博　士　論　文

Essays on the Economic Analysis of Social Norms and Gender

（社会規範とジェンダーの経済学的分析について）

矢ヶ崎　将之

Essays on the Economic Analysis of Social Norms and Gender

Masayuki Yagasaki

Chapter 1

Introduction

Traditional economic theory assumes that people are self-interested and pursue their material interest. In reality, however, people usually care about 'how one should be' or 'what is the appropriate behavior.' Namely, people respect social norms and choose their behavior accordingly, even at the expense of their material benefit. Therefore, social norms substantially influence our behaviors.

Recently, the policymakers have started to utilize 'nudge' policies to enhance people's concerns toward social norms and to promote norm-compliant behaviors. An example of such a policy is to provide with information on others' behaviors. While the evidence has found that the information increases the peoples' norm-compliant behaviors, our understandings of the underlying psychological processes of such an observation are left as a black box.

In response to these backgrounds, chapter 2 asks a question of why we follow social norms and how it interacts with the behavior of others. To approach this question, we use a standard revealed preference approach. Based on Yagasaki (2018), the chapter investigates the psychological process underlying the observed phenomenon mentioned above by developing a behavioral model where individuals feel pride and shame in a comparison with their own behaviors and those of others, and by axiomatizing these behaviors. Our model axiomatized in this chapter is consistent with a recent experiment conducted by Klinowski (2016). Recently, there is growing attention toward the nudge policies, which promote individuals' norm-compliant behaviors such as saving energies and charitable donation. The obtained implication also links to its design and welfare evaluations.

As Akerlof and Kranton (2000) claim, we in the real world live our lives as a member of multiple social categories. People play many roles of the social categories; men and women, black and white, jocks and nerds, rich and poor, constituting the society and the market. And individuals with such roles may decide caring the ways of behaviors by attempting to meet the expectation from the society in the form of norms rather than their own intrinsic incentives. As such, we always concern about the social categories we belong to and how we should behave as a member of these social categories.

Among many social categories, one of the pressing issues in our society is gender: the categories of men and women. Suppose that, as many existing studies have observed, women are expected to behave as 'typical' women being risk averse (Eckel and Grossman, 2002, 2008) and less competitive (Niederle and Vesterlund, 2007). If one of them deviates from the image of the social category taking risks and actively participating in the competitions in the market, she would be punished by being placed in unfavorable positions in labor and marriage markets (Bursztyn et al., 2017b). Taking account that the half of population is occupied by them, this can be the source of inefficiency in the economy because the traits characterized by the gender norms of 'typical' women can deter them from taking opportunities of pursuing to utilize their resources in terms of abilities and skills for economic activities in the market. Therefore, it is also important to look at how these traits are associated with economic outcomes. Moreover, if the female gender norms prohibit women to perform appropriately in the economy, it is required to find effective solutions.

Chapter 3 explores how these gender-linked behavior traits such as competitiveness and risk attitudes are associated with educational achievements, which in turn, can largely affect their labor market outcomes in the future. Specifically, based on Yagasaki and Nakamuro (2018), we show that the gender differences in competitiveness and risk attitudes are associated with the gender gap in the math achievement that has been attracting many social scholars for long period. While being more competitive, a part of male gender norms, leads to a positive relation with math achievement, being risk averse, a part of female gender norms can also have the association in the same direction. These results imply that behaving like a man does not necessarily improve the gender gap in math achievement. Thus, the effects of policies intended to encourage girls to "lean in" (Sandberg, 2013) - girls should be more competitive, and take on more risks, etc. - are overall ambiguous and may result in unexpected and unwanted outcomes. As such, we rather argue that designing institutions to address the gender gap is more promising than policies that are designed to change the way women behave (Niederle and Yestrumskas, 2008; Niederle, Segal, and Vesterlund, 2014; Bohnet, 2016).

Chapter 4 argues how to overcome the effects of gender norms with policy interventions. Specifically, we follow Yagasaki (2019) to investigate which policy is more effective to improve the women's participation in the competition, under the society where being competitive contradicts with female gender norms. The previous studies have already found that women's "masculine" ambitious behaviors generally lead to their unfavorable positions in marriage and dating market. Given the women's social cost to participate in the competitions, it requires careful consideration to avoid the cost of the social image that women's participation in the competition is not appropriate as women. In this chapter, we show that affirmative action policies, which grant preferential treatment to women, only have limited impacts to mitigate the negative effect of the social image of women's participation in the competition. On the other hand, it is demonstrated that introducing prosocial incentives, such as the opportunity to attend charitable activities, regarded as "feminine activities" into the competitive environment, can be an alternative solution. Finally, we argue the practical policy implications based on the results of the present and previous studies, mentioning what we should concern about in designing the policies to improve the women's participation in the competitions.

Chapter 5 concludes this dissertation arguing the implications for society and policy based on our results.

Chapter 2

Pride, Shame and Social Comparisons

Traditional economic theory assumes that people are self-interested and pursue their material interest. In reality, however, people often respect social norms and exhibit prosocial behaviors that are costly to themselves. People vote, donate their blood or money, help strangers, and volunteer etc. Although other-regarding preferences such as altruism are important in explaining these behavior, it cannot explain some important phenomena and puzzles. For example, it cannot explain the fact that a simple environmental cue that 'nudges' individuals often have a significant impact on increasing norm-compliant behavior.

One such example is a *social comparison* nudge. Frey and Meier (2004) show that informing a higher percentage of people have responded to solicitation mails increase the response rate to a college mailing campaign. Alcott (2011) studies the effect of social information on energy conservation and shows that a significant fraction of consumers reduced energy consumption.

The aim of this chapter is to explore the psychological process of how social comparisons operate to affect our behavior in a decision theoretic framework. In particular, we posit that providing information on others' behavior affects our behavior by activating psychological emotions of *pride* and *shame*.[1] Our main point can be summarized in the following example: Consider a decision maker who has an opportunity to contribute to a charity and compare his feelings when he contributes \$100 and when (i) the average

[1] Activation of pride and shame is recently well studied in the literature. Gerber et al. (2010) find that being reminded that one did (pride) or did not (shame) vote in the past both affect voter turnout. Panagopoulos (2010) tests whether potential voters are mobilized by telling them that names of voters or non-voters would be published in a local newspaper, and finds that both pride and shame interventions significantly impact voting behavior and promote participation.

contribution of his neighbors is $10 or (ii) the average contribution of his neighbors is $1000. In the first case, a sense of *superiority* is likely to translate into a positive feeling of pride. On the other hand, the second case should cause the decision maker a feeling of *inferiority* and likely to translate into a negative feeling of shame. [2] When given information on others' behavior, the decision maker's welfare depends not only on his choice but also to the choice chosen by others with whom the decision maker compares.

Based on this observation, we consider preference relations over sets such as in Gul and Pesendorfer (2001) with an additional model primitive that capture *reference choice.* Reference choice is interpreted as indicating how others are behaving in a given decision problem and provide a source of social comparisons. We interpret our model as a three-stage decision problem: in the first-stage, the decision maker learns what the reference choice is, in the second-stage, the decision maker chooses a set, in the third-stage, the decision maker chooses a choice from the chosen set. Note that the analogous situation frequently arises in reality. For example, some donation procedures mirror this three-stage decision problem: potential donors are first informed about social information regarding contributions of others, decide whether to participate in a donation and, if they opted in, they decide the amount of their contributions. Recently, Klinowski (2016) tests how providing information about the amount of others' contributions, either before or after the decisions to opt in, affects enter and exit into a donation environment and the size of contributions. We will discuss consistency between Klinowski's result and our model in Section 4.

There are several papers on decision theory that study pride and shame in a similar setup. Dillenberger and Sadowski (2012) study the two-stage setup with ex-ante *private* set choosing stage and the ex-post *public* choice choosing stage. Their purpose is to capture the shame of acting selfishly in a dictator game situation. Evren and Minardi (2017), on the other hand, study warm glow based on preference over sets. Saito (2015) and Hashidate (2017) generalize Dillenberger and Sadowski (2012) and Evren and Minardi (2017) to study pride of acting altruistically and temptation to act selfishly in addition to shame. Our study is different from those in two important ways. First of all, our model adds an exogenous model primitive, that captures reference behavior, to

[2] Festinger (1954), who originally proposed social comparison theory, argues that 'the level of aspiration (his statement of what he considers is a good performance) always moves close to the level of performance that others like himself performed.' In economics, Benabou and Tirole (2006) argue, 'what makes a given behavior socially or morally unacceptable is often the very fact that "it is just not done,"' and 'the fact that "everyone does it" allows the very same behavior to be free of all stigma.'

study social comparisons. [3] Second, unlike most other literature, our model does not require public observability of the behavior in the choice choosing stage. The second difference comes from the difference in environmental cues that nudge individuals to focus on norms. Individuals do not always have norms in mind. In psychology, it is considered that 'focusing' on norms is a crucial component in producing norm-compliant behavior (e.g., Cialdini, Reno and Kallgren, 1990; Krupka and Weber, 2009). In the previous literature, public observability at the choice choosing stage serves as a nudge that focuses decision makers on norms, while in our model informing others' behavior serves as a nudge.

Finally, our work adds to a recently growing literature on nudges (Thaler and Sunstein, 2008). In particular, by providing a revealed preference foundation of a social comparison nudge, we aim to provide an insight into how nudging individuals by providing information on others behavior affects the psychological benefit (pride) or cost (shame) and thus the welfare of the decision maker. The welfare effect of social comparison nudge is recently explored empirically for example in Allcott and Kessler (2015) but the decision theoretic foundation is not explored in the previous literature.

The rest of the chapter is organized as follows. Section 2 explains our model setup and presents our axioms. Section 3 provides our main theorem and representation. We also show the uniqueness of our representation in Section 3. Section 4 is devoted to providing applications of our model. The main application of our model is to explain the results of Klinowski (2016) through the lens of our model. We also show that the model describes why providing extrinsic incentives may crowd out prosocial activities as first suggested by Titmuss (1970). Section 5 concludes the chapter. All proofs are in the appendix.

2.1 Model

Let (Z, ρ) be a compact metric space, where Z is the set of all prizes and let $\Delta(Z)$ denote the set of all probability measure on the Borel σ-algebra of Z endowed with the weak topology. Let $\mathcal{A}$ be a set of all closed subsets of $\Delta(Z)$. Let us endow $\mathcal{A}$ with the topology generated by the Hausdorff metric,

[3] Our work is also related to social decision theory developed in Maccheroni, Marinacci and Rustichini (2012). The decision makers in their paper put the reference on the 'outcomes' of others. Rather, the decision makers in our model put the reference on the 'behaviors' of others.

$$d_H(A,B) = \max\left\{\max_{a\in A}\min_{b\in B} d(a,b), \max_{b\in B}\min_{a\in A} d(a,b)\right\},$$

where d is a metric that metrizes the weak topology. Define $\alpha A + (1-\alpha)B = \{z \in \Delta(Z) : z = \alpha a + (1-\alpha)b, a \in A, b \in B\}$ for $A, B \in \mathcal{A}$ and $\alpha \in [0,1]$. Define a binary relation $\succsim$ over $\mathcal{A}$. In this chapter, we consider a decision maker who has a preference relation over sets as in the related literature (e.g., Gul and Pesendorfer, 2001; Dillenberger and Sadowski, 2012; Evren and Minardi, 2017; Saito, 2015; Hashidate, 2018).

To explicitly model social comparisons in our decision theoretic framework, we add another model primitive interpreted as a choice other people are choosing in the society which serves as a source of social comparisons. Let $\varphi : \mathcal{A} \twoheadrightarrow \Delta(Z)$ be a choice correspondence so that $\varphi(A) \subset A$ for all $A \in \mathcal{A}$. We call φ as a reference choice correspondence and $\varphi(A)$ as a reference choice at A. We assume that the reference choice correspondence is rationalizable by a continuous, vNM utility function $r : \Delta(Z) \to \mathbb{R}$: that is,

$$\varphi(A) = \arg\max_{a\in A} r(a),$$

for all $A \in \mathcal{A}$. We interpret r as an underlying utility function of the reference choice correspondence. Overall, our model primitives are $(\succsim, \varphi)$ or, equivalently, $(\succsim, r)$.

The model basically follows setups in Gul and Pesendorfer (2001), Dillenberger and Sadowski (2012), Evren and Minardi (2017), Saito (2015) and Hashidate (2018) but with an additional ex-ante learning stage of φ. Namely, we interpret the model as describing the following three-stage decision problem:

1. In the first-stage, the decision maker learns a reference choice correspondence φ.

2. In the second-stage, the decision maker chooses a choice set $A \in \mathcal{A}$.

3. In the third-stage, the decision maker chooses a choice a from A.

In reality, analogous setting arises, say, when the potential donors are informed about how much others donate before the decision of participation into a donation. Note that the setups in Dillenberger and Sadowski (2012), Saito (2015) and Hashidate (2018) are two-stage with the ex-ante *private* set choosing stage and the ex-post *public* choice choosing stage. In contrast to those, our setup is three-stage, with the first

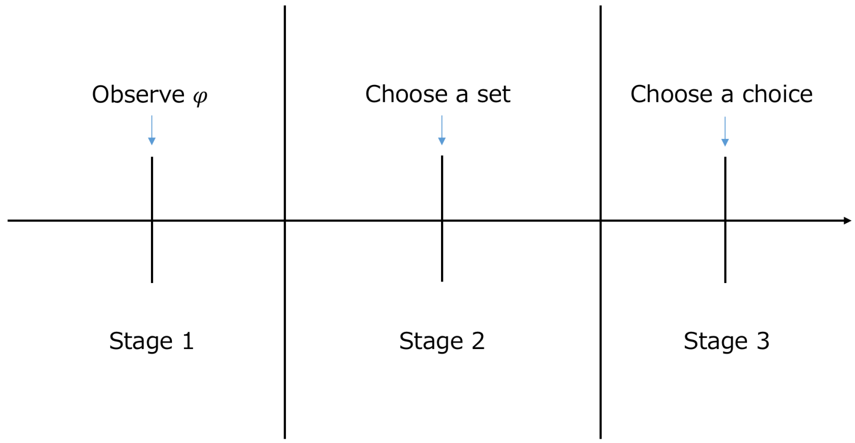


Figure 2.1: Timing of the decisions

reference choice learning stage. Furthermore, we do not require public observability of the behavior at the choice choosing stage.

The difference comes from the difference in environmental cues that nudge individuals to focus on social norms. Individuals do not always have norms in mind. When they are not aware of norms, norms play no role in shaping their behavior. Therefore, drawing attention to norms, or 'focusing' is a crucial component of producing norm-compliant behavior' (e.g., Cialdini, Reno and Kallgren, 1990; Krupka and Weber, 2009). While both models feature an environmental cue that nudges decision makers who would otherwise act solely on their intrinsic preference rankings to be aware of social norms, the trigger is different as follows. In the previous literature, public observability of the behavior at the choice choosing stage serves as a nudge of focusing on norms. In our setup, on the other hand, informing others' behavior makes the decision maker aware of the social reference and therefore the pride and shame, which are emotions arising from the normative comparison of their action and the social reference action. [4] Importantly, in either case the presumption is that pride and shame are activated only at the choice choosing stage and those are not relevant at the time when the decision maker chooses a set. This eliminates the problem of the infinite-regress problem pointed out by Spiegler (2013).

[4]Indeed, psychologists' view of pride and shame does not necessarily require publicity of the behavior. According to Scheff (1990), shame occurs when one feels negatively evaluated by self or others, while pride is evident when one feels positively evaluated by self or others. Publicity of the behavior is a sufficient condition but not a necessary condition for activation of pride and shame.

2.1.1 Axioms

We present our set of axioms that characterize the representation. The first four axioms are familiar with the literature and impose basic properties on $\succsim$.

Axiom 1 (Order): $\succsim$ is complete and transitive.

Axiom 2a (Lower Semi-Continuity): For any $A \in \mathcal{A}$, $\{B \in \mathcal{A} : A \succsim B\}$ is closed.

Axiom 2b (Upper von Neumann-Morgenstern Continuity): $A \succ B \succ C$ implies $B \succ \alpha A + (1 - \alpha)C$ for some $\alpha \in (0, 1)$.

Axiom 2c (Upper Singleton Continuity): $\{\{b\} \in \mathcal{A} : \{b\} \succsim \{a\}\}$ is closed.

Axiom 3 (Independence): $A \succ B$ implies $\alpha A + (1 - \alpha)C \succ \alpha B + (1 - \alpha)C$ for all $\alpha \in (0, 1]$.

The next two axioms represent the relationship between φ and $\succsim$. The following Axiom 4 is the most important axiom in this study.

Axiom 4 (φ–Social Comparison): $\varphi(A \cup B) = \varphi(A)$ implies $A \cup B \succsim A$.

To understand the meaning of this axiom, suppose $A = \{a\}$, $B = \{b\}$, and $\varphi(\{a, b\}) = \{a\}$. It says that the reference choice at $\{a, b\}$ is to choose a from $\{a, b\}$. As previously mentioned, we posit that the decision maker feels pride or shame when he compares his choice and the reference choice. As a result, singletons are free from such psychological feelings since the actual choice and the reference choice always coincide. In addition, at $\{a, b\}$, the decision maker can obtain the same utility as $\{a\}$ by choosing the reference choice a at $\{a, b\}$. This suggests that $\varphi(\{a, b\}) = \{a\}$ implies $\{a, b\} \succsim \{a\}$.

We identify the ex-post choice from any of the following relations:

$$\begin{aligned}
\varphi(\{a, b\}) &= \{b\} \text{ and } \{a\} \succ \{a, b\} \succ \{b\}, \\
\varphi(\{a, b\}) &= \{a\} \text{ and } \{a, b\} \succ \{a\} \succ \{b\}, \\
\varphi(\{a, b\}) &= \{b\} \text{ and } \{a, b\} \succ \{a\} \succ \{b\}.
\end{aligned}$$

The first relation captures the situation where the decision maker feels shame at $\{a,b\}$ by choosing a. The second relation captures the situation where the decision maker feels pride at $\{a,b\}$ by choosing b. The third relation captures the situation where the decision maker feels pride at $\{a,b\}$ by choosing a[5]. The basic idea here is that, if the decision maker is choosing the same choice with that of the reference behavior at $\{a,b\}$, it must be the case that $\{a,b\}$ is indifferent to the singleton of the reference choice. Generally, if,

$$\varphi(\{a,b\}) = \{a\} \text{ and } \{a,b\} \succ \{a\},$$

then the decision maker feels pride or shame at $\{a,b\}$ by not choosing the reference choice a.

Finally, since we are assuming that φ is a choice correspondence, we need an axiom that suggests which choice to be the point on which the decision maker put reference when $\varphi(A)$ is a set. The following axiom plays that role.

Axiom 5 (φ–Set Betweeness): $\varphi(A \cup B) = \varphi(A) \cup \varphi(B)$ and $A \succsim B$ imply $A \succsim A \cup B \succsim B$.

Axiom 5 is a weakened version of Set Betweenness axiom of Gul and Pesendorfer (2001). The axiom ensures that, when $\varphi(A)$ is a set, the normatively best choice in $\varphi(A)$ will be the reference point.

2.2 Main Theorem

In this section, we present our main representation theorem.

THEOREM 1: *The pair of $(\succsim, \varphi)$ satisfies Axiom 1, 2a-c, 3, 4, 5 if and only if there are continuous linear functions u and w such that*

$$V_{PS}(A) = \max_{a \in A} \left[u(a) - \left\{ \max_{b \in \varphi(A)} w(b) - w(a) \right\} \right]$$

where V_{PS} represents $\succsim$.

[5]Note that the case,

$$\varphi(\{a,b\}) = \{a\} \text{ and } \{a\} \succ \{a,b\} \succ \{b\},$$

is impossible by Axiom 4.

Proof. See Appendix.

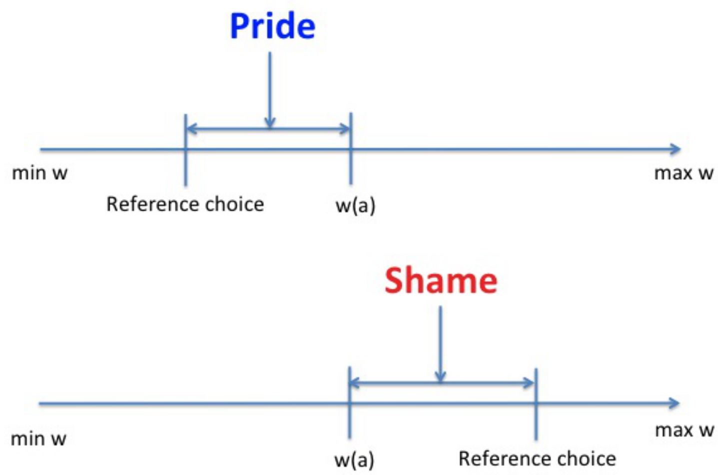


Figure 2.2: Pride and Shame

We interpret u as representing the decision maker's *intrinsic* utility function. Without any environmental cues that nudge a decision maker to be aware of norms, we assume that the decision maker simply maximizes u. Here, since the decision maker is nudged by learning how others are behaving, the term $\max_{\varphi(A)} w - w(a)$ arises as an additional component. We interpret w as representing a *subjective norm* function. Therefore, the term $\max_{\varphi(A)} w - w(a)$ captures a normative comparison between the reference choice and the actual choice, which can be interpreted as pride and shame. Namely, if $\max_{\varphi(A)} w - w(a) < 0$, we interpret that the decision maker feels the additional psychological benefit of pride. In contrast, if $\max_{\varphi(A)} w - w(a) > 0$, we interpret that the decision maker feels psychological cost of shame (See Figure 2.2). [6]

[6] Note that, since $\varphi(A) = \arg\max_A r$, we have the form called *Strotz* form in the representation, which is familiar in the literature of temptation. This is a unique and interesting aspect of our representation. Strotz form arises in the literature of temptation to model a decision maker who cannot resist temptation in the ex-post choice choosing stage and thus evaluate his ex-post choice based on the ex-ante utility function. Our model, in contrast, interprets the form as evaluating others

The representation suggests that the decision maker chooses a choice in A that maximizes $u + w$. Note that w might be affected by the type of information given to the decision maker if, for instance, the decision maker infers what is normatively the best choice from others' behavior. In that case, w depends on φ. In contrast, if we assume that w is stable across the type of information given, the model has some important implications.

First of all, at the choice choosing stage, regardless how others are behaving, the decision maker behaves in a more norm-compliant way relative to the behavior under which the decision maker is not aware of how others are behaving. This is consistent to the 'focusing' theory in psychology that we mentioned. Second, informing that others are behaving more normatively decreases the welfare of a given choice set. Therefore, what the reference choice affects the choice of a set. In section 4, we show that these are indeed consistent with the experimental results in Klinowski (2016).

The proof of Theorem 1 follows the strategy in Gul and Pesendorfer (2001). Axiom 1, 2a-c and 3 ensure the existence of linear $V_{PS} : \mathcal{A} \to \mathbb{R}$ that represents $\succsim$. The following Lemma is critical in our proof and is a modified version of Lemma in Gul and Pesendorfer (2001).

LEMMA: *Given the reference choice correspondence φ, let $V_{PS} : \mathcal{A} \to \mathbb{R}$ be a function that represents some $\succsim$ satisfying Axiom 4 and 5. If $A \in \mathcal{A}$ is a finite set, then,*

$$V_{PS}(A) = \max_{a \in A} \min_{b \in \varphi(A)} V_{PS}(\{a, b\}) = \min_{b \in \varphi(A)} \max_{a \in A} V_{PS}(\{a, b\}).$$

Proof. See Appendix.

The intuition of the above Lemma is that, for any finite set, the value of a set can be characterized by two choices: the ex-post choice and the reference choice. The Lemma differs that of Gul and Pesendorfer (2001) in the sense that one of the choices that characterizes the value of a set A is the reference choice $\varphi(A)$. As a result of this Lemma, we can exploit the strategy taken in Gul and Pesendorfer (2001) to show the representation. Namely, we first show that the representation is satisfied for any binary sets. Secondly, we extend this representation result to all finite sets by using Lemma. Finally, by Axiom 2a-c in the Hausdorff metric topology, the representation can be

behavior based on the subjective norm function and serves as the reference point.

extended to all $A \in \mathcal{A}$, as desired.

We identify the intrinsic utility function u from preferences over singletons. Subjective norm function w is identified by first identifying ex-post choice from the relation such as

$$\varphi(\{a,b\}) = \{a\} \text{ and } \{a,b\} \succ \{a\}.$$

The intuition here is robust to general sets and we define this formally in the following.

DEFINITION: *Given the reference choice corresponcence φ, the preference $\succsim$ feels pride or shame at a set C if and only if there are subsets $A, B \subset C$ such that $A \cup B = C$, $\varphi(A \cup B) = \varphi(A)$ and $A \cup B \succ A$.*

Above definition means that the decision maker will choose a choice different from the reference choice at some choice sets and thus feels pride or shame. The following theorem shows that, if $\succsim$ feels pride or shame, u and w are uniquely identified up to affine transformation. The proof is straightforward from the uniqueness of V_{PS}.

THEOREM 2: *(Identification) Given the reference choice corresponcence φ, let $\succsim$ be a preference relation satisfying Axiom 1, 2a-c, 3, 4, 5 and feels pride or shame. Then following two statements are equivalent:*
(i) If (u,w) represents $\succsim$, then (u',w') also represents $\succsim$.
(ii) $u' = \alpha u + \beta_u$ and $w' = \alpha w + \beta_w$ for some $\alpha > 0$ and $\beta_u, \beta_w \in \mathbb{R}$.

Proof. See Appendix.

2.3 Applications

In this section, we discuss the applications of our model. First, we first show that our model is consistent with recent experimental findings in Klinowski (2016). Secondly, using our model, we show that providing extrinsic incentives to foster prosocial behavior sometimes discourage individuals to participate in prosocial activities.

2.3.1 Klinowski (2016)

Klinowski (2016) conducts a laboratory experiment in which participants can make anonymous, private donations to a nonprofit organization by responding to the following solicitation procedure: first, subjects indicate whether they intend to donate; second, if they opted in, they state the amount of their contributions. He investigates how providing information about how much others donate, either before or after subjects indicate that they will give, affects the decisions to opt in and the size of the contributions. The findings are summarized as follows:

1. When social information is provided $before$ the decision to opt in, relative to providing no information, participants are 61% more likely to opt in if they know that another subject donated a low amount, and

2. 40% less likely to opt in if they know that another subject donated a high amount.

3. When social information is provided $after$ the decision to opt in, both high and low information shifts up the average contribution relative to no information.

Note that the experimental setting in Klinowski (2016) mirrors our setting and thus interpreting the results through the lens of our model is straightforward. Let a be a choice representing 'to make large donation' and b be a choice representing 'to make no (or little) donation.' Suppose subjects have to decide whether to 'participate' or 'do not participate' in a donation. Here, 'participate' means subjects put themselves to a situation where they can make a donation, which we interpret it as choosing a choice set $\{a, b\}$. On the other hand, 'do not participate' means subjects commit to a situation where they cannot make a donation, which we interpret it as choosing a choice set $\{b\}$.

Suppose 'to make large donation' is normatively better than 'to make no (or little) donation' (i.e. $w(a) > w(b)$). Then providing information such as other people 'made large donation' (i.e. $\varphi(\{a, b\}) = \{a\}$) shifts up the reference point and thus it makes subjects more costly to choose $\{a, b\}$ over $\{a\}$ than providing no information or low information such as other people 'did not make a donation' (i.e. $\varphi(\{a, b\}) = \{b\}$). This explains the first finding of which the low participation rate is observed when high information is given before the decision to opt in. Analogous logic applies to the second finding.

The third finding is also consistent with our theoretical prediction that providing social information increases norm-compliant behavior regardless of how others are behaving. This is actually the effect of 'focusing' on social norms triggered by providing social information (Cialdini, Reno and Kallgren, 1990; Krupka and Weber, 2009). [7]

2.3.2 Crowding Out of Prosocial Behavior by Extrinsic Incentives

Providing extrinsic incentives to foster prosocial behavior sometimes has a perverse effect, reducing the total contribution provided by individuals (e.g., Titmuss, 1970; Gneezy and Rustichini, 2000). Under some assumptions, our model predicts providing extrinsic incentives may reduce the number of people who 'participate' in the prosocial activities.

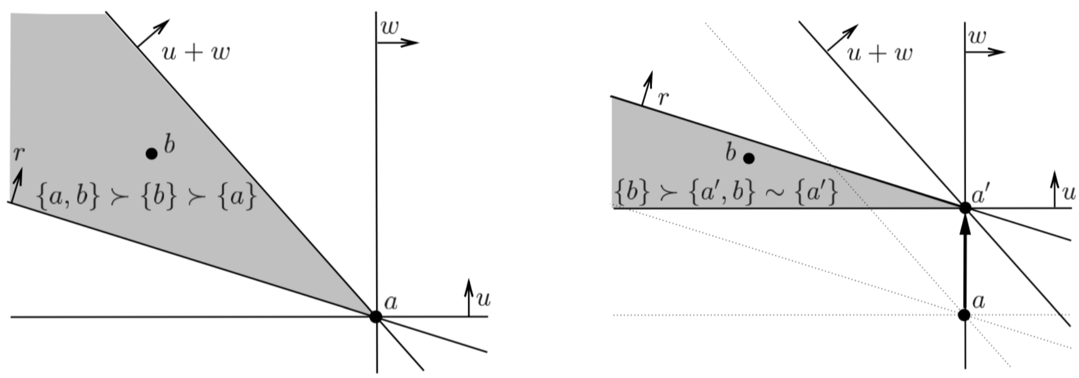


Figure 2.3: The effect of compensation

Let a represent 'to make large donation' and b represent 'to make no (or little) donation' as in the previous section. We consider a situation where decision maker observes others are not making a donation ($\varphi(\{a,b\}) = \{b\}$) before any decisions. Assume that 'to make large donation' is intrinsically preferred to 'to make no (or little) donation' (i.e. $u(a) < u(b)$) by the decision maker, 'to make large donation' is normatively better than 'to make no (or little) donation' (i.e. $w(a) > w(b)$) and the decision maker's ex-post choice given choice set $\{a,b\}$ is to choose a over b (i.e. $u(a) + w(a) > u(b) + w(b)$). Under these assumptions, the benefit of pride associated with 'participation' (i.e., $\{a,b\}$) exceeds the cost of intrinsic utility and we have,

$$V_{PS}(\{a,b\}) = u(a) + w(a) - w(b) > u(b) = V_{PS}(\{b\}).$$

[7] We are assuming that u and w are not affected by what kind of information is given.

This situation is displayed in the left panel of Figure 2.3.

We now consider a situation where extrinsic incentives is offered to the donation. Let a' be a choice representing 'to make large donation with extrinsic incentives.' We maintain almost the same set of assumptions, $u(b) > u(a'), w(a') > w(b)$, and $u(a') + w(a') > u(b) + w(b)$, but $\varphi(\{a', b\}) = \{a'\}$. In this case, the decision maker can no longer feel pride from participating in a donation and thus,

$$V_{PS}(\{a', b\}) = u(a') < u(b) = V_{PS}(\{b\}),$$

which ends up being not participating in a donation. This situation is displayed in the right panel of Figure 2.3. [8]

In words, providing extrinsic incentives with the aim of fostering prosocial behavior may crowd out participation in a prosocial activities since providing extrinsic incentives makes the prosocial behavior an 'average' behavior by which the decision maker could no longer feel pride.

2.4 Conclusion

Understanding when and why people respect social norms and exhibit prosocial behavior, many times at the expense of their material interest, is an important topic in social science. The aim of this chapter is to explore the relationship between social comparisons and psychological emotions of pride and shame in a decision theoretic framework. Our representation suggests some important policy implications for the implementation of a social comparison nudge. First of all, providing information that others are behaving prosocially decreases the utility of the decision makers since it activates the emotional cost of shame. A related point was also argued by Loewenstein and O'Donoghue (2006), Glaezer (2009) that many nudges are essentially emotional tax on 'inappropriate' behavior. As a result, providing prosocial information about others may decrease the number of decision makers who participate in prosocial activities. Second, providing anti-social information maybe effective in enhancing norm-compliant behavior from two points. One, it makes the decision makers to be free from feeling shame and provides a chance to feel pride by acting prosocially. This may increase the degree of prosocial behavior by not harming the decision makers' welfare. Two, as a result of one, the number of decision makers who participate in prosocial activities may

[8] We assume $w(a) = w(a')$ in the figure.

increase.

However, an important assumption which underlies the above arguments is that providing information does not dramatically change what the decision maker believes an appropriate behavior. In some experiments, anti-social information changes the notion of how one should behave and increases anti-social behavior. Therefore, when designing a social comparison nudge, policymaker should be aware of how people's perceived norms are delicate to social information as well.

Finally, our model does not capture a situation where the ex-post behavior is affected by the reference behavior. A possible extension of our model would be to weaken independence axiom and allow the ex-post behavior to depend on the reference behavior. We left this topic for future research.

2.5 Appendix

2.5.1 Proof of Theorem 1

LEMMA 1: *Let $\succsim$ be a binary relation over $\mathcal{A}$ satisfying Axiom 1, 2a-c, 3. Then there exists a linear function $V_{PS}: \mathcal{A} \to \mathbb{R}$ that represents $\succsim$. V_{PS} is unique up to affine transformation.*

Proof. See Gul and Pesendorfer (2001) Lemma 1. *Q.E.D.*

Let $\varphi : \mathcal{A} \twoheadrightarrow \Delta(Z)$ be a choice correspondence so that $\varphi(A) \subset A$ for all $A \in \mathcal{A}$. We assume that the reference choice correspondence is rationalizable by a continuous, vNM utility function $r : \Delta(Z) \to \mathbb{R}$: that is,

$$\varphi(A) = \arg\max_{a \in A} r(a),$$

for all $A \in \mathcal{A}$. In what follows, we assume that φ (or r) is exogenously given.

LEMMA 2: *Let $V_{PS}: \mathcal{A} \to \mathbb{R}$ be a function that represents some $\succsim$ satisfying Axiom 4 and 5. If $A \in \mathcal{A}$ is a finite set, then,*

$$V_{PS}(A) = \max_{a \in A} \min_{b \in \varphi(A)} V_{PS}(\{a,b\}) = \min_{b \in \varphi(A)} \max_{a \in A} V_{PS}(\{a,b\}).$$

Proof. Put $\max_{a\in A}\min_{b\in\varphi(A)} V_{PS}(\{a,b\}) = V_{PS}(\{a^*,b^*\})$. Since $V_{PS}(\{a^*,b^*\}) \le V_{PS}(\{a^*,b\})$ for all $b \in \varphi(A)$, iteratively applying Axiom 5 yields $V_{PS}(\{a^*,b^*\}) \le V_{PS}(\{a^*\}\cup\varphi(A))$. Note that $\varphi((\{a^*\}\cup\varphi(A))\cup(A\setminus(\{a^*\}\cup\varphi(A)))) = \varphi(\{a^*\}\cup\varphi(A))$. Then applying Axiom 4 yields $V_{PS}(\{a^*,b^*\}) \le V_{PS}(A)$. Secondly, let us show the opposite inequality. Since $V_{PS}(\{a^*,b^*\}) \ge V_{PS}(\{a,b_a\})$ for all $a \in A$ where $b_a \in \arg\min_{b\in\varphi(A)} V_{PS}(\{a,b\})$. Then iteratively applying Axiom 5 yields $V_{PS}(\{a^*,b^*\}) \ge V_{PS}(A)$. Another equality is shown in a similar manner. *Q.E.D.*

LEMMA 3: *Let V_{PS} be a function that represents $\succsim$ satisfying Axiom 1, 2a-c, 3, 4, 5. Suppose,*

$$r(a) > r(b) \text{ and } V_{PS}(\{a,b\}) > V_{PS}(\{a\}),$$

$$r(c) > r(d) \text{ and } V_{PS}(\{c,d\}) > V_{PS}(\{c\}).$$

Then,

$$V_{PS}(\delta\{a,b\} + (1-\delta)\{c,d\}) = V_{PS}(\{\delta a + (1-\delta)c, \delta b + (1-\delta)d\}),$$

for all $\delta \in (0,1)$.

Proof. Put $A = \delta\{a,b\} + (1-\delta)\{c,d\}$. Note that, by the linearity of r, $\arg\max_A r = \{\delta a + (1-\delta)c\}$. Therefore, by Lemma 2, $V_{PS}(A) = V_{PS}(\{x, \delta a + (1-\delta)c\})$ for some $x \in A$. Now suppose $x = \delta a + (1-\delta)d$. Since V_{PS} is linear, we have

$$V_{PS}(A) = \delta V_{PS}(\{a\}) + (1-\delta)V_{PS}(\{c,d\}) < \delta V_{PS}(\{a,b\}) + (1-\delta)V_{PS}(\{c,d\}) = V_{PS}(A)$$

which is a contradiction. Suppose $x = \delta a + (1-\delta)c$. Then

$$V_{PS}(A) = \delta V_{PS}(\{a\}) + (1-\delta)V_{PS}(\{c\}) < \delta V_{PS}(\{a,b\}) + (1-\delta)V_{PS}(\{c,d\}) = V_{PS}(A)$$

which is a contradiction. Suppose $x = \delta b + (1-\delta)c$. Then

$$V_{PS}(A) = \delta V_{PS}(\{a,b\}) + (1-\delta)V_{PS}(\{c\}) < \delta V_{PS}(\{a,b\}) + (1-\delta)V_{PS}(\{c,d\}) = V_{PS}(A)$$

which is a contradiction. Therefore, $x = \delta b + (1-\delta)d$. *Q.E.D.*

We are now in a position to identify u and w. Let $u(a) = V_{PS}(\{a\})$ for all $a \in \Delta(Z)$.

Suppose for some $x, y \in \Delta(Z)$, $r(x) > r(y)$ and $\{x, y\} \succ \{x\}$. This suggests that the decision maker feels pride or shame at $\{x, y\}$ by not choosing the reference choice x. Throughout, we fix this $x, y \in \Delta(Z)$. Lower semi-continuity (Axiom 2a) of V_{PS}, continuity of r and compactness of $\Delta(Z)$ imply that there exists sufficiently small $\delta \in (0,1)$ such that

$$r(x) > r((1-\delta)y + \delta c) \text{ and } V_{PS}(\{x, (1-\delta)y + \delta c\}) > V_{PS}(\{x\}),$$

for all $c \in \Delta(Z)$. Then define

$$w(c; x, y, \delta) = \frac{1}{\delta} V_{PS}(\{x, (1-\delta)y + \delta c\}) - \frac{1-\delta}{\delta} V_{PS}(\{x, y\}) - V_{PS}(\{c\}).$$

LEMMA 4: *Let V_{PS} be a function that represents $\succsim$ satisfying Axiom 1, 2a-c,3,4,5. Suppose $r(x) > r((1-\delta)y + \delta c)$ and $V_{PS}(\{x, (1-\delta)y + \delta c\}) > V_{PS}(\{x\})$ for all $c \in \Delta(Z)$. Then:*

(i) If $r(x) > r(c)$ and $V_{PS}(\{x, c\}) > V_{PS}(\{x\})$, then $w(c; x, y, \delta) = V_{PS}(\{x, c\}) - V_{PS}(\{c\})$.

(ii) $w(x; x, y, \delta) = 0$.
(iii) $w(\alpha c + (1-\alpha)c'; x, y, \delta) = \alpha w(c; x, y, \delta) + (1-\alpha) w(c'; x, y, \delta)$ where $\alpha \in (0,1)$.
(iv) $w(c; x, y, \delta) = w(c; x, y, \delta')$ for all $\delta' \in (0, \delta)$.
(v) If $r(a) > r(b)$ and $V_{PS}(\{a, b\}) > V_{PS}(\{a\})$, then $w(c; x, y, \delta) = w(c; a, b, \delta) + w(a; x, y, \delta)$.

Proof.

(i) Suppose $r(x) > r(c)$ and $V_{PS}(\{x, c\}) > V_{PS}(\{x\})$. Note that Lemma 3 implies that $V_{PS}(\{x, (1-\delta)y + \delta c\}) = V_{PS}((1-\delta)\{x, y\} + \delta\{x, c\})$. Therefore,

$$\begin{aligned} w(c; x, y, \delta) &= \frac{1}{\delta} V_{PS}(\{x, (1-\delta)y + \delta c\}) - \frac{1-\delta}{\delta} V_{PS}(\{x, y\}) - V_{PS}(\{c\}) \\ &= \frac{1-\delta}{\delta} V_{PS}(\{x, y\}) + V_{PS}(\{x, c\}) - \frac{1-\delta}{\delta} V_{PS}(\{x, y\}) - V_{PS}(\{c\}) \\ &= V_{PS}(\{x, c\}) - V_{PS}(\{c\}). \end{aligned}$$

(ii) By definition,

$$\begin{aligned} w(x;x,y,\delta) &= \frac{1}{\delta}V_{PS}(\{x,(1-\delta)y+\delta x\}) - \frac{1-\delta}{\delta}V_{PS}(\{x,y\}) - V_{PS}(\{x\}) \\ &= \frac{1-\delta}{\delta}V_{PS}(\{x,y\}) + V_{PS}(\{x\}) - \frac{1-\delta}{\delta}V_{PS}(\{x,y\}) - V_{PS}(\{x\}) \\ &= 0. \end{aligned}$$

The second equality follows from $\{x,(1-\delta)y+\delta x\} = (1-\delta)\{x,y\}+\delta\{x\}$ and linearity of V_{PS}.

(iii) Note that Lemma 3 implies that

$$V_{PS}(\{x,\alpha[(1-\delta)y+\delta c]+(1-\alpha)[(1-\delta)y+\delta c']\}) = V_{PS}(\alpha\{x,(1-\delta)y+\delta c\}+(1-\alpha)\{x,(1-\delta)y+\delta c'\}).$$

Therefore,

$$\begin{aligned} w(\alpha c+(1-\alpha)c';x,y,\delta) &= \frac{1}{\delta}V_{PS}(\{x,\alpha[(1-\delta)y+\delta c]+(1-\alpha)[(1-\delta)y+\delta c']\}) \\ &\quad -\frac{1-\delta}{\delta}V_{PS}(\{x,y\}) - V_{PS}(\{\alpha c+(1-\alpha)c'\}) \\ &= \alpha\frac{1}{\delta}V_{PS}(\{x,(1-\delta)y+\delta c\}) + (1-\alpha)\frac{1}{\delta}V_{PS}(\{x,(1-\delta)y+\delta c'\}) \\ &\quad -\frac{1-\delta}{\delta}V_{PS}(\{x,y\}) - \alpha V_{PS}(\{c\}) + (1-\alpha)V_{PS}(\{c'\}) \\ &= \alpha w(c;x,y,\delta) + (1-\alpha)w(c';x,y,\delta). \end{aligned}$$

(iv) Let $\delta' \in (0,\delta)$. Then note that $(1-\delta')y+\delta' c = \frac{\delta-\delta'}{\delta}y + (1-\frac{\delta-\delta'}{\delta})\{(1-\delta)y+\delta c\}$. And Lemma 3 implies that

$$\begin{aligned} &V_{PS}\left(\left\{x, \frac{\delta-\delta'}{\delta}y + (1-\frac{\delta-\delta'}{\delta})\{(1-\delta)y+\delta c\}\right\}\right) \\ = \; &V_{PS}\left(\frac{\delta-\delta'}{\delta}\{x,y\} + \left(1-\frac{\delta-\delta'}{\delta}\right)\{x,(1-\delta)y+\delta c\}\right). \end{aligned}$$

Therefore,

$$V_{PS}(\{x,(1-\delta)y+\delta c\}) = \frac{\delta}{\delta'}V_{PS}(\{x,(1-\delta')y+\delta' c\}) - \frac{\delta-\delta'}{\delta'}V_{PS}(\{x,y\}).$$

Substituting this relation into the definition, we have

$$\begin{aligned} w(c;x,y,\delta) &= \frac{1}{\delta}V_{PS}(\{x,(1-\delta)y+\delta c\}) - \frac{1-\delta}{\delta}V_{PS}(\{x,y\}) - V_{PS}(\{c\}) \\ &= \frac{1}{\delta'}V_{PS}(\{x,(1-\delta')y+\delta' c\}) - \frac{\delta-\delta'}{\delta\delta'}V_{PS}(\{x,y\}) \\ &\quad -\frac{1-\delta}{\delta}V_{PS}(\{x,y\}) - V_{PS}(\{c\}) \\ &= w(c;x,y,\delta'). \end{aligned}$$

(v) Suppose $r(a) > r(b)$ and $V_{PS}(\{a,b\}) > V_{PS}(\{a\})$. What to be shown is that

$$\begin{aligned} & w(c;x,y,\delta) = w(c;a,b,\delta) + w(a;x,y,\delta) \\ \Leftrightarrow\quad & \frac{1}{\delta}V_{PS}(\{x,(1-\delta)y+\delta c\}) = \frac{1}{\delta}V_{PS}(\{a,(1-\delta)b+\delta c\}) - \frac{1-\delta}{\delta}V_{PS}(\{a,b\}) \\ & \qquad -V_{PS}(\{a\}) + \frac{1}{\delta}V_{PS}(\{x,(1-\delta)y+\delta a\}). \end{aligned}$$

Now, by (ii), we have $V_{PS}(\{a\}) = \frac{1}{\delta}V_{PS}(\{a,(1-\delta)b+\delta a\}) - \frac{1-\delta}{\delta}V_{PS}(\{a,b\})$. Substituting this relation, what to be shown is that

$$V_{PS}(.5\{x,(1-\delta)y+\delta c\} + .5\{a,(1-\delta)b+\delta a\}) = V_{PS}(.5\{a,(1-\delta)b+\delta c\} + .5\{x,(1-\delta)y+\delta a\}).$$

But Lemma 3 implies that both sides of the equation is equal to

$$V_{PS}(\{.5x+.5a, .5(1-\delta)(y+b)+.5\delta(a+c)\}).$$

LEMMA 5: *Let V_{PS} be a function that represents $\succsim$ satisfying Axiom 1, 2a-c, 3, 4, 5. Consider $x,d \in \Delta(Z)$ such that $r(x) \geq r(b)$ and $V_{PS}(\{x,b\}) \geq V_{PS}(\{x\})$. Suppose $r(x) > r((1-\delta)y+\delta c)$ and $V_{PS}(\{x,(1-\delta)y+\delta c\}) > V_{PS}(\{x\})$ for all $c \in \Delta(Z)$. Then*

$$V_{PS}(\{x,b\}) = \max_{c\in\{x,b\}}\{u(c)+w(c;x,y,\delta)\} - \max_{c'\in M_r(\{x,b\})} w(c';x,y,\delta)$$

where $M_r(A) = \arg\max_A r$.

Proof. First of all, suppose $r(x) > r(b)$ and $V_{PS}(\{x,b\}) > V_{PS}(\{x\})$. Then, by Lemma

4, we have

$$\begin{aligned} u(b) + w(b; x, y, \delta) - w(x; x, y, \delta) &= V_{PS}(\{b\}) + V_{PS}(\{x, b\}) - V_{PS}(\{b\}) \\ &= V_{PS}(\{x, b\}) > V_{PS}(\{x\}) \\ &= u(x) + w(x; x, y, \delta) - w(x; x, y, \delta). \end{aligned}$$

Therefore, it holds. Secondly, suppose $r(x) > r(b)$ and $V_{PS}(\{x, b\}) = V_{PS}(\{x\})$. Then we need to show

$$\begin{aligned} & u(x) + w(x; x, y, \delta) \geq u(b) + w(b; x, y, \delta) \\ \Leftrightarrow \quad & V_{PS}(\{x, (1-\delta)y + \delta x\}) \geq V_{PS}(\{x, (1-\delta)y + \delta b\}) \\ \Leftrightarrow \quad & V_{PS}(\delta\{x, b\} + (1-\delta)\{x, y\}) \geq V_{PS}(\{x, (1-\delta)y + \delta b\}). \end{aligned}$$

But this is trivial from Lemma 2. Therefore, it holds. Thirdly, suppose $r(x) = r(b)$ and $V_{PS}(\{x, b\}) > V_{PS}(\{x\})$. Axiom 5 implies that, in this case, $V_{PS}(\{b\}) \geq V_{PS}(\{x, b\}) > V_{PS}(\{x\})$ must hold. Therefore, we can divide this case into two cases; $V_{PS}(\{b\}) = V_{PS}(\{x, b\}) > V_{PS}(\{x\})$ and $V_{PS}(\{b\}) > V_{PS}(\{x, b\}) > V_{PS}(\{x\})$. In either cases, we claim that, denoting $A = (1-\delta)\{x, y\} + \delta\{x, b\}$,

$$V_{PS}(A) = \min_{c' \in M_r(A)} V_{PS}(\{c', (1-\delta)y + \delta b\}). \tag{2.1}$$

By Lemma 2, there exists $c \in A$ such that $V_{PS}(A) = \min_{c' \in M_r(A)} V_{PS}(\{c, c'\})$. Suppose $c = x$. Then

$$V_{PS}(A) \leq V_{PS}(\{x\}) < (1-\delta)V_{PS}(\{x, y\}) + \delta V_{PS}(\{x, b\}) = V_{PS}(A),$$

which is a contradiction. Suppose $c = (1-\delta)y + \delta x$. Then

$$V_{PS}(A) \leq V_{PS}(\{x, (1-\delta)y + \delta x\}) < (1-\delta)V_{PS}(\{x, y\}) + \delta V_{PS}(\{x, b\}) = V_{PS}(A),$$

which is a contradiction. Suppose $c = (1-\delta)x + \delta b$. Then

$$V_{PS}(A) \leq V_{PS}(\{(1-\delta)x + \delta b, x\}) < (1-\delta)V_{PS}(\{x, y\}) + \delta V_{PS}(\{x, b\}) = V_{PS}(A),$$

which is a contradiction. Therefore, the claim holds. Let us consider the former case.

Then it suffices to show that

$$
\begin{aligned}
& w(b;x,y,\delta) \geq w(x;x,y,\delta) = 0 \\
\Leftrightarrow \quad & V_{PS}(\{x,(1-\delta)y+\delta b\}) \geq (1-\delta)V_{PS}(\{x,y\}) + \delta V_{PS}(\{b\}) \\
\Leftrightarrow \quad & V_{PS}(\{x,(1-\delta)y+\delta b\}) \geq (1-\delta)V_{PS}(\{x,y\}) + \delta V_{PS}(\{x,b\}),
\end{aligned}
$$

and this is trivial from the claim. Let us consider the latter case $V_{PS}(\{b\}) > V_{PS}(\{x,b\}) > V_{PS}(\{x\})$. We will show that

$$
V_{PS}(\{x,(1-\delta)y+\delta b\}) = (1-\delta)V_{PS}(\{x,y\}) + \delta V_{PS}(\{x,b\}).
$$

Suppose $z' = (1-\delta)x + \delta b$. Then

$$
\begin{aligned}
V_{PS}(A) &= V_{PS}(\{(1-\delta)x+\delta b,(1-\delta)y+\delta b\}) \\
&= (1-\delta)V_{PS}(\{x,y\}) + \delta V_{PS}(\{b\}) \\
&> (1-\delta)V_{PS}(\{x,y\}) + \delta V_{PS}(\{x,b\}) = V_{PS}(A),
\end{aligned}
$$

which is a contradiction. Therefore,

$$
\begin{aligned}
w(b;x,y,\delta) &= \frac{1}{\delta}V_{PS}(\{x,(1-\delta)y+\delta b\}) - \frac{1-\delta}{\delta}V_{PS}(\{x,y\}) - V_{PS}(\{b\}) \\
&= V_{PS}(\{x,b\}) - V_{PS}(\{b\}) < 0 = w(x;x,y,\delta).
\end{aligned}
$$

Hence,

$$
\begin{aligned}
u(b) + w(b;x,y,\delta) - w(x;x,y,\delta) &= u(d) + w(b;x,y,\delta) \\
&= \frac{1}{\delta}V_{PS}(\{x,(1-\delta)y+\delta b\}) - \frac{1-\delta}{\delta}V_{PS}(\{x,y\}) \\
&= V_{PS}(\{x,b\}) > V_{PS}(\{x\}) = u(x) + w(x;x,y,\delta) - w(x;x,y,\delta),
\end{aligned}
$$

and the representation holds. Fourth, suppose $r(x) = r(b)$ and $V_{PS}(\{b\}) > V_{PS}(\{x,b\}) = V_{PS}(\{x\})$. In this case, it suffices to show that

$$
\begin{aligned}
& u(x) + w(x;x,y,\delta) \geq u(d) + w(b;x,y,\delta) \\
\Leftrightarrow \quad & V_{PS}(\{x,(1-\delta)y+\delta x\}) \geq V_{PS}(\{x,(1-\delta)y+\delta b\}) \\
\Leftrightarrow \quad & V_{PS}((1-\delta)\{x,y\} + \delta\{x,b\}) \geq V_{PS}(\{x,(1-\delta)y+\delta b\}).
\end{aligned}
$$

To see this, we claim that

$$V_{PS}(A) = \max_{c \in A} V_{PS}(\{c, x\}).$$

By Lemma 2, $V_{PS}(A) = \max_{c \in A} \min_{c' \in M_r(A)} V_{PS}(\{c, c'\})$. If $c' = (1-\delta)x + \delta b$,

$$V_{PS}(\{(1-\delta)x + \delta b, (1-\delta)y + \delta b\}) \le V_{PS}(A) < V_{PS}(\{(1-\delta)x + \delta b, (1-\delta)y + \delta b\}),$$

which is a contradiction. Therefore, the claim holds and thus the representation holds. The last case is $V_{PS}(\{x, b\}) = V_{PS}(\{x\}) = V_{PS}(\{b\})$ but this case is trivial.

Proof of the Theorem: We can divide cases into two cases: (i) $V_{PS}(\{x, y\}) > V_{PS}(\{x\})$ and $r(x) > r(y)$ for some $x, y \in \Delta(Z)$.(ii) $V_{PS}(\{x, y\}) = V_{PS}(\{x\})$ for all $x, y \in \Delta(Z)$ such that $r(x) > r(y)$. However (ii) is obvious by letting u is equal to constant.

(i) Suppose $V_{PS}(\{x, y\}) > V_{PS}(\{x\})$ and $r(x) > r(y)$ for some $x, y \in \Delta(Z)$. Choose sufficiently small $\delta \in (0, 1)$ such that $V_{PS}(\{x, (1-\delta)y + \delta z\}) > V_{PS}(\{x\})$ and $r(x) > r((1-\delta)y + \delta z)$ for all $z \in \Delta(Z)$. Consider the set $A = \{a, b\}$, where a and b are in the relative interior of $\Delta(Z)$. Without loss of generality, assume $r(a) \ge r(b)$ and $V_{PS}(\{a, b\}) \ge V_{PS}(\{a\})$.[9] Since a is in the relative interior of $\Delta(Z)$, there exists $a' \in \Delta(Z)$ and $\alpha \in (0, 1)$ such that $\alpha a' + (1-\alpha)x = a$. Define $c = \alpha a' + (1-\alpha)y$. Then since

$$V_{PS}(\{a, c\}) = \alpha V_{PS}(\{a'\}) + (1-\alpha) V_{PS}(\{x, y\}) > V_{PS}(\{a\}),$$

and

$$r(a) = \alpha r(a') + (1-\alpha) r(x) > \alpha r(a') + (1-\alpha) r(y) = r(c),$$

for sufficiently small $\delta' \in (0, 1)$, $V_{PS}(\{a, (1-\delta')c + \delta' z\}) > V_{PS}(\{a\})$ and $r(a) > r((1-\delta')c + \delta' z)$ for all $z \in \Delta(Z)$. Hence by lemma6,

$$V_{PS}(\{a, b\}) = \max_{z \in \{a, b\}} \{u(z) + w(z; a, c, \delta')\} - \max_{z' \in M_r(\{a, b\})} w(z'; a, c, \delta').$$

Now let $\delta^* = \min\{\delta, \delta'\}$. Then $w(\cdot; x, y, \delta) = w(\cdot; x, y, \delta^*), w(\cdot; a, c, \delta') = w(\cdot; a, c, \delta^*)$ and

[9] In case of $r(a) > r(b)$, it is trivial. In case of $r(a) = r(b)$, $V_{PS}(\{a, b\}) \ge V_{PS}(\{a\})$ or $V_{PS}(\{a, b\}) \ge V_{PS}(\{b\})$ is true so it does not lose any generality.

$w(\cdot; a, c, \delta^*) = w(\cdot; x, y, \delta^*) + k$ from lemma5. Therefore, defining $w(\cdot; x, y, \delta) = w(\cdot)$ yields

$$V_{PS}(\{a,b\}) = \max_{z \in \{a,b\}} \{u(z) + w(z)\} - \max_{z' \in M_r(\{a,b\})} w(z').$$

Next step is to show that the above equation holds for all $a, b \in \Delta(Z)$. Let $a \in \Delta(Z)$, possibly in the boundary of $\Delta(Z)$, and let b be in the relative interior of $\Delta(Z)$. Define $\max_A\{u(\cdot) + w(\cdot)\} = W_1(A)$ and $\max_{M_r(A)} w(\cdot) = W_2(A)$. Since for $\{(1-\delta)a + \delta b, b\}$, where $\delta \in (0,1)$, we have

$$V_{PS}(\{(1-\delta)a + \delta b, b\}) = W_1(\{(1-\delta)a + \delta b, b\}) - W_2(\{(1-\delta)a + \delta b, b\})$$

which is equivalent to

$$(1-\delta)V_{PS}(\{a,b\}) + \delta V(\{b\}) = (1-\delta)W_1(\{a,b\}) + \delta W_1(\{b\}) - (1-\delta)W_2(\{a,b\}) - \delta W_2(\{b\})$$

by the linearity of V_{PS}, W_1, W_2. Letting $\delta \to 0$ yields the result. For the case where a, b are both possibly in the boundary of $\Delta(Z)$ is straightforward now. Therefore, the above equation holds for all $a, b \in \Delta(Z)$. Now, for any finite set $A \in \mathcal{A}$, we have

$$\begin{aligned} V_{PS}(A) &= \max_{a \in A} \min_{b \in M_r(A)} V_{PS}(\{a,b\}) \\ &= \max_{a \in A} \min_{b \in M_r(A)} \big[\max_{v \in \{a,b\}} \{u(v) + w(v)\} - \max_{z \in M_r(\{a,b\})} w(z) \big] \\ &= \max_{a \in A} \{u(a) + w(a)\} - \max_{b \in M_r(A)} w(b). \end{aligned}$$

Finally, we will show that the representation holds for any closed set $A \in \mathcal{A}$. To see this, let us show the following lemma.

LEMMA 6: *Let $\succsim$ be a preference relation on $\mathcal{A}$ that satisfies Axiom 2a,5. Suppose for any $A \in \mathcal{A}$, there exists a finite subset A' of A such that (i) $\max_A r = \max'_A r$ and (ii) For any finite A'' such that $A' \subset A'' \subset A$, $A'' \sim A'$. Then we have $A \sim A'$.*

Proof: Note that there exists a sequence of finite subsets $\{A_n\}_{n=1}^{\infty}$ of A such that $d_H(A_n, A) \to 0$ as $n \to \infty$ by Lemma 0 in Gul and Pesendorfer (2001). Since $A' \sim A_n \cup A'$ for all n, $A' \succsim A \cup A' = A$ by Axiom 2a. Now we will show the opposite direction:i.e. $A \succsim A'$. Since A is compact, for every $\epsilon > 0$, there are finite $x_1, \cdots, x_n \in A$ such that $A \subset \cup_{i=1}^{n} N(x_i, \epsilon)$. Suppose $(B \cup \overline{N(x_i, \epsilon)}) \cap A \succ A$ for all $i = 1, \cdots, n$. Then by iteratively applying Axiom 5 yields $A = \cup_{i=1}^{n}\{(A' \cup \overline{N(x_i,\epsilon)}) \cap A\} \succ A$ which is a contradiction. Therefore, $A \gtrsim (A' \cup \overline{N(x_i,\epsilon)}) \cap A$ for some i. Now, let $\{x_n\}_{n=1}^{\infty}$ be a sequence in A such that $A \gtrsim (A' \cup \overline{N(x_n,\frac{1}{n})}) \cap A$ for all $n = 1,2,\cdots$. Since A is compact, there exists a subsequence $\{x_{n_k}\}_{k=1}^{\infty}$ such that $x_{n_k} \to x^* \in A$. Then letting $k \to \infty$ yields $A \gtrsim A' \cup \{x^*\} \sim A'$ by Axiom 2a. *Q.E.D.*

Proof of the Theorem cont: Let $A \in \mathcal{A}$ be an arbitrary closed set. Let $x^* \in \arg\max_A u(x)$ and $y^* \in \arg\max_{M_r(A)} w(y)$. Put $B = \{x^*, y^*\}$. What to be shown is that $V_{PS}(A) = V_{PS}(B)$. From above discussion, $V_{PS}(B) = V_{PS}(C)$ for all $B \subset C \subset A$ where C is finite. Then by lemma7, we have $V_{PS}(A) = V_{PS}(B)$.

Q.E.D.

2.5.2 Proof of Theorem 2

Proof: (ii) implies (i) is trivial. Let us show that (i) implies (ii). Let us denote the functions that represent $\gtrsim$ using (u,w) and (u',w') by V_{PS} and V'_{PS} respectively. Since V_{PS} is unique up to affine transformation, $u'(x) = V'_{PS}(\{x\}) = \alpha V_{PS}(\{x\}) + \beta_u = \alpha u(x) + \beta_u$ for some $\alpha > 0$ and $\beta_u \in R$. Since $\gtrsim$ feels pride or shame at some $C \in \mathcal{A}$, there exists $a, b \in C$ such that $\{a,b\} \succ \{a\}$ and $r(a) > r(b)$. Now, for sufficiently small $\delta \in (0,1)$ we have

$$\begin{aligned}
u'(z) + w'(z) - w'(a) &= \frac{1}{\delta}V'_{PS}(\{a,(1-\delta)b+\delta z\}) - \frac{1-\delta}{\delta}V'_{PS}(\{a,b\}) \\
&= \frac{1}{\delta}[\alpha V_{PS}(\{a,(1-\delta)b+\delta z\}) + \beta_u] - \frac{1-\delta}{\delta}[\alpha V_{PS}(\{a,b\}) + \beta_u] \\
&= \alpha\left[\frac{1}{\delta}V_{PS}(\{a,(1-\delta)b+\delta z\}) - \frac{1-\delta}{\delta}V_{PS}(\{a,b\})\right] + \beta_u \\
&= \alpha\{u(z) + w(z) - w(a)\} + \beta_u.
\end{aligned}$$

Since $u'(z) = \alpha u(z) + \beta_u$, $w'(z) = \alpha w(z) - \alpha w(a) + w'(a)$. Then letting $\beta_w = -\alpha w(a) + w'(a)$ yields the result. *Q.E.D.*

Chapter 3

Competitiveness, Risk Attitudes, and the Gender Gap in Math Achievement

Over the last century, there have been substantial improvements in the educational outcomes of female students and they are now attaining higher education at rates similar to or higher than male students in many developed countries (Goldin, Katz, and Kuziemko, 2006). Despite this, we still observe girls performing worse than boys on standardized math examinations. For example, the 2015 Program for International Student Assessment (PISA) finds that boys outperform girls in math by 8 score points on average across OECD countries; Boy's advantage at the mean is statistically significant in 28 countries and economies that participated in PISA (OECD, 2017).

This gender gap in math test scores has gotten particular attention in economics for at least two reasons. First of all, in contrast to other subjects such as reading, math performance and preparation serve as a good predictor of future labor market outcomes (e.g., Paglin and Rufolo, 1990; Grogger and Eide, 1995; Altonji and Blank, 1999; Weinberger, 1999, 2001; Murnane et al. 2000; Joensen and Nielsen, 2009, 2016). In particular, Joensen and Nielsen (2009, 2016) exploit an institutional reduction in the costs of acquiring advanced high school math in Denmark and provide evidence that choice of a more math-intensive high school specialization has a causal effect on future labor market earnings. Secondly, it is also thought that mathematical proficiency does not just benefit individuals but also is considered crucial to drive economic growth and create innovation (Hanushek and Kimko, 2000; Jamison, Jamison, and Hanushek, 2007).

The objective of this study is to investigate how gender-linked behavioral traits such as competitiveness and risk attitudes are related to math achievement test scores among middle school students in Japan, and examine to what extent the gender gap in math test scores is attributable to gender differences in competitiveness and risk attitudes. There is a broad consensus in the experimental literature that women, on average, are less competitive (e.g., Gneezy, Niederle, and Rustichini, 2003; Niederle and Vesterlund, 2007) and exhibit greater risk aversion (e.g., Eckel and Grossman, 2002, 2008) than men. These two noncognitive behavioral traits maybe important in the production of cognitive achievements. As Heckman (2006) argues, noncognitive traits could cause people to endogenously create environments during childhood that foster faster cognitive development.

As for competitiveness, for example, students who are more competitive may compete for school performances with their peers and improve their cognitive achievements through academic competitions (Gneezy, Niederle, and Rustichini, 2003). In particular, Niederle and Vesterlund (2010) argue that math may be seen as a competitive discipline. Math answers are either right or wrong, thus in contrast to other subjects such as reading, math test scores may predict actual rank as well as future relative earnings. Given the gender differences in response to competitions, Niederle and Vesterlund (2010) suggest that the competitive nature of math does not just affect the investment decisions but also the individual's test score performance in math that may magnify gender differences in math skills. Despite their insightful hypothesis to explain the gender gap in math test scores, the hypothesis is left uninvestigated so far in the literature. The present study attempt to test this hypothesis and this is the first contribution to the literature.

Risk attitudes has been also actively studied its relation to educational investment since the theoretical work by Lehvari and Weiss (1974). If the returns to education are uncertain, risk averse students may lower educational investment which results in lower achievement. On the other hand, if education has an insurance character, risk averse students may be eager to attain higher educational achievement. While previous studies have investigated these mechanisms in the situations of schooling decisions (e.g., Belzil and Leonardi, 2007, 2013; Checchi, Fiorio, and Leonardi, 2014), the mechanisms can also apply to the situations that students allocate their effort into each subject. For example, given that math skills have a higher return in labor market relative to other subjects, risk averse students may allocate more effort in doing math. On the other hand, as mentioned and studied in Buser, Niederle and Oosterbeek (2014), STEM career which requires the math skills can be a risky career choice because math is a competitive subjects. If students drop out due to losing their understanding of math halfway, the door on their career should be shut. Even if they complete the school curriculum, the bad math grade bring them into unfavorable academic careers and further career paths in the future. Consequently, studying math toward STEM career requires effort involving the risks of losing in the competition. Indeed, Buser, Niederle, and Oosterbeek (2014) observed greater risk aversion is associated with lower entering in STEM careers. If the objective of studying math is for the preparation for the entry of STEM career, risk averse students maybe reluctant to do so. The direction of students' risk attitudes toward math achievement is thus ambiguous whether it is positive or negative. As such, while the economists can easily expect the existence of this relationship between risk attitudes and educational performance, this issue has been relatively unexplored in the formal analyses. We here tackle this research agenda which is our second contribution to the literature.

To this end, we conduct an incentivized experiment at six public middle schools in Japan to collect measures of competitiveness and risk attitudes and merge them with an administrative dataset containing information on students' cognitive achievements. We find that, as hypothesized by Niederle and Vesterlund (2010), competitiveness is positively associated with math achievement test scores conditional on students' prior achievements and demographics. Regarding risk attitudes, we find that greater risk aversion is associated with higher math achievement. Since girls are less competitive and exhibit greater risk aversion compared to boys, the results indicate that the gender differences in competitiveness are widening the gender gap in math achievement, but that the gender differences in risk attitudes contribute to narrowing it.

This chapter is related to several strands of the literature. First, our study is related to the empirical literature of the production of cognitive achievements (e.g., Todd and Wolpin, 2003, 2007; Cunha and Heckman, 2008). In particular, Cunha and Heckman (2008) construct a dynamic structural model in which cognitive and noncognitive skills evolve jointly and estimate its production function parameters. Even though our approach in this chapter is not structural, the study examines how noncognitive skills such as competitiveness and risk attitudes are related to the production of cognitive skills. To the best of our knowledge, this is the first study which tackles such a question.

Second, the study adds to the growing literature of behavioral economics of education (e.g., Koch, Nafziger, and Nielsen, 2014; Lavecchia, Liu, and Oreopoulos, 2016). Especially, recent literature accumulates mounting evidence showing that competitiveness is predictive of educational outcomes outside the lab. Buser, Niederle, and Oosterbeek (2014) investigate whether competitiveness explains academic track choice of middle school students in the Netherlands. They find that competitiveness predicts the choice of math-heavy specializations in high school and the gender gap in specializations is largely accounted for (about 20%) by the gender differences in competitiveness. For high school students, Almas et al. (2016) show that competitiveness correlates with choosing the college track in Norway and Buser, Peter, and Wolter (2017) show that competitiveness can explain a significant portion of the gender gap in math-intensive specialization choices in Switzerland. Similarly, Zhang (2013) provides evidence that students who are more inclined to compete are more likely to take a competitive entrance exam for high school in China. Aside from educational choices, recent evidence suggests that competitiveness is predictive of other outcomes such as earnings and investment behavior.[1] In contrast to this literature, our focus is on cognitive achievements, especially math, rather than the educational choices such as academic track choice. As Niederle and Vesterlund (2010) first hypothesized, we will see that competitiveness is positively associated with math achievement, explaining part of the gender gap in math.

Starting from a theoretical work by Lehvari and Weiss (1974), the relationship between risk attitudes and educational outcomes is a long-standing area of active research in economics. Traditional view is that risk aversion is inversely associated with educational outcomes since uncertainty in returns to education depresses educational investment (e.g., Belzil and Leonardi, 2007, 2013; Checchi, Fiorio, and Leonardi, 2014). Recent literature in experimental economics complements this view. In Buser, Niederle, and Oosterbeek (2014), the authors find that risk attitudes itself is predictive of academic track choices. They report that the more risk averse students are less likely to choose more math-heavy specializations in high school and about 16% of the gender gap in track choices can be explained by the gender differences in risk attitudes. Tannenbaum (2012) analyzes a data sample from the Fall 2001 math SAT and finds that women skip significantly more questions than men. He attributes this difference primarily to gender differences in risk aversion since, in SAT, students are penalized for incorrect answers but not for leaving questions blank. He argues that the gender gap in questions skipped can explain up to 40% of the gender gap in SAT scores. Sim-

[1]Reuben, Sapienza, and Zingales (2015) link the starting salary and industry choice of MBA students and find that competitive individuals earn 9 % more than their less competitive peers. Furthermore, they find that gender differences in tournament entry account for about 10 % of the gender gap in earnings. Berge et al. (2015) show that competitiveness predicts investment choices of entrepreneurs in Tanzania.

ilarly, using an experiment, Baldiga (2013) finds that women answered significantly fewer questions than men when the wrong answer was penalized, but not when there was no penalty. In contrast to the literature which supports the view that risk aversion is negatively related to educational outcomes, we show that risk aversion is positively related to math achievements.

Finally, the study adds to the literature on the gender gap in math. A wide range of theories has been proposed to explain the gender gap in math. These theories can be classified into two broad categories. On on hand, scientists find the source of the gender gap in math in biological innate differences. The studies raised differences in spatial ability, hormone levels, and brain composition and development as the factors causing the gender gap (Davison and Susman 2001; Gallagher and Kaufman, 2005; Kucian et al. 2005; Lawton and Hatcher 2005). On the other hand, recent studies emphasize the importance of societal factors such as differential treatment by parents and teachers, stereotypical threats, etc (Guiso et al. 2008; Fryer and Levitt, 2010; Nollenberger, Rodriguez-Planas, and Sevilla, 2016; Carlana, 2019).

Obviously, figuring out whether the gender math gap is biological or societal is important since these two imply different policy implications. However, our aim of this chapter is not to contribute to that discussion. Rather, we address the validity of the argument that encourages women to "lean-in" (Sandberg, 2013): women should be more competitive and take on more risks.[2] Our results suggest that, at least from the viewpoint of the gender gap in math achievement, encouraging girls to become more risk tolerant may backfire leading to the loss of an advantage of girls in the production of math achievement while encouraging them to be more competitive can lead to their higher performance in math. Given our findings, we might be tempted to design a policy that enhances girls' competitiveness but leaving the risk attitudes unchanged to close the gender math gap. However, we do not know how to target a single trait to change with an intervention. Further, previous literature suggests that risk taking is associated with positive economic outcomes in other contexts (e.g., Tannenbaum, 2012; Baldiga, 2013; Buser, Niederle, and Oosterbeek, 2014). Therefore, effects of policies aiming to change women's attitudes are ambiguous and may result in unexpected and unwanted conclusions. Thus, we argue that designing institutions to address the gender gap is more promising than policies that are designed to change the way women behave (Niederle and Yestrumskas, 2008; Bohnet, 2016).

[2]We are inspired by the discussion of Shurchkov and Eckel (2018) on this part. A related question is whether women should "lean-in" to negotiate more (e.g., Exley, Niederle, and Vesterlund, 2016).

The remainder of the chapter unfolds as follows. Section 2 describes the data collection and experimental procedures. Section 3 presents benchmark analysis. We first demonstrate that there is a significant gender gap in math conditional on prior achievements. We then see that there are significant gender differences in experimental measures such as competitiveness, confidence, and risk attitudes and asses to what extent gender differences in competitiveness can be attributed to gender differences in confidence and risk attitudes. In Section 4, we examine whether competitiveness and risk attitudes correlate with math achievement. We also provide subsample analysis by gender and the regression results of reading and English achievements. Section 5 concludes.

3.1 Background and Data Collection

We invited 8th-grade students of all 6 public middle schools within the same city of an anonymous prefecture. Schools are geographically located within 12 km radius. Approximately two months prior to the experiment (Feb 2 through 13, 2017), the authors directly visited all schools and explained the schedule, setting, and financial incentive of the experiment in detail. Students were distributed a letter about details of the experiment to families and a parental consent form, and were required to return a signed consent form by about two weeks.[3]

After all, we received 848 students' parental consent forms (out of a possible 1080) and finally 811 students (389 male, 422 female) from 30 classes participated in our experiment, which were accounted for 75% out of the entire 8th-grade students.[4] To prevent the detailed information on the experiments from spreading to other schools, we set up the experiments and collected data within three consecutive days, March 21, 22, and 23, 2017.

Students who participated in the experiment received, on average, 1,022JPY (=10USD),

[3]However, the students were not informed on the specific task of the experiment at that time to prevent students from self-selecting into the participation in experiments, based on their favorite tasks. The parental consent form included the same information given to the students. Teachers, except for the principle, were not fully informed about the experiments to make sure students did not find out about the purpose of this experiment.

[4]According to the official statistics, the total numbers of 8th-grade students at the beginning of 2016 academic semester was 1108. However, we excluded 28 students from this calculation who (i) students who were absent on the day of the standardized exam; (ii) students who transferred from/to other schools after the day of the standardized exam; and (iii) students who belonged to special education classrooms.

with minimum of 500JPY (=5USD) and maximum of 3,400JPY (=34USD), including a fixed participation fee, 500JPY (=5USD). It should be noted that, due to administrative and educational reasons, students were paid by the combination of bookstore gift cards and regular gift cards (called "QUO card" which can be used in many stores, such as convenience stores, drugstores, restaurants, and gas stations, etc). Although students were informed that they were paid with gift cards in advance, they left uninformed of how much they were paid with bookstore gift cards or how much regular gift cards. Since either gift cards can be easily cashed at a cash voucher shop or anywhere, it is unlikely that paying in gift cards, not cash, will cause a potential problem for our results. These gift cards were mailed to each student three months after the experiments, although it was later than the initial schedule (one month after the experiment) due to the unexpected accident on the postage.

3.1.1 Experiment

Each day on March 21, 22 and 23, 2017, the experiment was conducted after school and it took about an hour. Students were randomly assigned to 44 classrooms in 6 schools, ranging in size from 11 to 28 of them each. To prevent copying the answers from neighbors, students were asked to sit in every other seat in the classroom. We, with assistance of two Research Assistants (RAs) per classroom, administered the experiment for about 60 minutes, including the short survey. To see how experimental environments affect individual decision makings, we used a between-subjects 2 × 2 design and randomly manipulate environments in the classrooms.[5] The environments differed in the visibility of the choices (private vs public), and the experimental peer groups (same-sex vs mixed gender), as explained below.

The visibility of the choices. We randomly assigned students to choose their choices in the experiment in "public" situations or in "private" situations. In the public treatment, students were announced that their choices during the experiment would be made public to the students who were participating in the experiment in the same room by our research assistants at the end of the experiment. In the private treatment, the choices would be kept private throughout the experiment as in the standard literature.

The experimental peer groups. We randomly assigned students to participate in the experiment with same-sex peer groups or mixed-sex peer groups. This treatment concerns the gender composition in the room where the experiments take place.

[5] We stratified students by school and gender.

Students were randomly assigned a room either with same-sex peers or with mixed-sex peers.

These treatments are designed to see how social image concerns (Bursztyn, Fujiwara, and Parrais, 2017; Buser, Ranehill, and Veldhuizen, 2017; Yagasaki, 2019) as well as the presence of opposite sex peers (Boschini, Muren and Persson, 2012) affect economic decision making among middle school students. Eventually, however, we see no statistically significant impacts across any treatments.[6] This suggests that our experimental measures such as competitiveness and risk attitudes are robust to these treatments, enabling us to pool the samples in the following analysis.

The experiment basically follows the standard design of Niederle and Vesterlund (2007). The students were informed that they would earn points during the experiment, which were paid as the reward in addition to the fixed participation fee. One point earned in the experiment was converted into 1JPY in the gift cards mentioned above. The experiment consisted of five rounds, one of which was randomly selected for payment. In the first three rounds, participants were asked to solve as many mazes as possible in three minutes. Mazes was chosen as a task because an addition task (Niederle and Vesterlund, 2007; Buser, Niederle, and Oosterbeek, 2014), a natural task for investigating the link between competitiveness and math achievement, was unavailable for administrative reasons. Thus, we choose mazes since it is stereotypically male tasks as math is. The experiment was conducted using paper and pencil. An example of a maze is shown in Figure 1.

The incentive structure of each round is laid out below.

Round 1: Piece Rate. Students would receive 50 points for each maze correctly solved.

Round 2: Compulsory Tournament. Students were randomly divided into groups of three, and a student who solved the maze most among the three can obtain 150 points per each but the remaining two could not get any points at all. Students were not informed about who they were assigned into the same group as themselves throughout the experiment. If the number of mazes solved were tied at the first place, the winner were chosen randomly.

[6] Detailed analysis of this part is under preparation and available upon request.

Round 3: Choice. Students were asked to choose either piece rate or tournament before performing task. If they were to choose piece rate, they would get 50 points per maze solved correctly. If they were to choose tournament, they would get 150 points per maze solved correctly if there score exceeded that of remaining two of the group members in round 2, otherwise they would receive no payment. In case of ties the winner were chosen randomly.

Round 4: Submitting Piece Rate Performance. No maze task was performed here. Students were asked to choose either piece rate or tournament to apply their round 1 piece rate performance. If they were to choose piece rate, they would receive the same payment as they did in round 1. If they were to choose tournament, they would get 150 points per maze if there round 1 score exceeded that of remaining two of the group members in round 2, otherwise they would receive no payment. In case of ties the winner were chosen randomly.

Round 5: Lottery. Students were asked to pick one option among a sure payoff of 400 points and five 50/50 lotteries: 500 or 350, 600 or 300, 700 or 250, 800 or 200 and 900 or 100 (points). (See Table 3.1.) For lotteries 1-5, the expected payoff increases linearly with risk, as represented by the standard deviation. Note that lottery 6 has the same expected payoff as lottery 5 but with a higher standard deviation. These lotteries are designed so that higher number of the choice of a lottery implies greater preference for risks.[7] The outcome of the lottery was determined by flipping a coin at the end of the experiment if this round was randomly chosen for compensation.

In rounds 3, 4 and 5, students in the public treatment were announced that the choice of that round would be made public to the peers in the same room, if it was randomly chosen for compensation, at the end of the experiment. Finally, students answered a detailed questionnaire including questions on demographics such as family patterns, parental employment status, number of siblings and psychological attributes such as confidence, self-assessed risk attitudes etc. Measures of confidence were elicited by asking students to guess their relative rank in round 1 and round 2 performances of

[7]The last column in Table 3.1 represents implied CRRA range corresponding to each chosen lotteries. The intervals are determined by assuming $u(x) = x^{1-r}$ and calculating the value of r that would make the individual indifferent between the lottery s/he chose and the two adjacent lotteries. Theoretically, individuals with $r > 0$ can be classified as risk averse, $r < 0$ as risk loving and $r = 0$ as risk neutral.

their group of three. If their guesses were correct, they receive 50 points for each.

Self-assessed risk attitudes were asked using the same general risk question asked in GSOEP:

"Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?"

Students circle a box ranging from 0 ("unwilling to take risks") to 10 ("fully prepared to take risks"). As advocated by Dohmen et al. (2011), this question has an advantage to capture the general risk attitudes compared to the one only targeting the situation of risks in a specific context. Indeed, this question has been shown to predict risk taking behavior across different domains (e.g., Bonin et al., 2007; Jaeger et al., 2010; Dohmen et al., 2011; Lonnqvist et al., 2015). The question has the advantage of being easy to understand, thus mitigating the problem of decision errors or noise (Andersson et al. 2016).

3.1.2 Administrative Data

A few months after the experiment, we obtained several administrative data from the local government and matched with the data collected through the experiment.

Firstly, we are allowed to access standardized test scores that the local government of the anonymous prefecture administered every academic year. The standardized test, which started from 2015, was constructed as panel data, tracking down the same students over time. Students took the standardized tests in the second week of April in each of the study years since April is the beginning of the academic year in Japan. An important feature of the standardized test is employing the Item Response Theory (IRT) in estimating students' cognitive achievements more precisely (for details, see Embreston and Reise, 2000). Contrary to the Classical Test Theory (CCT), the IRT is successful to separate the difficulty level of problems on the test from the difference in students' cognitive achievement. In addition, achievement estimates of IRT at different times are mapped in a common scale so that the IRT scores of the same student are comparable across different time periods. An important drawback of IRT, however, is that if a student gets either zero or perfect test score, an achievement estimate of IRT diverges to negative of positive infinity. Consequently, for these two cases, IRT fails to yield an achievement estimate and the data is coded as some symbol to indicate what has happened. We will explain how we cope with this problem later.

Secondly, we obtain the information on students' demographics and current educational inputs by the following three ways. One, as mentioned, there are some information on demographics such as family patterns, parental employment status and the number of siblings in the questionnaire collected during the experiment. Two, in administering the standardized tests, the local government ask students to answer a series of questionnaires. These questionnaires include students' information on age in months, cram school attendance etc. The questionnaires also include various information on students' noncognitive traits which we will use in section 3.4. Three, we access the administrative data that the local government of the city collected every year, such as whether students' guardians receives public assistances and the subsidies for school lunch and school supplies, both of which are the proxy of socioeconomic status (SES) of students' family.

3.2 Descriptive Analysis

In this section, we describe basic characteristics of the students who participated in the experiment. Descriptive statistics of variables we use in our main analysis are displayed by gender in Table 3.2. To keep the sample constant, we had to drop 49 students because at least one of these key variables are missing for those students. This leaves us with a sample of 762 students (358 boys, 404 girls). Here, as we mentioned, IRT scores are 'missing' for students who took perfect points in standardized tests. Although we calculate the summary statics dropping these students, they are included in the following analyses.

We cope with this problem as follows. First, we use 9-th grade IRT scores directly as dependent variables in the following analysis. We deal with the problem of missing IRT scores of students who did perfect in the standardized test by estimating Tobit model censored at the second highest score where we obtain exact IRT estimates of achievement levels. Secondly, as for the 8th-grade achievement levels that are used as control variables, we assign numbers, beginning with 1, on 8th-grade IRT scores based on their ordinal rank in an ascending order. We then standardize them to have mean zero and a standard deviation of 1 as well as other non-binary control variables that are used in our analysis to facilitate the comparison of the magnitude of the coefficients of different variables.

3.2.1 The Gender Gap in Math Achievement

Even though our primary focus is on math test score, it is useful to see test scores on reading and English by gender as well. It is widely known that girls traditionally exceeds boys in overall middle school performance. Indeed, as displayed in Table 3.2, in both 8-th grade and 9-th grade, girls are outperforming boys in reading and English. As suggested by Goldin, Katz, and Kuziemko (2006), this maybe due to the later maturation of boys. However, even though the difference is not statistically significant, we see that girls are not performing better than boys in math for both 8-th grade and 9-th grade as reported in Table 3.2.

In order to understand the gender effects on achievements more precisely, we estimate regression models. Table 3.3 reports the results of Tobit regressions using 9-th grade IRT scores of each subject as dependent variables. As described above, we use Tobit model to account for the censoring issue due to the use of IRT. We include school fixed effects for all specifications.

Again, columns (1) to (3) show that girls are on average better at reading and English compared to boys, whereas boys are on average better at math than girls. Columns (4) to (6) additionally include cognitive achievements in the previous year.[8] The estimated coefficient of the female dummy in column (4) is negative and significant at the 1% level, implying that boys are likely to achieve greater improvement in math than girls. Given the growth in math of a typical student is about .5 as displayed in Table 3.2, the coefficient on female dummy variable (.148) amounts to roughly 30% of one year growth in math of a typical student. The statistical significance of female coefficients of reading and English disappear after controlling prior achievements as shown in column (5) and (6).

In addition to prior achievements, Column (7) to (9) adds students' demographic variables, which deemed to affect student achievements and are often controlled in standard education production functions (see Todd and Wolpin, 2003, 2007). One of the variables that represent family wealth is a dummy variable that takes one if a students' parents receives either public assistances, or the subsidy for school lunch and school supplies, zero otherwise. Moreover, we also control for family patterns and parental employment status. Family patterns are classified into three types of household; (i)

[8]The specifications include lagged achievements not only in math but also in reading and English. If students allocate their resources, such as time and concentration, to maximize the overall cognitive achievements, not a performance for a particular subject, it is more convincing to control for the prior own achievement outcomes in reading and English as well as math.

nuclear family (i.e. a couple and a child(ren)), (ii) single parent and a child(ren) and (iii) other. Parental employment status is expressed as a series of dummy variables that correspond to information on who are engaged on a job in household (father, mother, both, or other). An important control, which could be regarded as a current input measure, is the dummy variable taking one if a student attends for-profit private cram schools outside of formal education, making very important role for students to prepare for the entrance examination of high schools, zero otherwise. Further, widely known determinants of student achievements, the number of siblings and student's age in month are also included in our estimation.

According to columns (7) to (9), the coefficients are quantitatively and qualitatively similar even after controlling for these variables. In the following empirical analysis, we investigate what factors lie behind the gender gap in math achievement observed in column (7) in Table 3.3.

3.2.2 The Gender Differences in Experimental Measures

Table 3.2 reports average choices and performance in the experiment by gender. Consistent to most of the literature, we find that boys are significantly more likely to enter the tournament than girls are. In our sample, boys are approximately 18 percentage points more likely to choose tournament in round 3 (see Figure 3.2). For round 4, boys are 9 percentage points more likely to choose tournament. We also find that boys are on average better in performing mazes in both round 1 and round 2 and the differences are statistically significant.

Confidence and risk attitudes also follow the previous literature. We find that boys are more confident about their relative performance in both round 1 and round 2. In addition, boys choose more risky lotteries in round 5 and report themselves as "prepared to take risks" on the general risk question than girls. Figure 3.3 and Figure 3.4 graphically show the gender differences in risk attitudes. For confidence, in Table 3.2 we see that both boys and girls guess their relative performance to be higher when it comes to round 2. This may reflect the effect of learning between rounds 1 and 2. For risk attitudes, Table 3.2 shows that boys choose a more risky lottery than girls on average than girls do and the difference is statistically significant. The correlations between the lottery choice and the score of the general risk question were 0.494 for boys ($p < 0.01$)and 0.418 ($p < 0.01$) for girls.

In summary, our sample exhibit the standard patterns of gender differences that are observed in most of the literature. However, it is not clear to what extent the gender differences in tournament entry is attributable to the gender differences in performance, confidence and risk attitudes in our sample. Therefore, we move on to the regression analysis in the next analysis.

Table 3.4 reports the results of Probit regressions of tournament entry in round 3. All specifications include school fixed effects. Column (1) shows that girls are 17.7 percentage points less likely to enter the tournament than boys, when only controlling for school fixed effects. Column (2) shows that adding performance in round 2, the difference in performance between rounds 1 and 2, and 8th-grade cognitive achievements reduce the gender effect by 3.3 percentage points (compare columns (1) and (2)). The reduction is as expected, given the gender differences in the number of mazes correctly solved in our sample.

In column (3), we add the guessed ranks of rounds 1 and 2 as measures of confidence. We see that adding confidence measures reduces the gender coefficient slightly from 14.4 to 12.8 percentage points. On the other hand, we see a substantial drop in the gender effect when we add the choice of lottery which is a measure of risk attitudes. Comparing columns (3) and (4), adding both lottery choice in round 5 and the responses to general risk question reduce the coefficient of female dummy dramatically by 6.8 percentage points (from 12.8 to 6.0 percentage points). Finally in column (5) and (6) we include the dummy of round 4 choice of tournament entry, hereinafter called "submitting the PR", to control other possible factors that influence tournament entry such as feedback aversion. Although submitting the PR significantly predicts tournament entry in round 3, we see almost no effect on the gender effect. Column (6) adds individual controls. Individual controls include dummies of low socioeconomic status, dummies of family patterns, dummies of parental employment status, cram school attendance, age in months and the number of siblings. Controlling all variables leaves 5.7 percentage points gender gap in tournament entry which is statistically significant at a 10% level.

Overall, the middle school students in our sample exhibit significant gender differences in competitiveness but the point estimate of the gender effect is small (about 6 percentage points) after controlling performance, confidence and risk attitudes. In particular, we see measures of confidence do not have a large impact on the gender gap in tournament entry, whereas the risk attitudes do eliminate substantial portion of the gender effect. This is in contrast with the literature such as Niederle and Vesterlund (2007) and Buser, Niederle, and Oosterbeek (2014) in which authors conclude that significant amount of the gender differences in tournament entry is driven by the gender difference in confidence, whereas the risk attitudes do not have a large impact on the gender differences in tournament entry once controlling for confidence.[9] On the other hand, the results are in line with, for example, Gillen, Snowberg, and Yariv (2019) in which authors argue that differences in risk attitudes, rather than (over)confidence, account for the gender gap in their study.

3.3 Main Results

This section reports our main results of this chapter. In Table 3.5, we estimate different specifications of Tobit model with 9th-grade IRT math score as the dependent variable.[10] All specifications include 8th-grade cognitive achievements (math, reading and English), performance in round 2 of the experiment, the difference in performance between rounds 1 and 2, guessed ranks of rounds 1 and 2, submitting the PR, school fixed effects, and the same set of individual controls as in the previous analysis.

Column (1) shows that girls' math achievement is on average significantly lower than that of boys conditional on prior cognitive achievements as well as on control variables described above. In columns (2) to (8), we add measures of competitiveness or (and) risk attitudes. In addition to two measures of risk attitudes, we use a single combined measure of risk attitudes, which we call "average risk-taking score" and is constructed by averaging the two standardized measures of risk attitudes and then standardizing the resulting average.[11] The aim of using this measure is to mitigate the measurement error problem that is said to have a serious problem in the recent literature (e.g., Castillo, Jordan, and Petrie, 2018; Gillen, Snowberg, and Yariv, 2019; van Veldhuizen, 2018) and to make interpretation easier. Indeed, the predictability of this variable is very strong as depicted in the Table 3.5. Note also that the female coefficient remains negative and significant even after controlling additional experimental measures. The magnitude of the coefficients, however, varies across specifications, clarifying which factor narrows and widens the gender gap in math achievement.

In columns (2) to (5), we estimate the model by adding either measures of competitiveness or risk attitudes. Column (2) reports the result when we add the tournament entry dummy. The coefficient on the tournament entry dummy is positive and sta-

[9] See Niederle and Vesterlund (2011) for a survey on this line.

[10] The results are not sensitive to the normality assumption imposed on Tobit model. As a robustness check, we also implement other estimation methods such as OLS by dropping censored data and censored LAD estimator developed in Powell (1984). The results do not change qualitatively.

[11] This is equivalent in doing principal-component analysis using two measures.

tistically significant at 10% level, implying that the tournament entry is positively associated with math achievement. Columns (3) to (5) report the results of risk attitudes. All estimated coefficients in columns (3) to (5) are negative and statistically significant, which suggests that greater risk aversion is associated with higher math achievement, and quantitatively similar across different measures. Recalling the gender gap in tournament entry in round 3 is largely driven by risk attitudes in our sample, it is noteworthy that the estimated coefficients of tournament entry and risk attitudes point in the opposite directions. The results provide an evidence that entering tournament in round 3 is capturing individual trait that is different from risk attitudes.

Even though the estimated results in columns (2) to (5) show the statistically significant impacts of tournament entry and risk attitudes on math achievement, coefficients should be subject to omitted variable bias. As we have discussed in the previous section, risk tolerance and entering the tournament in round 3 are positively correlated, and the tournament entry decision (risk tolerance) is positively (negatively) correlated with math achievement. Therefore, the coefficients of the tournament entry dummy and the measures of risk attitudes in columns (2) to (5) should be biased toward zero.

Columns (6) to (8) show the results when we control both the tournament entry dummy and the measures of risk attitudes. As we have expected, the coefficients on the tournament entry dummy and the measures of risk attitudes increase in an absolute sense, which led to an increase in statistical significance. The results show that the tournament entry in round 3 is positively associated with math achievement and the impacts are statistically significant at 5% level in columns (6), (7) and at 1% level in column (8). The magnitudes of the coefficients are substantial for two reasons. First of all, since the average growth in IRT math score between 8-th and 9-th grade academic year is about .5 (see Table 3.2), the coefficients on the tournament entry dummy (.132 to .161) amount to roughly 25 to 30% of one-year growth in math of a typical student. Secondly, comparing the coefficients on the female and the tournament entry dummies, we see that the magnitudes of the tournament entry are similar or slightly larger than that of being female.

For risk attitudes, the effects are also substantial. Column (6) reports that a one standard deviation increase in the choice of lottery (about 1.8 increase in the number of chosen lottery) results in .064 decrease in IRT math score (about 12% of average one-year growth) and the coefficient is statistically significant at 5% level. Similarly, column (7) shows that a one standard deviation increase in the response to the general risk question (about 2.26 increase in the reported score of the general risk question) results in .077 decrease in IRT math score (about 15% of average on-year growth) and the coefficient is statistically significant at 1% level. The estimated result using the average risk-taking score in column (8) is even larger and statistically significant at 1% level. In all subsequent regressions we use the average risk-taking score as explanatory variables.

In Table 3.6, we explore the relationship of tournament entry and risk attitudes to achievements across subjects and gender. For math, columns (2) and (3) show the effects are qualitatively similar across gender in the way that the tournament entry is associated with higher math achievement whereas the risk tolerance is associated with lower achievement. We see that the effects of girls are slightly bigger than that of boys, even though the differences are not statistically significant. Columns (4) and (7) show that tournament entry decision is not significantly related to reading and English achievement test scores using full samples. However, we generally see that being competitive is at least not harmful for achievements. In particular, column (6) shows that the tournament entry is positively associated with higher achievement in reading for girls and the relationship is significant. For risk attitudes, we generally see that greater risk aversion is associated with higher achievements. Using full samples, we see the statistically significant relationship between risk aversion and higher achievement in reading. For boys, we see that this significant relationship holds for both reading and English.

Therefore, regarding the relationship between achievement test scores and two behavioral traits, some basic patterns emerge across all subjects and gender: (i) competitiveness is positively or at least not negatively associated with achievement test scores, (ii) risk aversion tend to be related to higher achievement test scores. Math is, however, special among subjects because its performance is strongly correlated with competitiveness and risk attitudes. Specifically, as one can see in column (1) of Table 3.6, math is the only subject that competitiveness significantly predicts achievement in overall samples. In addition, comparing coefficients of risk attitudes, the effect on math is generally stronger than those of reading and English.

We finally assess the impacts of including the tournament entry dummy and the measures of risk attitudes on the gender gap in math achievement. As in Buser, Niederle, and Oosterbeek (2014), we bootstrapped changes in the gender coefficient of Table 3.5 upon adding the tournament entry dummy. The results are reported in Panel A of Table 3.7. Pairwise comparisons between columns show that the reductions in the female coefficient by including the tournament entry dummy are statistically significant at 5% level. The results show that the gender differences in competitiveness account for 6.1% to 11.3% of the (remaining) gender gap in math achievement. In other words, the gender differences in competitiveness is widening the gender gap in math achievement. On the other hand, the impacts of adding risk attitudes on the female coefficient are reported in Panel B of Table 3.7. Since girls are more likely to be risk averse and greater risk aversion is associated with higher math achievements, controlling risk attitudes increases, in absolute sense, the female coefficient by 16.5% to 35.2%. The magnitudes are statistically significant at 5% level for all specifications. This means that the gender differences in risk attitudes contribute to narrowing the gender gap in math achievements.

Finally, we investigate the relative impacts of controlling competitiveness and risk attitudes. The bottom row (Panel C) reports the reduction in the female coefficient upon controlling competitiveness and risk attitudes simultaneously. This investigation provides an insight toward the recent argument that encourages women to "lean-in" (Sandberg, 2013): women should be more competitive and take on more risks. The investigation is also important from the point of view that designing a policy that exclusively changes one of the traits without affecting the other is not so easy. Interventions to affect competitiveness might also influence risk attitudes as well (e.g., Booth and Nolen, 2012a, b). As displayed in Panel C, the impact is all negative suggesting that the impact of controlling risk attitudes is slightly stronger than controlling competitiveness in our sample. Although the impact is mostly not statistically significant, one specification exhibits significant impact at 10% level.

In summary, we show that the tournament entry is associated with higher math achievement, which we interpret as establishing a positive relationship between competitiveness and math achievement. On the other hand, greater risk aversion is associated with higher math achievement. These relationships are partially observed in reading and English achievements as well. However, the relationships are the clearest and strongest for math. Since girls are less competitive and more averse to taking risks compare to boys, the results indicate that the gender differences in competitiveness are widening the gender gap in math achievement, but that the gender differences in risk attitudes contribute to narrowing it. Therefore, the policy intervention that changes women's competitiveness and risk attitudes does not contribute to narrow the gender math gap or even backfire in our sample.

3.4 Disscussion

Competitiveness

We first discuss whether the positive effect of tournament entry in round 3 on math achievement is attributable to competitiveness. Recent critical studies such as Gillen, Snowberg, and Yariv (2019) and van Veldhuizen (2018) show that the gender differences in tournament entry observed in the literature is due to mismeasurement of risk attitudes and confidence. Including various measures of risk attitudes and confidence, Gillen, Snowberg, and Yariv (2019) show that the gender gap in tournament entry can be fully explained by the gender differences in risk attitudes and confidence, casting a doubt on the importance of competitiveness. In Table 3.8, in the spirit of Gillen, Snowberg, and Yariv (2019), we include different measures of (or likely to be related to) risk attitudes and confidence in the regressions to discuss whether the remaining residuals of the tournament entry are attributable to risk attitudes and confidence which maybe not fully controlled by already included measures of those traits. As we have seen in Table 3.4, most of the gender differences in tournament entry are explained by the gender differences in risk attitudes in our sample. In addition, the results in the previous section suggest that tournament entry is capturing very different traits from risk attitudes since coefficients of two variables have opposite signs. Therefore, we mainly focus on confidence.[12]

We use two measures taken from the questionnaire asked to students when administrating standardized test as proxies for confidence of overall academic performance. The first measure is self-efficacy for learning and performance developed by Pintrich et al. (1991). Self-efficacy has been found to be strongly associated with work and academic performance (Lent and Hackett, 1987; Stajkovic and Luthans, 1998). Also, consistent with the fact that women are less confident than men, the previous studies find that women report their self-efficacy lower than men (Lent and Hackett, 1987; Stajkovic and Luthans, 1998). The second measure is the subjective difficulties of each subject similar to the one used in Buser, Niederle, and Oosterbeek (2014). When administrating 8-th grade standardized tests, the local government asked students how difficult were the exams taken on a scale from 1(=easy) to 4(=hard).[13] These measures could be also regarded as additional measures of confidence for each subject.

[12]As Croson and Gneezy (2009) note, confidence maybe related to risk taking behavior.

[13]Unfortunately, the local government stopped to collect these data when administrating 9-th grade achievements.

We drop additional 20 students in order to keep the sample constant. Column (1) in Table 3.8 shows that the results in the previous section are unchanged. Column (2) adds the measure of self-efficacy. The result shows that self-efficacy strongly predicts math achievement and the magnitude of female coefficient substantially decreases. However, the relationship between tournament entry and math achievement is still positive and significant. In column (3), we add measures of subjective difficulties of each subject. Interestingly, the greater difficulty in math is associated with significantly lower math achievement, while greater difficulties in reading and English are associated with higher math achievement. This maybe the result of specialization according to comparative advantage (Cicalla, Fryer, and Spenkuch, 2017). Although, subjective difficulties predict math achievement significantly and further reduce the female coefficient, the coefficient of tournament entry dummy remains positive and significant.

In column (4), we include a measure of challenge-seeking. One question in the administrative questionnaire ask students "do you challenge difficult task without fear of failiure?" on a scale from 1(=no) to 4(=yes). Challenge-seeking is itself an object of interest in the literature. Niederle and Yestrumstun (2009) show that female likely to avoid challenging higher difficulty levels on a task. They show that the gender differences in challenge-seeking are fully driven by the gender differences in risk attitudes and confidence. Also, how is the tournament entry decision different from challenge-seeking behavior is often posed in the literature (Buser, Niederle, and Oosterbeek, 2014). Including our measure of challenge-seeking, column (4) shows that a more challenge-seeking behavior is associated with lower math achievement and its statistically significant. The coefficient of tournament entry, however, is not affected and still positive and significant. Thus, the choice of entering a tournament is different from challenge-seeking behavior.

Therefore, the main conclusion to be drawn from Table 3.8 is that the coefficients on the tournament entry dummy remains positive and significant, even when including additional measures of (academic) confidence and the measure of challenge-seeking. This further supports our view that the positive effect of tournament entry is capturing competitiveness.

In sum, our result is consistent with Niederle and Vesterlund (2010). They emphasize the "competitive" properties of math compared with other subjects such as reading and English. For example, the yardstick classifying the math answers into "right" or "wrong" is clearer and more explicit than other subjects. Therefore, math clearly ranks students and has a similar structure of competition dividing participants into two parts of "win" or "lose". The more competitive students are considered to be fond of math because of the similarity of these structures. Furthermore, in predicting their future wages, math ability is strongly linked with the students' social statuses in the future (Joensen and Nielsen, 2009; 2016). Students who aim to earn a high salary being a winner in the labor market may invest in studying math more than other subjects.[14]

Risk Attitudes

In different streams of literature that examines the determinants of risk attitudes, some studies document the positive relationship between cognitive ability and risk-taking (e.g., Burks et al 2009; Dohmen et al. 2010; Benjamin et al. 2013; Andreoni et al. 2019). Among adolescents, positive relationship between risk taking and cognitive ability, especially math skill, is found in Benjamin et al. (2013) and Andreoni et al. (2019). However, Eckel et al. (2012) and Sutter et al. (2013) do not find such an association of risk attitudes and math ability. Eckel et al. (2012) report that math literacy and risk-taking are negatively correlated among their 11-th grade samples. In our sample, we see that math achievement test score is negatively correlated with risk-taking. On the other hand, we observe that the performance of maze in both round 1 and round 2, which can be regarded as another measure of cognitive ability, is positively correlated with risk taking with statistical significance at 1% level. Therefore, fairly divergent results observed in the previous literature might be partly driven by how cognitive ability is measured.[15]

[14]It should be also mentioned that mazes, the task used in our experiment, is a male stereotypical task. The exiting studies have observed that the competitiveness depends on the tasks the subjects take (e.g., Grosse and Riener, 2010; Kamas and Preston, 2010; Shurchkov, 2012; Dreber, von Essen, and Ranehill, 2014). As the competitiveness measured in our experiment is the competitiveness under the male stereotypical task, it is natural that students with the higher competitiveness in our analysis indicate the remarkable difference in math outcomes, which is a male stereotypical subject.

[15]Measurement of risk attitudes is also subject to some concerns. For instance, Andersson et al. (2016) have shown that the correlation of the degree of risk aversion and cognitive ability can be positive or negative depending on the way of how MPL (Multiple-Price List) format, which is a widely used method for eliciting risk attitudes, is designed. According to Andersson et al. (2016), cognitive ability is correlated with behavioral noise so that individuals with low cognitive ability tend to make mistakes in choosing choices. Together with the fact that previous studies systematically used MPL with more choices in the risk aversion domain, Anderson et al. (2016) argue that behavioral error concentrated on the risk aversion domain, which causes overestimation of the relationship between cognitive ability and the risk aversion. We note that considering concerns of Andersson et al. (2016) do not change our conclusion. First of all, the risk task used in round 5, which follows Eckel and Grossman (2002, 2008), also has more choices in the risk averse domain. As the corresponding CRRA parameters in Table 3.1 show, four out of six options indicate the risk averse properties (i.e., positive value of CRRA). Considering the argument of Andersson et al. (2016), the students with low cognitive

One clear distinction between maze and achievement test is that former is a measure of fluid intelligence while the latter is a measure of crystallized intelligence (Cattel 1971; 1987). Fluid intelligence captures the set of abilities to solve novel problems and is related to innate abilities that people are genetically endowed with. Therefore, fluid intelligence are usually to a great extent not influenced by environments. On the other hand, crystallized intelligence captures acquired skills or knowledge. Thus, its development critically depends on environmental factors and students' effort that is endogenously determined by underlying economic preferences.[16]

Indeed, since the seminal work by Lehvari and Weiss (1974), economists have traditionally investigated the relationship between risk attitudes and human capital accumulation. If the return to educational investment is uncertain, risk averse students may hesitate to exert efforts to education. If, on the other hand, accumulating cognitive skills plays a role of an insurance and mitigate future income fluctuation, the risk averse students might be more eager to do so. Furthermore, if students believe that studying math is less uncertain investment with higher economic returns than those of reading and English, it is optimal for risk averse students to take time in studying math. Our result that the greater risk aversion is particularly associated with higher achievement in math is consistent with this story.

In addition, recent studies from experimental economics find that risk-taking is associated with poorer school outcomes. For example, Castillo, Jordan, and Petrie (2018) children who are more risk averse are less likely to receive disciplinary referrals and are more likely to complete high school, even controlling for economic rationality, family background, scholarly achievement and past misbehavior. Andreoni et al. (2019) also find that and extreme risk taking preferences are associated with an increase in disciplinary referrals.[17] Because middle school students in our sample are at a sensitive age and are exposed to dangerous temptations, their higher tolerance of risk may lead them to unproductive behavior (e.g., smoking, drinking and sexual activities).

---

ability are likely to choose the risk averse options by behavioral noise. Even though this may lead to the estimated coefficient to be positive biased, it does not reverse our result of the relation of students' risk attitude and math achievement. Secondly, the general risk question, which is our second measure of risk attitudes, does not suffer from such a concern.

[16]Indeed, recent studies show that fluid intelligence is not affected by educational environments while crystallized intelligence does (Finn et al. 2014; Carlson et al. 2015; Dahmann, 2017).

[17]Similarly, according to Barsky et al. (1997), individuals who are risk tolerant tend to invest in equity with higher return, while they also engage in health-risky behaviors such as smoking and drinking alcohol.

3.5 Conclusion

Despite its importance of math skills in life, recent data indicates that boys continue to outperform girls in many developed countries. Consequently, understanding the sources of the gender gap in math achievement has received particular attention in economics. The aim of this chapter is to investigate whether gender-linked behavioral traits such as competitiveness and risk attitudes are predictive of math achievement among middle school students. We find that competitiveness is positively correlated with math achievement conditional on students' prior achievements and demographics, while greater risk aversion is associated with higher math achievement. Although we partly observe the similar relationships for reading and English, math is the clearest. The results indicate that the gender differences in competitiveness are widening the gender gap in math achievement, but that the gender differences in risk attitudes contribute to narrowing it.

These findings have a significant policy implication. Given our findings, policymakers might be tempted to design a policy that enhances girls' competitiveness but leaving the risk attitudes unchanged to close the gender math gap. However, such a policy is difficult to implement. As an illustration of the difficulty of such a policy, for example, consider single-sex education that is often discussed as a way to address gender gap in behavioral traits. According to Booth and Nolen (2012a, 2012b), single-sex education not only enhances girls' competitiveness but also makes girls risk tolerant. Together with our results, the effect of single-sex education on girls' math test score is thus ambiguous depending on which traits have stronger impacts.

In summary, our conclusion is that the effects of policies intended to encourage girls to "lean in" (Sandberg, 2013) - girls should be more competitive, and take on more risks, etc. - are overall ambiguous and may result in unexpected and unwanted outcomes. As such, we rather argue that designing institutions to address the gender gap is more promising than policies that are designed to change the way women behave (Niederle and Yestrumskas, 2008; Bohnet, 2016).

3.6 Tables

Table 3.1: Lotteries in Round 5

Choice(50/50 lottery)	High	Low	Mean	SD	Implied CRRA range
Lottery 1	400	400	400	0	$3.94 < r$
Lottery 2	500	350	425	75	$1.32 < r < 3.94$
Lottery 3	600	300	450	150	$0.81 < r < 1.32$
Lottery 4	700	250	475	225	$0.57 < r < 0.81$
Lottery 5	800	200	500	300	$0 < r < 0.57$
Lottery 6	900	100	500	400	$r < 0$

Notes. This table shows the choice of lotteries in round 5. In the experiments, we show only points associated to each lotteries to the students. We do not show means and standard deviations displayed in the table. The last column represents implied CRRA range corresponding to each chosen lotteries. The intervals are determined by assuming $u(x) = x^{1-r}$ and calculating the value of r that would make the individual indifferent between the lottery s/he chose and the two adjacent lotteries. Theoretically, individuals with $r > 0$ can be classified as risk averse, $r < 0$ as risk loving and $r = 0$ as risk neutral.

Table 3.2: Descriptive Statistics

	Boys			Girls			Difference
	N	Mean	SD	N	Mean	SD	*t*-test
IRT scores							
9-th grade math	350	1.43	1.08	399	1.33	1.06	
9-th grade reading	358	1.55	1.35	404	1.85	1.26	***
9-th grade English	353	1.08	1.21	400	1.36	1.15	***
8-th grade math	347	0.93	1.07	399	0.84	0.96	
8-th grade reading	358	0.89	1.10	404	1.22	1.04	***
8-th grade English	354	0.21	1.06	403	0.50	0.99	***
Growth in math	347	0.51	0.65	399	0.52	0.72	
Growth in reading	358	0.66	0.92	404	0.63	0.88	
Growth in English	354	0.91	0.70	403	0.89	0.70	
Performance in maze							
Performance (Piece-rate)	358	6.13	1.85	404	5.48	1.76	***
Performance (Tournament)	358	8.30	2.33	404	7.44	2.29	***
Tournament entry							
Tournament entry (round 3)	358	0.41	0.49	404	0.23	0.42	***
Tournament entry (round 4)	358	0.24	0.43	404	0.15	0.36	***
Confidence							
Guessed rank (round 1)	358	2.04	0.65	404	2.22	0.59	***
Guessed rank (round 2)	358	1.56	0.66	404	1.78	0.73	***
Risk attitudes							
Lottery	358	4.05	1.80	404	3.03	1.61	***
General risk question	358	5.01	2.54	404	4.04	1.90	***
Parental employment status							
Only father is employed	358	0.16	0.37	404	0.16	0.37	
Only mother is employed	358	0.08	0.26	404	0.04	0.21	*
Both	358	0.75	0.43	404	0.78	0.41	
Other	358	0.01	0.09	404	0.01	0.12	
Family patterns							
Nuclear family	358	0.74	0.44	404	0.78	0.42	
Single parent and a child(ren)	358	0.11	0.31	404	0.06	0.25	*
Other	358	0.15	0.36	404	0.16	0.37	
Other controls							
Cram school attendance	358	0.75	0.43	404	0.73	0.45	
Number of siblings	358	1.24	0.82	404	1.28	0.89	
Age in months	358	173.50	3.34	404	173.32	3.44	
Low SES	358	0.16	0.37	404	0.15	0.36	

Notes. The table reports means and standard deviations of variables by gender based on 762 students. The last column reports gender differences in means where the significance levels are from t-test ; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.3: Gender and Cognitive Achievements

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Math	Reading	English	Math	Reading	English	Math	Reading	English
Female	-0.141*	0.278***	0.252***	-0.148***	0.072	0.004	-0.140***	0.072	0.004
	(0.075)	(0.089)	(0.068)	(0.047)	(0.058)	(0.045)	(0.046)	(0.058)	(0.045)
8th-grade math				0.734***	0.361***	0.204***	0.721***	0.361***	0.204***
				(0.040)	(0.049)	(0.038)	(0.039)	(0.049)	(0.038)
8th-grade reading				0.074***	0.473***	0.197***	0.076***	0.473***	0.197***
				(0.024)	(0.046)	(0.029)	(0.026)	(0.046)	(0.029)
8th-grade English				0.213***	0.370***	0.744***	0.202***	0.370***	0.744***
				(0.036)	(0.050)	(0.035)	(0.038)	(0.050)	(0.035)
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	No	No	No	No	No	No	Yes	Yes	Yes
Observations	762	762	762	762	762	762	762	762	762
Pseudo R^2	0.013	0.009	0.010	0.380	0.324	0.388	0.384	0.324	0.388

Notes. Coefficients are from Tobit regressions using 9-th grade IRT scores as dependent variables. All specifications include school fixed effects. Individual controls include dummies of low socioeconomic status, dummies of family patterns, dummies of parental employment status, cram school attendance, age in months and the number of siblings. Standard errors in parentheses are clustered at the 8-th grade classroom level; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.4: Determinants of Tournament Entry

	(1)	(2)	(3)	(4)	(5)	(6)
Female	-0.177***	-0.144***	-0.128***	-0.060**	-0.059*	-0.057*
	(0.032)	(0.033)	(0.033)	(0.028)	(0.035)	(0.034)
T-PR		0.005	0.018	0.017	0.028	0.028
		(0.026)	(0.026)	(0.022)	(0.024)	(0.023)
Tournament		0.084***	0.027	0.023	0.011	0.008
		(0.021)	(0.021)	(0.021)	(0.022)	(0.021)
8th-grade math		0.057***	0.044**	0.055**	0.056***	0.062***
		(0.022)	(0.021)	(0.023)	(0.021)	(0.022)
8th-grade reading		0.038*	0.033	0.044**	0.045**	0.044**
		(0.021)	(0.021)	(0.020)	(0.019)	(0.018)
8th-grade English		-0.031	-0.031	-0.031	-0.030	-0.034
		(0.027)	(0.026)	(0.026)	(0.025)	(0.024)
Guessed rank R1			-0.035*	-0.024	-0.008	-0.006
			(0.018)	(0.017)	(0.018)	(0.018)
Guessed rank R2			-0.089***	-0.057***	-0.059***	-0.062***
			(0.016)	(0.016)	(0.016)	(0.016)
Lottery				0.059***	0.051***	0.045**
				(0.016)	(0.018)	(0.018)
General risk question				0.096***	0.092***	0.100***
				(0.015)	(0.014)	(0.014)
Submitting the PR					0.118**	0.129***
					(0.046)	(0.043)
School FE	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	No	No	No	No	No	Yes
Observations	762	762	762	762	762	762

Notes. Dependent variable: tournament entry dummy of round 3. The table presents marginal effects from Probit regressions. All specifications control for school fixed effects. Tournament is performance in the round 2 compulsory tournament. T-PR is the difference in performance between the round 2 tournament and the round 1 piece rates. Submitting the PR is the tournament entry dummy of round 4. Individual controls are dummies of low socioeconomic status, dummies of family patterns, dummies of parental employment status, cram school attendance, age in months and the number of siblings. Standard errors in parentheses are clustered at the 8-th grade classroom level; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.5: Math Achievement and Behavioral Traits

	(1) Math	(2) Math	(3) Math	(4) Math	(5) Math	(6) Math	(7) Math	(8) Math
Female	-0.115**	-0.102**	-0.141***	-0.140***	-0.151***	-0.130**	-0.126***	-0.142***
	(0.047)	(0.048)	(0.051)	(0.045)	(0.048)	(0.052)	(0.045)	(0.048)
Entry		0.103*				0.132**	0.164***	0.166***
		(0.058)				(0.055)	(0.063)	(0.058)
Lottery			-0.051*			-0.064**		
			(0.031)			(0.029)		
General risk question				-0.072***			-0.094***	
				(0.022)			(0.024)	
Average risk-taking score					-0.075***			-0.098***
					(0.024)			(0.024)
Other experimental variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8-th grade achievements	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	762	762	762	762	762	762	762	762
Pseudo R^2	0.389	0.390	0.390	0.392	0.392	0.393	0.396	0.396

Notes. Coefficients are from Tobit regressions using 9-th grade math IRT score as a dependent variable. All specifications include performance in round 2 of the experiment, the difference in performance between rounds 1 and 2, submitting the PR, guessed ranks of rounds 1 and 2, 8-th grade math, reading and Enlish achievements, school fixed effects, and individual controls. Individual controls include dummies of low socioeconomic status, dummies of family patterns, dummies of parental employment status, cram school attendance, age in months and the number of siblings. Standard errors in parentheses are clustered at the 8-th grade classroom level; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.6: Achievements and Behavioral Traits across Subjects and Gender

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Math			Reading			English	
	Full	Boys	Girls	Full	Boys	Girls	Full	Boys	Girls
Female	-0.142***			0.065			0.009		
	(0.048)			(0.055)			(0.044)		
Entry	0.166***	0.140*	0.221***	0.065	-0.027	0.170**	0.056	0.078	0.061
	(0.058)	(0.079)	(0.080)	(0.054)	(0.085)	(0.080)	(0.065)	(0.083)	(0.094)
Average risk-taking score	-0.098***	-0.077***	-0.137***	-0.067**	-0.067**	-0.066	-0.020	-0.056*	0.010
	(0.024)	(0.029)	(0.034)	(0.031)	(0.034)	(0.057)	(0.029)	(0.032)	(0.041)
Other experimental variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8-th grade achievements	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	762	358	404	762	358	404	762	358	404
Pseudo R^2	0.396	0.439	0.372	0.330	0.338	0.338	0.394	0.415	0.385

Notes. Coefficients are from Tobit regressions using 9-th grade math, reading, and English IRT scores as dependent variables. All specifications include performance in round 2 of the experiment, the difference in performance between rounds 1 and 2, submitting the PR, guessed ranks of rounds 1 and 2, 8-th grade math, reading and English achievements, school fixed effects, and individual controls. Individual controls include dummies of low socioeconomic status, dummies of family patterns, dummies of parental employment status, cram school attendance, age in months and the number of siblings. Standard errors in parentheses are clustered at the 8-th grade classroom level; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.7: Bootstrap Results of the Reductions in the Female Coefficient

	Columns	Difference	Percentage change	p-value
Panel A: Competitiveness	(1)-(2)	0.013	11.3%	0.039
	(3)-(6)	0.011	7.8%	0.026
	(4)-(7)	0.014	10.0%	0.012
	(5)-(8)	0.009	6.0%	0.044
Panel B: Risk attitudes	(1)-(3)	-0.026	-22.6%	0.028
	(2)-(6)	-0.028	-27.4%	0.009
	(1)-(4)	-0.025	-21.7%	0.011
	(2)-(7)	-0.024	-23.5%	0.003
	(1)-(5)	-0.036	-31.3%	0.008
	(2)-(8)	-0.040	-39.2%	0.001
Panel C: Competitiveness + Risk attitudes	(1)-(6)	-0.015	-13.0%	0.158
	(1)-(7)	-0.09	-7.8%	0.321
	(1)-(8)	-0.027	-23.5%	0.069

Notes. This table reports the results of bootstrap for the reduction in the female coefficient upon controlling for competitiveness and risk attitudes with 10,000 repetitions. p-value is equal to the number of repetitions divided by 10,000 in which the reduction points toward the opposite direction.

Table 3.8: Robustness to Other Traits

	(1) Math	(2) Math	(3) Math	(4) Math
Female	-0.131***	-0.085**	-0.075*	-0.058
	(0.044)	(0.042)	(0.042)	(0.042)
Entry	0.160***	0.145**	0.150**	0.150**
	(0.058)	(0.062)	(0.063)	(0.060)
Average risk-taking score	-0.105***	-0.103***	-0.098***	-0.085***
	(0.026)	(0.024)	(0.024)	(0.025)
Self-efficacy		0.181***	0.177***	0.214***
		(0.029)	(0.031)	(0.034)
Math difficulty			-0.113***	-0.106***
			(0.023)	(0.024)
Reading difficulty			0.052*	0.049*
			(0.028)	(0.027)
English difficulty			0.071**	0.067**
			(0.029)	(0.029)
Challenge-seeking				-0.089***
				(0.017)
Other experimental variables	Yes	Yes	Yes	Yes
8-th grade achievements	Yes	Yes	Yes	Yes
School FE	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes
Observations	743	743	743	743
Pseudo R^2	0.400	0.420	0.428	0.434

Notes. Coefficients are from Tobit regressions using 9-th grade math IRT score a as dependent variables. All specifications include 8-th grade math, reading and Enlish achievements, performance in round 2 of the experiment, the difference in performance between rounds 1 and 2, submitting the PR, guessed ranks of rounds 1 and 2, school fixed effects, and individual controls. Individual controls include dummies of low socioeconomic status, dummies of family patterns, dummies of parental employment status, cram school attendance, age in months and the number of siblings. Standard errors in parentheses are clustered at the 8-th grade classroom level; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.7 Figures

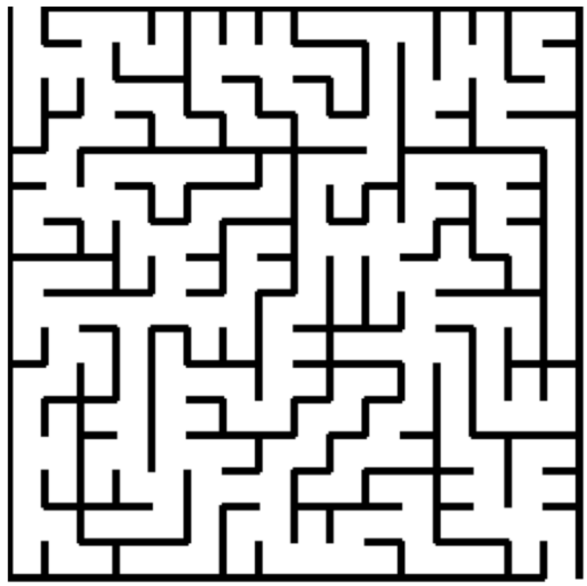


Figure 3.1: Example of a maze

Figure 3.2: Tournament Entry in Round 3

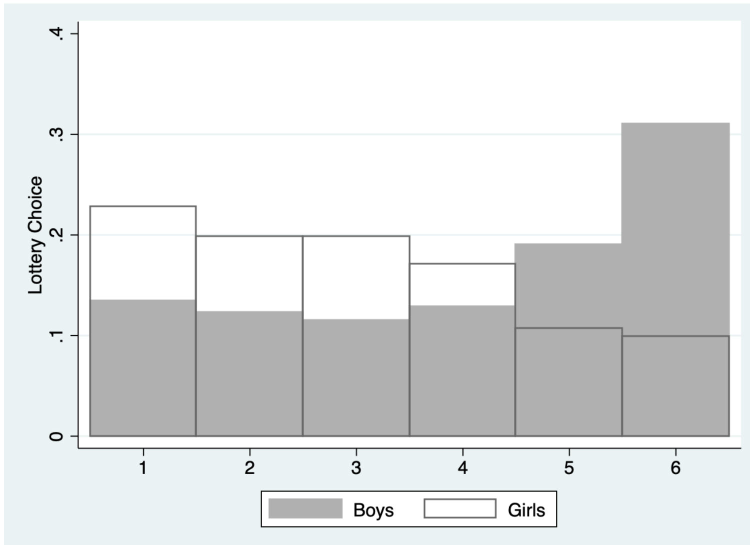


Figure 3.3: Lottery Choice in Round 5

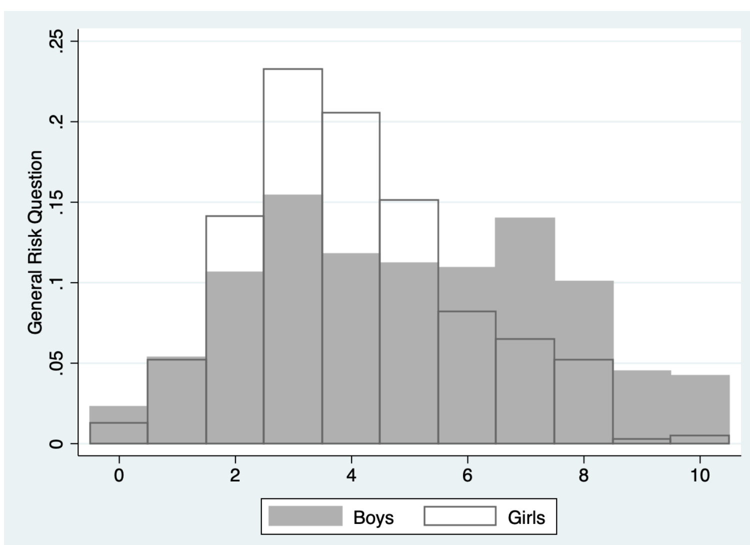


Figure 3.4: General risk question

Chapter 4

Encouraging Women to Compete: Social Image and Prosocial Incentives

While women in many developed countries are attaining higher education at rates similar to men, a gender gap in earnings still exists and women are significantly less likely to hold executive positions in firms. Traditional explanations for the gender gap in labor market outcomes include differences in ability, discrimination, and differences in labor market experiences due to child rearing, and so on. Although these traditional explanations remain undoubtedly important, an alternative explanation that has been suggested for the last decade is the gender differences in willingness to compete. Seminal work by Niederle and Vesterlund (2007) shows that men choose to enter a tournament in a laboratory setting twice as much as women, despite no differences in performance. Recently, there is mounting evidence that willingness to compete measured in laboratory settings correlates with decisions and outcomes in the field (e.g., Buser et al., 2014; Reuben et al., 2015; Berge et al., 2015; Almas et al., 2016; Yagasaki and Nakamuro, 2018).

Even though there is no conclusive evidence on whether gender differences in willingness to compete are inherent or societal, the literature has reached the consensus that societal context is one of the crucial factor for women's participation in competitions (e.g., Gneezy et al., 2009; Booth and Nolen, 2012a, b). Namely, in most of the developed society, being competitive is regarded as a part of male gender norms but not of female gender norms, contributing to women's lower standing in competitive environments (e.g., Akerlof and Kranton, 2000).

Deviating from female gender norms is costly for women, especially when their behaviors are *publicly observed* by others. Specifically, under public observability, women have to care about their *social images* associated with their behaviors. In prior research that follows Niederle and Vesterlund (2007), it is common to ensure the anonymity of the subjects' decisions of whether or not to compete in the experiment so that subjects do not have to care about their social images associated with their decisions. In reality, on the other hand, many of our decisions of whether or not to compete are observed by the people around us. For example, competing in an exam at school, participating in a promotion competition at work, and running in an election for Congress are usually publicly observable to others. Therefore, if women hesitate to show behavior that conflicts with female gender norms, due to dating or marriage market concerns (Fisman et al., 2006; Bursztyn et al. 2017b) or a direct psychological cost of shame from "acting male," such social image concerns may discourage women's willingness to compete and exacerbate their underrepresentation in competitive environments.

If social image concerns play a significant role in deriving women's underrepresentation in competitive environments, it is important to investigate what kind of policy interventions mitigate such negative effect of social image concerns. The previous experimental literature has demonstrated that affirmative action policies favoring women, such as gender quotas or preferential treatment, can encourage women to compete effectively (Niederle et al. 2013, Balafoutas and Sutter. 2012). However, affirmative action policies are not necessarily designed to resolve the gender norm conflict. They treat women preferentially, but women entering competitions under affirmative action may still face a tradeoff between 'what women should be like' and 'being competitive.' An ideal policy should strike a balance between these, which is relatively unexplored in the literature.

The purpose of this chapter is to present an effective policy to encourage women to compete in the presence of social image concerns. For our purpose, we investigate the effect of social image concerns on women's decisions to compete under three different treatments: baseline treatment (no intervention), preferential treatment as a form of affirmative action policies that treat competing women preferentially, and prosocial incentive treatment, under which donation opportunities are introduced in the competitive environment.[1] Prosocial incentive treatment is designed to make women free from the gender norm conflict as women are expected to care about others and society. Indeed, Amanatullah and Morris (2010) find that women negotiate more assertively

[1]Mellström and Johannesson (2008) consider a similar treatment in blood donations and show that this type of treatment eliminates monetary crowding out of prosocial behavior.

when women negotiate for someone else. Therefore, introducing prosocial incentives in the competitive environment may attenuate the effect of social image concerns.

To make our points clear, we first construct a simple theoretical model that incorporates social image concerns along standard economic incentives when deciding whether to compete. Our model assumes two types of women: f and m. The former are assumed to be intrinsically $feminine$, that is, incur a high cost from participating in competitions and have high motives to behave prosocially. On the other hand, the latter are assumed to be more *masculine*, that is, have a lower cost from participating in competitions and be more selfish than the former. We show that, if women are strongly motivated to signal that they are women of type f due to dating market concerns (e.g., Fisman et al., 2006; Bursztyn et al., 2017) or more psychological concerns, such as a direct shame effect of "acting male," participating in a competition under baseline or affirmative action policies is costly from a social image viewpoint, resulting in low participation rates in the public environment. Conversely, participating in a competition with prosocial incentives is not costly from the social image viewpoint, since it does not contradict female gender norms, which suggests women to be altruistic.

On the basis of these theoretical predictions, we conduct a laboratory experiment builds upon Niederle and Vesterlund (2007) and test these hypotheses. In the experiment, we randomly assigned sessions into two conditions: "private" and "public." In the private condition, subjects' decision to compete in the experiment were kept private as in the standard design. On the other hand, in the public condition, subjects were told that their decisions in the experiment would be made public to the other subjects participating in the same session at the end of the experiment. We investigate the impacts of this public observability on women's decisions to compete under three different situations: baseline, preferential, and prosocial incentive treatments.

Our experimental results are fairly consistent with the theoretical predictions. Preferential and prosocial incentive treatments are both effective in encouraging women to compete under private condition. When the decisions to compete are made public, we observe statistically significant declines in women's participation rates in both the baseline and preferential treatments but not in the prosocial incentive treatment, which supports our theoretical predictions. [2] The results are further supported by regression analysis and robust to additional controls. Overall, we experimentally identify the significant impacts of social image concerns on women's decisions to compete and find

[2]We see no statistically significant effect under public observability for men in all treatments.

that the prosocial incentive treatment is robust to those concerns.

This study contributes to many strands of literature. First, the study relates to the economic literature finding willingness to compete is affected by the notion of gender stereotypes defined by a society where individuals belong. For example, Gneezy et al. (2009) explore gender differences in willingness to compete in a patriarchal society, the Maasai in Tanzania, and a matrilineal society, the Khasi in India. They find that while men in the patriarchal society compete more than women in the patriarchal society, women in the matrilineal society compete more than men in the matrilineal society. Booth and Nolen (2012a, b) show that, in a sample of English 15-year-olds, girls from mixed-gender schools are less willing to compete than the girls from single-sex schools.[3] The present study contributes this strand of literature by showing that the public observability enhance gender stereotypical behavior and decreases women's participation in competitions.

The present study also provides many insights into the policy measures. The second piece of literature we contribute to is on the effectiveness of affirmative action policies. Niederle et al. (2013) and Balafoutas and Sutter (2012) show that affirmative action policies, such as quotas or preferential treatment, are effective in inducing women to competitions. Furthermore, despite the usual criticisms of reverse discrimination, they show that there is limited or no efficiency cost. In a more recent study, however, Leibbrandt et al. (2017) study gender quotas with peer review and show that women become targets of sabotage under gender quotas. In their paper, the possibility of sabotage renders gender quotas ineffective in encouraging women to compete. In our study, even if there is no sabotage, publicity of the decisions discourage women to compete under affirmative action policies.

Thirdly, our study adds a new understanding of the literature on the policies to promote women's willingness to compete by stimulating their other-regarding preferences. A few studies have investigated the effect of introducing concerns for others on decisions to compete. Cassar et al. (2016) collect data from the parents of middle and high school students in China and show that using child-benefits vouchers as rewards removes gender differences in the willingness to compete of those parents. Samek (2019) use a large field experiment to show that introducing jobs within prosocial framing increases application rates. In addition to showing its effectiveness on encouraging women to compete, an important contribution of this chapter is to show that introducing proso-

[3] See also Lee et al. (2014).

cial incentives to competitive environments is a promising approach to offsetting the negative consequences of social image concerns.

Fourthly, our study also directly relates to the literature on social image concerns of individuals. Research on the effect of public observability on economic behavior is mounting and includes charitable donations (Ariely et al., 2009; DellaVigna et al., 2012), education (e.g., Bursztyn and Jensen, 2015; Bursztyn et al., 2017a), voting (e.g., Gerber et al., 2008), and women's career choices (Bursztyn et al., 2017b). Bursztyn et al., (2017b) find that in a survey to be used by students' career advisers, single female MBA students under-report their financial ambitions, their willingness to have longer work hours and travel for work, and some of their personality traits (e.g., ambition and leadership in day-to-day interactions) when they believe their classmates will observe their choices.[4] In an independent work, Buser et al. (2017) conduct an experiment a la Niederle and Vesterlund (2007) to investigate how the decisions to participate in competitions are influenced by the fact that the decisions to participate in competitions are made observable to others. They find that public observability of decisions does not have a statistically significant impact on subjects' decisions to compete and conclude that the effect of the social image concerns is limited. As in their study, we also examine the effect of public observability on participation in competitions in a laboratory experiment. However, our study is different from theirs in a few important ways. First, we find a statistically significant reduction in the rate of participation into competitions among women when public observability is introduced.[5] [6] Second, we rather focus on the policy interventions that can mitigate the negative effect of the social image concerns and effectively encourage women to compete, in an environment where social image concerns significantly discourage them from participating in competitions. While there is accumulated knowledge that social image concern has negative

[4]These effects are much weaker among married female students and not present among male students.

[5]The discrepancy of our results with the results from Buser et al. (2017) maybe due to the difference in societal context between Japan and Germany. Indeed, according to the Global Gender Gap Index in 2017 reported by the World Economic Forum, Japan is among the lowest performing countries which ranks 114th, whereas Germany is among the highest which ranks 12th. In addition, in cultural anthropology, Japan is described as a typical example of a 'shame culture' as opposed to a 'guilt culture' (Benedict, 1946).

[6]Note that even though the results in Buser et al. (2017) are statistically insignificant, their results imply that female subjects under the public-choice condition are around 30 percent less likely to participate in competitions than those under the control condition (16% vs. 23%). In addition, comparing the private condition with the public-choice condition, female subjects are about 12 percentage points less likely to participate in tournaments in the latter condition than in the former, which corresponds to a reduction of about 40 percent of the participation rate under the private condition (28%).

effects on individuals ' behaviors, it is relatively unexplored how to overcome these phenomena. To our best knowledge, this is the first study to provide a potential policy to solve the cost of social image concerns. This is precisely our best contribution to the literature.

Finally, this study adds to the experimental literature on the effect of prosocial incentives on labor market outcomes. There are numerous experimental studies that investigate the effectiveness of prosocial incentives on workers efforts or performance (e.g., Tonin and Vlassopoulos, 2010, 2015; Imas, 2014; Charness et al., 2016; DellaVigna and Pope, 2016). While most previous research shows prosocial incentives are powerful in inducing efforts or enhancing productivity in a given working environment, there are relatively few studies on whether prosocial incentives are enough to motivate workers to self-select into such an environment. [7]A notable exception is Schwartz et al. (2019) in which the authors investigate the effectiveness of prosocial incentives on people's decisions to opt-in to an incentivized activity. Surprisingly, they find that individuals are more likely to avoid working activities that involve *any* type of prosocial incentives. Our study, as well as Cassar et al. (2016) and Samek (2015), contribute to this strand of research by demonstrating how effective are prosocial incentives in motivating women to opt-in to a 'competitive' environment.

The rest of this chapter is organized as follows. In Section 2, we construct a theoretical model to clarify the role social image concerns in women's decisions to compete. Section 3 describes our experimental procedure. Section 4 presents the results, and Section 5 concludes.

4.1 Theoretical Model

In this section, we construct a simple theoretical model to clarify the role social image concerns in women's decisions to compete. We here theoretically compare three different treatments which are investigated in the later experiment: (i) Baseline treatment (no intervention), (ii) Affirmative action policies favoring women and (iii) Prosocial incentive treatment. We first clarify why baseline and affirmative action policies, such as quotas or preferential treatments, could be vulnerable to public observability. We then posit introducing prosocial incentives in a competitive environment can potentially overcome the situation.

[7]To the best of our knowledge, Lazear et al. (2012) is the first to emphasize self-selection in economic experiments especially in the context of prosocial incentives.

The model below follows the framework first proposed by Benabou and Tirole (2006) and is a direct extension of the model in Bursztyn, et al. (2017a). There is also a clear link between our model and the identity model of Akerlof and Kranton (2000).

4.1.1 Baseline

Assume a continuum of women that have to decide whether to participate in a competition that delivers benefit b_T if they win, or 0 otherwise. The winning probability of the competition is denoted as $w \in (0,1)$. On the other hand, if they decide not to compete, they receive b_P for sure. We assume two types of women $\tau_i \in \{f = (c_f, \theta_f), m = (c_m, \theta_m)\}$, which is private information. Here, women of type f are interpreted as intrinsically '*feminine*' women, while those of type m are interpreted as '*manlier*' than the former. We denote the share of women of type m by q; $\Pr(\tau_i = m) = q$.

Each gender type is two-dimensional and $g = (c_g, \theta_g)$, where $g = f, m$. The first component, c_g, is a cost associated with participating in competitions and we assume that $0 = c_m < wb_T - b_P < c_f$. In other words, women of type m have no cost from participating in a competition, but those of type f have a high cost to compete.

The second component, θ_g, represents the degree of women's altruism and we assume $\theta_m < 0 < \theta_f - c_f$. This represents that women of type f are more altruistic or socially minded compare to the others. Note that, in this modeling strategy, we assume that the preference for competition and the degree of altruism correlate perfectly. This is for simplicity, but there are empirical evidences that show willingness to compete and other-regarding preferences are correlated (e.g., Bartling et al., 2009; Balafoutas et al., 2012; Dasgupta et al., 2019).[8][9]

If a woman enters the competition, the total payoff is

$$wb_T - c_i + \lambda \Pr(\tau_i = f \mid d_i = 1),$$

[8] In the following analysis, we also see that the willingness to pay (WTP) for donations, which is a measure of altruism in our analysis, negatively correlates with tournament entry under the private condition (see Table 4.3).

[9] We are still able to illustrate our main message by dropping the assumption of there are only two types of women (i.e., c_i and θ_i are perfectly correlated). However, in this case, the equilibrium structure becomes so complicated. Therefore, as the simplest approximation to the great variety of personalities of women, we assume there are only two types.

whereas if a woman does not participate in the competition, her total payoff is,

$$b_P + \lambda \Pr(\tau_i = f \mid d_i = 0).$$

The last term represents the benefit of being perceived as a woman of type f given the choices made, and $\lambda \geq 0$ captures the strength of such social image concerns. To be more precise, λ can be decomposed into two components: i.e. $\lambda = x \cdot v$. $x \geq 0$ is interpreted as a measure of visibility or salience of the decisions, while $v \geq 0$ represents women's desire to be perceived as a woman of type f. The underlying mechanism that generates the latter component could be dating or marriage concerns (e.g., Fisman et al., 2006; Bursztyn et al., 2017b) or more psychological ones, such as a direct shame effect from "acting male." In our experiment, we randomly manipulate the public observability observability of decisions to compete and exogenously vary x in this model.

Overall, the setting is completely analogous to Bursztyn et al. (2017a), with only minor notational differences. The following proposition corresponds to Proposition 1 in Bursztyn et al. (2017a) and states that, if the decision to compete is publicly observed, women are discouraged to enter into the competitive environment because of social image concerns. Throughout, we denote $r = \Pr(d_i = 1 \mid \tau_i = f)$ and $\rho = \Pr(d_i = 1 \mid \tau_i = m)$.

Proposition 1. *Women's tournament participation rate is characterized as follows:*

(i) If $\lambda \leq wb_T - b_P$, $r = 0$ *and* $\rho = 1$*;*

(ii) if $\lambda \in \left(wb_T - b_P, \frac{wb_T - b_P}{1-q}\right)$, $r = 0$ *and* $\rho = \frac{1}{q}\left(1 - \frac{\lambda}{wb_T - b_P}(1-q)\right) \in (0,1)$*; and*

(iii) if $\lambda \geq \frac{wb_T - b_P}{1-q}$, $r = 0$ *and* $\rho = 0$*.*

4.1.2 Affirmative Action Policies Favoring Women

Consider the same model but with affirmative action policies favoring women. Note that affirmative action policies such as quotas or preferential treatments increase women's winning probability in competitions. Then, let w_A be the winning probability under an affirmative action policy and assume $0 = c_m < c_f < w_A b_T - b_P$. This assumption guarantees that the affirmative action policy is effective enough to encourage women of type f to participate in a competition under the private situation. However, even in this case, the participation rate converges to 0 as λ increases, which is formally stated below.

Proposition 2. *Women's tournament participation rate is characterized as follows:*

(i) If $0 \le \lambda \le \frac{w_A b_T - b_P - c_f}{q}$, $r = 1$ *and* $\rho = 1$*;*

(ii) if $w_A b_T - b_P - c_f \le \lambda \le \frac{w_A b_T - b_P - c_f}{q}$, $r = \frac{q}{1-q}\frac{\lambda - (w_A b_T - b_P - c_f)}{w_A b_T - b_P - c_f}$ *and* $\rho = 1$*;*

(iii) if $w_A b_T - b_P - c_f \le \lambda \le w_A b_T - b_P$, $r = 0$ *and* $\rho = 1$*;*

(iv) if $w_A b_T - b_P \le \lambda \le \frac{w_A b_T - b_P}{1-q}$, $r = 0$ *and* $\rho = \frac{1}{q}(1 - \frac{\lambda}{w_A b_T - b_P}(1-q))$*; and*

(v) if $\frac{w_A b_T - b_P}{1-q} \le \lambda$, $r = 0$ *and* $\rho = 0$. [10]

Two remarks are in order. First, although fragile, affirmative action policies have an effect in mitigating negative image associated with participating in a competition. This is because that, with high w_A, women of type f participate in a competition which contributes to weakening image concerns. Second, however, in order to mitigate the negative effect of social image concerns and sustain high participation rate (as in (i) in Proposition 2) by using affirmative action policies, policymaker should set w_A sufficiently high so that women of type f have high enough incentive to participate in a competition. In reality, setting w_A high enough makes the problem of reverse discrimination much more severe and could be seen as unfair. This is a persistent source of concern in affirmative action policies. The following idea of prosocial incentives has the potential to eliminate these concerns.

4.1.3 Introducing Prosocial Incentives

In the previous subsections, we have seen that the reason why the baseline and affirmative action policies are fragile to public observability is that women of type f always had a weaker incentive to participate in the competition compared to women of type m. This made the noncompetitive environment always more beneficial from the social image viewpoint and uniquely supported the equilibrium with no participation for a λ sufficiently large by the D1 criterion (Cho and Kreps, 1987; Banks and Sobel, 1987).

Here, the idea is to use prosocial incentives to reverse this relationship. We expect that introducing prosocial incentives in the competitive environment plays two roles: (i) it induces women of type f, who are intrinsically motivated by prosocial incentives, to compete (ii) it makes participating in a competition not costly for women from the social image viewpoint, since the women of type f are now having stronger incentives to participating in it.

[10] Note that the equilibrium in (ii) is unstable with respect to perturbation in λ.

In addition to financial reward b_T, assume women are given an opportunity to make a charitable donation when they win if they participate in a competition. We denote by $a_i \in \{0, 1\}$ a discrete decision of whether to make a charitable donation or not. Then, the payoff obtained by participating in the competition is given by,

$$\max_{a_i \in \{0,1\}} w(b_T + \theta_i a_i) - c_i + \lambda \Pr(\tau_i = f \mid a_i, d_i = 1),$$

where the payoff of not participating in the competition is the same as in the previous cases. Assuming $\theta_m < 0 < \theta_f - c_f$, note that now women of type f always have a stronger incentive to participate in a competition compared to the others.

Proposition 3 shows this treatment indeed accomplishes full participation for any $\lambda \geq 0$. The only decision for which λ matters is the decision to donate. Throughout, we denote $r_T = \Pr(a_i = 1 \mid \tau_i = f, d_i = 1)$ and $\rho_T = \Pr(a_i = 1 \mid \tau_i = m, d_i = 1)$.

Proposition 3. *For every $\lambda \geq 0$, $r = 1$ and $\rho = 1$. Additionally,*

(i) if $0 \leq \lambda \leq -w\theta_m$, $r_T = 1$ and $\rho_T = 0$;

(ii) if $-w\theta_m \leq \lambda \leq -\frac{w\theta_m}{1-q}$, $r_T = 1$ and $\rho_T = 1 - \frac{1}{q}(1 + \lambda \frac{1-q}{w\theta_m})$; and

(iii) if $\lambda \geq -\frac{w\theta_m}{1-q}$, then $r_T = 1$ and $\rho_T = 1$.

Finally, it is worthwhile mentioning the case of men. For men, the previous analyses can be easily adjusted by assuming that men benefit from being perceived by others as male stereotypical, given their choices. In this case, the model predicts exactly the opposite to the case of women. Specifically, men are encouraged to enter into the competitive environment under baseline and affirmative action policies while they are discouraged when under prosocial incentive treatment as long as λ is large. However, in the literature, there is evidence that men are less sensitive to social image concerns compared to women so that public observability has little impact on male behaviors (e.g., Ariely et al., 2009; Bursztyn et al., 2017b). Therefore, we expect the effect of public observability to be small or close to 0 (i.e., $\lambda = 0$), as opposed to women, which is why we mainly focus on women in the following analyses.

4.2 Experimental Procedures

The experiment was conducted in November and December, 2016. We conducted 10 sessions at the University of Tokyo (Hongo campus). Subjects were recruited through fliers posted throughout the campus, handed out, and uploaded on Twitter and Facebook by our research assistants. We randomly chose 100 subjects for each gender from the students interested in our research who had registered online. Finally, 188 subjects (97 men, 91 women) participated in the experiment.

Upon arrival, subjects were told they would receive a participation fee of JPY 4,000 and might earn additional money, JPY 2,000 on average, depending on their performance in the experiment.[11]

Our experimental design builds upon the standard experimental design of Niederle and Vesterlund (2007). At the start of the experiment, subjects were told they were randomly divided into groups of three men and three women, and that they would be performing a number of tasks. One of these would be randomly chosen for payment at the end of the experiment.

The experiment took place in a large and spacious room and was conducted using paper and pencil. In each round, subjects had 3 minutes to solve as many as possible mazes as the one in Figure 4.1. One experimenter read aloud the instruction to everyone participating and one research assistant supervised the experiment. Before starting the first task, subjects were explained how to solve mazes and allowed to practice for 3 minutes. Then, subjects were informed of the nature of the task to be carried out and the payment scheme only immediately before performing the task. In rounds 1 and 2, the experimenter read aloud the instructions of the payment scheme to everyone participating. The specific payment schemes of the first two rounds are as follows.

Round 1: Piece Rate

Subjects were asked to solve as many mazes as possible in 3 minutes. They would receive JPY 50 for each maze correctly solved if this task was randomly selected for payment.

Round 2: Compulsory Tournament

Subjects were asked to solve as many mazes as possible in 3 minutes. If this task was randomly selected for payment, the two subjects who solved the largest number of correct mazes in each group would each receive JPY 150 for each maze solved correctly,

[11]Total fees were payed at the University of Tokyo (Hongo campus) in about two weeks later. Our participation fee is relatively high compared to the literature, since it includes transportation costs during the experiment and another experiment, which ended about 30 mins, was conducted *after* the present experiment.

while the other subjects would receive no payment. In case of ties, the winners were chosen randomly.

In rounds 3-5, we use a combination of within-subject design, to determine how different treatments of compensation schemes affect decisions, and between-subject design, to see how public observability affects decisions and explore the robustness of effects for each treatment to social image concerns.

Rounds 3-5: Randomized Treatments

Subjects sequentially faced the following treatments, with the treatment order randomly assigned to rounds 3-5 and had to choose under which payment scheme their subsequent performance would be compensated. Namely, we let the subjects to read the instructions of the payment schemes by themselves and randomly assigned the order of treatments across subjects within sessions. The order is randomized in order to minimize order effects. Subjects were not allowed to communicate so that they did not know the order of treatments was randomized.

- **Baseline Treatment.** Subjects were asked to choose either the piece rate or tournament and then solve as many mazes as possible in 3 minutes. Payment would depend on which payment scheme they chose if this round was randomly selected for payment. If a subject were to choose piece rate, he/she would get JPY 50 per correctly solved maze. If he/she chose tournament, he/she would get JPY 150 per maze solved correctly if his/her score exceeded that of at least four other group members, otherwise he/she would receive no payment. In case of ties, the winners were chosen randomly.

- **Preferential Treatment.** In preferential treatment, each woman's performance was automatically increased by one unit (i.e., one correct maze). Given the augmented scoring rule for women, subjects were asked to choose either piece rate or tournament and solve as many mazes as possible in 3 minutes. Payment was determined according to the rules of the baseline treatment.

- **Prosocial Incentive Treatment.** In the prosocial incentive treatment, subjects were allowed to donate from their rewards to a charity organization *only when they chose tournament*. Subjects were asked to choose either piece rate or tournament and solve as many mazes as possible in 3 minutes. Additionally, if they were to choose tournament, they were told that they could decide how much of the JPY 150 per correct maze (if they won) to keep for themselves and how much to pass on to a charity of their choice.[12]

In addition to the above treatments, we randomly manipulate the public observability of decisions in rounds 3-5 to determine how social image concerns affect the decisions to compete. We randomly assigned *private* and *public* conditions to *sessions*. We informed subjects of private and public nature of their decisions in two ways. First, before subjects read their payment schemes they faced, the experimenter announced their public and private nature of their decisions. Second, it was explicitly written in the instruction.

✓ **Private Condition.** Subjects were informed that their decisions were kept private throughout the experiment, as in the standard literature.

✓ **Public Condition.** Subjects were informed that their decisions to choose piece rate or tournament would be made public to other subjects participating in the same session. In the prosocial incentive treatment, subjects were additionally informed that the amount given to the charity would be also made public if they chose tournament.

Post-experimental Questionnaire

At the end of the experiment, subjects were asked to answer a post-experimental questionnaire. As well as demographic and socio-economic questions, the questionnaires include subjects' guess of their relative rank in compulsory tournament, risk attitudes, and willingness to pay (WTP henceforth) for donation.

Risk attitudes were collected in two ways (Buser et al., 2014). First, subjects picked one option among a sure reward of JPY 200 and four 50/50 lotteries with increasing riskiness and expected rewards: JPY 300 or JPY 150; JPY 400 or JPY 100; JPY 500 or JPY 50; JPY 600 or JPY 0. The outcome was determined by throwing a coin at the end of the experiment. Second, we asked subjects "On a scale from 0 to 10 how

[12]Subjects chose charities from (i) Japanese Red Cross Society 2016 Kumamoto earthquake donations, (ii) the Japan Committee of UNICEF, (iii) Save the Children, and (iv) the University of Tokyo Foundation.

prepared are you to take risks" where 0 was labeled 'not at all prepared to take risks' and 10 was labeled 'fully prepared to take risks'.

The WTP for donation is measured using a procedure similar to the Multiple Price List (MPL) elicitation methods (Cassar et al., 2016). Specifically, subjects were asked to choose between option A, JPY 300 donation to the chosen charity, and option B, a cash reward. A cash reward in option B increased by JPY 50 from JPY 100 to JPY 350 while the amount of charitable donation in option A stays constant. We record six choices (1-6) and then randomly draw a number from 1-6 to determine which of subjects' choices to implement after the experiment. A typical subject starts from option A and at some point switches to option B (and then never switches back). We use the switch point from option A to option B as an estimate of how much each subject valued the donation opportunity in the prosocial incentive treatment.[13]

4.2.1 Descriptive Statistics

We will be examining tournament entry choice and see whether making the decisions public has an effect or not. In doing so, we control for performance in mazes, guessed rank, risk attitudes, and the WTP for donation that could affect the decisions of tournament entry. Table 4.1 and 4.2 show the summary statistics by gender.

There are no statistical differences between subjects under public or private conditions for most variables but we see some important differences between these groups. For men, subjects in the public treatment are significantly more risk seeking, in that they choose more risky lotteries than those in the private condition (see Table 4.1). On the other hand, for women, subjects in the public condition are less confident and have higher WTP for donation (see Table 4.2). These observable differences are important in our analysis, since the differences themselves could generate differences in tournament entry choice between subjects in public and private conditions.

One potential explanation for this observed imbalance between subjects in public and private conditions is that, since we collected guessed rank, risk attitudes, and WTP for donation after the experiment, subjects in the public condition is affected by the intervention which made the decisions publicly observable. Indeed, in the literature of self-presentation in social psychology, there is evidence of behaviors pursued under public observability changing the self-concept of individuals and resulting in behavioral changes (see Tice, 1992). Consistent with this explanation, we almost see no statisti-

[13]WTP for donation of subjects who never switched are labeled 6.

cally significant differences in variables determined before the intervention. We further discuss this point in section 4.

4.2.2 Hypotheses Testing

Based on the previous theoretical analysis, we state the following hypotheses regarding the effects of each intervention and the public observability of women's decision to compete. First, we expect both preferential treatment and prosocial incentive treatment are effective in inducing women to the competitive environment when decisions are completely private.

Hypothesis 1. *When decisions are private, we expect women's higher tournament participation rate in both the preferential and prosocial incentive treatments than in the baseline treatment.*

Our model also predicts that making the decision to compete public would discourage women's tournament participation in the baseline and preferential treatments. On the other hand, we expect no such effect in the prosocial incentive treatment, which is robust to public observability.

Hypothesis 2.

(i) When decisions are public, we expect women's tournament participation rate to be lower in the both baseline and preferential treatments than in the respective private case.

(ii) We expect no significant difference in women's tournament participation rate in the prosocial incentive treatment.

4.3 Results

Here, we present our experimental results and discuss whether the results are consistent to the stated testing hypothesis. Our preliminary results are displayed in Figure 4.2, which presents the proportion of subjects who choose tournament in each treatment.

First, in the baseline, although the difference is not statistically significant (tournament entry rate among women and men, respectively: 0.46, 0.57, p= 0.30), we observe women are 11 percentage points less likely to enter into the tournament in the private condition. In the public condition, however, there is a significant gender difference in the tournament entry rate (0.24, 0.65, p = 0.000). Compared to the private condition, women entering into the tournament significantly decreased from 0.46 to 0.24 (p = 0.034), which is consistent with hypothesis 2(i), while men increased their entering into the tournament from 0.57 to 0.65, but not significantly (p = 0.416).

Second, in the private condition, the introduction of preferential treatment increased women's entering the tournament from 0.46 to 0.63 and decreased men's from 0.57 to 0.41, with the impacts being statistically significant for both women and men (p = 0.032 and p = 0.034 for women and men, respectively).[14] This is consistent to hypothesis 1 and as expected, since the introduction of the preferential treatment increases the probability of winning the tournament for women (and decreases it for men). In the public condition, we see a similar trend, with the tournament entry rate increasing for women from 0.24 to 0.51 and decreasing for men from 0.65 to 0.53 with statistically significant impacts (p = 0.010 and p = 0.010). Particularly, compared to the private condition, women are still underrepresented in the tournament and the difference is significant (p = 0.047), which supports hypothesis 2(i).

Finally, as displayed in Figure 4.2, we observe the prosocial incentive treatment is as effective as the preferential treatment for women while maintaining men's tournament participation similar to that of the baseline in the private condition. Indeed, the actual rates of tournament entry in the prosocial incentive treatment are 0.61 for women and 0.50 for men and the impacts, compared with the baseline, are statistically significant for women but not for men (p = 0.092 and p = 0.326), which is consistent with hypothesis 1. On the other hand, in the public condition, women dramatically increased their tournament entry rate from 0.24 to 0.57 (p = 0.00), but men did not. Compared to the private condition, women are no longer underrepresented in the tournament and the difference between private and public conditions is now insignificant (p = 0.767). This supports hypothesis 2(ii).

4.3.1 Regression Analysis

Overall, the preliminary results are fairly consistent with our hypotheses. However, although we randomized public and private conditions, we had some observable differences between these groups. In particular, in our sample, women under the public

[14] p-values are calculated by regressing the tournament entry dummy on the dummies of preferential and prosocial incentive treatment clustered by individuals.

condition had high WTP for donations compared to women under the private condition. There are two potential possibilities of why we observe this kind of imbalance. First, as mentioned earlier, it might be the case that making decisions public changed the self-concept for subjects in the public condition (Tice, 1992). In this case, the above analysis does not suffer so much and is still valid. Another possibility is that the imbalance is purely driven by the randomization failure. This case is problematic and should be considered very carefully. As in the previous theoretical analysis, if women's willingness to compete and WTP for donations are negatively correlated, the results regarding public observability could be explained by the negative correlations between these two factors. To be more precise,

- **Concern 1:** We observe the low participation rate in tournaments in baseline and preferential treatments under public condition since we had more subjects with a high WTP for donations who are supposed to have high cost in participating in competitions.

- **Concern 2:** We observe a dramatic increase in tournament entry in prosocial incentive treatment under public condition since we had subjects with a high WTP compared to those in the private condition.

These concerns challenge our view that the effect is driven by social image concerns. In what follows, assuming that the imbalance is driven by randomization failure, we try to eliminate concerns 1 and 2 by using regression analysis as well as to explore the robustness of our results.

Subsample Analysis

In Table 4.3, we present the results of regressions for women's decisions to enter a tournament.[15] In columns (1) and (3), we restrict our sample to women in private and public conditions, respectively, and regress the tournament entry dummy on dummies of preferential and prosocial incentive treatments, probability of winning a tournament[16], guessed rank, and risk attitudes. Standard errors are clustered by individuals to account for the lack of independence among the three individual observations.

[15] We had to drop four observations for which the WTPs for donation were missing.

[16] Following Niederle et al. (2013), for any given performance level in round 2, we draw 1,000,000 groups consisting of three men and three women using our sample with replacement and calculate the frequency of wins in this set of simulated groups.

For the preferential treatment, the effect is positive and statistically significant, even accounting for the change in winning probability for both private and public conditions. For the prosocial incentive treatment, we see that the effect is not statistically significant but it is still substantial in the private condition. On the other hand, the effect of prosocial incentive treatment is strong and statistically significant in the public condition.

In columns (2) and (4), we include WTP for donations and an interaction term between WTP for donation and the prosocial incentive treatment to explore the mechanism underlying the effects of each treatment. The interaction term is included to represent the introduction of the donation opportunity in the tournament environment changes the benefit associated with entering the tournament especially for women with high donation WTPs. The focus here is to check whether WTPs affect the tournament entry decisions in a qualitatively similar way across private and public conditions. Namely, if concern 1 above is true, we should observe that the coefficient on WTP for donation should be negative for both private and public conditions. In addition, if concern 2 above is true and the effect of the prosocial incentive treatment is solely driven by women with high WTP for donation, we should observe that the coefficient on the interaction term between WTP and the prosocial incentive treatment dummy is positive and the coefficient on the prosocial incentive treatment dummy to become 0 in columns (2) and (4).

In column (2), we see that WTPs play a significant role in determining tournament entry decisions as indicated in Table 4.3. Including variables of WTPs reduces the coefficient on the prosocial incentive treatment dummy to almost zero. Furthermore, the coefficient of WTP for donation is negative and significant, suggesting that women who have high WTP for donation tend to avoid tournament entry under baseline and preferential treatments. The coefficient of the interaction term of WTP for donation and the prosocial incentive treatment dummy is positive and significant, which means that women having high WTP enter tournament under prosocial incentive treatment. Thus, we conclude that the effect of the prosocial incentive treatment in the private condition is driven by inducing women who are intrinsically motivated by the donation opportunity, which is consistent with our theoretical analysis. Additionally, in the private condition, the coefficient on WTP is negative and significant. This is also consistent with our theoretical model, in which we assumed the willingness to compete and the level of altruism correlate negatively.

On the other hand, in column (4), adding WTPs does not reduce the coefficient on the prosocial incentive treatment and the effect is still strongly positive and significant under public observability. Indeed, neither WTP nor the interaction term is significant in column (4). This indicates that, under public observability, the reason that women are motivated to enter the tournament under the prosocial incentive treatment is not necessarily that they are intrinsically motivated by the donation opportunity but perhaps involves other factors. This is consistent with the social image explanation of our theoretical model, that is, the introduction of prosocial incentives makes entering the tournament not costly from a social image viewpoint. It also supports our statement that the observed strong effect of the prosocial incentive treatment under public observability is *not* driven by having more women with high WTP in the public condition than in the private one. Overall, the results in Table 4.3 are in line with hypotheses 1 and 2.

Controlling Confounders

To determine the effect of public observability on each treatment, Table 4.4 reports the results of regressions for the decision to enter a tournament on the dummy of public observability of each treatment.[17] All specifications include round-fixed effects and, from columns (3)-(6), we take the probability of winning, guessed rank, and WTP for donation. Columns (5) and (6) include demographic controls, such as age, mother and father's education, and major fixed effects.

In the baseline and preferential treatments, the effect of public observability on tournament entry is negatively significant across all specifications for women. The only treatment under which the coefficient on public observability is not significant for women is the prosocial incentive treatment. This is another supportive evidence that public observability is an independent factor from other factors such as confidence and WTP for donation, which is consistent to the view that social image concerns matter. Altogether, hypothesis 2 is supported.

Finally, for men, the coefficients are statistically insignificant across all treatments and specifications. This supports our presumption that men are not sensitive to public observability compared to women, which is also consistent with the literature. Table 4.4 reports p-values for gender differences on the coefficients of public observability. We observe significant gender differences in the coefficients on the public observability of

[17]The results do not change, even if we use regressions with pooled sample standard errors clustered by individuals.

the baseline and preferential treatments but not for the prosocial incentive treatment, which is again consistent with our hypotheses.

4.4 Conclusion

In this chapter, we theoretically and experimentally demonstrate that social image concerns negatively affect women's decisions to compete since it conflicts with the female gender norms. Since affirmative action policies keep noncompetitive environments attractive from the social image viewpoint, we find that it cannot resolve the trade-off between the benefit for women participating in the competition and the associated cost of social image. Alternatively, we also show that introducing prosocial incentives in the competitive environment can effectively encourage women to compete even under public observability. This is because prosocial incentives resolve the aforementioned tradeoff resulting in that the policies may make competitive environments beneficial from the social image viewpoint.

In addition, unlike affirmative action policies, the benefit of using prosocial incentives to attain gender equality is that it does not treat men and women unfairly. If policymakers try to offset the social image cost of women's participation in the competition with affirmative action policies, they should further enhance the level of favoritism toward women. This may make the potential problems associated with affirmative action policies such as efficiency loss due to reverse discrimination (Niederle et al. 2013; Balafoutas and Sutter, 2012) and sabotage (Leibbrandt et al. 2017) even severe. On the other hand, policies with prosocial incentives treat men and women equally and eliminate such persistent source of concerns related to affirmative action policies (see also Cassar et al. 2017). Overall, we suggest that when designing policies to promote gender equality in competitive environments, using prosocial incentives through company philanthropy or other social responsibility policies could be promising.

Nonetheless, research on the use of prosocial incentives to encourage women to compete is still limited. Therefore, an important direction for future research would be to extend our findings to investigate various forms of prosocial incentives, as in Tonin and Vlassopoulos (2010, 2015), which may contribute to the further understandings of policy design firms can implement to promote gender equality. Furthermore, it is promising to investigate the policy mix of affirmative action policies favoring women and the use of prosocial incentives. By extending our theoretical model, it is straightforward to verify prosocial incentives eliminate women's cost of the social image associated with affirmative action policies. In addition to this, it is interesting to experimentally investigate whether prosocial incentives eliminate concerns toward sabotage under gender quotas with peer review observed in Leibbrandt et al. (2017).

Relatedly, aside from prosocial incentives, it maybe possible to mitigate negative social image effects through other channels, as discussed in Bursztyn and Jensen (2017). For example, Bursztyn et al. (2018) provide evidence that men's attitudes towards women working in Saudi Arabia is misperceived, where most men support female labor force participation but incorrectly believe that most other men are against it. If women's beliefs about how others perceive women's competitive behavior are incorrect, interventions correcting those beliefs might be effective.

Finally, future work should also address the important open question of how policies that are intended to encourage women to compete affect the evolution of gender norms or the notion of gender stereotypes in the society in the long run. One needs to be aware of, for instance, the possibility that affirmative action policies that treat women preferentially can generate the misconception that women are "weaker," "less intelligent," or "inferior" to men, which could lead to undesirable gender stereotypes. An ideal policy should be effective enough in inducing women to participate in competitions and break the glass ceiling faced by women in the long run.

4.5 Proof of Propositions

Proof of Proposition 1. See Bursztyn et al. (2017a) Proposition 1.

Proof of Proposition 2. (i) Assume $r = 1$ and $\rho = 1$. Then, $\Pr(\tau_i = f \mid d_i = 0) = 1$, since $\tau_i = m$ is eliminated by applying the D1 criterion. Hence,

$$b_P + \lambda \leq w_A b_T - c_f + \lambda(1-q) \Leftrightarrow 0 \leq \lambda \leq \frac{w_A b_T - b_P - c_f}{q}.$$

(ii) Assume $0 < r < 1$. Then, $\rho = 1$ follows. Thus, we have

$$\Pr(\tau_i = f \mid d_i = 0) = \tfrac{(1-q)(1-r)}{(1-q)(1-r)} = 1,$$
$$\Pr(\tau_i = f \mid d_i = 1) = \tfrac{(1-q)r}{(1-q)r+q}.$$

Therefore, $0 < r < 1$ implies

$$\begin{aligned} b_P + \lambda &= w_A b_T - c_f + \lambda \frac{(1-q)r}{(1-q)r+q} \\ \Leftrightarrow \quad r &= \frac{q}{1-q} \frac{\lambda - (w_A b_T - b_P - c_f)}{w_A b_T - b_P - c_f}. \end{aligned}$$

Further, in order for $0 < r < 1$ to hold, we have

$$w_A b_T - b_P - c_f < \lambda < \frac{w_A b_T - b_P - c_f}{q}.$$

(iii) Assume $r = 0$ and $\rho = 1$. Then, we have

$$\Pr(\tau_i = f \mid d_i = 0) = \tfrac{(1-q)(1-r)}{(1-q)(1-r)+q(1-\rho)} = 1,$$
$$\Pr(\tau_i = f \mid d_i = 1) = \tfrac{(1-q)r}{(1-q)r+q(1-\rho)} = 0.$$

Therefore,

$$\begin{aligned} b_P + \lambda &\geq w_A b_T - c_f \\ \text{and} \quad b_P + \lambda &\leq w_A b_T - c_m = w_A b_T, \end{aligned}$$

where $w_A b_T - b_P - c_f \leq \lambda \leq w_A b_T - b_P$.

(iv) Assume $0 < \rho < 1$. Then, $r = 0$ should be true. Therefore,

$$b_P + \lambda \frac{1-q}{1-q\rho} = w_A b_T \Leftrightarrow \rho = \frac{1}{q}(1 - \frac{\lambda}{w_A b_T - b_P}(1-q)),$$

and ρ is in $(0,1)$ when $w_A b_T - b_P < \lambda < \frac{w_A b_T - b_P}{1-q}$.

(v) Assume $r = 0$ and $\rho = 0$. Then, we have

$$\Pr(\tau_i = f \mid d_i = 0) = 1 - q.$$

Off-equilibrium path $\Pr(\tau_i = f \mid d_i = 1)$ is assumed to be 0, since $\tau_i = f$ is eliminated by the D1 criterion. Therefore,

$$b_P + \lambda(1-q) \geq w_A b_T (= w_A b_T - c_m) \Leftrightarrow \frac{w_A b_T - b_P}{1-q} \leq \lambda.$$

This completes the proof. QED

Proof of Proposition 3. First, we show that $r_T = 1$. If $r_T < 1$, $a_i = 0$ is weakly preferred to $a_i = 1$ by $\tau_i = f$ and thus,

$$\begin{aligned} w(b_T + \theta_m) - c_m + \lambda \Pr(\tau_i = f \mid a_i = 1, d_i = 1) &< w(b_T + \theta_f) - c_f + \lambda \Pr(\tau_i = f \mid a_i = 1, d_i = 1) \\ &\leq wb_T - c_f + \lambda \Pr(\tau_i = f \mid a_i = 0, d_i = 1) \\ &< wb_T - c_m + \lambda \Pr(\tau_i = f \mid a_i = 0, d_i = 1), \end{aligned}$$

hence, $\rho_T = 0$. It follows that $\Pr(\tau_i = f \mid a_i = 0, d_i = 1) < 1 = \Pr(\tau_i = f \mid a_i = 1, d_i = 1)$ and

$$w(b_T + \theta_f) - c_f + \lambda \Pr(\tau_i = f \mid a_i = 1, d_i = 1) > wb_T - c_f + \lambda \Pr(\tau_i = f \mid a_i = 0, d_i = 1),$$

which is a contradiction. Therefore, $r_T = 1$. Second, we show that $r = 1$. Assume $r < 1$. Given that $r_T = 1$, note that $\Pr(\tau_i = f \mid a_i = 0, d_i = 1) = 0 < \Pr(\tau_i = f \mid a_i = 1, d_i = 1)$.[18] Then,

$$\begin{aligned} \max_{a_i \in \{0,1\}} w(b_T + \theta_m a_i) - c_m + \lambda \Pr(\tau_i = f \mid a_i, d_i = 1) &< w(b_T + \theta_f) - c_f + \lambda \Pr(\tau_i = f \mid a_i = 1, d_i = 1) \\ &= \max_{a_i \in \{0,1\}} w(b_T + \theta_f a_i) - c_f + \lambda \Pr(\tau_i = f \mid a_i, d_i = 1) \\ &\leq b_P + \lambda \Pr(\tau_i = f \mid d_i = 0). \end{aligned}$$

[18]Specifically, we apply the D1 criterion whenever paths are off-equilibrium.

Hence, we have $\rho = 0$. However, it follows that $\Pr(\tau_i = f \mid d_i = 0) < 1$, $\Pr(\tau_i = f \mid a_i = 1, d_i = 1) = 1$ and thus,

$$\begin{aligned} b_P + \lambda \Pr(\tau_i = f \mid d_i = 0) &< b_P + \lambda \\ &< w(b_T + \theta_f) - c_f + \lambda \\ &= \max_{a_i \in \{0,1\}} w(b_T + \theta_f a_i) - c_f + \lambda \Pr(\tau_i = f \mid a_i, d_i = 1), \end{aligned}$$

which is a contradiction. Therefore, $r = 1$. Third, we show that $\rho = 1$. Given that $r = 1$ and $r_T = 1$, this is obvious. Finally, let us solve for ρ_T. Assume $0 < \rho_T < 1$. Then,

$$wb_T = w(b_T + \theta_m) + \lambda \frac{1-q}{1-q(1-\rho_T)},$$

must hold. Solving this, we obtain,

$$\rho_T = 1 - \frac{1}{q}(1 + \lambda \frac{1-q}{w\theta_m}),$$

and together with condition $0 < \rho_T < 1$ we have

$$-w\theta_m < \lambda < -\frac{w\theta_m}{1-q}.$$

This completes the proof. QED

4.6 Figures and Tables

Figure 4.1: Maze example

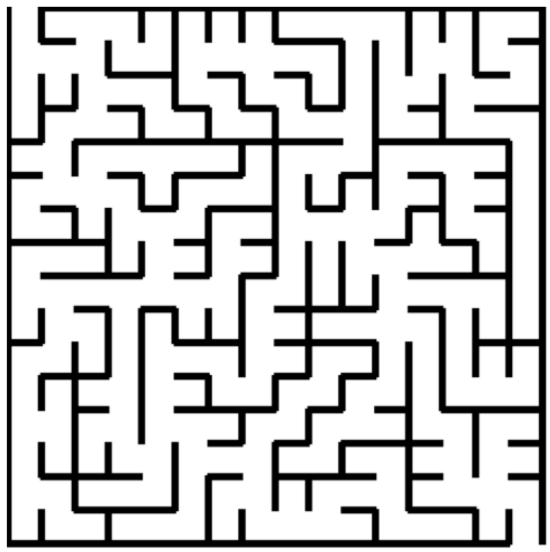
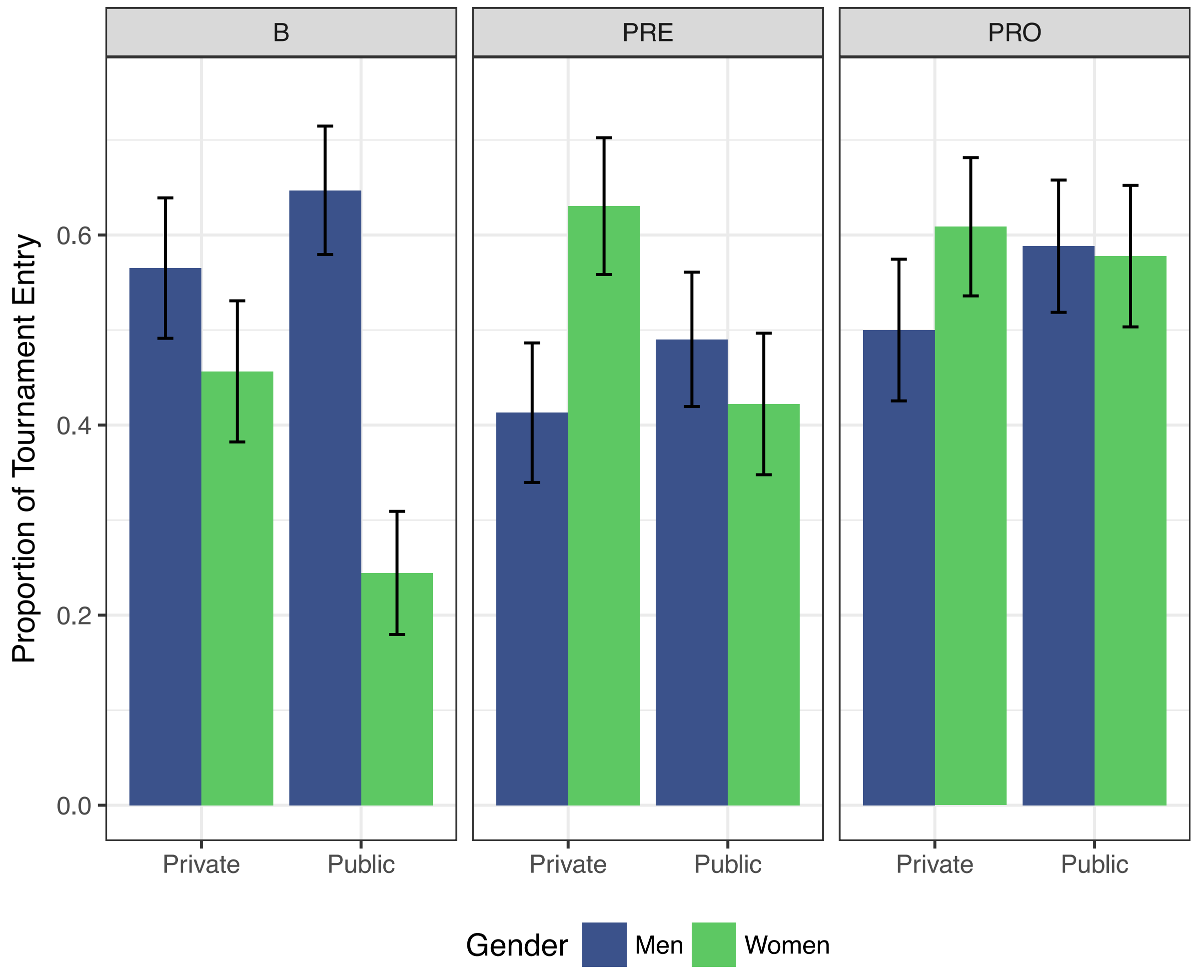


Figure 4.2: Proportion of Subjects Entering Tournaments



Notes. The figure reports the proportion of subjects who enter tournaments. B, PRE, and PRO represent baseline, preferential, and prosocial incentive treatments respectively.

Table 4.1: Descriptive Statistics of Men under Private and Public Conditions

	Private			Public			p-value
	N	Mean	SD	N	Mean	SD	t-test
Performance (Piece-rate)	46	10	2.4	51	11	3.4	0.37
Performance (Tournament)	46	9	2	51	9.4	2.5	0.39
Performance (B)	46	9.8	2.5	51	9.6	2.9	0.72
Performance (PRE)	46	10	2.8	51	10	2.9	0.95
Performance (PRO)	46	11	3.1	51	10	3.4	0.59
Guessed Rank	46	2.9	1.1	51	2.9	1.1	0.89
Overconfidence	46	0.72	1.9	51	0.31	1.7	0.27
Risk (Self-report)	46	4.8	2.1	51	5	2.5	0.67
Risk (Lottery)	46	3.3	1.5	51	3.9	1.5	0.046
WTP for Donation	45	2.1	1.7	50	1.8	1.2	0.37

Table 4.2: Descriptive Statistics of Women under Private and Public Conditions

	Private			Public			p-value
	N	Mean	SD	N	Mean	SD	t-test
Performance (Piece-rate)	46	9.6	2.9	45	9.8	2.7	0.72
Performance (Tournament)	46	8.9	2.3	45	8.7	2.3	0.61
Performance (B)	46	9.4	2.7	45	9.6	2.6	0.7
Performance (PRE)	46	10	3.1	45	9.3	2.4	0.23
Performance (PRO)	46	10	3.6	45	10	3.1	0.66
Guessed Rank	46	3.2	1.1	45	3.5	1.1	0.095
Overconfidence	46	0.28	1.6	45	0.13	1.6	0.66
Risk (Self-report)	46	4.4	2.2	45	4.2	2.2	0.78
Risk (Lottery)	46	2.8	1.5	45	2.8	1.4	0.88
WTP for Donation	44	2.3	1.7	43	3.4	1.8	0.0043

Table 4.3: Effects of Preferential and Prosocial Incentive Treatments on Women

	(1) private	(2) private	(3) public	(4) public
PRE	0.161*	0.160*	0.196***	0.194***
	(0.085)	(0.086)	(0.068)	(0.069)
PRO	0.136	-0.037	0.326***	0.305**
	(0.094)	(0.096)	(0.075)	(0.120)
Performance (Tournament)	0.186	0.185	-0.065	-0.053
	(0.153)	(0.155)	(0.122)	(0.123)
Guessed rank	-0.021	-0.021	-0.135**	-0.128**
	(0.056)	(0.057)	(0.052)	(0.053)
Risk(Self-report)	0.055***	0.053**	0.070**	0.069**
	(0.020)	(0.020)	(0.028)	(0.028)
Risk(Lottery)	0.058	0.057	0.025	0.019
	(0.040)	(0.041)	(0.036)	(0.038)
WTP for Donation		-0.056**		0.018
		(0.024)		(0.027)
PRO × WTP		0.132***		0.009
		(0.041)		(0.037)
Observations	132	132	129	129

Notes. The table reports the regression results of tournament entry of women under private and public conditions. PRE is the dummy of the preferential treatment, PRO the dummy of the prosocial incentive treatment, Performance the probability of winning the round 2 tournament. All specifications include round-fixed effects. Standard errors clustered by individuals are between parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4.4: Effects of Public Observability by Gender

	(1) men	(2) women	(3) men	(4) women	(5) men	(6) women
Baseline	0.068	-0.225**	0.083	-0.185**	0.117	-0.231***
	(0.099)	(0.098)	(0.089)	(0.093)	(0.094)	(0.093)
p-values for gender differences	0.032		0.029		0.004	
Preferential Treatment	0.076	-0.212**	0.007	-0.196*	0.063	-0.192*
	(0.103)	(0.104)	(0.097)	(0.106)	(0.102)	(0.110)
p-values for gender differences	0.045		0.138		0.063	
Prosocial Incentive Treatment	0.076	-0.042	0.077	-0.073	0.099	-0.073
	(0.103)	(0.101)	(0.097)	(0.105)	(0.104)	(0.110)
p-values for gender differences	0.403		0.273		0.215	
Round-FE	✓	✓	✓	✓	✓	✓
Performance and Psychological Attributes			✓	✓	✓	✓
Demographic Controls					✓	✓
Observations	97	91	94	86	93	84

Notes. The table reports the regression results on the effect of public observability on tournament entry. Performance is the probability of winning the round 2 tournament and psychological attributes include guessed rank, risk attitudes, and WTP for donations. Demographic controls include age, mother and father's education, and major fixed effects. All specifications include round-fixed effects. Robust standard errors are between parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Chapter 5

Conclusion

This dissertation explores the relation between social norms and individuals' decisions and behaviors using economic analysis. Social norms play a striking role in shaping behavior, but our understanding of when and why people respect social norms is still limited. Social norms influence the people's behaviors detaching them from those arising from intrinsic preferences. These behaviors can have impacts on the whole society through the economic activities in markets. Therefore, to investigate the individuals' behaviors facing the significant role of social norms can lead to an academic contribution to the literature of economics.

The first purpose of this dissertation is to consider the individuals' phycological process to follow norms when they are informed about others' behaviors. This type of policy is called social comparison nudge and recently attracting much attention of policymakers and scholars. Chapter 2 constructs a decision-theoretic model and posits that providing information on others' behaviors operates to enhance our norm-compliant behavior by activating psychological emotions of pride and shame. Our model is consistent with recent experimental findings in Klinowski (2016). The study provides with understanding for the individuals' psychological responses to the nudge policies, which is observed in the existing studies but left unexplained in economic theoretical foundations.

Another theme in this dissertation is gender. Social norms exist in various forms: norms prescribe how men/women should behave are called the gender norms. In the second part of this dissertation, we focus on gender norms. We have first explored the relationship between the gender gap in economic outcomes and the gender differences in behavioral traits such as competitiveness and risk attitudes. If these behavioral traits can be the source of economic inefficiency, the appropriate policy instruments are required. The study secondly seeks the effective policy interventions to overcome this gender differences in behavioral traits.

In Chapter 3, we investigate how competitiveness and risk attitudes are related to math achievement test scores among middle school students. We conduct an experiment at six public middle schools in Japan to collect measures of competitiveness and risk attitudes and merge them with an administrative dataset containing information on students' achievement test scores. The results from the experiment show that girls are less competitive and exhibit greater risk aversion compared to boys, which are in line with the previous literature. We find that competitiveness is positively correlated with math achievement conditional on students' prior achievements and demographics, while greater risk aversion is associated with higher math achievement. While we partially observe similar relationships for reading and English achievement test scores, math is the clearest among subjects. Taken together, the results indicate that the gender differences in competitiveness are widening the gender gap in math achievement, but that the gender differences in risk attitudes contribute to narrowing it.

Chapter 4 investigates how social image concerns affect women's decisions to compete. We first propose a theoretical model to show that participating in a competition is costly for women from the social image viewpoint, since such behavior deviates from traditional female gender norms. This results in women's lower standing in competitive environments, even under affirmative action policies favoring women, when decisions to compete are observed. We posit and theoretically demonstrate that introducing prosocial incentives in a competitive environment can effectively encourage women to compete even under public observability. Second, we conduct a laboratory experiment, randomly manipulate the public observability of decisions to compete, and test our theoretical predictions. The results of the experiment are fairly consistent with the theoretical predictions. We suggest that, when designing policies to promote gender equality in competitive environments, using prosocial incentives through company philanthropy or other social responsibility policies could be promising.

Finally, we discuss the implications of this dissertation. Our results have some implications for Japanese society as well. People in Japan put high value on the coordination and eyes of the groups they belong to. As Benedict (1946) argue, while Western people behaves based on a sense of guilt rooted in Christianity, Japanese tries to avoid the different behaviors from other people reflecting the culture of shame. Consequently, it is expected that Japanese people's decisions and behaviors are strongly affected by the social norms compared to other countries. Thus, designing a policy which takes social norms into account is important, especially in Japan where individuals feel shame strongly comparing with other people. Related to the relative importance of social norms in the Japanese society, as we discussed in Chapter 4, the women's presence in Japan is much behind compared to other developed countries. We proposed a new possible intervention that combines competitions and prosocial activities such as charitable donation, leading women's participation in the competition without their cost of social images. This is just one idea and we need to further seek how one can mitigate the social image cost of women participating in the competitions. If we can make women to enter competitions without any societal cost which comes from female gender norms, we might be able to discover new talent that has not been utilized so far in the society.

Bibliography

[1] Akerlof, George and Rachel E. Kranton, 2000. "Economics and Identity," Quarterly Journal of Economics, 115 (3), 715-753.

[2] Allcott, H., 2011. "Social Norms and Energy Conservation" *Journal of Public Economics*, 95, 1082-1095.

[3] Allcott, H., and Kessler, J., 2015. "The Welfare Effects of Nudges: A Case Study of Energy Use Social Comparisons," NBER working paper.

[4] Almas, Ingvild, Alexander W. Cappelen, Kjell G. Salvanes, Erik . Srensen, and Bertil Tungodden, 2016. "What Explains the Gender Gap in College Track Dropout? Experimental and Administrative Evidence," American Economic Review, 106 (5): 296-302.

[5] Altonji, Joseph G., and Rebecca M. Blank, 1999. "Race and Gender in the Labor Market." Handbook of Labor Economics 3: 3143-3259.

[6] Amanatullah, Emily T., and Michael W. Morris, 2010. "Negotiating Gender Roles: Gender Differences in Assertive Negotiating are Mediated by Women ' s Fear of Backlash and Attenuated When Negotiating on Behalf of Others." Journal of Personality and Social Psychology 98 (2) 256.

[7] Andersson, Ola, Hakan J. Holm, Jean-Robert Tyran, and Erik Wengstrom, 2015. "Risk Aversion Relates to Cognitive Ability: Preferences or Noise?" Journal of the European Economic Association 14, no. 5 : 1129-1154.

[8] Andreoni, James, Amalia Di Girolamo, John A. List, Claire Mackevicius, Anya Samek, 2019. "Risk Preferences of Children and Adolescents in Relation to Gender, Cognitive Skills, Soft Skills, and Executive Functions." No. w25723. National Bureau of Economic Research, 2019.

[9] Ariely, Dan, Anat Bracha, and Stephan Meier, 2009. "Doing Good or Doing Well? Image Motivation and Monetary Incentives in Behaving Prosocially," American economic review, 99 (1), 544-555.

[10] Balafoutas, Loukas, Rudolf Kerschbamer, and Matthias Sutter, 2012. "Distributional preferences and competitive behavior." Journal of Economic Behavior and Organization 83 (1), 125-135.

[11] Balafoutas, Loukas and Matthias Sutter, 2012. "Affirmative Action Policies Promote Women and Do Not Harm Efficiency in the Laboratory," Science, 335 (6068), 579-582.

[12] Baldiga, K.A., 2013. "Gender Differences in Willingness to Guess." Management Science. 60(2): 434-448.

[13] Banks, Jeffrey S and Joel Sobel, 1987. "Equilibrium Selection in Signaling Games," Econometrica: Journal of the Econometric Society, pp. 647-661.

[14] Barsky, Robert. B., Thomas F. Juster, , Miles S., Kimball, and Matthew D. Shapiro, 1997. "Preference Parameters and Behavioral Heterogeneity: An Experimental Approach in the Health and Retirement Study." The Quarterly Journal of Economics, 112(2), 537-579.

[15] Bartling, Bjorn, Ernst Fehr, Michel Andre Marechal, and Daniel Schunk, 2009. "Egalitarianism and Competitiveness," American Economic Review, 99 (2), 93-98.

[16] Benabou, Roland, Jean Tirole, 2002. "Self-confidence and Personal Motivation." Quarterly Journal of Economics 117 (3), 871-916.

[17] Benabou, Roland and Jean Tirole, 2006. "Incentives and Prosocial Behavior," American Economic Review, 96 (5), 1652-1678.

[18] Benedict, Ruth, 1946. "The Chrysanthemum and the Sword: Patterns of Japanese Culture." Mariner Books.

[19] Benjamin, Daniel J., Sebastian A. Brown, and Jesse M. Shapiro, 2013. "Who is Behavioral? Cognitive Ability and Anomalous Preferences." Journal of the European Economic Association, 11, 1231-1255.

[20] Belzil, Christian, and Marco Leonardi, 2007. "Can Risk Aversion Explain Schooling Attainments? Evidence from Italy." Labour Economics, 14(6), 957-970.

[21] Belzil, Christian, and Marco Leonardi, 2013 "Risk aversion and schooling decisions." Annals of Economics and Statistics: 35-70.

[22] Berge, Lars Ivar Oppedal, Kjetil Bjorvatn, Armando Jose Garcia Pires, and Bertil Tungodden, 2015. "Competitive in the Lab, Successful in the Field?" Journal of Economic Behavior and Organization,118, 303-317.

[23] Blau, D. Francine, and Lawrence M. Kahn, 2017. " The Gender Wage Gap: Extent, Trends, and Explanations," Journal of Economic Literature, 55 (3), 789-865.

[24] Bohnet, Iris, 2016. "What Works." Harvard University Press.

[25] Bonin, Holger, Thomas Dohmen, Armin Falk, David Huffman, and Uwe Sunde, 2007. "Cross-Sectional Earnings Risk and Occupational Sorting: The Role of Risk Attitudes." Labour Economics, 14(6), 926-937.

[26] Booth, Alison and Patrick Nolen, 2012a. "Gender Differences in Risk Behaviour: Does Nurture Matter?." The Economic Journal 122.558: F56-F78.

[27] Booth, Alison and Patrick Nolen, 2012b. "Choosing to Compete: How Different are Girls and Boys?," Journal of Economic Behavior and Organization, 81 (2), 542-555.

[28] Boschini, Anne, Astri Muren, and Mats Persson, 2012 "Constructing gender differences in the economics lab." Journal of Economic Behavior and Organization 84 (3), 741-752.

[29] Burks, Stephen V., Jeffrey P. Carpenter, Lorenz Goette, and Aldo Rustichini, 2009. "Cognitive Skills Affect Economic Preferences, Strategic Behavior, and Job Attachment." Proceedings of the National Academy of Sciences, 106, 7745-7750.

[30] Bursztyn, Leonardo, Thomas Fujiwara, and Amanda Pallais, 2017. "'Acting Wife': Marriage Market Incentives and Labor Market Investments," American Economic Review, 107 (11): 3288-3319.

[31] Bursztyn, Leonardo, Georgy Egorov, and Robert Jensen, 2018. "Cool to be Smart or Smart to be Cool? Understanding Peer Pressure in Education," Review of Economic Studies.

[32] Buser, Thomas, Muriel Niederle, and Hessel Oosterbeek, 2014. "Gender, Competitiveness and Career Choices," Quarterly Journal of Economics 129 (3):1409-1447.

[33] Buser, Thomas, Noemi Peter, and Stefan C. Wolter, 2017. "Gender, competitiveness, and study choices in high school: Evidence from Switzerland." American economic review 107 (5): 125-30.

[34] Buser, Thomas, Noemi Peter, and Stefan C. Wolter, 2017. "Gender, Willingness to Compete and Career Choices along the Whole Ability Distribution." IZA Discussion Papers, No. 10976, Institute of Labor Economics (IZA), Bonn

[35] Buser, Thomas, Eva Ranehill, and Roel van Veldhuizen, 2017. "Gender Differences in Willingness to Compete: The Role of Public Observability," available at SSRN

[36] Carlsson, Magnus, Gordon D. Dahl, Bjorn Ockert, Dan-Olof Rooth, 2015. "The effect of schooling on cognitive skills." Review of Economics and Statistics 97(3): 533-547.

[37] Castillo, Marco, Jeffrey L. Jordan, and Ragan Petrie, 2018. "Children's rationality, risk attitudes and field behavior." European Economic Review 102: 62-81.

[38] Cassar, Alessandra, Feven Wordofa, and Y. Jane Zhang, 2016. "Competing for the Benefit of Offspring Eliminates the Gender Gap in Competitiveness," Proceedings of the National Academy of Sciences, 113 (19), 5201-5205.

[39] Carlana, Michela, 2019. "Implicit stereotypes: Evidence from teachers' gender bias." The Quarterly Journal of Economics 134(3): 1163-1224.

[40] Charness, Gary, Ramon Cobo-Reyes, and Angela Sanchez, 2016. "The Effect of Charitable Giving on Workers' Performance: Experimental Evidence," Journal of Economic Behavior and Organization,131, Part A, 61-74.

[41] Charness, Gary, Ramon Cobo-Reyes, and Angela Sanchez, 2016. "The Effect of Charitable Giving on Workers' Performance: Experimental Evidence." Journal of Economic Behavior and Organization 131: 61-74.

[42] Checchi, D., Fiorio, C. V., and Leonardi, M., 2014. "Parents' Risk Aversion and Children's Educational Attainment." Labour Economics, 30(0), 164-175.

[43] Cho, In-Koo and David M. Kreps, 1987. "Signaling Games and Stable Equilibria," Quarterly Journal of Economics,102 (2), 179-221.

[44] Cialdini, R., Reno, R., and Kallgren, C., 1990. "A Focus Theory of Normative Conduct: Recycling the Concept of Norms to Reduce Littering in Public Places." *Journal of Personality and Social Psychology,* 58, 1015-1026.

[45] Cicala, Steve, Roland G. Fryer, and Jorg L. Spenkuch, 2017. "Self-selection and Comparative Advantage in Social Interactions." Journal of the European Economic Association 16(4), 983-1020.

[46] Cunha, F., Heckman, J.J., 2008. "Formulating, Identifying and Estimating the Technology of Cognitive and Noncognitive Skill Formation." Journal of Human Resources. 43 (4), 738-782.

[47] Dahmann, Sarah C., 2017. "How does education improve cognitive skills? Instructional time versus timing of instruction." Labour Economics 47: 35-47.

[48] Dasgupta, Utteeyo, Subha Mani, Smriti Sharma, Saurabh Singhal. 2019. "Can gender differences in distributional preferences explain gender gaps in competition?." Journal of Economic Psychology 70: 1-11.

[49] DellaVigna, Stefano and Devin Pope, 2017. "What Motivates Effort? Evidence and Expert Forecasts," Review of Economic Studies.

[50] DellaVigna, Stefano, John A. List, and Ulrike Malmendier, 2012. "Testing for Altruism and Social Pressure in Charitable Giving," Quarterly Journal of Economics, 127 (1), 1.

[51] Dillenberger, D., and Sadowski, P., 2012. "Ashamed to be Selfish," *Theoretical Economics,* 7, 99-124.

[52] Dohmen, Thomas, Armin Falk, David Huffman, and Uwe Sunde, 2010. "Are Risk Aversion and Impatience Related to Cognitive Ability?" American Economic Review, 100(3), 1238-1260.

[53] Dreber, Anna, Emma von Essen, and Eva Ranehill, 2014. “Gender and Competition in Adolescence: Task Matters.” Experimental Economics 17 (1), 154-72.

[54] Eckel, Catherine C., Grossman, Philip J., 2002. “Sex Differences and Statistical Stereotyping in Attitudes Toward Financial Risk.” Evolution and Human Behavior 23(4): 281-295.

[55] Eckel, Catherine C., Grossman, Philip J., Johnson, C.A., de Oliveira, A.C.M., Rojas, C., Wilson, R.K., 2012. “School Environment and Risk Preferences: Experimental Evidence.” Journal of Risk and Uncertainy 45 (3), 265-292.

[56] Embretson S. E., and Reise, S. P., 2000. “Item Response Theory for Psychologists.” Mahwah, NJ : Psychology Press.

[57] Evren, O., and Minardi, S., 2017. “Warm-Glow Giving and Freedom to be Selfish,” *Economic Journal.*

[58] Exley, Christine L., Muriel Niederle, and Lise Vesterlund, 2016. “Knowing When to Ask: The Cost of Leaning-in.” HBS Working Paper 16-115.

[59] Festinger, L., 1954. “A Theory of Social Comparison Processes,” *Human Relations,* 7, 117- 140.

[60] Finn, Amy S., Matthew A. Kraft, Martin R. West, Julia A. Leonard, Crystal E. Bish, Rebecca E. Martin, Margaret A. Sheridan, Christopher F. O. Gabarieli, And John D. E. Gabrieli. 2014. “Cognitive skills, student achievement tests, and schools.” Psychological Science 25(3): 736-744.

[61] Fisman, Raymond, Sheena S. Iyengar, Emir Kamenica, and Itamar Simonson, 2006. “Gender Differences in Mate Selection: Evidence from a Speed Dating Experiment,” Quarterly Journal of Economics 121 (2):673-697.

[62] Frederick, Shane, 2005. “Cognitive Reflection and Decision Making.” Journal of Economic Perspectives, 19(4), 25-42.

[63] Frey, B., and Meier, S., 2004. “Social Comparisons and Pro-Social Behavior: Testing Conditional Cooperation a Field Experiment.” *American Economic Review,* 94, 1717-1722.

[64] Fryer Jr, Roland G., and Steven D. Levitt, 2010. "An Empirical Analysis of the Gender Gap in Mathematics." American Economic Journal: Applied Economics 2.2: 210-40.

[65] Gerber, Alan S., Donald P. Green, and Christopher W. Larimer, 2008. "Social Pressure and Voter Turnout: Evidence from a Large-Scale Field Experiment," American Political Science Review, 102 (01), 33-48.

[66] Gerber, A., Green, D., and Larimer, C., 2010. " An Experiment Testing the Relative Effectiveness of Encouraging Voter Participation by Inducing Feeling of Pride or Shame, " *Political Behavior*: 32, 409-422.

[67] Gillen, Ben, Erik Snowberg, and Leeat Yariv, 2019. "Experimenting with Measurement Error: Techniques with Applications to the Caltech Cohort Study." Journal of Political Economy 127(4): 1826-1863.

[68] Glaeser, E., 2006. "Paternalism and Psychology." University of Chicago Law Review. 73, 133-156.

[69] Gneezy, U., and Rustichini, A., 2000. "Pay Enough or Don't Pay at All." *Quarterly Journal of Economics,* 115, 791-810.

[70] Gneezy, Uri, Kenneth L. Leonard, and John A. List, 2009. "Gender Differences in Competition: Evidence From a Matrilineal and a Patriarchal Society," Econometrica, 77 (5), 1637-1664.

[71] Goldin C., Katz LF, Kuziemko I., 2006. "The Homecoming of American College Women: the Reversal of the College Gender Gap." Journal of Economic Perspectives. 20(4):133-56.

[72] Grogger, Jeff, and Eric Eide, 1995. "Changes in College Skills and the Rise in the College Wage Premium."' Journal of Human Resources: 280-310.

[73] Grosse, Niels Daniel, and Gerhard Riener, 2010. "Explaining Gender Differences in Competitiveness: Gender-Task Stereotypes." Jena economic research papers, 2010-017.

[74] Guiso, Monte, F., Sapienza, P., Zingales, L., 2008. "Culture, Gender, and Math." Science 320.5880: 1164-1165.

[75] Gul, F., and Pesendorfer, W., 2001. "Temptation and Self-Control," *Econometrica,* 69, 1403-1435.

[76] Halpern, D., C. Benbow, D. Geary, R. Gur, J. Hyde and M. Gernsbacher, 2007. "The Science of Sex Differences in Science and Mathematics." Psychological Science in the Public Interest, vol. 8(1), pp. 1-51.

[77] Hanushek, E. and D. Kimko, 2000. "Schooling, Labor-Force Quality and the Growth of Nations." American Economic Review 90(5):1184-1208.

[78] Hashidate, Y., 2018. "A Cognitive Foundation for Social Image Concerns," mimeo, University of Tokyo.

[79] Heckman, James, 2006. "Skill Formation and the Economics of Investing in Disadvantaged Children." Science, 312(5782): 1900-02.

[80] Imas, Alex, 2014. "Working for the "Warm Glow": On the Benefits and Limits of Prosocial Incentives," Journal of Public Economics, 114, 14-18.

[81] Jaeger, David A., Thomas Dohmen, Armin Falk, David Huffman, Uwe Sunde, and Holger Bonin, 2010. "Direct Evidence on Risk Attitudes and Migration." The Review of Economics and Statistics, 92(3): 684-689.

[82] Jamison, E., D. Jamison, and E. Hanushek, 2007. "The Effects of Education Quality on Income Growth and Mortality Decline." Economics of Education Review, 26(6): 771-88.

[83] Joensen, J. S. and H. S. Nielsen, 2009. "Is There a Causal Effect of High School Math on Labor Market Outcomes?" Journal of Human Resources 44 (1):171-198.

[84] Joensen, J. S. and H. S. Nielsen, 2016. "Mathematics and Gender: Heterogeneity in Causes and Consequences." Economic Journal, 126:1129-1163.

[85] Kamas, Linda, and Anne Preston, 2010 "Are Women Really Less Competitive than Men?."

[86] Krupka, E., and Weber, R., 2009. "The Focusing and Informational Effects of Norms on Pro-social Behavior," *Journal of Economic Psychology,* 30, 307-320.

[87] Klinowski, D., 2016. "Reluctant Donors and Their Reactions to Social Information," mimeo.

[88] Koch, A., Nafziger, J., and Nielsen, H.S., 2014. "Behavioral Economics of Education." Journal of Economic Behavior and Organization, 115, 3-17.

[89] Lavecchia, A., H. Liu, and P. Oreopoulos, 2016. "Behavioral Economics of Education: Progress and Possibilities." in Handbook of the Economics of Education, ed. by S. M. Eric A. Hanushek, and L. Woessmann, vol. 5, chap. 1, pp. 1-74. Elsevier.

[90] Lazear, Edward P., Ulrike Malmendier, and Roberto A. Weber, 2012. "Sorting in Experiments with Application to Social Preferences," American Economic Journal: Applied Economics, 4 (1), 136-63.

[91] Lee, Soohyung, Muriel Niederle, and Namwook Kang, 2014. "Do Single-sex Schools Make Girls More Competitive?," Economics Letters, 124 (3), 474-477.

[92] Lent, Robert W., and Gail Hackett, 1987. "Career Self-Efficacy: Empirical Status and Future Directions." Journal of vocational Behavior 30(3): 347-382.

[93] Lehvari, D., Weiss, Y., 1974. "The Effect of Risk on the Investment in Human Capital. " American Economic Review. 64, 950-963.

[94] Leibbrandt, Andreas, Wang L. Choon, and Foo, Cordelia, 2017 "Gender Quotas, Competitions, and Peer Review: Experimental Evidence on the Backlash Against Women," Management Science, 64 (8).

[95] Lonnqvist, Jan E., Markku Verkasalo, Gari Walkowitz, and Philipp C. Wichardt, 2015. Measuring Individual Risk Attitudes in the Lab: Task or Ask? An Empirical Comparison. Journal of Economic Behavior and Organization, 119, 254-266.

[96] Loewenstein, G., and O'Donoghue, T., 2006. ""We Can Do This the Easy Way or the Hard Way" Negative Emotions, Self-Regulation, and the Law," 73 The University of Chicago Law Review, 183,190.

[97] Maccheroni, F., Marinacci, M., and Rustichini, A., 2012. "Social Decision Theory: Choosing within and between Groups," *Review of Economic Studies,* 79, 1591-1636.

[98] Mellström, Carl and Magnus Johannesson, 2008. "Crowding Out in Blood Donations: Was Titmuss Right? " Journal of the European Economic Association, 6, 845-863.

[99] Mollerstrom, Johanna, 2014. "Favoritism Reduces Cooperation, " Working Paper.

[100] Murnane, Richard J., John B. Willet, Yves Duhaldeborde, John H. Tyler. 2000. "How Important are the Cognitive Skills of Teenagers in Predicting Subsequent Earnings?." Journal of Policy Analysis and Management 19.4: 547-568.

[101] Niederle, Muriel, 2017. "A Gender Agenda: A Progress Report on Competitiveness," American Economic Review, 107 (5), 115-19.

[102] Niederle, Muriel, Carmit Segal, and Lise Vesterlund, 2013. "How Costly Is Diversity? Affirmative Action in Light of Gender Differences in Competitiveness," Management Science, 59 (1), 1–16.

[103] Niederle, Muriel, and Lise Vesterlund, 2007. "Do Women Shy Away from Competition? Do Men Compete too Much?," Quarterly Journal of Economics 122 (3): 1067-1101.

[104] Niederle, M and L. Vesterlund, 2010. "Explaining the Gender Gap in Math Test Scores: The Role of Competition." Journal of Economic Perspectives 24(2):129-144.

[105] Niederle, M. L. Vesterlund, 2011 "Gender and Competition" Annual Review of Economics, 3, 601-630.

[106] Niederle, Muriel, and Alexandra H. Yestrumskas, 2008. "Gender Differences in Seeking Challenges: The Role of Institutions," Unpublished manuscript.

[107] Nollenberger, Natalia, Nuria Rodriguez-Planas, and Almudena Sevilla, 2016. "The Math Gender Gap: The Role of Culture." American Economic Review 106(5): 257-61.

[108] Paglin, Morton, and Anthony M. Rufolo, 1990. "Heterogeneous Human Capital, Occupational Choice, and Male-Female Earnings Differences." Journal of Labor Economics 8.1, Part 1:123-144.

[109] Powell, James, 1984. "Least Absolute Deviations Estimator for the Censored Regression Model." Journal of Econometrics 25, 303-325.

[110] Pintrich, Paul R, 1991. "A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ)."

[111] Panagopoulos, C., 2010. " Affect, Social Pressure and Prosocial Motivation: Field Experimental Evidence of the Mobilizing Effects of Pride, Shame and Publicizing Voting Behavior," *Political Behavior,* 32, 369-386.

[112] Reuben, Ernesto, Paola Sapienza, and Luigi Zingales, 2015. "Taste for Competition and the Gender Gap Among Young Business Professionals," Working Paper 21695, National Bureau of Economic Research November.

[113] Saito, K., 2015. "Impure Altruism and Impure Selfishness," *Journal of Economic Theory,* 136, 197-216.

[114] Samak, Anya and Roman Sheremeta, 2013. "Visibility of Contributors and Cost of Information: An Experiment on Public Goods," MPRA Paper, University Library of Munich.

[115] Sandberg, Sheryl, 2013. "Lean in: Women, Work, and the Will to Lead." New York: Alfred A. Knopf.

[116] Samek, Anya, 2019. "Gender Differences in Job Entry Decisions: A University-Wide Field Experiment," Management Science.

[117] Scheff, T., 1990. "Socialization of Emotions: Pride and Shame as Causal Agents, " In Theodore D. Kemper (Ed.) Research Agendas in the Sociology of Emotions. Albany: State University of New York Press.

[118] Shurchkov, O., and C. C. Eckel., 2018. "Gender Differences in Behavioral Traits and Labor Market Outcomes." In S. L. Averett, L. M. Argys, and S. D. Hoffman (eds.), Oxford Handbook on Women and the Economy. Oxford: Oxford University Press.

[119] Schwartz, Daniel, Elizabeth A. Keenan, Alex Imas, Ayelet Gneezy "Opting-in to prosocial incentives." Organizational Behavior and Human Decision Processes.

[120] Spiegler, R., 2013. " Comments on 'Behavioral' Decision Theory, " In *Advances in Economics and Econometrics: Tenth World Congress, Volume I: Economic Theory,* 289-304. Cambridge and New York: Cambridge University Press.

[121] Sutter, Mathias, Kocher, M.G., Glatzle-Rutzler, D., Trautmann, S.T., 2013. "Impatience and Uncertainty: Experimental Decisions Predict Adolescents' Field Behavior." American Economic Review.103 (1), 510-531.

[122] Tannenbaum, Daniel I., 2012. “Do Gender Differences in Risk Aversion Explain the Gender Gap in SAT Scores? Uncovering Risk Attitudes and the Test Score Gap.” working paper

[123] Thaler, R., and Sunstein, C., 2008. “Nudge: Improving Decisions about Health, Wealth, and Happiness, ” New Haven: Yale University Press.

[124] Tice, Dianne M., 1992. “Self-Concept Change and Self-Presentation: The Looking Glass Self is also a Magnifying Glass,” Journal of Personality and Social Psychology, 63 (3): 435-451.

[125] Titmuss, R., 1970. “The Gift Relationship: From Human Blood to Social Policy,” London: Allen and Unwin.

[126] Todd, P., Wolpin, K., 2003. “On the Specification and Estimation of the Production Function for Cognitive Achievement.” Economic Journal.113, 3-33.

[127] Todd, P., and Wolpin, K., 2007. “The production of cognitive achievement in children: Home, school, and racial test score gaps.” Journal of Human capital 1.1. 91-136.

[128] Tonin, Mirco and Michael Vlassopoulos, 2010. “Disentangling the Sources of Pro-Socially Motivated Effort: A Field Experiment,” Journal of Public Economics, 94 (11–12):1086-1092.

[129] Tonin, Mirco and Michael Vlassopoulos, 2015. “Corporate Philanthropy and Productivity: Evidence from an Online Real Effort Experiment,” Management Science, 61 (8): 1795-1811.

[130] van Veldhuizen, Roel. 2018. “Gender Differences in Tournament Choices: Risk Preferences, Overconfidence, or Competitiveness?” WZB Berlin, mimeo.

[131] Weinberger, Catherine J., 1999. “Mathematical College Majors and the Gender Gap in Wages.” Industrial Relations: A Journal of Economy and Society 38.3: 407-413.

[132] Weinberger, Catherine J., 2001 “Is Teaching More Girls More Math the Key to Higher Wages?.” Squaring Up: Policy Strategies to Raise Women ’ s Incomes in the US: 226-255.

[133] Yagasaki, Masayuki. 2018 “Pride, Shame and Social Comparisons.” Available at SSRN 3414146.

[134] Yagasaki, Masayuki and Makiko Nakamuro, 2018. “Competitiveness, Risk Attitudes, and the Gender Gap in Math Achievement,” RIETI Discussion Paper Series 18-E-066.

[135] Yagasaki, Masayuki. 2019. “Encouraging Women to Compete: Social Image and Prosocial Incentives.” Available at SSRN 3416380.

[136] Yeager, D. S., Henderson, M. D., Paunesku, D., Walton, G. M., D’Mello, S., Spitzer, B. J., and Duckworth, A. L., 2014. ”Boring but important: A self-transcendent purpose for learning fosters academic self-regulation.” Journal of Personality and Social Psychology, 107(4), 559-580.

[137] Zhang Y. Jane, 2013. “Can Experimental Economics Explain Competitive Behavior Outside the Lab?” mimeo, University of California, Berkeley.