On the failure of hindsight-biased principals to delegate optimally

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With the help of a simple model, we show that the hindsight bias can lead to inefficient delegation decisions. This prediction is tested experimentally. In an online experiment that was conducted during the FIFA World Cup 2010 participants were asked to predict a number of outcomes of the ongoing World Cup and had to recall their assessments after the outcomes had been realized. Their answers were used to construct individual measures of the hindsight bias. The participants also had to make choices in a delegation game. Our data confirm that hindsight-biased subjects more frequently fail to delegate optimally than subjects whom we have classified as not hindsight biased.

Keywords: hindsight bias, delegation, experiments

1. Introduction

There is ample evidence that people fail to remember their past beliefs correctly. After having received new information affecting these beliefs, people tend to exaggerate the availability of their current information to their past selves. Hence, people are not surprised by new information because they think they knew it all along. This incorrect recall of one's past information state is called the hindsight bias. Using a novel experimental design, we show how this behavioral bias affects delegation decisions in a systematic and predictable fashion. In a principal-agent relationship the hindsight bias has the paradoxical effect that additional information about the performance of the agent can increase the inefficiency of the principal's delegation decision.

Consider the following example in the context of medicine where a physician has to decide whether a subordinate doctor should examine a patient. Suppose that in the past, the subordinate doctor had seen a radiograph of another patient but overlooked the tumor. Suppose further that the tumor had been found later on. The superior—who is hindsight biased—evaluates the subordinate's ability to diagnose cancer. Being informed about the location of the tumor, the superior overestimates the likelihood that she would have detected the tumor herself in the early radiograph.[1] As a consequence, the superior might underestimate the relative ability of the young doctor, compared to her own (Madarász 2012). This might induce her not to delegate the examination of a further patient to the subordinate doctor.

We propose a simple two-period model of a delegation game to demonstrate how the hindsight bias can result in an incorrect evaluation of another person's relative ability and, in consequence, to suboptimal delegation decisions. In the game, a principal (she) has to decide whether to delegate a decision to an agent (he) after having received information about her own and the agent's ability at an interim stage. To delegate optimally, the principal needs to evaluate the agent's ability relative to her own. If the principal is hindsight biased, she accounts differently for the interim information than if she was rational. A principal's biased memory of her ex ante state of information toward the true outcome

[1] In reality, after a tumor has been diagnosed, in hindsight 90 percent of lung cancers and 70 percent of breast cancers that had previously not been recognized are observed on radiographs (as indicated in a testimony by the radiologist Leonard Berlin). See Berlin (2003).

results in an irrationally high level of self-confidence and thus leads to inefficiently little delegation.[2]

Our experiment links the hindsight bias as a personal trait to a person's delegation decision. The experiment consists of two parts. First, in several memory tasks each participant's ability to correctly remember his or her ex ante beliefs is measured. In addition, participants take part in a delegation game which is based on the model. Having classified subjects as hindsight biased or not according to the prediction task, we investigate their delegation decisions in the delegation game. Indeed, we find that subjects whom we categorize as hindsight biased delegate significantly less often than other subjects precisely in those situations where the hindsight bias should prevent delegation, as indicated by the predictions of the model. In other situations where the hindsight bias should not affect the delegation decision, we find no significant difference between subjects whom we have classified as hindsight biased or rational. Thus, we are able to establish a link between hindsight bias as a personal trait and suboptimal delegation decisions. To our knowledge, this is the first paper that documents a relationship between hindsight bias and delegation.

We contribute to two separate strands of the literature. First, our study relates to the literature on optimal delegation and interim information in multi-period principal-agent relationships. In principle, receiving interim information in such relationships is considered useful for the principal in order to mitigate the problems of asymmetric ex ante information (Strausz 2006) and uncertainty (Dessein 2005). For instance, venture capital contracts should account for interim information about the agent: If the initial authority is with the entrepreneur, control rights can be shifted to the venture capitalist later on if unfavorable information about the entrepreneur's ability is released at intermediate stages (Chan et al. 1990). Empirically, the venture capitalist has more control rights the more uncertain he or she is about the quality of the project or the entrepreneur's ability (Kaplan and Strömberg 2004). However, this literature presupposes that principals are fully rational and that they correctly account for all current and past information available to them when making their investment decisions. If the principals are hindsight biased, receiving new information can

[2] The interdependence of self-confidence and delegation decisions has been studied by Bénabou and Tirole (2002) and Bénabou and Tirole (2003). They show how principals act strategically in order to influence the agent's self-confidence and therefore his performance. Our focus, by contrast, is on how the principal's self-confidence affects her delegation decisions. For this, we do not need a conflict of interest between the principal and the agent. Hence, in our setting, the principal and the agent have the same payoffs from the project at hand and ex ante information is symmetric, so that there can be no problem of moral hazard.

distort their relative performance evaluation and hence lead to inefficient decisions. This renders interim information less useful, or even harmful.[3]

The decision as to whether to delegate control rights can be influenced by several factors, such as the informational advantages of the agent, the principal's disutility from taking a decision perceived as unkind (Bartling and Fischbacher 2012), as well as the principal's desire to create incentives for effort provision by the agent when there is a conflict of interest (Aghion and Tirole 1997). An experimental test by Fehr et al. (2013) of the model by Aghion and Tirole (1997) shows that agents respond to control rights more strongly than predicted under standard game-theoretic assumptions. Agents underexert effort if they do not have the decision right and they overexert effort otherwise. Although this profile of effort choices makes delegation relatively attractive for the principals, very often the majority of them retain control when they would have received higher returns by delegating authority. Fehr et al. (2013) summarize: "We find a strong behavioral bias among principals to retain authority against their pecuniary interests and often to the disadvantage of both the principal and the agent.[...] Our results suggest that authority has non-pecuniary consequences that inhibit the reallocation of authority." This finding has been corroborated by Bartling et al. (2014) and is in line with the psychological findings on agents' desire for self-determination (Ryan and Deci 2000).

The second strand of literature to which our study contributes is work on the hindsight bias itself. All economic studies on the hindsight bias, including our own, build on experiments by Fischhoff (1975), Fischhoff and Beyth (1975), and many others, summarized in the meta-analysis by Guilbault et al. (2004). The vast psychological literature has demonstrated the bias in a number of very different contexts and designs. Our study is most closely related to two experiments that establish a relationship between information projection and economic behavior. In an asset market experiment, Camerer et al. (1989) show that compared to individual decisions the curse of knowledge is reduced by a market environment, but that it is not entirely eliminated. In another study on asset markets by Biais and Weber (2009), subjects were informed of the current prices of a number of assets and had to predict the price of these assets one week later. When asked to recall their

[3] A different reason for interim information leading to biased performance evaluations is due to the attribution bias. For example, the principal evaluates the agent simply based on performance without taking into account the known difficulty of the task. Thus she misperceives the ability of the agent, but not of herself as in the presence of the hindsight bias. See Durell (2001).

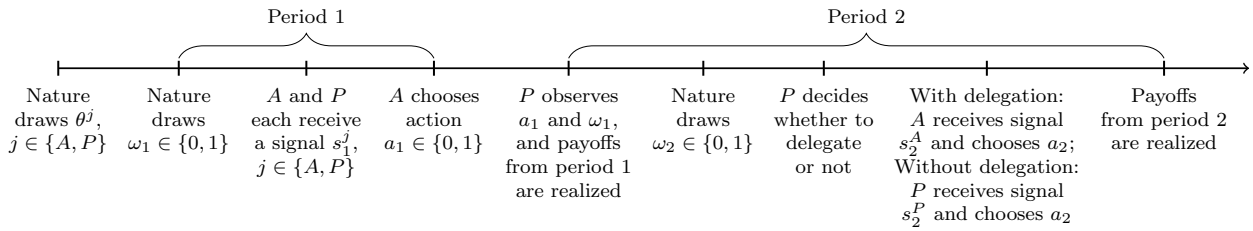

Figure 1 Timeline of the delegation game.

prediction after being informed of the actual price, subjects underestimated their previous uncertainty. In a second experiment with investment bankers, the authors show that more hindsight-biased managers earn less money. The model by Madarász (2012) is the most comprehensive theoretical treatment of the projection bias which encompasses the hindsight bias as a one specification. It shows how optimal incentives need to be adjusted in the presence of agents prone to information projection in a number of different contexts.

In §2 we will first introduce our model of the delegation game. It allows us to derive hypotheses concerning the choices of both fully rational Bayesian and hindsight-biased players. In §3, the experimental design is described, and in §4, we present the empirical results. Section 5 concludes with a discussion of our findings.

2. Principal-agent framework

In this section, we present a model to investigate under which conditions principals who are prone to the hindsight bias take inefficient delegation decisions.

2.1. The delegation game

The hindsight bias results from distorted memories. Thus, a model with two periods is necessary. The two-period delegation game is summarized in Figure 1.

First, nature draws the type θ^j of the principal (P) and of the agent (A), with $j \in \{P, A\}$. Both can be either a good type, $\overline{\theta}^j$, or a bad type, $\underline{\theta}^j$, and the type remains constant for the two periods. Types are drawn independently, and the prior probability of being a good type is r^P for the principal and r^A for the agent, respectively. Neither the principal nor the agent know their own type, nor do they know the other player's type, but the type distributions are common knowledge. At the beginning of each period $t \in \{1, 2\}$, nature draws the state of the world, $\omega_t \in \{0, 1\}$. States of the world are drawn independently across periods, and the two possible realizations, 0 and 1, are equally likely.

In the first period, the principal and the agent each receive a private signal $s_1^j \in \{0,1\}, j \in \{P,A\}$, about the true state of the world. The signal technology is as follows:

$$\begin{aligned} &\Pr\left\{s_t^j = \omega_t \mid \theta^j = \overline{\theta}^j\right\} = \overline{\rho} \text{ and} \\ &\Pr\left\{s_t^j = \omega_t \mid \theta^j = \underline{\theta}^j\right\} = \underline{\rho} \text{ for } j \in \{A,P\} \text{ and with } t \in \{1,2\}. \end{aligned} \tag{1}$$

Thus, the quality of the signal, i.e., the probability ρ that the signal corresponds to the true state of the world, depends on the type θ^j of the player j. A good type $\overline{\theta}^j$ receives signals that are correct with probability $\overline{\rho}$ whereas a bad type's signals are only correct with probability $\underline{\rho}$, where $0.5 \leq \underline{\rho} < \overline{\rho} \leq 1$. After having observed his signal in the first period, the agent has to take an action $a_1 \in \{0,1\}$. If this action corresponds to ω_1, both the agent and the principal receive a positive payoff z. If the action was incorrect, both receive zero payoffs.

At the beginning of the second period, the principal learns the agent's action a_1, and the true state of the world ω_1 that prevailed in the first period is revealed. The principal updates her belief about her own and the agent's type. Then she decides whether she herself or the agent will make the next decision. If the principal opts for delegation, the agent will receive a private signal $s_2^A \in \{0,1\}$ about the state of the world $\omega_2 \in \{0,1\}$ in the second period and will choose an action $a_2 \in \{0,1\}$. If the principal decides herself, she receives a signal $s_2^P \in \{0,1\}$ about ω_2, and chooses an action $a_2 \in \{0,1\}$ herself. Both players again receive the positive payoff z if a_2 turns out to correspond to ω_2, but zero otherwise. Then the game ends.

Subjects derive a positive utility from being in control of their own situation. This has been found by psychologists and is stated as the theory of self-determination (Ryan and Deci 2000). The wish to retain decision rights and control over oneself is traced back to the human desire and need for autonomy, personal development, and self-regulation. Moreover, such an additional utility derived from the right to make decisions has also manifested itself in previous delegation experiments in economics (Fehr et al. 2013, Owens et al. 2014, Dominguez-Martinez et al. 2014). In order to capture this value from self-determination we introduce a variable $v \in \mathbb{R}^+$which denotes a psychic payoff from being in control. To account for the unobserved heterogeneity of individuals, we assume that nature draws v at the beginning of the game for each player according to some continuous distribution $F(v)$, with $F'(v) > 0$. These psychic payoffs are drawn independently for all players.

Since we want to test whether hindsight-biased individuals delegate too little, we make delegation attractive for rational decision makers. In particular, we assume that the ex ante likelihood r^j of being a good type $\overline{\theta}^j$ is smaller for the principal than for the agent, $r^P < r^A < 1$. Hence, ex ante, the agent is better at predicting the true state of the world. We assume that the principal has a per-period utility that is linear in the monetary payoff z as well as in the non-pecuniary utility of self-determination v. The same is true for the agent. Hence, the incentives to predict the true state of the world are aligned. The principal's per-period utility is denoted by $U^D = \widetilde{z}$ if the principal delegates the decision and by $U^{ND} = \widetilde{z} + v$ if she does not, with $\widetilde{z} = z > 0$ if $a_t = \omega_t$ but $\widetilde{z} = 0$ else. The agent's utility is defined analogously. To solve the model, we will determine the probability that the principal delegates the second-period decision based on the parameters of the game and the distribution $F(.)$.

Finally, we turn to the delegation decision of a potentially hindsight-biased principal. In the second period, a hindsight-biased principal does not correctly remember her signal realization s_1^P from the first period. Instead, her memory is biased into the direction of the true state of the world that has been revealed in the meantime. We formalize this along the lines of the model of information projection provided by Madarász (2012): The hindsight-biased principal believes that with probability λ, she has received the signal $\widetilde{s}_1^P = \omega_1$, and with probability $(1-\lambda)$ she has received the signal $\widetilde{s}_1^P = s_1^P$ which is the true realization of the principal's signal. The parameter $\lambda \in (0,1]$ denotes the strength of the hindsight bias.[4] Thus, the principal's posterior belief of being a good type, based on her belief β about her received signal, is given by

$$\Pr\left\{\theta^P = \overline{\theta}^P \mid \beta\right\} = \lambda \Pr\left\{\theta^P = \overline{\theta}^P \mid \widetilde{s}_1^P = \omega_1\right\} + (1-\lambda)\Pr\left\{\theta^P = \overline{\theta}^P \mid \widetilde{s}_1^P = s_1^P\right\}.$$

The intuition behind this modelling is that the principal only has a limited memory of her true past signal if she is hindsight biased. The second term on the right hand side of the above formula represents a memory of the true signal realization observed in the past; and the first term represents a potentially false memory resulting from the projection of the principal's current knowledge of the state of the world onto his past signal. These two

[4] Note the subtle difference of this approach to that of Camerer et al. (1989) as well as Biais and Weber (2009) where λ is used to form the linear combination of the true signal and the true state of the world. In our approach, in contrast, the principal believes that she saw either the true signal or the true state of the world, and the parameter λ governs the weight of the two.

potentially conflicting memories are weighted with $(1-\lambda)$ and λ, respectively. Hence, the parameter λ directly captures the degree of information projection. Note that there is no conflict of memories when $s_1^P = \omega_1$. Thus, the hindsight bias can only affect the principal's posterior beliefs about her own type if the signal s_1^P contradicts the state of the world ω_1, because otherwise no distortion of the memory is possible. For this understanding of the model, full naiveté about the hindsight bias must be assumed; otherwise, the hindsight-biased principal could always fully infer whether her signal was correct or not.[5]

In general, the principal might also project information on the agent.[6] Our model and experiment have been set up to minimize such interpersonal effects. Note that in our setting the principal learns the agent's action a_1 right before the delegation decision. Without having to recall anything from memory, she can infer the signal that the agent has received in a pure-strategy equilibrium. Moreover, we only measure the intrapersonal bias of all participants with the help of the memory tasks and use this measure to predict choices in the delegation game. As a consequence, we only analyze the effect of an intrapersonal bias of the principal on her delegation decision.

2.2. Equilibrium analysis

We apply the equilibrium concept of Perfect Bayesian Nash Equilibrium: Given their beliefs, all players make optimal decisions at all information sets; and they update their beliefs according to Bayes' rule whenever it is defined. The game has multiple equilibria, but for reasons of plausibility, we restrict attention to the (unique) pure-strategy equilibrium in which the agent always follows his signal in the first period, i.e., $s_1^A = a_1$. To derive this equilibrium, consider the principal's delegation decision, and assume that the agent followed his signal in $t = 1$. Four cases must be distinguished. In the first two cases the principal's signal and the agent's action in the first period correspond, that is, they are both either 0 or 1. In the other two cases, the principal's signal and the agent's action in the first period contradict each other, i.e., the principal's signal is 0 and the agent's action is 1 or vice versa.

[5] It is common practice in Behavioral Economics to introduce biases that lead to deviations from Bayesian updating but keep the general concept of Perfect Bayesian equilibrium intact. Two prominent examples are Rabin and Schrag (1999) and Bénabou (2013).

[6] See the psychological literature on the curse of knowledge starting with Fischhoff (1975). In economics, the interpersonal bias has been investigated by Loewenstein et al. (2006), Schuett and Wagner (2011), and Madarász (2012).

2.2.1. Case I: $\omega_1 \neq s_1^P = s_1^A = a_1$

Suppose that both the principal and the agent have received an incorrect signal about the state of the world ω_1. Consider first the *rational* principal indicated by the subscript R. For Case I, we calculate the critical value v_R^I of the utility from self-determination at which the rational principal is just indifferent between delegating and not delegating in period 2.

Since both the agent and the principal obtained an incorrect signal in the first period, the principal's posterior belief about her own type is

$$\Pr\left\{\theta^P = \overline{\theta}^P \mid s_1^P \neq \omega_1\right\} = \frac{r^P\left(1-\overline{\rho}\right)}{r^P\left(1-\overline{\rho}\right)+\left(1-r^P\right)\left(1-\underline{\rho}\right)}, \tag{2}$$

while her posterior belief about the agent is given by

$$\Pr\left\{\theta^A = \overline{\theta}^A \mid s_1^A \neq \omega_1\right\} = \frac{r^A\left(1-\overline{\rho}\right)}{r^A\left(1-\overline{\rho}\right)+\left(1-r^A\right)\left(1-\underline{\rho}\right)}. \tag{3}$$

The principal's expected utility from *not delegating* (ND) in the second period depends on the probability of her taking the correct decision. This probability depends on $\Pr\left\{\theta^P = \overline{\theta}^P \mid s_1^P \neq \omega_1\right\}$, defined in (2) and denoted by $p_R^{s\neq\omega}$, as in this case the rational principal has seen the incorrect signal in period 1. Hence her expected utility from not delegating is

$$E\left(U_R^{ND}\right) = v + z p_R^{s\neq\omega},$$

with

$$p_R^{s\neq\omega} \equiv \frac{r^P\left(1-\overline{\rho}\right)\overline{\rho}+\left(1-r^P\right)\left(1-\underline{\rho}\right)\underline{\rho}}{r^P\left(1-\overline{\rho}\right)+\left(1-r^P\right)\left(1-\underline{\rho}\right)}.$$

If, in contrast, the principal *delegates* (D), her expected payoff depends on the likelihood that the agent takes the right decision after he has received an incorrect signal in period 1. This probability depends on $\Pr\left\{\theta^A = \overline{\theta}^A \mid s_1^A \neq \omega_1\right\}$ given in (3) and is denoted by $q^{s\neq\omega}$. Hence, her expected payoff from delegating is

$$E\left(U_R^{D}\right) = z q^{s\neq\omega},$$

where

$$q^{s\neq\omega} \equiv \frac{r^A\left(1-\overline{\rho}\right)\overline{\rho}+\left(1-r^A\right)\left(1-\underline{\rho}\right)\underline{\rho}}{r^A\left(1-\overline{\rho}\right)+\left(1-r^A\right)\left(1-\underline{\rho}\right)}.$$

We now define the critical value v_R^I to be that level of utility from self-determination at which the rational principal is indifferent between delegating and not delegating:

$$v_R^I + zp_R^{s\neq\omega} = zq^{s\neq\omega} \text{ or } v_R^I = z\left(q^{s\neq\omega} - p_R^{s\neq\omega}\right). \tag{4}$$

The rational principal chooses to take the decision herself if and only if her utility from self-determination exceeds v_R^I.[7]

Consider now the *hindsight-biased* principal, indicated by the subscript H. Her posterior belief about the agent's type is rational and is given by (3). But since $s_1^P \neq \omega_1$, she has conflicting memories (or her memories are vague), and her posterior belief about her own type is irrationally optimistic, namely

$$\begin{aligned}\Pr\left\{\theta^P = \overline{\theta}^P \mid \beta\right\} &= \lambda \Pr\left\{\theta^P = \overline{\theta}^P \mid \widetilde{s}_1^P = \omega_1\right\} + (1-\lambda)\Pr\left\{\theta^P = \overline{\theta}^P \mid \widetilde{s}_1^P = s_1^P\right\} \\ &= \lambda \frac{r^P \overline{\rho}}{r^P\overline{\rho} + (1-r^P)\,\underline{\rho}} + (1-\lambda)\,\frac{r^P\,(1-\overline{\rho})}{r^P\,(1-\overline{\rho}) + (1-r^P)\,(1-\underline{\rho})},\end{aligned} \tag{5}$$

where β denotes her belief about the signal she received in period 1.

Therefore, her expected utility from *not delegating* amounts to:

$$E\left(U_H^{ND}\right) = v + zp_H^{s\neq\omega}, \tag{6}$$

with

$$p_H^{s\neq\omega} \equiv \lambda \frac{r^P\overline{\rho}^2 + \left(1-r^P\right)\underline{\rho}^2}{r^P\overline{\rho} + (1-r^P)\,\underline{\rho}} + (1-\lambda)\,p_R^{s\neq\omega} > p_R^{s\neq\omega}.$$

By contrast, if the hindsight-biased principal delegates, her expected payoff from delegation is the same as if she were rational, i.e., $E\left(U_H^D\right) = E\left(U_R^D\right) = zq^{s\neq\omega}$. Consequently, the hindsight-biased principal chooses to decide herself if and only if her utility from self-determination exceeds the critical value for Case I, v_H^I, which is defined by the following equation:[8]

$$v_H^I + zp_H^{s\neq\omega} = zq^{s\neq\omega} \text{ or } v_H^I = z\left(q^{s\neq\omega} - p_H^{s\neq\omega}\right). \tag{7}$$

We now proceed to analyze how the hindsight bias affects the principal's propensity to delegate. To do so, we compare the critical values at which the rational and the hindsight-biased principal are indifferent between delegating and not delegating. From (4) and (7), we can infer that

$$v_R^I + zp_R^{s\neq\omega} = v_H^I + zp_H^{s\neq\omega}. \tag{8}$$

[7] Note that $v_R^I > 0$ since $r^P < r^A$.

[8] Note that v_H^I might be negative in which case the hindsight-biased principal always delegates in Case I.

Remember that $p_R^{s\neq\omega}$ is strictly smaller than $p_H^{s\neq\omega}$. Consequently, (8) implies that v_R^I must be strictly greater than v_H^I. Thus, for some values of v a rational principal delegates whereas a hindsight-biased principal does not delegate. Since $F'(v) > 0$, we formulate our first prediction:

THEORETICAL PREDICTION 1. *Let $\omega_1 \neq s_1^P = s_1^A = a_1$. Then, the probability of delegation is strictly lower for the hindsight-biased principal than for the rational principal.*

Intuitively, the hindsight-biased principal fails to recognize that she is less likely to be a good type compared to the agent when she received an incorrect signal and the agent chose the incorrect action. As a consequence, she believes that she is more likely than the agent to get a correct signal in the second period. A rational principal, in contrast, would recognize that her probability of being a good type is still lower than the agent's probability if both received an incorrect signal. Therefore the critical value of the utility from self-determination, making it just optimal to delegate, is lower for the hindsight biased than for the rational principal.

We now proceed to analyze the case in which both the principal and the agent receive a correct signal in the first period.

2.2.2. Case II: $\omega_1 = s_1^P = s_1^A = a_1$

Suppose that both the principal and the agent have received a correct signal about the state of the world in period 1. In this case there is no scope for the hindsight bias to affect updated beliefs as the principal's signal was correct and, hence, did not trigger conflicting memories. Therefore, the hindsight biased and the rational principals have precisely the same belief about their own type. In fact, this belief corresponds to the belief that the hindsight-biased principal holds about her own type in Case I in which she remembers having received a correct signal. Now, in Case II, her period-1 signal was in fact correct, leading to the same belief. The agent is good with probability $\frac{r^A\overline{\rho}}{r^A\overline{\rho}+(1-r^A)\underline{\rho}}$. Thus, in Case II the fully hindsight-biased principal ($\lambda = 1$) always has the same expected utility as the rational principal from delegating or not delegating. Calculations analogous to those conducted in the analysis of Case I for the cutoff values v_H^I and v_R^I reveal that the biased and the rational principal do not delegate if and only if the utility from self-determination exceeds a cut-off value v^{II}. (Note that v^{II} and $p^{s=\omega}$ do not carry the indices R and H as

the values are identical for the rational and the hindsight-biased principal.) This cut-off is defined by the equation

$$v^{II} + zp^{s=\omega} = zq^{s=\omega}, \tag{9}$$

where $p^{s=\omega}$ can be derived from $p_H^{s\neq\omega}$ by setting λ equal to one, and

$$q^{s=\omega} \equiv \frac{r^A\overline{\rho}^2 + \left(1-r^A\right)\underline{\rho}^2}{r^A\overline{\rho} + \left(1-r^A\right)\underline{\rho}}.$$

This provides us with our second prediction:

THEORETICAL PREDICTION 2. *Let $\omega_1 = s_1^P = s_1^A = a_1$. Then, the probability of delegation is the same for the hindsight biased and for the rational principal.*

2.2.3. Cases III and IV: $\omega_1 = s_1^P \neq s_1^A = a_1$ and $\omega_1 \neq s_1^P \neq s_1^A = a_1$, respectively

In Case III, the rational and the hindsight-biased principal behave in identical ways. Both take the decision themselves if and only if their utility from self-determination, v, is above $v^{III} \equiv z\left(q^{s\neq\omega} - p^{s=\omega}\right)$. To see this, note that since the principal receives the correct first-period signal in Case III, there is no room for the hindsight bias to affect her belief about her own type. Moreover, beliefs about the agent are always unaffected due to equilibrium conditions.

Consider now Case IV. The hindsight-biased principal has a more optimistic belief about herself than her rational counterpart. She takes the decision herself if her psychic utility from self-determination v exceeds $v_H^{IV} \equiv z\left(q^{s=\omega} - p_H^{s\neq\omega}\right) < v_R^{IV} \equiv z\left(q^{s=\omega} - p_R^{s\neq\omega}\right)$. The gap between v_R^{IV} and v_H^{IV} is increasing in λ, the parameter of the hindsight bias.

Qualitatively, cases III and IV are very similar to cases II and I , respectively: The hindsight bias affects the delegation probability if and only if the principal's signal in the first period was incorrect.

2.2.4. Equilibrium predictions and hypotheses

So far, we have assumed that the agent always follows his signal in the first period. We now argue that this is indeed an equilibrium strategy. Consider the agent when he has just received his signal in the first period. At this moment, all he knows about his type is that he is, a priori, more likely than the principal to get the correct signal in any period. Thus, his expected second-period payoff increases with the probability of delegation. The probability of delegation, however, increases with the principal's posterior belief that the

agent is a good type. (Note that this is true regardless of whether the principal is rational or hindsight biased.) But given that in the second period the principal believes that the agent has followed his signal, the principal's trust in the agent will be highest if the agent chooses the action that matches the state of the world in period one. This, again, becomes more likely if the agent follows his signal. The expected first-period payoff of the agent also increases with the probability of matching the state of the world and therefore with the probability with which the agent follows his signal. Consequently, the agent always strictly prefers to follow his signal, given that he is expected to do so. Note that any player who chooses the action in the second period has a strict incentive to follow his or her signal. We get the following:

PROPOSITION 1. *The game has a Perfect Bayesian Nash Equilibrium in pure strategies in which the agent always follows his signal in the first period, the principal follows her signal in the second period if she does not delegate, and the agent follows his signal in the second period if the principal delegates. The principal does not delegate the decision in Case I [Case II, III, IV] if and only if she is either rational and her utility from self-determination exceeds* $v_R^I[v^{II}, v^{III}, v_R^{IV}]$ *or if she is hindsight biased and her utility from self-determination exceeds* $v_H^I[v^{II}, v^{III}, v_H^{IV}]$*, with* $v_H^I < v_R^I$ *and* $v_H^{IV} < v_R^{IV}$*.*

Note that this equilibrium is *not* unique: Consider a situation in which the principal believes that the agent always chooses the action that was *not* indicated by his signal in the first period, although the agent would follow his signal in the second period. Moreover, assume that the agent has infinite utility from self-determination. Then, all that the agent cares about in the first period is maximizing the likelihood of delegation. Thus, he wants to maximize the posterior belief of the principal that he, the agent, is a good type. Given the principal's beliefs, this is only possible if the agent does *not* follow his signal in the first period, thereby justifying the principal's belief. It is possible to find parameters for which this is an equilibrium. However, this equilibrium is implausible because in reality competence is rarely signaled by failures. Thus, we restrict attention to the equilibrium that is characterized by the Proposition 1.

We are now in a position to derive the two main hypotheses that we test in the experiment:

HYPOTHESIS 1. *If the principal receives an incorrect signal in the first period (cases I and IV), then the hindsight-biased principal is strictly less likely to delegate in the second period than the rational principal.*

HYPOTHESIS 2. *If the principal receives a correct signal in the first period (cases II and III), then the hindsight-biased principal is as likely to delegate in the second period as the rational principal.*

Of course, the model makes some identifying assumptions. Our hypotheses only hold if the parameters λ and v are uncorrelated. We are not aware of any empirical evidence that would suggest a correlation. Furthermore, we assume that v does not depend on the outcome of period 1, i.e., it is the same across all cases.

3. Experimental Implementation

3.1. Specification of the delegation game

The following parameter specification was implemented in our experimental design:

$$r^P = \frac{2}{5},\ r^A = \frac{1}{2},$$
$$\overline{\rho} = \frac{2}{3},\ \underline{\rho} = \frac{1}{2}, z = 75$$

Moreover, we implemented an additional cost of $c = 3$ for the principal if she decides herself and takes the correct decision.[9] If we evaluate the critical case-specific values v for this specification of the parameters, we can derive the expected utility of delegation and non-delegation.

For the experiment and the subsequent analysis we chose to concentrate on a comparison between Case I and Case II. Including Case III and IV in the analysis does not lead to qualitatively new testable hypotheses because they only mirror Case I and II: Case III can be compared to Case II in that hindsight biased and rational principals are not expected to differ in their delegation behavior. Similarly, Case I mirrors Case IV as hindsight-biased principals should delegate less often than rational principals. Only the respective threshold values of v and consequently the expected delegation rates differ across the mirror cases.

[9] This cost is not decisive for the qualitative properties of the game, but slightly changes the thresholds. It shifts the range of values v for which the rational and the hindsight-biased principal differ in their delegation decision. With this cost, we gave the principals an additional incentive to delegate. Note that we did not deduct the cost in the event of a wrong decision as this may have resulted in a negative payoff.

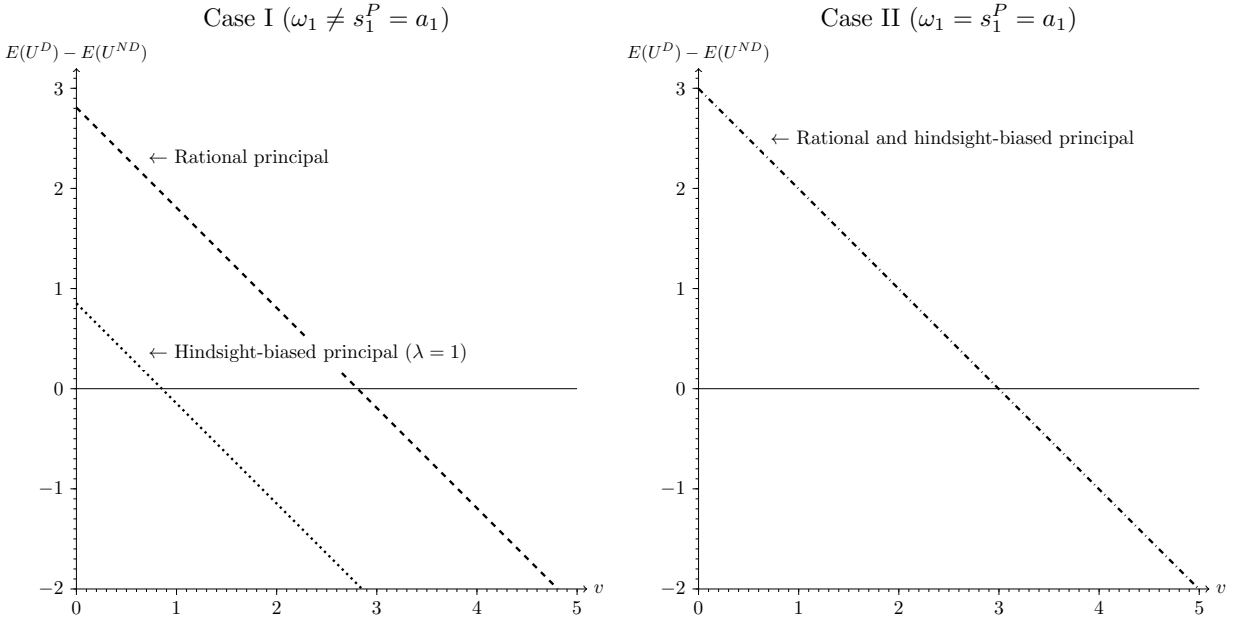

Figure 2 Difference between expected utility from delegation and non-delegation depending on utility from self-determination.

Furthermore, focusing on the comparison of Case I and II encompasses the advantage that the expected delegation rates of rational principals are approximately the same in Case I and II, which is not true in Case III and IV (see Hypothesis 3 below). Hence, including Case III and IV would reduce the number of observations per case without adding any clear benefits. Still, as we have a few observations for Case III and IV, we incorporate them in the aggregate measure of hindsight bias in section 4.3. and in the regression analysis in section 4.4. as a robustness check.

Figure 2 depicts the difference in the expected utilities of delegation versus nondelegation $\Delta E(U) = E\left(U^D\right) - E\left(U^{ND}\right)$ for a rational and a hindsight-biased principal in Case I (left panel) and Case II (right panel). The difference in expected utility $\Delta E(U)$ depends on the principal's utility from self-determination, v. If $\Delta E(U) > 0$, the principal opts for delegation. The dashed lines depict the difference in utility for a rational principal, $E\left(U_R^D\right) - E\left(U_R^{ND}\right)$; the dotted lines represent this difference for a hindsight-biased principal, $E\left(U_H^D\right) - E\left(U_H^{ND}\right)$. In Case I (left panel) a rational principal chooses to delegate if $0.853 < v < 2.808$, whereas a hindsight-biased principal does not delegate for these values of

v. In Case II (right panel) all principals opt for delegation if $v < 2.996$, no matter whether they are biased or not.[10]

For our parameter specification, we state the following additional hypotheses that we can test:

HYPOTHESIS 3. *Rational principals show similar delegation rates in Case I and Case II.*

HYPOTHESIS 4. *Hindsight-biased principals are less likely to delegate after both players receive incorrect signals (Case I) than after correct signals (Case II).*

HYPOTHESIS 5. *When comparing delegation rates in Case II and Case I, hindsight-biased principals show a stronger decrease in delegation rates than rational principals.*

3.2. Experimental procedure

In order to identify the effects of the hindsight bias on delegation decisions, we conducted an online experiment during the FIFA World Cup 2010. The experiment consisted of two stages. In the first stage, participants had to answer a questionnaire and played the first part of the delegation game. This stage was conducted during the preliminary round of the World Cup. The second stage consisted of another questionnaire and the second part of the delegation game, which started directly following the World Cup semi-finals (see Figure 3). The two-stage design was necessary to allow for a biased memory.

In order to measure a participant's hindsight bias we asked the following questions about the outcomes of the ongoing championship during the preliminary round:

1. What is the likelihood of [nation] reaching the final of the World Cup 2010?

2. How many goals will be scored during the eighth-final, quarter-final, and semi-final (within regular playing time, 14 matches overall)?

For the first question, which we will refer to as the "finals task,"we specified the nations to be Argentina, Spain, and Germany, respectively. We chose to ask this question for each of the three countries because we hoped that at least one of them would indeed reach the final. The reason is that previous studies have shown that the hindsight bias is stronger if a certain event turns out to be true than when it turns out not to be true (Fischhoff 1975,

[10] Note that the parameters are chosen so that a principal with no utility from self-determination, $v = 0$, wants to delegate in Case I and Case II, regardless of whether she is rational or hindsight biased. Because we expect that individuals derive non-pecuniary utility from having the right to decide, $v > 0$, we wanted to avoid a situation where principals almost never delegate the decision to the agent. Thus, we have chosen the parameters so that we can expect enough variation in delegation decisions across treatments.

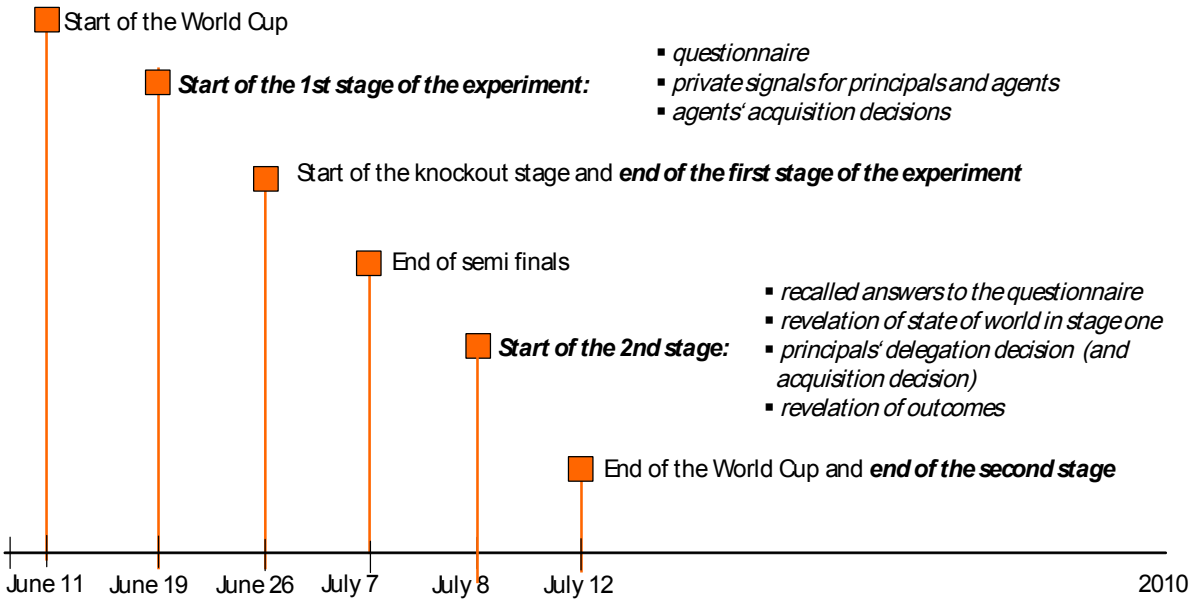

Figure 3 Timeline of the Experiment.

Slovic and Fischhoff 1977, Fischhoff and Beyth 1975).[11] The question about the number of goals ("goals task") provided us with a slightly different test for the hindsight bias which was not based on a binary outcome variable. In order to incentivize participants at the first stage, we raffled five sets of two tickets for the "11-Freunde-WM-Quartier," a popular location in Berlin for the public viewing of World Cup matches. About two weeks later, when the semi-finals were over, the second stage of our experiment started and the participants had to recall their answers to the questions above.[12] Prior to stating their recalled answers, subjects were told the true outcome for each question. The order of the questions was different in this second questionnaire to prevent subjects from remembering their answers simply due to their ordering. For the memory task at the second stage, we paid 100 Euro to the 10 subjects who best remembered their answers from the first stage. It turned out that 14 subjects perfectly remembered their answers, and we decided to pay all of them 100 Euro.

[11] We also added the question "What is the likelihood of Italy dropping out before the semi-final of the World Cup 2010?" to introduce some variation in the questions. However, during the first stage of the experiment, it became clear that Italy would not make it to the knock-out round. This rendered the question useless for our purposes. In addition, we asked participants about their favorite team in the World Championship. We used this question to study the robustness of the results with respect to wishful thinking. We observe that subjects' estimates of how likely it is that a team would participate in the final depended on whether this team was the subjects' favorite. Subjects' hindsight bias, however, is unaffected by this.

[12] Before answering the questions in the first stage, participants were informed that they would be approached again in about two weeks from then, without knowing what they would have to do at the second stage.

In addition to answering the questionnaire, the participants played the delegation game described in section 2.2. The game was framed as the interaction between a manager (principal) and a coach (agent) of a soccer club in two subsequent seasons. In each period, a decision about the acquisition of a particular new player for the soccer club had to be taken. The state of the world in each season was the true talent of this new player. It was optimal to acquire a talented player, but an untalented player should not be acquired. The private signals of the principal and the agent were framed to be advice about the talent of the new player received through a (good or bad) personal talent scout. As in the model, the quality of the signal depended on the principal's and the agent's type. That is, with the parameters above, the talent scout advising the manager was good in 40% of the cases ($r^P = 0.4$) and the scout advising the coach was good in 50% of the cases ($r^A = 0.5$). A good talent scout gave correct advice in two-thirds of the cases ($\overline{\rho} = 2/3$) whereas a bad talent scout gave correct advice in only 50% of the cases $\left(\underline{\rho} = 0.5\right)$. The talent scout of the manager and the coach, respectively, remained the same for the two periods of the game.

The first 24 participants who logged in were assigned to be agents, and all other participants were principals. As our main interest is in the decisions of the principals, we replicated the decisions of the agents and matched them to the principals accordingly (e.g., the first agent was matched to the principals with the numbers 1, 25, 49, etc.). Upon logging in, the participants had to answer the questions regarding the World Cup, read the instructions to the delegation game, and were informed of their role. Both the principals and the agents received their private signal, i.e., they were given advice from their talent scout. Then, the agents had to make the decision as to whether or not to buy the new player for the team in this season. This decision was revealed to the principal to whom they were matched. The agents had to decide whether to acquire a new player for the second season after they had received a new signal about the new player's talent. Although their decision for the first season was implemented for certain, the implementation of their decision for the second season depended on whether the principal had decided to delegate this decision to the agent in the second stage. Hence, we applied the strategy method for the agents' decision in order to avoid having to rely on their participation in the second stage.

About two weeks later in the second stage of the experiment, all participants who had completed the first stage were asked to recall and write down their answers to the questions

about the World Cup from the first stage. In addition, the principals had to complete the delegation game. First, they learned the state of the world in the first stage (i.e., whether the new player was talented or not). Furthermore, the principals were reminded of the agent's decision, but not of their private signal at the first stage. The principals then had to decide whether or not to delegate the decision concerning the acquisition of a new player for the second season. If they decided to take the acquisition decision themselves, they received a signal about the talent of the second new soccer player. Then they were asked whether or not they wanted to buy this player. If they had delegated the decision to the agent, the (already elicited) decision of their agent was implemented. At the end of the second stage, all participants were informed of the true state of the world and the outcome of their decisions.

In order to incentivize the participants in the delegation game, 10 randomly drawn subjects were paid according to their decisions in this game. A randomly drawn subject in the role of an agent received 75 Euro for a correct decision and nothing otherwise, at both stages 1 and 2. For example, if the agent in the first stage decided to buy the player and this turned out to be the correct decision (i.e., the player was talented), the agent received 75 Euro. If the agent decided not to buy the player in the second stage and the player turned out not to be talented, the agent earned another 75 Euro. A randomly drawn subject in the role of the principal received 75 Euro for a correct decision of her matched agent in the first stage. In addition, this principal received 75 Euro for the second stage if she had delegated the decision to her matched agent and it was correct, whereas she only received 72 Euro for a correct decision if she had not delegated the decision to the agent but had decided herself. Together with the incentives from the memory task, participants could earn up to 250 Euro.

We recruited subjects via a call for participation in the sports section of the Berlin newspaper *Der Tagesspiegel* and from the subject pool of the experimental lab at the Technical University Berlin using the recruiting tool ORSEE (Greiner 2004). In total, 419 subjects completed the experiment.[13]

As we used the decisions of the agents for multiple principals, it was necessary for the underlying true state of the world to be the same for the agents and their matched

[13] For the instructions (translated from German) see Appendix B.

principals. Thus, to keep things simple, we randomly drew the state of the world upfront for both periods and implemented this draw for all participants. The random draw determined that it was beneficial to buy the new soccer player in each season. Given these states of the world in periods 1 and 2, we determined the types of the principals and the agents as well as their signals according to the probabilities specified in section 3.1. As we wanted to generate a large number of observations for Case I and Case II, whenever possible we matched the agents and the principals according to their signal realization in the first period. This, of course, implies that the signal realizations of principals and agents are not independent, unlike in the model.[14] However, as the subjects only played the game once, they were not able to draw any inferences concerning the dependence of the signals.

4. Results

In the following we will present our results along the lines of the predictions derived above. We will first describe how we classify subjects as hindsight biased or not with the help of the four prediction and memory tasks. We then proceed to the analysis of the delegation game based on these task-specific classifications. In a next step, we estimate an aggregate measure of the individual hindsight bias and relate this to the delegation choices.

4.1. Descriptive statistics of memory tasks and classification of subjects

Regarding the three finals tasks, we had asked for one of the actual participants in the final, namely Spain. The distributions of the actual and the recalled predictions in the Spain task are depicted in the left panel of Figure 4.[15] The average likelihood that our subjects assigned ex ante to Spain's participation in the final was 32.5%. After Spain was known to be participating in the final, the subjects' average recalled likelihood assessment was 39.6%. A Wilcoxon signed-rank test confirms a significant shift in the distribution of recalled likelihood assessments toward the actual outcome ($p < 0.001$). We use the individual recalled predictions to classify the subjects as hindsight biased or rational. A subject is classified as rational, i.e., unbiased, if she remembers her prediction correctly. We find that 26.1% of the subjects fall into this category. If a subject reports a recalled prediction that is higher than her actual prediction, she is classified as hindsight biased. This is true

[14] In fact, only five principals received private signals different from the signals of their matched agent signal in the first period. However, five agents did not follow their signal when making the acquisition decision in the first period. Hence, only 303 out of 395 principals received a signal in line with the observed action by the agent.

[15] Gaussian kernels are used for the density estimates. The selected bandwidths are 0.04 (panel A) and 1.8 (panel B).

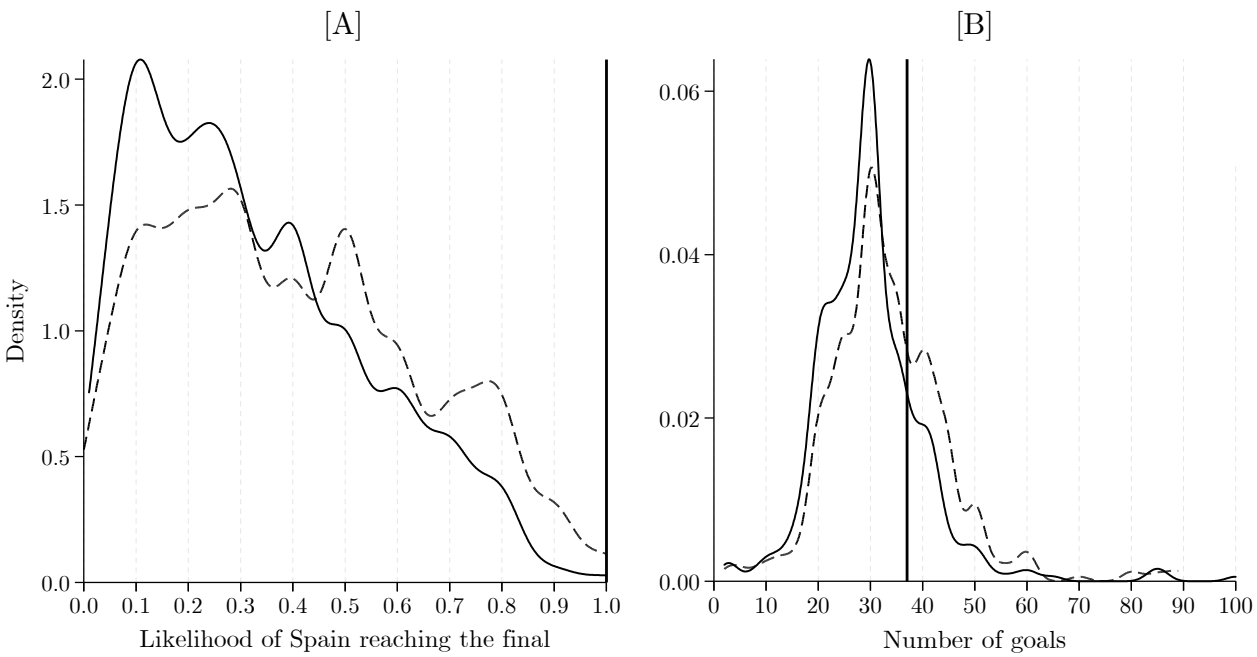

Figure 4 Kernel density estimates of actual predictions (solid lines) and recalled predictions (dashed lines) of Spain's likelihood of entering the final (panel A) and the number of goals (panel B). Solid vertical lines indicate the values of the true outcomes (1 and 37 respectively).

for 51.1% of the subjects. A considerable fraction of 22.8% of the subjects report recalled predictions that are lower than they actually were, but this fraction is significantly smaller than the fraction of hindsight-biased subjects (binomial test, $p < 0.001$). As these subjects behave neither in line with rational behavior nor with the hindsight bias, we refer to them as "unclassified" and report results regarding their behavior separately.

Regarding Argentina and Germany who did not reach the final, we do not observe the hindsight bias on average. Regarding Argentina, the distributions of predictions and recalled predictions are virtually the same. With regard to Germany, the recalled predictions are significantly higher than actual predictions on average although Germany failed to participate in the final. As these tasks do not generate an average hindsight bias, we do not use each of them separately to classify subjects. However, we will use the individual decisions in these two tasks to classify subjects as hindsight biased or rational in the joint analysis of the three finals tasks that we present in sections 4.3. and 4.4.

A pattern similar to the finals task regarding Spain is found in the goals task for which subjects stated the predicted and recalled number of goals during the remainder of the tournament. First note that 79.7% of the subjects underestimated the true number of goals shot during the eighth-, quarter-, and semi-final (37). In line with the hindsight bias, the

mean of the recalled predictions (34.3) is larger than the mean of the actual predictions (31.0). Again, a Wilcoxon signed-rank test indicates that this shift in the distributions is significant ($p < 0.001$). On the individual level we find 22.5% of rational subjects who remember their prediction accurately. We observe that 43.5% can be classified as hindsight biased as their recalled predictions are closer to the actual outcome of 37 than to their original predictions.[16] Finally, 33.9% remain unclassified as their recalled predictions are further away from the true outcome than their original predictions. Again this fraction is significantly lower than the fraction of hindsight-biased subjects (binomial test, $p = 0.034$).

The percentages of subjects displaying the opposite of the hindsight bias found in Fischhoff and Beyth (1975) and in our study are remarkably similar. Fischhoff and Beyth (1975) observe that 32.74%–34.29% of their subjects who are biased show a reverse hindsight bias which is well in the range of the corresponding fractions of 30.82% (43.79%) [35.93%] that we infer from the Spain task (goals task) [our λ_i estimated based on the finals tasks, see section 4.3]. Other related studies such as Biais and Weber (2009) on the intrapersonal bias do not report data at the individual level (they report only the median or the average for each task).

We attempt to correlate the degree of the hindsight bias as an individual characteristic with the choices in the delegation game. Therefore, we assess the consistency of both measures. We find that both measures are significantly dependent:[17] While 73% of the subjects who give hindsight-biased answers in the goals task are hindsight biased in the Spain task as well, only 50% of the subjects who correctly remembered their predictions in the goals task show some degree of hindsight bias in the Spain task.

Since the dependence between the two tasks is significant but not perfect, we introduce an additional classification of subjects based on both prediction tasks together. Here, we classify a subject as rational if and only if she remembered her predictions correctly in both tasks (9% of all subjects) and as hindsight biased if she was classified as hindsight biased in one of the tasks and as either rational or hindsight biased in the other (41% of

[16] For example, a subject predicting 30 goals at first and recalling a prediction of 40 is classified as hindsight biased as her recalled prediction is closer to the true outcome than her actual prediction.

[17] Throughout, pairwise comparisons of the binary classifications of subjects as (i) rational or (ii) hindsight biased according to the Spain task, the Germany task, the Argentina task, and the goals task, as well as the combined measure (based on the Spain and the goals task) reveal a positive relation between the classifications (Spearman's $\rho > 0$ for all comparisons). The (two-sided) Fisher's exact test rejects independence between the classifications for all pairwise comparisons except for the relation between the goals task and the Argentina task (at the 5% level of significance).

all subjects). For most of the analysis, we do not consider subjects who are unclassified according to one of the two tasks. However, we include these subjects in the analysis that we report in sections 4.3. and 4.4.

The subjects in our experiment reveal a hindsight bias that classifies as partial information projection, and there are only very few answers consistent with full projection. However, we observe some extreme choices in both prediction tasks. We therefore also investigate the effect of outliers as a robustness check. For example, regarding the Spain task one subject assessed Spain's likelihood of attending the final as 3% in the first place and then recalled it as being 100% after Spain was known to be participating. Another subject estimated the number of goals scored during the eighth-, quarter-, and semi-final to be 210 and remembered her prediction as being 60 after the true outcome of 37 was announced. The Grubbs' test for outliers identifies four extreme observations that are relevant for the analysis in this section.[18] Although we do not exclude these observations in our main analysis below, we report on those instances where their deletion affects the results.

4.2. Effect of hindsight bias in Spain and goals task on delegation behavior

Out of 395 participants in the role of the principal, 303 were in a situation where their private signal corresponded to the agent's action (Case I and II). Depending on their delegation decision and on whether the predictions in stages 1 and 2 were correct, the principals could earn Euro $0, 72, 75, 147$, or 150 if they were randomly selected to be paid at the end of the experiment. In Case I, the average payoff of a principal who was chosen to be paid was Euro 44.98 while in Case II, the average payoff was Euro 115.31.[19] Out of the 303 subjects in Case I and Case II, 229 (203) can be classified as being either rational or hindsight biased based on the Spain task (goals task). Based on the combination of

[18] The other six observations are those of unclassified subjects. A full list of the outliers in the prediction and memory tasks together with the corresponding delegation decisions can be found in table A.1 in the appendix. Although the Shapiro-Wilk tests reject normality for the distributions of the differences between recalled and actual predictions for both tasks (which could be due to the outliers besides non-normality of the population), the Grubbs' test is applied in order to employ a nonarbitrary criterion for the exclusion of apparently extreme observations.

[19] The corresponding number for Case III is 43.29 and for Case IV 92.71. (As we paid only 10 out of 420 participants, the actual expected payoffs were 1/42 times this amount.) Note that this payoff includes the payoff from the first stage, i.e., payoffs are higher in Case II and IV where the agent received a correct signal. And payoffs are highest in Case II where both the principal and agent received a correct signal. We also investigated the principal's payoff depending on the hindsight bias. When we regress the payoff either on the hindsight parameter estimated from the three finals tasks, as described in section 4.3., or on the classification based on the goals task, we find that the payoff slightly decreases in the hindsight bias, but this decrease is not significant.

both tasks, 150 subjects can be classified. As our model does not yield any predictions regarding unclassified subjects, these observations are excluded from the analysis below, but they will be used in sections 4.3. and 4.4. where we estimate and use an individual hindsight-bias parameter based on all three finals tasks.

Table 1 gives an overview of the principals' delegation rates conditional on their available information and their classification based on the tasks. First, we note that the delegation rates support our assumption that subjects derive a positive utility from self-determination, as delegation rates should be 100% without such a non-pecuniary utility both for rational and hindsight-biased principals.

Table 1 Delegation rates by task, principal's type and information.

Information	Spain task (n=229)		Goals task (n=203)		Combined (n=150)	
	Rational	Biased	Rational	Biased	Rational	Biased
Case I ($\omega_1 \neq s_1^P = a_1$)	66.7% ($\frac{24}{36}$)	55.2% ($\frac{37}{67}$)	75.9% ($\frac{22}{29}$)	55.4% ($\frac{36}{65}$)	81.8% ($\frac{9}{11}$)	55.9% ($\frac{33}{59}$)
Case II ($\omega_1 = s_1^P = a_1$)	71.8% ($\frac{28}{39}$)	70.1% ($\frac{61}{87}$)	67.4% ($\frac{29}{43}$)	66.7% ($\frac{44}{66}$)	60.0% ($\frac{9}{15}$)	76.9% ($\frac{50}{65}$)

In line with *Hypothesis 1*, the table shows that irrespective of the task(s) used for categorizing subjects as hindsight biased or rational, the delegation rates are lower for hindsight-biased principals than for rational principals in situations where the principal and the agent both received incorrect signals (Case I). Furthermore, in line with *Hypothesis 2*, the table reveals that the delegation rates for rational and hindsight-biased subjects are very similar when the agent's decision coincides with the state of the world (Case II), except for the combined categorization.

In order to test for *Hypotheses 1–5*, we employ probit regressions for each classification with the principals' probability to delegate as the dependent variable and a constant, a dummy variable for Case I, a dummy variable for principals classified as hindsight biased and an interaction of both dummies as independent variables.[20] Table 2 shows Wald tests of the differences between delegation rates obtained by proper transformations of the estimated coefficients.[21]

[20] Table A.2 in the appendix reports the estimated coefficients and standard errors for each categorization.

[21] Tests are one-sided for directed hypotheses (*Hypotheses 1*, *4*, and *5*) and two-sided for undirected hypotheses (*Hypotheses 2* and *3*).

Table 2 Differences in delegation rates by type and information of principals.

		Spain task	Goals task	Both tasks
Hypothesis 1:	$\pi_H^I - \pi_R^I < 0$	−0.114	**−0.205****	**−0.259****
Hypothesis 2:	$\pi_H^{II} - \pi_R^{II} = 0$	**−0.017**	**−0.008**	**0.169**
Hypothesis 3:	$\Delta_R := \pi_R^I - \pi_R^{II} \approx 0$	**−0.051**	**0.084**	**0.218**
Hypothesis 4:	$\Delta_H := \pi_H^I - \pi_H^{II} < 0$	**−0.149****	**−0.113***	**−0.210*****
Hypothesis 5:	$\Delta_H - \Delta_R < 0$	−0.098	**−0.197***	**−0.428****

Note: Bold values represent results in line with our hypothesis. Entries π_l^k denote the delegation rates with $k \in \{I, II\}$ for Case I and Case II and $l \in \{R, H\}$ for rational and hindsight-biased principals respectively. The p-values are based on Wald tests: $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

The first row in the table lends support to *Hypothesis 1*. In Case I, hindsight-biased principals delegate less often than rational principals (significant for the goals-task classification and the combined classification). Furthermore, in line with *Hypothesis 2*, the second row of the table indicates that irrespective of the classification of subjects, there is no significant difference between the delegation rates of rational and hindsight-biased principals in Case II.

Also regarding the comparisons across cases formulated in *Hypotheses 3–5*, we find support for our theoretical predictions. First, independent of the classification method, we find that the delegation rates of rational principals are not significantly different between the two cases (*Hypothesis 3*). Second, hindsight-biased principals exhibit a decreased propensity to delegate when they face a situation where the agent's decision contradicts the state of the world (Case I) compared to situations where the agent's decision and the state of the world coincide (Case II). This result that supports *Hypothesis 4* is significant for the Spain-task classification and the combined classification while only marginally significant for the goals-task classification. Finally, in line with *Hypothesis 5*, we find that hindsight-biased principals show a stronger reduction in delegation rates than rational principals when moving from Case II to Case I (significant for the combined classification and marginally significant for the goals-task classification). Our results are robust with respect to the exclusion of outliers (for the detailed analysis see table A.3 in the appendix).

For the classifications based only on the finals tasks regarding Germany and Argentina, respectively, we do not find support for our hypotheses.[22] This is in line with the literature according to which the hindsight bias is stronger if a certain event turns out to be true

[22] The corresponding analyses are available upon request from the authors.

than when it turns out not to be true (Fischhoff 1975, Slovic and Fischhoff 1977, Fischhoff and Beyth 1975). We interpret this as evidence that the Germany and Argentina task do not lead to a classification of subjects with respect to the hindsight bias that is accurate enough. However, in sections 4.3. and 4.4. we integrate the results based on the Germany and Argentina task in an aggregate measure of the hindsight bias.

We finally comment on the delegation behavior of unclassified subjects. Irrespective of whether subjects are classified according to the Spain, the Germany, the Argentina, or the goals task (or both the Spain and the goals task), unclassified subjects show no significant differences in the delegation rates between Case I and Case II.[23] Within cases, no significant differences in delegation rates are found between unclassified and rational participants (who are also not expected to show different delegation rates between cases).[24] Unclassified participants delegate significantly less often than hindsight-biased participants in Case II (as well as Case II and Case III jointly) when the classification is based on the Spain task (or on both the Spain and the goals task). Thus, the delegation choices of unclassified subjects are statistically indistinguishable from those of rational subjects.

4.3. Aggregate measure of hindsight bias

In this section, we construct a measure of the hindsight bias that is based on all three finals tasks. We do not include the goals task for econometric reasons as its scale differs from the scale of the finals tasks. Based on this aggregate measure of the hindsight bias, we then investigate whether it is correlated with the decision to delegate. For this analysis, we use all observations including the subjects who neither behaved in line with the hindsight bias nor were rational. We also include the data of Case III and Case IV.

Regarding the finals tasks we assume that subject i's recalled prediction p_{2ik} in finals task $k \in \{Spain, Argentina, Germany\}$ depends on her actual prediction p_{1ik} and her degree of hindsight bias λ_i as follows:

$$p_{2ik} = (1 - \lambda_i)p_{1ik} + \lambda_i \omega_k + \varepsilon_{ik},$$

[23] In all cases and classifications (including the classification based on the Argentina task, the Germany task, and the combined classification), there is only one instance (out of 30) of a significant difference in the delegation behavior of unclassified participants between cases: Subjects who are unclassified with respect to the Spain task exhibit a significantly higher propensity to delegate in Case I than in Case III (as well as in Case I and Case IV compared to Case II and Case III). Excluding the outliers renders these differences insignificant (at the 5% level).

[24] A marginally significant difference (significant at the 10%-level) is found for the Spain task in Case II, and the goals task when considering Case I and IV jointly.

where ω_k denotes the state of the world for task k perfectly revealed between stage 1 and stage 2 of the experiment, and ε_{ik} denotes noise. Assuming that ε_{ik} follows a normal distribution with zero mean and variance σ_i^2, we can estimate λ_i based on the three finals tasks by maximizing

$$\log L = \ln\left(\prod_{k=1}^{3} \frac{1}{\sqrt{2\pi\sigma_i^2}} \exp\left(-\frac{(p_{2ik} - (p_{1ik} + \lambda_i(\omega_k - p_{1ik})))^2}{2\sigma_i^2}\right)\right) \tag{10}$$

for each individual. In total, 36 subjects recalled their predictions perfectly for each of the finals tasks in the second stage. We did not estimate (10) for these subjects, but set $\hat{\lambda}_i = 0$.

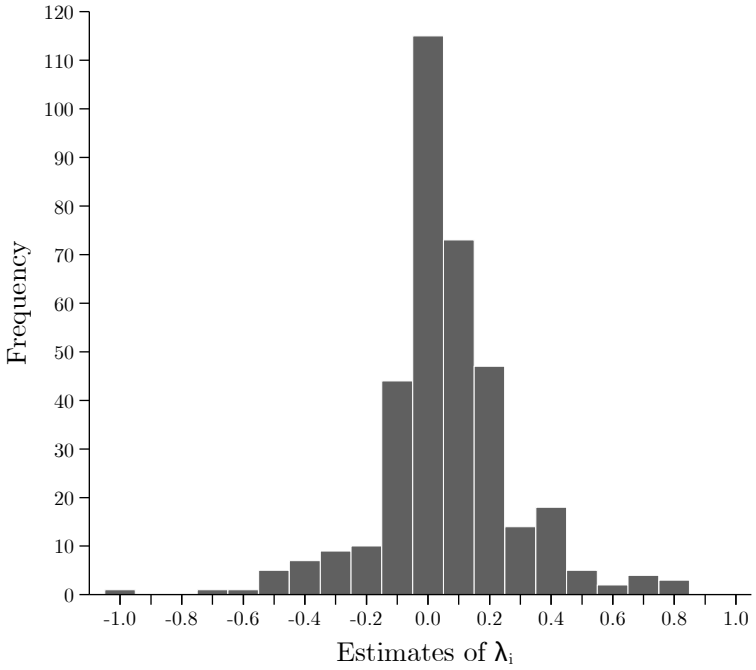

Figure 5 Histogram of $\hat{\lambda}_i$ based on the three finals tasks.

Figure 5 displays the histogram of the estimated individual parameters for the hindsight bias. We first note that there are more subjects with $\hat{\lambda}_i > 0$ than subjects with $\hat{\lambda}_i < 0$. In particular, of the subjects with imperfect recall (i.e., those subjects for whom $\hat{\lambda}_i$ is different from zero), 64.1% exhibit a positive $\hat{\lambda}_i$, and the number of subjects with a strictly positive $\hat{\lambda}_i$ is significantly larger than the number of subjects with a (strictly) negative $\hat{\lambda}_i$ (test of proportions yields $p < 0.001$).[25]

[25] See also table A.4 in the appendix.

The estimated λ_i seem to successfully aggregate the hindsight bias measured by each of the finals tasks for two reasons. First, the average $\hat{\lambda}_i$ is significantly larger for those subjects who have been classified as hindsight biased than for the subjects who have been classified as rational according to any of the finals tasks. Thus, there is a significant relation between the aggregate measure of hindsight bias and the classification of subjects according to each of the finals tasks alone. Second, the average $\hat{\lambda}_i$ is significantly larger than zero for subjects who have been classified as hindsight biased according to either finals task, while the average $\hat{\lambda}_i$ is not significantly different from zero for subjects who have been classified as rational according to each of the finals tasks—except for the Germany task.[26]

4.4. Aggregate measure of the hindsight bias and the delegation decision

According to our hypotheses, we expect a significant and negative relation between the individual hindsight bias and delegation in Case I but not in Case II. Our previous findings are corroborated when considering the aggregate, continuous measure for an individual's tendency towards hindsight bias. Table 3 reports on the results of probit regressions of the principals' propensity to delegate on $\hat{\lambda}_i$. Column 1 (column 4) of the table reveals that the probability of delegation is significantly decreasing in $\hat{\lambda}_i$ in Case I (Case I and IV together), which reconfirms Hypothesis 1. In line with Hypothesis 2, column 2 (column 5) shows that there is no significant effect of individual hindsight bias on the probability to delegate in Case II (Case II and III together). Finally, in line with Hypothesis 5, column 3 (column 6) shows that the relationship between the probability of delegation and $\hat{\lambda}_i$ is significantly different between Case I (Case I and IV) and Case II (Case II and III). In line with the hypotheses we conclude that there is a significantly negative relationship between the hindsight bias and the propensity to delegate in cases where the state of the world revealed in period 2 conflicts with the principals' information received in period 1.

5. Discussion

Using a novel experimental design, we document the predictive power of the concept of information projection. In particular, we show that the hindsight bias can lead to suboptimal delegation decisions. This bias plays a role when an economic actor has imprecise information about the state of the world. Then, once the true state of the world is revealed,

[26] See table A.5 in the appendix for an analysis of the relationship of $\hat{\lambda}_i$ to the hindsight bias measured in the separate tasks.

Table 3 Probit regressions of delegation on individual estimates of hindsight bias (based on finals tasks).

	Case I versus II			Case I&III versus II&IV		
	Case I	Case II	Case I&II	Case I&IV	Case II&III	All cases
	(1)	(2)	(3)	(4)	(5)	(6)
$\hat{\lambda}_i$	-1.187^{**}	0.380	0.380	-1.108^{**}	0.638	0.638
	(0.569)	(0.452)	(0.452)	(0.507)	(0.401)	(0.401)
$1_{\text{Case I(/IV)}}$			-0.034			0.028
			(0.154)			(0.134)
$1_{\text{Case I(/IV)}} \times \hat{\lambda}_i$			-1.567^{**}			-1.746^{***}
			(0.727)			(0.646)
Constant	0.360^{***}	0.394^{***}	0.394^{***}	0.350^{***}	0.322^{***}	0.322^{***}
	(0.114)	(0.103)	(0.103)	(0.100)	(0.090)	(0.090)
N	138	165	303	179	216	395
$\log L$	-89.676	-105.352	-195.028	-116.858	-140.008	-256.866
χ^2_1	4.468	0.704	5.823	4.956	2.535	7.739

Note: Stars represent p-values: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

hindsight-biased principals fail to remember their earlier assessment. Thus, in a principal-agent relationship the principal's confidence in herself relative to the agent is not correctly updated. Hindsight-biased principals are frequently too self-confident and therefore delegate too little, compared to rational principals.

There might be alternative reasons for principals not to delegate although standard theory predicts them to do so. For example, overconfidence can potentially affect delegation decisions in our game. In both Case I and Case II, overconfidence should push decisions into the same direction, i.e., toward less delegation. Indeed, as we find that participants in our experiment delegate less than predicted in both cases, overconfidence might be part of the story. However, overconfidence cannot explain the observed differences in delegation rates. First, suppose that overconfidence is uncorrelated with the hindsight bias. Then overconfidence cannot explain the difference we observe between rational and hindsight-biased subjects in Case I. Second, if the hindsight bias and overconfidence are correlated, then those subjects we classify as hindsight biased are also overconfident and should delegate less than rational individuals both in Case I and Case II. This is not what we observe as we only find such a difference in Case I.

In contrast to results from the standard principal-agent literature, our finding shows that interim information in a multi-period principal-agent relationship does not necessarily

help to mitigate distortions that originate in asymmetric ex ante information or ex ante uncertainty. Instead, our results suggest that hindsight-biased principals (e.g., managers, doctors or venture capitalists) are not able to update information correctly when evaluating the relative ability of their agents. This makes additional information about the agent less valuable.

Since we have identified a specific source of the inability to delegate optimally, the question arises as to whether management instruments can be used to counteract the hindsight bias. Documenting the principal's information at certain points in time can alleviate the effects of her biased memory. For example, a manager could be forced to document evaluations of his subordinates' decisions before she knows whether these decisions turned out to be right or not; or a venture capitalist could document his earlier assessment of the entrepreneur and his venture.

Concerning methodology, our paper makes use of the heterogeneity of experimental subjects and exploits individual differences in the degree of the hindsight bias. We are able to predict a person's behavior in a strategic situation (the delegation game) with the help of the answers to a few questions (the prediction tasks) eliciting a certain individual trait. In experimental economics, this is a routine exercise for risk aversion. In these studies, risk aversion is measured in an individual decision task, and this measure is then used to explain behavior in a game. The procedure is much less common when dealing with other personal traits, but our findings suggest that it could be used more widely to deliver insights for a number of biases discussed in the literature.

Acknowledgments

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Appendix

A. Supplemental Tables

Table A.1 Observations classified as outliers by Grubbs' maximum normed residual test.

Task	ID	Prediction	Remembered Prediction	Difference*	Explained by rational behavior or hindsight bias	Decision to delegate
Spain	91	100	0	−100	unexplained	yes
	382	3	100	97	hindsight bias	no
Goals	40	31	5	−26	unexplained	yes
	135	60	89	−29	unexplained	no
	148	2	30	28	hindsight bias	yes
	157	210	60	150	hindsight bias	yes
	209	30	120	−76	unexplained	no
	263	36	86	−48	unexplained	yes
	360	40	70	−30	unexplained	no
	381	10	37	27	hindsight bias	no

*Note: In line with the categorical classification of the subjects with respect to the goals task, the responses to the goals task are compared based on their absolute deviations from the true outcome (37).

Table A.2 Probit regressions of delegation on principal's type and information.

	Propensity to delegate		
	Spain task	Goals task	Combined
Constant	0.577	0.452	0.253
	(0.213)	(0.198)	(0.327)
Case I	−0.146	0.250	0.655
	(0.304)	(0.323)	(0.549)
hindsight biased	−0.049	−0.021	0.483
	(0.256)	(0.255)	(0.370)
Case I×hindsight biased	−0.250	−0.545	−1.242
	(0.368)	(0.393)	(0.598)
n	229	203	150
$\log L$	−145.25	−129.85	−90.90
$\chi^2_{(3)}$	4.58	4.33	7.73

Note: Values in parantheses represent standard errors.

Table A.3 Estimated effects of principals' information and type on delegation rates.

	Testing hypotheses		Spain task		Goals task		Combined	
	H_0	H_1	incl. outliers	w/o outliers	incl. outliers	w/o outliers	incl. outliers	w/o outliers
Hypothesis 1: $\pi_H^I < \pi_R^I$	$\pi_H^I - \pi_R^I = 0$	$\pi_H^I - \pi_R^I < 0$	-0.114	-0.147	-0.205	-0.226	-0.259	-0.266
			(0.125)	(0.070)	(0.021)	(0.013)	(0.026)	(0.023)
Hypothesis 2: $\pi_H^{II} = \pi_R^{II}$	$\pi_H^{II} - \pi_R^{II} = 0$	$\pi_H^{II} - \pi_R^{II} \neq 0$	-0.017	0.000	-0.008	0.003	0.169	0.169
			(0.847)	(0.997)	(0.933)	(0.978)	(0.216)	(0.216)
Hypothesis 3: $\pi_R^I \approx \pi_R^{II}$	$\Delta_R := \pi_R^I - \pi_R^{II} = 0$	$\pi_R^I - \pi_R^{II} \neq 0$	-0.051	-0.032	0.084	0.084	0.218	0.218
			(0.630)	(0.762)	(0.431)	(0.431)	(0.204)	(0.204)
Hypothesis 4: $\pi_H^I < \pi_H^{II}$	$\Delta_H := \pi_H^I - \pi_H^{II} = 0$	$\pi_H^I - \pi_H^{II} < 0$	-0.149	-0.179	-0.113	-0.145	-0.210	-0.218
			(0.028)	(0.011)	(0.091)	(0.046)	(0.006)	(0.005)
Hypothesis 5: $\Delta_H < \Delta_R$	$\Delta_H - \Delta_R = 0$	$\Delta_H - \Delta_R < 0$	-0.098	-0.147	-0.197	-0.229	-0.428	-0.436
			(0.230)	(0.134)	(0.074)	(0.048)	(0.012)	(0.011)

Note: Entries π_l^k denote the delegation rates with $k \in \{I, II\}$ for Case I and Case II and $l \in \{R, H\}$ for rational and hindsight-biased principals respectively. The values in brackets correspond to p-values obtained by Wald tests of the non-linear restrictions given in column "H_0". For example, given the estimated parameters in table A.2, *Hypothesis 3* is tested by the restriction $\pi_R^I = \pi_R^{II}$ with $\widehat{\pi}_R^{II} = \Phi(\widehat{b}_{const})$ and $\widehat{\pi}_H^I = \Phi(\widehat{b}_{const} + \widehat{b}_{CaseI})$ where $\Phi(\cdot)$ denotes the standard normal cumulative distribution function.

Table A.4 Overview of estimated hindsight bias.

	Freq.	Percent
Hindsight biased ($\hat{\lambda}_i > 0$)	230	58.23
Unbiased ($\hat{\lambda}_i = 0$)	36	9.11
Reverse hindsight biased ($\hat{\lambda}_i < 0$)	129	32.66
Total	395	100.00

Table A.5 Average hindsight bias according to aggregate measure of hindsight bias (based on the three finals tasks) by categories of hindsight bias measured by each task separately.

	Average $\hat{\lambda}_i$			Differences in average $\hat{\lambda}_i$		
Memory task	Unclassified	Rational	Hinds. bsd.	(3)−(2)	(2)−(1)	(3)−(1)
	(1)	(2)	(3)	(4)	(5)	(6)
Spain	-0.100^{***}	0.007	0.144^{***}	0.137^{***}	0.107^{***}	0.245^{***}
Germany	0.038^{**}	0.035^{***}	0.114^{***}	0.079^{***}	-0.003	0.076^{**}
Argentina	0.007	0.015	0.111^{***}	0.096^{***}	0.008	0.105^{***}

Note: Stars represent p-values of (two-sided) t-tests: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

B. Instructions

B.1. Instructions for the agents: Round 1

Thank you for participating in our survey and the following little game!

Information regarding participation and lottery:

Among all participants we will raffle

> **5 x 2 cards for the 11-Friends-World Cup**
> on June 26, 2010, at 1 p.m.

We will contact you again on July 8 to conduct another survey and finish the game.

Then you will have the chance to win between 75 and 250 Euro. If you are among the winners, we will contact you separately and transfer your earnings to your account.

Please answer the following seven questions:

1. Likelihood of Germany reaching the final of the World Cup 2010? (Please give a percentage between 0 to 100.)

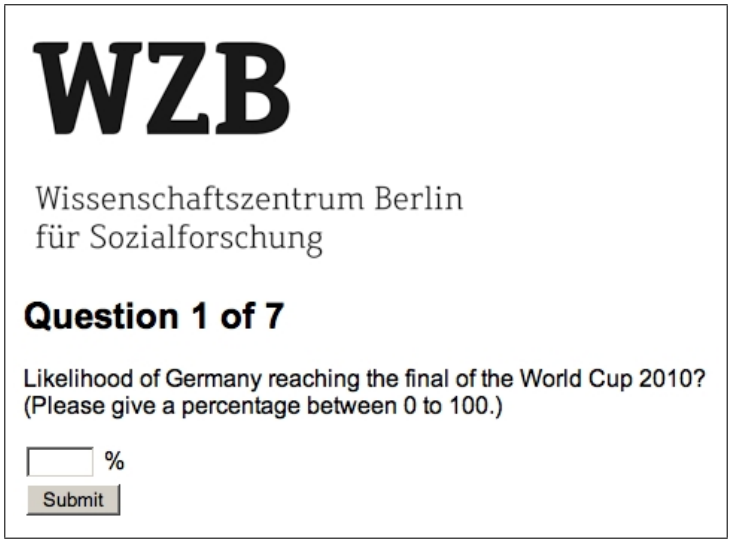

Figure B.1 How questions were presented to the participants, e.g. question 1.

2. What is the likelihood of Spain reaching the final of the World Cup 2010? (Please give a percentage.)
3. What is the likelihood of Argentina reaching the final of the World Cup 2010? (Please give a percentage.)
4. What is the likelihood of Italy dropping out **before** the semi-final? (Please give a percentage.)
5. How many goals will be scored within the regular playing time (90 min.) during the eighth-final, quarter-final, and semi-final (14 matches overall)?
6. Suppose there are 100 people (including yourself) who – just like you – have just guessed how many goals will be scored during the eighth-final, quarter-final, and semi-final. These estimations can be ranked so that the best estimation is first ranked. How would you rank your estimate? Is your estimation between

- rank 1 and 10,
- rank 11 and 20,
- rank 21 and 30,
- rank 31 and 40,
- rank 41 and 50,
- rank 51 and 60,
- rank 61 and 70,
- rank 71 and 80,
- rank 81 and 90,
- rank 91 and 100?

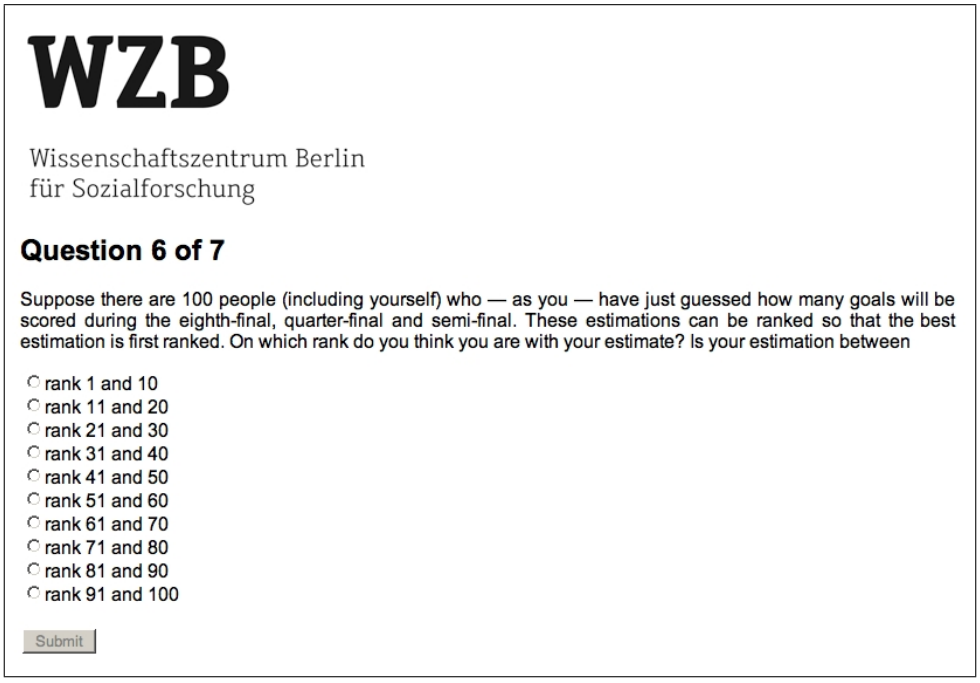

Figure B.2 Determining the participants' degree of overconfidence.

7. Which team is your personal favorite for winning the World Cup 2010?

Thank you for answering the previous questions.

Please read the following instructions very carefully and make the decisions you are asked for. You can win a considerable amount of money for it. On July 11 we will hold a raffle for all participants of the game and will draw 10 winners. If you are among the winners you will earn 75 Euro for each correct decision!

Imagine the following situation in which you will either take the role of the coach or of the manager:

During this season the coach and the manager of the soccer club "SC World-Champion" have to decide whether or not to buy a talented young player named Lion Elmess.

If the player evolves into a good player during the season, it is advantageous to have him as a member of the team. If the player doesn't evolve into a good player, it is not advantageous to have him as a member of the team. A young player evolves into a good player in half the cases.

To guide their decision, both the coach and the manager turn to a talent scout. A talent scout can be of a good or bad type. The coach as well as the manager cannot recognize the type of the talent scout. But the trainer turns to a good talent scout in five out of 10 cases (50 percent) while the manager turns to a good talent scout in only four out of 10 cases (40 percent) and in six out of 10 cases a bad type.

What distinguishes a good talent scout from a bad one?

The advice of a good talent scout is correct in two-thirds of cases. That is, in two out of three cases the young player evolves into a good player if a good talent scout rated him as a good player. In the same way, a young talent evolves into a bad player if a good talent scout rated him as a bad player.

In contrast, a bad talent scout can't predict the development of a young player that well. He is correct only in half the cases. If a bad talent scout rated a young player as a good player, he is correct only in one of two cases. In the same way, a young player nevertheless evolves into a good player even if a bad talent scout rated him as a bad player.

By pressing "Next" you will either get the role of the coach or the role of the manager and will have to make your decision.

You are in the role of the coach.

You are given the following advice by the talent scout you turned to:

["Lion Elmess seems to have great talent."]

["Lion Elmess seems to have insufficient talent."]

Please decide whether or not to buy Lion Elmess. If your decision is correct (that means in favor of the club), you win 75 Euro if you win the lottery.

[Buy]

[Don't buy]

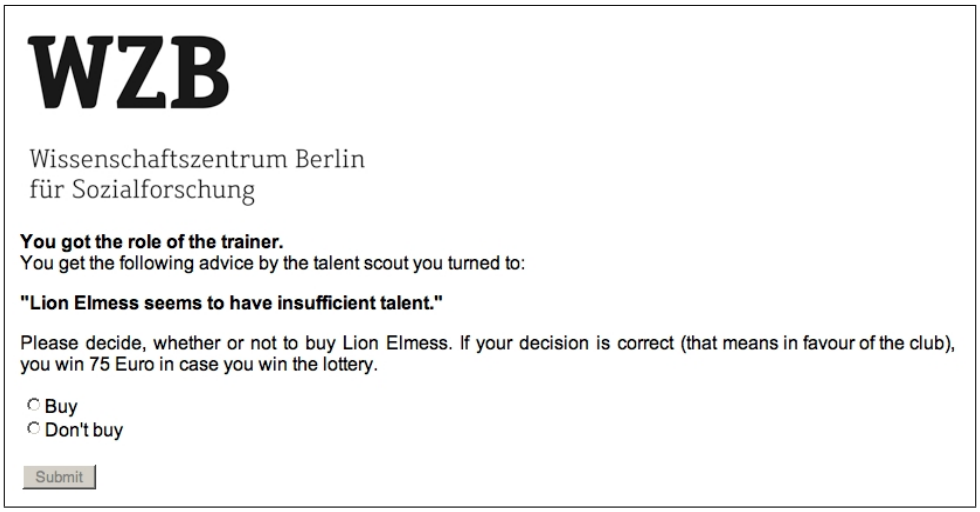

Figure B.3 First decision task of the agents in the first stage.

You will find out whether [your acquisition] turned out to be a good decision at the end of the season in three weeks.

You will find out whether [your decision not to buy Lion Elmess] turned out to be a good decision at the end of the season in three weeks.

Before the start of the next season (in three weeks), both the trainer and manager again have to decide whether or not to buy a young player named Lukas Hashüpfer.

Concerning the quality of the talent scout and the player's feasible talent, the same assumptions hold as for the decision regarding Lion Elmess.

In three weeks the manager has to decide whether she will leave the decision of whether or not to buy Lukas Hashüpfer to you or whether she will take it herself.

For practical reasons we ask you to now take the decision whether or not to buy Lukas Hashüpfer in the event of the manager leaving the decision to you. Again, you get 75 Euro should you win the lottery and if your decision is correct.

Again, you ask your talent scout for her advice. It is the same talent scout you had asked with regard to Lion Elmess. You get the following advice by your talent scout:

["Lukas Hashüpfer seems to have great talent."]
["Lukas Hashüpfer seems to have insufficient talent."]

Please decide now, whether or not to buy Lukas Hashüpfer for the next season:
[Buy]
[Don't buy]

You will find out whether [your acquisition] turned out to be a good decision in three weeks.

You will find out whether [your decision not to buy Lukas Hashüpfer] turned out to be a good decision in three weeks.

Thank you for participating!

We will contact you again on July 8 by email. Then you will get the chance to win between 75 and 250 Euro. If you are drawn for the tickets for the 11-Friends-World Cup, we will contact you on June 26.

B.2. Instructions for the agents: Round 2

Thank you for participating in the second stage of our survey and the following little game.

Information regarding participation and lottery:
Among the participants who complete the second stage of our game, we will inform those of you who have won between 72 and 250 Euro. We will explain later on how you can win the prize.

During the first stage three weeks ago, you were asked to state the likelihood of certain events in the course of the ongoing championship. You are now asked to remember your stated likelihoods in this first stage as precisely as you can.

The 10 participants who best remember their stated likelihoods in stage one will earn 100 Euro each. Only those participants who completed the entire second stage (including the game) will be considered.

Argentina did not reach the final of the World Cup 2010.

1. What likelihood for Argentina reaching the final of the World Cup 2010 did you state in the last survey? (Please give a percentage between 0 to 100.)

During the eighth-final, quarter-final, and semi-final 37 goals were scored (within regular playing time).

2. In the last survey, how many goals did you predict would be scored during the eighth-final, quarter-final, and semi-final?

Germany did not reach the final of the World Cup 2010.

3. What likelihood of Germany reaching the final of the World Cup 2010 did you state in the last survey? (Please give a percentage.)

Spain did reach the final of the World Cup 2010.

4. What likelihood for Spain reaching the final of the World Cup 2010 did you state in the last survey? (Please give a percentage.)

Italy was eliminated during the preliminary round and therefore did not reach the semi-final.

5. What likelihood for Italy being eliminated before the semi-final of the World Cup 2010 did you state in the last survey? (Please give a percentage.)

(This question will not be taken into account because the outcome was already known within the first stage of the survey.)

Three weeks ago you were given the role of the coach of the club SC World-Champion. As the coach, you had to decide whether or not to buy the young talents Lion Elmess and Lukas Hashüpfer. You will now find out whether your decisions turned out to be good or bad.

Three weeks ago you decided [to buy Lion Elmess].
Congratulations, the acquisition of Lion Elmess turned out to be a good one. Lion Elmess was a great asset to the team. In the event of your winning the lottery, you will receive 75 Euro.

Three weeks ago you decided [not to buy Lion Elmess].
Unfortunately, this decision was a bad one and Lion Elmess turned out to have a great deal of talent. Therefore you won't get any money for this decision in the event of your winning the lottery.

Furthermore, you decided [to buy Lukas Hashüpfer] three weeks ago.

Congratulations, the acquisition of Lukas Hashüpfer turned out to be a good one. Lukas Hashüpfer will be a great asset to the team this season. You will get 75 Euro in the event of your winning the lottery.

Furthermore, you decided [not to buy Lukas Hashüpfer] three weeks ago.

Unfortunately, this decision was bad and Lukas Hashüpfer turned out to have a great deal of talent. Therefore you won't get any money for this decision in the event of your winning the lottery.

Thank you for participating!

We will contact you again if your name is drawn in the raffle on July 13. Should you have any further questions, do not hesitate to contact us.

B.3. Instructions for the principals: Round 1

The instructions for the principals were exactly the same as for the agents, until they learned their role in the delegation game:

You are in the role of the manager.

You are given the following advice by the talent scout you turned to:
"Lion Elmess seems to have great talent."
"Lion Elmess seems to have insufficient talent."

Please enter the advice you got in the following form.

Lion Elmess seems to have [Entry] talent.

For this season you will have to leave the decision whether or not to buy Lion Elmess to your coach. In the meantime, your coach was also given advice by her talent scout and took the following decision: [Decision]

You have to wait until the season is over in order to find out whether your coach's decision turned out to be good. The season lasts until July 8. On that date we will contact you again and inform you as to whether Lion Elmess evolved as a good or bad player, that is, whether your coach's decision to buy or not buy Lion Elmess turned out to be good. If the decision turns out to be good, you will win 75 Euro in the event that you win the lottery.

Before the start of the next season (in three weeks), both the trainer and the manager have to decide again whether or not to buy a young player named Lukas Hashüpfer. Concerning the quality of the talent scout and the player's feasible talent, the same assumptions hold as for the decision regarding Lion Elmess.

We will then ask you to decide, who – your coach or you yourself – will take the decision on Lukas Hashüpfer.

Please keep in mind that you only take part in the lottery if you complete both parts of the game.

Thank you for participating!

We will contact you again on July 8 by email. Then you will get the chance to win between 75 and 250 Euro. If you are drawn for the tickets for the 11-Friends-World Cup, we will contact you on June 26.

B.4. Instructions for the principals: Round 2

Thank you for participating in the second stage of our survey and the following little game.

Information regarding participation and lottery:
Among the participants who completed the second stage of our game, we will inform those of you who have won between 72 and 250 Euro. We will explain later on how you can win the prize.

During the first stage three weeks ago, you were asked to state the likelihood of certain events in the course of the ongoing championship. You are now asked to remember your stated likelihoods in stage one as precisely as you can.

[...] Again, the way the principals' remembered predictions were elicited was the same as for the agents.

Please remember the situation with regard to the first stage. You were given the role of the manager of the club SC World-Champion:
Your coach had to decide whether or not to buy the talented player Lion Elmess. You will now find out whether her decision turned out to be a good or bad decision.

For the next season a decision has to be taken as to whether or not to buy another talented young player named Lukas Hashüpfer. You have to decide whether you will leave this decision to your coach or whether you will take it yourself.

Basically, you are once again facing the following decision about the acquisition of a new player:

If the player evolves into a good player during the season, it is advantageous to have him as a member of the team. If the player doesn't evolve into a good player, it is not advantageous to have him as a member of the team. A young player evolves into a good player in half the cases.

To guide their decision, both your coach and you as the manager turn to a talent scout. A talent scout can be of good or bad type. The coach as well as the manager cannot recognize the type of the talent scout. But the trainer turns to a good talent scout in five out of 10 cases (50 percent) while the manager turns to a good talent scout in only four out of 10 cases (40 percent) and in six out of 10 cases a bad type.

What distinguishes a good talent scout from a bad one?
The advice of a good talent scout is correct in two-thirds of cases. That is, in two out of three cases the young player evolves into a good player if a good talent scout rated him as a good player. In the same way, a young talent evolves into a bad player if a good talent scout rated him as a bad player.

In contrast, a bad talent scout can't predict the development of a young player that well. He is correct in only half the cases. If a bad talent scout rated a young player as a good player, he is correct only in one of two cases. In the same way, a young player nevertheless evolves into a good player even if a bad talent scout rated him as a bad player.

By pressing "Next" you will find out your coach's decision in the last season (stage one) regarding Lion Elmess.

The coach's decision in the last season

After you and your coach turned to a talent scout last season, your coach decided to buy Lion Elmess. The acquisition of Lion Elmess turned out to be a good one. Lion Elmess was a great asset to the team. In the event of your winning the lottery, you will receive 75 Euro.

After you and your coach turned to a talent scout last season, your coach decided not to buy Lion Elmess. Unfortunately, this decision was a bad one and Lion Elmess turned out to have a great deal talent. Therefore you won't get any money for this decision in the event of your winning the lottery.

Decision for the next season

For the next season, the decision whether or not to buy Lukas Hashüpfer has to be taken. You can take this decision on your own or leave it to your coach. If you take it on your own, the same talent scout you turned to last season will give you advice. If you leave the decision to your coach, she will also turn to the same talent scout as last season.

If you take the decision on your own and your decision is a good one, you will earn **72 Euro** in the event of your winning the lottery.

If you leave the decision to your coach again and her decision is a good one, you will earn **75 Euro** if you win the lottery.

If your decision or the decision of your coach turns out to be bad you won't earn any money.

☐ [I will take the decision regarding the acquisition of Lukas Hashüpfer on my own.]

☐ [I will leave the decision regarding the acquisition of Lukas Hashüpfer to my coach.]

You have decided to take the decision regarding Lukas Hashüpfer on your own.

You are given the following advice by your talent scout:

"Lukas Hashüpfer seems to have insufficient talent."

"Lukas Hashüpfer seems to have a great deal of talent."

Please decide now whether or not to buy Lukas Hashüpfer for the next season. If your decision is a good one, you will earn 72 Euro in the event you win the lottery.

[Buy]

[Don't buy]

Congratulations, the acquisition of Lukas Hashüpfer turned out to be a good one. Lukas Hashüpfer will be a great asset to the team. In the event that you win the lottery, you will receive 72 Euro.

Unfortunately, this decision was a bad one and Lukas Hashüpfer turned out to have a great deal of talent. Therefore you won't get any money for this decision in the event that you win the lottery.

You have decided to leave the decision regarding Lukas Hashüpfer to your coach.

Your coach decided to buy Lukas Hashüpfer. Congratulations, the acquisition of Lukas Hashüpfer turned out to be a good one. Lukas Hashüpfer will be a great asset to the team. In the event of your winning the lottery, you will receive 75 Euro.

Your coach decided not to buy Lukas Hashüpfer. Unfortunately, this decision was a bad one and Lukas Hashüpfer turned out to have a great deal of talent. Therefore you won't get any money for this decision in the event of your winning the lottery.

Please enter the advice you were given by your talent scout regarding Lion Elmess in stage one.

☐ "Lion Elmess seems to have great talent."
☐ "Lion Elmess seems to have insufficient talent."

Thank you for participating!

We will contact you again if your name is drawn in the lottery on July 13. Should you have any further questions, do not hesitate to contact us.

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