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The Pygmalion effect : an agency model with reference dependent preferences

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THE PYGMALION EFFECT: AN AGENCY MODEL WITH REFERENCE DEPENDENT PREFERENCES

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Abstract

We attempt to formulate and explain two types of self-fulfilling prophecy, called the Pygmalion effect (if a supervisor thinks her subordinates will succeed, they are more likely to succeed) and the Galatea effect (if a person thinks he will succeed, he is more likely to succeed). To this purpose, we extend a simple agency model with moral hazard and limited liability by introducing a model of reference dependent preferences (RDP) by Kőszegi and Rabin (2004). We show that the agent with high expectations about his performance can be induced to choose high effort with low-powered incentives. We then show that the principal's expectation has an important role as an equilibrium selection device.

JEL Code: B49, D82, M12, M52, M54.

Keywords: self-fulfilling prophecy, Pygmalion effect, Galatea effect, reference dependent preferences, agency model, moral hazard.

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> I shall always be a flower girl to Professor Higgins because he always treats me as a flower girl and always will; but I know I can be a lady to you because you always treat me as a lady and always will.
>
> —Eliza Doolittle, in *Pygmalion* by George Bernard Shaw

1 Introduction

People (pupils, subordinates, and so on) tend to act in accordance with the expectation of others (teachers, managers, and so on). In particular, the former may, to some degree, internalize the higher expectations placed on them by the latter, and then act in ways to fulfill those expectations. A pioneering work by Rosenthal and Jacobson (1968) shows, through their experimental research, that a teacher's expectation for a pupil's intellectual competence can come to serve as an educational self-fulfilling prophecy, and names this phenomenon the *Pygmalion effect* after Greek myths.[1] Livingston (1969) discusses the Pygmalion effect not in educational setting but in managerial setting.[2] He argues that (a) "what managers expect of subordinates and the way they treat them largely determine their performance and career progress," (b) "a unique characteristic of superior managers is the ability to create high performance expectations that subordinates fulfill," (c) "less effective managers fail to develop similar expectations, and as a consequence, the productivity of their subordinates suffers," and (d) "subordinates, more often than not, appear to do what they believe they are expected to do." Since Livingston (1969), many researchers have been

[1] A series of research by Rosenthal and his collaborators studies the Pygmalion effect in educational setting. Jussim (1986) provides a theoretical model of the Pygmalion effect in the classroom.

[2] See also Goddard (1985).

studying the Pygmalion effect in business or military organizations. Kierein and Gold (2000) and McNatt (2000) conduct meta-analysis of relevant studies within management contexts, and both find that the Pygmalion effect is in general fairly strong.

From these existing studies, we can summarize the way the Pygmalion effect occurs as follows. A manager's high expectation influences her attitude toward her subordinates, and such attitude has positive effects on subordinates' self-expectancy. The subordinates' enhanced self-expectancy then improves their performance. In this process, the part that a person's enhanced self-expectation improves his own performance is often called the *Galatea effect*. For example, Kierein and Gold (2000) explain the Galatea effect as one of other types of expectation effects: "The Galatea effect occurs not when the leader has expectations of subordinates, but when subordinates' raised expectations of themselves are realized in their higher performance." They however state that it is part of the Pygmalion effect, and examine the Pygmalion and Galatea effects together in their meta-analysis.[3]

In this paper we attempt to formalize and explain both the Pygmalion and the Galatea effects. To this purpose, we extend a simple but standard model of a principal and an agent with moral hazard and limited liability. A key extension from this standard model is that the agent has *reference dependent preferences* (henceforth RDP). What a person has PDP means that his preferences are conditional on a reference point, and various anomalies such as loss aversion, endowment effects, status quo bias, and so on, are consistent with RDP.[4] More precisely, the payoff depends on the realized

[3]On the other hand, McNatt (2000) seems to emphasize that the feature that a manager's expectation has the impact on her subordinate's self-expectancy appears uniquely in the Pygmalion effect.

[4]The seminal paper by Kahneman and Tversky (1979) explores issues on RDP. Recently, various models of RDP have been developed. For example, Masatlioglu and Ok (2003), Sagi (2004), and Sugden (2003) give axiomatic foundations for models of RDP.

consumption as gain or loss relative to a reference level. What serves as the reference point is thus crucial to the model with RDP. In this respect, Masatlioglu and Ok (2003) and Sagi (2004) assume that the status quo serves as the reference point, and Sugden (2003) considers the reference point as one's current endowment which is determined by a "reference lottery." Note that in these studies reference points are exogenously given.

Our model is built on a yet another model of RDP by Kőszegi and Rabin (2004), which has the following two important features.[5] First, a person's reference point is her recent expectation, represented by a probability measure, over outcomes.[6] Second, the model by Kőszegi and Rabin (2004) has a prominent feature that the reference point is endogenously determined by the person's rational expectation.[7] To this end, they define the *personal equilibrium* which requires that a person maximize his payoff given his rational expectations about outcomes, and hence the expectations themselves depend on his own anticipated behavior.

Following Kőszegi and Rabin (2004), we suppose that the agent's utility depends not only on his material payoff, as in the standard model, but also on the gain-loss payoff which is defined by the agent's evaluation of his consumption bundle as gains or losses relative to a reference point. The reference point of the agent is his expectation about the effort level chosen by the agent and the resulting success probability of the project. We then define the personal equilibrium that determines the agent's reference point endogenously. Our main contribution is to analyze interaction between RDP

[5] We give a brief sketch of their model in the next section.

[6] In this sense, their model is similar to that of Sugden (2003). In Kőszegi and Rabin (2004), however, each outcome is compared to all outcomes in the support of the reference lottery, while in Sugden (2003), an outcome is compared only to the outcome that would have resulted from the reference lottery in the same state.

[7] Munro and Sugden (2003) and Falk and Knell (2004) also study the endogenous determination of reference points.

and incentives designed by the principal. We first take a contract as given, and analyze the agent's personal equilibrium. We show that compared with the standard model without RDP, the agent's higher expectation enables the principal to implement high effort with lower-powered incentives. We interpret this result as the Galatea effect. We also show that when the power of incentives is intermediate, multiple equilibria may exist. In this case the agent's expectations are self-fulfilling: he chooses high effort if he expects to do so, while he chooses low effort if it is his expected effort. We then study the optimal contract solving the principal's problem. The principal's contract affects the agent's personal equilibrium and hence his expectations. Furthermore, the principal wants to make the agent attend to high effort in the region with multiple equilibria. In this respect, we can interpret the Pygmalion effect as the principal's attempt to make the agent choose a particular personal equilibrium.

Although we are unaware of any economic literature studying the Pygmalion effect, there are possible alternative approaches to explaining this effect. First, there is a simple explanation that the principal with high expectation takes some explicit actions to improve the agent's productivity. This is nothing but the theory of human capital. In contrast to this explanation, we consider the situation where the principal's expectation implicitly influences the agent's performance. In other words, our model does not have any component which directly affects the agent's productivity. The second, more interesting approach is to focus on the role of information transmission by the principal. When the agent does not know his own productivity, the principal with high expectation may effectively transmit her private information on the agent's productivity.[8] Bénabou and Tirole (2003) is an example

[8]Note that the principal's mere expression of her expectation is not credible to the agent, since it is just cheap talk.

along this line. In their model, the principal's policy (wage scheme) as a signal informs the agent of his ability and then affects his action: costly signal from the principal serves as a motivational device for the agent. However, this kind of explanation disregards the crux of the Pygmalion effect. Firstly, the Pygmalion effect works even when agents know their own abilities without such informative signals. An experimental result illustrated in Livingston (1969) shows this point. At an office of the Metropolitan Life Insurance Company, a manager decided to group his insurance agents according to their abilities. Then, the performance of the top group which consists of his best agents improved dramatically. However, the performance of the middle group which consists of his average agents also significantly improved. Surprisingly, this group increased its productivity by a higher percentage than the top group did. Secondly, Bénabou and Tirole (2003) assume that the agent devotes more effort when he receives a good signal that convinces him that his ability is high. That is, the Galatea effect is exogenously given. In our model, in contrast to this signaling approach, there is no information transmission, and both the Galatea and the Pygmalion effects are explained endogenously.

The rest of the paper is organized as follows. In section 2 we introduce the model of RDP based on Kőszegi and Rabin (2004). In section 3 we build a simple agency model with RDP. We analyze the personal equilibrium and study the optimal incentive scheme in the same section. In section 4 we extend our model to some directions. Section 5 concludes.

2 Reference Dependent Preferences

Following Kőszegi and Rabin (2004), we formulate the reference dependent nature of preferences as the following way. Let $c = (c_1, \ldots, c_n)$ be a con-

sumption bundle of an agent, and $r = (r_1, \ldots, r_n)$ be a reference consumption bundle. We define the agent's overall payoff $u(c \mid r)$ by

$$u(c \mid r) = v(c) + z(c \mid r) = \sum_{k=1}^{n} v_k(c_k) + \sum_{k=1}^{n} z_k(c_k \mid r_k), \tag{1}$$

where $v(c)$ is his material payoff, as in standard models, and $z(c \mid r)$ represents the agent's evaluation of his consumption bundle as gains and losses relative to a reference point. We call this part of the agent's payoff as gain-loss payoff. (1) implies that each dimension of consumption is assumed to be additively separable.

This model is extended to cases in which there is uncertainty in consumption outcomes as well as reference points. Let F be the probablity distribution function of consumption bundle c, and G be the distribution function of reference point r. The agent's payoff is then given by

$$U(F \mid G) = \int_c \int_r u(c \mid r) dF(c) dG(r).$$

We further assume that each dimension is evaluated by the same function $\mu(\cdot)$ of the difference of consumption from the reference level, evaluated by material payoff:

$$z(c \mid r) = \sum_{k=1}^{n} \mu(v_k(c_k) - v_k(r_k)) \tag{2}$$

The "universal" gain-loss function $\mu(\cdot)$ is assumed to have the following properties. They captures important features of how people evaluate gain and loss from the reference point.

A0 $\mu(0) = 0$ and $\mu'(y) > 0$.

A1 $\mu''(y) \leq 0$ for $y > 0$, and $\mu'(y) > 0$ and $\mu''(y) \geq 0$ for $y < 0$.

A2 If $y > y' > 0$, $\mu(y) - \mu(y') < \mu(-y') - \mu(-y)$ holds.

A3 $\lim_{y \uparrow 0} \mu'(y) / \lim_{y \downarrow 0} \mu'(y) \equiv \gamma > 1$.

A1 represents *diminishing sensitivity*, implying that as the consumption level moves further away from the reference level, the marginal valuation of gains and losses decreases. And A2 and A3 capture *loss aversion*, A2 for "large" stakes and A3 for marginal ones.

In the current version of the paper, we isolate the effect of loss aversion by assuming $\mu(\cdot)$ is linear, and define

$$\mu(v_k(c_k) - v_k(r_k)) = \begin{cases} \alpha(v_k(c_k) - v_k(r_k)) & \text{if } v_k(c_k) - v_k(r_k) > 0, \\ \alpha\gamma(v_k(c_k) - v_k(r_k)) & \text{if } v_k(c_k) - v_k(r_k) < 0, \end{cases} \tag{3}$$

where α, a positive constant, is the weight on the gain-loss payoff, and $\gamma > 1$ is the "coefficient of loss aversion" which is the same as γ defined in A3.

3 A Simple Agency Model

There are two risk neutral parties, a principal and an agent. The agent engages in one project on behalf of the principal. The outcome of the project is either success (s) or failure (f), and the probability distribution depends on the agent's effort. We assume there are two feasible effort levels e_0 and e_1, and denote by p_i the probability of success under effort e_i.[9] We assume $0 < p_0 < p_1 < 1$ and denote $\Delta_p \equiv p_1 - p_0$.

In the standard agency model, the agent's payoff depends on his "consumption" bundle (w, e_i) where w is remuneration received from the principal. Let $v(w, e_i)$ be his *material* payoff function, and assume it is additively separable: $v(w, e_i) = w - d_i$ where d_i is the agent's private cost of effort e_i. For simplicity we assume $d_0 = 0 < d_1$, and denote $d = d_1$. Using the formulation introduced in Section 2, we extend this standard model as follows. Let $(\overline{w}, e_j)$ be a reference point, and define the agent's overall payoff $u(w, e_i \mid \overline{w}, e_j)$ by

$$u(w, e_i \mid \overline{w}, e_j) = w - d_i + \mu(w - \overline{w}) + \mu(d_j - d_i) \tag{4}$$

[9] In Section 4, we consider a case where the effort variable is continuous.

where the gain-loss function $\mu(\cdot)$ is defined by (3).

The agent's effort is unobservable to the principal, while the outcome of the project is verifiable. The principal can thus design an incentive compensation scheme (b_s, b_f) where b_i is remuneration paid from the principal to the agent when outcome is $i \in \{s, f\}$. We assume that b_i must satisfy the limited liability constraint $b_i \geq 0$. We also denote the difference in payment by $\Delta_b = b_s - b_f$.

The timing of the game is as follows.

1. The principal offers a contract.
2. The agent either accepts or rejects the contract. If he rejects it, the game ends and each of the parties receives the reservation payoff zero. If the agent accepts the contract, the game moves to the next stage.
3. The reference point of the agent is determined.[10]
4. The agent chooses effort.
5. The outcome of the project realizes and the payment is made according to the contract.

We now discuss how the agent's reference point is determined. First, we follow Kőszegi and Rabin (2004) by taking the standpoint that the reference point is determined by the agent's expectations about what he is going to get. In most literature, the reference point of an individual is given exogenously as his current or past endowments, while little is known both theoretically and empirically concerning how the reference point is determined. Kőszegi and Rabin (2004) argue that expectations play a central role in determining reference points. For example, they argue that most existing empirical work

[10] Our results are not affected by an alternative timing as long as the agent determines his reference point *after* the principal offers a contract and *before* he chooses effort.

on loss aversion, in which the status quo is exogenously given, can also be interpreted in terms of expectations as reference points. Since we study the effects of expectations on performance, their formulation in particular fits well with our research agenda.

If we adopt the expectation-as-reference view and apply it to our agent, the agent's preferences depend on his expectations, which themselves depend on his preferences. The agent with some predictive ability will take this feedback into account, and will reach a state in which his expectations are consistent with his eventual outcomes. Following Kőszegi and Rabin (2004), we thus model the agent's decision making in terms of an "equilibrium" as follows.

Suppose that a compensation scheme (b_s, b_f) has been accepted by the agent. The agent's reference point consists of effort e_j he is expected to choose, and the resulting probability distribution over (b_s, b_f), which is represented by the probability of success p_j. Then (e_j, p_j) is a *personal equilibrium* if for $i \neq j$,

$$U(e_j, p_j \mid e_j, p_j) \geq U(e_i, p_i \mid e_j, p_j) \tag{5}$$

where $U(\cdot)$ is the agent's expected payoff and is given by

$$\begin{aligned} U(e_i, p_i \mid e_j, p_j) = b_f + p_i \Delta_b - d_i \\ + p_i(1-p_j)\mu(\Delta_b) + (1-p_i)p_j\mu(-\Delta_b) \\ + \mu(d_j - d_i). \end{aligned} \tag{6}$$

The first line of (6) is the expected material payoff. The second and third lines represent the gain-loss payoff under reference point (e_j, p_j).[11] For example, suppose that the reference point is (e_1, p_1), and the agent's choice is

[11] Since p_j is uniquely determined by e_j, it is enough to define reference points and equilibria in terms of effort only. We however include the probability distribution in order to emphasize the existence of gains and losses in terms of outcome-dependent payments.

(e_0, p_0). The agent enjoys gain αd (the third line) because he saves cost d by not choosing e_1 which he was expecting to choose by spending cost d. If the agent succeeds, he enjoys gain $\alpha\Delta_b$ with probability $1 - p_1$ because he was expecting to fail with this probability. Similarly, when the agent actually fails, he suffers from loss $\alpha\gamma\Delta_b$ with probability p_1 since he was expecting to succeed with this probability. These gain and loss correspond to the second line.

The definition of the personal equilibrium states that if the agent's reference point is the expectation to choose e_j and hence to succeed with probability p_j, then he should indeed be willing to choose e_j. The reference point is thus determined endogenously by the agent, anticipating his choice, and then given the reference point, the agent chooses effort consistent with his expectation.

3.1 Analysis: The Agent's Personal Equilibrium

Suppose that the principal offers a contract (b_s, b_f), which is accepted by the agent. Given the contract, we analyze the agent's personal equilibrium. In the next subsection, we analyze the optimal contract.

There are two candidates for personal equilibria, (e_1, p_1) and (e_0, p_0).[12] First consider (e_1, p_1). The relevant expected payoffs are calculated as follows:

$$U(e_1, p_1 \mid e_1, p_1) = b_f + p_1\Delta_b - d + p_1(1 - p_1)\alpha\Delta_b - (1 - p_1)p_1\alpha\gamma\Delta_b$$

$$U(e_0, p_0 \mid e_1, p_1) = b_f + p_0\Delta_b + \alpha d + p_0(1 - p_1)\alpha\Delta_b - (1 - p_0)p_1\alpha\gamma\Delta_b$$

Pair (e_1, p_1) is a personal equilibrium if $U(e_1, p_1 \mid e_1, p_1) \geq U(e_0, p_0 \mid e_1, p_1)$, or

$$\Delta_b \geq \beta_1 \equiv \frac{d}{\Delta_p}\frac{1 + \alpha}{1 + \alpha + \alpha p_1(\gamma - 1)} \tag{PE1}$$

[12] Mixed strategies will be analyzed later in Section 4.

Next consider (e_0, p_0). The following expected payoffs are relevant.

$$U(e_0, p_0 \mid e_0, p_0) = b_f + p_0\Delta_b + p_0(1-p_0)\alpha\Delta_b - (1-p_0)p_0\alpha\gamma\Delta_b$$

$$U(e_1, p_1 \mid e_0, p_0) = b_f + p_1\Delta_b - d - \alpha\gamma d + p_1(1-p_0)\alpha\Delta_b - (1-p_1)p_0\alpha\gamma\Delta_b$$

Then (e_0, p_0) is a personal equilibrium if $U(e_0, p_0 \mid e_0, p_0) \geq U(e_1, p_1 \mid e_0, p_0)$, or

$$\Delta_b \leq \beta_0 \equiv \frac{d}{\Delta_p}\frac{1+\alpha\gamma}{1+\alpha+\alpha p_0(\gamma-1)} \tag{PE0}$$

It is easy to show the following results.

Proposition 1. (i) $\beta_0 > d/\Delta_p > \beta_1$. (ii) When contract (b_s, b_f) is given, there are three ranges of "incentive intensity" Δ_b that characterize personal equilibria.

(a) If $\Delta_b > \beta_0$, then (e_1, p_1) is the only personal equilibrium.

(b) If $\Delta_b < \beta_1$, then (e_0, p_0) is the only personal equilibrium.

(c) If $\beta_1 \leq \Delta_b \leq \beta_0$, both (e_0, p_0) and (e_1, p_1) are personal equilibria.

To understand the results, consider first the standard agency model in which the agent does not exhibit RDP (corresponding to $\alpha = 0$ in our model). The agent then prefers to choose e_1 if $\Delta_b > d/\Delta_p$, and choose e_0 if $\Delta_b < d/\Delta_p$. Proposition 1 (i) then implies that the agent with RDP, when he expects to choose e_1, actually chooses e_1 for incentive intensity Δ_b lower than d/Δ_p, the critical value under the standard case. And the agent, expecting to choose e_0, actually chooses e_0 for Δ_b higher than d/Δ_p.

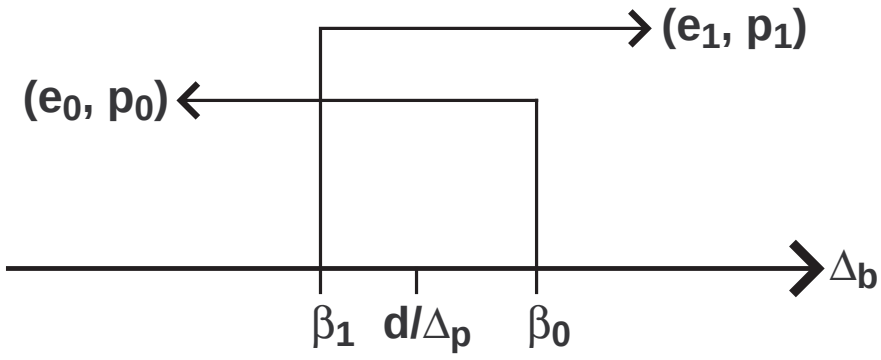
Intuitively, Proposition 1 (i) can be understood as follows. First consider result $d/\Delta_p > \beta_1$. RDP introduce the following positive incentive effects. If the agent, expecting the outcome to be success with probability p_1,chooses e_1 instead of e_0, then the chance of "gain" increases from $p_0(1-p_1)$ to

$p_1(1-p_1)$, and that of "loss" decreases from $(1-p_0)p_1$ to $(1-p_1)p_1$. These effects reinforce the incentive to choose e_1 via incentive pay. On the other hand, there is a negative effect from RDP. When the agent's reference effort is e_1, shirking (e_0) benefits the agent by saving the cost of effort. This effect is represented by αd. The positive effects dominate because of $\gamma > 1$, the agent's loss aversion.

The intuition behind $\beta_0 > d/\Delta_p$ is similar. When the agent's reference point is (e_0, p_0), e_1 is more attractive under RDP than without RDP, because gain (loss) is more (less, respectively) likely. However, the agent is more reluctant to choose e_1 because he experiences loss $\alpha\gamma d$. This latter negative effect dominates because of loss aversion, and thereby the agent chooses e_0 even though incentives strong enough to induce e_1 are provided for the agent without RDP.

Figure 1 illustrates three ranges of Δ_b in Proposition 1 (ii). An important finding is that in the intermediate range, there are multiple personal equilibria. In this range, the agent chooses e_1 if he expects to do so, while he chooses e_0 if e_0 is his expected effort.

Figure 1: Personal Equilibria



The next proposition reports some comparative statics results.

Proposition 2.

(a) β_0 is increasing in α and γ, and decreasing in p_1.

(b) β_1 is decreasing in α, γ and p_1.

(c) $\beta_0 - \beta_1$ is increasing in α, γ and decreasing in p_1.

Proof. Results (a) and (b) directly follow from the definitions in (PE0) and (PE1). For (c), the comparative statics results for α and γ are immediate from (a) and (b). By differentiating β_0 and β_1 by p_1, we obtain

$$\begin{aligned}
\frac{\partial \beta_0}{\partial p_1} - \frac{\partial \beta_1}{\partial p_1} &= -\frac{d}{\Delta_p^2}\left(\frac{1+\alpha\gamma}{1+\alpha+\alpha p_0(\gamma-1)} - \frac{1+\alpha}{1+\alpha+\alpha p_1(\gamma-1)}\right) \\
&\quad + \frac{d}{\Delta_p}\frac{\alpha(\gamma-1)(1+\alpha)}{(1+\alpha+\alpha p_1(\gamma-1))^2} \\
&\leq -\frac{d}{\Delta_p^2}\frac{\alpha(\gamma-1)}{1+\alpha+\alpha p_1(\gamma-1)} + \frac{d}{\Delta_p}\frac{\alpha(\gamma-1)(1+\alpha)}{(1+\alpha+\alpha p_1(\gamma-1))^2} \\
&\leq -\frac{d}{\Delta_p}\frac{\alpha(\gamma-1)}{(1+\alpha+\alpha p_1(\gamma-1))^2}(1+\alpha+\alpha p_1(\gamma-1)-(1+\alpha)) \\
&< 0
\end{aligned}$$

□

As the agent's preferences are more reference dependent or more averse to losses, both (e_1, p_1) and (e_0, p_0) are personal equilibria for broader ranges of incentive intensity, and hence the region where multiple equilibria exist also enlarges. A more interesting exercise is to examine the effect of p_1, which we can interpret as a parameter representing the agent's ability. Higher effort e_1 becomes more attractive to the agent because of higher success probability by choosing e_1. This effect works to reduce both β_0 and β_1 while it affects β_0 more than β_1 because $\beta_0 > \beta_1$. For (e_1, p_1), there is an additional effect of increasing p_1 via the reference point itself: Higher p_1 raises the

probability of the reference being success (and hence the probability of loss), as well as reduces the probability of the reference being failure (and hence the probability of gain). Because of loss aversion, the former change dominates, which change in turn increases the marginal benefit from higher p_1. The additional effect thus also works to reduce β_1. However, this additional effect is not large enough to upset the smaller first effect on β_1 than on β_0. The region where there are multiple equilibria therefore becomes smaller as the agent has a higher ability.

3.2 Analysis: The Optimal Contract

Now consider the principal's problem of solving the optimal contract. We assume that the benefit of success to the principal is so large that she wants to implement effort e_1 with least costs. The principal's problem is then to minimize the expected payment $b_f + p_1\Delta_b$ subject to the agent's participation constraint

$$U(e_1, p_1 \mid e_1, p_1) \geq 0, \tag{PC}$$

and a condition that the agent chooses (e_1, p_1) as a personal equilibrium, which we call IC (incentive compatibility constraint). (PC) implies that after observing the principal's offer, the agent anticipates his reference point and effort choice. Although the reservation payoff is normalized to zero, all our results continue to hold under a general reservation payoff $\overline{U}$ with minor modification.

Constraint (IC) faces a problem of multiple equilibria, but suppose for a while that Δ_b can implement (e_1, p_1) as a personal equilibrium. For example, if the principal sets Δ_b a little above β_0, then she can guarantee the agent to play (e_1, p_1) since it is the only personal equilibrium.

Given Δ_b, the principal wants to minimize the expected payment. By

(PC), the expected payment is bounded from below since

$$b_f + p_1\Delta_b \geq d + p_1(1-p_1)\alpha\Delta_b(\gamma - 1). \tag{7}$$

If $b_f = 0$ satisfies (7), then $(b_s, b_f) = (\Delta_b, 0)$ is the optimal contract. If (7) does not hold under $b_f = 0$, then b_f is determined by the condition such that the inequality in (7) is replaced by equality.

Note that the principal's expected payment is increasing in Δ_b: If (7) does not bind, the agent earns rent, which is increasing in Δ_b; and if (7) binds, the principal's expected payment is equal to the right-hand side of (7), which is increasing in Δ_b.

3.3 The Pygmalion and Galatea Effects

Our formulation naturally explains the Galatea effect, one type of "self-fulfilling prophecy" which means that the agent's self-expectation about his performance determines his actual performance: If the agent thinks he can succeed, then he is more likely to succeed. More precisely, Proposition 1 states that the Galatea effect prevails when $\Delta_b \geq \beta_1$ holds.

The Pygmalion effect, on the other hand, involves the principal. The principal in our model can influence the personal equilibrium by changing incentive intensity Δ_b. If she sets Δ_b a little above β_0, then the only personal equilibrium is (e_1, p_1), and hence the agent expects to choose e_1 and succeed with probability p_1 (and he does). The principal could also play an important role in influencing the agent's formation of the reference point. The principal prefers to reduce Δ_b further up to β_1, if she can make sure the agent plays (e_1, p_1) in the range with multiple equilibria. We can thus say that the Pygmalion effect, meaning that the agent performs in accordance with the principal's expectations, realizes in our model if the principal can induce the agent to attend to the "right" expectation.

Note that the principal's expectation has this role in the region where multiple equilibria exit. By Proposition 2, this range increases with α, γ, and decreases with p_1, and hence the principal's expectation is more likely to matter as the agent is more dependent on the reference point, more averse to losses, or the agent's ability is lower. This last property is consistent with the empirical result that the Pygmalion effect works best for people whose initial performance level is low (Kierein and Gold, 2000; McNatt, 2000).

One potential obstacle against the principal's attempt to make the agent attend to a particular reference point is that the agent himself may consciously choose his preferred equilibrium. The agent's payoff difference is calculated as follows.

$$\begin{aligned} &U(e_1, p_1 \mid e_1, p_1) - U(e_0, p_0 \mid e_0, p_0) \\ &\quad = \Delta_b \Delta_p [1 + \alpha(\gamma - 1)(p_0 + p_1) - \alpha(\gamma - 1)] - d \end{aligned} \tag{8}$$

We thus obtain the following results.

Proposition 3.

(a) If $p_1 \leq 1 - p_0 - (\alpha(\gamma - 1))^{-1}$, then $U(e_1, p_1 \mid e_1, p_1) < U(e_0, p_0 \mid e_0, p_0)$.

(b) If $p_1 > 1 - p_0 - (\alpha(\gamma - 1))^{-1}$, then $U(e_1, p_1 \mid e_1, p_1) \geq U(e_0, p_0 \mid e_0, p_0)$ if and only if

$$\Delta_b \geq \hat{\beta} \equiv \frac{d}{\Delta_b} \frac{1}{1 + \alpha(\gamma - 1)(p_0 + p_1) - \alpha(\gamma - 1)}. \tag{9}$$

Threshold value $\hat{\beta}$ is decreasing in p_1, and $\hat{\beta} < \beta_0$ for sufficiently large p_1.

Proof. (a) and (9) follow from the right-hand side of (8). (8) also shows that $\hat{\beta}$ is decreasing in p_1. And $\hat{\beta} < \beta_0$ holds if and only if

$$p_1 > \frac{\alpha\gamma}{1 + \alpha\gamma}(1 - p_0), \tag{10}$$

which is true if $p_1 \to 1$.[13] $\square$

If p_1 is sufficiently small ($p_1 \leq 1-p_0-(\alpha(\gamma-1))^{-1}$), or in the intermediate range ($p_1 > 1-p_0-(\alpha(\gamma-1))^{-1}$ holds but (10) fails to hold), then the agent always prefers (e_0, p_0) to (e_1, p_1) in the region with multiple equilibria, and hence the principal's attempt to make the agent attend to (e_1, p_1) may not be effective, and she may not be able to lower Δ_b below β_0.

If p_1 is large enough (so that (10) is true), (e_1, p_1) may be implementable with incentive intensity lower than β_0, but implementation may be difficult for Δ_b below $\hat{\beta}$ if the agent chooses his preferred equilibrium.

4 Extensions

4.1 Mixed Strategies

In the analysis in the previous section, we have focused on pure strategies (e_0 or e_1). Now suppose the agent expects to choose e_1 with probability q (and e_0 with $1-q$). The agent's expected payoff, when actually choosing e_1 with probability s, is given as follows.

$$\begin{aligned} U(s \mid q) =& b_f + p(s)\Delta_b - sd \\ & - s(1-q)\alpha\gamma d + (1-s)q\alpha d \\ & + p(s)(1-p(q))\alpha\Delta_b - (1-p(s))p(q)\alpha\gamma\Delta_b \end{aligned}$$

where $p(x)$ is the probability of success under mixed strategy x, and is given by $p(x) = xp_1 + (1-x)p_0$. Given Δ_b, $(q, p(q))$ is a personal equilibrium if $U(q \mid q) \geq U(s \mid q)$ for all s. This holds if and only if the agent is indifferent

[13] $\beta_1 < \hat{\beta}$ holds if and only if

$$\frac{1+\alpha}{\alpha}(1-p_0) > p_1.$$

This may or may not hold as $p_1 \to 1$.

between e_0 and e_1, or q satisfies

$$\Delta_b = \frac{d}{\Delta_p} \frac{1 + \alpha\gamma - \alpha(\gamma - 1)q}{1 + \alpha + \alpha(\gamma - 1)p(q)}. \tag{11}$$

The right-hand side is decreasing in q, and is equal to β_0 if $q = 0$, and is equal to β_1 if $q = 1$. A unique mixed strategy personal equilibrium thus exists in the region with multiple equilibria, that is, if Δ_b satisfies $\beta_1 < \Delta_b < \beta_0$. Interestingly, as the principal provides stronger incentive intensity, in the mixed strategy equilibrium the agent is less likely to choose e_1: Increasing Δ_b leads to e_1 being more attractive, and hence q must be reduced to make e_1 and e_0 indifferent.

Note that the agent's expected payoff under the mixed strategy equilibrium is between the expected payoffs at two pure strategy equilibria. This is the reason we have focused on pure strategies in the main analysis: it is unlikely that either the principal or the agent is interested in playing the mixed strategy equilibrium.

4.2 Continuous Effort

Our main analysis is restricted to the simple case in which there are two outcomes and two effort levels. In this subsection we continue to assume the outcome of the project is either success or failure, while we relax the former restriction and instead assume that the set of feasible effort is continuous.

We suppose that the agent chooses effort e from $E = [0, \overline{e}]$. For simplicity, the agent's cost of effort is e. The project succeeds with probability $p(e)$, which we assume twice-continuously differentiable and satisfies $p'(e) > 0$ and $p''(e) < 0$ for all e. When the agent expects to choose e (and succeed with probability $p(e)$) and actually chooses $\hat{e} \leq e$, his expected payoff is

given as follows.

$$\begin{aligned} U(\hat{e} \mid e) = b_f &+ p(\hat{e})\Delta_b - \hat{e} \\ &+ p(\hat{e})(1-p(e))\alpha\Delta_b - (1-p(\hat{e}))p(e)\alpha\gamma\Delta_b \\ &+ \alpha(e-\hat{e}). \end{aligned}$$

The first-order condition for the agent to choose e is given by

$$p'(e)(1+\alpha+\alpha(\gamma-1)p(e))\Delta_b \geq 1+\alpha. \tag{12}$$

Similarly, the agent's expected payoff, when he chooses $\hat{e} \geq e$, is

$$\begin{aligned} U(\hat{e} \mid e) = b_f &+ p(\hat{e})\Delta_b - \hat{e} \\ &+ p(\hat{e})(1-p(e))\alpha\Delta_b - (1-p(\hat{e}))p(e)\alpha\gamma\Delta_b \\ &- \alpha\gamma(\hat{e}-e). \end{aligned}$$

The first-order condition is given by

$$p'(e)(1+\alpha+\alpha(\gamma-1)p(e))\Delta_b \leq 1+\alpha\gamma. \tag{13}$$

If the principal wants to implement e, then by setting Δ_b satisfying both (12) and (13), she can induce e to be a personal equilibrium for the agent. Although there is the multiple equilibrium problem as before, we here suppose that the agent attends to the equilibrium the principal prefers most, in order to explore the interaction between personal equilibria and incentives. Since the principal prefers lower Δ_b, it is optimal for her to set Δ_b such that (12) holds with equality, and hence the following incentive intensity is optimal.

$$\Delta_b = \frac{1}{p'(e)}\frac{1+\alpha}{1+\alpha+\alpha(\gamma-1)p(e)} \tag{14}$$

Differentiating Δ_b with regard to e yields the following result.

$$\text{sign}\left[\frac{\partial\Delta_b}{\partial e}\right] = -\text{sign}\left[\alpha(\gamma-1)\{p(e)p''(e)+(p'(e))^2\}+p''(e)(1+\alpha)\right] \tag{15}$$

First consider the agent with the standard reference-independent preferences ($\alpha = 0$). Then from (15) it is easy to see Δ_b is increasing in e: A more powerful incentive intensity is needed for implementation of a higher effort. This is a standard result. Now suppose the agent has RDP ($\alpha > 0$). (15) then does not tell us whether or not Δ_b is increasing. In other words, there is a possibility that the optimal incentive intensity decreases with effort.[14] The agent expecting a higher effort as a reference point faces a higher chance of loss and a lower chance of gain. Because of loss aversion, the former effect dominates, and hence the agent is more motivated to choose a higher effort. If this effect is sufficiently large, the principal can save monetary incentives, and lower Δ_b is optimal.

5 Concluding Remarks

In this paper we present the agency model with RDP to explain both the Pygmalion and Galatea effects. We first show that the agent's higher expectation enables the principal to implement high effort with lower-powered incentives. Our agent evaluates his future choice based on his expectation as a reference point. The agent with higher self-expectation is thus going to perform better. We interpret this as the Galatea effect. We also show that when the power of incentives is intermediate, multiple equilibria exist. The principal wants to make the agent attend to high effort in the region with multiple equilibria, and we interpret the Pygmalion effect as an equilibrium selection device.

It is crucial for us to take the viewpoint that the reference point is the agent's expectation. However, there is an alternative interpretation of reference points based on the goal setting theory in social psychology

[14] We can construct an example such that Δ_b is decreasing in all e.

(Locke and Latham, 2002). The goal setting theory shows that goals enhance performance by affecting reference points. It is easy to modify our model such that the reference point is the goal set by the principal. We can then show that it is optimal for the principal to choose the highest effort level as the reference point. This line of research may also be helpful to explain the Pygmalion effect.

As we have seen in the introduction, much research in social psychology, management, and so on, including laboratory and field studies, shows that the Pygmalion effect is significant. By contrast, there exists little economic research on the Pygmalion effect as far as we know. However, we believe that the Pygmalion effect also brings rich economic implications. We hope our paper stimulates future economic research, especially experimental one, on the Pygmalion effect, or more generally, self-fulfilling prophecy.

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