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"Wise men change their minds, fools never."

– from Zhouyi ("The Book of Changes")

"Not to amend a fault after you commit it, that is a true fault."

– from Analects of Confucius

1 Introduction

Leadership is an extremely abstract and complex notion which cannot be easily summarized by a few characteristics. Although it is perhaps true that no one characteristic makes a good leader all by itself, it is also true that there are some characteristics that appear to be more important than others. One of such characteristics might be vision – the ability to correctly foresee the future and let her followers know about it by taking a clear stance. Led by a leader with a strong and clear vision who can take a stance before things unfold themselves, the organization can better identify tasks needed to be done before it becomes too late. When a leader is indecisive and fails to take a stance soon enough, on the other hand, the organization often loses its way, consequently ending up with mediocre outcomes.

There is little doubt that having a clear vision and a strong will to stand by it, even in turbulent times, is an important qualification of effective leaders. At the same time, though, there seems to be much more to leadership than simply taking a stance early on and persevering afterwards. In a dynamic context where things gradually unfold themselves, leaders must be open-minded enough to respond rationally and objectively to new information without being prejudiced by any prior beliefs. We call this characteristic flexibility, which is taken as another key component of effective leadership. For instance, a leader may become obsessive about her initial stance after a sequence of "lucky" draws; or, on a flip side, she may become stubborn and adhere to the initial stance when all the signs that subsequently become available indicate otherwise. Along with vision, flexibility is presumably another rare characteristic, as it is best exemplified by an old Chinese proverb "wise men change their minds, fools never."[1]

Besides the fact that vision and flexibility are both rare to come by, the problem compounds even more because there seems to be only a thin line between these two notions. How can a person possess vision and flexibility, which at a glance seem to contradict with each other, at the same time? The goal of this paper is to address this issue, aiming to explore into the workings behind vision and flexibility. To this end, we construct a two-period model where a decision maker must make decisions sequentially in an uncertain environment. In each period, she can observe a free signal which partially reflects the state of nature: for clarity, we refer to the signal observed in the first (second) period as the first (second) signal. The observed signal is either informative or noisy depending on some factors beyond her control, and when it is informative, its accuracy depends on her own ability. Based on the available information, she then makes an inference about the realized state and takes an appropriate action. The problem is that the decision maker does not know whether any given signal is informative or not beyond its objective probability (which we refer to as the objective informativeness).

The fact that the informativeness of the signal depends possibly on some exogenous factors provides some leeways for the decision maker. While a rational decision maker forms a belief based on its objective informativeness, we deviate from this conventional paradigm by allowing her to deceive herself and believe whatever she wants to believe regarding the informativeness of any observed signal. More precisely, we consider a situation where, upon observing a signal, the decision maker subjectively assesses its informativeness to serve her self-interests: that is, she may believe that the observed signal is informative and reliable, more than its objective value, if the observed signal is favorable to her while she downplays the informativeness of the signal if it is not favorable. This information manipulation is not costless, however, because a distorted belief would lead to a distorted action which is in general less efficient.[2] This tradeoff creates a tension within herself and constrains the extent

[1] To "change minds," one must be keen enough to find an error in own judgements and at the same time courageous enough to admit it. The proverb implies that it is indeed difficult to achieve both of them.

[2] A case in point is an instance of workers in a hazardous job, as depicted in Akerlof and Dickens (1982). To escape from the fear of injury, they have an incentive to believe that the job is actually safe, but in this state of self-deception, they also often fail to wear required safety equipments – an apparently inefficient action.

of information manipulation. The subjective informativeness is determined as an optimal response to this tradeoff.

An important question to ask at this juncture is then what information is actually “favorable” to the decision maker. Would she have any reason to deceive herself into believing that any given signal is more or less informative than its objective estimate? The answer is yes, if she cares about her self-images in a dynamic context like this. To see why and when she prefers to bend the truth, note that the signals observed by a low-ability decision maker tend to be less reliable, and she is hence more prone to observing inconsistent signals. Conversely speaking, observing inconsistent signals is a sign of incapability and consequently undermines her self-confidence while observing consistent signals does the opposite. When self-confidence is a valuable asset, therefore, this quest for better self-images gives the decision maker an incentive to distort her view of the world: to preserve or boost her self-confidence, she tends to overvalue consistent signals and undervalue inconsistent ones, to the extent that it is not warranted objectively.

We attempt to capture this process by constructing a model of intrapersonal conflicts between the objective self and the subjective self who differ in their objectives and cognitive capabilities. The objective self represents a rational side of the decision maker who is forward-looking and processes information objectively, while the subjective self represents a more primitive and instinctive side who is myopic and, with imperfect knowledge of herself, cares about her self-images (ego preferences). This setup contains two sources of cognitive bias. First, the subjective self possesses ego preferences, and the objective self must compromise with the subjective self to satisfy her ego by biasing the view of the world. Second, the difference in time horizon between the two selves amounts to time-inconsistent objectives, which gives rise to a self-control problem and the need to regulate future selves. With these two sources at work, this simple setting yields three types of behavioral bias, which we refer to as obsession, stubbornness and indecisiveness for expositional purposes. We summarize our main findings as follows:

1. Consistent information is exaggerated (obsession).

2. Inconsistent information is discounted (stubbornness).

3. Early information is discounted (indecisiveness).

The first two biases concern what happens in the second period where the decision maker has accumulated information. The driving force of these biases is the subjective self's quest for better self-images. As stated above, if the second signal is consistent with the first one and informative, chances are that she has made the the right observation. She then exaggerates the informativeness of the second signal but, as a consequence of self-deception, ends up with an extreme position. On the other hand, inconsistent signals are a bad news for the decision maker because this may indicate the lack of ability on her part. To reduce dissonance, she then downplays the importance of the second signal by disregarding it as uninformative. These two biases indicate that she is prejudiced by the first signal, one way or the other: in either case, the decision maker lacks flexibility as she fails to respond objectively to new information.

In contrast, the last bias, termed as indecisiveness, concerns what happens in the first period. The underlying logic leading to this last bias is to be separated from the first two, as it now stems from a self-control problem due to time-inconsistent objectives. To see how this bias arises, notice that while the decision maker's information processing in the second period is biased, its magnitude is heavily dependent on the informativeness of the first signal. The magnitude is larger if she relies strongly on the first signal and takes a clear stance: for instance, if the first signal is regarded as a complete noise containing no relevant information, the second signal provides no information about her ability type whatsoever, and there arises no need to justify herself. For a decision maker who is hampered by the self-control problem, discounting the informativeness of the first signal and remaining rather ambiguous are therefore a way to regulate her future self. In so doing, however, she fails to articulate her vision and take a clear stance before things unfold themselves, which we take as representing the lack of vision.

The present setup allows us to identify several important factors that affect the way the decision maker processes information over time and hence critical determinants of vision and flexibility. First, a key factor in this entire process is the objective self's dominance over the subjective self. We say that the decision maker possesses strong willpower to regulate herself (or, more precisely, the subjective self) when the objective self has better control over the subjective self. The lack of willpower, or the lack of control over the subjective self, is the source of all behavioral biases in our model. A decision maker with weak willpower must compromise more and consequently end up with a more biased view of the world. All sorts of biases disappear if the objective self has perfect control over the subjective self, which allows the decision maker to rationally and objectively process information.

Another important factor is the decision maker's self-confidence in her own ability, which consists of two aspects: the level (the mean) and the fragility (the variance). The self-confidence fragility is about how secure the decision maker feels about herself and measured by the prior variance of the ability type, as perceived by the subjective self. The effect of the self-confidence fragility is complementary to the effect of willpower and works in the same direction. If the decision maker is perfectly sure about her own ability, whatever she observes does not change her assessment of herself, and the incentive to preserve self-confidence disappears no matter how severe the self-control problem is. As she becomes less secure about herself, the need to preserve self-confidence intensifies, leading to all sorts of biased behavior.

In contrast, the effect of the self-confidence level, measured by the prior expectation of the ability type, is more complicated compared to the other two factors. In general, a decision maker with more self-confidence exhibits a lager bias in period 2 in both directions (both obsession and stubbornness) and hence is less flexible. This is because those with high self-confidence have more trust in the first signal, and the cost of biasing the interpretation of the second signal is relatively low,[3] indicating that high self-confidence *per se* does not necessarily leads to better and objective judgments. In contrast, the effect of the self-confidence level on vision is less certain, as it could go either way. The logic is now partially reversed because the first signal is more reliable for those with high self-confidence and it is relatively more costly for them to bias its interpretation. There is a countervailing effect, however, since the second-

[3]To be more precise, this is because we consider a situation where the prediction ability is tested more in the first period. We explore more on this point later.

period bias is larger for those with high self-confidence and the self-control problem is hence severer, given the same level of willpower and self-confidence fragility. The overall effect is determined by this tradeoff but we argue that the first effect is more likely to dominate the second. In light of this, we claim that high self-confidence makes a decision maker less flexible, while it tends to make her more visionary.

The paper proceeds as follows. In the remainder of this section, we briefly discuss related literatures. Section 2 outlines the basic model of subjective information evaluation. Section 3 provides the main results of the paper, with special attention paid to the effects of self-confidence and willpower. Section 4 extends the basic model to show that the main results are reasonably robust to some alterations. Finally, section 5 makes some concluding remarks.

Related literature

The paper spans over several distinct areas, and there are accordingly several strands of related literature. First, both obsession and stubbornness are a manifestation of what is called confirmation bias or, more generally, self-serving bias in the psychology literature.[4] While this has been well recognized in psychology, the importance of the self-serving nature of our belief system has also gained some recognition among economists,[5] and several attempts are made to capture this seemingly robust human nature.[6] One of the attempts to model belief distortions as a result of optimized behaviors is provided by Benabou and Tirole (2002, 2006, 2007) and Benabou (2008a, 2008b). In these papers, they consider cases where an agent can manipulate her own memory with some cost (e.g., forget bad news), thereby explicitly looking into the process of biased belief formation.[7] The basic tenet of our model largely

[4]A self-serving bias refers to a human tendency to make internal attributions for success and external attribution for failure. The study on this issue has yielded a voluminous literature; see, for instance, Zuckerman (1979).

[5]See, for instance, Babcock and Loewenstein (1997).

[6]Formal analyses which incorporate confirmation bias and explore its consequences include Rabin and Schrag (1999) and Compte and Postlewaite (2004). The approach of this paper is different, as we derive it as an optimized behavior of divided selves, instead of assuming it and exploring its consequences.

[7]Several recent works also derive overconfidence, a type of self-serving bias, without explicitly assuming biased information processing. Van den Steen (2004) argues that facing a choice of actions, people are more likely to choose an action of which they overestimate the probability of success, and hence tend to be overoptimistic about the current action that they choose. Santos-Pinto and Sobel (2005) consider a case where different individuals hold different opinions about how skills combine to determines an ability level. In that setting, positive self-image arises because they work more on a skill that is critical to their production function. Also, see Köszegi (2006) for

falls into this category in that the entire logic is centered around endogenous and self-serving belief distortions.

Although the current paper shares certain aspects with the line of works by Benabou and Tirole, there are also some distinctions, aside from the fact that we focus on a totally different issue. One important distinction lies in the fundamental mechanism which gives rise to belief distortions, which inherently calls for a different modeling approach. It is well recognized in psychology that the sources of self-serving bias can be fairly diverse, and the literature has accordingly identified several different "tricks" to sustain favorable views of oneself. One of such tricks is that people tend to recall favorable experiences more readily and forget unfavorable ones, which is precisely the approach taken by Benabou and Tirole.[8] This paper focuses on yet another trick, i.e., a tendency to bias interpretations of evidence or events in a self-serving manner. According to the literature, people manage to hold an overoptimistic view of themselves because they discover flaws in evidence that conflicts with their self-interests but rely excessively on evidence that portrays them in a good light: for instance, several studies show that people tend to be more critical of the validity of tests on which they failed (Wyer and Frey, 1983; Pyszczynski et al, 1985). Both of the tricks, along with some others, are generally regarded as important sources of self-serving bias; we choose the current approach simply because it better serves our purposes.

Whereas both forms of inflexibility are deeply rooted in self-serving bias, the lack of vision in our model stems from a type of self-control problem due to time-inconsistent objectives. In this sense, the paper is related to Carrillo and Mariotti (2000) and Benabou and Tirole (2002, 2004), among many others, who explore various aspects of self-regulation for individuals with time-inconsistent preferences. In the present model, the self-control problem arises due to the difference in time horizon between the two selves, where the myopic subjective self gets in the way to obstruct the objective self to make a fully rational decision. The lack of vision surfaces because taking an ambiguous stance early on is a way to reduce any concern for protecting self-images and hence to regulate the future subjective self.

how a rational agent comes to hold an overoptimistic view of herself.

[8]For instance, Crary (1966) shows that people boost self-esteem by not remembering failures.

Besides these so-called "behavioral" aspects, the main thrust of the paper is the dynamic nature of information acquisition. Works along this line include Prendergast and Stole (1996) and Li (2007) who consider dynamic aspects of reputation concerns in signaling models. This paper is especially related to Prendergast and Stole (1996) who consider a situation where an agent signals his ability to acquire information and examine how that signaling incentive changes over the course of his career. They show that the agent exaggerates information when young and tends to become more conservative as he gets older. An important aspect of their model is that changing behavior from previous periods is costly because that signals the lack of ability on his part. Our model shares this aspect, which is the driving force of one side of inflexibility termed as stubbornness. Aside from this, however, there are several notable differences. First, we consider a totally different setup, which allows us to focus on the flip side of inflexibility, i.e., exaggeration of favorable information which we refer to as obsession.[9] Second, while Prendergast and Stole (1996) only consider static incentives (maximization of the current payoff), we explicitly consider dynamic incentives to regulate the future self, which results in the discounting of early information.

Finally, several papers explicitly focus on the notion of vision. To name a few, Rotemberg and Saloner (2000) model vision as a bias which makes the manager favor one project over the other.[10] Van den Steen (2005) also formalizes the notion of vision and shows that a leader with strong beliefs would attract employees with similar beliefs. This sorting effect improves coordination within the firm, suggesting a channel through which strong vision can affect the firm's performance. In this paper, we focus on a different aspect of vision, defined as the ability to effectively utilize early information before things unfold themselves.[11]

[9]In their model, the state space is extended on the real line and hence has no "extreme" points. In this specification, there is no way to exaggerate information in our sense.

[10]Similarly, Rotemberg and Saloner (1994) argue that a firm could be better off by committing to a specific business strategy.

[11]In a different vein, Ishida (2008) discusses how reputation concerns force a decision maker to become indecisive in that she adheres excessively to the status quo

2 The model

Our optimization problem rests on the tradeoff between biased beliefs and biased actions, which stems from our inherent desire for coherence and consistency as suggested by theories of cognitive dissonance. The basic premises of the present model follow Akerlof and Dickens (1982): (i) people have preferences not only over states of the world, but also over their beliefs about the state of the world; (ii) they also have some control over the beliefs; (iii) the beliefs once chosen persist over time. The last premise is particularly important, as it links distorted beliefs with distorted actions. Because of this link, a tradeoff arises which constrains the extent of information manipulation.

2.1 Setup

Consider a two-period model where a risk-neutral decision maker (DM) engages in some long-term project. In each period, DM observes a signal, evaluates it and takes an action based on the evaluation. The action chosen in each period yields a payoff which is realized and received at the end of period 2. The value of the project depends on the action taken in each period and the (time-invariant) state of nature $\theta \in \{0, 1\}$. The state of nature is not directly observable, and its prior distribution is given by

$$\texttt{prob}\{\theta = 0\} = \texttt{prob}\{\theta = 1\} = 0.5.$$

That is, each state occurs equally likely *ex ante*.

In this environment, DM's job is to correctly predict the state and choose an appropriate course of action accordingly. More precisely, let $a_t \in [0, 1]$ denote the action chosen in period $t = 1, 2$. Given some realized state θ, the value of the project (for period t) is given by $v_\theta(a_t)$ where $v_0(a) = -a^2$ and $v_1(a) = -(1-a)^2$. This specification implies that the actions are *ex ante* symmetric in every respect. Given the action a and some belief $\rho := \texttt{prob}\{\theta = 1 \mid \text{available information}\}$, the expected value of the project is computed as

$$R(a, \rho) = -\rho(1-a)^2 - (1-\rho)a^2. \tag{1}$$

The first-order condition implies that the optimal action is $a = \rho$, i.e., to match with the belief about the realized state.

2.2 Signals

At the beginning of each period, DM has a chance to observe a signal, which possibly contains some information about the state of nature. The signal is either informative or noisy, and the (objective) probability that any given signal is informative is $\tilde{\gamma} \in (0, 1)$. When the signal is noisy, it contains no information about the realized state, so that

$$\text{prob}\{s_t = \theta \mid \text{the signal is noisy}, \eta\} = 0.5, \ t = 1, 2.$$

When it is informative, on the other hand, the signal coveys some information about the realized state although its accuracy differs across periods. DM's judgement ability is tested more in period 1, and hence the accuracy depends more on her ability type, denoted by $\eta \in [0, 1]$:

$$\text{prob}\{s_1 = \theta \mid \text{the signal is informative}, \eta\} = \frac{1+\eta}{2}.$$

The situation unfolds itself and becomes more predictable as time passes by, so that an informative signal in period 2 perfectly reflects the realized state:

$$\text{prob}\{s_2 = \theta \mid \text{the signal is informative}, \eta\} = 1.$$

It is perhaps worth emphasizing that the second signal contains information not just about the realized state but also about the ability type, because DM with low ability is more likely to observe inconsistent signals.

2.3 Information processing and the intrapersonal conflict

Although DM knows nothing more than the fact that any given signal is informative with probability $\tilde{\gamma}$, we here consider a situation where she can deceive herself and subjectively assign the informativeness to each observed signal in a self-serving manner. Let $\gamma_t \in [0, 1]$ denote the subjective informativeness of the observed signal, i.e., the subjective assessment of the probability that the signal observed in period t is informative. In each period, upon observing a signal s_t, DM chooses γ_t to serve her self-interests. There is a cost associated with this information manipulation, however, because a distorted belief would persist and subsequently result in an inefficient action. The subjective informativeness is determined by taking into account this tradeoff.

While there are potentially many ways to capture this aspect, we model DM as a multi-layered self with divided interests between the objective self, the subjective self, and the actor.[12] The objective and subjective selves are jointly responsible for processing information and constructing DM's own view of the world, which is represented by the (subjective) information set Ω_t:

$$\Omega_1 := (s_1, \gamma_1) \text{ and } \Omega_2 := (s_1, s_2, \gamma_1, \gamma_2).$$

Given the information set Ω_t, the actor then maps it into an action to maximize the expected value of the project. Formally, we divide each period into two stages and suppose that DM goes through the following process:

Stage 1 (the information-processing stage). Upon observing s_t, the objective and subjective selves assign γ_t to it so as to maximize the overall payoff π_t (to be explained next).

Stage 2 (the action stage). Given the information set Ω_t, the actor implements the optimal action.

The focus of attention is on the intrapersonal conflict in the first stage while the presence of the actor is artificially introduced to make a link between a belief and an action. The driving force of the intrapersonal conflict is the misalignment of incentives between the objective and subjective selves, which we describe below.

The objective self: The objective self represents a rational, though manipulable, side of DM who is forward-looking and processes information in an objective manner as conventionally assumed. The objective self correctly understands that any given signal is informative with probability $\tilde{\gamma}$ and uses this objective informativeness to evaluate her payoff: let $\tilde{p}_t$ denote the objective self's (unbiased) belief about θ in period t. The objective self is interested solely in

[12]For a different approach, see Brocas and Carrillo (2008) who model the brain as a hierarchical organization.

the expected value of the project, and her payoff in period 1 is hence given by

$$\pi_1^{\mathrm{O}}(a_1;\gamma_1) = R(a_1,\tilde{\rho}_1) + \delta\Pi_2^{\mathrm{O}}(\gamma_1), \tag{2}$$

where $\Pi_2^{\mathrm{O}}(\gamma_1)$ is the objective self's expected payoff in period 2 as a function of γ_1 and $\delta \in (0,1]$ the objective self's discount factor. Similarly, the payoff in period 2 is

$$\pi_2^{\mathrm{O}}(a_1,a_2;\gamma_1,\gamma_2) = R(a_2,\tilde{\rho}_2). \tag{3}$$

The subjective self: The subjective self represents a more primitive and instinctive side of DM who is myopic and, with imperfect knowledge about herself, cares about her self-images (ego preferences). The prior distribution of η, as recognized by the subjective self, is given by F with mean $\mu := \int \eta dF$ and variance $\sigma^2 := \int \eta^2 dF - \mu^2$. The prior mean reflects DM's initial self-confidence level while the variance reflects its fragility: we say that DM is more secure about her self-images when σ^2 is smaller and close to zero. Being myopic, the subjective self totally disregards the value of the project which realizes in the future and instead cares only about the immediate gain, i.e., her self-images at each moment. The subjective self's payoff in each period is thus simply given by

$$\pi_1^{\mathrm{S}}(\gamma_1) = E[\eta \mid \Omega_1], \tag{4}$$

$$\pi_2^{\mathrm{S}}(\gamma_1,\gamma_2) = E[\eta \mid \Omega_2], \tag{5}$$

The subjective self is totally manipulable and capable of believing whatever she wants to believe.

The intrapersonal conflict: The subjective informativeness is chosen so as to maximize the overall payoff π_t, which is defined as a weighted average of π^{O} and π^{S}:

$$\pi_t = \alpha\pi_t^{\mathrm{S}} + (1-\alpha)\pi_t^{\mathrm{O}}, \tag{6}$$

where α is the subjective self's share. Define $\beta := \alpha/(1-\alpha)$, which we take as a measure of DM's willpower where she is regarded as possessing strong willpower to regulate herself (or the subjective self) when β is large.

A critical aspect of the model is that once the subjective informativeness is chosen, it persists over time and distorts subsequent decisions. We capture this aspect by assuming that the actor is naive and takes Ω_t as if it represents the true state of the world when choosing the optimal action. This entire process eventually amounts to the following constrained optimization problem:

$$\max_{\gamma_t} \ \pi_t,$$

subject to

$$a_t = \text{prob}\{\theta = 1 \mid \Omega_t\}.$$

In what follows, the entire process is described as if DM singlehandedly solves this constrained problem. Other than the interpretation detailed just above, this setup yields a wide variety of interpretations as to the structure behind it. In any event, though, the bottom line is the tradeoff between distorted beliefs and distorted actions and any structure that can (at least partially) capture this aspect can suffice for our purposes.

3 Optimal information processing

3.1 Preliminary

Before we move on, we first describe in some depth how the beliefs are formed in this model. There are two unknowns in this model, the ability type η and the state of nature θ, and a belief must be formed on each of them. Let g_t denote the informativeness of the signal in period t, which is either $\tilde{\gamma}$ or γ_t depending on who forms the belief. Given some informativeness (g_1, g_2), define

$$\mu_1(s_1; g_1) := E[\eta \mid s_1, g_1], \ \mu_2(s_1, s_2; g_1; g_2) := E[\eta \mid s_1, s_2, g_1, g_2],$$

as the belief about η. Similarly, define

$$\rho_1(s_1; g_1) := \text{prob}\{\theta = 1 \mid s_1, g_1\}, \ \rho_2(s_1, s_2; g_1, g_2) := \text{prob}\{\theta = 1 \mid s_1, s_2, g_1, g_2\},$$

denote the belief about θ.

To be more precise, the objective self and the actor must form a belief about the state of the world ρ_t. Given some informativeness g_1, the best estimate of θ in period 1 is obtained as

$$\rho_1(1; g_1) = \frac{1 + g_1\mu}{2}, \tag{7}$$

where $g_t = \tilde{\gamma}$ when the belief is evaluated by the objective self and $g_t = \gamma_t$ if it is evaluated by the actor.[13] Due to the symmetric nature of the states, $\rho_1(0; g) = 1 - \rho_1(1; g)$. Since the states are symmetric, we shall hereafter focus on $s_1 = 1$ without loss of generality. The manipulable range of the belief is depicted in figure 1.

[Figure 1]

With an additional signal in period 2, the belief about θ is updated and given by

$$\rho_2(1, 1; g_1, g_2) = \frac{(1 + g_2)(1 + g_1\mu)}{2((1 - g_2)(1 - g_1\mu) + (1 + g_2)(1 + g_1\mu))} = \frac{(1 + g_2)(1 + g_1\mu)}{2(1 + g_1 g_2\mu)}. \tag{8}$$

$$\rho_2(1, 0; g_1, g_2) = \frac{(1 - g_2)(1 + g_1\mu)}{2((1 + g_2)(1 - g_1\mu) + (1 - g_2)(1 + g_1\mu))} = \frac{(1 - g_2)(1 + g_1\mu)}{2(1 - g_1 g_2\mu)}, \tag{9}$$

where g_t depends on who forms the belief in the same way as above.[14] To ease notation, define

$$\rho_C(g_1, g_2) := \rho_2(1, 1; g_1, g_2) \text{ and } \rho_I(g_1, g_2) := \rho_2(1, 0; g_1, g_2).$$

The manipulable range of the belief is depicted in figure 2.

[Figure 2]

Being uncertain about her own ability, on the other hand, the subjective self must form a belief about η, which we refer to as the self-confidence level. The inference is only relevant in period 2 because one signal conveys no information about η. The self-confidence level in period 2 is obtained as

$$\mu_2(1, 1; g_1, g_2) = \frac{g_1 g_2 \int_0^1 \eta(1 + \eta)dF + (1 - g_1 g_2)\mu}{g_1 g_2 \int_0^1 (1 + \eta)dF + (1 - g_1 g_2)} = \frac{\mu + g_1 g_2 E[\eta^2]}{1 + g_1 g_2\mu}, \tag{10}$$

[13] In either case, $E[\eta] = \mu$ is imposed to obtain the belief.

[14] The belief $E[\eta] = \mu$ is again imposed to obtain this updated belief. This implies that both the objective self and the actor believe that the true ability type is known and fixed at μ (no updating through the observation of s_1 and s_2). Though somewhat restrictive, this assumption drastically simplifies the analysis and thus helps to yield clearer and sharper predictions while preserving the substance of the model. In section 4, we relax this assumption to clarify its role and implications.

$$\mu_2(1,0;g_1,g_2) = \frac{g_1 g_2 \int_0^1 \eta(1-\eta)dF + (1-g_1 g_2)\mu}{g_1 g_2 \int_0^1 (1-\eta)dF + (1-g_1 g_2)} = \frac{\mu - g_1 g_2 E[\eta^2]}{1 - g_1 g_2 \mu}. \tag{11}$$

where, since the belief is formed by the subjective self, $g_t = \gamma_t$. Similarly as above, define

$$\mu_C(\gamma_1,\gamma_2) := \mu_2(1,1;\gamma_1,\gamma_2) \text{ and } \mu_I(\gamma_1,\gamma_2) := \mu_2(1,0;\gamma_1,\gamma_2).$$

Notice that $\mu_C > \mu > \mu_I$ for any $\gamma_1\gamma_2 > 0$ and $\sigma^2 > 0$, i.e., consistent signals are a good news for DM while inconsistent signals are a bad news.

3.2 Flexibility: the second-period problem

In period 2, DM observes an additional signal, which may nor may not be consistent with the first signal. DM's flexibility, which is defined as the ability to respond rationally and objectively to new information, is tested in this situation. When DM is prejudiced by the first signal and fails to respond objectively to the second signal, the consequent action is distorted and becomes necessarily inefficient. Here, we examine when and to what extent DM exhibits this type of behavioral bias.

In period 2, DM observes s_2 and assigns the subjective informativeness to it, taking (s_1, s_2) and γ_1 as given. The optimization problem is thus defined as

$$\max_{\gamma_2} \quad \alpha\mu_2(s_1,s_2;\gamma_1,\gamma_2) + (1-\alpha)R(\rho_2(s_1,s_2;\gamma_1,\gamma_2), \rho_2(s_1,s_2;\tilde{\gamma},\tilde{\gamma})).$$

The first-order condition is obtained as

$$\alpha\frac{\partial\mu_2}{\partial\gamma_2} - 2(1-\alpha)(\rho_2(s_1,s_2;\gamma_1,\gamma_2) - \rho_2(s_1,s_2;\tilde{\gamma},\tilde{\gamma}))\frac{\partial\rho_2}{\partial\gamma_2} = 0, \tag{12}$$

assuming that there exists an interior solution. The solution is obtained as a function of γ_1 and denoted as $\rho_2^*(s_1,s_2;\gamma_1)$. Given some optimal belief $\rho_2^*(s_1,s_2;\gamma_1)$, we refer to $b_2(s_1.s_2;\gamma_1) := \rho_2^*(s_1,s_2;\gamma_1) - \tilde{\rho}_2(s_1,s_2;\tilde{\gamma},\tilde{\gamma})$ as the optimal bias as perceived by the objective self. We take this as a measure of flexibility where DM is less prejudiced and hence more flexible when the bias is smaller.

When the signals are consistent, this condition becomes

$$\frac{\alpha\gamma_1\sigma^2}{(1+\gamma_1\gamma_2\mu)^2} - (1-\alpha)(\rho_2 - \tilde{\rho}_C)\frac{1-(\gamma_1\mu)^2}{(1+\gamma_1\gamma_2\mu)^2} = 0, \tag{13}$$

where $\tilde{\rho}_C := \rho_C(\tilde{\gamma}, \tilde{\gamma})$. The optimal belief ρ_C^* in this contingency as a function of γ_1 is given by

$$\rho_C^*(\gamma_1) - \tilde{\rho}_C = \frac{\beta\sigma^2\gamma_1}{1 - (\gamma_1\mu)^2}, \tag{14}$$

where $\beta := \alpha/(1-\alpha)$ is a measure of DM's willpower. It follows from this that $\rho_C^* > \tilde{\rho}_C$ for any $\gamma_1 > 0$, meaning that DM exaggerates her information even more when the observed signals are consistent.

Similarly, when the signals are inconsistent, this condition becomes

$$-\frac{\alpha\gamma_1\sigma^2}{(1-\gamma_1\gamma_2\mu)^2} + (1-\alpha)(\rho_2 - \tilde{\rho}_I)\frac{1-(\gamma_1\mu)^2}{(1-\gamma_1\gamma_2\mu)^2} = 0, \tag{15}$$

where $\tilde{\rho}_I := \rho_I(\gamma_1, \tilde{\gamma})$. The optimal belief ρ_I^* as a function of γ_1 is then given by

$$\rho_I^*(\gamma_1) - \tilde{\rho}_I = \frac{\beta\sigma^2\gamma_1}{1 - (\gamma_1\mu)^2}, \tag{16}$$

which again implies that $\rho_I^* > \tilde{\rho}_I$ for any γ_1. This means that DM undervalues the second signal and instead favors the first one in order to justify her prior stance. Note also that the optimal bias is symmetric, i.e., $b_2(1,0;\gamma_1) = b_2(1,1;\gamma_1)$ for any γ_1. Define $b_2^*(\gamma_1) := b_2(1,0;\gamma_1) = b_2(1,1;\gamma_1)$, which can be seen as a measure of DM's flexibility.

Proposition 1 *The optimal second-period bias is always positive and given by*

$$b_2^*(\gamma_1) = \frac{\beta\sigma^2\gamma_1}{1 - (\gamma_1\mu)^2}.$$

For any given γ_1, the bias is increasing in β, σ^2 and μ and disappears as $\beta \to 0$ and/or $\sigma^2 \to 0$. Moreover, the bias is increasing in γ_1.

PROOF: Most of the proposition is self-evident from the discussion made thus far. We only show that the optimal bias is increasing in γ_1. This is the case if

$$\frac{\beta\sigma^2(1 + (\gamma_1\mu)^2)}{(1-(\gamma_1\mu)^2)^2} > 0, \tag{17}$$

which always holds.

Q.E.D.

Several remarks are in order. First, the optimal second-period bias is always positive, meaning that DM biases her decision in the direction of the first signal. There are two sides to this biased information processing. When the observed signals are consistent, DM overreacts to the second signal, becoming rather obsessive about her initial stance. As a flip side, when the observed signals are inconsistent, she downplays the importance of the second signal and sticks stubbornly with her initial stance. In either case, with imperfect willpower $\beta > 0$ and imperfect knowledge about herself $\sigma^2 > 0$, DM in general exhibits a degree of inflexibility as she fails to respond rationally and objectively to new information.

Second, taking γ_1 as given, the size of the bias depends on attributes such as the self-confidence level and fragility as well as the strength of willpower. The effects of the self-confidence fragility and the strength of willpower are identical and relatively straightforward. The bias is smaller when DM is more secure about herself and/or she has strong willpower to regulate herself: in fact, when DM is perfectly secure about herself ($\sigma^2 = 0$) or has perfect willpower ($\beta = 0$), the intrapersonal conflict disappears and she exhibits no bias whatsoever.[15] What is more interesting but intuitively less straightforward is perhaps the effect of the self-confidence level. The analysis reveals that DM who has more confidence in herself is less likely to reverse her prior decisions and hence more prone to exhibiting inflexibility in both ways. This suggests that although high ability itself is helpful in making good judgements, high self-confidence is often an obstacle to making objective decisions. This result comes from the fact that the accuracy of the first signal is more sensitive to ability than that of the second signal. Since DM with high self-confidence trusts her first observation more than that with low self-confidence, the cost of biasing the interpretation of the second signal is lower in a relative sense. This biases her information processing in order to protect her self-images, making inflexibility more of a problem for DM with high self-confidence.

Finally, it is important to note that the optimal bias is also a function of an endogenous choice variable γ_1. The bias is larger when DM puts more stock in the first signal and de-

[15] As an alternative interpretation, the self-confidence fragility can be taken as reflecting how the predictability of the underlying environment is related to DM's ability. For instance, if the accuracy of the first signal is less ability-intensive and related only weakly to η, not much is revealed about her ability type. The situation corresponds to a case with a smaller σ^2.

creases as γ_1 decreases, meaning that vision and flexibility are substitutes. In particular, when $\gamma_1 = 0$, i.e., DM believes that the first signal is not at all informative, nothing she observes undermines her self-confidence, and there is hence no need to bias her decision making in order to justify herself. This aspect gives rise to critical dynamic interactions, because the objective self in period 1 can reasonably control the subjective self in period 2 by disregarding the first signal and remaining rather ambiguous. This is precisely the problem faced by DM in period 1, which we will next turn to.

3.3 Vision: the first-period problem

The prediction ability is tested more in period 1, so that the accuracy of the first signal depends positively on DM's ability. In this setting, vision is defined as the ability to respond rationally and objectively to early information before things unfold themselves. The key factor at this stage is the presence of time-inconsistent objectives, which stems from the difference in time horizon between the two selves. The objective self knows that her second-period prediction will be biased, to the detriment of her own interests, to accommodate the subjective self's ego preferences. The objective self thus has an incentive to minimize this bias, if it is possible at all. There is indeed a way to achieve this because, as we have seen, the optimal bias in period 2 depends positively on the informativeness of the first signal γ_1. Disregarding the first signal frees the future self from any concern about her self-images and allows her to react more objectively to the second signal, thereby minimizing the prediction bias which works against the objective self's interests. There is of course a cost associated with it, because a failure to objectively utilize the first signal generally results in an inefficient action in period 1. The optimal bias in period 1 is determined by this tradeoff.

Since γ_1 and γ_2 are intertemporally linked, DM can influence her future self through the choice of γ_1. The objective self's expected payoff in period 2 as a function of γ_1 is given by

$$\Pi_2^O(\gamma_1) = \frac{1+\tilde{\gamma}^2\mu}{2}\pi_C(\gamma_1) + \frac{1-\tilde{\gamma}^2\mu}{2}\pi_I(\gamma_1), \tag{18}$$

where

$$\pi_C(\gamma_1) := R(\rho_C^*(\gamma_1), \tilde{\rho}_C) = -\tilde{\rho}_C(1-\rho_C^*(\gamma_1)) - (1-\tilde{\rho}_C)\rho_C^*(\gamma_1), \tag{19}$$

$$\pi_I(\gamma_1) := R(\rho_I^*(\gamma_1), \tilde{\rho}_I) = -\tilde{\rho}_I(1-\rho_I^*(\gamma_1)) - (1-\tilde{\rho}_I)\rho_I^*(\gamma_1). \tag{20}$$

Upon observing $s_1 = 1$, DM's problem in period 1 is defined as

$$\max_{\gamma_1} \quad \alpha\mu + (1-\alpha)\Big(R(\rho_1(1;\gamma_1), \rho_1(1;\tilde{\gamma})) + \delta\Pi_2^O(\gamma_1)\Big).$$

Notice that the myopic subjective self has nothing at stake in period 1, so that the problem is strictly about how the objective self regulates the future subjective self.

Define $\tilde{\rho}_1 := \rho_1(1;\tilde{\gamma})$ and $b_1^*(\gamma_1) := \rho_1(1;\gamma_1) - \tilde{\rho}_1$ where we take b_1^* as a measure of DM's vision: the larger b_1^* is, the more visionary she is.[16] The first-order condition is then given by

$$-\frac{2b_1^*(\gamma_1)}{\delta}\frac{\partial\rho_1}{\partial\gamma_1} + \frac{1+\tilde{\gamma}^2\mu}{2}\frac{\partial\pi_C}{\partial\gamma_1} + \frac{1-\tilde{\gamma}^2\mu}{2}\frac{\partial\pi_I}{\partial\gamma_1} = 0. \tag{21}$$

Since

$$\frac{\partial\pi_C}{\partial\gamma_1} = \frac{\partial\pi_I}{\partial\gamma_1} = -2b_2^*(\gamma_1)\frac{d\rho_C^*}{d\gamma_1}, \tag{22}$$

(21) can be written as

$$b_1^*(\gamma_1) = R(\gamma_1)b_2^*(\gamma_1), \tag{23}$$

where

$$R(\gamma_1) := -\frac{\delta\frac{d\rho_C^*}{d\gamma_1}}{\frac{\partial\rho_1}{\partial\gamma_1}} = -\frac{2\delta\beta\sigma^2(1+(\gamma_1\mu)^2)}{\mu(1-(\gamma_1\mu)^2)^2}, \tag{24}$$

Proposition 2 *The optimal first-period bias is always negative. The bias is increasing in β, σ^2 and δ and disappears as they tend to zero, whereas it is decreasing in μ if*

$$1 - 4(\tilde{\gamma}\mu)^2 - 3(\tilde{\gamma}\mu)^4 > 0.$$

Moreover, $\gamma_1 = 0$ (the complete lack of vision) if μ is sufficiently small.

PROOF: See Appendix.

The optimal first-period bias is always negative, in contrast to the second-period bias, where DM biases her prediction towards her prior mean and takes an ambiguous stance to allow her future self to be free of any self-esteem concerns. This is taken as a sign of the lack

[16]Evidently, there is a right degree of vision, i.e., more vision is not necessarily better. DM indeed takes an excessively strong stance when $b_1^* > 0$ although, as we will see later, this would not occur in equilibrium.

of vision (or indecisiveness). As in period 2, the bias is increasing in β and σ^2, because the need to regulate the future self is simply larger. This indicates that DM fails to articulate her vision when she is insecure about herself and/or lacks willpower to regulate herself.

In period 1, there is another factor that comes into play, i.e., the objective self's discount factor δ. In general, the bias is decreasing in δ, meaning that the more forward-looking DM is, the less visionary she becomes. This is perhaps intuitive because the source of the bias lies in time-inconsistent objectives, which arise from the difference in time horizon between the two selves. As $\delta \to 0$, the objective self becomes more myopic and time-inconsistency eventually disappears, meaning that more far-sighted individuals tend to be less visionary and take a more ambiguous initial position.[17]

It is, on the other hand, more complicated to see how a change in μ affects γ_1. On one hand, an increase in μ enlarges the second-period bias for any given γ_1, which raises the marginal gain of lowering γ_1. On the other hand, there is also a countervailing effect. To see this, recall that an increase in μ tends to make DM more inflexible in period 2 because with the first signal being more accurate, the cost of disregarding the second signal is relatively small. As can be imagined, the situation is totally reversed in period 1: the cost of disregarding the first signal is now larger for DM with high self-confidence. While the optimal bias could go either way due to this tradeoff, it is decreasing in μ when $\tilde{\gamma}$ is sufficiently small,[18] because the second-period bias becomes negligibly small, and the need for self-regulation diminishes in this case. Then, since the cost of disregarding the first signal is larger, the first-period bias becomes smaller for DM with high self-confidence who articulates a clearer vision.

The effect of the self-confidence level can also be seen from an alternative perspective. Notice that, as $\mu \to 0$, the choice of γ_1 becomes totally irrelevant, because the signal is not

[17]Of course, there are several caveats for this interpretation. First, δ is apparently not the only measure of one's far-sightedness and patience. Here, we vary δ while fixing the subjective self's discount factor at zero: we obtain the opposite implication if we instead vary the subjective self's discount factor while fixing δ at some level, say one. Also, the model only predicts that an increase in δ (caring more about future) makes DM less visionary fixing all other factors constant. This recognition is important because δ may be correlated with other attributes if more patient individuals tend to possess better cognitive abilities.

[18]The bias is in fact decreasing in μ for all $\mu \in [0, 1]$ if $\tilde{\gamma} < \bar{\gamma} \approx 0.464$. Of course, this is only a sufficient condition, indicating that the bias is decreasing in μ for a wider range of parameter values.

informative anyway, no matter how she interprets it. Since the cost of biasing the interpretation is vanishingly small, there is no reason to assign any positive informativeness to the first signal. As the proposition indicates, the optimal response is the complete lack of vision ($\gamma_1 = 0$) for DM with sufficiently low self-confidence. When that happens, DM totally disregards early information and does not make up her mind until things become sufficiently clear.

3.4 A tradeoff between vision and flexibility

In section 3.2, we have discussed how the second-period bias b_2^* varies in response to changes in parameters such as β, σ^2 and μ when γ_1 is exogenously given and fixed. Since γ_1 itself is a function of those parameters, however, indirect effects through γ_1 must also be taken into account to fully understand the overall impact on flexibility. As suggested, vision and flexibility are substitutes in that when one goes up, the other other must go down. Changes in exogenous parameters also affect the relative value of vision and flexibility, as captured by $R(\gamma_1)$, thereby yielding some indirect effects. Although our primary focus is on the direct effects, we here briefly discuss the overall impact of exogenous parameters on the degree of flexibility.

We first examine the impact of changes in β or σ^2. Since these two parameters yield exactly the same effect, we focus on changes in β. As we have seen, an increase in β raises γ_1 and, taking γ_1 as given, also γ_2. At the same time, though, a change in β also changes the relative value of vision and flexibility. While the bias increases up to some point with an increase in β, the cost of inflexibility rises as β becomes sufficiently large. Once β reaches some point, therefore, the first-period bias becomes less of a concern, and DM attempts to minimize the second-period bias by decreasing γ_1 towards zero. This indicates that the impact of changes in β (or σ^2 as well) on the second-period bias is non-monotonic, where the bias disappears when β is either too small or too large.

Second, the impact of changes in δ is relatively straightforward. Because it yields no direct effect on the second-period bias, we only need to look at the indirect effect though γ_1. As we have seen, an increase in δ decreases γ_1 away from $\tilde{\gamma}$. This in turn monotonically decreases the second-period bias, making DM more flexible.

Finally, the impact of changes in μ is somewhat more complicated, because the direct effect can in principle go either way. As we have seen, though, the second-period bias is decreasing in μ for a wide range of parameter values. In that case, we can obtain an unambiguous prediction because both the direct and indirect effects work in the same direction. For a sufficiently low value of μ, DM is perfectly flexible although it comes at the expense of the complete lack of vision. An increase in μ then unambiguously raises the second-period bias, where DM becomes less and less flexible. We can thus summarize this finding as follows: while high self-confidence *per se* makes DM more visionary, it makes her less flexible in that she sticks excessively to her initial stance.

4 Extensions

We have made several assumptions, some of which are made strictly to avoid unnecessary complication. Among them, we have somewhat arbitrarily assumed that the actor's belief about η is constant and fixed at μ.[19] This assumption has two aspects: one is that the actor has secure knowledge about η where the prior variance of η is zero; the other is that the actor's prior expectation of η coincides with the subjective self's. We deliberately chose this specification as it simplifies the analysis while preserving the substance of the model. In this sense, it is important to check robustness of our main results to some possible alterations to the basic setup. Here, we relax these assumptions to show that the main results of the paper basically go through with alterations to the baseline model. In each case, the first-order condition in period 1 is virtually identical, so that similar conclusion would follow if the basic properties in period 2 were to hold.

4.1 The actor with insecure knowledge about herself

First, we have assumed that the actor has secure knowledge about herself in that her estimate of the ability type is constant regardless of what she observes. The role of this assumption is

[19]We have also assumed that the objective self's belief is fixed at μ, but this assumption plays only a minor role anyway since the bias is measured in terms of a deviation from the objective self's belief.

fairly innocuous in the qualitative sense, mostly to ease the computation and obtain sharper and clearer predictions. To see the impact of this assumption, consider an alternative specification where the actor has identical knowledge to the subjective self, where the prior belief is given by F with mean μ and variance σ^2. The only change that it brings about is that the actor now also learns about herself, which affects her estimate of the realized state. The exact impact of this change depends on how the actor utilizes the revised belief about her ability type in estimating the realized state.

If the actor cannot revise the belief in retrospect, i.e., cannot reestimate ρ_1 with the revised belief μ_2, the beliefs are still given as in (8) and (9), and nothing changes.[20] Things become a bit more complicated, however, if she goes back in time and reestimate ρ_1 using the revised belief μ_2. In this case, the beliefs are now obtained as

$$\rho_C(\gamma_1, \gamma_2) = \frac{(1+\gamma_2)(1+\gamma_1\mu_C)}{2(1+\gamma_1\gamma_2\mu_C)}. \tag{25}$$

$$\rho_I(\gamma_1, \gamma_2) = \frac{(1-\gamma_2)(1+\gamma_1\mu_I)}{2(1-\gamma_1\gamma_2\mu_I)}. \tag{26}$$

The first-order conditions in period 2 are now modified as

$$\frac{\alpha\sigma^2\gamma_1}{(1+\gamma_1\gamma_2\mu)^2} - (1-\alpha)(\rho_C - \tilde{\rho}_C)\frac{1-(\gamma_1\tilde{\mu}_C)^2 + \gamma_1(1-\gamma_2{}^2)\frac{\partial\mu_C}{\partial\gamma_2}}{(1+\gamma_1\gamma_2\mu_C)^2} = 0, \tag{27}$$

for consistent signals and

$$-\frac{\alpha\sigma^2\gamma_1}{(1-\gamma_1\gamma_2\mu)^2} + (1-\alpha)(\rho_I - \tilde{\rho}_I)\frac{1-(\gamma_1\mu_I)^2 - \gamma_1(1-\gamma_2{}^2)\frac{\partial\mu_I}{\partial\gamma_2}}{(1-\gamma_1\gamma_2\mu_I)^2} = 0, \tag{28}$$

for inconsistent signals.[21] As can easily be seen, the problem becomes much more complicated, but the basic properties of the model remain largely intact. First, since

$$\frac{\alpha\sigma^2\gamma_1}{(1-\gamma_1\gamma_2\mu)^2} > 0, \tag{29}$$

when $\gamma_1 > 0$, DM exaggerates a consistent second signal if

$$1-(\gamma_1\tilde{\mu}_C)^2 + \gamma_1(1-\gamma_2{}^2)\frac{\partial\mu_C}{\partial\gamma_2} > 0. \tag{30}$$

[20]This is perhaps the case if the actor only remembers ρ_1 but not how that belief was formed in the first place.

[21]As already state, the assumption that the objective self's belief is fixed at μ only has a minor impact. The only difference it makes is that $\tilde{\rho}_C$ and $\tilde{\rho}_I$ are now estimated with μ_C and μ_I, respectively, instead of μ.

This holds since μ_C is increasing in γ_2. Similarly, DM discount an inconsistent signal ($\rho_I > \tilde{\rho}_I$) if

$$1 - (\gamma_1 \mu_I)^2 - \gamma_1(1 - \gamma_2{}^2)\frac{\partial \mu_I}{\partial \gamma_2} > 0, \tag{31}$$

which also holds because μ_I is now decreasing in γ_2. Second, one can easily verify that the bias disappears as $\beta \to 0$ or $\sigma^2 \to 0$. Finally, the choice of γ_1 has a critical impact on the bias, which gives rise to the same self-control problem.

4.2 The actor's prior coincides with the subjective self's

Another assumption that might seem restrictive is that the actor's prior coincides with the subjective self's prior μ (we for now set the actor's prior variance back to zero). Suppose instead that the actor's prior belief is fixed at $\tilde{\mu}$ which may or may not coincide with μ. With the differing priors, the first-order condition in period 2 is

$$\frac{\alpha\sigma^2\gamma_1}{(1 + \gamma_1\gamma_2\mu)^2} - (1 - \alpha)(\rho_2 - \tilde{\rho}_C)\frac{1 - (\gamma_1\tilde{\mu})^2}{(1 + \gamma_1\gamma_2\tilde{\mu})^2} = 0, \tag{32}$$

for consistent signals and

$$-\frac{\alpha\sigma^2\gamma_1}{(1 - \gamma_1\gamma_2\mu)^2} + (1 - \alpha)(\rho_2 - \tilde{\rho}_I)\frac{1 - (\gamma_1\tilde{\mu})^2}{(1 - \gamma_1\gamma_2\tilde{\mu})^2} = 0, \tag{33}$$

for inconsistent signals. It is evident from these that the same conclusions hold in this case as well: consistent signals are exaggerated while inconsistent ones are discounted, and the bias disappears as $\beta \to 0$ or $\sigma^2 \to 0$. Also, the choice of γ_1 affects the size of the bias, which again gives rise to the same self-control problem.

5 Conclusion

The paper sheds light on two important aspects of effective leadership – vision and flexibility – and provides a framework to illustrate the workings behind these seemingly contradictory notions, with particular focus on a human tendency to exaggerate favorable information and discount unfavorable information. As the misalignment of incentives is a typical source of inefficient decision making in an organization, the driving force of the model is the misalignment of incentives within oneself. In the present model, two distinct sources of intrapersonal conflicts are merged into a single framework: on one hand, the objective and subjective selves differ in their objectives, which eventually forces DM to bend the truth to protect her ego; on the other hand, the two selves also differ in their time horizon, thus leading to time-inconsistent objectives type and, as a direct consequence, a type of of self-control problem. This framework allows us to illuminate the workings behind vision and flexibility: among other things, we show that vision and flexibility are substitutes where a decision maker with weak willpower often strategically settles for an ambiguous initial stance in order to allow her future self to act more flexibly.

Appendix: Proof of Proposition 2

Since

$$\frac{\partial \rho_1}{\partial \gamma_1} = \frac{\mu}{2}, \tag{34}$$

$$\frac{\partial \rho_C^*}{\partial \gamma_1} = \frac{\partial \rho_I^*}{\partial \gamma_1} = \frac{\beta\sigma^2(1+(\gamma_1\mu)^2)}{(1-(\gamma_1\mu)^2)^2}, \tag{35}$$

the first-order condition becomes

$$\frac{(\gamma_1 - \tilde{\gamma})\mu^2}{4\delta} + \frac{\beta\sigma^2\gamma_1}{1-(\gamma_1\mu)^2}\frac{\beta\sigma^2(1+(\gamma_1\mu)^2)}{(1-(\gamma_1\mu)^2)^2} = 0. \tag{36}$$

Define

$$D(\beta, \sigma^2, \mu, \gamma_1) := \frac{4(\beta\sigma^2)^2(1+(\gamma_1\mu)^2)\gamma_1}{\mu^2(1-(\gamma_1\mu)^2)^3}, \tag{37}$$

so that the optimal informativeness is obtained as the following fixed point:

$$\gamma_1 = \tilde{\gamma} - \delta D(\beta, \sigma^2, \mu, \gamma_1). \tag{38}$$

It is immediately clear from this that $\gamma_1 < \tilde{\gamma}$. Moreover, the size of the bias is increasing in δ and disappears as $\delta \to 0$. For all other cases, the properties of γ_1 depend on how D respond to changes in exogenous parameters such as β, σ^2 and μ. Since the size of δ is totally irrelevant (as long as $\delta > 0$), we let $\delta = 1$ for notational simplicity in what follows.

We now examine how γ_1 respond to changes in β, σ^2 and μ. It is easy to see that $\partial D/\partial\beta > 0$, implying that γ_1 is decreasing and the size of the bias is hence increasing in β. By the same logic, one can show that the size of the bias is increasing in σ^2. The effect of μ is, on the other hand, more complicated. To see this, note that $\partial D/\partial\mu < 0$ if

$$(\gamma_1\mu)^2(1-(\gamma_1\mu)^2)-(1+(\gamma_1\mu)^2)(1-4(\gamma_1\mu)^2)<0. \tag{39}$$

which can be written as

$$1-4(\gamma_1\mu)^2-3(\gamma_1\mu)^4>0. \tag{40}$$

Since we already know that $\gamma_1 < \tilde{\gamma}$, a sufficient condition for this is

$$1-4(\tilde{\gamma}\mu)^2-3(\tilde{\gamma}\mu)^4>0. \tag{41}$$

When this condition holds, the size of the bias is decreasing in μ.

Finally, we show that $\gamma_1 \to 0$ as $\mu \to 0$. This is relatively straightforward since

$$\lim_{\mu\to 0} D(\beta,\sigma^2,\mu,\gamma_1)=\infty, \tag{42}$$

for any $\gamma_1 > 0$. An interior solution thus fails to exist and the optimal choice is bounded at $\gamma_1 = 0$.

Q.E.D.

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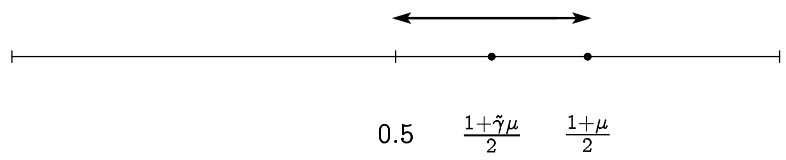

Figure 1: The manipulable range of the belief when $s_1 = 1$ ($\mu = 0.5$, $\tilde{\gamma} = 0.5$).

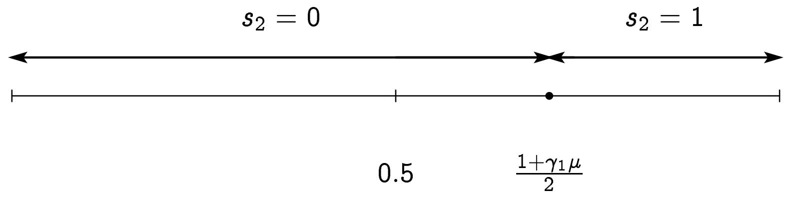

Figure 2: the manipulable range of the belief when $s_1 = 1$ ($\mu = 0.5$, $\tilde{\gamma} = 0.5$, $\gamma_1 = 0.8$).