a p-value of 0.11, therefore barely not significant anymore. This observation backs our previous interpretation that subjects with higher loss aversion in week 1 include too much risk in their plans, because this result is not tied to winning or loosing in the actual investment game. Once we include subjects whose behavior is not described by Prospect Theory, all results vanish.

Our second prediction states that the willingness to pay for commitment should increase in the loss aversion for sophisticated decision maker. Since naive agents do not anticipate their dynamic inconsistencies and in turn underestimate the value of a carefully crafted plan, a positive effect of loss aversion on the willingness to pay for commitment is at least suggestive that some participants are sophisticated about their loss aversion.

The baseline regression uses the Prospect Theory parameter of both weeks as explana-

[9] This result is especially important, because previous research has failed to establish the link, see AppendixB.1.

tory variables and the subject's commitment choice as dependent variable.

$$\text{WTP}_i = \text{cons} + \gamma_1 \alpha 1_i + \gamma_2 \beta 1_i + \gamma_3 \lambda 1_i + \gamma_4 \alpha 2_i + \gamma_5 \beta 2_i + \gamma_6 \lambda 2_i \tag{2.2}$$

In column (2) we add the same demographics as in Table 2.5.3 with the addition of the duration (in seconds) subjects took for their plans. Columns (3) and (4) are the same regressions as (1) and (2), however we drop the restriction that subjects have to be consistent. Table 2.5.4 presents the results.

Table 2.5.4: Willingness to Pay for Commitment

	(1)	(2)	(3)	(4)
$\alpha 1$	0.0952	0.0848	0.131	-0.0938
	(1.931)	(1.988)	(0.233)	(0.261)
$\beta 1$	-0.402	-0.312	-0.124	0.0532
	(1.210)	(1.296)	(0.175)	(0.206)
$\lambda 1$	0.916	1.547*	-9.57e-11	-5.64e-11
	(0.726)	(0.849)	(5.92e-11)	(6.58e-11)
$\alpha 2$	-1.318	-0.207	-0.0192	-0.0632
	(1.170)	(1.298)	(0.102)	(0.127)
$\beta 2$	-0.849	-0.973	-0.0338	-0.0379
	(0.814)	(1.170)	(0.0423)	(0.0426)
$\lambda 2$	-0.208	-0.391	0.00126*	0.00112
	(0.441)	(0.566)	(0.000746)	(0.000799)
Female		-0.974		-0.936
		(1.470)		(0.806)
Age		0.0283		0.0575
		(0.0803)		(0.0485)
Mathgrade		0.830		0.334
		(0.723)		(0.471)
Complex		0.117		-0.00235
		(0.265)		(0.167)
CRT		0.652		0.0297
		(0.710)		(0.409)
Duration		-0.00645*		-0.00466**
		(0.00331)		(0.00228)
Constant	3.531	0.119	0.776*	0.861
	(2.426)	(4.447)	(0.452)	(2.274)
Observations	35	35	64	64
R^2	0.221	0.397	0.068	0.199

*** 1% significance level; ** 5% significance level; * 10% significance level;

We find a strong positive effect of $\lambda 1$ on the willingness to pay for commitment. While the result is not significant in the baseline regression, once we control for demographics it is at the 10% level with a strong effect of EUR 1.54. An increase of loss aversion by 1 increases the willingness to pay for commitment by EUR 1.54. The effect becomes a clear null effect once we include the "bad fit" subjects, which strengthens our interpretation. Loss aversion in the second week, $\lambda 2$ should have no impact on willingness to pay for commitment other than through its correlation with $\lambda 1$. The exception in column (3) is a most likely generated by coincidence, since the result vanishes when controlled for demographics.

The time subjects took for their plan has a significant and negative influence on the willingness to pay. The effect holds for both the restricted as well as the full sample. In the mean subjects spent around 383 seconds on their plan with a standard deviation of 160 seconds. Therefore if the time spent on a plan increases by one standard deviation, subject's willingness to pay decreases by EUR 1.03. The result suggests that subjects who plan with more care are more confident in their ability to carry through with the plan, thereby reducing their willingness to pay for it.

2.5.3 Naivete with respect to Prospect Theory Behavior

Having established that loss aversion has an impact on the behavior in the investment game and on the willingness to pay for the commitment, we can investigate the quality of our subjects' anticipations of their own Prospect Theory behaviors. We do so by establishing two measures of naivete: the quality of the complete contingent plan and the quality of the commitment decision.

We assess the quality of our subjects' complete contingent plans by interpreting them as compound lotteries and calculating their Prospect Theory utilities based on our above parameter estimates.[10] As long as a plan yields non-negative Prospect Theory utility, we classify the subject as a good, otherwise as a poor planer. This is a very conservative threshold, as each subject could achieve a utility of zero if they would plan to never

[10] We focus on our estimates for week 2 as we believe that these reflect the preferences at the time when this compound lottery is actually played.

invest in any contingency, regardless of their Prospect Theory parameters[11]:

$$1_{\text{good plan}} = \begin{cases} 1 \text{ if } \mathrm{E}U(\text{plan}_i) \geq 0 \\ 0 \text{ if } \mathrm{E}U(\text{plan}_i) < 0. \end{cases}$$

In order to assess the quality of our subjects' commitment decisions, we have to investigate whether their plans were superior or inferior compared to their actual play, and to what extent. Hence, we have to calculate a utility from their play. Clearly, we do not want to assess the quality of our subjects' decisions based on their outcome luck, so we have to calculate an ex ante utility of their play. In particular, we have to view their play as an implementation of an alternated complete contingent plan. As we can observe our subjects' behaviors only in the contingencies that have actually realized, we have to impose an assumption on how they would have played in the contingencies that did not materialize. We do so in the most conservative way by assuming that they would have stuck to their initial plans in all other contingencies.

We classify a commitment decision as poor if the utility of the original week 1 plan, where all payoffs are reduced by the willingness to pay for the commitment (respectively increased by the willingness to accept) and another EUR 1.00 tolerance, exceeds the utility of the actual play.[12] As we only account for actually observed plan-deviations (i.e. a maximum of 4 deviations) and allow for considerable trembling (EUR 1.00 tolerance), a subject's commitment decision is classified as poor only in case of extremely harmful deviations:

$$1_{\text{good commitment}} = \begin{cases} 1 \text{ if } \mathrm{E}U(\text{plan}_i - \text{wtp}_i \pm 1.00) \geq \mathrm{E}U(\text{investment}_i) \\ 0 \text{ if } \mathrm{E}U(\text{plan}_i - \text{wtp}_i \pm 1.00) < \mathrm{E}U(\text{investment}_i). \end{cases}$$

According to our classification 26 subjects as poor planners and 19 subjects are poor committers. There are only 3 subjects in the overlap of the two types of errors, which

[11] We use this zero threshold as benchmark instead of the optimal attainable plan because there is a total of 9^{15} possible plans per subject, and it is computationally more than demanding to figure out which one is actually optimal, whereas the zero utility plan of never investing is easily conceivable.

[12] We include this EUR 1.00 tolerance to account for noise in order not to classify a subject as naive because of a "mistake" of very little consequence.

is a result of our conservative calibration: To end up in this overlap, one has to make a plan that yields negative utility in the first place and than play so poorly that it would have been worthwhile to pay at least one additional euro for committing to that plan. Put differently, poor planning makes it very unlikely to also commit poorly, as we only observe the commitment error of paying too little. Table 2.5.5 summarizes the naivete classification for our original estimations. The italic numbers represent subjects for whom Prospect Theory is a good descriptive model.

		Commitment		
		poor	good	Sum
Plan	poor	3	23	26
		2	*10*	*12*
	good	16	22	38
		7	*16*	*23*
	Sum	19	45	64
		9	*26*	*35*

Table 2.5.5: Classification of naivete, full sample; original regression, *bad fit excluded*

We create a joint measure that also accounts for the magnitude of mistakes. Therefore we compute the optimal commitment decision for subject i is implicitly defined through:

$$U(\text{plan}_i - \text{optimal commitment}_i) = U(\text{investment}_i).$$

The willingness to pay for commitment depends on both the quality of the plan and the actual investment decisions. Subjects that make poor plans rationally would require compensation for implementing the plan, therefore as long as the plan is worse than the actual investment decisions, the optimal commitment should be negative (willingness to accept). In comparison if the plan is better than the actual investment behavior the decision maker should be willing to pay for the plan, i.e the optimal commitment should be positive (willingness to pay).

When we compare the actual commitment decision to the optimal commitment decision, we have a joint measure for both the quality of the plan in comparison to the actual decisions and for the quality of the commitment decision:

$$\text{decision quality}_i = \text{actual commitment}_i - \text{optimal commitment}_i.$$

The decision quality becomes positive for each subject that is willing to pay more for the plan than she optimally should. For these subjects the quality of the plan is lower than their actual investment decisions, but they incorrectly believe that their plan is of higher quality. The effect can be driven by overestimation of dynamic inconsistencies or a subjects inability to make reasonable plans in the first place. A negative sign for decision quality implies that the decision maker plans better than her actual investment decisions, but overestimates her ability to stick to the previous plan and in turn pays too little for the commitment. Prospect Theory predicts that decision maker who are naive about their Prospect Theory behavior will systematically pay too little for their commitment.

However, we observe that subjects pay EUR 0.9 too much on average for their plan. The basic tendency to overpay for commitment is not connected to our theory. In addition the tendency is at odds with research on failing commitments (see John (2017)), where subjects systematically underestimate their self control problems which leads them to choose ineffective commitments. In our case the result is driven by a small number of subjects who always choose the plan to be implemented.

In our baseline regression we use the decision quality as dependent variable and our measures for personality traits as explanatory variables:

$$\begin{aligned}\text{decision quality}_i = \text{cons} + \gamma_1\text{Female}_i + \gamma_2\text{Age}_i + \gamma_3\text{Mathgrade}_i + \\ \gamma_4\text{Duration}_i + \gamma_5\text{Complex}_i + \gamma_6\text{Duration}_i * \text{Complex}_i + \gamma_7\text{CRT}_i.\end{aligned} \tag{2.3}$$

The variables are the same as in Table 2.5.3 except for the interaction term of time spent on and complexity of the plan. Column (1) displays the results of the regression for the restricted sample of agents who experienced losses and for whom Prospect Theory is a good description of actual behavior. In column (2) we include the personality traits as measured by the Big Five personality test. Columns (3) and (4) include subjects that won during the investment stage. (5) and (6) represent the results for the full sample.

Table 2.5.6: Quality of Plan and Commitment Decision

	(1)	(2)	(3)	(4)	(5)	(6)
Female	-1.064	-1.001	-2.351**	-0.621	-2.147***	-1.434
	(1.097)	(1.461)	(1.096)	(1.374)	(0.770)	(0.874)
Age	0.192**	0.147	0.0613	0.0584	0.00442	-0.0145
	(0.0858)	(0.0992)	(0.0853)	(0.0830)	(0.0481)	(0.0465)
Mathgrade	0.844	1.822*	0.481	0.985	0.0881	0.141
	(0.733)	(0.910)	(0.723)	(0.742)	(0.419)	(0.417)
Duration	-0.0294***	-0.0244**	-0.0221**	-0.0217**	-0.0143**	-0.0176***
	(0.00891)	(0.0107)	(0.00867)	(0.00855)	(0.00632)	(0.00637)
Complex	-1.174*	-0.979	-1.064*	-0.984	-0.476	-0.636
	(0.589)	(0.771)	(0.593)	(0.604)	(0.413)	(0.432)
Duration*complex	0.00426**	0.00369	0.00333*	0.00385**	0.00210*	0.00285**
	(0.00171)	(0.00213)	(0.00163)	(0.00161)	(0.00121)	(0.00126)
CRT	0.137	0.456	-0.286	0.0498	-0.194	-0.264
	(0.569)	(0.667)	(0.657)	(0.697)	(0.405)	(0.402)
Conscientiousness		-0.105		-0.0266		0.00882
		(0.207)		(0.169)		(0.101)
Extraversion		0.159		0.147		0.180
		(0.170)		(0.175)		(0.121)
Agreeableness		-0.298		-0.523**		-0.265**
		(0.239)		(0.206)		(0.115)
Openness		0.177		0.139		-0.0547
		(0.178)		(0.168)		(0.103)
Neuroticism		0.139		0.00440		-0.0324
		(0.191)		(0.174)		(0.116)
Constant	3.066	-0.782	7.041	4.715	5.118*	7.543*
	(3.787)	(6.539)	(4.198)	(5.807)	(2.899)	(4.065)
Observations	26	26	35	35	64	64
R^2	0.567	0.669	0.353	0.546	0.208	0.343

*** 1% significance level; ** 5% significance level; * 10% significance level;

Contrary to our prediction subjects with higher scores in CRT, math and conscientiousness do not plan better. However, a plan's complexity and the duration taken for the plan decrease overpayment. Carefully crafted plans that combine refinement to different nodes, i.e. higher complexity, with a longer duration in planing overall increase the likelihood to be optimal.

Column (1) displays the main results that remain basically unchanged even as the subject pool widens. First, the time spent on the plan (Duration) significantly reduces the error that leads to overpayment, significant at the 1% significance level. The effect -0.0294 is large, because an increase of the time spent on the plan by one standard deviation implies a reduction of EUR 4.70. The magnitude of the effect makes clear that duration also facilitates too low commitment choices and not only reduces overpayment.

The complexity of plans has the same direction. Complexity varies between significance at the 10% level and narrowly missing significance. The magnitude of the effect is remarkable, because an increase of a plans complexity by 1 decreases the overpayment by EUR 1.17. Both effects counteract the general tendency to bid too much, however also lead to underpayment for commitment. The interaction term is for almost all regressions significant at the 5% or 10% level and is a countervailing effect. This combination of duration, complexity and their interaction effect show that the more mental resources are used the better is the plan. Complex plans that were carefully drafted are more likely to actually result in a good commitment choice.

The only personality trait that becomes and stays significant at the 5% level is agreeableness. Agreeableness captures personality traits for interpersonal interaction, social preferences, trust, sympathy (see McCrae and John (1992)). Therefore, we argue that subjects who score higher in this dimension are better in taking another person's perspective and anticipate their feeling in a situation. This increases the ability to foresee own behavior. Effect and size of agreeableness strengthen this line of argument, because an increase in agreeableness by one standard deviation (3.32 points) reduces the overpayment by EUR 1.73. The increase by one standard deviation can be interpreted on a seven point Likert scale as changing one answer from indifferent between being social or not, to displaying strongly social behavior.

It is remarkable that all variables that are naturally associated with sophisticated planning are not significant. Not even by mere chance become conscientiousness, cognitive reflection and math skills significant. All three capture a different aspect of sophisticated planning: conscientiousness is the category of the Big Five personality test that is described with the adjectives efficient, organized, planful, reliable, responsible and thorough (see McCrae and John (1992)). Cognitive reflection and math skills are a good proxy for a subject's ability to reflect on their intuitive assessment of decision situations.

Our interpretation of columns (5) and (6) is limited by the fact that we use subjects' parameters to calculate the quality of plan for whom Prospect Theory holds little to none descriptive power. Nevertheless the effects of careful planing through complex plans and high amount of time spent on the plan seem to be robust and consistent for all subjects, indicating that the effort put into the plan actually increases its quality.

Since we started with a strong prediction about the positive influence of System 2 on decision quality, a natural question is if our measurement of cognitive reflection is correct. In line with Frederick (2005) we find that almost every subject in our experiment answers either EUR 5 or EUR 10 in the ball and bat question[13]. 95.3% chose one of those two answers and two of the remaining three participants seem to have misread the question as they gave the correct answer for the price of the bat (instead of the ball's price). A similar pattern holds for first question, where 93.8% of our Participants chose either the correct answer or the incorrect answer.

	Correct	Intuitive Incorrect	Other Incorrect
Q1	31	29	4
Q2	44	17	3
Q3	47	5	12

Answer Types per Question.

No. of Correct Answers			
0	1	2	3
6	15	22	21
9.4%	23.4%	34.4%	32.8%

CRT score distribution.

6 out of 64 participants gave zero correct answers. 5 out of these 6 chose the intuitive incorrect answer at least twice, and the remaining one gave one intuitive incorrect answer. Since our cognitive reflection test was both incentivized and produced no outliers in the answers given, we are convinced that the CRT is valid. For additional analysis of CRT see Appendix B.3.

[13] see Section 2.3.

2.6 Discussion

Research on Prospect Theory has focused on static decisions. However most interesting predictions with regard to behavior and strategies in sequential gambles rely on assumptions of the decision makers ability or disability to anticipate their own behavior once they face losses. We contribute to the literature by providing evidence that loss aversion actually drives the decision maker's deviations from her plans. An increase of loss aversion in the second week by 1 unit increases the average deviation by EUR 0.16 per round. The effect is large at 10% of the per round endowment. We also find suggestive evidence that at least some individuals are sophisticated as their willingness to pay for commitment increases with their loss aversion in week 1, indicating that they foresee potential self control problems caused by loss aversion in the investment game.

In a second step we devise a joint measure for the quality of plan and commitment in order to attribute how personality traits influence the quality of planning. Contrary to our predictions we find no effect of cognitive reflection, math skills and conscientiousness although they are all associated with careful planning and a preference for plans. Rather it matters how much time subjects spent on their plan and how delicate the plan is. In addition we found a surprisingly robust influence of agreeableness, i.e. the subjects ability to empathize with other people. This seemingly also increases the self awareness and foresight of own behavior.

We are aware that our experimental design suffers from several methodological shortcomings. First, the order of the Prospect Theory parameter elicitation and the investment game were reversed between weeks 1 and 2. So potentially, our measurement of Prospect Theory parameter in-consistency might suffer from order effects. We cannot address this issue with the data we have.

Second, our subjects could in principle commit to their plan or play deterministically by never switching in the choice list, and 14 out of 64 subjects did so. As 11 of them committed to their plans at any price and as our assessment of the quality of commitment decisions does only account for the error of paying too little for the commitment, this does not qualitatively affect our results on the commitment decisions. In total, only two of these 14 subjects are classified as poor committers. Also, this deterministic commitment does not affect our assessment of the planning decisions of the 11 deterministic planners, as we evaluate plans not relative to the play, but relative to the benchmark of zero utility.

Third, when estimating Prospect Theory parameters on an individual basis, we have to be weary of “over-fitting” as we estimate up to 10 parameters from only 20 data points. That is, we have to ask ourselves whether our individual level estimates really do capture individual level heterogeneity, or simply noise. We believe it is reasonable to assume that these estimates capture some of both, and we tried to address this issue by our grouping exercise, i.e. by reporting for each subject how well it fits, or put differently, how much explanatory power Prospect Theory has for this specific subject’s behavior. Clearly, we feel much more comfortable in drawing inferences about subjects for which Prospect Theory is a good descriptive model.

Last but not least, our classifications rely on the assumption that our elicited week 2 Prospect Theory parameters reflect actual risk preferences at the time when subjects get their payoffs, and that this is the relevant objective both for planning and for playing. That is, we assume that commitment is used solely in order to avoid the above described spillovers between individual risky choices, not in order to tie oneself to one’s original week 1 preferences when these are different form week 2 preferences. Our consistency classification was meant to control for this second commitment channel, and we found much more inconsistency than we had originally expected.

If we take this inconsistency classification at face value, we have to ask ourselves how to interpret such inconsistencies. Do we want to think of this as changing preferences, or should we rather not view Prospect Theory as description of (non-standard) preferences? Instead, Prospect Theory behaviors could reflect impulsive, heuristic decision making which is driven by current moods, emotions, and depletion and could, potentially, be viewed as mistakes. Whereas both interpretations have their own merit, they give rise to vastly different welfare implications.

Because of these difficulties further research needs to separate the question for time-consistency and measurement of Prospect Theory parameters from the question of choices in sequential gambles. Conducting both the plan and the investment game in the same session might induce anchoring, but reduces the degrees of freedom introduced through different consistency and quality of fit definitions. In addition a better way of presenting the commitment choice than a choice list is necessary to strengthen the argument that the results are not driven by the subjects' lack of understanding. Also a treatment variation of plans and commitment (e.g. doing a trial round up front) can help to strengthen the results. Last, a questionnaire on the subjects' feelings during the planning rounds and during the investment game can help to identify sophisticated and naive subjects easier than through our reverse engineered optimal choice for commitment.

Chapter 3

Unions, Communication, and Cooperation in Organizations*

3.1 Introduction

Relational (or implicit) contracts have been widely employed to analyze the relation between worker and firm.[2] In models of relational contracts information that is observable to the contracting parties, but not verifiable, is utilized in the context of a repeated game between firm and worker. These models added numerous important insights to our understanding of the firm-worker relationship and its potential consequences for labor market outcomes. However, this approach generally has been less concerned with generating realistic dynamic patterns of these relations. In reality, firm-worker relations in ongoing organizations generally seem to be characterized by good cooperation, interrupted by phases of, sometimes fierce, conflict. Krueger and Mas (2004) and Mas (2008) present evidence from Bridgestone/Firestone and Caterpillar that documents that these quarrels can be very costly to firms. In this paper, we present a simple model that is rich enough to generate such patterns and that still allows us to analyze how unionization can help firms

* This paper is based on joint work with Florian Englmaier (LMU) and Carmit Segal (University of Zurich).

[2] Examples for theoretical work are Shapiro and Stiglitz (1984), Bull (1987), MacLeod and Malcomson (1989, 1998), Baker, Gibbons, and Murphy (1994), or Levin (2003). Examples that highlight the empirical relevance of relational contracts are Beaudry and DiNardo (1991) or Hayes and Schaefer (2000).

to mitigate this unfortunate cycle and increase efficiency. In this sense, our model links to the literature on (positive) productivity effects of unions as prominently advocated by Freeman and Medoff (1984).[3]

We analyze a situation where a worker and a firm interact repeatedly. Though there is an underlying contracting problem in that the worker's effort is observable but not contractible, the repeated interaction, in principle, enables the parties to rely on a relational contract to implement the efficient outcome: The worker exerts high effort and is paid ex-post a bonus by the firm that observes the high effort choice. We modify the situation slightly and assume that there are some states of the world in which the firm is hit by a transitory adverse shock, unobservable by the worker, and cannot pay the promised bonus. In this setting, the firm always has an incentive to claim that it was hit by the adverse shock and has to renege on the promised bonus. We characterize an equilibrium that has the property that along the equilibrium path there are periods of cooperation (high effort and bonus payment) and conflict (low effort and no bonus payments). Though in equilibrium there are no false claims of adverse shocks by the firm, the conflict phases are still needed to deter the firm from making a false claim and to sustain cooperation. Thus, in this framework, firm-worker-quarrels can be interpreted as an equilibrium property and not as failures of the relational contract. This reasoning is similar to the one in Green and Porter (1984) or Radner (1985) where the collusive paths of an oligopoly or the cooperation patterns in a general principal-agent-game are analyzed, respectively.

Our model allows us to shed light on the role of labor market institutions, in particular unions. Following the logic of our model, an important function of these institutions is to ease communication within firms, i.e. to help workers learn the true state of the world. Therefore, unions may increase efficiency of the firm-worker relationship by reducing equilibrium conflict. We suggest that stronger unions not only allow workers to capture a larger share of the accruing rent, but also make it more likely that the workers will learn the true state of the world. In this case, we extend the model and show that a stronger union increases efficiency as it decreases the length of conflict phases. Hence

[3] Cardoso and Portela (2009) for Portugal and Gartner (2011) for Germany provide evidence that in unionized firms relational contracts are more prominent means of motivating workers.

the tradeoff is obvious: A stronger union implies that the firm needs to give up a larger share, but in return the available pie is also larger as there are less conflicts. We show that in this environment, optimal behavior of firms is to cede some power to the union. The results of this extended model confirm and generalize the results in Freeman and Lazear's (1995) pioneering work on work councils and unions. Specifically, we show that their insights regarding the role of work councils and unions in asymmetric information environments are important in a dynamic relational contracting framework. Moreover, we show how the presence of unions alters the nature of the relational contract as it reduces the incidence and the length of conflict phases.

A recent example that allows us to more closely inspect this process and that shows how important the unions' role in enforcing this information transmission is can be found in the case of *United Airlines'* endeavors to renegotiate the pay packages with their employees in 2003 to avoid bankruptcy. *The New York Times* reported in its issue of January 1, 2003 that the machinist's union I.A.M. refused to negotiate the package as it had "not yet been provided with all of the financial information needed to evaluate United's business plan". In response to this setback to United's restructuring efforts, the company made its case more conclusively. As a consequence of the company's efforts and being convinced of the direness of the companies state, eventually, as *The New York Times* reported in its May 1, 2003 edition, the United machinists' union approved pay concessions amounting to $794 million a year in wage and benefit concessions for six years, corresponding to salary cuts of 13% for the employees.

A current and very publicized example for the importance of our paper's form of asymmetric information in labor disputes is the breakdown in negotiations leading to the lockout in the NFL in the 2011 off-season. The dispute was over $800 million (annually) that the owners of the NFL teams would like the players to give up due to what they claim are financial difficulties. However, the owners were only willing to grant the players' union access to partial accounting information. Vonnie Holliday, the Redskins' player representative, said "we want a fair CBA [collective bargaining agreement]. That's it. The owners are saying that they're losing money and they want 18% back. Okay, if you are losing money, then in fact show us that. We are not opposed to restructuring, but they refused to do that."[4] The lockout ended on July 25, having lasted 130 days. A new collective bargaining agreement (CBA), running through 2021, became effective on August 4 and the players won $1 billion in additional benefits.[5]

The above described equilibrium has the property that there is no separation of the relationship even though, ex-post, the worker's outside option is not met in some periods as the firm cannot live up to its initially promised bonus. The liquidity constraint has the effect that workers partly insure firms against adverse shocks. This specific kind of insurance has been in the focus of an early literature on relational contracts, surveyed in Hart (1983), where it has been explained by risk aversion of the firms. While this literature also dealt with asymmetric information about the true state of the world, it abstracted from the effort elicitation problem. The focus was on optimal risk-sharing arrangements between workers and firms in finitely repeated interactions, using the employment level within firms, which are observable to both the firm and the workers, as means to credibly transmit information.

Freeman and Lazear (1995) argue that worker representation (by work councils or unions) improves productivity by easing worker-management communications and improving and speeding-up of decision processes in organizations. They show that, despite its social desirability, management and labor force still have socially suboptimal incentives to establish worker representation and they show how different election rules will affect its efficiency effect. Freeman and Lazear sketch models showing how unions (or work councils) ease the information flow from workers to management, and - central for our argument - from management to workers. In their latter example, workers have to be convinced in hard times to exert extra effort to guarantee the firm's survival. In

[4] See: Amy Shipley (March 11, 2011). "Why Won't NFL Owners Open Their Books to Players," *The Washington Post* (http://www.washingtonpost.com/wp-dyn/content/article/2011/03/10/AR2011031006187.html), Mark Maske and Amy Shipley (March 12, 2011). "NFL Lockout Is Now In Effect; Pro Football Enters First Work Stoppage Since 1987," *The Washington Post* (http://www.washingtonpost.com/wp-dyn/content/article/2011/03/11/AR2011031107057.html), Michael Silver (September 8, 2011). "Fans' guide to NFL labor battle" on *Yahoo! Sports* (http://sports.yahoo.com/nfl/news?slug=ms-laborquestions090810), and (http://sportsillustrated.cnn.com/2011/football/nfl/07/25/cba-settlement-summary/index.html).

[5] In detail, major aspects of the new CBA were changes to the free agency guidelines, a salary cap of now $120.375 million (with a salary minimum of $107.1 million), caps to rookie player compensation, an increase in the league's minimum salary, and that players secured a revenue share of 55% of national media revenue, 45% of all NFL Ventures revenue, and 40% of local club revenue.

our setting, it is not extra effort that has to be ensured but workers have to accept wage moderation and have to be held back from punishing the firm by exerting low effort for a perceived breach of contract.[6] So while Freeman and Lazear predict excess effort flexibility through work councils, we predict less effort variability. Information transmission is not the only avenue suggested in the literature through which unions may improve welfare. For example, Malcomson (1983) argues that unions may be beneficial in the context of optimal risk-sharing between workers and firms by overcoming the collective action problem between workers. Hogan (2001) shows that unions enable firms to increase the size of their labor force while sustaining a relational contract.

Our paper also relates to the literature on relational contracts. In particular, we build on Levin (2003) who shows that inefficient punishments occur in equilibrium in an optimal relational contract when the agent's effort is unobservable and the level of output is observed only by the principal such that there is a situation of private monitoring and MacLeod (2003) who extends this setting by introducing risk aversion. More specifically, we relate to a recently emerging literature that derives rich equilibrium dynamics in relational contracting. Chassang (2010) shows how private information determines to which of different long run equilibria a relationship converges and Fong and Li (2010) characterize how particular job aspects like job security, pay level, and performance sensitivity vary over time in a situation of moral hazard combined with limitedly liable agents. As opposed to the papers by Halac (2012) or Yang (2013), where private information over the employees type leads to equilibrium updating and convergence to a longterm steady state, in our paper the source of equilibrium dynamics is moral hazard combined with private information that is idiosyncratically varying over time. Hence, we do not get convergence to a steady state but cyclical equilibrium patterns. Closest to our study are the contemporaneous papers by Li and Matouschek (2013) and Yared (2010). In Li and Matouschek (2013), the principal has private information about how costly it is in any given period to live up to his bonus promises. The authors show that equilibrium patterns are generally characterized by a sluggish decay of the relationship and sudden recoveries. Yared (2010) is set in a political economy context and characterizes the equilibrium

[6] Note also that in our setting, workers' effort cannot help the firm to escape a bad state.

relationship between an aggressive country that seeks concessions from a non-aggressive country which has private information about the costs of concessions. Li and Matouschek (2013) and Yared (2010), like us, allow for inefficient transfers and assume one-sided private information. Both these papers focus on solving for the optimal relational contract. In this contract, even though firms do not pay the promised bonus in shock states, they manage to avoid conflict by promising to make up for this in the next period. These "escalating demands" improve efficiency, as they avoid some inefficient conflicts. However, Bewley (1999) documents that firms are very reluctant to reduce wages as they are afraid of immediate adverse effects on "morale". Similarly, Campbell and Kamlani (1997) document that managers expect a reduction in effort (and "morale") and an increased turnover in response to wage cuts. Smith (2013) provides evidence from a representative sample of British workers that substantiates these claims of managers. Specifically, Smith (2013) finds that workers are "insulted" by nominal wage cuts. This effect is present also when the industry is contracting and is only alleviated if all similar workers suffer wage cuts too, which can be interpreted as signal that indeed the firm is in dire state. In this spirit, our model prescribes a conflict phase whenever the firm does not pay the promised bonus for high effort. In addition, we are able to pin down the structure of the contract and to study general cooperation and conflict patterns and the role of unions in improving the relationship.

The remainder of the paper is structured as follows. The next two sections lay out the basic model and the structure of the relational contract under symmetric, Section 3.2, and asymmetric, Section 3.3, information with respect to the state of the world. Section 3.4 analyzes how unions can help to mitigate the problems from asymmetric information. Finally, we conclude. The Appendix contains derivations of key conditions.

3.2 Symmetric Information Model

3.2.1 Setup of the Model

One firm and one worker are interacting repeatedly with an infinite horizon. The discount factors are β for the firm and δ for the worker.[7] The worker decides whether or not to exert costly effort that has a positive effect on the firm's profit. The worker's effort choice is observable by the firm, but is not contractible. To focus on our main argument, we abstract from any explicit performance contracts. The firm has all the bargaining power and makes a take it or leave it offer to the worker.[8]

The worker's utility is increasing and linear in monetary compensation, which takes the form of a contractible base salary, w, and a discretionary bonus, b, and decreasing in effort. The worker decides whether to exert effort, $e = 1$, or shirk, $e = 0$. Only by exerting high effort the agent occurs costs of $c > 0$. The agent's per period utility function for $e = 1$ is: $U_t = w + b - c$

The agent's outside option is by assumption zero $\bar{U} = 0$. Since the outside option determines the base wage, the assumption is without loss of generality. However, the outside option might influence the decision to employ an agent in the first place. The worker is assumed to be liquidity constrained, hence all payments have to be weakly positive.

In each period one of two states of the world materializes, either the good state G or the bad state B, $s = \{G, B\}$. Neither the principal nor the agent can influence these states, but both know the probability of their occurrence: $Prob(s = G) = p$, $Prob(s = B) = 1 - p$. High effort increases the principal's revenue $\Pi(s, e)$ in both states, i.e. $\Pi(s, e = 1) > \Pi(s, e = 0)$.

We assume that in expectation it is always efficient to implement high effort ($e = 1$),

[7] While much of the classical literature on relational contracts has been concerned with the question when relational contracts are sustainable, i.e. to find a critical β, we are interested in the patterns of the relational contract and hence implicitly will assume that the discount rates are "high enough" and the relational contract is sustainable.

[8] This assumption is relaxed in Section 3.4 where we allow for unions with varying bargaining power.

or

$$[p\Pi(G,1) + (1-p)\Pi(B,1)] - [p\Pi(G,0) + (1-p)\Pi(B,0)] > 0 \tag{3.1}$$

In addition we assume, that shirking leads to revenues just enough to provide the worker with his outside option: $\Pi(B,0) - \bar{U} = \Pi(G,0) - \bar{U} = 0$. This implicitly entails that the good and bad state don't differ in revenues when the agent shirks. Although the principal has perfect information on the agent's effort decision, we assume that they cannot verify the effort before a court.

Since the main focus of the paper is the continued cooperation between principal and agent, the assumption seems fair.

The timing of the model is as follows: for each period t, first the contract is offered. Then the worker chooses effort ($e = 0, 1$). The state (G, B) is realized. Afterwards the profits are realized and the bonus is paid.

We are looking for a relational contract that, with a combination of contractible wage and discretionary bonus, implements high effort. A relational contract is a pair of strategies for the firm and the worker that form a Perfect Public Nash Equilibrium. Before finding the relational contract in this case it is illustrative to first consider two benchmark cases.

Benchmark Case 1: The Stage Game The firm and the worker interact only once. In this case it is obviously impossible to implement high effort. Hence, the firm will employ the worker, pay her a fixed wage w such that $u(w) = \bar{U} = 0$ and the worker will choose $e = 0$.

Benchmark Case 2: A World with Only One (Observable) State Assume that only the good state of the world can occur, i.e., the firm's profit is either $\Pi(G,1)$ or $\Pi(G,0)$. In this situation, the following relational contract implements high effort:

> The firm's strategy is to pay the worker a base salary w such that $w = \bar{U} = 0$.
> As long as the worker chooses $e = 1$ the firm also pays a bonus $b_{\text{benchmark}} = c$.

If the worker chooses $e = 0$ the firm does not pay the bonus in this period and in all subsequent ones. The worker strategy is to choose $e = 1$ as long as the firm paid the bonus in all previous periods and to choose $e = 0$ forever as soon as the form has defaulted on the bonus once. Thus, the firm and the worker return to the equilibrium of the stage game once cooperation has broken down.

See Appendix C.1 for the derivation.

3.2.2 Symmetric Information

Now we turn attention to the original setting where the state can be either G or B and is observable to the worker. To make this situation interesting we assume that the profits in the bad state are not high enough to pay b_{const} even if the worker has chosen $e = 1$, i.e., $0 < \Pi(B, 1)) - w < b_{const}$. We assume that the firm cannot save or borrow money at the capital market.[9] This assumption is equivalent to assuming that there exists an upper bound on how much the firm can borrow which is lower than what is necessary to pay b_{const} or that the costs from borrowing are sufficiently convex.[10] Thus, implicitly, we assume a situation of "large" shocks. While this assumption has little consequences for equilibrium cooperation in the symmetric information case, it will have a bearing in the asymmetric information case.

Both states are possible, but the worker can observe which state occurs. However, we assume that for high effort $e = 1$ the revenues in the bad state are not high enough to pay a constant bonus b_{const} for both states. Therefore the benchmark case 2 cannot be used to implement high effort, because in the bad state the firm cannot pay high bonuses. Thus a higher bonus in the good state is required to compensate the worker for high effort.[11] The menu of bonuses in the symmetric information case is denoted by

[9] Obviously, then it has to generally hold that $\Pi(\theta, e) \geq w + b$. We omit an explicit discussion to focus on the interesting aspect of liquidity constraints under shocks.

[10] See Englmaier and Fahn (2014) for a formal exposition in a distinct but related setting, showing that allowing for saving or granting the firm access to the financial market does not undo the results.

[11] The same argument is even stronger for risk averse agents, since the principal has to compensate those in addition for the imposed risk.

$b = \{\bar{b}_S, \underline{b}\}$. Here $\bar{b}_S$ denotes the bonus payment in the high effort, symmetric information good state. We are going to compare the bonus payments in the good states in the different information and institution environments, because the bonuses in the bad state are fixed by assumption. In order to keep the results close to the risk averse agent setting, we focus on the equilibria, where $\Pi(B,1) - w - \underline{b} = 0$. The interpretation is straight forward: The firm tries to smooth the bonuses over states. Since it is impossible to pay a constant bonus b_{const}, the firm tries to avoid huge variations in the bonus payments by paying the whole revenue created as bonus in the bad state. For a risk neutral agent the smoothing over states has no additional value, unlike the risk averse case, where this reduces the firms overall payments, because it imposes less risk on agents.

The **new relational contract(symmetric information)** is defined as follows:

> The firm's strategy is to pay the worker a base salary w s.t. $u(w) = \bar{U}$, therefore $w = 0$. As long as the worker chooses $e = 1$, the firm pays in addition a bonus. The bonus of the symmetric information case if the state of the world is revealed to be a good state is $\bar{b}_S$ and for the bad state $\underline{b}$ otherwise, where $\bar{b}_S > \underline{b}$. If the worker chooses $e = 0$ the firm does not pay the bonus in this and all subsequent periods. The worker's strategy is to choose $e = 1$ as long as the firm has paid the promised bonus in all previous periods and to choose $e = 0$ forever as soon as the form has defaulted on the bonus once.

See Appendix C.2 for the derivation.

The findings above are summarized in the following proposition. Note the general contract characterizes the most efficient equilibrium in this game.

Proposition 1. *In a situation with observable stochastic shocks to the firm's profit as described above the following two strategies form an relational contract that implements* $e = 1$*:*
The worker chooses $e = 1$ *as long as the firm has paid the promised bonuses in all previous periods. Once the firm has defaulted on paying the bonus, the worker chooses* $e = 0$ *forever. The firm pays the base wage* $w = 0$ *and the bonuses,* $\underline{b}$ *in the bad state and*

$\bar{b}_S > \underline{b}$ *in the good state, in all periods as long as the worker has always chosen* $e = 1$. *The firm stops paying any bonus immediately after the worker has chosen* $e = 0$ *once.*

$$\underline{b} = \Pi(B, 1)$$
$$\bar{b}_S = \frac{c - (1-p)\Pi(B,1)}{p}.$$

3.3 Asymmetric Information Model

In the asymmetric case the state of the world is only observable by the firm. The relational contract described in Proposition 1 can therefore no longer implement $e = 1$ as the firm has always an incentive to claim that the state is B and save $\bar{b}_S - \underline{b}$ in bonus payments. We propose a "simple" equilibrium to implement cooperation and truthtelling by a similar argument to Green and Porter (1984) and Radner (1985). The new equilibrium strategy entails that the firm announces the state and in case their announcement is B, with a bonus payment of $\underline{b}$, a conflict phase of T periods follows.[12] During this conflict the worker chooses $e = 0$ and is only paid his outside option, $w = 0$, i.e. the equilibrium of the stage game is played. After these T periods the firm and the worker revert to the cooperative equilibrium in which the firm pays a bonus $\bar{b}_A$, A for the asymmetric information model, whenever the state is good and the worker chooses $e = 1$. Another bad state with a bonus of $\underline{b}$ triggers a new conflict phase.

While we don't have to check again that it is optimal for the firm not to default completely on the bonus (since the argument is qualitatively the same as under symmetric information), for the new pair of strategies to form an equilibrium it has to hold that:

a) The firm prefers to announce the state truthfully,

b) the worker prefers to execute the punishment, and

c) the worker prefers to choose $e = 1$ as long as the bonuses are paid (and the game

[12] Note that we abstract from divisibility issues in deriving T to ease the exposition of our arguments. To close the gap to our continuous formulation, there would have to be a public randomization with suitably chosen probabilities that would determine whether the last period of punishment is executed or whether the conflict phase is ended.

is not in a conflict phase).

Denote the continuation value of the firm's profits from cooperating (announcing the state truthfully) if the state is G as $V_F^C(G,1)$ and if the state is B as $V_F^C(B,1)$. The continuation value of the firm's profits in the beginning of the conflict period is denoted by $V_F^P(\cdot,0)$. The following equations define these continuation values:

$$V_F^C(G,1) = \Pi(G,1) - \bar{b}_A + \beta[pV_F^C(G,1) + (1-p)V_F^C(B,1)]$$

$$V_F^C(B,1) = 0 + \beta V_F^P(\cdot,0) = \beta V_F^P(\cdot,0)$$

$$V_F^P(\cdot,0) = \sum_{t=0}^{T-1} \beta^t 0 + \beta^T[pV_F^C(G,1) + (1-p)V_F^C(B,1)] = \beta^T[pV_F^C(G,1) + (1-p)V_F^C(B,1)].$$

Solving these equations we get that:

$$V_F^C(G,1) = [\Pi(G,1) - \bar{b}_A]\frac{1-(1-p)\beta^{T+1}}{1-(1-p)\beta^{T+1}-\beta p} \quad (3.2)$$

$$V_F^C(B,1) = [\Pi(G,1) - \bar{b}_A]\frac{\beta^{T+1}p}{1-(1-p)\beta^{T+1}-\beta p} \quad (3.3)$$

$$V_F^P(\cdot,0) = [\Pi(G,1) - \bar{b}_A]\frac{\beta^{T}p}{1-(1-p)\beta^{T+1}-\beta p}. \quad (3.4)$$

The continuation value of the firm's profit if it announces state B when the true state is G (i.e. if the firm *defects*), $V_F^D(G,1)$, is given by

$$V_F^D(G,1) = \Pi(G,1) - \underline{b} + \beta V_F^P(\cdot,0).$$

Substituting for $V_F^P(\cdot,0)$ and rearranging we get:

$$V_F^D(G,1) = [\Pi(G,1) - \underline{b}] + [\Pi(G,1) - \bar{b}_A]\frac{\beta^{T}p}{1-(1-p)\beta^{T+1}-\beta p}. \quad (3.5)$$

We now turn to condition a), the firm has to prefer to announce the state truthfully.

Thus it has to hold that $V_F^D(G,1) < V_F^C(G,1)$, or more explicitly that

$$[\Pi(G,1) - \underline{b}] < [\Pi(G,1) - \bar{b}_A] \frac{1-\beta^{T+1}}{1-(1-p)\beta^{T+1} - \beta p}.$$

Note that $\frac{1-\beta^{T+1}}{1-(1-p)\beta^{T+1}-\beta p}$ is increasing in T. Moreover, for $T = 0$ the condition above is violated as it would imply that $[\Pi(G,1) - \underline{b}] < [\Pi(G,1) - \bar{b}_A]$ and thus that $\bar{b}_A < \underline{b}$, which as we know cannot be true. Thus, there exists a $T^* > 0$ for which the condition above holds. In equilibrium the firm will be just indifferent and thus

$$[\Pi(G,1) - \underline{b}] \frac{1-(1-p)\beta^{T^*+1} - \beta p}{1-\beta^{T^*+1}} - [\Pi(G,1) - \bar{b}_A] = 0. \tag{3.6}$$

Implicitly this defines the efficient length of conflict phase T^*. Choosing the optimal amount of conflict periods deters the firm from defaulting on the bonus in state G.

Now we check condition b), namely that the worker prefers to execute the punishment. Given the strategy of the firm, i.e., pay $w = 0$ for T^* periods after announcing state B, exerting high effort will not benefit the worker as no bonus is being paid. Thus the worker has no incentive to choose $e = 1$ in these T^* periods.

Finally we check condition c) and show that as long as the firm has never defaulted on the bonus the worker prefers to choose $e = 1$. The worker does not know which state will realize when she makes her effort choice, and thus does not know whether she will receive a bonus $\underline{b}$ or $\bar{b}_A$. Define the worker's expected utility as

$$U = p\bar{b}_A + (1-p)\underline{b} - c.$$

The continuation value for the worker's utility from exerting high effort if the firm fulfilled its promises, V_W^C, is given by

$$V_W^C = p\bar{b}_A + (1-p)\underline{b} - c + \delta(pV_W^C + (1-p)V_W^P),$$

where V_W^P denotes the continuation value for the worker's utility at the beginning of a conflict phase, which is defined as

$$V_W^P = \sum_{t=0}^{T-1} \delta^t \bar{U} + \delta^T V_W^C = \delta^T V_W^C.$$

We can use these two expressions to solve for V_W^C:

$$V_W^C = p\bar{b}_A + (1-p)\underline{b} - c + \delta p V_W^C + \delta(1-p)\delta^T V_W^C.$$

Rearranging then yields:

$$V_W^C = \frac{p\bar{b}_A + (1-p)\underline{b} - c}{1 - \delta p - \delta^{T+1}(1-p)}. \tag{3.7}$$

The continuation value for the worker's utility from defecting and exerting low effort even though the firm did not default on its promises and the game is not in conflict phase, V_W^D, is given by

$$V_W^D = \sum_{t=0}^{\infty} \delta^t \bar{U} = 0. \tag{3.8}$$

In order to ensure that the worker prefers choosing $e = 1$, $V_W^C \geq V_W^D$ has to hold:

$$\frac{p\bar{b}_A + (1-p)\underline{b} - c}{1 - \delta p - \delta^{T+1}(1-p)} \geq 0$$

$$p\bar{b}_A + (1-p)\underline{b} \geq c$$

$$\bar{b}_A = \frac{c - (1-p)\underline{b}}{p}. \tag{3.9}$$

This is the same condition as under symmetric information, $\bar{b}_A = \bar{b}_S$. We summarize these findings in the following proposition:

Proposition 2. *In a situation with stochastic shocks to the firm's profits can only be observed by the firm itself, the following two strategies form an relational contract that* *implements* $e = 1$*:*

In a cooperation period, the worker chooses $e = 1$ *as long as the firm has not announced a bad state and has always paid the promised bonuses,* $\underline{b}$ *in the bad state and* $\bar{b}_A$ *in the good state, in all previous cooperation periods. When the firm announces the bad state and pays* $\underline{b}$ *a conflict phase starts, lasting* T^* *periods, where in each period the worker chooses* $e = 0$*. Thereafter the worker moves back to cooperating, i.e., choosing* $e = 1$ *as long as the firm announces the good state and pays the bonus. Once the firm has defaulted on paying the bonus in a cooperation period the worker chooses* $e = 0$ *forever. The firm pays the base wage* $w = 0$ *and the bonus,* $\underline{b}$ *in the bad state and* $\bar{b}_A$ *in the good state, in all cooperation periods as long as the worker has always chosen* $e = 1$ *in the previous cooperation periods. After a bad state has occurred the firm pays no bonus for the next* T^* *periods. The firm stops paying any bonus immediately after the worker has once chosen* $e = 0$ *in a cooperation period.*

$$\underline{b} = \Pi(B, 1).$$

$\bar{b}_A$ *is defined by:*

$$\bar{b}_A = \frac{c - (1-p)\Pi(B,1)}{p}.$$

T^* *is implicitly defined by*

$$[\Pi(G,1) - \underline{b}]\frac{1-(1-p)\beta^{T^*+1} - \beta p}{1-\beta^{T^*+1}} - [\Pi(G,1) - \bar{b}_A] = 0.$$

or explicitly by

$$T^* = \frac{\ln\left(\frac{\beta p\Pi(G,1)+(1-p)(1-\beta p)\Pi(B,1)+\frac{1-p}{p}\Pi(B,1)-\frac{c}{p}}{p\Pi(G,1)+(1-p)(1-p)\Pi(B,1)+\frac{1-p}{p}\Pi(B,1)-\frac{c}{p}}\right)}{\ln\beta} - 1.$$

To clarify the mechanics of the model, consider a couple of comparative statistic derivations. Based on these comparative statics it becomes clear that equilibrium inefficiencies are gravest in past-their-prime (low β), highly volatile (low π), and more liquidity constraint (low $\underline{b}$) industries. We derive these in the more general setting treated in Appendix C.3.5.

3.4 The Role of Unions

3.4.1 Introducing Union to the Model

Though the conflict phases allow worker and firm to sustain a cooperative equilibrium also under asymmetric information regarding the adverse shocks, there is still an efficiency loss due to the lost rents in the conflict periods along the equilibrium path. Hence, there is scope for a Pareto improvement by reducing these inefficiencies. Based on the comparative statics results, the largest scope for such an improvement should be found in past-their-prime (low β), highly volatile (low π), and most liquidity constraint (low $\underline{b}$) industries in which inefficiencies are gravest.

One approach for firms to improve things is to take steps to lower individual worker's costs of observing the true state of the world. This could explain the endeavors of firms to improve the financial literacy of their staff. A prominent example is Gordon Cain who was one of the precursors of the LBO wave in the 1980s and who dedicated careful attention to make the workers of acquired firms aware of the true financial situation of their firms such that they were willing to support his suggested course of restructuring.[13]

However, often it is very hard for firms to credibly communicate this information. Unions can be an institution that helps overcoming the asymmetric information problem and generate more rents. This insight regarding the role of unions as facilitating the transmission of information between management and workers was first suggested by Freeman and Lazear (1995). They show in a static environment that economic inefficiency will be reduced due to unions moderating workers' demands during hard times. We use our dynamic environment to investigate how the presence of unions changes the nature of the relational contract. We then show that Freeman and Lazear's insights regarding the role of unions are present in our extended model; we also establish that unions facilitate wage moderation in times of crises.[14]

[13] Jack Welch stresses in his books, e.g. Welch and Welch (2005), the importance of transparency for a successful management strategy. According to him it is pivotal that workers understand the situation of the firm and are willing to follow management's suggestions to cope with challenges.

[14] Interestingly, in a related but distinct vein, the management of labour relationships in the context of relational contracts has been emphasized by Gibbons and Henderson (2013) and the important role of unions in this context is discussed in Helper and Henderson (2014).

An intuitive explanation why unions are necessary in order for the workers to overcome the asymmetric information problem is that of a collective action problem. Specifically, consider the case where the true state of the world is observable, although it requires a costly investment to do so. Assume the costs are such that it does not pay for an individual worker to acquire this information, but it would be worthwhile for all workers. Thus, the workers in our model are faced with a collective action problem, similar to Shleifer and Vishny's (1986) model of corporate governance where management is not effectively controlled due to dispersed stock ownership. If this collective action problem was completely solved, the efficiency of the entire interaction could be improved as full cooperation without conflict phases could be achieved on the equilibrium path. Similar to large shareholders in Shleifer and Vishny (1986), unions can serve as a coordination device to overcome this collective action problem.[15]

We do not model the information process explicitly but assume outright that unionization allows the firm to credibly transmit, albeit stochastically, that it is indeed in a dire state and has to cut wages. In a non-unionized firm this information could not be as credibly transmitted to (or observed by) individual workers and wage cuts would thus lead to a very harsh reaction by the workers. Of course there is also a cost associated with unions. Allowing the workers to organize themselves will most likely help them to bargain for a greater share of the profits. However, note that these profits are now bigger. Thus, for the firm it might be still worthwhile to receive a smaller share of a bigger pie. Below we explicitly model these two roles of unions. In doing so, we abstract from explicitly modeling the collective action problem, but rather focus on the effect of the union on a representative worker.

The conflict periods ensure continued cooperation, however induce an efficiency loss due to the lost rents in the conflict periods. Unions can be an institution that helps overcoming the asymmetric information problem and generates more rents. The introduction of unions comes at a cost for the firm, it has to pay a higher share of its profits to the agent. For our analysis we simply assume that the information transmission efficiency of the union is directly connected to its bargaining power $\sigma \in [0, 1]$. Even with a more

[15] Moreover, only in the presence of unions agents receive a positive rent and thus care about improving equilibrium dynamics.

complicated relation, i.e. information transmission is a function of bargaining power $\gamma = f(\sigma)$, the results would not qualitatively change. If they were not connected, the firm's problem becomes trivial as firms always prefer unions with less bargaining power and higher information transmission efficiency. For our analysis of the cutoff level of bargaining power that makes the introduction of a union profitable for the firm, the tradeoff between smaller profits and higher information efficiency is crucial.

Since the worker now receives a share of the overall revenue, we need to reformulate the utility function and the revenue function. First for the cases where the worker invests high effort. The workers utility in the good state is given by:

$$U(G,1) = \bar{b}_A^{\sigma} + \sigma(\Pi(G,1) - \bar{b}_A^{\sigma}) - c = \sigma\Pi(G,1) + (1-\sigma)\bar{b}_A^{\sigma} - c.$$

The workers utility in the bad state is:

$$U(B,1) = \sigma\Pi(B,1) + (1-\sigma)\underline{b}_A^{\sigma} - c.$$

Where $\bar{b}_A^{\sigma}$ denotes the bonus payment in the good state, while $\underline{b}_A^{\sigma}$ denotes the bonus payment in the bad state. The expected utility of exerting high effort is therefore:

$$EU_{A,\sigma}(\cdot,1;\sigma) = p[\sigma\Pi(G,1) + (1-\sigma)\bar{b}_A^{\sigma}] + (1-p)[\sigma\Pi(B,1) + (1-\sigma)\underline{b}_A^{\sigma}] - c.$$

The continuation values for workers from exerting in a cooperation period:

$$V_{w,\sigma}^{C} = EU_{A,\sigma}(\cdot,1;\sigma) + \delta(pV_{w,\sigma}^{C} + (1-p)[\sigma V_{w,\sigma}^{C} + (1-\sigma)V_{w,\sigma}^{P}]).$$

The continuation value at the beginning of a conflict period:

$$V_{w,\sigma}^{P} = \sum_{t=0}^{T-1} \delta^t \bar{U} + \delta^T V_{w,\sigma}^{C} = \delta^T V_{w,\sigma}^{C}.$$

With this we can solve for $V^C_{w,\sigma}$:

$$V^C_{w,\sigma} = \frac{EU_{A,\sigma}(\cdot, 1; \sigma)}{1 - \delta p - \delta(1-p)\sigma - \delta^{T+1}(1-p)(1-\sigma)}. \tag{3.10}$$

Note that for $\sigma \to 0$, i.e. union power is negligible, we get the same condition that we got in the case without unions.

The continuation value for the worker's utility from defecting while the firm did not default on its promises:

$$V^D_{w,\sigma} = \sum_{t=0}^{\infty} \delta^t \bar{U} = 0. \tag{3.11}$$

To ensure incentive compatibility the worker has to weakly prefer to choose $e = 1$, i.e. $V^C_{w,\sigma} \geq V^D_{w,\sigma}$ which simplifies to

$$EU_{A,\sigma}(\cdot, 1; \sigma) \geq 0. \tag{3.12}$$

The worker receives two different forms of compensation, the bonus payment as well as his share of the remaining revenue. A higher bonus payment reduces the remaining revenue and therefore the worker's share. Thus, if σ is high enough bonus payments are no longer necessary. We can determine the value for $\bar{\sigma}$ when both bonuses become zero and the agent is entirely compensated through the share of profits in the good state. For $\sigma > \bar{\sigma}$, condition 3.12 becomes slack. If the bargaining power is low, we assume the firm to choose $\underline{b}^\sigma = \Pi(B, 1)$. Therefore, $\bar{\sigma}$ solves the equation:

$$p\bar{\sigma}\Pi(G, 1) + (1-p)\Pi(B, 1) - c = 0.$$

The solution is:

$$\bar{\sigma} = \frac{c - (1-p)\Pi(B, 1)}{p\Pi(G, 1)}. \tag{3.13}$$

Therefore, $\bar{\sigma}$ is the highest value of σ for which the firm will pay a bonus in the good state of the world. Note, as σ increases beyond $\bar{\sigma}$, the firm can still make condition 3.12 hold with equality by lowering the bonus in the bad state.

We can derive the bonus payments conditional on the bargaining power of the union:

$$\bar{b}_A^{\sigma} = \begin{cases} \frac{c - p\sigma\Pi(G,1) - (1-p)\Pi(B,1)}{(1-\sigma)p} & \text{if } \sigma \leq \bar{\sigma} \\ 0 & \text{Otherwise} \end{cases} \tag{3.14}$$

and

$$\underline{b}^{\sigma} = \begin{cases} \Pi(B,1) & \text{if } \sigma \leq \bar{\sigma} \\ 0 & \text{Otherwise.} \end{cases} \tag{3.15}$$

We turn to the firm's optimization problem. In the good state of the world the firm's profits are $(1-\sigma)(\Pi(G,1) - \bar{b}_A^{\sigma})$, while in the bad state the firm's profits are give by $(1-\sigma)(\Pi(B,1) - \underline{b}^{\sigma})$. If $\sigma > \bar{\sigma}$ the firm will have profits in the bad state as well, a difference to the case without unions.

Keep in mind that conditional on the firm announcing the bad state, B, the union and hence the worker gets informed with probability σ that the state of the world is indeed B, we denote by $V_{F,\sigma}^C(G,1;\sigma)$ and $V_{F,\sigma}^C(B,1;\sigma)$ the continuation value of the firm's profits from cooperating, i.e. announcing the state truthfully. The continuation value of the firm's profits at the beginning of a conflict (or punishment) period is denoted by $V_{F,\sigma}^P(\cdot,1;\sigma)$. The following equations define these continuation values:

$$V_{F,\sigma}^C(G,1;\sigma) = (1-\sigma)(\Pi(G,1) - \bar{b}_A^{\sigma}) + \beta[pV_{F,\sigma}^C(G,1;\sigma) + (1-p)V_{F,\sigma}^C(B,1;\sigma)]$$

$$V_{F,\sigma}^C(B,1;\sigma) = (1-\sigma)(\Pi(G,1) - \underline{b}^{\sigma}) + \beta((1-\sigma)V_{F,\sigma}^P(\cdot,1;\sigma) + \sigma[pV_{F,\sigma}^C(G,1;\sigma) + (1-p)V_{F,\sigma}^C(B,1;\sigma)$$

$$V_{F,\sigma}^P(\cdot,1;\sigma) = \sum^{T} \beta^t 0 + \beta^T[pV_{F,\sigma}^C(G,1;\sigma) + (1-p)V_{F,\sigma}^C(B,1;\sigma)] = \beta^T[pV_{F,\sigma}^C(G,1;\sigma) + (1-p)V_{F,\sigma}^C(B,1;\sigma)].$$

We use these expressions and solve for the continuation values:

$$V^C_{F,\sigma}(G,1;\sigma) = \frac{(1-\sigma)[\Pi(G,1)-\bar{b}^\sigma_A][1-\beta(1-p)(\beta^T(1-\sigma)+\sigma)] + \beta(1-\sigma)[\Pi(B,1)-\underline{b}^\sigma]}{1-\beta(1-p)[\beta^T(1-\sigma)+\sigma]-\beta p} \tag{3.16}$$

$$V^C_{F,\sigma}(B,1;\sigma) = \frac{\beta p[\beta^T(1-\sigma)+\sigma][\Pi(G,1)-\bar{b}^\sigma_A] + (1-\sigma)(1-\beta p)[\Pi(B,1)-\underline{b}^\sigma]}{1-\beta(1-p)[\beta^T(1-\sigma)+\sigma]-\beta p} \tag{3.17}$$

$$V^P_{F,\sigma}(\cdot,1;\sigma) = \beta^T(1-\sigma)\frac{p[\Pi(G,1)-\bar{b}^\sigma_A] + (1-p)[\Pi(B,1)-\underline{b}^\sigma]}{1-\beta(1-p)[\beta^T(1-\sigma)+\sigma]-\beta p}. \tag{3.18}$$

The continuation value of the firm's profits from defecting, i.e., announcing a state B when the true state is G, $V^D_{F,\sigma}(G,1;\sigma)$ is given by:

$$V^D_{F,\sigma}(G,1;\sigma) = \Pi(G,1) - \underline{b}^\sigma - \sigma(\Pi(B,1)-\underline{b}^\sigma) + \frac{\beta^{T+1}(1-\sigma)^2[p[\Pi(G,1)-\bar{b}^\sigma_A] + (1-p)[\Pi(B,1)-\underline{b}^\sigma]]}{1-\beta(1-p)[\beta^T(1-\sigma)+\sigma]-\beta p}.$$

The firm has to prefer to announce the state truthfully. Thus it has to hold that

$$V^D_{F,\sigma}(G,1;\sigma) < V^C_{F,\sigma}(G,1;\sigma).$$

Substituting and rearranging the equations above yields the condition for continued cooperation:

$$\sigma(\Pi(G,1)-\Pi(B,1)) + (1-\sigma)[\bar{b}^\sigma_A - \underline{b}^\sigma] \leq (1-\sigma)\beta(1-\beta^T(1-\sigma))\frac{p(\Pi(G,1)-\bar{b}^\sigma_A) + (1-p)(\Pi(B,1)-\underline{b}^\sigma)}{1-\beta(1-p)[\beta^T(1-\sigma)+\sigma]-\beta p}. \tag{3.19}$$

First, note that if $\sigma = 1$ then the firm will prefer to lie and announce that the state of the world is B when it is in fact G. The intuition is obvious, in this case the firm relinquishes all its profits to the workers, and hence defection - which has a positive value - is attractive from its perspective. We know that when $\sigma = 0$ there exists T^* such that the condition for continued cooperation holds with equality. For all $\sigma < \bar{\sigma}$, an increase in σ increases does not change the LHS stays but leads to an increase in the RHS. Therefore exists a solution for the period of conflicts, $T < T^*$. In turn we know, there has to exits a range of σ values for which the condition 3.19 holds. We summarize these findings in the following proposition.

Proposition 3. In a situation in which stochastic shocks to the firm's profits can only be observed by the firm itself and the worker is part of a union of power $\sigma \leq \tilde{\sigma}$, the following two strategies form an relational contract that implements $e = 1$: *In a cooperation period, the worker chooses $e = 1$ as long as a) the firm either announced a good state or announced a bad state that was verified by the union and b) the firm has always paid the promised bonuses, $\underline{b}$ in the bad state and $\bar{b}^{\sigma}_{A}$ in the good state, in all previous cooperation periods. When the firm announces a bad state that the union cannot verify the firm pays $\underline{b}$ and a conflict phase, lasting $T^*_{A,\sigma}$ periods starts, where in each period the worker chooses $e = 0$. Thereafter the worker moves back to cooperating, i.e. choosing $e = 1$ as long as the firm pays the bonus and announces the good state or the union can verify that the state is bad. Once the firm has defaulted on paying the bonus in a cooperation period the worker chooses $e = 0$ forever. The firm pays the bonus, $\underline{b}^{\sigma}$ in the bad state and $\bar{b}^{\sigma}_{A}$ in the good state, in all cooperation periods as long as the worker has always chosen $e = 1$ in the previous cooperation periods. After a ad state that the union could not verify has occurred the firm pays no bonus for the next $T^*_{A,\sigma}$ (punishment) periods. The firm stops paying any bonus immediately after the worker has once chosen $e = 0$ in a cooperation period:* $\underline{b}^{\sigma}$, $\bar{b}^{\sigma}_{A}$ and $T^*_{A,\sigma}$ are defined by the following conditions.

$$\bar{b}^{\sigma}_{A} = \begin{cases} \frac{c - p\sigma\Pi(G,1) - (1-p)\Pi(B,1)}{(1-\sigma)p} & \textit{if } \sigma \leq \bar{\sigma} \\ 0 & \textit{Otherwise} \end{cases} \tag{3.20}$$

and

$$\underline{b}^{\sigma} = \begin{cases} \Pi(B,1) & \textit{if } \sigma \leq \bar{\sigma} \\ 0 & \textit{Otherwise} \end{cases} \tag{3.21}$$

and

$$\sigma(\Pi(G,1) - \Pi(B,1)) + (1-\sigma)[\bar{\sigma}_A^{\sigma} - \underline{b}^{\sigma}] \leq \\ (1-\sigma)\beta(1-\beta^{T^*_{A,\sigma}}(1-\sigma))\frac{p(\Pi(G,1) - \bar{\sigma}_A^{\sigma}) + (1-p)(\Pi(B,1) - \underline{b}^{\sigma})}{1 - \beta(1-p)[\beta^{T^*_{A,\sigma}}(1-\sigma) + \sigma] - \beta p} \tag{3.22}$$

3.4.2 (When) is it optimal to cede power to a union?

Next we investigate whether a firm will want to cede power to a union. Meaning, assuming that the firm can decide on the size of σ, will it choose a positive one? Because the result for risk neutral agents strongly depends on the interaction between the union power σ and the firms time discount factor β, we can only describe the basic intuition. A more clear cut analysis provides the model for risk averse agents in Appendix C.3.

The main tradeoff the firm faces, is the tradeoff between the reduction of efficiency loss through cooperation breakdowns and the concession of profit to the agent. For $\sigma < \bar{\sigma}$ the firm offsets the increasing share it has to pay to the agent through a reduction in bonus payment for the good state, G. Therefore it always will at least cede $\sigma = \bar{\sigma}$ power to the union.

For $\sigma > \bar{\sigma}$ we know that the firm has to share rent with the agent. Since $\sigma = 1$ hands over the firm's whole rent to the agent, we know that it is better for the firm to choose a union power $\sigma < 1$. Therefore the optimal union power, σ, has to lie in between:

$$\bar{\sigma} < \sigma < 1 \tag{3.23}$$

3.5 Conclusion

We present a model generating non-trivial dynamic patterns in an ongoing firm-worker relationship. Though firm and worker are in an ongoing relational contract there are phases of cooperation and phases of conflict along the equilibrium path. The reason for the conflict phases is that the firm needs to be deterred from announcing a false state of the world and reneging on the contractually specified bonus payments. The basic logic of the model resembles the reasoning in Green and Porter (1984) and Radner (1985). We have shown that the conflict phases that are needed in the case of asymmetric information to implement the high effort levels in the cooperative periods reduce the totally accrued profits. Thus, being able to shift the situation from one of asymmetric to one with symmetric information could lead to a Pareto improvement. We show how unions can help to achieve this goal. Though in this environment giving more power to the unions increases the share of the rent but improves efficiency by reducing the occurrence of conflict periods, the firm *always* finds it worthwhile to cede power to a union and to thus secure a smaller share of a bigger pie.

Recalling the comparative statics results, unions should be most desirable in industries where inefficiencies are gravest, i.e. in mature (low β), highly volatile (high π), and most liquidity constraint (low $\underline{b}$) industries. This prediction is in principle testable.

Nowadays, firms employ more and more novel human resource management practices.[16] Black and Lynch (2001) examine the impact of such workplace practices, information technology and human capital investments on productivity. They find that those unionized establishments that have adopted what have been called new or transformed industrial relations practices, promoting joint decision making coupled with incentive based compensation, have higher productivity than other similar non-union plants. This finding hints at a complementarity between “old” and “new” labor market institutions. Studying this relation more intensely is possible within our suggested framework and seems a promising avenue for future research.

Though this is beyond the scope of this paper, we believe that the basic logic of our

[16] For evidence on these see Ichniowsky, Shaw, and Prennushi (1997) and the references therein.

model carries over to richer settings than those of our admittedly very stylized model. In a richer model one would have firms employing more than one worker. In this setting the firm has an additional strategic variable next to the bonus payment, namely its employment level.[17] The structure of an equilibrium following our basic logic should have high effort all along the way but the firm would be forced to reduce employment after announcing a bad state and thus forego profits if it lied about the state. This model would endogenously generate recalls on the equilibrium path, an issue that has been widely studied among labor economists, starting with Feldstein (1976), because of its important effects on the measured unemployment rate.

[17] Grossman and Hart (1981) analyze such a setting in a static model in the context of optimal risk sharing between workers and firms. Hart (1983) surveys the closely related early relational contracts literature which focussed on optimal risk sharing as opposed to efficient incentive provision.

Appendix A

Focusing Attention in Multiple Tasks

A.1 Derivation of Focusing Weights in the Example

The minimum for the focusing range is always given by a_l, whereas the maximum is given by a_h.

$$\min_{F\in\mathbf{F}}(E_F[u(e_h)] - \frac{1}{2}S_F[u(e_h)]) > \min_{F\in\mathbf{F}}(E_F[u(e_l)] - \frac{1}{2}S_F[u(e_l)])$$

Since:

$$\underbrace{p(e_h)b}_{E_F[u(e_h)]} - \frac{1}{2}\underbrace{2\,|b-0|\,p(e_h)(1-p(e_h))}_{S_F[u(e_h)])} = p(e_h)^2 b$$

$$\underbrace{p(e_l)b}_{E_F[u(e_l)]} - \frac{1}{2}\underbrace{2\,|b-0|\,p(e_l)(1-p(e_l))}_{S_F[u(e_l)])} = p(e_l)^2 b$$

It always holds that,

$$p(e_h)^2 b > p(e_l)^2 b$$

Therefore low effort generates the smaller minimum range.

The maximum of the focusing range is always given by e_h:

$$\max_{F\in\mathbf{F}}(E_F[u(e_h)] + \frac{1}{2}S_F[u(e_h)]) > \max_{F\in\mathbf{F}}(E_F[u(e_l)] + \frac{1}{2}S_F[u(e_l)])$$

With:

$$\underbrace{p(e_h)b}_{E_F[u(e_h)]} + \frac{1}{2}\underbrace{2\,|b-0|\,p(e_h)(1-p(e_h))}_{S_F[u(e_h)])} = p(e_h)b[2-p(e_h)]$$

and

$$\underbrace{p(e_l)b}_{E_F[u(e_l)]} + \frac{1}{2}\underbrace{2\,|b-0|\,p(e_l)(1-p(e_l))}_{S_F[u(e_l)])} = p(e_l)b[2-p(e_l)]$$

high effort generates the higher maximum:

$$p(e_h)b[2-p(e_h)] > p(e_l)b[2-p(e_l)]$$

$$2[p(e_h)-p(e_l)] > [p(e_h)^2 - p(e_l)^2]$$

This translates to

$$2 > p(e_h) + p(e_l)$$

which is always true.

A.2 Example - Optimal Contract for Focusing Agents

I derive the optimal contract for a focusing thinker. The principal has to use the perceived participation (PC^p) and incentive compatibility (ICC^p) constraints.

$$\max_{w,b,a_1,a_2} B(a_1,a_2) - wa_1 - p(a_2)b \tag{A.1}$$

$$(PC^p)\ g(\Delta_{a_1})wa_1 + g(\Delta_{a_2})p(a_2)b \geq \bar{U} \tag{A.2}$$

$$(ICC^p)\ \max_{a_1,a_2} g(\Delta_{a_1})wa_1^* + g(\Delta_{a_2})p(a_2^*)b \geq \tag{A.3}$$

$$g(\Delta_{a_1})wa_1 + g(\Delta_{a_2})p(a_2)b. \tag{A.4}$$

I again assume that the principal leaves no rent for the agent, therefore (PC^p) and (ICC^p) have to be binding. For simplification, I assume $g(x) = x$, in order to put as little emphasis on the weighting function as possible. The optimal contract now looks as follows:

$$w^{FT} = (\bar{U}\frac{1}{a_h - a_l}\frac{p(a_h)a_h - p(a_l)a_l}{p(a_h) - p(a_l)})^{\frac{1}{2}} \tag{A.5}$$

$$b^{FT} = \frac{1}{p(a_h) - p(a_l)}(\bar{U}\frac{(a_h - a_l)(p(a_h)a_h - p(a_l)a_l)}{2p(a_h) - p(a_h)^2 - p(a_l)^2})^{\frac{1}{2}}. \tag{A.6}$$

It is not straight forward to compare the new reward scheme (w^{FT}, b^{FT}) to the old (w^*, b^*). The conditions for the new reward scheme being smaller than the old are given by:

Condition 1. $w^* > w^{FT} \Leftrightarrow \bar{U} > \frac{1}{a_h - a_l}[\frac{p(a_h)a_h - p(a_l)a_l}{p(a_h) - p(a_l)}]^3$

Condition 2. $b^* > b^{FT} \Leftrightarrow \bar{U} > \frac{1}{a_h - a_l}[\frac{p(a_h)a_h - p(a_l)a_l}{p(a_h) - p(a_l)}]^2 \frac{p(a_h)a_h - p(a_l)a_l}{2p(a_h) - p(a_h)^2 - p(a_l)^2}$

The first condition, $w^* > w^{FT}$, is stronger, i.e. whenever $w^* > w^{FT}$ is fulfilled $b^* > b^{FT}$ is automatically fulfilled as well. Therefore three different cases emerge:
First, when the outside option is high enough, then the new reward scheme is smaller in both tasks, i.e. $w^* > w^{FT}$ and $b^* > b^{FT}$. Since the outside option enters the weighting function, a higher outside option increases the overall perception of compensation and therefore makes it easier to fulfill the participation constraint: $\bar{U} > \frac{1}{a_h - a_l}[\frac{p(a_h)a_h - p(a_l)a_l}{p(a_h) - p(a_l)}]^3$.

Second, when the outside option is very low, the focusing thinker wouldn't accept the initial proposed contract, since it violates the participation constraint. In order to motivate the agent in the first place, the principal has to offer higher incentives and therefore increases both tasks in the new reward scheme, $w^{FT} > w^*$ and $b^{FT} > b^*$: $\frac{1}{a_h - a_l}[\frac{p(a_h)a_h - p(a_l)a_l}{p(a_h) - p(a_l)}]^2 \frac{p(a_h)a_h - p(a_l)a_l}{2p(a_h) - p(a_h)^2 - p(a_l)^2} > \bar{U}$.

The third case is the most interesting one, because it foreshadows one important result from the general setup. When the outside option is in an intermediate range, $\frac{1}{a_h - a_l}[\frac{p(a_h)a_h - p(a_l)a_l}{p(a_h) - p(a_l)}]^3 > \bar{U} > \frac{1}{a_h - a_l}[\frac{p(a_h)a_h - p(a_l)a_l}{p(a_h) - p(a_l)}]^2 \frac{p(a_h)a_h - p(a_l)a_l}{2p(a_h) - p(a_h)^2 - p(a_l)^2}$, the piece rate has to be increased, while the bonus payment has to be decreased. Therefore from the focusing thinkers perspective the incentives for both tasks become more similar.

This leads to my second lemma:

Lemma A.2.1. *As long as*

$$\frac{1}{a_h - a_l}[\frac{p(a_h)a_h - p(a_l)a_l}{p(a_h) - p(a_l)}]^3 > \bar{U} > \tag{A.7}$$

$$\frac{1}{a_h - a_l}[\frac{p(a_h)a_h - p(a_l)a_l}{p(a_h) - p(a_l)}]^2 \frac{p(a_h)a_h - p(a_l)a_l}{2p(a_h) - p(a_h)^2 - p(a_l)^2} \tag{A.8}$$

holds, the principal has to assimilate incentives, i.e. increase the piece rate and decrease the bonus, in order to prevent the focusing agent from choosing the opposite effort allocation.

The intuition behind the proposition is that a focusing thinker views both tasks differently, because of their difference in payoffs and involved risk. The higher outcome in the quality task draws his attention to this task, resulting in higher effort in the quality dimension. Since this assessment of the tasks works intuitively, the treatment variation by Englmaier et al. (2016) of pointing out the true payoffs was able to disrupt the assessment of the situation, which led to their effect of higher effort in the piece rate.

A.3 Results under Uncertainty

The model can be translated into a framework similar to Holmström and Milgrom (1991) and Ederer et al. (2014). A principal hires an agent to perform several different tasks, N. The performance in each task can be measured, x_j with $j \in N$, and is verifiable. The performance depends on the agent's effort in the task, e_j, as well as a random shock, ϵ_j. Neither effort nor the shock can be verified. The performance in each task is therefore given by $x_j = e_j + \epsilon_j$. The realized random shocks have a multivariate normal distribution with mean 0 and variance σ_j. For simplicity I assume that there is no correlation of shocks. This allows for clear results with increasing number of tasks, because only their individual variance matters and not the interaction with other tasks.

For the first two results, I limit the number of tasks to two, i.e. $j \in 1, 2$. In order to obtain interior solutions, I assume the cost function to be convex in both tasks, $c(e_1, e_2) = \frac{1}{2}(e_1^2 + e_2^2)$, and the benefit function is $B(e_1, e_2) = e_1 + e_2$. I restrict my attention to compensation schedules in which the agent's payment is a linear and separable function of the performance measures: $s(x_1, x_2) = \alpha_1 x_1 + \alpha_2 x_2 + \beta$. The agent is risk averse and has an exponential von Neumann-Morgenstern utility function with coefficient of absolute risk aversion r:

$$u(s(x)) = -e^{-r[\alpha_1 x_1 + \alpha_2 x_2 + \beta - C(e_1,e_2))]}.$$

Rational Benchmark

The solution for a rational agent is given by choosing the linear sharing rule that maximizes the certainty equivalent (CE):

$$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} -\exp(-r[\alpha_1 x_1 + \alpha_2 x_2 + \beta - \frac{1}{2}(e_1^2 + e_2^2)])\frac{1}{\sqrt{2\pi\sigma_1\sigma_2}}\exp(-\frac{1}{2}[(\frac{x_1 - e_1}{\sigma_1})^2 + (\frac{x_2 - e_2}{\sigma_2})^2)dx_1 dx_2 = -\exp(-rCE). \tag{A.9}$$

This results in the equation for the certainty equivalent:

$$CE = \alpha_1 e_1 + \alpha_2 e_2 + \beta - \frac{1}{2}e_1^2 - \frac{1}{2}e_2^2 - \frac{r}{2}\alpha_1\sigma_1^2 - \frac{r}{2}\alpha_2\sigma_2^2. \tag{A.10}$$

From the resulting first order conditions, I know that $\alpha_i = e_i$ and by setting $CE = 0$, I can derive

$$\beta = -\frac{1}{2}e_1^2 - \frac{1}{2}e_2^2 + \frac{r}{2}\alpha_1\sigma_1^2 + \frac{r}{2}\alpha_2\sigma_2^2$$

The principal is solving her maximization problem: $B(e_1, e_2) - (\alpha_1 e_1 + \alpha_2 e_2 + \beta)$.

$$\max_{e_1,e_2}\ e_1 + e_2 - e_1^2 - e_2^2 + \frac{1}{2}e_1^2 + \frac{1}{2}e_2^2 - \frac{r}{2}e_1\sigma_1^2 - \frac{r}{2}e_2\sigma_2^2. \tag{A.11}$$

Therefore the optimal choices for effort and the linear sharing rule are given by:

$$\begin{aligned} \alpha_1^* &= 1 - \frac{r}{2}\sigma_1^2 = e_1^* \\ \alpha_2^* &= 1 - \frac{r}{2}\sigma_2^2 = e_2^* \\ \beta^* &= -1 + r\sigma_1^2 - \frac{3}{2}(\frac{r}{2}\sigma_1^2)^2 + r\sigma_2^2 - \frac{3}{2}(\frac{r}{2}\sigma_2^2)^2. \end{aligned} \tag{A.12}$$

Effort Allocation of a Focusing Agent

With the rational benchmark I can first analyze how a focusing agent will choose effort under the optimal incentive scheme for a rational agent. Therefore I introduce a salience distortion to the agent's utility function:

$$u_{ft}(s(x)) = -\exp(-r[g(\Delta_1)s(x_1) + g(\Delta_2)s(x_2) + \beta - C(e_1, e_2)]). \tag{A.13}$$

The focusing distortion influences the agents perception of the linear sharing rules for each task. This influence is generated through a weighting function, that is increasing in the range of outcomes in each task. I deviate from the authors definition by using the expected value and the variance of a task instead of expected value and average self-distance in order to generate results that are easier to interpret. The basic intuition is, that those tasks with higher payment variation receive more attention and therefore a higher weight. In addition I normalize the variance by the slope α_i for each task, which also simplifies the analysis and is being relaxed in ongoing work.

$$\Delta_i = \frac{1}{\alpha_i}\max_{F\in\mathcal{F}}(E_F[\alpha_i x_i] + \frac{1}{2}Var_F[\alpha_i x_i]) - \frac{1}{\alpha_i}\min_{F\in\mathcal{F}}(E_F[\alpha_i x_i] + \frac{1}{2}Var_F[\alpha_i x_i]). \tag{A.14}$$

Since the distribution for the error term is always the same, the previous equation simplifies to:

$$\Delta_i = \frac{1}{\alpha_i}Var_F[\alpha_i x_i] = \alpha_i Var_F[\epsilon_i] = \alpha_i\sigma_i^2. \tag{A.15}$$

I include the focus weights into the agents optimization problem with the optimal linear sharing rule for a rational agent and, again, set the weighting function to be linear, $g(x) = x$. The agent will optimize his certainty equivalent by choosing his effort:

$$\max_{e_1,e_2}\; g(\Delta_1)\alpha_1^* e_1 + g(\Delta_2)\alpha_2^* e_2 + \beta^* - \frac{1}{2}e_1^2 - \frac{1}{2}e_2^2 - \frac{r}{2}\alpha_1^*\sigma_1^2 - \frac{r}{2}\alpha_2^*\sigma_2^2. \tag{A.16}$$

The focusing agent's effort choice is given by:

$$\begin{aligned} e_1^{FT} &= (1 - \frac{r}{2}\sigma_1^2)^2\sigma_1^2 \\ e_2^{FT} &= (1 - \frac{r}{2}\sigma_2^2)^2\sigma_2^2. \end{aligned} \tag{A.17}$$

Comparing the optimal effort choices for the rational and the focusing agent, it is clear that $e_i^* > e_i^{FT}$. Taking the partial derivatives of the effort choices with respect to the variance leads to:

$$\begin{aligned} \frac{\partial e_i^*}{\partial \sigma_i} < 0 \\ \frac{\partial e_i^{FT}}{\partial \sigma_i} > 0. \end{aligned} \tag{A.18}$$

The partial derivative for the second equation holds as long as the variance in the task dimension is smaller than $\sigma_i < (\frac{2}{3r})^{\frac{1}{2}}$. Therefore, tasks with higher variance in outcomes attract the agents attention which in turn leads to the effort distortion characterized in Proposition 1, which I can state more formally now:

Proposition A.3.1. *As long as $\sigma_i < (\frac{2}{3r})^{\frac{1}{2}}$ holds,*

$$\frac{\partial e_i^{FT}}{\partial \sigma_i} = 2\sigma_i(1 - \frac{r}{2}\sigma_i^2)[1 - \frac{3r}{2}\sigma_i^2] > 0. \tag{A.19}$$

This implies, if the principal does not regard the effect of the framing of incentive contract on the agent's perception, the optimal contract for a rational thinker induces a focusing thinker to exert higher effort in those dimensions with higher variation.

The proposition shows, that if the contract is not 'focusing-proof' the agent will deviate from the principals intended effort. The contract fails to implement the optimal effort allocation. Comparing this result with the example in section III highlights that the distortion can also be found in structural similar reward schemes. Although the exact framing of a contract might have an additional influence.

Optimal Contract for Focusing Agents

The optimal contract for a focusing thinker can be derived similar to the rational benchmark with the addition of the focus weighting functions to the linear sharing rule.

$$\begin{aligned} \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} - \exp(-r[g(\Delta_1)\alpha_1 x_1 + g(\Delta_2)\alpha_2 x_2 + \beta - \frac{1}{2}(e_1^2 + e_2^2)])\frac{1}{\sqrt{2\pi\sigma_1\sigma_2}} \\ \exp(-\frac{1}{2}[(\frac{x_1 - e_1}{\sigma_1})^2 + (\frac{x_2 - e_2}{\sigma_2})^2)dx_1 dx_2 = -\exp(-rCE). \end{aligned} \tag{A.20}$$

The equation for the agent's certainty equivalent differs from the rational benchmark:

$$CE = \underbrace{e_1\alpha_1^2\sigma_1^2 + e_2\alpha_2^2\sigma_2^2 + \beta}_{\text{linear sharing rule}} - \underbrace{(\frac{1}{2}e_1^2 + \frac{1}{2}e_2^2)}_{\text{effort cost}} - \underbrace{(\frac{1}{2}r\alpha_1^4\sigma_1^6 + \frac{1}{2}r\alpha_2^4\sigma_2^6)}_{\text{risk premium}}. \tag{A.21}$$

The optimal choices for the linear sharing rule are given by:

$$\begin{aligned} \alpha_1^p &= e_1^{\frac{1}{2}}\sigma_1^{-1} \\ \alpha_2^p &= e_2^{\frac{1}{2}}\sigma_2^{-1} \\ \beta^p &= -\frac{1}{2}e_1^2 - \frac{1}{2}e_2^2 + (\frac{1}{2}r\alpha_1^4\sigma_1^6 + \frac{1}{2}r\alpha_2^4\sigma_2^6). \end{aligned} \tag{A.22}$$

On this basis I can solve the principals optimization problem:

$$\max_{e_1,e_2} \; e_1 + e_2 - \alpha_1 e_1 - \alpha_2 e_2 - \beta. \tag{A.23}$$

The first order conditions implicitly define e_i:

$$1 - \frac{1}{2}e_1^{-\frac{1}{2}}\sigma_1^{-1} + e_1 - re_1\sigma_1^2 = 0.$$

The implicit function theorem provides the basic insight, that the optimal effort in each task is now decreasing in the variance:

$$\frac{\partial e_i(\sigma_i)}{\partial \sigma} = -\frac{\frac{1}{2}e_i^{-\frac{1}{2}}\sigma_i^{-2} - 2re_i\sigma_i^2}{\frac{1}{4}e_i^{-\frac{3}{2}}\sigma_i^{-1} + 1 - r\sigma - i^2} < 0. \tag{A.24}$$

In order for this to happen, the linear sharing rule has to compensate for the focusing weight. This implies a higher correction factor for dimensions with a higher variation in outcomes. In order to balance the focusing weights, the principal needs to increase the slopes of flatter linear sharing rules, while she decreases the slope of steeper ones. This could be achieved through introducing additional noise terms. In expectations this results in a higher perceived similarity between the different tasks.

Appendix B

On the Dynamics of Prospect Theory

B.1 Prospect Parameter and External Validity of Results

The design of our investment game over four rounds is borrowed from Imas (2016). Hence, we can use our data to replicate his analysis. Since our investment game also entails both the paper and the realization group we can estimate the treatment effect. The replication has to goals. First, we want to discuss potential differences in our experiments, as we find significant differences to Imas (2016). Second, we want to discuss how robust Imas' findings are without the inclusion of covariables.

Imas uses in his analysis a t-test to compare the difference in investments of round four and round three between the treatment and the control group. If a subject invests more in round four than in round three the difference becomes positive. Therefore, positive signs indicate increased risk taking, while negative signs indicate a reduction in risk taking.

Since his model only makes predictions for decision maker in the loss domain, Imas conducts the analysis for subjects who were in the loss domain after the third round[1].

In Table B.1.1 we report the effect of realization treatment and control. The first column we included the estimation from Imas (2016), in the second column we report our estimation of his data. The third column reports the result of the same t-test for our data.

[1] We reverse engineered the analysis, since Imas does not explicitly describe his approach. However, we cannot replicate which subject he excluded, therefore our estimations differ slightly from the original report.

	Imas (2016)	Replication	Our Data
Paper Treatment	+0.23***	0.28***	0.16
Realization Treatment	−0.15***	−0.15***	0.01
Total Effect	−0.38***	−0.42***	−0.18
N (Paper/Realized)	53(?/?)	54(28/26)	41(13/30)

*** 1% significance level; ** 5% significance level; * 10% significance level;

Table B.1.1: Comparing Realization Effects

In the fourth row we display the number of observations and distinguish between subjects in the paper and the realization group. The first number in brackets denotes the observations in the paper group, the second the observations in the realization group.

Although our control group, i.e. the paper treatment, has only 13 observations, the effect has a p-value of 0.13 and therefore barely misses the 10% significance level. With respect to the results of Imas (2016) our effect has the same sign and when put into relation to the the amount of endowment (USD 2 vs. EUR 1.60) the same magnitude as well. Therefore the effect of paper losses is robust among the experiments. Subjects invest more in round four than in round three if they only experienced losses so far and

However, when we compare the results of the realization treatment, we find huge differences between Imas (2016) and our experiment. Imas has a strong negative effect, that is significant at the 1% significance level, whereas we have a null effect. It is important to note that our result is not driven by lack of statistical power, as our realization treatment has more observations than Imas. Our results strongly suggest that there is no effect at all.

Our experiment differed to Imas (2016) in two dimensions. First, our subjects were asked beforehand to make a complete contingent plan. The plan forced them to anticipate how they would feel when they experience losses. Perhaps this anticipation on its own made them aware on how to close the mental frame, thereby reducing the effect of realization. Although this explanation is appealing, it cannot account for the fact that we still find a strong effect of the paper treatment. Additionally, it is far fetched to assume that the plan is able to influence the mental frame of decisions made one week later.

Second, our subjects had to do the Prospect Theory elicitation task, before they could actually choose their investments. The elicitation task could have interfered with the investment decisions as both entailed decisions in the loss domain. However, one would expect that all investment decisions becomes noisier and not only the realization treatment.

Thus, it remains unclear as to why the results of Imas (2016) and our experiment differ significantly in the realization treatment.

In order to discuss how robust the results of Imas (2016) are without the inclusion of covariables, we can take a look if his predictions are backed by his own data. Although it is not explicitly stated, in all rounds of the investment game previous to the fourth round decision makers are in the paper loss control group. Since their losses are not realized subjects who experience losses according to Imas' theory are supposed to increase their invested shares.

We test this hypothesis for each round separately in columns (1) and (3). In columns (2) and (4) we condition the results in the subject being in the treatment group. Being in the treatment group should not influence investment decisions in previous rounds, because Imas hypothesized that only the act of taking away money closes the mental account. Table B.1.2 presents our results.

Table B.1.2: Effect of losses on risk taking in previous rounds

	(1) $\Delta_{3,2}$	(2) $\Delta_{3,2}\|_{\text{real}}$	(3) $\Delta_{2,1}$	(4) $\Delta_{2,1}\|_{\text{real}}$
Loss	-0.134	-0.0666	0.0111	-0.0666
	(0.0878)	(0.111)	(0.0949)	(0.129)
Constant	0.0741	-0.0227	-0.0926	-0.0227
	(0.0717)	(0.0938)	(0.0775)	(0.109)
Observations	81	39	81	39
R^2	0.029	0.010	0.000	0.007

*** 1% significance level; ** 5% significance level; * 10% significance level;

Although conditioning on the realization treatment results in different effect signs in round 2, all effects remain insignificant. Therefore, we know that randomization in treatment and control group worked. However, while the effect of being in the losses should lead to increased risk taking in the subsequent round, the effects in Imas' data set are insignificant at best. It is important to note, that almost all effects point in the opposite direction. The effect in column (1) has a p-value of 0.13, barely missing the 10% significance. With an effect size of -0.134 it indicates that subjects reduced their investment after a loss in the second round by USD 0.13.

The missing effects in the previous rounds are troubling for the theory of Imas. Although his treatment effect is significant and goes in the predicted direction, theory also has clear predictions for the previous investment rounds. That there are null results at best, that point in the opposite direction casts serious doubt if the results for the treatment effect could have a different cause than loss aversion and mental accounts. Therefore it is inevitable for further research to also establish a link between investment decisions and

Prospect Theory parameters of subjects. Only through this link it can be unambiguously established that increasing risk seeking is driven by Prospect Theory behavior.

B.2 Quality of fit and consistency of Prospect Theory Parameters

In this section we first discuss the joint estimation of Prospect Theory parameters. Second, we suggest a more fine tuned classification of quality of fit, as well as potential remedies through complexity reductions. Third, we discuss the role of consistency between both weeks.

The regression equation for joint estimations for both weeks together is:

$$\begin{aligned} E =& \mathbb{1}_G(w^+x^\alpha + (1-w^+)y^\alpha)^{\frac{1}{\alpha}} - \mathbb{1}_L(w^-(-x)^\beta + (1-w^-)(-y)^\beta)^{\frac{1}{\beta}} \\ &- \mathbb{1}_M\left(\frac{w^+x^\alpha}{\lambda w^-}\right)^{\frac{1}{\beta}}. \end{aligned}$$

The results of the pooled regressions of both weeks jointly and both weeks separately are summarized in Table B.2.1.

	Coefficient	Std.Error	t.value	p.value
w^+	0.3896	0.0343	11.36	$1.43E-28$
α	1.5236	0.1548	9.84	$4.54E-22$
w^-	0.2412	0.0321	7.51	$1.11E-13$
β	1.8359	0.1866	9.84	$4.54E-22$
λ	1.5831	0.1441	10.98	$7.06E-27$

Table B.2.1: Pooled estimation, both weeks jointly

In the pooled regression, we find under-weighting both for gains and losses as well as loss aversion, as Prospect Theory suggests. However, we do not find the usual S-shape of the value function, but an inverse S-shape, as our curvature parameters are bigger than 1, not smaller.

As in previous analysis our main focus lies on the individual estimations per subject, as we aim at individually classifying our subjects. The results of the individual regressions per subject are summarized in Table B.2.2 for both weeks jointly. The complete list of all participants' individual estimations is deferred to Tables A.1 and A.2 in the appendix.

	Minimum	25%	Median	75%	Maximum	Average
w^+	0.00	0.21	0.41	0.53	0.85	0.39
$(Std.Error)$	(0.00)	(0.07)	(0.10)	(0.15)	(1.67)	(0.14)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.14]	[1.00]	[0.18]
α	0.47	1.00	1.48	2.39	17.81	2.54
$(Std.Error)$	(0.00)	(0.27)	(0.48)	(1.34)	(743.33)	(15.76)
$[p.value]$	[0.00]	[0.00]	[0.02]	[0.26]	[0.98]	[0.15]
w^-	0.00	0.03	0.23	0.42	0.55	0.24
$(Std.Error)$	(0.00)	(0.04)	(0.09)	(0.12)	(0.29)	(0.09)
$[p.value]$	[0.00]	[0.00]	[0.06]	[0.72]	[1.00]	[0.30]
β	0.82	1.25	1.91	3.59	37.38	3.96
$(Std.Error)$	(0.00)	(0.40)	(0.64)	(3.13)	(717.38)	(20.47)
$[p.value]$	[0.00]	[0.00]	[0.02]	[0.31]	[0.98]	[0.17]
λ	0.01	0.91	1.40	4.64	$1.5E+09$	$3.7E+07$
$(Std.Error)$	(0.00)	(0.19)	(0.48)	(2.87)	$(1.7E+11)$	$(4.1E+09)$
$[p.value]$	[0.00]	[0.00]	[0.02]	[0.50]	[1.00]	[0.24]

Table B.2.2: Distribution of individual estimates, both weeks jointly

The trouble with these individual estimations is that they substantially lack power, as only 20 observations are available per subject, but up to 10 parameters are to be estimated. The natural approaches to this issue are reductions of the model-complexity (i.e. dropping parameters), disregarding subjects (i.e. dropping observations), and combinations of the two.

Complexity reductions of Prospect Theory are quite common, e.g. disregarding probability weighting (i.e. $w^+ = w^- = 0.5$), assuming a reflection property of probability weights (i.e. $w^+ = w^-$ as suggested in Kahneman and Tversky (1979) or $w^+ = 1 - w^-$ as suggested in Tversky and Kahneman (1992)), disregarding curvature (i.e. $\alpha = \beta = 1$), assuming a reflection property of curvature(i.e. $\alpha = \beta$), or even disregarding loss aversion (i.e. $\lambda = 1$). However, which complexity reduction is appropriate, if any, depends on the individual behavior. For a risk neutral Expected Utility Theory type on the one hand, any complexity reduction is completely fine. As a matter of fact, all of them together would be fine. On the other hand, for each possible complexity reduction, there are some subjects for whom they harm the quality of fit.

Dropping observations (e.g. by classifying them as "outliers") is also a common approach to restore model fit, but poses two major challenges. First, it reduces power for subsequent analyses and second, it entails the risk of disregarding potentially relevant heterogeneity in our subjects' behaviors.

We pursue the following mixed approach. First, we group our subjects according to their model fit such that we can selectively exclude the worst-fitting subjects from subsequent analyses. Second, we apply 2 "layers" of complexity reductions.

Grouping

When grouping our subjects, we assess the quality of fit based on p-values and standard errors. Usual measures for quality of fit, such as R^2 or Akaike's An Information Criterion (AIC) are not suitable in our case. First, our regressions are non-linear least squares, and there is no consensus on how to define R^2 for these. Second, the AIC is designed to compare quality of fit of different models for one data-set, whereas we have to do the exact opposite, i.e. comparing quality of fit of one model (the fully-fledged Prospect Theory parameterization) for several data-sets (the various participants of our experiment).

The p-values are relevant here because fitting the Prospect Theory parameterization with any zero coefficient is clearly defeating the model: a zero probability weight for gains would imply rejection of 50:50 gambles with arbitrarily high gains and an ε loss; a zero probability weight for losses or a zero loss aversion would imply acceptance of 50:50 gambles with arbitrarily high losses and an ε gain; zero curvature parameters would imply a complete neglect of magnitudes, i.e. an ε payoff would be perceived as just as good or bad as an arbitrarily high payoff. The standard errors, on the other hand, are relevant because they are a measure of precision.

We are aware that setting such thresholds is somewhat arbitrary and driven by the data. In order to impose at least some discipline on us, we tie the thresholds for the standard errors to the maximum (sensible) range of the respective parameters, which we believe to be the intervals $[0, 1]$ for probability weights, $[0, 2]$ for curvature parameters, and $[0, 4]$ for loss aversion. As thresholds for the standard errors, we impose 10%, 25%, 50%, and 100% of the respective interval length. For the p-values, we start with "confidence-levels" of 5% and 10%, but then increase the thresholds to 25% and 50%. These latter thresholds may seem extraordinary high, but as they apply to 10 parameters separately they are mostly non-binding. To illustrate this fact, Table B.2.3 not only summarizes the thresholds per group, but also the average p-values and standard errors of their respective group members.

Table B.2.3: Definitions and basic characteristics of groups

Group		p-value	Std. Error of w^+, w^-	α, β	λ	# ♀
Green	$\leq$	0.05	0.10	0.20	0.40	
	$\varnothing$	0.00	0.02	0.07	0.07	8
Yellow	$\leq$	0.10	0.25	0.50	1.00	
	$\varnothing$	0.01	0.09	0.31	0.15	6
Blue	$\leq$	0.25	0.50	1.00	2.00	
	$\varnothing$	0.04	0.14	0.53	0.60	8
Purple	$\leq$	0.50	1.00	2.00	4.00	
	$\varnothing$	0.10	0.16	0.76	1.29	13
Red	$\leq$	1.00	∞	∞	∞	
	$\varnothing$	0.49	6.38	$2.3E+03$	$3.2E+12$	29

For the definition in 2.5.1, we use category red as "bad fit" and treat those subjects separately.

Complexity Reductions

When contemplating potential complexity reductions to improve the model fit, there are a few decisions to be taken. First, complexity could either be reduced uniformly by applying the same reduction to all subjects, or heterogeneously by applying different reductions to different subjects. The former approach has the advantage of maintaining comparability between the subjects at the cost of not suiting everyone's behaviors as good as possible, whereas the reverse holds true for the latter. Second, one model could be applied to both weeks, or they could have different models. Again, the benefit of the former is comparability, whereas the latter could be better tailored to individual behaviors. Third, and probably most importantly, a decision has to be made which parameter is to be dropped. An obvious choice seems to be the worst-fitting parameter, but it is not necessarily clear which one it is and, due to the simultaneous determination of all parameters in the regression, it is not even clear whether this would actually be the best choice.

	Minimum	25%	Median	75%	Maximum	Average
w^+	0.00	0.44	0.54	0.70	0.96	0.57
$(Std.Error)$	(0.00)	(0.05)	(0.06)	(0.08)	(0.15)	(0.07)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.00]	[1.00]	[0.02]
α	0.14	0.55	0.87	1.09	15.94	1.07
$(Std.Error)$	(0.00)	(0.11)	(0.15)	(0.24)	(201.45)	(3.32)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.00]	[0.94]	[0.04]
β	0.31	0.88	0.99	1.07	2.06	0.95
$(Std.Error)$	(0.00)	(0.09)	(0.12)	(0.17)	(0.32)	(0.14)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]
λ	0.69	0.92	1.17	1.68	$1.6E+09$	$2.5E+07$
$(Std.Error)$	(0.00)	(0.14)	(0.20)	(0.35)	$(4.1E+11)$	$(6.5E+09)$
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.00]	[1.00]	[0.02]

Table B.2.4: Distribution of individual estimates of complexity reduction 1, both weeks jointly

We chose to maintain as much comparability as possible and, hence, apply uniform complexity reductions to all subjects and to both weeks. Table B.2.2 and Table 2.5.2 reveal that the w^- estimates have the highest average p-values and that their point-estimates are closest to zero. Hence, our first complexity reduction drops the parameter w^-. Trial and error suggests that this is in fact the best choice in terms of quality of fit, both for all subjects and for the subjects in the red group. Table B.2.4 and B.2.5 summarize the results of this first complexity reduction for both weeks jointly and for both weeks separately, respectively. The complete list of all participants' individual estimations is deferred to Tables A.3 and A.4 in the appendix.

Clearly, subjects can be grouped again using the same thresholds as for the original regressions. A big advantage of this first complexity reduction is that it does not harm any subject's quality of fit so much that they would drop to a lower group, but improves the quality of fit for 42 subjects, many of whom improve by multiple steps. In particular, 20 out of 29 originally red subjects enter some non-red group. Table B.2.6 summarizes the average p-values and standard errors of the various groups for the complexity reduction 1 regressions.

To allow for probability weighting for gains but not for losses feels unnatural. This is

	Minimum	25%	Median	75%	Maximum	Average
w_1^+	0.00	0.41	0.61	0.75	1.00	0.57
$(Std.Error)$	(0.00)	(0.08)	(0.13)	(0.20)	(0.47)	(0.15)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.04]	[1.00]	[0.06]
α_1	0.11	0.56	0.82	1.10	25.71	1.29
$(Std.Error)$	(0.00)	(0.22)	(0.34)	(0.49)	$(2.2E+04)$	(342.62)
$[p.value]$	[0.00]	[0.00]	[0.05]	[0.16]	[1.00]	[0.14]
β_1	0.40	0.86	1.00	1.32	3.54	1.09
$(Std.Error)$	(0.00)	(0.16)	(0.24)	(0.38)	(1.45)	(0.30)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.02]	[0.21]	[0.02]
λ_1	0.37	0.86	1.18	1.80	$1.2E+11$	$1.9E+09$
$(Std.Error)$	(0.00)	(0.22)	(0.32)	(0.56)	$(2.4E+15)$	$(3.8E+13)$
$[p.value]$	[0.00]	[0.00]	[0.01]	[0.05]	[1.00]	[0.08]
w_2^+	0.01	0.46	0.53	0.64	0.98	0.56
$(Std.Error)$	(0.00)	(0.04)	(0.06)	(0.10)	(194.99)	(3.12)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.00]	[1.00]	[0.03]
α_2	0.00	0.67	0.90	1.01	4.75	0.88
$(Std.Error)$	(0.00)	(0.11)	(0.16)	(0.26)	(7.88)	(0.32)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.01]	[1.00]	[0.06]
β_2	0.26	0.83	0.95	1.04	1.70	0.92
$(Std.Error)$	(0.00)	(0.09)	(0.13)	(0.18)	(0.35)	(0.14)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.00]	[0.06]	[0.00]
λ_2	0.30	0.96	1.16	1.64	654.64	11.74
$(Std.Error)$	(0.00)	(0.15)	(0.24)	(0.54)	$(6.3E+03)$	(102.40)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.02]	[1.00]	[0.05]

Table B.2.5: Distribution of individual estimates of complexity reduction 1, both weeks separately

not meant to be taken literally as if people would actually weight their gain probabilities, but not their loss probabilities, but has to be interpreted rather as an artifact of the lack of power and the non-linear least squares regression, which is well known to have a range of coefficients that all fit almost equally well. We impose this complexity reduction not to “repair” our subjects’ behaviors, but to “repair” our regression.

Still, we feel inclined to provide the “full” reduction without any probability weighting as well, which is our complexity reduction 2. However, this reduction harms the quality of fit for several subjects, both compared to the original regression as well as compared to the complexity reduction 1. Table B.2.7 and B.2.8 summarize the results of this second complexity reduction for both weeks jointly and for both weeks separately, respectively. The complete list of all participants’ individual estimations is deferred to Tables A.3 and

Group		p-value	Std. Error of w^+, w^-	α, β	λ	#
Green	$\leq$	0.05	0.10	0.20	0.40	
	$\varnothing$	0.00	0.03	0.07	0.09	13
Yellow	$\leq$	0.10	0.25	0.50	1.00	
	$\varnothing$	0.01	0.09	0.20	0.28	24
Blue	$\leq$	0.25	0.50	1.00	2.00	
	$\varnothing$	0.04	0.14	0.33	0.61	12
Purple	$\leq$	0.50	1.00	2.00	4.00	
	$\varnothing$	0.08	0.15	0.37	0.59	6
Red	$\leq$	1.00	∞	∞	∞	
	$\varnothing$	0.27	11.03	609.14	$1.3E+14$	9

Table B.2.6: Definitions and basic characteristics of groups for complexity reduction 1

	Minimum	25%	Median	75%	Maximum	Average
α	0.57	0.82	0.93	1.09	3.66	1.02
$(Std.Error)$	(0.00)	(0.08)	(0.13)	(0.19)	(1.55)	(0.17)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.00]	[0.03]	[0.00]
β	0.30	0.93	0.99	1.10	2.02	1.02
$(Std.Error)$	(0.00)	(0.09)	(0.13)	(0.20)	(0.36)	(0.15)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]
λ	0.62	0.93	1.12	1.81	$1.8E+03$	30.05
$(Std.Error)$	(0.00)	(0.14)	(0.25)	(0.45)	$(5.8E+03)$	(90.88)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.01]	[0.76]	[0.04]

Table B.2.7: Distribution of individual estimates of complexity reduction 2, both weeks jointly

A.5 in the appendix.

Again, subjects can be grouped as above. This second complexity reduction improves the quality of fit for 22 subjects, but harms it for 11 subjects, relative to complexity reduction 1 by terms of group membership. Still, it improves the quality of fit for 46 subjects and harms it for 1 subject, relative to the original non-reduced regressions by terms of group membership. Table B.2.9 summarizes the average p-values and standard errors of the various groups for the complexity reduction 2 regressions.

From the categorization it becomes clear that the complexity reduction increase the overall quality of fit dramatically. For complexity reduction 2 only the behavior of 8 subjects is badly described by Prospect Theory in comparison to the 29 of our baseline analysis.

	Minimum	25%	Median	75%	Maximum	Average
α_1	0.48	0.78	0.99	1.20	2.79	1.04
$(Std.Error)$	(0.00)	(0.15)	(0.24)	(0.38)	(1.64)	(0.29)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.01]	[0.14]	[0.02]
β_1	0.42	0.93	1.04	1.37	3.03	1.17
$(Std.Error)$	(0.00)	(0.17)	(0.28)	(0.46)	(1.18)	(0.33)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.03]	[0.12]	[0.02]
λ_1	0.40	0.83	1.13	2.06	71.99	2.69
$(Std.Error)$	(0.00)	(0.22)	(0.40)	(0.84)	(377.74)	(6.92)
$[p.value]$	[0.00]	[0.00]	[0.02]	[0.14]	[0.85]	[0.10]
α_2	0.51	0.82	0.95	1.08	6.94	1.16
$(Std.Error)$	(0.00)	(0.09)	(0.15)	(0.20)	(4.81)	(0.31)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.00]	[0.17]	[0.01]
β_2	0.25	0.88	0.96	1.04	1.86	0.96
$(Std.Error)$	(0.00)	(0.10)	(0.14)	(0.19)	(0.42)	(0.16)
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.00]	[0.06]	[0.00]
λ_2	0.60	0.96	1.13	1.90	$1.5E+06$	$2.4E+04$
$(Std.Error)$	(0.00)	(0.15)	(0.29)	(0.83)	$(1.5E+07)$	$(2.4E+05)$
$[p.value]$	[0.00]	[0.00]	[0.00]	[0.03]	[0.92]	[0.08]

Table B.2.8: Distribution of individual estimates of complexity reduction 2, both weeks separately

Group		p-value	Std. Error of w^+, w^-	α, β	λ	#
Green	$\leq$	0.05	0.10	0.20	0.40	
	$\varnothing$	0.00	–	0.09	0.15	16
Yellow	$\leq$	0.10	0.25	0.50	1.00	
	$\varnothing$	0.02	–	0.21	0.43	24
Blue	$\leq$	0.25	0.50	1.00	2.00	
	$\varnothing$	0.04	–	0.32	25.73	12
Purple	$\leq$	0.50	1.00	2.00	4.00	
	$\varnothing$	0.05	–	0.32	0.97	4
Red	$\leq$	1.00	∞	∞	∞	
	$\varnothing$	0.14	–	0.60	$8.5E+05$	8

Table B.2.9: Definitions and basic characteristics of groups for complexity reduction 2

Consistency of Prospect Theory Behaviors

Based on the above estimations, we individually classify our subjects as stable or unstable Prospect Theory types according to the inter-temporal consistency of their Prospect Theory parameters. For this purpose, we need to statistically test for (in-)equality of the week 1 and week 2 parameters of each participant.

Usual parametric tests such as the Wald Test are not suitable in our case, because they do not allow for comparability between subjects or, put differently, they would not treat different subjects equally "fair". The trouble with those two-sided tests for coefficient (in-)equality is that they are designed to answer the question whether there is a statistically significant difference between the coefficients, but completely neglect how big a difference there is. When investigating a single regression, this is not an issue, but a feature, because strictness respectively lenience of the test can be calibrated by choice of the confidence level. In our case, however, applying the same test (i.e. the same confidence level) to all subjects would result in rejecting consistency for the subjects with the most precise estimates because of miniscule differences in their point estimates, but not rejecting consistency for subjects with completely different point estimates, as long as they are noisy enough.

Clearly, we want to find a notion of consistency that reflects stability of behaviors. In particular, we would not regard a subject with a very precise parameter difference of ε as inconsistent, as very small parameter differences do not translate into any behavioral differences. Also, we would not regard a subject as consistent if there was too much noise in their estimates, because a lot of noise essentially means that a subject does not behave consistently even within one week.

Hence, we "design" our own test for consistency by asking how much probability weight of any week's estimate falls within a fixed band around the joint estimate for both weeks together. In order to do this, we impose the assumption that our estimated coefficients are normally distributed around their point estimates with their standard errors as standard deviations. Now, we can fix one band for each of the five Prospect Theory parameters for all subjects and a "significance level" of how much probability weight of the estimates has to fall within this interval.

We set our band as +/- 1.96 times the standard error of the pooled estimation of both weeks jointly, i.e. a 95% confidence interval of the pooled estimation for both weeks jointly, in order to account for different levels of noise for different parameters, but set the mid-point of this interval to the individual subject's own joint estimate (because we do not demand that subjects are consistent with the average behavior of all subjects, but with their own individual behavior). If there is an estimate of one parameter in one week with less than 5% probability weight within that interval around the joint estimation, we reject the null hypothesis of consistency. So if we reject consistency, than there is a parameter with at least 95% chance of both weeks' estimates to be at least 1.96 times the standard error of the pooled estimation apart from each other, which is behaviorally meaningful for all parameters.

For the fully fledged 5-parameter model, we classify 35 subjects as in-consistent, 24 of whom belong to the red group. They exhibit 1 to 8 violations of the above defined consistency criteria with an average of 3.3 violations. Table B.2.10 summarizes the consistency classification and average number of deviations per group of the original 5-parameter model.

Group	Total # 🯅	Consistent # 🯅	∅ # Violations*
Green	8	6	1.5
Yellow	6	4	3.0
Blue	8	3	1.6
Purple	13	11	1.5
Red	29	5	4.0

Table B.2.10: Summary of consistency classification of the original specification, *) conditional on being inconsistent, maximum number 10

For complexity reduction 1, we classify only 17 subjects as inconsistent, 5 of whom belong to the (complexity reduction 1) red group. They exhibit 1 to 4 violations of the consistency criteria with an average of 1.9 violations. Table B.2.11 summarizes the consistency classification and average number of deviations per group of complexity reduction 1.

Group	Total # 🯅	Consistent # 🯅	∅ # Violations*
Green	13	10	2.3
Yellow	24	18	1.3
Blue	12	12	-
Purple	6	3	1.7
Red	9	4	2.6

Table B.2.11: Summary of consistency classification of complexity reduction 1, *) conditional on being inconsistent, maximum number 8

For complexity reduction 2, we classify 32 subjects as inconsistent, 8 of whom belong to the (complexity reduction 2) red group. They exhibit 1 to 4 violations of the consistency criteria with an average of 1.9 violations. Table B.2.12 summarizes the consistency classification and average number of deviations per group of complexity reduction 2.

Group	Total # 🯅	Consistent # 🯅	∅ # Violations*
Green	16	13	2.0
Yellow	24	15	1.3
Blue	12	3	1.2
Purple	4	1	2.0
Red	8	0	3.1

Table B.2.12: Summary of consistency classification of complexity reduction 2, *) conditional on being inconsistent, maximum number 6

Consistency is our null hypothesis, we set a wide tolerance band of +/- 1.96 standard errors of the pooled estimation, and we reject the hypothesis only if at least 95% of the probability weight of one estimate falls outside the tolerance band. Put differently, we are fairly generous in classifying subjects as consistent. Still, also in the most consistent specification (complexity reduction 1) more than a quarter of our subjects is classified as inconsistent. Hence, we feel safe to say that a considerable fraction of our subjects does not exhibit consistent Prospect Theory behavior.

Changes in Sophistication with changing consistency of Prospect Theory Parameters

The ultimate goal of this paper is to investigate the quality of our subjects' anticipations of their own Prospect Theory behaviors. We do so by establishing two measures of naivete: the quality of the complete contingent plan and the quality of the commitment decision. However, since this assessment critically depends on the Prospect Theory parameter, we discuss the changes to our measures through the change of quality of fit and consistency.

We classify a commitment decision as poor if the utility of the original week 1 plan, where all payoffs are reduced by the willingness to pay for the commitment (respectively increased by the willingness to accept) and another EUR 1.00 tolerance, exceeds the utility of the actual play.[2] As we only account for actually observed plan-deviations (i.e. a maximum of 4 deviations) and allow for considerable trembling (EUR 1.00 tolerance), a subject's commitment decision is classified as poor only in case of extremely harmful deviations.

For our original regression, we classify 26 subjects as poor planners and 19 subjects as poor committers. There are only 3 subjects in the overlap of the two types of errors, which is a result of our conservative calibration: To end up in this overlap, one has to make a plan that yields negative utility in the first place and than play so poorly that it would have been worthwhile to pay at least one additional euro for committing to that plan. Put differently, poor planning makes it very unlikely to also commit poorly, as we only observe the commitment error of paying too little. Table B.2.13 summarizes the naivete classification for our original estimations as well as our two complexity reductions. Table B.2.14 does the same for the samples that are restricted to the respective non-red groups.

As we can see, the change of estimation method, i.e. switching from the baseline to complexity reduction 1 and complexity reduction 2, changes the results in TableB.2.13 only slightly. Most notably, the number of subjects who made a good plan, but choose poor commitments decreases form 16 to 12, 11 respectively. Through the complexity reduction subjects in the full sample are more likely to be classified as good planner and good committers.

It is important to notice, that the increase of subjects who both choose good plans and commitments B.2.14 looks salient, but is actually driven by the inclusion of additional subjects. Since complexity reductions 1 and 2 increase the number of subjects for which Prospect Theory is a good fit, the increase of good committers is entirely driven by the increase in number of subjects that are in the non-red category. Nonetheless the increase of subjects with poor plans but good commitments is significant in comparison to TableB.2.13. This increase implies that most subjects who switch from the red-category make bad plans, but choose good commitments.

Our discussion of categorization, complexity reduction and consistency emphasizes

[2] We include this EUR 1.00 tolerance to account for noise in order not to classify a subject as naive because of a "mistake" of very little consequence.

		Commitment poor	Commitment good	Sum
Plan	poor	3 *4 / 4*	23 *24 / 25*	26 *28 / 29*
	good	16 *12 / 11*	22 *24 / 24*	38 *36 / 35*
	Sum	19 *16 / 15*	45 *48 / 49*	64 *64 / 64*

Table B.2.13: Classification of naivete, full sample; original regression, *complexity reduction 1 / complexity reduction 2*

		Commitment poor	Commitment good	Sum
Plan	poor	2 *3 / 3*	10 *20 / 21*	12 *23 / 24*
	good	7 *10 / 11*	16 *22 / 21*	23 *32 / 32*
	Sum	9 *13 / 14*	26 *42 / 42*	35 *55 / 56*

Table B.2.14: Classification of naivete, non-red sample; original regression, *complexity reduction 1 / complexity reduction 2*

two points. First, when it comes to inter temporal choice in Prospect Theory there is still ground work to do with regard to how parameter can be estimated and what decision criterion allows a researcher to assume a subject behaves consistent over time and according to Prospect Theory. Second, the introduction of complexity reductions changes the assessment of categorization, consistency and quality of plans. Since there is no standard in the literature so far, the possibility of different complexity reduction represents an important degree of freedom for a researcher, that can change the results of an analysis.

B.3 Additional Cogntivie Relfection Test Results

The literature on CRT identified a series of testable predictions that help to assess the quality of our measures. Frederick (2005) as well as Kahneman and Frederick (2002) find that individuals with high CRT scores are on the one hand more patient than low CRT individuals, and on the other hand are more willing to bear risk in favorable lotteries. We can test the following three hypotheses:

1. Participants with higher CRT scores plan to invest more.
2. Participants with higher CRT scores are less likely to pay too much for their commitment.
3. Participants with higher CRT scores are less risk seeking in the loss domain.

Frederick (2005) states that participants with higher CRT scores are more willing to participate in hypothetical lotteries with positive expected values. Since our investment game has a positive expected value, participants with higher CRT scores should be more willing to invest in the game. To test the first hypothesis, we look at the cumulated investment in all plan contingencies. By using the plan instead of the game, we are able to include all participants in our test.

	(1)	(2)	(3)	(4)	(5)	(6)
OLS	Total Plan	Total Plan	Total Plan	Total Plan	Total Plan	Total Plan
CRT Score	1.574	1.824*	1.866*	2.137**	2.309**	2.319**
	(0.979)	(1.016)	(1.034)	(1.051)	(1.056)	(1.073)
Age		0.116	0.112	0.119	0.0577	0.0568
		(0.125)	(0.127)	(0.126)	(0.135)	(0.137)
Female			0.574	1.127	0.343	0.342
			(1.952)	(1.992)	(2.082)	(2.101)
λ_2				-0.000840	-0.000903	-0.000909
				(0.000667)	(0.000666)	(0.000677)
α_2					0.357	0.370
					(0.290)	(0.342)
β_2						-0.00868
						(0.125)
Constant	20.19***	16.84***	16.60***	15.88***	16.46***	16.47***
	(2.091)	(4.160)	(4.269)	(4.287)	(4.294)	(4.337)
Observations	64	64	64	64	64	64
R^2	0.040	0.054	0.055	0.080	0.103	0.103

We find that participants with higher CRT scores do plan to invest more over all, significantly so if we control for demographics, loss aversion, and curvature. This matches the results from the literature and further confirms the validity of our Cognitive Reflection Test.

The second hypothesis is based on two channels. First, a higher CRT score is a sign for a higher level of self awareness, therefore we expect that participants with higher CRT are better in anticipating their own loss aversion and risk-seeking in losses. Hence, they will know whether they are likely to stick to their plans, in which case, they should not pay for commitment, or whether they will know that unfavorable deviation from their plan is likely, thus making commitment more valuable.

Second, as we expect high CRT score participants to plan better, their plans are on average more valuable (in terms of utility calculated with Prospect Theory parameters) than others' plans. Since we cropped the maximum commitment value at EUR 4.80, there is less possibility for overpayment.

	(1)	(2)	(3)	(4)	(5)	(6)
OLS	Overpaid	Overpaid	Overpaid	Overpaid	Overpaid	Overpaid
CRT Score	-0.148	-0.325	-0.334	-0.329	-0.202	-0.148
	(0.201)	(0.207)	(0.270)	(0.282)	(0.327)	(0.341)
Value Comm.	1.001***	0.973***	1.084***	1.045***	1.050***	0.988***
	(0.0759)	(0.0739)	(0.0776)	(0.0838)	(0.107)	(0.124)
Age		-0.0339		0.0147		0.0252
		(0.0245)		(0.0367)		(0.0547)
Female		-1.047***		-0.725		-0.827
		(0.392)		(0.482)		(0.612)
Mathgrade		-0.0616		-0.136		0.00879
		(0.217)		(0.306)		(0.400)
Constant	0.191	1.992*	0.628	0.859	0.386	0.0207
	(0.429)	(1.022)	(0.600)	(1.376)	(0.750)	(1.852)
Observations	64	64	35	35	26	26
R^2	0.741	0.780	0.861	0.872	0.806	0.828

We test if CRT scores lead to less overpayment. While there seems to be a slight tendency, we cannot confirm significant results for either all participants (Columns 1-2), those with a good fit with Prospect Theory (Columns 3-4), or those who end up in the loss domain later in the game (Columns 5-6).

The third hypothesis checks whether participants with high CRT scores behave differently in the loss domain. Frederick (2005) finds that high CRT score participants are less likely to gamble in loss lotteries. Hence we expect to find that, in both planning stage and game, high CRT participants should gamble less after losing in previous rounds and being in the loss domain. Such participants are therefore less likely to gamble for resurrection, which would make it easier for them to stick to their plans, making commitment less valuable.

	Plan Investments				Game Investments		
OLS	Stage 2	Stage 3	Stage 4r	Stage 4p	Stage 2	Stage 3	Stage 4
CRT Score	0.0816	0.133**	0.0484	0.0485	0.128**	0.0648	0.0689
	(0.0614)	(0.0621)	(0.0826)	(0.0723)	(0.0584)	(0.0731)	(0.0837)
Constant	0.720***	0.565***	0.720***	0.654***	0.638***	0.708***	0.766***
	(0.132)	(0.133)	(0.176)	(0.154)	(0.124)	(0.155)	(0.178)
Observations	63	64	64	64	56	46	43
R^2	0.028	0.069	0.006	0.007	0.082	0.018	0.016

To test this hypothesis, we look at planning contingencies in which all previous rounds had been losses and include only participants that are strictly in the loss domain. One person did not invest anything in round one and was therefore not in the loss domain in stage two. For the game investments, we only look at those who are strictly in the loss domain. Participants who had won at least once ended up in the gain domain in our experiment due to their investment amount and our return on investment in the winning case, which explains why we get fewer observations with each round. If our high CRT participants are less likely to gamble in the loss domain, we would expect them to invest less than their low CRT counterparts.

We cannot confirm that high CRT scores lead to less risk seeking in the loss domain, if anything, we find the opposite.

B.4 Tables

Table A.1: Individual Prospect Theory parameter estimates, both weeks jointly with standard errors in (.) and p-values in [.]

	w^+	α	w^-	β	λ
1	0.00	9.18	0.08	3.41	$4.9E+06$
	(0.01)	(17.59)	(0.18)	(3.41)	$(1.2E+08)$
	[0.94]	[0.61]	[0.68]	[0.33]	[0.97]
2	0.53	0.68	0.21	2.47	1.38
	(0.21)	(0.46)	(0.29)	(2.42)	(0.90)
	[0.02]	[0.16]	[0.49]	[0.32]	[0.15]
3	0.30	1.55	0.26	1.66	1.92
	(0.09)	(0.44)	(0.09)	(0.47)	(0.57)
	[0.01]	[0.00]	[0.01]	[0.00]	[0.00]
4	0.24	1.97	0.21	2.21	0.78
	(0.15)	(0.93)	(0.14)	(1.05)	(0.32)
	[0.12]	[0.05]	[0.16]	[0.05]	[0.03]
5	0.52	0.95	0.42	1.18	0.77
	(0.13)	(0.40)	(0.14)	(0.50)	(0.20)
	[0.00]	[0.03]	[0.01]	[0.03]	[0.00]
6	0.35	1.86	0.16	2.13	0.66
	(0.09)	(0.49)	(0.07)	(0.56)	(0.15)
	[0.00]	[0.00]	[0.04]	[0.00]	[0.00]
7	0.77	0.74	0.50	1.44	0.91
	(0.08)	(0.29)	(0.12)	(0.57)	(0.21)
	[0.00]	[0.02]	[0.00]	[0.02]	[0.00]
8	0.50	1.00	0.50	1.00	1.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

♀	w^+	α	w^-	β	λ
9	0.44	1.02	0.24	1.86	3.22
	(0.07)	(0.23)	(0.08)	(0.46)	(0.96)
	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]
10	0.58	0.81	0.55	0.82	1.03
	(0.02)	(0.04)	(0.02)	(0.04)	(0.02)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
11	0.81	0.50	0.03	2.97	9.79
	(0.15)	(0.47)	(0.12)	(3.13)	(20.07)
	[0.00]	[0.30]	[0.77]	[0.36]	[0.63]
12	0.44	1.20	0.55	0.85	1.71
	(0.12)	(0.43)	(0.11)	(0.30)	(0.48)
	[0.00]	[0.01]	[0.00]	[0.01]	[0.00]
13	0.66	0.89	0.25	1.97	0.98
	(0.13)	(0.46)	(0.17)	(1.04)	(0.40)
	[0.00]	[0.08]	[0.16]	[0.08]	[0.03]
14	0.83	0.82	0.00	8.24	$1.5E+09$
	(0.15)	(0.86)	(0.00)	(45.60)	$(1.7E+11)$
	[0.00]	[0.35]	[0.99]	[0.86]	[0.99]
15	0.20	2.39	0.02	5.45	0.41
	(0.18)	(1.47)	(0.04)	(3.50)	(0.42)
	[0.28]	[0.12]	[0.70]	[0.14]	[0.34]
16	0.62	1.50	0.13	1.80	2.50
	(0.12)	(0.65)	(0.10)	(0.77)	(1.12)
	[0.00]	[0.04]	[0.24]	[0.03]	[0.04]
17	0.16	2.11	0.00	11.87	0.05
	(0.23)	(1.80)	(0.00)	(15.68)	(0.25)
	[0.48]	[0.26]	[0.93]	[0.46]	[0.84]

♀	w^+	α	w^-	β	λ
18	0.00	17.23	0.00	12.99	$1.2E+03$
	(0.00)	(98.17)	(0.00)	(74.00)	$(5.1E+04)$
	[0.99]	[0.86]	[0.99]	[0.86]	[0.98]
19	0.00	8.48	0.00	24.92	0.01
	(0.03)	(33.25)	(0.00)	(98.35)	(0.12)
	[0.97]	[0.80]	[0.99]	[0.80]	[0.96]
20	0.56	0.85	0.37	1.15	0.88
	(0.06)	(0.16)	(0.07)	(0.22)	(0.10)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
21	0.50	1.00	0.50	1.00	0.99
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
22	0.01	17.81	0.00	17.19	$3.0E+03$
	(1.67)	(743.33)	(0.00)	(717.38)	$(9.9E+05)$
	[1.00]	[0.98]	[1.00]	[0.98]	[1.00]
23	0.50	1.00	0.50	1.00	0.99
	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
24	0.55	1.19	0.38	1.31	1.05
	(0.11)	(0.44)	(0.12)	(0.48)	(0.22)
	[0.00]	[0.02]	[0.01]	[0.02]	[0.00]
25	0.62	1.50	0.01	3.59	11.29
	(0.20)	(1.13)	(0.04)	(2.73)	(20.63)
	[0.01]	[0.20]	[0.76]	[0.21]	[0.59]
26	0.21	1.47	0.10	3.40	3.93
	(0.11)	(0.55)	(0.11)	(1.72)	(2.87)
	[0.08]	[0.02]	[0.37]	[0.07]	[0.19]

♀	w^+	α	w^-	β	λ
27	0.01	6.01	0.02	5.41	0.29
	(0.07)	(8.26)	(0.09)	(7.44)	(0.57)
	[0.86]	[0.48]	[0.85]	[0.48]	[0.62]
28	0.52	0.95	0.18	2.65	0.44
	(0.08)	(0.24)	(0.08)	(0.74)	(0.17)
	[0.00]	[0.00]	[0.04]	[0.00]	[0.02]
29	0.43	1.04	0.37	1.45	0.71
	(0.10)	(0.31)	(0.10)	(0.44)	(0.16)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
30	0.44	0.96	0.51	0.97	0.85
	(0.07)	(0.19)	(0.06)	(0.19)	(0.09)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
31	0.37	1.87	0.30	1.36	3.30
	(0.16)	(0.87)	(0.15)	(0.63)	(2.09)
	[0.03]	[0.05]	[0.07]	[0.05]	[0.14]
32	0.36	1.74	0.32	2.26	2.07
	(0.09)	(0.49)	(0.10)	(0.65)	(0.66)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]
33	0.44	1.00	0.50	1.02	0.87
	(0.04)	(0.12)	(0.04)	(0.13)	(0.06)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
34	0.64	0.73	0.31	1.42	1.06
	(0.10)	(0.27)	(0.12)	(0.53)	(0.25)
	[0.00]	[0.02]	[0.02]	[0.02]	[0.00]
35	0.49	0.84	0.33	1.89	1.64
	(0.09)	(0.23)	(0.11)	(0.61)	(0.40)
	[0.00]	[0.00]	[0.01]	[0.01]	[0.00]

♀	w^+	α	w^-	β	λ
36	0.21	2.02	0.29	1.93	1.29
	(0.08)	(0.51)	(0.08)	(0.48)	(0.29)
	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]
37	0.43	1.20	0.49	1.04	1.22
	(0.08)	(0.27)	(0.07)	(0.24)	(0.17)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
38	0.38	1.25	0.45	1.25	1.10
	(0.07)	(0.25)	(0.07)	(0.25)	(0.15)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
39	0.14	1.56	0.34	1.85	0.79
	(0.06)	(0.40)	(0.09)	(0.49)	(0.19)
	[0.05]	[0.00]	[0.00]	[0.00]	[0.00]
40	0.17	3.27	0.01	8.20	$1.4E+03$
	(0.27)	(3.20)	(0.04)	(10.08)	$(1.1E+04)$
	[0.55]	[0.32]	[0.87]	[0.43]	[0.90]
41	0.60	1.24	0.05	1.23	11.46
	(0.06)	(0.26)	(0.03)	(0.26)	(6.07)
	[0.00]	[0.00]	[0.12]	[0.00]	[0.08]
42	0.13	2.88	0.03	4.57	1.08
	(0.08)	(1.01)	(0.03)	(1.63)	(0.41)
	[0.16]	[0.01]	[0.43]	[0.01]	[0.02]
43	0.85	1.05	0.19	1.38	2.07
	(0.08)	(0.51)	(0.14)	(0.66)	(0.79)
	[0.00]	[0.06]	[0.18]	[0.06]	[0.02]
44	0.01	6.54	0.02	5.72	1.01
	(0.12)	(15.97)	(0.20)	(13.97)	(1.41)
	[0.93]	[0.69]	[0.91]	[0.69]	[0.48]

♀	w^+	α	w^-	β	λ
45	0.71	0.47	0.34	0.90	1.97
	(0.10)	(0.19)	(0.13)	(0.35)	(0.55)
	[0.00]	[0.03]	[0.02]	[0.02]	[0.00]
46	0.40	1.09	0.47	1.51	0.91
	(0.06)	(0.20)	(0.06)	(0.29)	(0.12)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
47	0.02	7.44	0.01	6.83	2.13
	(0.45)	(38.75)	(0.27)	(35.57)	(8.60)
	[0.96]	[0.85]	[0.97]	[0.85]	[0.81]
48	0.08	4.80	0.00	9.32	4.86
	(0.32)	(8.11)	(0.01)	(15.83)	(14.15)
	[0.81]	[0.56]	[0.93]	[0.56]	[0.74]
49	0.72	0.88	0.05	2.33	12.59
	(0.21)	(0.82)	(0.13)	(2.24)	(27.50)
	[0.00]	[0.30]	[0.72]	[0.31]	[0.65]
50	0.46	0.86	0.52	0.93	1.43
	(0.08)	(0.22)	(0.08)	(0.24)	(0.25)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
51	0.32	2.68	0.00	37.38	$8.2E+08$
	(0.55)	(4.40)	(0.00)	(222.86)	$(9.2E+10)$
	[0.57]	[0.55]	[1.00]	[0.87]	[0.99]
52	0.03	3.98	0.04	5.93	0.61
	(0.09)	(3.42)	(0.11)	(5.21)	(0.59)
	[0.72]	[0.26]	[0.72]	[0.27]	[0.32]
53	0.36	1.68	0.20	2.17	1.56
	(0.11)	(0.55)	(0.10)	(0.72)	(0.48)
	[0.00]	[0.01]	[0.06]	[0.01]	[0.01]

♀	w^+	α	w^-	β	λ
54	0.46	1.21	0.46	1.19	1.04
	(0.12)	(0.42)	(0.12)	(0.41)	(0.21)
	[0.00]	[0.01]	[0.00]	[0.01]	[0.00]
55	0.40	2.51	0.03	2.17	15.25
	(0.18)	(1.34)	(0.06)	(1.16)	(22.30)
	[0.05]	[0.08]	[0.58]	[0.08]	[0.50]
56	0.40	1.55	0.24	1.90	5.66
	(0.09)	(0.42)	(0.08)	(0.51)	(2.79)
	[0.00]	[0.00]	[0.01]	[0.00]	[0.06]
57	0.37	1.68	0.15	1.42	1.62
	(0.10)	(0.51)	(0.08)	(0.43)	(0.42)
	[0.00]	[0.00]	[0.08]	[0.00]	[0.00]
58	0.30	1.60	0.36	1.57	0.88
	(0.07)	(0.34)	(0.07)	(0.34)	(0.14)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
59	0.44	1.06	0.47	1.07	0.94
	(0.02)	(0.05)	(0.02)	(0.05)	(0.02)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
60	0.77	0.97	0.23	1.18	5.11
	(0.07)	(0.36)	(0.11)	(0.40)	(2.87)
	[0.00]	[0.02]	[0.04]	[0.01]	[0.10]
61	0.30	1.54	0.25	2.21	2.03
	(0.12)	(0.55)	(0.12)	(0.83)	(0.84)
	[0.02]	[0.01]	[0.06]	[0.02]	[0.03]
62	0.34	2.52	0.44	2.47	4.64
	(0.22)	(1.66)	(0.22)	(1.64)	(5.28)
	[0.14]	[0.15]	[0.07]	[0.15]	[0.39]

	w^+	α	w^-	β	λ
63	0.02	6.46	0.02	5.27	59.61
	(0.10)	(8.20)	(0.10)	(6.68)	(307.96)
	[0.84]	[0.44]	[0.83]	[0.44]	[0.85]
64	0.45	1.53	0.18	2.14	2.88
	(0.12)	(0.55)	(0.10)	(0.78)	(1.34)
	[0.00]	[0.01]	[0.10]	[0.01]	[0.05]

Table A.2: Individual Prospect Theory parameter estimates, both weeks separately with standard errors in (.) and p-values in [.]

	w_1^+	α_1	w_1^-	β_1	λ_1	w_2^+	α_2	w_2^-	β_2	λ_2
1	0.00	24.00	0.31	2.40	$1.9E+11$	0.01	5.27	0.11	2.48	$1.1E+04$
	(0.00)	$(1.1E+03)$	(0.78)	(5.43)	$(1.9E+14)$	(0.06)	(7.69)	(0.18)	(1.99)	$(1.2E+05)$
	[1.00]	[0.98]	[0.70]	[0.67]	[1.00]	[0.88]	[0.51]	[0.54]	[0.24]	[0.92]
2	0.21	0.99	0.66	0.62	0.54	0.53	0.87	0.11	3.61	13.35
	(0.25)	(0.77)	(0.21)	(0.49)	(0.30)	(0.12)	(0.35)	(0.20)	(3.27)	(25.04)
	[0.43]	[0.23]	[0.01]	[0.23]	[0.10]	[0.00]	[0.03]	[0.60]	[0.30]	[0.61]
3	0.26	1.34	0.46	1.59	0.85	0.35	1.48	0.23	1.59	2.44
	(0.17)	(0.65)	(0.17)	(0.79)	(0.21)	(0.06)	(0.29)	(0.06)	(0.31)	(0.61)
	[0.14]	[0.07]	[0.03]	[0.07]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
4	0.35	1.12	0.24	2.43	0.34	0.24	2.21	0.16	2.47	0.86
	(0.36)	(1.13)	(0.35)	(2.55)	(0.44)	(0.17)	(1.19)	(0.14)	(1.33)	(0.46)
	[0.35]	[0.35]	[0.51]	[0.36]	[0.45]	[0.18]	[0.09]	[0.29]	[0.09]	[0.09]
5	0.57	0.82	0.43	1.23	0.58	0.49	1.05	0.45	1.06	1.07
	(0.41)	(1.05)	(0.46)	(1.58)	(0.49)	(0.16)	(0.53)	(0.16)	(0.53)	(0.35)
	[0.19]	[0.45]	[0.37]	[0.45]	[0.26]	[0.01]	[0.07]	[0.02]	[0.07]	[0.01]
6	0.71	0.77	0.40	1.07	0.84	0.30	1.97	0.15	2.23	0.59
	(0.11)	(0.36)	(0.16)	(0.49)	(0.14)	(0.07)	(0.44)	(0.06)	(0.50)	(0.14)
	[0.00]	[0.05]	[0.03]	[0.05]	[0.00]	[0.00]	[0.00]	[0.03]	[0.00]	[0.00]

♀	w_1^+	α_1	w_1^-	β_1	λ_1	w_2^+	α_2	w_2^-	β_2	λ_2
7	0.21	3.42	0.00	16.12	0.00	0.78	0.79	0.56	1.14	1.33
	(0.63)	(6.80)	(0.01)	(34.03)	(0.02)	(0.07)	(0.29)	(0.10)	(0.40)	(0.31)
	[0.74]	[0.63]	[0.95]	[0.65]	[0.95]	[0.00]	[0.02]	[0.00]	[0.02]	[0.00]
8	0.50	1.00	0.50	1.00	1.01	0.50	1.00	0.50	1.00	1.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
9	0.48	1.08	0.30	1.70	2.87	0.43	0.95	0.25	1.69	3.18
	(0.23)	(0.72)	(0.24)	(1.15)	(2.06)	(0.08)	(0.25)	(0.09)	(0.50)	(1.14)
	[0.06]	[0.16]	[0.24]	[0.17]	[0.19]	[0.00]	[0.00]	[0.02]	[0.01]	[0.02]
10	0.50	0.99	0.49	1.01	0.99	0.59	0.79	0.56	0.81	1.03
	(0.05)	(0.15)	(0.05)	(0.16)	(0.05)	(0.02)	(0.05)	(0.02)	(0.05)	(0.03)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
11	0.79	0.29	0.20	1.92	1.97	0.81	0.73	0.03	2.68	19.22
	(0.41)	(0.65)	(0.66)	(4.04)	(2.84)	(0.19)	(0.87)	(0.12)	(3.10)	(55.80)
	[0.08]	[0.66]	[0.76]	[0.64]	[0.50]	[0.00]	[0.42]	[0.80]	[0.41]	[0.74]
12	0.46	1.10	0.53	0.91	2.27	0.50	1.00	0.50	1.00	0.99
	(0.06)	(0.18)	(0.05)	(0.15)	(0.32)	(0.02)	(0.06)	(0.02)	(0.06)	(0.04)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
13	0.75	0.69	0.50	0.72	1.35	0.58	1.18	0.19	2.68	1.31
	(0.12)	(0.39)	(0.19)	(0.40)	(0.27)	(0.09)	(0.37)	(0.10)	(0.91)	(0.49)
	[0.00]	[0.11]	[0.02]	[0.10]	[0.00]	[0.00]	[0.01]	[0.08]	[0.01]	[0.02]
14	0.57	0.92	0.00	4.33	$1.0E+04$	0.86	1.38	0.00	2.35	$3.5E+03$
	(0.31)	(0.93)	(0.02)	(13.04)	$(2.8E+05)$	(0.15)	(1.81)	(0.03)	(3.25)	$(3.8E+04)$
	[0.10]	[0.34]	[0.96]	[0.75]	[0.97]	[0.00]	[0.46]	[0.90]	[0.49]	[0.93]
15	0.32	2.49	0.06	3.81	2.17	0.25	1.77	0.01	6.91	0.05
	(0.38)	(2.66)	(0.17)	(4.08)	(2.33)	(0.12)	(0.72)	(0.01)	(3.59)	(0.09)
	[0.41]	[0.37]	[0.74]	[0.37]	[0.37]	[0.07]	[0.03]	[0.71]	[0.08]	[0.63]

♀	w_1^+	α_1	w_1^-	β_1	λ_1	w_2^+	α_2	w_2^-	β_2	λ_2
16	0.60	1.03	0.36	1.52	0.65	0.64	1.64	0.09	1.71	5.85
	(0.13)	(0.45)	(0.16)	(0.66)	(0.17)	(0.06)	(0.38)	(0.05)	(0.38)	(2.33)
	[0.00]	[0.05]	[0.04]	[0.05]	[0.00]	[0.00]	[0.00]	[0.07]	[0.00]	[0.03]
17	0.55	0.79	0.30	2.91	0.39	0.14	2.18	0.00	42.09	0.00
	(0.48)	(1.20)	(0.63)	(5.18)	(0.80)	(0.21)	(1.88)	(0.00)	(169.16)	(0.00)
	[0.28]	[0.53]	[0.64]	[0.59]	[0.64]	[0.52]	[0.27]	[0.99]	[0.81]	[0.99]
18	0.00	6.74	0.00	12.22	$1.6E+03$	0.00	21.51	0.00	21.52	947.38
	(0.01)	(36.70)	(0.05)	(66.81)	$(6.4E+04)$	(0.00)	(131.15)	(0.00)	(131.24)	$(4.0E+04)$
	[0.98]	[0.86]	[0.98]	[0.86]	[0.98]	[0.99]	[0.87]	[0.99]	[0.87]	[0.98]
19	0.32	1.12	0.41	1.15	0.75	0.00	9.55	0.00	54.95	0.00
	(0.27)	(0.84)	(0.27)	(0.87)	(0.29)	(0.03)	(53.36)	(0.00)	(311.22)	(0.00)
	[0.26]	[0.21]	[0.16]	[0.22]	[0.03]	[0.98]	[0.86]	[1.00]	[0.86]	[0.99]
20	0.62	0.68	0.40	0.93	0.91	0.53	0.97	0.38	1.16	1.03
	(0.12)	(0.27)	(0.14)	(0.37)	(0.12)	(0.05)	(0.16)	(0.05)	(0.19)	(0.12)
	[0.00]	[0.03]	[0.02]	[0.03]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
21	0.50	1.00	0.50	1.00	0.99	0.50	1.00	0.50	1.00	0.99
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
22	0.96	8.35	0.00	7.51	914.18	0.03	9.70	0.00	9.69	17.84
	(0.91)	(52.28)	(0.14)	(46.93)	$(3.9E+04)$	(1.72)	(157.00)	(0.16)	(156.89)	(816.96)
	[0.31]	[0.88]	[0.98]	[0.88]	[0.98]	[0.99]	[0.95]	[0.99]	[0.95]	[0.98]
23	0.50	1.00	0.50	1.00	0.98	0.50	1.00	0.50	1.00	0.99
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
24	0.68	1.48	0.27	1.84	1.19	0.53	1.04	0.44	1.06	1.09
	(0.31)	(1.74)	(0.40)	(2.14)	(0.62)	(0.11)	(0.36)	(0.11)	(0.36)	(0.24)
	[0.05]	[0.42]	[0.52]	[0.41]	[0.08]	[0.00]	[0.02]	[0.00]	[0.02]	[0.00]

♀	w_1^+	α_1	w_1^-	β_1	λ_1	w_2^+	α_2	w_2^-	β_2	λ_2
25	0.85	0.53	0.32	0.80	2.79	0.40	3.08	0.00	24.73	29.95
	(0.17)	(0.62)	(0.38)	(0.86)	(3.02)	(0.74)	(6.74)	(0.00)	(62.92)	(279.50)
	[0.00]	[0.41]	[0.42]	[0.37]	[0.38]	[0.60]	[0.66]	[0.99]	[0.70]	[0.92]
26	0.45	1.19	0.35	1.92	2.71	0.22	1.19	0.09	3.45	3.24
	(0.24)	(0.84)	(0.26)	(1.41)	(2.03)	(0.09)	(0.36)	(0.10)	(1.69)	(2.07)
	[0.09]	[0.18]	[0.21]	[0.20]	[0.21]	[0.03]	[0.01]	[0.39]	[0.07]	[0.15]
27	0.56	1.16	0.36	1.72	0.47	0.00	12.00	0.00	10.42	0.09
	(0.24)	(0.86)	(0.26)	(1.27)	(0.31)	(0.00)	(43.12)	(0.01)	(37.44)	(0.79)
	[0.04]	[0.21]	[0.20]	[0.21]	[0.16]	[0.98]	[0.79]	[0.97]	[0.79]	[0.91]
28	0.53	0.98	0.39	1.65	0.65	0.54	0.89	0.09	3.64	0.23
	(0.18)	(0.55)	(0.20)	(0.94)	(0.23)	(0.08)	(0.23)	(0.07)	(1.30)	(0.18)
	[0.02]	[0.11]	[0.08]	[0.11]	[0.02]	[0.00]	[0.00]	[0.24]	[0.02]	[0.23]
29	0.39	1.07	0.50	1.16	0.60	0.42	1.09	0.36	1.37	0.97
	(0.25)	(0.76)	(0.24)	(0.82)	(0.26)	(0.09)	(0.31)	(0.10)	(0.39)	(0.23)
	[0.15]	[0.19]	[0.06]	[0.19]	[0.05]	[0.00]	[0.01]	[0.00]	[0.01]	[0.00]
30	0.35	0.76	0.58	0.76	0.60	0.44	1.14	0.47	1.13	0.97
	(0.07)	(0.15)	(0.06)	(0.15)	(0.07)	(0.03)	(0.10)	(0.03)	(0.10)	(0.06)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
31	0.66	0.48	0.46	0.84	1.36	0.35	2.40	0.18	2.05	3.19
	(0.16)	(0.27)	(0.20)	(0.47)	(0.29)	(0.12)	(0.84)	(0.10)	(0.71)	(1.55)
	[0.00]	[0.11]	[0.04]	[0.11]	[0.00]	[0.01]	[0.02]	[0.09]	[0.02]	[0.07]
32	0.48	1.33	0.36	2.44	2.25	0.39	1.51	0.30	2.31	1.27
	(0.18)	(0.72)	(0.21)	(1.40)	(1.14)	(0.07)	(0.33)	(0.08)	(0.54)	(0.32)
	[0.03]	[0.09]	[0.11]	[0.11]	[0.08]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
33	0.30	1.20	0.47	1.20	0.66	0.46	1.02	0.50	1.02	0.96
	(0.11)	(0.37)	(0.11)	(0.37)	(0.12)	(0.04)	(0.12)	(0.04)	(0.12)	(0.08)
	[0.02]	[0.01]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

	w_1^+	α_1	w_1^-	β_1	λ_1	w_2^+	α_2	w_2^-	β_2	λ_2
34	0.75	0.71	0.38	0.71	1.96	0.60	0.74	0.30	1.78	0.77
	(0.04)	(0.15)	(0.07)	(0.14)	(0.27)	(0.02)	(0.06)	(0.03)	(0.17)	(0.07)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
35	0.41	1.10	0.55	1.30	1.31	0.52	0.74	0.28	2.00	1.86
	(0.25)	(0.78)	(0.24)	(0.96)	(0.46)	(0.09)	(0.22)	(0.13)	(0.80)	(0.61)
	[0.13]	[0.19]	[0.04]	[0.21]	[0.02]	[0.00]	[0.01]	[0.05]	[0.03]	[0.01]
36	0.44	0.91	0.57	0.82	1.16	0.15	2.58	0.18	2.81	0.88
	(0.15)	(0.37)	(0.13)	(0.34)	(0.17)	(0.07)	(0.75)	(0.08)	(0.82)	(0.26)
	[0.01]	[0.04]	[0.00]	[0.04]	[0.00]	[0.07]	[0.01]	[0.05]	[0.01]	[0.01]
37	0.46	1.15	0.68	0.54	1.69	0.43	1.17	0.45	1.18	0.94
	(0.13)	(0.43)	(0.10)	(0.20)	(0.39)	(0.05)	(0.17)	(0.05)	(0.17)	(0.10)
	[0.01]	[0.02]	[0.00]	[0.02]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
38	0.30	1.11	0.56	1.02	0.78	0.40	1.34	0.39	1.42	1.15
	(0.12)	(0.38)	(0.11)	(0.35)	(0.12)	(0.05)	(0.20)	(0.05)	(0.21)	(0.14)
	[0.03]	[0.01]	[0.00]	[0.02]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
39	0.35	0.76	0.68	0.84	0.72	0.12	1.73	0.30	1.92	1.01
	(0.20)	(0.44)	(0.16)	(0.51)	(0.18)	(0.06)	(0.49)	(0.09)	(0.56)	(0.33)
	[0.12]	[0.11]	[0.00]	[0.13]	[0.00]	[0.10]	[0.01]	[0.01]	[0.01]	[0.01]
40	0.00	13.57	0.00	19.77	$1.2E+04$	0.31	2.02	0.02	5.37	850.43
	(0.13)	(417.94)	(0.21)	(608.66)	$(3.3E+06)$	(0.13)	(0.85)	(0.06)	(4.21)	$(3.5E+03)$
	[1.00]	[0.97]	[1.00]	[0.97]	[1.00]	[0.04]	[0.04]	[0.74]	[0.23]	[0.81]
41	0.62	1.22	0.12	1.19	5.21	0.62	1.11	0.04	1.11	14.27
	(0.13)	(0.55)	(0.11)	(0.54)	(3.92)	(0.06)	(0.24)	(0.03)	(0.25)	(8.85)
	[0.00]	[0.05]	[0.31]	[0.05]	[0.21]	[0.00]	[0.00]	[0.18]	[0.00]	[0.14]
42	0.44	1.11	0.30	1.47	1.10	0.05	4.23	0.00	7.09	0.96
	(0.18)	(0.56)	(0.18)	(0.74)	(0.25)	(0.10)	(2.91)	(0.01)	(4.93)	(0.76)
	[0.03]	[0.07]	[0.12]	[0.07]	[0.00]	[0.61]	[0.18]	[0.80]	[0.18]	[0.23]

♀	w_1^+	α_1	w_1^-	β_1	λ_1	w_2^+	α_2	w_2^-	β_2	λ_2
43	0.84	0.96	0.32	0.84	2.31	0.84	1.21	0.17	1.56	2.35
	(0.19)	(1.15)	(0.41)	(0.99)	(2.28)	(0.10)	(0.70)	(0.15)	(0.87)	(1.26)
	[0.00]	[0.42]	[0.45]	[0.41]	[0.33]	[0.00]	[0.11]	[0.28]	[0.10]	[0.09]
44	0.50	0.79	0.29	2.51	0.28	0.00	17.17	0.00	15.48	0.63
	(0.34)	(0.81)	(0.39)	(2.79)	(0.44)	(0.01)	$(1.0E+03)$	(0.01)	(910.79)	(17.82)
	[0.17]	[0.35]	[0.47]	[0.39]	[0.53]	[1.00]	[0.99]	[1.00]	[0.99]	[0.97]
45	0.66	0.50	0.25	2.05	2.09	0.75	0.42	0.32	0.77	2.04
	(0.28)	(0.53)	(0.40)	(2.42)	(1.87)	(0.08)	(0.15)	(0.11)	(0.26)	(0.51)
	[0.04]	[0.37]	[0.54]	[0.42]	[0.29]	[0.00]	[0.02]	[0.01]	[0.01]	[0.00]
46	0.12	2.74	0.29	2.55	1.37	0.43	0.94	0.48	1.42	0.85
	(0.16)	(1.72)	(0.22)	(1.62)	(0.64)	(0.06)	(0.17)	(0.06)	(0.28)	(0.14)
	[0.46]	[0.14]	[0.22]	[0.15]	[0.06]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
47	0.35	1.37	0.28	2.82	0.36	0.01	10.01	0.00	11.30	0.17
	(0.54)	(2.09)	(0.56)	(4.49)	(0.70)	(0.95)	(201.22)	(0.05)	(227.27)	(6.25)
	[0.53]	[0.53]	[0.63]	[0.54]	[0.61]	[0.99]	[0.96]	[1.00]	[0.96]	[0.98]
48	0.13	4.09	0.00	10.15	0.20	0.19	2.89	0.05	3.66	10.11
	(0.52)	(8.41)	(0.01)	(21.15)	(0.78)	(0.15)	(1.52)	(0.07)	(1.92)	(13.33)
	[0.81]	[0.64]	[0.95]	[0.64]	[0.80]	[0.23]	[0.09]	[0.51]	[0.09]	[0.47]
49	0.44	0.69	0.05	2.14	10.64	0.71	1.83	0.00	4.47	80.25
	(0.52)	(1.03)	(0.29)	(4.26)	(52.30)	(0.35)	(2.91)	(0.04)	(6.81)	(520.53)
	[0.42]	[0.52]	[0.87]	[0.63]	[0.84]	[0.07]	[0.54]	[0.90]	[0.53]	[0.88]
50	0.45	1.13	0.55	0.83	2.55	0.49	0.71	0.49	1.06	0.95
	(0.19)	(0.60)	(0.17)	(0.44)	(1.32)	(0.06)	(0.14)	(0.07)	(0.22)	(0.13)
	[0.04]	[0.09]	[0.01]	[0.09]	[0.08]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
51	0.40	1.20	0.15	2.85	3.13	0.53	1.67	0.00	6.94	229.53
	(0.67)	(2.29)	(0.58)	(6.05)	(7.71)	(0.43)	(2.47)	(0.07)	(18.79)	$(2.6E+03)$
	[0.57]	[0.61]	[0.81]	[0.65]	[0.69]	[0.25]	[0.51]	[0.94]	[0.72]	[0.93]

	w_1^+	α_1	w_1^-	β_1	λ_1	w_2^+	α_2	w_2^-	β_2	λ_2
52	0.46	0.80	0.53	0.89	0.94	0.00	8.81	0.00	11.36	3.19
	(0.26)	(0.59)	(0.25)	(0.66)	(0.23)	(0.02)	(28.82)	(0.05)	(37.25)	(15.71)
	[0.10]	[0.20]	[0.06]	[0.21]	[0.00]	[0.97]	[0.77]	[0.96]	[0.77]	[0.84]
53	0.51	0.78	0.29	1.53	0.94	0.29	2.40	0.15	2.70	2.82
	(0.19)	(0.45)	(0.21)	(0.90)	(0.25)	(0.13)	(0.96)	(0.10)	(1.08)	(1.61)
	[0.03]	[0.11]	[0.19]	[0.12]	[0.00]	[0.05]	[0.03]	[0.18]	[0.03]	[0.11]
54	0.43	2.51	0.22	3.07	1.29	0.48	0.90	0.50	0.93	0.87
	(0.43)	(3.09)	(0.39)	(3.77)	(0.93)	(0.08)	(0.22)	(0.08)	(0.23)	(0.13)
	[0.35]	[0.44]	[0.59]	[0.43]	[0.20]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
55	0.12	3.56	0.01	2.91	17.44	0.45	2.64	0.02	2.49	19.29
	(0.31)	(4.47)	(0.08)	(3.66)	(65.23)	(0.19)	(1.52)	(0.04)	(1.43)	(32.93)
	[0.70]	[0.44]	[0.86]	[0.45]	[0.79]	[0.04]	[0.11]	[0.67]	[0.11]	[0.57]
56	0.50	1.29	0.42	1.44	3.34	0.41	1.45	0.23	1.79	5.51
	(0.24)	(0.92)	(0.25)	(1.02)	(2.90)	(0.10)	(0.43)	(0.09)	(0.53)	(3.06)
	[0.06]	[0.19]	[0.12]	[0.19]	[0.28]	[0.00]	[0.01]	[0.03]	[0.01]	[0.10]
57	0.58	0.88	0.20	0.99	1.54	0.33	1.94	0.13	1.64	1.49
	(0.20)	(0.58)	(0.20)	(0.65)	(0.62)	(0.10)	(0.61)	(0.08)	(0.51)	(0.42)
	[0.02]	[0.16]	[0.36]	[0.16]	[0.03]	[0.01]	[0.01]	[0.11]	[0.01]	[0.01]
58	0.69	0.56	0.67	0.57	1.02	0.23	1.90	0.31	1.84	0.80
	(0.13)	(0.28)	(0.13)	(0.29)	(0.09)	(0.07)	(0.45)	(0.08)	(0.44)	(0.18)
	[0.00]	[0.08]	[0.00]	[0.08]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]
59	0.50	1.00	0.50	1.00	1.01	0.44	1.04	0.47	1.05	0.91
	(0.03)	(0.08)	(0.03)	(0.08)	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.02)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
60	0.73	1.19	0.36	1.06	5.46	0.82	0.71	0.21	1.15	3.63
	(0.23)	(1.14)	(0.31)	(0.94)	(8.45)	(0.07)	(0.28)	(0.10)	(0.41)	(1.70)
	[0.01]	[0.32]	[0.28]	[0.29]	[0.53]	[0.00]	[0.03]	[0.07]	[0.02]	[0.06]

	w_1^+	α_1	w_1^-	β_1	λ_1	w_2^+	α_2	w_2^-	β_2	λ_2
61	0.51	1.65	0.20	3.51	1.81	0.29	1.25	0.33	1.52	1.87
	(0.10)	(0.49)	(0.10)	(1.08)	(0.45)	(0.02)	(0.09)	(0.03)	(0.12)	(0.16)
	[0.00]	[0.01]	[0.07]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
62	0.00	18.55	0.02	18.55	$3.5E+04$	0.46	1.58	0.55	1.47	2.88
	(113.42)	$(1.3E+05)$	(599.90)	$(1.3E+05)$	$(2.6E+09)$	(0.15)	(0.72)	(0.14)	(0.68)	(1.87)
	[1.00]	[1.00]	[1.00]	[1.00]	[1.00]	[0.01]	[0.05]	[0.00]	[0.06]	[0.15]
63	0.00	11.45	0.00	15.68	210.27	0.11	3.47	0.07	3.09	8.40
	(0.36)	(242.76)	(0.15)	(332.59)	$(2.4E+04)$	(0.09)	(1.41)	(0.07)	(1.24)	(8.06)
	[0.99]	[0.96]	[0.99]	[0.96]	[0.99]	[0.26]	[0.03]	[0.34]	[0.03]	[0.32]
64	0.74	0.83	0.32	1.19	2.40	0.39	1.62	0.19	2.21	2.70
	(0.20)	(0.74)	(0.30)	(1.01)	(1.85)	(0.13)	(0.66)	(0.12)	(0.91)	(1.56)
	[0.00]	[0.29]	[0.32]	[0.27]	[0.22]	[0.01]	[0.03]	[0.13]	[0.03]	[0.11]

Table A.3: Individual Prospect Theory parameter estimates for complexity reduction 1 and complexity reduction 2, both weeks jointly with standard errors in (.) and p-values in [.]

	Complexity Reduction 1				Complexity Reduction 2		
	w^+	α	β	λ	α	β	λ
1	0.00	15.94	0.88	$1.6E+09$	0.83	0.87	10.43
	(0.00)	(201.45)	(0.15)	$(4.1E+11)$	(0.18)	(0.19)	(11.48)
	[1.00]	[0.94]	[0.00]	[1.00]	[0.00]	[0.00]	[0.38]
2	0.63	0.47	1.09	1.21	0.67	1.16	1.24
	(0.15)	(0.26)	(0.28)	(0.38)	(0.15)	(0.29)	(0.45)
	[0.00]	[0.09]	[0.00]	[0.01]	[0.00]	[0.00]	[0.01]
3	0.48	0.89	0.88	1.39	0.84	0.87	1.39
	(0.06)	(0.15)	(0.11)	(0.22)	(0.08)	(0.09)	(0.21)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

	Complexity Reduction 1				Complexity Reduction 2		
	w^+	α	β	λ	α	β	λ
4	0.47	0.94	1.03	0.82	0.89	0.99	0.85
	(0.08)	(0.19)	(0.17)	(0.18)	(0.11)	(0.13)	(0.16)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
5	0.58	0.78	0.95	0.80	0.90	1.05	0.71
	(0.07)	(0.16)	(0.16)	(0.16)	(0.12)	(0.14)	(0.14)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
6	0.62	0.74	0.83	0.81	0.92	0.98	0.65
	(0.05)	(0.10)	(0.10)	(0.11)	(0.10)	(0.11)	(0.09)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
7	0.77	0.73	1.43	0.91	1.56	2.02	1.06
	(0.05)	(0.16)	(0.18)	(0.19)	(0.25)	(0.35)	(0.48)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.04]
8	0.51	0.99	0.99	1.01	1.00	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
9	0.57	0.66	0.90	1.93	0.78	0.93	2.06
	(0.07)	(0.14)	(0.09)	(0.31)	(0.08)	(0.09)	(0.34)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
10	0.54	0.94	0.96	1.04	1.01	1.01	1.01
	(0.01)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
11	0.94	0.14	0.58	1.68	1.27	0.74	6.95
	(0.07)	(0.18)	(0.14)	(0.35)	(0.42)	(0.22)	(5.97)
	[0.00]	[0.45]	[0.00]	[0.00]	[0.01]	[0.00]	[0.26]
12	0.40	1.38	0.99	1.88	1.15	0.88	1.83
	(0.07)	(0.24)	(0.14)	(0.43)	(0.14)	(0.10)	(0.37)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

	Complexity Reduction 1				Complexity Reduction 2		
	w^+	α	β	λ	α	β	λ
13	0.80	0.47	0.96	1.04	1.05	1.39	0.96
	(0.06)	(0.15)	(0.17)	(0.21)	(0.22)	(0.30)	(0.40)
	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.03]
14	0.96	0.17	0.31	2.73	3.66	0.30	$1.8E+03$
	(0.06)	(0.24)	(0.10)	(0.91)	(1.55)	(0.11)	$(5.8E+03)$
	[0.00]	[0.47]	[0.01]	[0.01]	[0.03]	[0.01]	[0.76]
15	0.64	0.55	0.95	0.86	0.77	1.10	0.77
	(0.09)	(0.17)	(0.19)	(0.20)	(0.13)	(0.20)	(0.21)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
16	0.83	0.52	0.61	1.35	1.07	0.99	1.06
	(0.05)	(0.11)	(0.10)	(0.16)	(0.23)	(0.21)	(0.32)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
17	0.62	0.46	1.01	0.80	0.61	1.11	0.73
	(0.14)	(0.21)	(0.26)	(0.25)	(0.14)	(0.27)	(0.25)
	[0.00]	[0.05]	[0.00]	[0.01]	[0.00]	[0.00]	[0.01]
18	0.12	1.59	1.00	1.61	0.62	0.83	1.44
	(0.08)	(0.47)	(0.18)	(0.77)	(0.14)	(0.18)	(0.41)
	[0.14]	[0.00]	[0.00]	[0.05]	[0.00]	[0.00]	[0.00]
19	0.54	0.62	1.04	0.84	0.67	1.08	0.81
	(0.13)	(0.24)	(0.25)	(0.26)	(0.14)	(0.23)	(0.25)
	[0.00]	[0.02]	[0.00]	[0.01]	[0.00]	[0.00]	[0.01]
20	0.65	0.61	0.81	0.90	0.82	0.98	0.74
	(0.04)	(0.07)	(0.07)	(0.08)	(0.08)	(0.09)	(0.10)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
21	0.49	1.01	1.01	0.99	1.00	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

	Complexity Reduction 1				Complexity Reduction 2		
	w^+	α	β	λ	α	β	λ
22	0.74	1.14	1.04	1.78	1.74	1.41	1.81
	(0.10)	(0.34)	(0.25)	(0.58)	(0.41)	(0.33)	(0.90)
	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.06]
23	0.50	1.00	1.00	0.99	0.99	0.99	0.99
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
24	0.64	0.86	0.94	1.03	1.11	1.12	0.89
	(0.06)	(0.14)	(0.13)	(0.16)	(0.14)	(0.14)	(0.17)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
25	0.91	0.27	0.55	1.54	1.08	0.93	2.20
	(0.05)	(0.13)	(0.12)	(0.25)	(0.31)	(0.26)	(1.20)
	[0.00]	[0.05]	[0.00]	[0.00]	[0.00]	[0.00]	[0.08]
26	0.39	0.81	1.07	1.64	0.62	1.03	1.57
	(0.11)	(0.25)	(0.17)	(0.43)	(0.09)	(0.16)	(0.34)
	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
27	0.39	1.11	0.97	0.69	0.93	0.85	0.84
	(0.10)	(0.24)	(0.20)	(0.20)	(0.15)	(0.13)	(0.14)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
28	0.70	0.48	1.08	0.73	0.80	1.34	0.62
	(0.05)	(0.10)	(0.13)	(0.12)	(0.11)	(0.19)	(0.16)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
29	0.52	0.75	1.01	0.76	0.79	1.04	0.74
	(0.06)	(0.12)	(0.12)	(0.12)	(0.08)	(0.10)	(0.11)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
30	0.43	0.99	1.00	0.85	0.87	0.91	0.92
	(0.04)	(0.10)	(0.08)	(0.09)	(0.06)	(0.06)	(0.09)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

	Complexity Reduction 1				Complexity Reduction 2		
	w^+	α	β	λ	α	β	λ
31	0.54	1.09	0.78	1.92	1.16	0.81	1.93
	(0.08)	(0.21)	(0.13)	(0.39)	(0.15)	(0.10)	(0.41)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
32	0.48	1.16	1.41	1.61	1.11	1.39	1.57
	(0.05)	(0.18)	(0.14)	(0.31)	(0.09)	(0.12)	(0.27)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
33	0.43	1.01	1.03	0.87	0.90	0.95	0.94
	(0.02)	(0.06)	(0.05)	(0.06)	(0.04)	(0.04)	(0.06)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
34	0.74	0.47	0.84	1.05	0.85	1.11	0.93
	(0.06)	(0.11)	(0.12)	(0.16)	(0.14)	(0.19)	(0.25)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
35	0.55	0.68	1.20	1.44	0.78	1.22	1.50
	(0.07)	(0.15)	(0.13)	(0.24)	(0.08)	(0.13)	(0.26)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
36	0.37	1.19	1.09	1.12	0.93	0.95	1.20
	(0.05)	(0.15)	(0.11)	(0.17)	(0.09)	(0.09)	(0.17)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
37	0.44	1.16	1.01	1.21	1.05	0.94	1.26
	(0.04)	(0.12)	(0.09)	(0.14)	(0.08)	(0.07)	(0.14)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
38	0.42	1.09	1.08	1.08	0.94	0.99	1.12
	(0.04)	(0.11)	(0.08)	(0.12)	(0.06)	(0.07)	(0.12)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
39	0.23	1.09	1.21	0.81	0.57	1.06	0.92
	(0.05)	(0.16)	(0.12)	(0.15)	(0.08)	(0.15)	(0.17)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

	Complexity Reduction 1				Complexity Reduction 2		
	w^+	α	β	λ	α	β	λ
40	0.52	1.03	1.16	4.53	1.10	1.17	4.89
	(0.14)	(0.46)	(0.22)	(2.73)	(0.19)	(0.21)	(2.17)
	[0.00]	[0.04]	[0.00]	[0.12]	[0.00]	[0.00]	[0.04]
41	0.86	0.32	0.31	1.76	0.82	0.60	1.50
	(0.04)	(0.08)	(0.07)	(0.12)	(0.18)	(0.13)	(0.37)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
42	0.55	0.69	0.92	0.98	0.77	0.97	0.94
	(0.08)	(0.16)	(0.15)	(0.19)	(0.11)	(0.14)	(0.19)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
43	0.93	0.43	0.57	1.37	1.29	1.25	0.92
	(0.03)	(0.09)	(0.10)	(0.15)	(0.38)	(0.36)	(0.44)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.05]
44	0.36	1.31	1.09	0.92	1.03	0.93	1.08
	(0.11)	(0.35)	(0.26)	(0.32)	(0.19)	(0.17)	(0.27)
	[0.01]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]
45	0.76	0.36	0.59	1.60	0.80	0.71	1.94
	(0.07)	(0.12)	(0.09)	(0.21)	(0.14)	(0.12)	(0.51)
	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
46	0.42	1.01	1.38	0.92	0.84	1.29	0.93
	(0.04)	(0.11)	(0.10)	(0.11)	(0.05)	(0.09)	(0.11)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
47	0.49	1.26	1.11	1.11	1.25	1.10	1.11
	(0.13)	(0.39)	(0.30)	(0.40)	(0.27)	(0.23)	(0.36)
	[0.00]	[0.01]	[0.00]	[0.01]	[0.00]	[0.00]	[0.01]
48	0.66	0.65	0.93	1.25	0.93	1.08	1.28
	(0.10)	(0.21)	(0.19)	(0.30)	(0.17)	(0.20)	(0.40)
	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]

	Complexity Reduction 1				Complexity Reduction 2		
	w^+	α	β	λ	α	β	λ
49	0.88	0.29	0.53	1.95	1.31	0.66	6.92
	(0.09)	(0.22)	(0.15)	(0.51)	(0.44)	(0.20)	(6.11)
	[0.00]	[0.20]	[0.00]	[0.00]	[0.01]	[0.00]	[0.27]
50	0.44	0.91	0.99	1.46	0.80	0.95	1.42
	(0.06)	(0.15)	(0.10)	(0.23)	(0.07)	(0.09)	(0.20)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
51	0.76	0.53	0.96	2.52	1.21	1.08	5.75
	(0.15)	(0.41)	(0.26)	(1.31)	(0.35)	(0.31)	(4.34)
	[0.00]	[0.22]	[0.00]	[0.07]	[0.00]	[0.00]	[0.20]
52	0.33	1.12	1.39	0.82	0.77	1.22	0.88
	(0.10)	(0.30)	(0.26)	(0.27)	(0.12)	(0.21)	(0.25)
	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]
53	0.59	0.79	0.94	1.22	0.96	1.04	1.21
	(0.06)	(0.14)	(0.12)	(0.20)	(0.11)	(0.12)	(0.23)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
54	0.49	1.08	1.06	1.03	1.06	1.05	1.03
	(0.06)	(0.17)	(0.14)	(0.18)	(0.11)	(0.11)	(0.16)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
55	0.79	0.53	0.44	1.68	0.96	0.70	1.40
	(0.06)	(0.12)	(0.09)	(0.17)	(0.19)	(0.14)	(0.33)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
56	0.57	0.88	0.92	2.51	1.05	0.96	2.87
	(0.07)	(0.18)	(0.10)	(0.55)	(0.11)	(0.10)	(0.61)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
57	0.65	0.65	0.54	1.13	0.84	0.68	0.87
	(0.06)	(0.11)	(0.08)	(0.13)	(0.11)	(0.09)	(0.09)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

	Complexity Reduction 1				Complexity Reduction 2		
♀♂	w^+	α	β	λ	α	β	λ
58	0.42	1.11	1.07	0.90	0.96	0.97	0.98
	(0.04)	(0.11)	(0.09)	(0.11)	(0.07)	(0.07)	(0.10)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
59	0.46	0.99	0.98	0.94	0.92	0.94	0.97
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
60	0.87	0.47	0.55	2.21	1.50	0.77	6.96
	(0.04)	(0.12)	(0.08)	(0.33)	(0.36)	(0.16)	(4.73)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.16]
61	0.46	0.91	1.10	1.50	0.83	1.08	1.46
	(0.08)	(0.21)	(0.15)	(0.33)	(0.10)	(0.13)	(0.29)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
62	0.40	2.12	2.06	3.64	1.70	1.87	2.71
	(0.08)	(0.46)	(0.32)	(1.82)	(0.21)	(0.24)	(0.98)
	[0.00]	[0.00]	[0.00]	[0.06]	[0.00]	[0.00]	[0.01]
63	0.42	1.27	0.95	2.12	1.09	0.89	2.01
	(0.09)	(0.29)	(0.16)	(0.64)	(0.16)	(0.13)	(0.52)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
64	0.66	0.71	0.89	1.60	1.05	1.03	1.81
	(0.07)	(0.16)	(0.12)	(0.29)	(0.15)	(0.14)	(0.47)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

Table A.4: Individual Prospect Theory parameter estimates for complexity reduction 1, both weeks separately with standard errors in (.) and p-values in [.]

♀♂	w_1^+	α_1	β_1	λ_1	w_2^+	α_2	β_2	λ_2
1	0.00	25.71	1.39	$1.2E+11$	0.01	4.75	0.74	654.64
	(0.00)	$(2.2E+04)$	(0.53)	$(2.4E+15)$	(0.09)	(7.88)	(0.15)	$(6.3E+03)$
	[1.00]	[1.00]	[0.02]	[1.00]	[0.88]	[0.56]	[0.00]	[0.92]

♀	w_1^+	α_1	β_1	λ_1	w_2^+	α_2	β_2	λ_2
2	0.07	1.65	1.04	0.37	0.60	0.67	1.06	3.21
	(0.09)	(0.61)	(0.27)	(0.30)	(0.11)	(0.27)	(0.18)	(1.32)
	[0.41]	[0.02]	[0.00]	[0.25]	[0.00]	[0.03]	[0.00]	[0.03]
3	0.30	1.20	1.41	0.86	0.53	0.79	0.76	1.56
	(0.15)	(0.49)	(0.33)	(0.31)	(0.06)	(0.14)	(0.09)	(0.27)
	[0.07]	[0.03]	[0.00]	[0.02]	[0.00]	[0.00]	[0.00]	[0.00]
4	0.55	0.62	1.23	0.56	0.50	0.91	0.98	0.86
	(0.20)	(0.35)	(0.40)	(0.26)	(0.09)	(0.21)	(0.19)	(0.23)
	[0.02]	[0.10]	[0.01]	[0.05]	[0.00]	[0.00]	[0.00]	[0.00]
5	0.62	0.67	1.00	0.64	0.53	0.91	0.92	1.05
	(0.16)	(0.30)	(0.32)	(0.27)	(0.09)	(0.22)	(0.18)	(0.28)
	[0.00]	[0.05]	[0.01]	[0.03]	[0.00]	[0.00]	[0.00]	[0.00]
6	0.77	0.58	0.80	0.88	0.58	0.75	0.83	0.77
	(0.08)	(0.18)	(0.19)	(0.20)	(0.06)	(0.13)	(0.12)	(0.14)
	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
7	0.79	0.49	1.61	0.56	0.75	0.94	1.37	1.38
	(0.11)	(0.27)	(0.38)	(0.21)	(0.06)	(0.21)	(0.19)	(0.40)
	[0.00]	[0.10]	[0.00]	[0.02]	[0.00]	[0.00]	[0.00]	[0.00]
8	0.51	0.99	0.99	1.01	0.51	0.99	0.99	1.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
9	0.61	0.70	0.98	1.89	0.53	0.68	0.85	2.10
	(0.17)	(0.38)	(0.21)	(0.53)	(0.08)	(0.18)	(0.11)	(0.49)
	[0.00]	[0.09]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
10	0.51	0.97	0.99	0.99	0.55	0.93	0.96	1.05
	(0.03)	(0.08)	(0.05)	(0.07)	(0.02)	(0.04)	(0.03)	(0.05)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

♀	w_1^+	α_1	β_1	λ_1	w_2^+	α_2	β_2	λ_2
11	0.92	0.11	0.82	1.35	0.94	0.21	0.51	1.98
	(0.28)	(0.38)	(0.38)	(0.44)	(0.08)	(0.26)	(0.16)	(0.72)
	[0.01]	[0.78]	[0.05]	[0.01]	[0.00]	[0.44]	[0.01]	[0.02]
12	0.44	1.19	1.00	2.45	0.49	1.01	1.01	0.99
	(0.03)	(0.11)	(0.04)	(0.20)	(0.01)	(0.03)	(0.03)	(0.04)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
13	0.75	0.69	0.72	1.35	0.74	0.60	1.06	1.31
	(0.07)	(0.18)	(0.13)	(0.22)	(0.06)	(0.15)	(0.13)	(0.27)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
14	0.91	0.16	0.43	2.65	0.98	0.20	0.26	2.85
	(0.26)	(0.47)	(0.18)	(1.04)	(0.04)	(0.30)	(0.13)	(1.46)
	[0.00]	[0.74]	[0.04]	[0.03]	[0.00]	[0.52]	[0.06]	[0.08]
15	0.74	0.65	0.92	1.26	0.64	0.46	0.96	0.68
	(0.17)	(0.44)	(0.34)	(0.49)	(0.11)	(0.18)	(0.23)	(0.22)
	[0.00]	[0.16]	[0.02]	[0.03]	[0.00]	[0.02]	[0.00]	[0.01]
16	0.70	0.71	1.03	0.75	0.86	0.49	0.49	1.67
	(0.12)	(0.28)	(0.29)	(0.25)	(0.04)	(0.11)	(0.09)	(0.20)
	[0.00]	[0.03]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]
17	0.67	0.53	1.70	0.58	0.33	0.00	0.67	0.30
	(0.47)	(0.92)	(1.29)	(0.67)	(194.99)	(0.24)	(0.25)	(176.86)
	[0.18]	[0.58]	[0.21]	[0.40]	[1.00]	[1.00]	[0.02]	[1.00]
18	0.15	1.42	1.32	2.03	0.17	1.26	0.93	1.25
	(0.35)	(1.72)	(0.53)	(1.89)	(0.12)	(0.48)	(0.21)	(0.67)
	[0.67]	[0.43]	[0.03]	[0.31]	[0.16]	[0.02]	[0.00]	[0.09]
19	0.40	0.89	0.90	0.79	0.48	0.77	1.06	1.17
	(0.26)	(0.55)	(0.39)	(0.45)	(0.16)	(0.36)	(0.30)	(0.54)
	[0.15]	[0.13]	[0.04]	[0.11]	[0.01]	[0.06]	[0.00]	[0.05]

	w_1^+	α_1	β_1	λ_1	w_2^+	α_2	β_2	λ_2
20	0.68	0.53	0.71	0.92	0.61	0.72	0.84	1.01
	(0.06)	(0.09)	(0.09)	(0.11)	(0.04)	(0.07)	(0.07)	(0.10)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
21	0.49	1.01	1.01	0.99	0.49	1.01	1.01	0.99
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
22	1.00	1.07	0.95	2.41	0.64	1.24	1.10	1.63
	(0.16)	(0.72)	(0.43)	(1.78)	(0.13)	(0.46)	(0.33)	(0.80)
	[0.00]	[0.16]	[0.05]	[0.20]	[0.00]	[0.02]	[0.01]	[0.07]
23	0.49	1.01	1.01	0.98	0.50	0.99	0.99	0.99
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
24	0.82	0.77	0.96	1.10	0.57	0.89	0.90	1.06
	(0.08)	(0.24)	(0.21)	(0.26)	(0.06)	(0.15)	(0.12)	(0.19)
	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
25	0.90	0.33	0.48	1.86	0.94	0.17	0.57	1.26
	(0.11)	(0.33)	(0.22)	(0.56)	(0.05)	(0.15)	(0.16)	(0.30)
	[0.00]	[0.34]	[0.05]	[0.01]	[0.00]	[0.27]	[0.00]	[0.00]
26	0.55	0.88	1.27	2.00	0.34	0.76	0.97	1.51
	(0.24)	(0.63)	(0.36)	(0.93)	(0.11)	(0.26)	(0.16)	(0.46)
	[0.04]	[0.19]	[0.00]	[0.05]	[0.01]	[0.01]	[0.00]	[0.01]
27	0.66	0.81	1.18	0.59	0.34	1.07	0.90	0.66
	(0.17)	(0.40)	(0.44)	(0.32)	(0.10)	(0.26)	(0.19)	(0.21)
	[0.00]	[0.07]	[0.02]	[0.09]	[0.01]	[0.00]	[0.00]	[0.01]
28	0.62	0.74	1.22	0.73	0.72	0.41	1.04	0.73
	(0.14)	(0.31)	(0.32)	(0.25)	(0.07)	(0.12)	(0.16)	(0.16)
	[0.00]	[0.04]	[0.00]	[0.01]	[0.00]	[0.01]	[0.00]	[0.00]

♀	w_1^+	α_1	β_1	λ_1	w_2^+	α_2	β_2	λ_2
29	0.39	1.08	1.17	0.60	0.51	0.79	0.95	0.97
	(0.12)	(0.30)	(0.24)	(0.19)	(0.06)	(0.13)	(0.12)	(0.16)
	[0.01]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]
30	0.27	0.96	0.97	0.53	0.47	1.05	1.03	0.97
	(0.04)	(0.08)	(0.06)	(0.06)	(0.02)	(0.05)	(0.04)	(0.06)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
31	0.68	0.43	0.74	1.31	0.61	0.99	0.83	1.55
	(0.14)	(0.22)	(0.16)	(0.22)	(0.06)	(0.17)	(0.11)	(0.28)
	[0.00]	[0.07]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
32	0.57	0.99	1.65	1.80	0.51	0.99	1.35	1.21
	(0.13)	(0.40)	(0.29)	(0.58)	(0.05)	(0.16)	(0.13)	(0.24)
	[0.00]	[0.03]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]
33	0.33	1.10	1.10	0.68	0.46	1.02	1.01	0.96
	(0.05)	(0.13)	(0.09)	(0.08)	(0.02)	(0.06)	(0.05)	(0.07)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
34	0.81	0.52	0.51	1.63	0.69	0.51	1.02	0.91
	(0.04)	(0.09)	(0.06)	(0.13)	(0.04)	(0.07)	(0.08)	(0.10)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
35	0.37	1.25	1.51	1.36	0.56	0.63	1.09	1.61
	(0.17)	(0.55)	(0.35)	(0.51)	(0.08)	(0.17)	(0.14)	(0.36)
	[0.05]	[0.04]	[0.00]	[0.02]	[0.00]	[0.00]	[0.00]	[0.00]
36	0.38	1.09	1.00	1.20	0.39	1.14	1.14	0.96
	(0.13)	(0.35)	(0.19)	(0.31)	(0.06)	(0.18)	(0.14)	(0.20)
	[0.01]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
37	0.27	2.00	0.95	2.62	0.47	1.04	1.04	0.94
	(0.06)	(0.31)	(0.10)	(0.61)	(0.03)	(0.08)	(0.07)	(0.09)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

	w_1^+	α_1	β_1	λ_1	w_2^+	α_2	β_2	λ_2
38	0.24	1.31	1.22	0.75	0.48	1.02	1.05	1.10
	(0.07)	(0.23)	(0.14)	(0.15)	(0.03)	(0.09)	(0.07)	(0.12)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
39	0.19	1.26	1.49	0.61	0.22	1.12	1.12	0.96
	(0.13)	(0.49)	(0.33)	(0.25)	(0.06)	(0.21)	(0.13)	(0.24)
	[0.17]	[0.02]	[0.00]	[0.03]	[0.00]	[0.00]	[0.00]	[0.00]
40	0.31	2.11	2.13	4.05	0.46	1.25	0.93	9.41
	(0.30)	(1.74)	(0.91)	(5.58)	(0.17)	(0.68)	(0.18)	(9.96)
	[0.33]	[0.25]	[0.04]	[0.48]	[0.02]	[0.09]	[0.00]	[0.36]
41	0.85	0.41	0.40	1.73	0.87	0.29	0.28	1.77
	(0.10)	(0.22)	(0.16)	(0.30)	(0.05)	(0.11)	(0.10)	(0.17)
	[0.00]	[0.09]	[0.03]	[0.00]	[0.00]	[0.02]	[0.02]	[0.00]
42	0.60	0.67	0.86	1.05	0.52	0.74	0.93	1.02
	(0.20)	(0.38)	(0.30)	(0.37)	(0.11)	(0.24)	(0.20)	(0.31)
	[0.01]	[0.10]	[0.01]	[0.01]	[0.00]	[0.01]	[0.00]	[0.01]
43	0.90	0.59	0.52	1.67	0.93	0.46	0.59	1.42
	(0.08)	(0.23)	(0.16)	(0.32)	(0.04)	(0.12)	(0.12)	(0.22)
	[0.00]	[0.03]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
44	0.64	0.50	1.43	0.48	0.39	1.22	1.02	0.93
	(0.26)	(0.44)	(0.63)	(0.33)	(0.12)	(0.34)	(0.25)	(0.34)
	[0.03]	[0.28]	[0.04]	[0.17]	[0.01]	[0.00]	[0.00]	[0.02]
45	0.77	0.31	1.02	1.47	0.80	0.30	0.47	1.59
	(0.20)	(0.31)	(0.27)	(0.36)	(0.06)	(0.09)	(0.08)	(0.18)
	[0.00]	[0.35]	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]
46	0.28	1.60	1.45	1.17	0.44	0.91	1.35	0.86
	(0.08)	(0.34)	(0.19)	(0.27)	(0.04)	(0.11)	(0.11)	(0.13)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

♀	w_1^+	α_1	β_1	λ_1	w_2^+	α_2	β_2	λ_2
47	0.52	0.82	1.56	0.56	0.61	0.98	1.02	0.88
	(0.32)	(0.74)	(0.83)	(0.47)	(0.12)	(0.32)	(0.29)	(0.33)
	[0.13]	[0.29]	[0.09]	[0.25]	[0.00]	[0.01]	[0.00]	[0.02]
48	0.77	0.50	1.03	0.88	0.55	0.91	0.86	2.09
	(0.16)	(0.36)	(0.38)	(0.36)	(0.12)	(0.33)	(0.19)	(0.90)
	[0.00]	[0.18]	[0.02]	[0.03]	[0.00]	[0.02]	[0.00]	[0.04]
49	0.75	0.23	0.50	1.68	0.94	0.29	0.55	1.94
	(0.35)	(0.37)	(0.24)	(0.44)	(0.06)	(0.26)	(0.17)	(0.74)
	[0.05]	[0.54]	[0.06]	[0.00]	[0.00]	[0.28]	[0.01]	[0.02]
50	0.41	1.25	0.95	2.87	0.49	0.70	1.03	0.95
	(0.12)	(0.39)	(0.12)	(0.85)	(0.04)	(0.09)	(0.08)	(0.12)
	[0.00]	[0.01]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]
51	0.64	0.56	1.04	1.54	0.71	0.85	0.91	6.03
	(0.44)	(0.85)	(0.58)	(0.93)	(0.24)	(0.91)	(0.31)	(9.01)
	[0.17]	[0.52]	[0.09]	[0.12]	[0.01]	[0.37]	[0.01]	[0.52]
52	0.44	0.86	0.97	0.94	0.24	1.48	1.52	1.14
	(0.21)	(0.45)	(0.31)	(0.37)	(0.11)	(0.50)	(0.35)	(0.64)
	[0.06]	[0.08]	[0.01]	[0.02]	[0.06]	[0.01]	[0.00]	[0.10]
53	0.66	0.46	0.86	0.96	0.57	0.96	0.98	1.54
	(0.14)	(0.21)	(0.20)	(0.21)	(0.07)	(0.21)	(0.15)	(0.39)
	[0.00]	[0.05]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
54	0.67	1.16	1.38	1.13	0.48	0.90	0.94	0.87
	(0.10)	(0.33)	(0.27)	(0.32)	(0.05)	(0.12)	(0.10)	(0.12)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
55	0.67	0.64	0.49	1.58	0.84	0.47	0.43	1.64
	(0.17)	(0.34)	(0.19)	(0.41)	(0.06)	(0.14)	(0.12)	(0.23)
	[0.00]	[0.08]	[0.02]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]

	w_1^+	α_1	β_1	λ_1	w_2^+	α_2	β_2	λ_2
56	0.56	1.07	1.16	2.69	0.56	0.86	0.84	2.58
	(0.19)	(0.60)	(0.27)	(1.36)	(0.08)	(0.22)	(0.11)	(0.79)
	[0.01]	[0.10]	[0.00]	[0.07]	[0.00]	[0.00]	[0.00]	[0.01]
57	0.78	0.39	0.43	1.19	0.63	0.71	0.59	1.07
	(0.09)	(0.15)	(0.14)	(0.23)	(0.07)	(0.14)	(0.11)	(0.17)
	[0.00]	[0.02]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
58	0.55	0.92	0.96	1.04	0.38	1.18	1.10	0.86
	(0.09)	(0.22)	(0.16)	(0.20)	(0.05)	(0.15)	(0.12)	(0.15)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
59	0.50	0.99	0.99	1.01	0.46	0.97	0.98	0.91
	(0.01)	(0.04)	(0.03)	(0.03)	(0.01)	(0.02)	(0.02)	(0.02)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
60	0.80	0.82	0.72	3.21	0.91	0.33	0.49	1.82
	(0.13)	(0.51)	(0.18)	(1.75)	(0.04)	(0.11)	(0.09)	(0.27)
	[0.00]	[0.14]	[0.00]	[0.09]	[0.00]	[0.01]	[0.00]	[0.00]
61	0.71	0.80	1.51	1.35	0.39	0.90	0.95	1.54
	(0.08)	(0.26)	(0.22)	(0.31)	(0.05)	(0.12)	(0.07)	(0.22)
	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
62	0.32	3.56	3.54	7.14	0.42	1.80	1.70	3.29
	(0.23)	(2.10)	(1.45)	(12.11)	(0.09)	(0.44)	(0.27)	(1.84)
	[0.19]	[0.12]	[0.03]	[0.57]	[0.00]	[0.00]	[0.00]	[0.10]
63	0.44	1.59	1.65	2.25	0.46	1.01	0.80	1.76
	(0.27)	(1.12)	(0.64)	(2.01)	(0.10)	(0.27)	(0.15)	(0.55)
	[0.13]	[0.18]	[0.02]	[0.28]	[0.00]	[0.00]	[0.00]	[0.01]
64	0.83	0.51	0.72	1.70	0.59	0.81	0.95	1.63
	(0.10)	(0.27)	(0.18)	(0.42)	(0.08)	(0.22)	(0.15)	(0.46)
	[0.00]	[0.09]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

Table A.5: Individual Prospect Theory parameter estimates for complexity reduction 2, both weeks separately with standard errors in (.) and p-values in [.]

	α_1	β_1	λ_1	α_2	β_2	λ_2
1	1.21	1.38	71.99	0.72	0.74	6.68
	(0.52)	(0.64)	(377.74)	(0.18)	(0.18)	(6.46)
	[0.04]	[0.05]	[0.85]	[0.00]	[0.00]	[0.32]
2	0.58	0.78	0.85	0.90	1.08	4.15
	(0.15)	(0.20)	(0.22)	(0.17)	(0.21)	(1.99)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.06]
3	0.74	1.27	0.91	0.85	0.78	1.59
	(0.14)	(0.26)	(0.25)	(0.09)	(0.09)	(0.29)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
4	0.70	1.28	0.53	0.91	0.98	0.86
	(0.17)	(0.35)	(0.22)	(0.13)	(0.14)	(0.20)
	[0.00]	[0.00]	[0.03]	[0.00]	[0.00]	[0.00]
5	0.87	1.18	0.51	0.97	0.95	1.03
	(0.22)	(0.31)	(0.20)	(0.15)	(0.15)	(0.26)
	[0.00]	[0.00]	[0.03]	[0.00]	[0.00]	[0.00]
6	1.06	1.18	0.56	0.87	0.92	0.67
	(0.25)	(0.28)	(0.20)	(0.12)	(0.13)	(0.13)
	[0.00]	[0.00]	[0.02]	[0.00]	[0.00]	[0.00]
7	1.19	2.30	0.40	1.83	1.86	2.49
	(0.34)	(0.83)	(0.33)	(0.36)	(0.36)	(1.60)
	[0.00]	[0.02]	[0.26]	[0.00]	[0.00]	[0.14]
8	1.00	1.00	1.00	1.00	1.00	1.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
9	0.96	1.03	2.09	0.74	0.86	2.19
	(0.18)	(0.20)	(0.59)	(0.09)	(0.10)	(0.45)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

♀	α_1	β_1	λ_1	α_2	β_2	λ_2
10	0.98	0.99	0.99	1.02	1.02	1.02
	(0.06)	(0.06)	(0.08)	(0.04)	(0.04)	(0.06)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
11	0.68	1.07	1.33	2.91	0.49	286.10
	(0.34)	(0.57)	(0.84)	(1.60)	(0.18)	(945.50)
	[0.06]	[0.08]	[0.13]	[0.09]	[0.02]	[0.77]
12	1.02	0.98	2.25	1.00	1.00	1.00
	(0.04)	(0.04)	(0.14)	(0.02)	(0.02)	(0.04)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
13	1.20	0.96	1.25	1.17	1.31	1.90
	(0.30)	(0.23)	(0.46)	(0.21)	(0.24)	(0.83)
	[0.00]	[0.00]	[0.02]	[0.00]	[0.00]	[0.04]
14	1.13	0.42	6.55	6.94	0.25	$1.5E+06$
	(0.44)	(0.17)	(5.18)	(4.81)	(0.12)	$(1.5E+07)$
	[0.02]	[0.03]	[0.23]	[0.17]	[0.06]	[0.92]
15	1.17	1.14	1.29	0.64	1.09	0.60
	(0.41)	(0.40)	(0.74)	(0.14)	(0.24)	(0.22)
	[0.01]	[0.01]	[0.10]	[0.00]	[0.00]	[0.02]
16	1.10	1.33	0.57	1.15	0.82	1.85
	(0.46)	(0.57)	(0.41)	(0.30)	(0.20)	(0.87)
	[0.03]	[0.04]	[0.19]	[0.00]	[0.00]	[0.05]
17	0.86	1.95	0.51	0.51	0.93	0.74
	(0.39)	(1.18)	(0.57)	(0.15)	(0.27)	(0.29)
	[0.05]	[0.12]	[0.39]	[0.00]	[0.00]	[0.02]
18	0.54	1.26	2.22	0.60	0.77	1.24
	(0.23)	(0.61)	(1.75)	(0.15)	(0.19)	(0.41)
	[0.04]	[0.06]	[0.23]	[0.00]	[0.00]	[0.01]

♀	α_1	β_1	λ_1	α_2	β_2	λ_2
19	0.73	0.82	0.88	0.74	1.05	1.16
	(0.24)	(0.28)	(0.33)	(0.17)	(0.26)	(0.48)
	[0.01]	[0.01]	[0.02]	[0.00]	[0.00]	[0.03]
20	0.78	0.88	0.72	0.89	0.95	0.95
	(0.12)	(0.13)	(0.13)	(0.09)	(0.09)	(0.15)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
21	1.00	1.00	1.00	1.00	1.00	1.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
22	2.79	1.53	5.92	1.57	1.29	1.71
	(1.64)	(0.80)	(10.72)	(0.46)	(0.36)	(1.15)
	[0.11]	[0.08]	[0.59]	[0.00]	[0.00]	[0.16]
23	1.00	1.00	0.98	0.99	0.99	0.99
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
24	1.52	1.47	0.84	1.02	0.98	1.02
	(0.39)	(0.38)	(0.40)	(0.14)	(0.14)	(0.24)
	[0.00]	[0.00]	[0.05]	[0.00]	[0.00]	[0.00]
25	1.22	0.74	2.81	1.08	0.97	2.22
	(0.77)	(0.43)	(3.02)	(0.42)	(0.37)	(1.82)
	[0.14]	[0.11]	[0.37]	[0.02]	[0.02]	[0.24]
26	1.01	1.30	2.11	0.51	0.94	1.43
	(0.26)	(0.36)	(0.93)	(0.09)	(0.16)	(0.34)
	[0.00]	[0.00]	[0.04]	[0.00]	[0.00]	[0.00]
27	1.13	1.46	0.44	0.83	0.74	0.88
	(0.36)	(0.49)	(0.27)	(0.15)	(0.13)	(0.17)
	[0.01]	[0.01]	[0.13]	[0.00]	[0.00]	[0.00]

	α_1	β_1	λ_1	α_2	β_2	λ_2
28	0.96	1.37	0.65	0.77	1.27	0.67
	(0.25)	(0.39)	(0.31)	(0.13)	(0.23)	(0.23)
	[0.00]	[0.00]	[0.05]	[0.00]	[0.00]	[0.01]
29	0.88	1.04	0.71	0.82	0.96	0.96
	(0.14)	(0.16)	(0.15)	(0.08)	(0.10)	(0.16)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
30	0.60	0.80	0.78	0.98	1.00	0.99
	(0.06)	(0.08)	(0.08)	(0.06)	(0.06)	(0.10)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
31	0.71	0.82	1.28	1.21	0.94	1.56
	(0.15)	(0.18)	(0.31)	(0.16)	(0.12)	(0.36)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
32	1.21	1.70	2.00	1.02	1.36	1.23
	(0.17)	(0.27)	(0.57)	(0.08)	(0.12)	(0.22)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
33	0.79	0.95	0.83	0.94	0.96	0.98
	(0.07)	(0.09)	(0.10)	(0.05)	(0.06)	(0.09)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
34	1.09	0.73	1.63	0.84	1.19	0.94
	(0.24)	(0.15)	(0.49)	(0.13)	(0.19)	(0.27)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
35	0.90	1.43	1.28	0.76	1.11	1.75
	(0.16)	(0.29)	(0.38)	(0.09)	(0.14)	(0.38)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
36	0.83	0.93	1.22	0.93	1.02	1.00
	(0.15)	(0.17)	(0.28)	(0.10)	(0.11)	(0.19)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

♀	α_1	β_1	λ_1	α_2	β_2	λ_2
37	1.29	0.81	2.11	0.98	1.00	0.97
	(0.16)	(0.09)	(0.42)	(0.07)	(0.07)	(0.11)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
38	0.73	1.03	0.90	0.98	1.03	1.10
	(0.09)	(0.13)	(0.14)	(0.07)	(0.08)	(0.15)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
39	0.55	1.36	0.79	0.57	0.98	0.96
	(0.15)	(0.42)	(0.30)	(0.10)	(0.17)	(0.23)
	[0.00]	[0.01]	[0.02]	[0.00]	[0.00]	[0.00]
40	1.34	1.92	2.67	1.10	0.93	7.64
	(0.41)	(0.68)	(1.85)	(0.20)	(0.17)	(4.08)
	[0.01]	[0.01]	[0.17]	[0.00]	[0.00]	[0.08]
41	1.03	0.61	1.77	0.83	0.53	1.81
	(0.48)	(0.28)	(1.06)	(0.24)	(0.16)	(0.73)
	[0.05]	[0.05]	[0.12]	[0.00]	[0.00]	[0.03]
42	0.84	0.94	0.98	0.77	0.95	1.02
	(0.23)	(0.27)	(0.36)	(0.14)	(0.17)	(0.30)
	[0.00]	[0.00]	[0.02]	[0.00]	[0.00]	[0.00]
43	1.47	0.85	1.75	1.42	1.20	1.46
	(0.81)	(0.44)	(1.45)	(0.51)	(0.42)	(1.10)
	[0.09]	[0.07]	[0.25]	[0.02]	[0.01]	[0.21]
44	0.73	1.62	0.40	1.01	0.90	1.04
	(0.24)	(0.65)	(0.29)	(0.19)	(0.17)	(0.29)
	[0.01]	[0.03]	[0.19]	[0.00]	[0.00]	[0.00]
45	0.75	1.16	1.57	0.79	0.61	2.09
	(0.27)	(0.46)	(0.79)	(0.17)	(0.13)	(0.71)
	[0.01]	[0.02]	[0.07]	[0.00]	[0.00]	[0.01]

♀	α_1	β_1	λ_1	α_2	β_2	λ_2
46	0.97	1.26	1.11	0.79	1.30	0.85
	(0.12)	(0.17)	(0.23)	(0.06)	(0.11)	(0.14)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
47	0.86	1.59	0.55	1.19	1.17	0.77
	(0.33)	(0.72)	(0.43)	(0.27)	(0.26)	(0.30)
	[0.02]	[0.04]	[0.22]	[0.00]	[0.00]	[0.02]
48	1.02	1.37	0.74	1.01	0.89	2.25
	(0.33)	(0.47)	(0.42)	(0.21)	(0.18)	(0.94)
	[0.01]	[0.01]	[0.10]	[0.00]	[0.00]	[0.03]
49	0.48	0.57	1.53	3.99	0.54	$2.1E+03$
	(0.26)	(0.29)	(0.66)	(2.65)	(0.19)	$(1.2E+04)$
	[0.08]	[0.07]	[0.04]	[0.15]	[0.01]	[0.86]
50	0.99	0.94	2.49	0.69	1.02	0.95
	(0.12)	(0.11)	(0.46)	(0.05)	(0.07)	(0.11)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
51	0.81	1.13	1.59	1.81	0.88	37.63
	(0.38)	(0.57)	(1.07)	(0.74)	(0.29)	(63.84)
	[0.05]	[0.07]	[0.16]	[0.03]	[0.01]	[0.56]
52	0.74	0.93	0.97	0.81	1.29	0.95
	(0.23)	(0.29)	(0.36)	(0.17)	(0.29)	(0.40)
	[0.01]	[0.01]	[0.02]	[0.00]	[0.00]	[0.03]
53	0.70	0.98	0.85	1.12	1.04	1.64
	(0.14)	(0.21)	(0.22)	(0.15)	(0.14)	(0.45)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
54	1.64	1.65	1.15	0.87	0.92	0.89
	(0.29)	(0.29)	(0.43)	(0.08)	(0.08)	(0.12)
	[0.00]	[0.00]	[0.02]	[0.00]	[0.00]	[0.00]

	α_1	β_1	λ_1	α_2	β_2	λ_2
55	0.91	0.59	1.49	1.01	0.73	1.44
	(0.39)	(0.25)	(0.71)	(0.27)	(0.19)	(0.56)
	[0.04]	[0.03]	[0.06]	[0.00]	[0.00]	[0.02]
56	1.26	1.19	3.01	1.01	0.87	3.01
	(0.27)	(0.25)	(1.23)	(0.13)	(0.11)	(0.80)
	[0.00]	[0.00]	[0.03]	[0.00]	[0.00]	[0.00]
57	0.72	0.66	0.77	0.88	0.71	0.88
	(0.19)	(0.18)	(0.18)	(0.15)	(0.12)	(0.15)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
58	1.02	1.01	1.02	0.94	0.96	0.96
	(0.16)	(0.16)	(0.23)	(0.09)	(0.09)	(0.15)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
59	0.99	0.99	1.01	0.89	0.93	0.94
	(0.04)	(0.04)	(0.06)	(0.02)	(0.02)	(0.04)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
60	1.96	0.81	9.56	2.92	0.48	210.69
	(1.07)	(0.33)	(14.70)	(1.34)	(0.15)	(581.38)
	[0.09]	[0.03]	[0.53]	[0.05]	[0.01]	[0.72]
61	1.43	1.75	1.77	0.69	0.90	1.42
	(0.24)	(0.32)	(0.64)	(0.06)	(0.08)	(0.20)
	[0.00]	[0.00]	[0.02]	[0.00]	[0.00]	[0.00]
62	2.36	3.03	3.34	1.50	1.59	2.53
	(0.65)	(0.94)	(3.03)	(0.19)	(0.21)	(0.97)
	[0.00]	[0.01]	[0.29]	[0.00]	[0.00]	[0.02]
63	1.38	1.58	2.06	0.94	0.77	1.72
	(0.42)	(0.51)	(1.30)	(0.15)	(0.12)	(0.46)
	[0.01]	[0.01]	[0.14]	[0.00]	[0.00]	[0.00]

	α_1	β_1	λ_1	α_2	β_2	λ_2
64	1.28	0.96	2.28	1.01	1.01	1.85
	(0.37)	(0.26)	(1.15)	(0.18)	(0.18)	(0.65)
	[0.00]	[0.00]	[0.07]	[0.00]	[0.00]	[0.01]

B.5 Instructions

Herzlich willkommen im Regensburg Economic Science Lab RESL und vielen Dank für Ihre Teilnahme am Experiment!

Bitte sprechen Sie ab jetzt nicht mehr mit anderen Teilnehmern und schalten Sie Ihr Mobiltelefon aus. Verhalten Sie sich während des gesamten Experiments ruhig.

Allgemeines zum Ablauf

Dieses Experiment dient der Untersuchung ökonomischen Entscheidungsverhaltens. Sie können dabei Geld verdienen, das Ihnen im Anschluss an das Experiment privat in bar ausbezahlt wird.
Das gesamte Experiment besteht aus zwei zeitlich getrennten Sitzungen. Die erste Sitzung wird etwa 100 Minuten dauern und besteht aus drei Teilen. Die zweite Sitzung wird etwa 80 Minuten dauern und besteht aus zwei Teilen. Zu Beginn jedes Teils erhalten Sie detaillierte Instruktionen. Die Summe Ihres Verdienstes aus allen Teilen ergibt Ihren Gesamtverdienst aus dem Experiment. Dieser wird Ihnen nach Abschluss des zweiten Teils mitgeteilt und am Ende des Experiments einzeln und in bar ausbezahlt.
Während des Experiments werden Sie darum gebeten, Entscheidungen zu treffen. Ihre Entscheidungen haben keinen Einfluss auf die Auszahlungen der anderen Teilnehmer, nur auf Ihre eigene Auszahlung.
Sie erhalten in der ersten Sitzung eine Platzkarte, damit Sie in der zweiten Sitzung denselben Platz einnehmen können. Bringen Sie diese Karte unbedingt zur zweiten Sitzung mit!

Bezahlung

Während des Experiments berechnen sich Verdienste direkt in Euro. Zusätzlich zu dem Einkommen, das Sie während des Experiments verdienen können, erhalten Sie 5 € für Ihr pünktliches Erscheinen je Sitzung. Bitte berücksichtigen Sie, dass der Gesamtbetrag erst nach der zweiten Sitzung ausgezahlt wird. Daher ist es unbedingt notwendig, dass Sie auch zur zweiten Sitzung erscheinen und Ihre Platzkarte mitbringen.

Anonymität

Keiner der anderen Teilnehmer wird Ihre Entscheidungen im Experiment nachvollziehen können. Darüber hinaus werden die Daten aus dem Experiment ausschließlich anonym ausgewertet. Am Ende des Experiments müssen Sie eine Quittung über den Erhalt des Verdienstes unterschreiben. Diese dient nur der Abrechnung und wird nicht dazu verwendet, Ihre persönlichen Daten mit Ihren Entscheidungen zu verknüpfen. Ihr Name wird zu keinem Zeitpunkt mit Ihrem Verhalten im Experiment kombiniert. Die verteilten Platzkarten enthalten Ihren Namen, um sicherzustellen, dass auch tatsächlich Sie und niemand anderes an der zweiten Sitzung teilnehmen. Die Platzkarten verbleiben sowohl während, als auch nach dem Experiment, in Ihrem Besitz.

Hilfsmittel

An Ihrem Platz finden Sie einen Kugelschreiber und einen Taschenrechner. Bitte lassen Sie beide nach dem Experiment auf dem Tisch liegen. Bitte lassen Sie auch Ihre Notizen auf dem Tisch liegen, diese werden direkt im Anschluss vernichtet.

Sollten Sie nach den Instruktionen oder während des Experiments Fragen haben, heben Sie bitte die Hand. Einer der Experimentleiter wird dann zu Ihnen kommen und Ihre Fragen unter vier Augen beantworten.

Sonstiges

Bitte verwenden Sie als Trennzeichen bei Kommazahlen einen Punkt anstelle des Kommas. Beispielsweise verwende Sie „6.40“ für den Betrag „6 Euro und 40 Cent“.

Teil 1

Ablauf

Nächste Woche werden Sie hintereinander vier voneinander unabhängige Investitionsentscheidungen treffen. Sie bekommen für jede der vier Runden ein Startkapital von je 1,60 Euro. Das Geld wird Ihnen zu Beginn des Experiments nächste Woche in einem Umschlag in bar ausgehändigt.

In jeder Runde müssen Sie entscheiden, welchen Teilbetrag (in 20-Cent-Schritten) Ihres Startkapitals Sie investieren möchten. Der nichtinvestierte Teil Ihres Startkapitals wird Ihrem Vermögen eins-zu-eins gutgeschrieben.

Die Auszahlung Ihres Investments ist im Durchschnitt höher, hängt allerdings vom Zufall ab: Sie wählen in jeder Runde Ihre Erfolgszahl zwischen 1 und 6. Ein zufällig bestimmter Teilnehmer würfelt dann die gültige Erfolgszahl aus. Stimmt Ihre selbstgewählte Erfolgszahl mit der anschließend ausgewürfelten Erfolgszahl überein (dies geschieht mit einer Wahrscheinlichkeit von 16,67%), wird Ihnen der siebenfache Investitionsbetrag gutgeschrieben; andernfalls erhalten Sie den Investitionsbetrag nicht zurück.

Die Eingabemaske der Investitionsentscheidungen sieht dabei wie folgt aus:

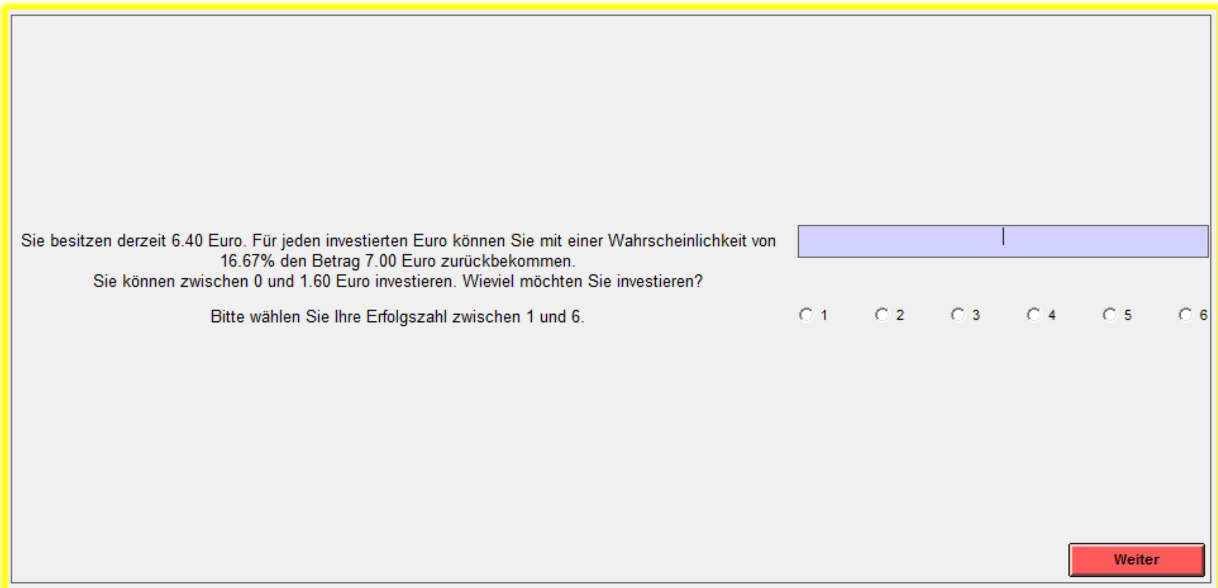

Abbildung 1: Investitionsentscheidung mit Glückszahl

Beispiel:
Sie investieren 80 Cent und entscheiden sich für die „4" als Erfolgszahl. Wenn der zufällig bestimmte Teilnehmer die „4" würfelt, erhalten Sie 5,60 Euro aus dem Investment zurück. Zusätzlich erhalten Sie den nichtinvestierten Betrag von 80 Cent. Insgesamt werden Ihnen also 6,40 Euro für diese Runde gutgeschrieben.
Würfelt der Teilnehmer eine andere Zahl, erhalten Sie lediglich den nichtinvestierten Betrag von 80 Cent zurück.

Sie treffen diese Entscheidung für jede der vier Runden neu und können maximal Ihr jeweiliges Startkapital investieren.

Heute sollen Sie planen, welche Entscheidungen Sie in der kommenden Woche treffen möchten.

In der Planungsphase können Sie für jede Runde eingeben, wieviel Sie investieren sollten. Sie finden jeweils links auf Ihrem Bildschirm die Auszahlung im Gewinnfall und rechts für den Verlustfall. Für jeden der Fälle können Sie dann individuell weiterplanen.

Ihr Bildschirm sieht dabei wie folgt aus:

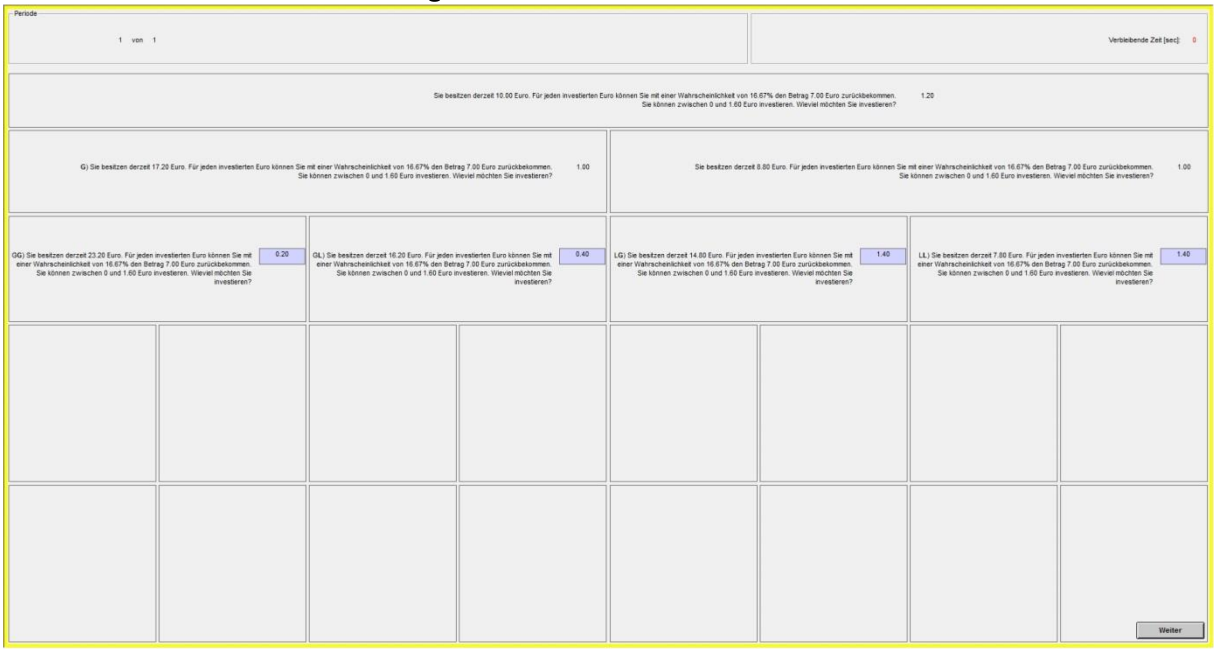

Abbildung 2: Beispiel für Ihre Vorhersage

Sie treffen die Investitionsentscheidungen also zweimal: Einmal heute als Plan und einmal nächste Woche tatsächlich.

Es wird allerdings nur entweder ihr heutiger Plan oder ihre Investitionsentscheidungen von nächster Woche umgesetzt.

Sie entscheiden 45-mal, ob Sie die Umsetzung Ihres heutigen Planes und einen Geldbetrag möchten, oder die Umsetzung Ihrer Investitionsentscheidungen von nächster Woche. Die 45 Entscheidungen variieren im Geldbetrag, der sowohl positiv (Gutschrift, +), als auch negativ (Abzug vom Guthaben, -) sein kann.

Eine dieser Entscheidungen wird nächste Woche ganz zum Schluss zufällig ausgewählt und umgesetzt. Unabhängig davon, wie Sie sich bei diesen 45 Entscheidungen entscheiden, müssen Sie nächste Woche in jedem Fall die tatsächlichen Investitionsentscheidungen treffen.

Ihr Bildschirm sieht dabei aus wie folgt:

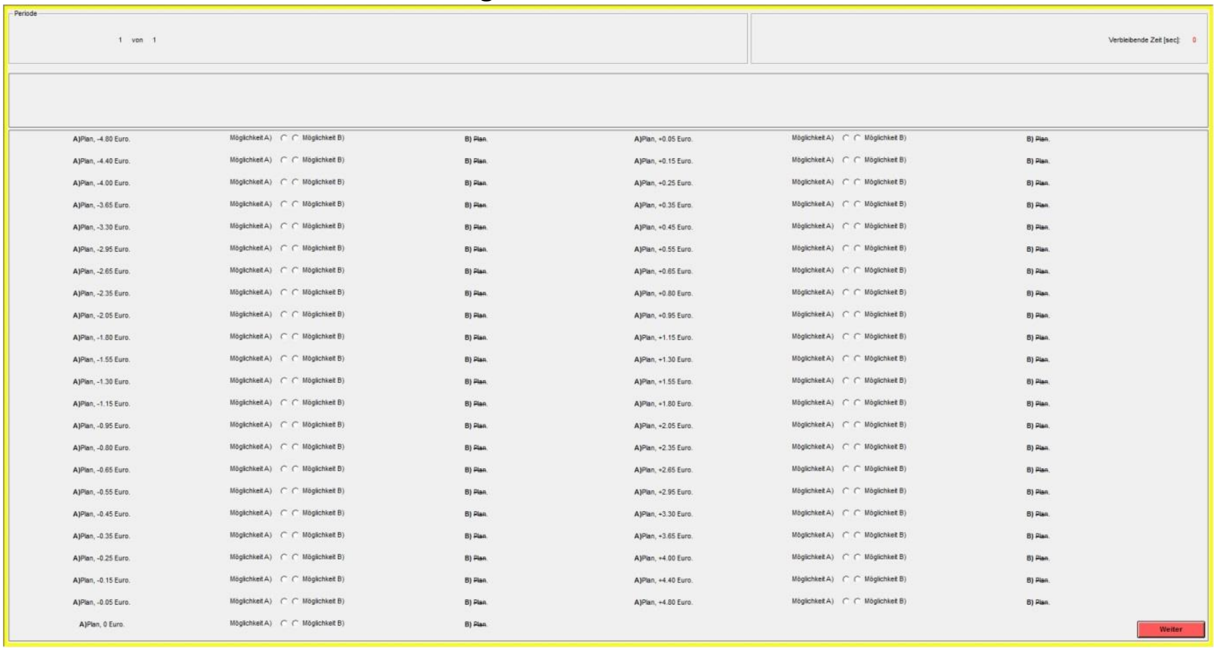

Abbildung 3: Soll Ihre Vorhersage umgesetzt werden?

Sobald Sie diese Informationen gelesen und verstanden haben, können Sie auf „Weiter" klicken.

Teil 2

Ablauf

In diesem Teil bekommen Sie zwei Aufgaben gestellt.

Als erstes sollen Sie drei Rechenaufgaben lösen. Für jede richtig gelöste Aufgabe werden Ihnen 0,50 Euro gutgeschrieben.

Als zweites bitten wir Sie, einen kurzen Fragebogen auszufüllen. Dieser enthält Aussagen zu Ihrer Person, die Sie auf einer Sieben-Punkte-Skala von „trifft nicht auf mich zu“ bis „trifft sehr auf mich zu“ qualifizieren sollen. Wir bitten Sie, diese wahrheitsgemäß zu beantworten. Für das Ausfüllen des Fragebogens schreiben wir Ihrem Vermögen 2 Euro gut. Ihr Bildschirm sieht dabei aus wie folgt:

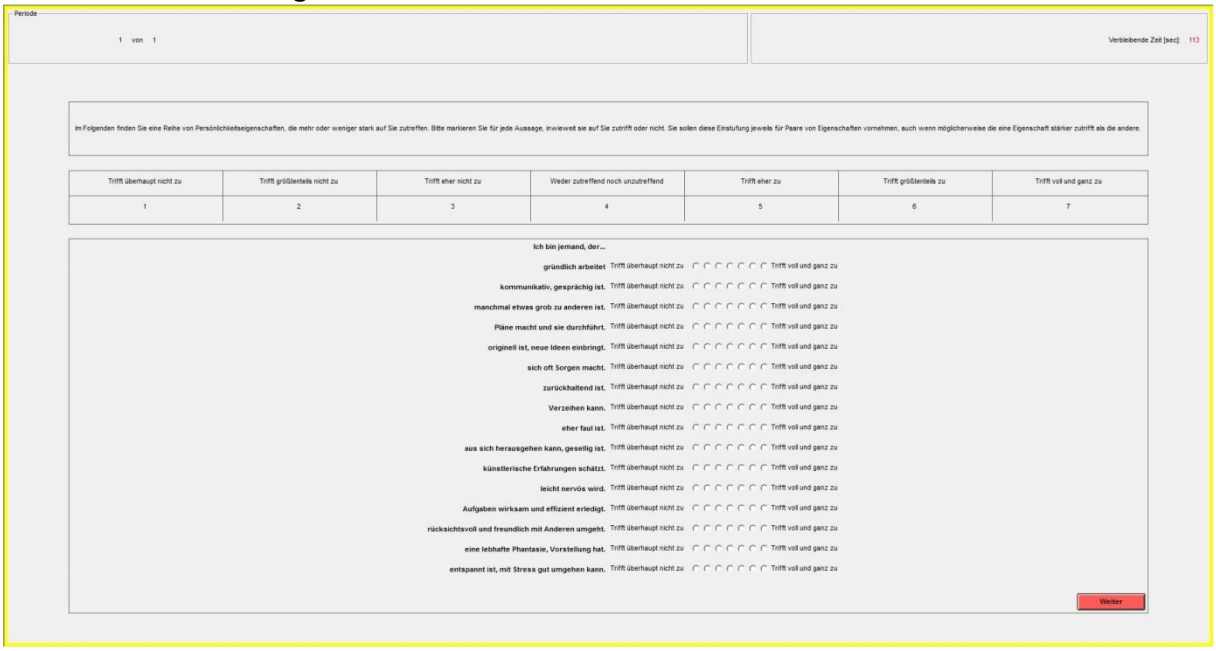

Abbildung 4: Fragebogen

Teil 3

Ablauf

In diesem Teil treffen Sie eine Reihe an Entscheidungen zwischen einem sicheren Geldbetrag (links) und einer Lotterie (rechts). Die Lotterie führt zu einer zufälligen Auszahlung von einem von zwei Beträgen, die sowohl positiv als auch negativ sein können. Jeder Betrag kommt mit 50% Wahrscheinlichkeit zur Auszahlung.

Ihr Bildschirm sieht dabei aus wie folgt:

Abbildung 5: Beispiel Sichere Option vs. Lotterie

Nächste Woche werden Sie u.a. eine Reihe ähnlicher Entscheidungen treffen. Am Ende des Experiments werden wir eine Ihrer Entscheidungen (aus beiden Wochen) zufällig ermitteln und ausführen. Positive Beträge werden Ihrem Einkommen gutgeschrieben, negative davon abgezogen.

Ende dieser Sitzung

Die Auszahlung für die Teilnahme gibt es erst nach der Teilnahme an der zweiten Sitzung. Dennoch bitten wir Sie, auf Ihrem Platz sitzen zu bleiben, bis ein Experimentator Bescheid gibt, dass das Labor verlassen werden kann. Vergessen Sie nicht, Ihre Platzkarte in einer Woche wieder mitzubringen!

Herzlich willkommen im Regensburg Economic Science Lab RESL und vielen Dank für Ihre Teilnahme am Experiment!

Bitte sprechen Sie ab jetzt nicht mehr mit anderen Teilnehmern und schalten Sie Ihr Mobiltelefon aus. Verhalten Sie sich während des gesamten Experiments ruhig.

Allgemeines zum Ablauf

Diese Sitzung ist der zweite Teil des in der vergangenen Woche gestarteten Experiments. Bitte stellen Sie sicher, dass Sie an dem Rechner derselben Platznummer sitzen, wie auf Ihrer Platzkarte vermerkt ist.
Diese Sitzung dauert voraussichtlich 80 Minuten und besteht aus zwei Teilen.

Bezahlung

Ihr Einkommen für Ihr pünktliches Erscheinen je Sitzung wurde auf 6 € erhöht. Am Ende dieser Sitzung wird Ihnen Ihr Verdienst aus beiden Sitzungen in bar ausbezahlt. Wir kommen dazu zu Ihnen an den Platz. Um die Anonymität zu wahren bitten wir Sie während der Auszahlung weiter an Ihrem Platz zu bleiben. Sobald Sie Ihr Verdienst erhalten und quittiert haben, bitten wir Sie den Raum leise zu verlassen.

Hilfsmittel

An Ihrem Platz finden Sie einen Kugelschreiber und einen Taschenrechner. Bitte lassen Sie beide nach dem Experiment auf dem Tisch liegen. Bitte lassen Sie auch Ihre Notizen auf dem Tisch liegen, diese werden direkt im Anschluss vernichtet.

Sollten Sie nach den Instruktionen oder während des Experiments Fragen haben, heben Sie bitte die Hand. Einer der Experimentleiter wird dann zu Ihnen kommen und Ihre Fragen unter vier Augen beantworten.

Sonstiges

Bitte verwenden Sie als Trennzeichen bei Kommazahlen einen Punkt anstelle des Kommas. Beispielsweise verwende Sie „6.40“ für den Betrag „6 Euro und 40 Cent“.

Teil 1

Ablauf

In diesem Teil treffen Sie eine Reihe an Entscheidungen zwischen einem sicheren Geldbetrag (links) und einer Lotterie (rechts). Die Lotterie führt zu einer zufälligen Auszahlung von einem von zwei Beträgen, die sowohl positiv als auch negativ sein können. Jeder Betrag kommt mit 50% Wahrscheinlichkeit zur Auszahlung.

Ihr Bildschirm sieht dabei aus wie folgt:

Abbildung 1: Beispiel Sichere Option vs. Lotterie

Am Ende dieser Sitzung werden wir eine Ihrer Entscheidungen (aus beiden Wochen) ermitteln und ausführen. Positive Beträge werden Ihrem Einkommen gutgeschrieben, negative davon abgezogen.

Teil 2

Ablauf

In dieser Sitzung treffen Sie die Investitionsentscheidungen, die Sie vergangene Woche bereits vorhergesagt haben. Der wesentliche Unterschied gegenüber letzter Woche besteht darin, dass Sie diesmal nach jeder Investitionsentscheidung direkt erfahren, ob Ihre Investition erfolgreich gewesen ist oder nicht, weswegen Sie nicht mehr für jede Kombination aus Gewinnen und Verlusten entscheiden müssen, sondern nur noch für Ihren tatsächlichen Verlauf.

Vor Ihnen liegt ein Umschlag mit 6,40 Euro, 1,60 Euro für jede Investitionsrunde. Die Stückelung beträgt 2€, 2€, 1€, 50¢, 50¢, 20¢, 10¢, 10¢. Bitte öffnen Sie den Umschlag und vergewissern Sie sich, dass er die genannten Münzen enthält. Belassen Sie das Geld im Umschlag.

In jeder von vier Runden können Sie bis zu 1,60 Euro ihres Vermögens in die risikobehaftete Anlage investieren. Zu Beginn jeder Runde erhalten Sie zufällig vom Computer eine Glückszahl zwischen 1 und 6 zugeteilt. Nachdem Sie diese Zahl gesehen haben, können Sie einen beliebigen Betrag (in 20 Eurocent Schritten) Ihres Vermögens investieren. Ihr Bildschirm sieht dabei aus wie folgt:

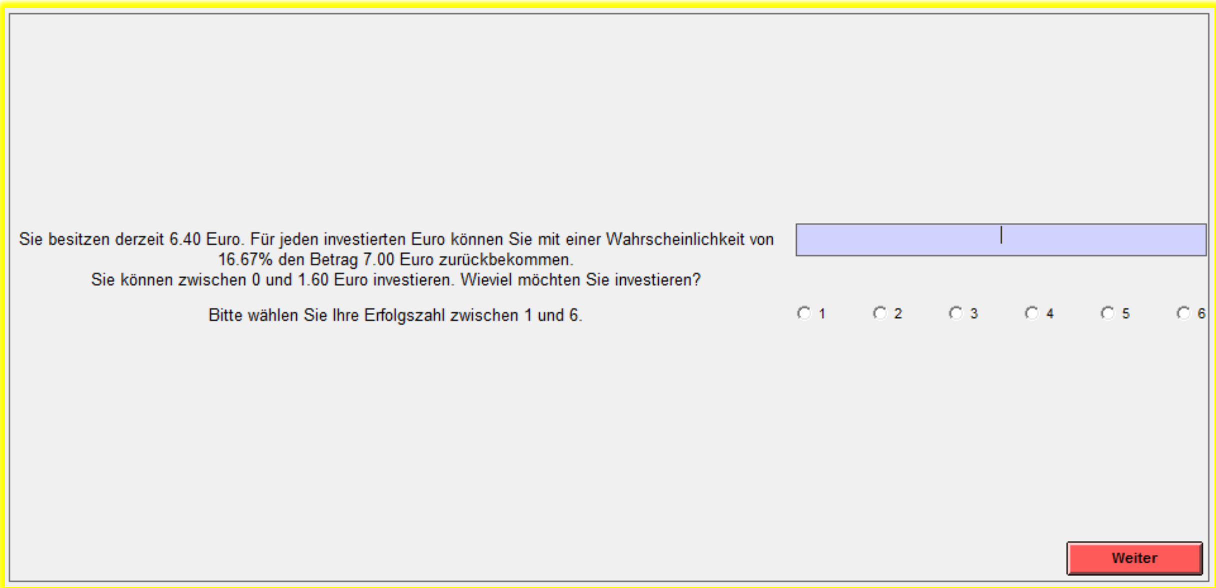

Abbildung 2: Investitionsentscheidung mit Glückszahl

Sobald sich alle Teilnehmer entschieden und ihre jeweiligen Beträge eingegeben haben, bestimmen die Experimentatoren einen zufälligen Teilnehmer, der mit einem fairen sechsseitigen Würfel würfelt. Entspricht das Ergebnis des Wurfes Ihrer persönlichen Glückszahl, wird Ihr Einsatz versiebenfacht. Entspricht das Ergebnis nicht Ihrer Glückszahl, verlieren Sie Ihren Einsatz.

Beispiel:

Ihre Glückszahl ist die „4“. Sie investieren 80 Eurocent. Wenn der zufällig bestimmte Teilnehmer die „4“ würfelt, erhalten Sie 5,60 Euro ausbezahlt. Würfelt der Teilnehmer eine andere Zahl, dann verlieren Sie Ihren Einsatz und erhalten 0 Euro.

Sie treffen diese Entscheidung für jede der vier Runden neu.

Sie treffen diese Entscheidung für jede der vier Runden neu und können maximal Ihr jeweiliges Startkapital investieren.

Bezahlung

Während wir die Auszahlung vorbereiten, bitten wir Sie, noch einen Fragebogen auszufüllen. Sobald alle Teilnehmer diesen abgeschlossen und auf „Weiter" gedrückt haben, werden wir zu Ihnen an den Platz kommen. Sie erhalten Ihr Einkommen aus beiden Sitzungen, sowie für Ihr pünktliches Erscheinen ausbezahlt. Um die Anonymität zu wahren bitten wir Sie während der Auszahlung weiter an Ihrem Platz zu bleiben. Sobald Sie Ihr Verdienst erhalten und quittiert haben, bitten wir Sie den Raum leise zu verlassen.

Appendix C

Unions, Communication, and Cooperation in Organizations

C.1 Derivation of Benachmark Case 2

The workers discounted utility from cooperating:

$$\sum_{t=0}^{T=\infty} \delta^t (w + b - c) = \frac{w + b - c}{1 - \delta}.$$

The workers discounted utility from defecting:

$$\sum_{t=0}^{T=\infty} \delta^t \bar{U} = \frac{\bar{U}}{1 - \delta} = 0.$$

Together they define $b_{\text{benchmark}}$ as the minimum bonus that implements $e = 1$ as:

$$\frac{w + b - c}{1 - \delta} = \frac{\bar{U}}{1 - \delta}.$$

Or equivalently: $w + b - c = 0$ and since $w = 0$, we know $b_{\text{benchmark}} = c$.

Given the workers strategy, the firm has to be at least weakly better off from implementing $e = 1$. The discounted sum of firm's profits from adhering to pay the bonus b in the current period if the worker chose $e = 1$ is given by:

$$\sum_{t=0}^{T=\infty} \beta^t (\Pi(G,1) - w - b) = \frac{(\Pi(G,1) - w - b)}{1-\beta}.$$

The discounted firm's profits from defaulting on the bonus b in this given period are given by:

$$\Pi(G,1) - w + \sum_{t=0}^{T=\infty} \beta^t (\Pi(G,0) - w) = \Pi(G,1) - w + 0 = \Pi(G,1) - w.$$

Therefore the maximum level $b^{\text{max}}_{\text{benchmark}}$ that the bonus can take is:

$$\frac{1}{1-\beta}(\Pi(G,1) - w - b^{\text{max}}_{\text{benchmark}}) = \Pi(G,1) - w \tag{C.1}$$

$$\beta\Pi(G,1) = b^{\text{max}}_{\text{benchmark}}. \tag{C.2}$$

C.2 Derivation of the Symmetric Information Result

For the case of Symmetric Information we derive the minimum bonus $\bar{b}_S$ that is necessary to implement $e = 1$.

If the agent continues to exert high effort, his discounted sum over all periods is:

$$\sum_{t=0}^{t=\infty} \delta^t [p\bar{b}_S + (1-p)\underline{b} - c] = \frac{1}{1-\delta}[p\bar{b}_S + (1-p)\underline{b} - c].$$

The agent's outside option is:

$$\sum_{t=0}^{t=\infty} \delta^t \bar{U} = \frac{\bar{U}}{1-\delta} = 0.$$

The worker has to prefere $e = 1$ to $e = 0$, therefore:

$$\frac{1}{1-\delta}[p\bar{b}_S + (1-p)\underline{b} - c] \geq \frac{\bar{U}}{1-\delta}.$$

In equilibrium this has to hold with equality:

$$[p\bar{b}_S + (1-p)\underline{b} - c] = 0.$$

Since $\underline{b}$ is given by $\underline{b} = \Pi(B, e=1)$, we can express $\bar{b}_S$ as:

$$p\bar{b}_S + (1-p)\Pi(B, e=1) - c = 0$$
$$\bar{b}_S = \frac{c - (1-p)\Pi(B, e=1)}{p}.$$

While we derived the lower bound of the bonus $\bar{b}_S$ in order for the worker to choose high effort, we now derive the upper bound for the bonus, the highest amount the firm is willing to pay. The firm has to prefer to pay the bonus in both states of the world, B and G.

The firm's decision in the bad state:

The total firm profits if bonus is not paid is the sum of the profit today, $\Pi(B, 1)$, plus the discounted value of the expected profit tomorrow and for all periods thereafter. The expected profits tomorrow (and in each period thereafter) are given by

$$p(\Pi(G, 0) - w) + (1-p)(\Pi(B, 0) - w) = p \times 0 + (1-p) \times 0 = 0.$$

Thus the discounted sum of a form's profit if it defaults on the bonus is given by:

$$\Pi(B, 1) + \sum_{t=1}^{t=\infty} \beta^t 0 = \Pi(B, 1).$$

The total expected firm's profit if the bonus is paid and the state is bad is given by the sum of the profit today, $\Pi(B, 1) - \underline{b} = 0$, and the discounted value of the expected profit tomorrow and for all periods thereafter. In this case, the expected profits tomorrow (and in each period thereafter) are given by:

$$p[\Pi(G, 1) - \bar{b}_S] + (1-p)[\Pi(B, 1) - \underline{b}] = p[\Pi(G, 1) - \bar{b}_S].$$

The firm has to (weakly) prefer paying the bonus, thus

$$\Pi(B,1) \leq \sum_{t=1}^{t=\infty} \beta^t p[\Pi(G,1) - \bar{b}_S]\Pi(B,1) + \sum_{t=1}^{t=\infty} \beta^t p \bar{b}_S \leq \sum_{t=1}^{t=\infty} \beta^t p[\Pi(G,1)].$$

The firm's decision in the good state:

The total firm profit if it defaults on the bonus and the state is good is the sum of the profit today, $\Pi(G,1)$, plus the discounted value of the expected profit tomorrow and for all periods thereafter, $p\Pi(G,0) = 0$. Thus the discounted sum is given by

$$\Pi(G,1) + \sum_{t=1}^{t=\infty} \beta^t 0 = \Pi(G,1).$$

The total firm profit if the bonus is paid and the state is good is the sum of the profit today, $\Pi(G,1) - \bar{b}_S$, plus the discounted value of expected profit tomorrow and for all periods thereafter, $p(\Pi(G,1) - \bar{b}_S)$. Thus the discounted sum is given by:

$$\Pi(G,1) - \bar{b}_S + \sum_{t=1}^{t=\infty} \beta^t p[\Pi(G,1) - \bar{b}_S].$$

The firm has to (weakly) prefer to pay the bonus, i.e.,

$$\Pi(G,1) \leq \Pi(G,1) - \bar{b}_S + \sum_{t=1}^{t=\infty} \beta^t p[\Pi(G,1) - \bar{b}_S] \tag{C.3}$$

$$\bar{b}_S + \sum_{t=1}^{t=\infty} \beta^t p \bar{b}_S \leq \sum_{t=1}^{t=\infty} \beta^t p \Pi(G,1). \tag{C.4}$$

Now we compare the two conditions for the firm in the good and in the bad states:

state G

$$\bar{b}_S + \sum_{t=1}^{t=\infty} \beta^t p \bar{b}_S \leq \sum_{t=1}^{t=\infty} \beta^t p \Pi(G,1).$$

state B

$$\Pi(B,1) + \sum_{t=1}^{t=\infty} \beta^t p \bar{b}_S \leq \sum_{t=1}^{t=\infty} \beta^t p[\Pi(G,1)].$$

Note that the right hand side of both conditions is identical. Furthermore, by the assumptions made above it is implied that $\Pi(B,1) < \bar{b}_S$. Thus, the condition in the good state G is more restrictive and determines implicitly the upper bound for $\bar{b}_S$, $\bar{b}_S^{\max}$, that the firm would be willing to pay in order to implement $e = 1$. Therefore,

$$\bar{b}_S^{\max} + \sum_{t=1}^{t=\infty} \beta^t p \bar{b}_S^{\max} \leq \sum_{t=1}^{t=\infty} \beta^t p \Pi(G,1)$$

leads to

$$\bar{b}_S^{\max} = \frac{\beta p}{1-\beta+\beta p}\Pi(G,1).$$

We assume that it is always efficient to implement $e = 1$. In this case this means that for an equilibrium to yield high effort, $\bar{b}_S^{\max} > \bar{b}_S$ has to hold. This implies that the maximal bonus payment, the firm would be willing to make, is higher than the actual required bonus payment for the worker to exert high effort. Therefore this condition ensures the existence of an equilibrium:

$$\bar{b}_S^{\max} > \bar{b}_S$$

$$\frac{\beta p}{1-\beta+\beta p}\Pi(G,1) > \frac{c-(1-p)\Pi(B,1)}{p}$$

$$\Pi(G,1) > \frac{(1-\beta+\beta p)(\frac{c}{p} - \frac{1-p}{p}\Pi(B,1))}{\beta p}.$$

We can always find a large enough $\Pi(G,1)$ to ensure this.[1]

C.3 A more general Model

C.3.1 Setup of the Model

One firm and one worker are interacting repeatedly with an infinite horizon. The discount factors are β for the firm and δ for the worker.[2] The worker decides whether or

[1] This result deviates from the risk averse case, making it easier to fulfill in the risk neutral case. Because the inverse of a strictly increasing concave function is a convex function, the second term in brackets in the right hand side numerator would be further increased.

[2] While much of the classical literature on relational contracts has been concerned with the question when relational contracts are sustainable, i.e. to find a critical β, we are interested in the patterns of the relational contract and hence implicitly will assume that the discount rates are “high enough” and the relational contract is sustainable.

not to exert costly effort that has a positive effect on the firm's profit. The worker's effort choice is observable by the firm, but is not contractible. To focus on our main argument, we abstract from any explicit performance contracts. The firm has all the bargaining power and makes a take it or leave it offer to the worker.[3]

The worker's utility is increasing and concave in monetary compensation, which takes the form of a contractible base salary, w, and a discretionary bonus, b, and decreasing in effort. The worker decides whether to exert effort, $e = 1$, or shirk, $e = 0$. Thus, her utility in period t is given by $U_t = u(w + b) - c(e)$ with $u' > 0, u'' < 0$. To ease notation we assume $c(e = 0) = 0$ and define $c(e = 1) = c$. The worker's outside option is $\bar{U}$.

There are two states of the world, good and bad (G and B, respectively) that affect the firm's profit. Thus the firm's profits can take on four values: $\Pi(G, e = 1)$, $\Pi(G, e = 0)$, $\Pi(B, e = 1)$, and $\Pi(B, e = 0)$ with $\Pi(G, \cdot) \geq \Pi(B, \cdot)$. To shorten the exposition we denote these values as $\Pi(G, 1)$, $\Pi(G, 0)$, $\Pi(B, 1)$, and $\Pi(B, 0)$, respectively. The exogenously given probability for the good state, G, is π and for the bad state, B, it is $(1 - \pi)$.

The timing of the model is as follows: for each period t, first the contract is offered. Then the worker chooses effort ($e = 0, 1$). The state (G, B) is realized. Afterwards the proifts are realized and the bonus is paid.

We assume that in expectation it is always efficient to implement high effort ($e = 1$), or

$$[\pi\Pi(G, 1) + (1 - \pi)\Pi(B, 1)] - [\pi\Pi(G, 0) + (1 - \pi)\Pi(B, 0)] > c. \tag{C.5}$$

To further ease exposition we assume that $\Pi(B, 0) - \bar{U} = \Pi(G, 0) - \bar{U} = 0$, i.e., if the worker is shirking the surplus being generated is just enough to provide the worker with her outside option in either state.

We are looking for a relational contract that, with a combination of contractible wage and discretionary bonus, implements high effort. A relational contract is a pair of strategies for the firm and the worker that form a Perfect Public Nash Equilibrium. Before finding the relational contract in this case it is illustrative to first consider two bench-

[3] This assumption is relaxed in Section C.3.4 where we allow for unions with varying bargaining power.

mark cases.

Benchmark Case 1: The Stage Game The firm and the worker interact only once. In this case it is obviously impossible to implement high effort. Hence, the firm will employ the worker, pay her a fixed wage w such that $u(w) = \bar{U}$ and the worker will choose $e = 0$.

Benchmark Case 2: A World with Only One (Observable) State Assume that only the good state of the world can occur, i.e., the firm's profit is either $\Pi(G, 1)$ or $\Pi(G, 0)$. In this situation, the following relational contract implements high effort:

> The firm's strategy is to pay the worker a base salary w s.t. $u(w) = \bar{U}$. As long as the worker chooses $e = 1$ the firm also pays a bonus $b_{const} > 0$ (derived in Appendix A) which is implicitly defined by $u(w + b_{const}) - c = \bar{U}$. If the worker chooses $e = 0$ the firm does not pay the bonus in this period and in all subsequent ones. The worker's strategy is to choose $e = 1$ as long as the firm has paid the bonus in all previous periods and to choose $e = 0$ forever as soon as the firm has defaulted on the bonus once.

For the *Benchmark Case 2: A World with Only One (Observable) State* we derive the bonus $b_{const} > 0$ that implements $e = 1$ and the maximum level $\bar{b}^{max}$ this bonus can take such that the firm is still willing to live up to its promises.

Given the firm's strategy the worker's discounted utility from exerting high effort, i.e., cooperating, in the current period is given by

$$\sum_{t=0}^{t=\infty} \delta^t \left(u\left(w + b\right) - c\right) = \frac{u(w + b) - c}{1 - \delta}.$$

The worker's discounted utility from defecting, i.e., choosing $e = 0$ in the current period is given by

$$\sum_{t=0}^{t=\infty} \delta^t \bar{U} = \frac{\bar{U}}{1 - \delta}.$$

As the worker has to be indifferent between choosing $e = 0$ and $e = 1$. This implicitly defines b_{const} – the minimum bonus that implements $e = 1$ – as

$$\sum_{t=0}^{t=\infty} \delta^t \left(u\left(w + b_{const}\right) - c\right) = \sum_{t=0}^{t=\infty} \delta^t \bar{U} \tag{C.6}$$

or equivalently

$$u(w + b_{const}) - c = \bar{U}. \tag{C.7}$$

Given the worker's strategy, the firm has to be at least weakly better off from implementing $e = 1$. The discounted sum of firm's profits from adhering to pay the bonus b in the current period if the worker chose $e = 1$ is given by

$$\sum_{t=0}^{t=\infty} \beta^t \left(\Pi\left(G,1\right) - w - b\right) = \frac{1}{1-\beta}\left(\Pi\left(G,1\right) - w - b\right).$$

The discounted sum of firm's profits from defaulting on b in this period is given by

$$\Pi\left(G,1\right) - w + \sum_{t=1}^{t=\infty} \beta^t \left[\Pi\left(G,0\right) - w\right] \quad = \quad \Pi\left(G,1\right) - w + 0 = \Pi\left(G, e=1\right) - w.$$

Thus the maximum level $\bar{b}^{max}$ that the bonus can take is

$$\begin{aligned} \frac{1}{1-\beta}\left(\Pi\left(G,1\right) - w - \bar{b}^{max}\right) &= \Pi\left(G,1\right) - w \\ \beta\left(\Pi\left(G,1\right) - w\right) &= \bar{b}^{max}. \end{aligned}$$

We assume in condition (C.5) that it always pays to implement $e = 1$. In the case under consideration this amounts to $\bar{b}^{max} > b_{const}$. For this condition to hold we need to assume that effort is sufficiently productive such that $\Pi\left(G,1\right) > \frac{1}{\beta}\nu(\bar{U} + c) + \frac{1}{\beta}w(\beta - 1)$, where $\nu(\cdot)$ is the inverse of the utility function.

Thus, the firm and the worker return to the equilibrium of the stage game once cooperation has broken down.

C.3.2 Symmetric Information

Now we turn attention to the original setting where the state can be either G or B and is observable to the worker. To make this situation interesting we assume that the profits in the bad state are not high enough to pay b_{const} even if the worker has chosen $e = 1$, i.e., $0 < \Pi(B, 1)) - w < b_{const}$. We assume that the firm cannot save or borrow money at the capital market.[4] This assumption is equivalent to assuming that there exists an upper bound on how much the firm can borrow which is lower than what is necessary to pay b_{const} or that the costs from borrowing are sufficiently convex.[5] Thus, implicitly, we assume a situation of "large" shocks. While this assumption has little consequences for equilibrium cooperation in the symmetric information case, it will have a bearing in the asymmetric information case.

In this new situation, the simple contract described in Section 2.1.2 can no longer be used to implement $e = 1$. In the bad states the worker actually gets a utility below his outside option. Therefore, a higher bonus $\bar{b}_S > b_{const}$ in the good states is needed, otherwise the worker will not find it worthwhile to choose $e = 1$ in any state.[6] Therefore, the following relational contract implements high effort in this more complicated situation:

> The firm's strategy is to pay the worker a base salary w s.t. $u(w) = \bar{U}$. As long as the worker chooses $e = 1$, the firm pays in addition a bonus. The bonus is $\bar{b}_S$ if the state of the world is revealed to be a good state and $\underline{b}$ otherwise, where $\bar{b}_S > \underline{b}$ (the values for these bonuses are derived below). If the worker chooses $e = 0$ the firm does not pay the bonus in this period and all subsequent periods. The worker's strategy is to choose $e = 1$ as long as the firm has paid the promised bonus in all previous periods and to choose $e = 0$ forever as soon as the firm has defaulted on the bonus once.

Due to the worker's risk aversion it will be optimal for the firm to minimize the worker's

[4] Obviously, then it has to generally hold that $\Pi(\theta, e) \geq w + b$. We omit an explicit discussion to focus on the interesting aspect of liquidity constraints under shocks.

[5] See Englmaier and Fahn (2014) for a formal exposition in a distinct but related setting, showing that allowing for saving or granting the firm access to the financial market does not undo the results.

[6] The subscript S denotes the case of *symmetric information*. The subscript A, used below, denotes the case of *asymmetric information* about the realization of the state of the world.

wage fluctuation and pay him as much as possible in the bad state. This means that in these bad states the firm foregoes any profits and that $\underline{b}$ is defined by $\Pi(B, e=1) - w - \underline{b} = 0$.

The following condition, derived in Appendix B, implicitly defines the minimum $\bar{b}_S$ necessary to implement $e = 1$:

$$EU_S(\cdot, 1) = \bar{U} \tag{C.8}$$

where $EU_S(\cdot, 1) \equiv \pi u(w + \bar{b}_S) + (1-\pi)u(w + \underline{b}) - c$.

This condition is straightforward to interpret. The relational contract has to generate enough expected utility in the future to make it worthwhile for the worker to forego his outside option and to incur the effort costs.

Due to incentive compatibility, the firm has to prefer to pay the bonus in both states of the world, B and G. Analyzing the problem yields that the condition, derived in Appendix C, for the good state is more restrictive and determines the upper bound for $\bar{b}_S$, $\bar{b}_S^{\max}$, that the firm would be willing to pay in order to implement $e = 1$:

$$\bar{b}_S^{\max} = \frac{\beta\pi}{(1-\beta+\beta\pi)} \left[\Pi(G, e=1) - w\right]. \tag{C.9}$$

If effort is sufficiently productive such that $\Pi(G, 1)$ is sufficiently large (see Appendix C for the exact condition), it will hold that $\bar{b}_S^{\max} > \bar{b}_S$.

The findings above are summarized in the following proposition. Note that the relational contract characterizes the most efficient equilibrium in this game.

Proposition C.3.1. *In a situation with observable stochastic shocks to the firm's profit as described above the following two strategies form an relational contract that implements* $e = 1$:

The worker chooses $e = 1$ *as long as the firm has paid the promised bonuses in all previous periods. Once the firm has defaulted on paying the bonus, the worker chooses* $e = 0$ *forever. The firm pays the base wage* w *and the bonuses,* $\underline{b}$ *in the bad state and* $\bar{b}_S > \underline{b}$ *in the good state, in all periods as long as the worker has always chosen* $e = 1$. *The firm stops paying any bonus immediately after the worker has chosen* $e = 0$ *once.*

$\underline{b}$ *is defined by* $\underline{b} = \Pi(B, 1) - w$, w *is defined by* $u(w) = \bar{U}$, *and* $\bar{b}_S$ *is implicitly defined by* $EU_S(\cdot, 1) = \bar{U}$.

We derive the minimum bonus $\bar{b}_S$ that is necessary to implement $e = 1$.

Recall that in this setting the worker does not know the state of the world when deciding on how much effort to exert but only learns it later. Thus, the discounted sum of the worker's expected utility from exerting effort $e = 1$ is given by

$$\sum_{t=0}^{t=\infty} \delta^t \left[\pi(u(w + \bar{b}_S)) + (1-\pi)\left(u\left(w + \underline{b}\right)\right) - c\right] = \frac{\pi u(w + \bar{b}_S) + (1-\pi)u(w + \underline{b}) - c}{1 - \delta}.$$

The discounted sum of the worker's expected utility from defecting, i.e., choosing $e = 0$ in the current period if the firm fulfilled its promises so far is given by

$$\sum_{t=0}^{t=\infty} \delta^t \bar{U} = \frac{\bar{U}}{1 - \delta}.$$

As the worker has to (weakly) prefer to choose $e = 1$ to $e = 0$, it must be that

$$\pi u(w + \bar{b}_S) + (1-\pi)u(w + \underline{b}) - c \geq \bar{U}.$$

In equilibrium this condition will bind

$$\pi u(w + \bar{b}_S) + (1-\pi)u(w + \bar{b}) - c = \bar{U}.$$

Since $\underline{b}$ is given by $\Pi(B,1) - w - \underline{b} = 0$, this condition implicitly defines $\bar{b}_S$ necessary to implement high effort.

Here we derive the conditions that ensure that the firm prefers to pay the bonus in both states of the world and show that the condition for the good state is more restrictive, determining the upper bound for $\bar{b}_S$, $\bar{b}_S^{\max}$ that the firm would still be willing to pay in order to implement $e = 1$.

The firm has to prefer to pay the bonus in both states of the world, B and G.

The firm's decision in the bad state: The total firm profits if bonus is not paid is the sum of the profit today, $\Pi(B,1) - w$, plus the discounted value of the expected profit tomorrow and for all periods thereafter. The expected profits tomorrow (and in each period thereafter) are given by

$$\pi\left(\Pi(G,0) - w\right) + (1-\pi)\left(\Pi(B,0) - w\right) = \pi 0 + (1-\pi)\, 0 = 0.$$

Thus the discounted sum of a firm's profit if it defaults on the bonus is given by

$$\Pi(B,1) - w + \sum_{t=1}^{t=\infty} \beta^t 0 = \Pi(B,1) - w.$$

The total expected firm's profit if the bonus is paid and the state is bad is given by the sum of the profit today, $\Pi(B,1) - w - \underline{b} = 0$, and the discounted value of the expected profit tomorrow and for all periods thereafter. In this case, the expected profits tomorrow (and in each period thereafter) are given by

$$\begin{aligned} \pi\left[\Pi(G,1) - w - \bar{b}_S\right] + (1-\pi)\left[\Pi(B,1) - w - \underline{b}\right] &= \\ \pi\left[\Pi(G,1) - w - \bar{b}_S\right] + (1-\pi)\, 0 &= \pi\left[\Pi(G,1) - w - \bar{b}_S\right]. \end{aligned}$$

The firm has to (weakly) prefer paying the bonus, thus

$$\begin{aligned}\Pi(B,1)-w &\leq \sum_{t=1}^{t=\infty}\beta^t\pi\left[\Pi(G,1)-w-\bar{b}_S\right]\\ \Pi(B,1)-w+\sum_{t=1}^{t=\infty}\beta^t\pi\bar{b}_S &\leq \sum_{t=1}^{t=\infty}\beta^t\pi\left[\Pi(G,1)-w\right].\end{aligned}$$

The firm's decision in the good state: The total firm profit if it defaults on the bonus and the state is good is the sum of the profit today, $\Pi(G,1)-w$, plus the discounted value of the expected profit tomorrow and for all periods thereafter, $\pi\left[\Pi(G,0)-w\right]=0$. Thus the discounted sum is given by

$$\Pi(G,1)-w+\sum_{t=1}^{t=\infty}\beta^t 0=\Pi(G,1)-w.$$

The total firm profit if the bonus is paid and the state is good is the sum of the profit today, $\Pi(G,1)-w-\bar{b}_S$, plus the discounted value of the expected profit tomorrow and for all periods thereafter, $\pi\left[\Pi(G,1)-w-\bar{b}_S\right]$. Thus the discounted sum is given by

$$\left[\Pi(G,1)-w-\bar{b}_S\right]+\sum_{t=1}^{t=\infty}\beta^t\pi\left[\Pi(G,1)-w-\bar{b}_S\right].$$

The firm has to (weakly) prefer to pay the bonus, i.e.,

$$\begin{aligned}\Pi(G,1)-w &\leq \Pi(G,1)-w-\bar{b}_S+\sum_{t=1}^{t=\infty}\beta^t\pi\left[\Pi(G,1)-w-\bar{b}_S\right]\\ \bar{b}_S+\sum_{t=1}^{t=\infty}\beta^t\pi\bar{b}_S &\leq \sum_{t=1}^{t=\infty}\beta^t\pi\left[\Pi(G,1)-w\right].\end{aligned}$$

Now we compare the two conditions for the firm in the good and the bad states:

$$\begin{aligned}&\text{state } G && \bar{b}_S+\sum_{t=1}^{t=\infty}\beta^t\pi\bar{b}_S \leq \sum_{t=1}^{t=\infty}\beta^t\pi\left[\Pi(G,1)-w\right]\\ &\text{state } B && \Pi(B,1)-w+\sum_{t=1}^{t=\infty}\beta^t\pi\bar{b}_S \leq \sum_{t=1}^{t=\infty}\beta^t\pi\left[\Pi(G,1)-w\right].\end{aligned}$$

Note that the right hand side of both conditions is identical. Furthermore, by the assumptions made above it is implied that $\Pi(B,1) - w < \bar{b}_S$. Thus, the condition in the good state G is more restrictive and determines implicitly the upper bound for $\bar{b}_S$, $\bar{b}_S^{\max}$, that the firm would be willing to pay in order to implement $e = 1$. Therefore,

$$\begin{aligned}
\bar{b}_S^{\max} + \sum_{t=1}^{t=\infty} \beta^t \pi \bar{b}_S^{\max} &= \sum_{t=1}^{t=\infty} \beta^t \pi \left[\Pi(G,1) - w\right] \\
\bar{b}_S^{\max} &= \frac{\beta\pi}{(1-\beta+\beta\pi)} \left[\Pi(G,1) - w\right].
\end{aligned}$$

We assume in condition (C.5) that it always efficient to implement $e = 1$. In this case this means that for an equilibrium to yield high effort, $\bar{b}_S^{\max} > \bar{b}_S$ has to hold. Substituting for $\underline{b}$, for this condition to hold it must be that

$$\Pi(G,1) > \frac{(1-\beta+\beta\pi)\,\nu\left(\frac{1}{\pi}\left[(\bar{U}+c) - (1-\pi)u(\Pi(B,1))\right]\right) - (1-\beta)w}{\beta\pi},$$

where $\nu(\cdot)$ is the inverse of the utility function. We can always find a large enough $\Pi(G,1)$ to ensure this.

C.3.3 Asymmetric Information Model

Having characterized the symmetric case, we now investigate the asymmetric one. Thus, we assume that the true state of the world, G or B, is only observable to the firm. As a result, the relational contract described in Proposition 1 can no longer implement $e = 1$ as the firm always has an incentive to claim that the state is B and save $\bar{b}_S - \underline{b}$ in bonus payments. In this new environment the relational contract has to be refined. We focus on a "simple" equilibrium to implement cooperation and truthtelling and follow the arguments in Green and Porter (1984) or Radner (1985) and amend the equilibrium strategies such that whenever the firm announces that the state is B and the bonus payment will be $\underline{b}$ a conflict (or punishment) phase follows. The conflict lasts for T periods in which the worker chooses $e = 0$ and only w is paid, i.e., the equilibrium of the stage game is played.[7] After these T periods the firm and the worker revert to the cooperative equilibrium in which the firm pays a bonus $\bar{b}_A$ whenever the state is good and the worker chooses $e = 1$. Another bad state with a bonus payment of $\underline{b}$ then triggers a new conflict phase.

Note that we do not have to check again that it is optimal for the firm not to default completely on the bonus. This would be detected by the worker and the condition is qualitatively the same as the one under symmetric information. However, for this new pair of strategies to form an equilibrium it has to hold that:

a) The firm prefers to announce the state truthfully,

b) the worker prefers to execute the punishment, and

c) the worker prefers to choose $e = 1$ as long as the bonuses are paid (and the game is not in a conflict phase).

We check these conditions now, starting with a). For the firm to prefer to announce the state truthfully the expected profits from this strategy have to exceed the expected profits from defecting. We only have to check this for the good state as the firm cannot deviate from truthtelling in the bad state as it cannot pay the high bonus.

By announcing state B when the actual state is G the firm saves $\bar{b}_A - \underline{b}$ on bonus payments. However, by announcing state B the firm triggers a conflict phase of T periods.

Denote the continuation value of the firm's profits from cooperating (i.e., announcing the state truthfully) if the state is G and if the state is B as $V_F^C(G, 1)$ and $V_F^C(B, 1)$, respectively. The continuation value of the firm's profits in the beginning of the conflict or punishment period is denoted by $V_F^P(\cdot, 0)$. The following equations define these

[7] Note that we abstract from divisibility issues in deriving T to ease the exposition of our arguments. To close the gap to our continuous formulation, there would have to be a public randomization with suitably chosen probabilities that would determine whether the last period of punishment is executed or whether the conflict phase is ended.

continuation values.

$$\begin{aligned}
V_F^C(G,1) &= \Pi(G,1) - w - \bar{b}_A + \beta\left[\pi V_F^C(G,1) + (1-\pi)V_F^C(B,1)\right] \\
V_F^C(B,1) &= 0 + \beta V_F^P(\cdot,0) = \beta V_F^P(\cdot,0) \\
V_F^P(\cdot,0) &= \sum_{t=0}^{t=T-1} \beta^t 0 + \beta^T\left[\pi V_F^C(G,1) + (1-\pi)V_F^C(B,1)\right] \\
&= \beta^T\left[\pi V_F^C(G,1) + (1-\pi)V_F^C(B,1)\right].
\end{aligned}$$

Solving these equations we get that

$$V_F^C(G,1) = \left[\Pi(G,1) - w - \bar{b}_A\right]\frac{1-(1-\pi)\beta^{T+1}}{1-(1-\pi)\beta^{T+1}-\beta\pi} \quad \text{(C.10)}$$

$$V_F^C(B,1) = \left[\Pi(G,1) - w - \bar{b}_A\right]\frac{\beta^{T+1}\pi}{1-(1-\pi)\beta^{T+1}-\beta\pi} \quad \text{(C.11)}$$

$$V_F^P(\cdot,0) = \left[\Pi(G,1) - w - \bar{b}_A\right]\frac{\beta^{T}\pi}{1-(1-\pi)\beta^{T+1}-\beta\pi}. \quad \text{(C.12)}$$

The continuation value of the firm's profits if it announces state B when the true state is G (i.e. if the firm *defects*), $V_F^D(G,1)$, is given by

$$V_F^D(G,1) = \Pi(G,1) - w - \underline{b} + \beta V_F^P(\cdot,0).$$

Substituting for $V_F^P(\cdot,0)$ and rearranging we get that

$$V_F^D(G,1) = \left[\Pi(G,1) - w - \underline{b}\right] + \left[\Pi(G,1) - w - \bar{b}_A\right]\frac{\beta^{T+1}\pi}{1-(1-\pi)\beta^{T+1}-\beta\pi}. \quad \text{(C.13)}$$

The firm has to prefer to announce the state truthfully. Thus it has to hold that $V_F^D(G,1) < V_F^C(G,1)$, or more explicitly that

$$\left[\Pi(G,1) - w - \underline{b}\right] < \left[\Pi(G,1) - w - \bar{b}_A\right]\left[\frac{1-\beta^{T+1}}{1-(1-\pi)\beta^{T+1}-\beta\pi}\right].$$

Note that $\frac{1-\beta^{T+1}}{1-(1-\pi)\beta^{T+1}-\beta\pi}$ is increasing in T. Moreover, for $T=0$ the condition above is violated as it would imply that $\left[\Pi(G,1) - w - \underline{b}\right] < \left[\Pi(G,1) - w - \bar{b}_A\right]$ and thus that $\bar{b}_A < \underline{b}$, which as we know cannot be true. Thus, there exists a $T^* > 0$ for which the condition above holds. In equilibrium the firm will be just indifferent and thus

$$[\Pi(G,1) - w - \underline{b}] \frac{1-(1-\pi)\beta^{T^*+1} - \beta\pi}{1-\beta^{T^*+1}} - \left[\Pi(G,1) - w - \bar{b}_A\right] = 0 \qquad \text{(C.14)}$$

implicitly defines the efficient length of the conflict phase T^*.

Now we check condition b), namely that the worker prefers to execute the punishment. Given the strategy of the firm, i.e., pay w such that $u(w) = \bar{U}$ for T^* periods after announcing state B, exerting high effort will not benefit the worker as no bonus is being paid. Thus the worker has no incentive to choose $e = 1$ in these T^* periods.

Finally we check condition c) and show that as long as the firm has never defaulted on the bonus the worker prefers to choose $e = 1$. The worker does not know which state will realize when she makes her effort choice, and thus does not know whether she will receive a bonus $\underline{b}$ or $\bar{b}_A$. Define the worker's expected utility as

$$\pi u(w + \bar{b}_A) + (1-\pi)\, u(w + \underline{b}) - c = EU_A(\cdot, 1) - c.$$

The continuation value for the worker's utility from exerting high effort if the firm fulfilled its promises, V_W^C, is given by

$$V_W^C = EU_A(\cdot,1) - c + \delta\left(\pi V_W^C + (1-\pi) V_W^P\right)$$

where V_W^P denotes the continuation value for the worker's utility at the beginning of a conflict (or punishment) phase which is defined as

$$V_W^P = \sum_{t=0}^{T-1} \delta^t \bar{U} + \delta^T V_W^C = \bar{U}\frac{1-\delta^T}{1-\delta} + \delta^T V_W^C.$$

We can use these two expressions to solve for V_W^C

$$\begin{aligned} V_W^C &= EU_A(\cdot,1) - c + \delta\left(\pi V_W^C + (1-\pi) V_W^P\right) \\ &= EU_A(\cdot,1) - c + \delta\left(\pi V_W^C + (1-\pi)(\bar{U}\frac{1-\delta^T}{1-\delta} + \delta^T V_W^C)\right). \end{aligned}$$

Rearranging then yields

$$V_W^C = \left(EU_A(\cdot,1) - c + \delta(1-\pi)\bar{U}\frac{1-\delta^T}{1-\delta} \right) \frac{1}{1-\delta\pi-(1-\pi)\delta^{T+1}}. \qquad \text{(C.15)}$$

The continuation value for the worker's utility from defecting and exerting low effort even though the firm did not default on its promises and the game is not in the conflict phase, V_W^D, is given by

$$V_W^D = \sum_{t=0}^{\infty} \delta^t \bar{U} = \frac{\bar{U}}{1-\delta}, \qquad \text{(C.16)}$$

i.e., outside the conflict periods, when the worker chooses $e = 0$ she will get no bonus now or forever after and is just left with her outside option utility, $\bar{U}$.

To ensure incentive compatibility the worker has to weakly prefer to choose $e = 1$, i.e., $V_W^C \geq V_W^D$, which will be binding in equilibrium. Therefore

$$\left(EU_A(\cdot,1) - c + \delta(1-\pi)\bar{U}\frac{1-\delta^T}{1-\delta} \right) \frac{1}{1-\delta\pi-(1-\pi)\delta^{T+1}} = \frac{\bar{U}}{1-\delta}$$

which simplifies to

$$EU_A(\cdot,1) - c = \bar{U}, \qquad \text{(C.17)}$$

i.e., the same condition as under symmetric information. Hence it holds that $\bar{b}_S = \bar{b}_A = \bar{b}$ and the agent is again held down to her outside option.

We summarize these findings in the following proposition.

Proposition C.3.2. *In a situation in which stochastic shocks to the firm's profits can only be observed by the firm itself, the following two strategies form an relational contract that implements* $e = 1$ *:*

In a cooperation period, the worker chooses $e = 1$ *as long as the firm has not announced a bad state and has always paid the promised bonuses,* $\underline{b}$ *in the bad state and* $\bar{b}$ *in the good state, in all previous cooperation periods. When the firm announces the bad state and pays* $\underline{b}$ *a conflict phase, lasting* T^* *periods, starts where in each period the worker chooses* $e = 0$*. Thereafter the worker moves back to cooperating, i.e., choosing* $e = 1$ *as long as the firm announces the good state and pays the bonus. Once the firm has defaulted on paying the bonus in a cooperation period the worker chooses* $e = 0$ *forever. The firm pays the base wage* w *and the bonus,* $\underline{b}$ *in the bad state and* $\bar{b}$ *in the good state, in all cooperation periods as long as the worker has always chosen* $e = 1$ *in the previous cooperation periods. After a bad state has occurred the firm pays no bonus for the next* T^* *periods. The firm stops paying any bonus immediately after the worker has once chosen* $e = 0$ *in a cooperation period.*

$\underline{b}$ *is defined by* $\Pi(B,1) - w = \underline{b}$*,* w *is defined by* $u(w) = \bar{U}$*, and* $\bar{b}$ *and* T^* *are implicitly defined by the following conditions:*

$$
\begin{aligned}
EU_A(\cdot,1) - c - \bar{U} &= 0 \\
[\Pi(G,1) - w - \underline{b}]\,\frac{1-(1-\pi)\beta^{T^*+1}-\beta\pi}{1-\beta^{T^*+1}} - \left[\Pi(G,1) - w - \bar{b}\right] &= 0.
\end{aligned}
$$

To clarify the mechanics of the model, in Appendix D we consider a couple of comparative statistic derivations. Based on these comparative statics it becomes clear that equilibrium inefficiencies are gravest in past-their-prime (low β), highly volatile (low π), and more liquidity constraint (low $\underline{b}$) industries.

C.3.4 The Role of Unions

Suppose a union's power is captured by σ with $\sigma \in [0,1]$. On the one hand, σ captures the bargaining power of the union, i.e., the more powerful the union is (i.e., the larger is σ) the bigger share of surplus the union can secure.[8] In addition, unique to our setting, a stronger union is more likely to verify a firm's claim that the state of the world is bad. Thus, not all (truthful) claims by the firm that the state of the world is bad will necessary lead to a conflict phase. To simplify the exposition we use σ to denote both the share of profits the union can secure to the worker and the probability that the union will verify that the state of the world is indeed bad. The results below do not depend on this specific assumption, which can be relaxed easily. For example, define the power of the union to appropriate rents as σ and the probability that the union can verify the state of the world as $f(\sigma)$, with $f' > 0$. Our results hold also for this flexible formulation. In any case, the equilibrium strategies are analogous to the ones in the asymmetric information case.

When investing high effort, the worker's utility in the good state is given by $U(G,1) = u(w + \bar{b}^{\sigma}_{A} + \sigma(\Pi(G,1) - w - \bar{b}^{\sigma}_{A})) - c = u(\sigma\Pi(G,1) + (1-\sigma)(w + \bar{b}^{\sigma}_{A})) - c$, where $\bar{b}^{\sigma}_{A}$ is the bonus in the good state. Similarly, in the bad state, the worker's utility is given by $U(B,1) = u(\sigma\Pi(B,1) + (1-\sigma)(w + \underline{b}^{\sigma})) - c$, where $\underline{b}^{\sigma}$ is the bonus in the bad state. Therefore, we can define the worker's expected utility from exerting effort as

$$EU_{A,\sigma}(\cdot,1;\sigma) = \pi u\left(\sigma\Pi(G,1) + (1-\sigma)(w + \bar{b}^{\sigma}_{A})\right) + (1-\pi)u\left(\sigma\Pi(B,1) + (1-\sigma)(w + \underline{b}^{\sigma})\right) - c$$

To see that the worker will indeed prefer to choose $e = 1$ as long as the bonuses are paid (and the game is not in a conflict phase) we apply the same arguments as before. We denote the continuation value for the worker's utility from exerting high effort in a cooperation period if the firm fulfilled its promises, $V^{C}_{W,\sigma}$. This value is given by

$$V^{C}_{W,\sigma} = EU_{A,\sigma}(\cdot,1;\sigma) - c + \delta\left(\pi V^{C}_{W,\sigma} + (1-\pi)\left[\sigma V^{C}_{W,\sigma} + (1-\sigma)V^{P}_{W,\sigma}\right]\right)$$

where $V^{P}_{W,\sigma}$ denotes the continuation value for the worker's utility at the beginning of a

[8] Following the above intuition of the collective action problem, suppose that a stronger union - standing to earn a higher rent - has stronger incentives to invest in getting informed.

conflict (or punishment) phase, which is defined as

$$V_{W,\sigma}^{P} = \sum_{t=0}^{T-1} \delta^t \bar{U} + \delta^T V_{W,\sigma}^{C} = \bar{U}\frac{1-\delta^T}{1-\delta} + \delta^T V_{W,\sigma}^{C}.$$

We use these two expressions to solve for $V_{W,\sigma}^{C}$ and we get that

$$V_{W,\sigma}^{C} = \frac{(1-\delta)\left(EU_{A,\sigma}(\cdot,1;\sigma) - c\right) + (1-\sigma)\delta(1-\pi)\bar{U}(1-\delta^T)}{(1-\delta)\left(1-\delta(\pi+(1-\pi)\sigma) - (1-\pi)(1-\sigma)\delta^{T+1}\right)}. \tag{C.18}$$

Note that for $\sigma \to 0$, i.e., union power is negligible we get the exact same condition that we got in the case without unions.

The continuation value for the worker's utility from defecting and exerting low effort even though the firm did not default on its promises, $V_{W,\sigma}^{D}$, is given by

$$V_{W,\sigma}^{D} = \sum_{t=0}^{\infty} \delta^t \bar{U} = \frac{\bar{U}}{1-\delta}. \tag{C.19}$$

To ensure incentive compatibility the worker has to weakly prefer to choose $e = 1$, i.e., $V_{W,\sigma}^{C} \geq V_{W,\sigma}^{D}$, which gives us (similarly to the no-union case)

$$\pi u\left(\sigma\Pi(G,1) + (1-\sigma)(w+\bar{b}_A^{\sigma})\right) + (1-\pi)u\left(\sigma\Pi(B,1) + (1-\sigma)(w+\underline{b}^{\sigma})\right) - c \geq \bar{U} \tag{C.20}$$

This condition is qualitatively the same condition as the one in the absence of unions. However, note that now it is possible that this condition holds already for $\bar{b}_A^{\sigma} = 0$ and possibly also for $\underline{b}^{\sigma} = 0$ if σ is high enough. In case that it does not, the firm needs to pay bonuses and then the condition will hold with equality. Note that when σ is low, the firm would like to set $\underline{b}^{\sigma} = \Pi(B,1) - w$, as was the case in the absence of unions for the same reason. Namely, due to the worker's risk aversion it is cheaper for the firm to minimize the worker's wage fluctuations. Define $\bar{\sigma}$ as the union power that solves the equation:

$$\pi u\left(\bar{\sigma}\Pi(G,1) + (1-\bar{\sigma})w\right) + (1-\pi)u\left(\Pi(B,1)\right) - c = \bar{U}.$$

Therefore, $\bar{\sigma}$ is the highest value of σ for which the firm will still pay a bonus in the good state of the world. Note that as σ increases beyond $\bar{\sigma}$, the firm can still make condition (C.20) hold with equality if it lowers the bonus in the bad state. Though there will be a value of σ, denoted by $\bar{\sigma}_H$ above which the worker's participation constraint, i.e., equation (C.20), will be slack. This value is determined by the equation: $\pi u\left(\bar{\sigma}_H \Pi\left(G,1\right)+(1-\bar{\sigma}_H)(w)\right)+(1-\pi)u\left(\bar{\sigma}_H \Pi\left(B,1\right)+(1-\sigma)w\right)-c=\bar{U}$. Therefore,

$$\bar{b}_A^{\sigma}=\begin{cases}\pi u\left(\sigma\Pi\left(G,1\right)+(1-\sigma)(w+\bar{b}_A^{\sigma})\right)+(1-\pi)u\left(\Pi\left(B,1\right)\right)-c=\bar{U} & \text{if } \sigma\leq\bar{\sigma}\\ 0 & \text{Otherwise}\end{cases}\tag{C.21}$$

and

$$\underline{b}^{\sigma}=\begin{cases}\Pi\left(B,1\right)-w=\Pi\left(B,1\right)-\bar{U} & \text{if } \sigma\leq\bar{\sigma}\\ \pi u\left(\sigma\Pi\left(G,1\right)+(1-\sigma)w\right)+(1-\pi)u\left(\sigma\Pi\left(B,1\right)+(1-\sigma)(w+\underline{b}^{\sigma})\right)-c=\bar{U} & \text{if } \bar{\sigma}<\sigma\leq\bar{\sigma}_H\\ 0 & \text{Otherwise.}\end{cases}\tag{C.22}$$

Now we turn to the firm's decision problem. In the good state of the world the firm's profits are $(1-\sigma)(\Pi\left(G,1\right)-w-\bar{b}_A^{\sigma})$, while in the bad state the firm's profits are given by: $(1-\sigma)(\Pi\left(B,1\right)-w-\underline{b}^{\sigma})$. If $\sigma>\bar{\sigma}$ the firms will have profits in the bad state, too.

Remembering that conditional on the firm announcing B, the union and hence the worker gets informed with probability σ that the state of the world is indeed B, we denote by $V_{F,\sigma}^{C}\left(G,1;\sigma\right)$ and $V_{F,\sigma}^{C}\left(B,1;\sigma\right)$ the continuation value of the firm's profits from cooperating, i.e., announcing the state truthfully. The continuation value of the firm's profits at the beginning of a conflict (or punishment) period is denoted by $V_{F,\sigma}^{P}\left(\cdot,0;\sigma\right)$. The following equations define these continuation values:

$$\begin{aligned}
V_{F,\sigma}^{C}\left(G,1;\sigma\right) &= (1-\sigma)\left(\Pi\left(G,1\right)-w-\bar{b}_A^{\sigma}\right)+\beta\left[\pi V_{F,\sigma}^{C}\left(G,1;\sigma\right)+(1-\pi)V_{F,\sigma}^{C}\left(B,1;\sigma\right)\right]\\
V_{F,\sigma}^{C}\left(B,1;\sigma\right) &= (1-\sigma)\left(\Pi\left(B,1\right)-w-\underline{b}^{\sigma}\right)+\\
&\quad +\beta\left((1-\sigma)V_{F,\sigma}^{P}\left(\cdot,0;\sigma\right)+\sigma\left[\pi V_{F,\sigma}^{C}\left(G,1;\sigma\right)+(1-\pi)V_{F,\sigma}^{C}\left(B,1;\sigma\right)\right]\right)\\
V_{F,\sigma}^{P}\left(\cdot,0;\sigma\right) &= \sum^{T}\beta^{t}0+\beta^{T}\left[\pi V_{F,\sigma}^{C}\left(G,1;\sigma\right)+(1-\pi)V_{F,\sigma}^{C}\left(B,1;\sigma\right)\right]\\
&= \beta^{T}\left[\pi V_{F,\sigma}^{C}\left(G,1;\sigma\right)+(1-\pi)V_{F,\sigma}^{C}\left(B,1;\sigma\right)\right].
\end{aligned}$$

We can use these expressions to solve for the continuation values

$$V^{C}_{F,\sigma}(G,1;\sigma) = \frac{(1-\sigma)[\Pi(G,1)-w-\bar{b}^{\sigma}_{A}]\left[1-\beta(1-\pi)\left(\beta^{T}(1-\sigma)+\sigma\right)\right]+\beta(1-\sigma)(1-\pi)[\Pi(B,1)-w-\underline{b}^{\sigma}]}{1-\beta(1-\pi)[\beta^{T}(1-\sigma)+\sigma]-\beta\pi} \quad (C.23)$$

$$V^{C}_{F,\sigma}(B,1;\sigma) = \frac{\beta\pi(1-\sigma)\left[\beta^{T}(1-\sigma)+\sigma\right]\left[\Pi(G,1)-w-\bar{b}^{\sigma}_{A}\right]+(1-\sigma)(1-\beta\pi)[\Pi(B,1)-w-\underline{b}^{\sigma}]}{1-\beta(1-\pi)[\beta^{T}(1-\sigma)+\sigma]-\beta\pi} \quad (C.24)$$

$$V^{P}_{F,\sigma}(\cdot,0;\sigma) = \beta^{T}(1-\sigma)\frac{\pi\left[\Pi(G,1)-w-\bar{b}^{\sigma}_{A}\right]+(1-\pi)[\Pi(B,1)-w-\underline{b}^{\sigma}]}{1-\beta(1-\pi)[\beta^{T}(1-\sigma)+\sigma]-\beta\pi}. \quad (C.25)$$

The continuation value of the firm's profits from defecting, i.e., announcing a state B when the true state is G, $V^{D}_{F,\sigma}(G,1;\sigma)$, is given by

$$V^{D}_{F,\sigma}(G,1;\sigma) = \Pi(G,1) - w - \underline{b}^{\sigma} - \sigma(\Pi(B,1) - w - \underline{b}^{\sigma}) + \frac{\beta^{T+1}(1-\sigma)^{2}\left[\pi\left[\Pi(G,1)-w-\bar{b}^{\sigma}_{A}\right]+(1-\pi)[\Pi(B,1)-w-\underline{b}^{\sigma}]\right]}{1-\beta(1-\pi)[\beta^{T}(1-\sigma)+\sigma]-\beta\pi}.$$

The firm has to prefer to announce the state truthfully. Thus it has to hold that

$$V^{D}_{F,\sigma}(G,1;\sigma) \leq V^{C}_{F,\sigma}(G,1;\sigma).$$

Substituting and rearranging the equations above yields

$$\sigma(\Pi(G,1) - \Pi(B,1)) + (1-\sigma)[\bar{b}^{\sigma}_{A} - \underline{b}^{\sigma}] \leq \frac{\beta(1-\sigma)\left[1-(1-\sigma)\beta^{T}\right]\left[\pi[\Pi(G,1)-w-\bar{b}^{\sigma}_{A}]+(1-\pi)[\Pi(B,1)-w-\underline{b}^{\sigma}]\right]}{1-\beta(1-\pi)[\beta^{T}(1-\sigma)+\sigma]-\beta\pi} \quad (C.26)$$

First, note that if $\sigma = 1$ then the firm will prefer to lie and announce that the state of the world is B when it is in fact G. The intuition in obvious, in this case the firm relinquishes all its profits to the workers, and hence defection – which has a positive value – is attractive from its perspective. We know that when $\sigma = 0$ there exists T^{*} such that condition (C.26) holds with equality. When σ increases, the LHS of condition (C.26) stays the same, while the RHS increases. Therefore there will be a solution with $T < T^{*}$. Therefore, there must be a range of σ-values for which condition (C.26) holds. We denote the largest σ-value for which condition (C.26) holds by $\tilde{\sigma}$. We summarize these findings in the following proposition.

Proposition C.3.3. *In a situation in which stochastic shocks to the firm's profits can only be observed by the firm itself and the worker is part of a union of power $\sigma \leq \tilde{\sigma}$, the following two strategies form an relational contract that implements $e = 1$:*

In a cooperation period, the worker chooses $e = 1$ as long as 1. the firm either announced a good state or announced a bad state that was verified by the union and 2. the firm has always paid the promised bonuses, $\underline{b}$ in the bad state and $\bar{b}^{\sigma}_{A}$ in the good state, in all previous cooperation periods. When the firm announces a bad state that the union cannot verify the firm pays $\underline{b}$ and a conflict phase, lasting $T^{*}_{A,\sigma}$ periods, starts where in each period the worker chooses $e = 0$. Thereafter the worker moves back to cooperating, i.e., choosing $e = 1$ as long as the firm pays the bonus and announces the good state or the union can verify that the stat is bad. Once the firm has defaulted on paying the bonus in a cooperation period the worker chooses $e = 0$ forever. The firm pays the base wage w and the bonus, $\underline{b}^{\sigma}$ in the bad state and $\bar{b}^{\sigma}_{A}$ in the good state, in all cooperation periods as long as the worker has always chosen $e = 1$ in the previous cooperation periods. After a bad state that the union could not verify has occurred the firm pays no bonus for the next $T^{*}_{A,\sigma}$ (punishment) periods. The firm stops paying any bonus immediately after the worker has once chosen $e = 0$ in a cooperation period.

w is defined by $u(w) = \bar{U}$, and $\underline{b}^{\sigma}$, $\bar{b}^{\sigma}_{A}$ and $T^{*}_{A,\sigma}$ are implicitly defined by the following conditions:

$$\bar{b}^{\sigma}_{A} = \begin{cases} \pi u\left(\sigma\Pi\left(G,1\right) + (1-\sigma)(w + \bar{b}^{\sigma}_{A})\right) + (1-\pi)u\left(\Pi\left(B,1\right)\right) - c = \bar{U} & \textit{if } \sigma \leq \bar{\sigma} \\ 0 & \textit{Otherwise} \end{cases}$$

$$\underline{b}^{\sigma} = \begin{cases} \Pi\left(B,1\right) - w = \Pi\left(B,1\right) - \bar{U} & \textit{if } \sigma \leq \bar{\sigma} \\ \pi u\left(\sigma\Pi\left(G,1\right) + (1-\sigma)w\right) + (1-\pi)u\left(\sigma\Pi\left(B,1\right) + (1-\sigma)(w + \underline{b}^{\sigma})\right) - c = \bar{U} & \textit{if } \bar{\sigma} < \sigma \leq \bar{\sigma}_{H} \\ 0 & \textit{Otherwise} \end{cases}$$

$$\sigma(\Pi\left(G,1\right) - \Pi\left(B,1\right)) + (1-\sigma)[\bar{b}^{\sigma}_{A} - \underline{b}^{\sigma}] \leq \frac{\beta(1-\sigma)\left[1-(1-\sigma)\beta^{T^{*}_{A,\sigma}}\right]\left[\pi[\Pi(G,1)-w-\bar{b}^{\sigma}_{A}]+(1-\pi)[\Pi(B,1)-w-\underline{b}^{\sigma}]\right]}{1-\beta(1-\pi)\left[\beta^{T^{*}_{A,\sigma}}(1-\sigma)+\sigma\right]-\beta\pi}.$$

Next we investigate whether a firm will want to cede power to a union. Meaning, assuming that the firm can decide on the size of σ, will it choose a positive one? The firm's problem is given by:

$$\underset{\sigma,\bar{b}^{\sigma}_{A},\underline{b}^{\sigma}}{\text{Max}} \frac{\pi\left[\Pi\left(G,1\right)-w-\bar{b}^{\sigma}_{A}\right]+(1-\pi)\left[\Pi\left(B,1\right)-w-\underline{b}^{\sigma}\right]}{1-\beta(1-\pi)\left[\beta^{T}(1-\sigma)+\sigma\right]-\beta\pi}$$

s.t.

$$\pi u\left(\sigma\Pi\left(G,1\right)+(1-\sigma)(w+\bar{b}^{\sigma}_{A})\right)+(1-\pi)u\left(\sigma\Pi\left(B,1\right)+(1-\sigma)(w+\underline{b}^{\sigma})\right)-c\geq\bar{U}$$

$$\sigma(\Pi\left(G,1\right)-\Pi\left(B,1\right))+(1-\sigma)[\bar{b}^{\sigma}_{A}-\underline{b}^{\sigma}]\leq\frac{\beta(1-\sigma)\left[1-(1-\sigma)\beta^{T}\right]\left[\pi[\Pi(G,1)-w-\bar{b}^{\sigma}_{A}]+(1-\pi)[\Pi(B,1)-w-\underline{b}^{\sigma}]\right]}{1-\beta(1-\pi)[\beta^{T}(1-\sigma)+\sigma]-\beta\pi}(IC).$$

The first order conditions are given by:

$$\frac{-\pi\left[[\Pi(G,1)-w-\bar{b}^{\sigma}_{A}]+(1-\sigma)\frac{d\bar{b}^{\sigma}_{A}}{d\sigma}\right]-(1-\pi)\left[[\Pi(B,1)-w-\underline{b}^{\sigma}]+(1-\sigma)\frac{d\underline{b}^{\sigma}}{d\sigma}\right]}{1-\beta(1-\pi)[\beta^{T}(1-\sigma)+\sigma]-\beta\pi}+ \\ +\frac{\beta(1-\sigma)(1-\pi)[1-\beta^{T}]\left[\pi[\Pi(G,1)-w-\bar{b}^{\sigma}_{A}]+(1-\pi)[\Pi(B,1)-w-\underline{b}^{\sigma}]\right]}{[1-\beta(1-\pi)[\beta^{T}(1-\sigma)+\sigma]-\beta\pi]^{2}}. \tag{C.27}$$

The interpretation of this condition is straightforward, The second term is the increase in the profits as a result of unions decreasing the occurrence of conflict periods. The first term capures the effect that an increase in union power has on the division of profits. It can be divided into two. The term

$$\frac{-\pi\left[[\Pi(G,1)-w-\bar{b}^{\sigma}_{A}]+\frac{d\bar{b}^{\sigma}_{A}}{d\sigma}\right]-(1-\pi)\left[[\Pi(B,1)-w-\underline{b}^{\sigma}]+\frac{d\underline{b}^{\sigma}}{d\sigma}\right]}{1-\beta(1-\pi)[\beta^{T}(1-\sigma)+\sigma]-\beta\pi}$$

captures the loss in revenues due to ceding a share σ to the workers. However, as the worker gets a share of the revenue in all state, smaller bonuses are needed to ensure high effort. Therefore, the term

$$\sigma\frac{\pi\frac{d\bar{b}^{\sigma}_{A}}{d\sigma}+(1-\pi)\frac{d\underline{b}^{\sigma}}{d\sigma}}{1-\beta(1-\pi)[\beta^{T}(1-\sigma)+\sigma]-\beta\pi}$$

captures an increase in profits due to this decrease in bonus payments. We next consider the different cases to see whether the firm will decide to cede any power to the union.

First, let us consider the case in which $\sigma\leq\bar{\sigma}$. Calculating the derivatives of equations for $\underline{b}^{\sigma}$ and $\bar{b}^{\sigma}_{A}$, we know that in this case $\frac{d\underline{b}^{\sigma}}{d\sigma}=0$ and $\frac{d\bar{b}^{\sigma}_{A}}{d\sigma}=-\frac{\Pi(G,1)-w-\bar{b}^{\sigma}_{A}}{1-\sigma}$. Therefore, condition (C.27) is reduced to $\frac{\beta(1-\pi)[1-\beta^{T}]}{[1-\beta(1-\pi)[\beta^{T}(1-\sigma)+\sigma]-\beta\pi]^{2}}$, which is always positive. Hence, as long as the firm's incentive compatibility constraint holds, the firm will choose union power which is at least as large as $\bar{\sigma}$.

Next we consider the case in which $\sigma > \bar{\sigma}_H$. In that case, $\bar{b}_A^\sigma = \underline{b}^\sigma = \frac{d\underline{b}^\sigma}{d\sigma} = \frac{d\bar{b}_A^\sigma}{d\sigma} = 0$. Thus, condition (C.27) now becomes: $-\frac{(1-\beta)[\pi[\Pi(G,1)-w]+(1-\pi)[\Pi(B,1)-w]]}{[1-\beta(1-\pi)[\beta^T(1-\sigma)+\sigma]-\beta\pi]^2}$, which is negative.[9] Therefore, the firm will never choose a solution in the range where $\sigma > \bar{\sigma}_H$.

When $\bar{\sigma} < \sigma \leq \bar{\sigma}_H$, we know that $\bar{b}_A^\sigma = \frac{d\underline{b}^\sigma}{d\sigma} = 0$, and that $\underline{b}^\sigma < \Pi(B,1) - \bar{U}$, and $\frac{d\underline{b}^\sigma}{d\sigma} = -\frac{\Pi(B,1)-w-\underline{b}^\sigma}{1-\sigma} - \frac{\pi}{(1-\sigma)(1-\pi)}\frac{u'(\sigma\Pi(G,1)+(1-\sigma)w)}{u'(\sigma\Pi(B,1)+(1-\sigma)(w+\underline{b}^\sigma))}$. Therefore, the first order condition (C.27) is:

$$\frac{\pi[\Pi(G,1)-w]}{1-\beta(1-\pi)[\beta^T(1-\sigma)+\sigma]-\beta\pi}\left[-1+\frac{u'(\sigma\Pi(G,1)+(1-\sigma)w)}{u'(\sigma\Pi(B,1)+(1-\sigma)(w+\underline{b}^\sigma))}\right]+ \\ +\frac{\beta(1-\sigma)(1-\pi)[1-\beta^T][\pi[\Pi(G,1)-w]+(1-\pi)[\Pi(B,1)-w-\underline{b}^\sigma]]}{[1-\beta(1-\pi)[\beta^T(1-\sigma)+\sigma]-\beta\pi]^2}. \tag{C.28}$$

Note that since u is concave, when $\sigma = \bar{\sigma}_H$ the first term of condition (C.28) above is negative. The second term is always positive. Therefore, there may exists σ^S in this range such that condition (C.28) is equal to zero. This σ^S is the union power that maximize the firm's profits. If not, then the optimal union power chosen by the firm will be $\bar{\sigma}_H$. We summarize these findings in the following proposition.

Proposition C.3.4. *In a situation in which stochastic shocks to the firm's profits can only be observed by the firm itself, the firm will choose to cede power σ^* to a union, where $\sigma^* = \min\{\sigma^S, \bar{\sigma}_H\}$ and σ^S solves*

$$\pi[\Pi(G,1)-w]\left[-1+\frac{u'(\sigma\Pi(G,1)+(1-\sigma)w)}{u'(\sigma\Pi(B,1)+(1-\sigma)(w+\underline{b}^\sigma))}\right]+\frac{\beta(1-\sigma)(1-\pi)[1-\beta^T][\pi[\Pi(G,1)-w]+(1-\pi)[\Pi(B,1)-w-\underline{b}^\sigma]]}{1-\beta(1-\pi)[\beta^T(1-\sigma)+\sigma]-\beta\pi}=0.$$

Intuitively, it is easy to see that the optimal σ has to be strictly interior as for $\sigma = 0$ the firm's value function strictly increases in σ and at $\sigma = 1$ all the revenue is appropriated by the union and workers.

[9] If we change the model such that the union power is σ while the probability of finding that the true state of the world is $f(\sigma)$ the numerator of the condition would be $-(1-\beta)[1-(1-\pi)(\sigma f(\sigma) - f'(\sigma))(1-\beta^T](\pi[\Pi(G,1)-w]+(1-\pi)[\Pi(B,1)-w])]$. As long as $f(\sigma)$ is an increasing and concave function with $f(0)=0$ and $f(1)=1$ the results remain the same.

C.3.5 Comparative Statistic

To better understand the mechanics of the model, it is instructive to consider a couple of comparative statistic derivations. We start with the conditions from Proposition 2 and apply the implicit function theorem to derive comparative statics. In particular we are interested in how $\bar{b}$ and T^* are affected when either π, $\underline{b}$, or β change. First we consider the derivatives w.r.t. π, the likelihood of the good state, where an increase in π should be interpreted as a decrease in an industry's volatility (remember that we think of bad states as rare phenomena, i.e., π close to 1):[10]

$$\frac{d\bar{b}}{d\pi} = -\frac{u\left(w+\bar{b}\right) - u\left(w+\underline{b}\right)}{\pi u'\left(w+\bar{b}\right)} < 0$$

as $\bar{b} > \underline{b}$ and hence $u\left(w+\bar{b}\right) - u\left(w+\underline{b}\right) > 0$.

$$\frac{dT^*}{d\pi} = \frac{-\frac{d\bar{b}}{d\pi}\left(\frac{1}{\Pi(G,1)-w-\underline{b}}\right) + \frac{\beta(1-\beta^{T^*})}{1-\beta^{T^*+1}}}{\frac{\pi(1-\beta)\beta^{T^*+1}\ln\beta}{\left(1-\beta^{T^*+1}\right)^2}} < 0$$

as we know from above that $\frac{d\bar{b}}{d\pi} < 0$ and $\ln\beta < 0$.

Thus, a less volatile industry has shorter (and mechanically less) conflict phases and a smaller pay differential between good and bad states. The intuition is clear: in a less volatile industry there are, in expectation, more good states that deliver rent. Therefore, the expected per period surplus is larger and it takes less time to destroy surplus.

Next we examine the derivatives w.r.t. $\underline{b}$. Remember that a higher $\underline{b}$ immediately implies that $\Pi(B,1)$ is higher, i.e., the firm is less liquidity constrained. Thus, in this exercise we investigate the effects of the adverse shocks' severity. For ease of exposition we do so by

[10] Note that an increase in π affects the volatility and the expected value of the relationship. As discussed above, we focus on $1-\pi$ close to zero and argue that the first order effect here is the increased volatility and not the expected value effect.

directly differentiating with respect to $\underline{b}$:

$$\frac{d\bar{b}}{d\underline{b}} = -\frac{(1-\pi)u'\left(w+\underline{b}\right)}{\pi u'\left(w+\bar{b}\right)} < 0$$
$$\frac{dT^*}{d\underline{b}} = \frac{-\frac{d\bar{b}}{d\underline{b}} + \frac{1-\beta\pi-(1-\pi)\beta^{T^*+1}}{1-\beta^{T^*+1}}}{\frac{[\Pi(G,1)-w-\underline{b}]\pi(1-\beta)\beta^{T^*+1}}{\left(1-\beta^{T^*+1}\right)^2}\ln\beta} < 0$$

as we know from above that $\frac{d\bar{b}}{d\underline{b}} < 0$ and we know that $\ln\beta < 0$.

If the bad state is "not as bad" the conflict phases are shorter, as the firm's deviation incentive is lower. In addition, the bonus in the good state is lower as there is less to be compensated for.

Finally, the derivatives w.r.t. β reflect variations in the importance of the future in an industry. A high β industry can be interpreted as a growing industry, while a low β can be interpreted as an already declining one:

$$\begin{aligned} \frac{d\bar{b}}{d\beta} &= 0 \\ \frac{dT^*}{d\beta} &= \frac{\pi}{\pi\left(1-\beta\right)\beta^{T^*+1}\ln\beta}\left[1-\beta^{T^*}\left(T^*\left(1-\beta\right)+1\right)\right]. \end{aligned}$$

Note that $\frac{\pi}{\pi(1-\beta)\beta^{T^*+1}\ln\beta} < 0$. Hence the sign of the second expression depends on the sign of $\left[1-\beta^{T^*}T^*\left(1-\beta\right)+1\right]$. The minimum of this expression in the admissible range of β w.r.t. T^* is at $-\frac{1}{\ln\beta}-\frac{1}{1-\beta}$. At this minimum the above expression is positive (for values of β ensuring that T^* is positive). Hence it is positive everywhere. Therefore, together with $\frac{\pi}{\pi(1-\beta)\beta^{T^*+1}\ln\beta} < 0$, we get that

$$\frac{dT^*}{d\beta} < 0.$$

That means that if the future becomes more valuable for the firm, the length of the necessary conflict phase goes down as future lost rents are also more valuable, i.e., it becomes easier to deter deviations. The bonus, obviously, does not depend on the firm's discount factor.

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