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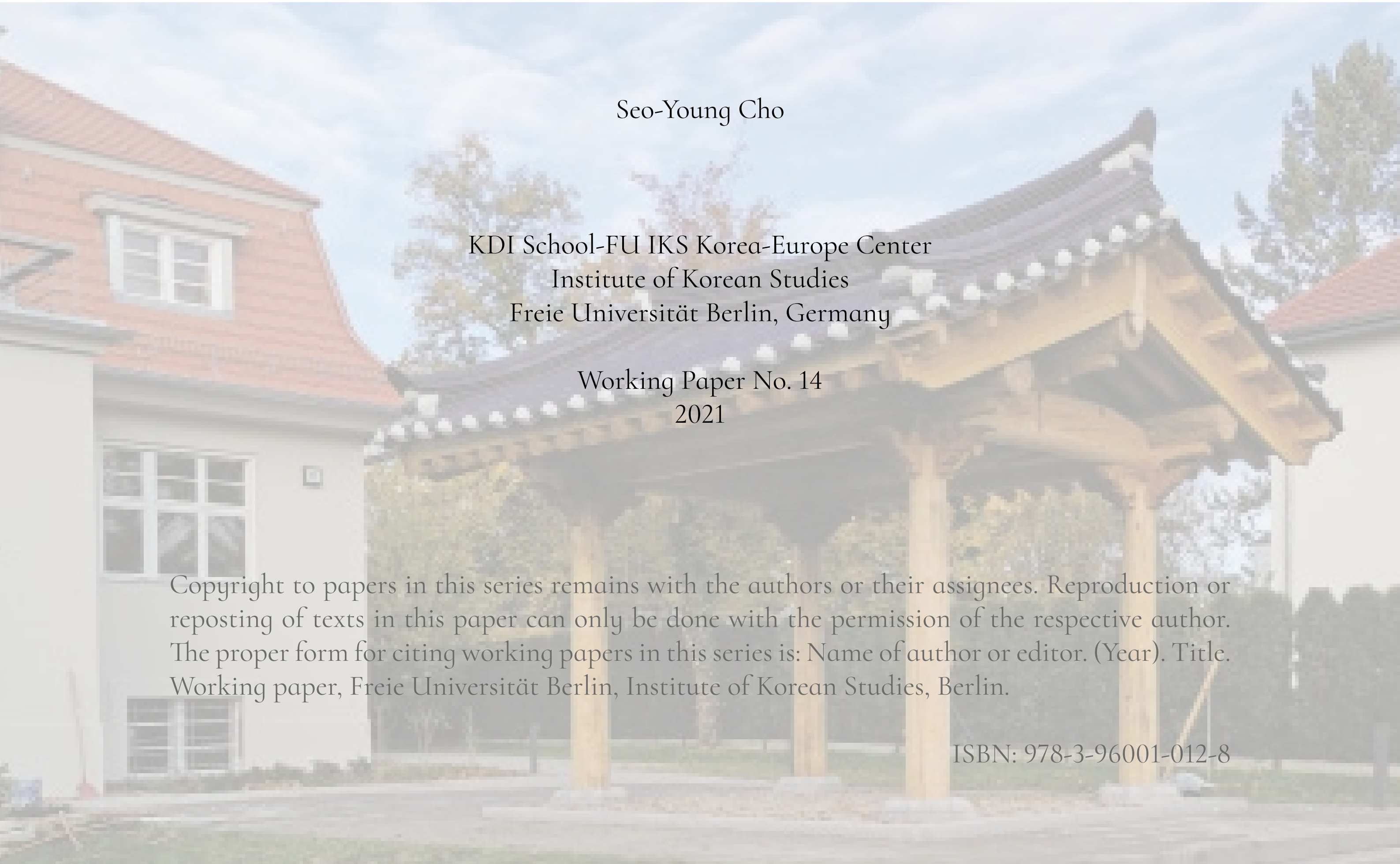

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Competition, Trust, and Gender – An Analysis of Education Data in East Asia

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Abstract: The PISA data reveals that girls trust the fairness of competition less and they are less willing to compete than boys. With this observation, this paper examines whether gender-matching environments can promote girls' competition by increasing their trust in the fairness of the rule. Analyzing the data of seven high-performing East Asian countries, the empirical findings show that gender composition of competition channels the effect of trust on competition. In mixed-sex competition, girls are more willing to compete if they trust the fairness of the rule. In contrast, trust has no effect on single-sex competition. This finding can be inferred that girls are more concerned about fairness when they have to compete with boys than competing with other girls possibly because of gender-based unequal treatment, while competition between girls reduces unfairness against girls. The channel effect of gender-matching environments emphasizes the importance of female representation for the enhancement of girls' competition.

Keywords: competition, trust, gender, gender-matching effects, math, East Asia
JEL codes: I24, J16, O17, O53

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1. INTRODUCTION

Competitiveness (willingness to compete) is an important non-cognitive ability in labor markets because individuals who are willing to undertake competition tend to aim higher and can accomplish more in their career development. Men and women often demonstrate differences in competition, in that women are more reluctant to compete. The low level of female participation in competition can be attributed to persisting gender gaps in earnings and promotion against women, despite improvement in female education (Niederle and Vesterlund 2010, 2011; de la Rica et al. 2008). In explaining gender gaps in competition, gender composition of environments is suggested as an important factor because women tend to shy away from competition more in male-dominated surroundings. Studies on female competition show that women are less willing to enter a competition if they have to compete with men, but they can be as competitive as men in single-sex matches (Booth and Nolen 2012a, b; Booth 2009; Boschini and Sjögren 2007; Datta Gupta et al. 2013; Niederle and Vesterlund 2007).

The positive gender-matching effect on competition documented in the literature can be explained by several channels: (i) competing with other women instead of men enhances women's confidence in their abilities, (ii) women can trust the fairness of the rule more when they compete with other female counterparts than competing with men, and (iii) single-sex environments reinforce a positive gender role for women and girls because active female peers and mentors are more available in these environments. Among these channels, linkages through confidence and gender-role models have been well examined in the literature (Niederle and Vesterlund 2007; Gneezy et al. 2003 for the former and Booth and Nolen 2012a, b; Booth 2009 for the latter). However, the literature has not elaborated the channel effect of gender-matching through increasing trust in the fairness of the rule.

To fill this gap in the literature, this paper is aimed to identify the channel of gender-matching environments in which girls can trust the fairness of competition more. In unraveling this effect, this study focuses on competition in math because competitive occupational choices that offer higher payment and promotion often require quantitative and mathematical skills (Friedman-Sokuler and Justman 2016). Thus, gender gaps in competition in math can provide a lens to peer into future gender gaps in competitive labor markets.

To do so, this paper concentrates on seven East Asian countries/economies – Hong Kong, Japan, South Korea, Macao, Shanghai (China), Singapore, and Taiwan – which are high-performing economies with high education.[1] For the empirical analysis, the education data of the 2012 Programme for International Student Assessments (PISA, OECD 2012), which was conducted with high school students in selected countries worldwide, is utilized because this edition of data includes a detailed survey on students' attitudes and plans for math studies. The seven East Asian countries/economies are the top seven performers in the PISA math test[2] and therefore the findings can provide implications particularly relevant for other high-performing countries in education. Also, this study diversifies regional focuses by shedding light on the evidence of East Asia, which overcomes the overrepresentation of North America and Europe in the literature on gender gaps in competition.

So far, the majority of the literature in the field has employed behavioral experiments, which reveal observed behavioral preferences for competition (Booth and Nolen 2012a, b; Buser et al. 2014; Gneezy et al. 2003; Niederle and Vesterlund 2007). Application of survey data examines another mode of preference for competition – stated behavioral choices. Therefore, the findings of a survey can add contributions supplementary to experimental results by revealing preferences through a different method. While survey data runs the potential risk of over-/understatements in answers, it provides advantages in expressing preferences in non-experimental (not controlled) settings.

The empirical results of this paper suggest that gender competition of competition channels girls' trust in the fairness of competition. Trust is important for girls when they compete with boys. A higher level of trust in the fairness of teachers (who are evaluators of competition) increases girls' willingness to compete in math when competition takes place in mixed-sex environments. In contrast, the effect of trust is insignificant in single-sex competition. This finding renders support for the argument that girls are more concerned about fairness when they have to compete with boys, while the trust effect is exhausted in same sex matches possibly because

[1] These countries further share important characteristics such as Buddhist and Confucianist heritages. These shared characteristics minimize the risks of biased results due to unobserved differences between countries.

[2] The country rankings of the PISA math test in 2012 (OECD 2012) are: 1. Shanghai-China (with a mean score of 613), 2. Singapore (573), 3. Hong Kong-China (561), 4. Taiwan (560), 5. South Korea (554), 6. Macao-China (538), and 7. Japan (536).

competition between girls reduces unfairness against girls. The channel effect of gender-matching environments emphasizes the importance of female representation for the promotion of girls' competition.

2. DESCRIPTIVE FINDINGS

This section presents descriptive evidence regarding how boys and girls are different in the key dimensions of individual attitudes and aptitudes for competition in math – namely, competitiveness (defined as willingness to compete), confidence and performance in math, as well as trust in the fairness of competition. To do so, the data of 6,215 male and 5,908 female high school students (age of 15) who participated in the PISA test in 2012 in the seven East Asian countries/economies are compared. Performance in math is measured by scores attained in the PISA math test and individual attitudes are gauged by using the survey of students conducted after the test. Table 1.2 summarizes the descriptive statistics of each dimension by gender. Overall, the descriptive findings highlight gender gaps against girls in competition in all dimensions evaluated.

First, competitiveness is evaluated by using survey questions that indicate the levels of one's participation in math competitions and motivation for pursuing a math-related career. These are measured by three indicators: the frequency of competing in math contests (*competition*), the frequency of participating in math clubs (*participation*), and the degree of instrumental motivation for math-related careers (*motivation*). Both *competition* and *participation* indicators have a scale from 1 (never) to 4 (always). *Motivation* is a composite index that combines four questions on one's study and career plan in the field of math. This indicator is measured on a continuous scale from –2.3 to +1.59. Appendix A provides details of the survey questions that were used to construct these measurements.

In all three measurements, boys demonstrate a higher level of competitiveness. The mean score of boys' participation in math contests (*competition*) is 1.39, substantially higher than 1.21 of girls. Furthermore, individual scores are differently distributed between boys and girls, in that boys' scores are placed significantly more on the right side of the space (i.e., higher scores). The z-statistic of the Mann–Whitney test of equal distributions is 14.39, indicating that the distributions of boys and girls are significantly different (p-value = 0.00***). The level of boys' participation in math clubs (*participation*) is also significantly higher than girls': the mean value of 1.22 and 1.10, respectively (MW z-statistics = 13.75, p-value = 0.00***). For instrumental motivation for math-related careers (*motivation*), the mean score of boys is 0.20 points higher than girls': –0.16 and –0.35, respectively. This gender gap against girls is maintained in all distribution tails of motivation scores (MW z-statistics = 11.11, p-value = 0.00***).

Second, trust in the fairness of the rule is proxied by the degree of trusting teachers. This variable provides a relevant indicator of students' attitudes for competition because teachers are responsible for evaluating their success in competition and advising for career choices. Hence, building trust with teachers is important to stimulate students' willingness to compete and performance. The level of trust in teachers is measured by the Index of Student-Teacher Relationship that captures the degree of a student's trust in his/her teachers. This index was constructed by using five questions on teachers' fairness and interpersonal attitudes towards students that were evaluated by individual students, measured on a continuous scale from –3.11 to +2.16. Boys express a higher level of trust in their teachers with a mean value of 0.10, compared to girls' score, 0.06. This gender difference is significant in all distribution tails of trust levels, placing boys' scores more on the right side than girls' (MW z-statistics = 1.97, p-value = 0.049**).

Third, the dimension of confidence refers to how confident a student is in his/her math studies. The Index of Self-Concept in Math that assembled five questions on students' self-confidence in math studies is used as a measurement here. Measured on a scale from –2.18 to +2.26, the level of confidence is considerably higher for boys on average: –0.03 for boys and –0.40 for girls (MW z-statistics = 21.59, p-value = 0.00***). On the other hand, girls are more anxious about math evaluation (evaluation aversion), which is used as a counter measurement of confidence. Evaluation aversion reveals the level of anxiety on receiving poor grades in math exams and is measured on a scale from 1 (not at all worried) to 4 (very worried). Girls express a significantly higher level of evaluation aversion than boys – with a mean value of 3.11 and 2.85, respectively (MW z-statistics = –14.90, p-value = 0.00***).

Fourth, the math score of each student in the PISA test is used to evaluate one's mathematical aptitudes as a performance-based measurement of abilities. Boys received about 11 points higher than girls on average in this test (test scores range from 0 to 1,000): 569.46 vs. 558.41. Moreover, this gender gap is significant at one percent level in all distribution tails of test scores (MW z-statistics = 6.46, p-value = 0.00***).

3. ARTICULATION OF TESTABLE HYPOTHESES

The main focus of this paper is whether trust in the fairness of competition can reduce gender gaps in competition. The literature has widely attributed gender gaps in competition to gender asymmetry in confidence and gender-specific role models (Booth and Nolen 2012a, b; Booth 2009; Datta Gupta et al. 2013; Gneezy et al. 2003, 2009; Niederle and Vesterlund 2007, 2011). However, little has been discussed regarding the influence of trust in the fairness of the rule, despite the fact that this can be crucial to one's decision to enter a competition. Without trusting rules that govern competition, individuals would be reluctant to participate in competition because they could be worried that their performance may not be evaluated fairly.

In the literature, it has been shown that women trust generally less than men (Buchan et al. 2008; Dohmen and Falk 2011; Glaeser et al. 2000). This is because women are social minorities who experience various forms of gender discrimination, and thus are less likely to believe that they are treated equally (Buchan et al. 2008). Given that, women tend to perceive the rules of a competition as unfair to them and this mistrust would be stronger especially when they compete against men who are the socially dominant group. In this respect, Niederle and Vesterlund (2007) propose women's distrust in the fairness of the game as a possible explanation for their shying away from competition. However, the authors do not further substantiate empirical evidence on the relationship between trust and competition, and instead emphasize the role of confidence in explaining gender gaps in competition.

Instead of building a direct relationship between gender gaps in trust and competition, the literature addresses the importance of trust by focusing on the effect of gender-matching environments. For instance, Gneezy et al. (2003) and Niederle and Vesterlund (2007) show that single-sex tournaments increase female participation in competition. Booth and Nolen (2012a, b) also find that girls in all-girls schools are more competitive and more often take risks than other girls in mixed-sex schools.[3] To explain how gender-matching environments can create positive effects on female competition, several channels are suggested. First is trust in the fairness of the rule. In single-sex environments, women would trust the fairness of the game more because they are not a social minority anymore in the absence of men. As they do not compete with men but with other women only, women can be more assured with the fairness of competition. Second, same-sex competition could boost women's confidence because women may evaluate their abilities more positively when competing with female counterparts instead of males. Third, gender-matching environments may provide a positive role model for women by increasing interaction with other women – e.g., female teachers, mentors, and peers. Thus, the assumed positive effect of single-sex environments for women and girls is presumably an outcome of the combination of increasing trust in fairness, confidence, and positive gender roles.

Considering all possible channels of gender-matching environments, this paper is aimed to shed light on the effect of trust in the fairness of the rule on female competition. To do so, the effect of trust is estimated in gender-matching and mixed-gender environments, respectively, and then, the difference is compared. This approach is articulated based on the argument that trust in fairness can be more important for women when they have to compete with men than competing with other women because women are more likely to be concerned about the fairness of the competition in cross-gender matches. Hence, the role of trust is expected to be larger for women in mixed-sex settings than in all-women environments.

With this in mind, the following hypotheses are proposed and tested empirically in school competitions by using the PISA data.

Hypothesis 1. Girls are less willing to compete than boys.

Hypothesis 2. A higher level of trust in the fairness of the rule increases one's willingness to compete.

Hypothesis 3. The positive effect of trust on competition is greater for girls in mixed-sex schools than others in all-girls schools.

[3] On the other hand, Lee et al. (2014) provide counter evidence through a country case study of South Korea, in that girls in single-sex schools are less competitive than girls in coeducational schools possibly because single-sex schools reinforce gender-stereotypes.

4. EMPIRICAL MODEL

To test for the hypotheses above, econometric models are formulated as presented below. Equation (1) corresponds to Hypotheses 1 and 2 and Equation (2) Hypothesis 3.

$$\text{Competitiveness}_{isc} = \alpha_s + \theta_c + \beta_1\text{Female}_{isc} + \beta_2\text{Trust}_{isc} + \beta_3\text{Trustworthiness}_{isc} + \beta_4\text{Math Score}_{isc} + \beta_5\text{Confidence}_{isc} + \beta_6\text{Evaluation Aversion}_{isc} + \beta_7\text{Single-sex School}_{isc} + \beta_8\,\text{Female}_{isc}{*}\text{Single-sex School}_{isc} + C_{isc}'\Pi + W_{isc}'\Lambda + u_{isc} \quad (1)$$

$$\text{Competitiveness}_{isc} = \alpha_s + \theta_c + \gamma_1\text{Trust}_{isc} + \gamma_2\text{Trustworthiness}_{isc} + \gamma_3\text{Math Score}_{isc} + \gamma_4\text{Confidence}_{isc} + \gamma_5\text{Evaluation Aversion}_{isc} + C_{isc}'\Pi + W_{isc}'\Lambda + u_{isc} \quad (2)$$

Equation 1 uses the full sample of all students so that the relationship between trust and competition can be drawn regardless of students' gender and the type of school they attend. In estimating Equation 2, the sample is divided into four groups based on school type and students' gender: i.e., girls in all-girls schools, boys in all-boys schools, girls in mixed-sex schools, and boys in mixed-sex schools. Through subgrouping students and comparing the effect of trust between the groups, the channel effect of gender-matching environments can be determined by identifying whether the effect is greater for girls in mixed-sex competition, as suggested in Hypothesis 3.

The data utilized for the analysis is the PISA test scores and survey of 12,123 individual students (i = 1,,,,, 12,123) in 1,029 schools (s = 1,,,,, 1,029) in the seven East Asian countries/economies (c = 1,,,, 7, i.e., Hong Kong, Japan, South Korea, Macao, China-Shanghai, Singapore, and Taiwan) in 2012.[4] Using this sample, the analysis exploits variations across individual students.

The dependent variable (*competitiveness*) is the level of a student's willingness to compete in math performance. As explained in Section 2, it is measured by the following three indicators, which enter the model separately: DV = {the frequency of participating in *competition* in math contests,

[4]According to the PISA administration, the double stratification of the sampling was used to ensure the random selection of schools and students (OECD 2014).

a scale from 1 to 4; the frequency of *participation* in math clubs, a scale from 1 to 4; and the level of instrumental *motivation* for a math-related career, a scale from –2.3 to +1.59}.

The independent variables of main interest are *female* and *trust*. The binary variable of *female* accounts for the gender effect of being a girl on competition (Hypothesis 1). In Equation 2, the *female* variable is omitted because the sample is sub-grouped by students' gender and school type. *Trust* measures the level of trust in the fairness of the rule, proxied by a student's self-assessed level of trusting the fairness of their math teachers – who evaluate their performance (Hypothesis 2). This is measured by using the PISA Index of Teacher-Student Relations on a scale from –3.11 to +2.16, as discussed in Section 2.

In addition to trust in teachers, the quality of teachers is separately controlled for in this model because trust level is determined not only by a student's attitudes of trust but also by the trustworthiness of teachers. Hence, it is necessary to distinguish these two aspects in order to single out the attitudinal effect of trust. Therefore, a variable of *trustworthiness* is added by using the Teachers' Morale Index that measures the quality of class teachers rated by school management. This index was constructed based on four questions on teachers' moral and professional attitudes in guiding students that were asked to the head of each school and was measured on a scale from –2.79 to +1.45 (see Appendix A for the details of the questions used for the Index). Given that this index accounts for a third-person's evaluation (other than students' and teachers'), it can be referred as an objective assessment of teachers' trustworthiness (quality).

The other explanatory variables are *confidence*, *evaluation aversion*, *math score*, *single-sex school*, and the vectors of cultural and resource-based capital variables (C and W, respectively). *Confidence* measures the level of a student's self-confidence in math studies by aggregating the answers of five questions that composes the Index of Self-Concept in Math (with a scale from –2.18 to +2.26). Confidence influences one's willingness to complete not only directly but also via gender-matching environments that can boost girls' confidence and trust simultaneously (Gneezy et al. 2003; Niederle and Vesterlund 2007). By accounting for such a compounding relationship between trust and confidence, one can isolate the influence of gender-matching environments on trust in Equation 2 (see Section 3 that discusses the three channels of promoting female competition through single-sex schooling). In addition, confidence is further controlled for by adding another mode of (counter)confidence in the model: evaluation aversion that indicates lack of confidence. Evaluation aversion takes into account that students may not participate in competition or pursue competitive career paths because of anxiety against negative feedback (Niederle and Yestrumskas 2008). This variable is constructed by using a question in the PISA survey, "*How much do you agree that you worry about getting poor grades in math*?" and the level of anxiety is measured on a scale from 1 to 4 (i.e., strongly disagree, disagree, agree, or strongly agree).

The model also incorporates PISA math scores as an explanatory variable because math abilities are likely a determinant of one's decision to compete in math. Here, PISA math scores are used as a measurement of performance-based cognitive abilities and range from 0 to 1,000. Scores were adjusted to have a mean of 500 test-score points and a standard deviation of 100 (OECD 2014). In this paper, the sample-mean score of the seven East Asian countries/economies is 564. This is 64 score points higher than the OECD-average, while the standard deviation (101) remains almost unchanged. Such a higher mean score corroborates a considerably high level of math abilities of East Asian students.

The *single-sex school* and *female*single-sex school* variables in Equation 1 represent gender-matching school environments. S*ingle-sex school* is a binary variable indicating whether a student attends a single-sex school (either an all-boys or all-girls school). The interaction term between *female* and *single-sex school* accounts for any augmented effect of single-sex schooling specifically for girls (i.e., attending an all-girl school). An additional effect on girls is presumed because girls are expected to participate in competition more often when they are matched with other girls instead of boys. As discussed in Section 3, single-sex schooling can promote girls' competition arguably through three channels – by increasing their trust in the fairness of the rule, boosting self-confidence in same-sex matches, and providing positive gender-role models. As trust and confidence are explicitly controlled for in this model, *female*single-sex school* is proxied for the third channel (gender-roles). When testing for Hypothesis 3 (Equation 2), the two gender-matching variables are omitted because the sample is sub-grouped by school type and students' gender in order to compare the effect of trust across the different groups of students who attend different types of schools.

Literature also suggests cultural influences as a determinant of one's decision to choose competitive studies and careers (Guiso et al. 2008; González de San Román and de la Rica Goiricelaya 2012). In this respect, one's country of origin is an important factor in his/her cultural background at the macro-level. Thus, the model controls for country-specific characteristics by adding seven country dummies denoted as θ_c (country fixed effects) in order to account for the effect of national cultural heritage on a student's willingness to compete. Additionally, *ethnic background* is included as a variable of cultural capital (C) to capture cases in which a student has a migrant status with an ethnic background different from the majority of people in the country of residence. Accordingly, it has a binary structure, taking a value of 1 for migrants and 0, otherwise. At the micro-level, family standing is incorporated as a cultural variable because it influences individual preferences and behaviors significantly from childhood onward. Especially, a mother's employment status can be a crucial determinant of girls' attitudes – in particular, their career ambition – because working mothers can serve as a professional female role model for their daughters (Farre and Vella 2013; Gneezy et al. 2009; Nollenberger et al. 2016). Hence, *mother's job* is added in Vector C. This variable measures the employment status of a mother on a four-point scale (out of labor force, in job markets, part-time, and full-time, respectively, a scale from 1 to 4).

In addition to cultural capital, resource-based capital that reflects a student's socioeconomic conditions can affect one's willingness to compete. Vector W comprises three variables in this respect: the level of family wealth and the availability of cultural and educational resources at home, respectively. Accordingly, the PISA Indices of Wealth, Cultural Possessions, and Home-based Educational Resources are used as the respective measurements: W = {*wealth*, a scale from –5.08 to +3.13; *cultural possessions*, a scale from –1.51 to +1.27; and *educational resources*, a scale from –3.93 to +1.12}.

The model also addresses school-specific effects because curriculum, school structures, and peer and teacher compositions differ across schools and they can influence a student's choice of competition and career ambition. The school effect is denoted as α_s in the model, and each school characteristics are accounted for by including school dummies (school fixed effects). Moreover, heterogeneous patterns of students' behaviors and performance across schools and countries are taken into account by constructing a multilevel model, in which observations of individual students are nested within schools which are further nested within countries (three-level nested model). In addition, robust standard errors are applied to correct for heteroscedasticity and correlations within the lowest level (i.e., individuals). The model is estimated by using a multilevel ordered probit method when the dependent variable is *competition* or *participation*. When the dependent variable is *motivation*, a multilevel linear regression method is applied. The results of the estimations are presented as average marginal effects.

5. RESULTS

5.1. TRUST, GENDER, AND COMPETITION

First, the results of the estimations that test for Hypotheses 1 and 2 are presented in Table 2. Columns 1–2 show the determinants of the frequency of one competing in math contests (*competition*). In Column 1, the gross gender effect is estimated without taking into account the other covariates, in that the level of girls' participation in competition is 4.1. percentage-points (p.p.) lower than boys (support for Hypothesis 1). Conditional on the other covariates (Column 2), the negative gender effect remains substantial, but its magnitude decreases by 40 percent: from 4.1 to 2.5 p.p. In other words, nearly 40 percent of the gender gap in competition can be attributed to gender differences in other observed characteristics such as trust, performance, confidence, and socioeconomic and school environments.

Among the effects of these observed factors, trust in the fairness of the rule has a significant effect, in that a one-standard deviation increase in trust level increases the frequency of joining competition in math by 0.45 p.p. As the trustworthiness of teachers is additionally controlled for in the estimation, this effect captures the effect of one's attitudes of trust exclusively. On the other hand, the effect of trustworthiness is less important than that of trust. A one-standard deviation increase in trustworthiness increases the frequency of one entering a competition by a lesser degree of 0.24 p.p., and this effect is marginally significant at the 10 percent level only. Among the other covariates, confidence and resource-based capital are important determinants of competition. Especially, the effect of confidence is substantial. Increasing the level of one's confidence by one-standard deviation increases the frequency of competition by 5.6 p.p. In contrast, performance (math scores), single-sex schooling, and cultural capital have no significant effect.

Second, examining the frequency of participating in math clubs (*participation*, Columns 3–4) corroborates the results of competition in math contests. In participation, a gross gender gap of 2.85 p.p. against girls is observed (Column 3), but it is mitigated to 2 p.p. by controlling for the other compounding effects (Column 4). This shows that the other observed characteristics of students explain about 30 percent of the gender gap in participation in math clubs.

Similar to the results of *competition*, trust is an important factor in explaining observed variations in *participation*. Increasing one's trust level by one-standard deviation results in more frequently participating in math clubs by 0.53 p.p. In contrast, trustworthiness has no effect. A student's performance in math is a significant determinant of participation in math clubs. However, it has an opposite direction of the effect to the expectation, as having a lower math score increases (rather than decreases) one's participation. Reducing one's math score by one-standard deviation raises one's participation level by 5.63 p.p. This is possibly because underperforming students participate in math clubs in order to improve their math scores. The effect of confidence remains positive on participation – with a smaller margin than the one in the competition model in Column 2. With an increase in confidence level by one-standard deviation, one participates in math clubs more often by 2.83 p.p. Resource-based capital also positively affects the frequency of one participating in math clubs. With a one-standard deviation increase in resource-based capital (cultural possessions and educational resources together), one increases his/her participation level by about 1 p.p.

Third, when one's willingness to compete is measured by instrumental motivation for math-related careers (Columns 5–6), a gross gender gap against girls is 4.79 p.p. (Column 5). This gap decreases to 1.18 p.p. by controlling for the other covariates – absorbing a three-quarter of the negative effect (Column 6). However, the negative gender effect against girls remains significant. The findings of motivation for math-related careers further verify the positive role of trust in the fairness of the rule. Increasing trust level by one-standard deviation reinforces one's motivation level by 5.54 p.p. This effect is substantially larger than the effect of trust on competition and participation above. Also, trustworthiness has a positive effect on motivation. By improving the trustworthiness of teachers by one-standard deviation, one's motivation level increases by 0.57 p.p.

In addition, confidence has a sizable effect. With a one-standard deviation increase in confidence level, the level of one's motivation increases by 11.7 p.p. Interestingly, a higher level of evaluation aversion strengthens one's motivation. A one-standard deviation increase in evaluation aversion raises one's motivation level by 2.78 p.p. Possibly, anxiety about grades reflects one's interest in studies that may positively be related to one's instrumental motivation for career development. Additionally, cultural capital enhances one's motivation, different from its insignificant effect on competition and participation. Belonging to the ethnic majority of the country of residence boosts an individual motivation level by about 1 p.p. On the other hand, the two variables of resource-based capital cancel out the effect of one another. The effect of a student's family wealth is negative with a magnitude of –0.068, while that of educational resources is positive with +0.066.

5.2. TRUST, COMPETITION, AND GENDER-MATCHING EFFECTS

The findings shown in Section 5.1. corroborate (i) the negative gender effect on girls' competition and (ii) the positive effect of trust in the fairness of the rule on competition. In this section, the relationship between trust and competition is further disentangled by examining the role of gender-matching school environments in generating the trust effect. As proposed in Hypothesis 3, gender-matching schooling can mediate the effect of trust on competition. This is because when girls are competing with other girls, they can be less concerned about unfair treatment caused by gender discrimination. Hence, the importance of trust in the fairness of the rule should be smaller for girls in all-girls schools than others in mixed-sex schools where competition takes place between boys and girls.

To test for this hypothesis, the sample is broken down into school type and students' gender, and the effect of trust is compared between the sub-samples. The sub-samples include four groups: (i) girls in all-girls schools, (ii) boys in all-boys schools, (iii) girls in mixed-sex schools, and (iv) boys in mixed-sex schools. Table 3 presents the results, in that the effect of trust is heterogeneous to the gender composition of competition. When competition takes place inside a school – i.e., competition in math contests and participation in math clubs –, the effect of trust is insignificant in single-sex schools but turns positive in mixed-sex schools (see Columns 1–8). This means that in same-sex competition, trust plays no role, whereas it maintains its positive influence on mixed-sex matches. This result applies to both girls and boys. However, the effect of trust on mixed-sex competition is significantly greater for girls. Regarding competition in math contests in mixed-sex schools, the size of the effect is twice as large on girls as boys, and it is about 40 percent larger on girls' participation in math clubs than boys'. With this finding, one can surmise that girls are more concerned about fairness when they have to compete with boys than boys' concerns in competing with girls.

When competition refers to instrumental motivation for competitive career choices, the effect of trust is consistently positive regardless of school type and students' gender (Columns 9–12). Instrumental motivation for math-related careers involves competition that takes place outside of school because in pursuing careers, one competes with others across schools. Thus, students in both single- and mixed-sex schools face mixed-sex competition in this regard. Accordingly, trust is predicted to have a positive effect regardless of school type, and the results support the prediction. However, the effect is larger on girls than boys and particularly, it is largest on girls in mixed-sex schools. Comparing the sizes of the effect between them, a one-standard deviation increase in trust level increases girls' motivation by 5.8 p.p. in mixed-sex schools and by 5.4 p.p. for girls in all-girls schools. On the other hand, the effect is smaller for boys, in that it is 5.3 p.p. in mixed-sex schools and 5 p.p. in all-boys schools as a result of increasing trust level by a one-standard deviation. Such differences between girls and boys in different types of schools are statistically significant at 1–5 percent levels: $\gamma_1(\text{trust})_{\text{girls, all-girls}} > \gamma_1(\text{trust})_{\text{girls, mixed-sex}} > \gamma_1(\text{trust})_{\text{boys, all-boys}} > \gamma_1(\text{trust})_{\text{boys, mixed-sex}}$.

The larger effect on girls in mixed-sex schools can be interpreted as reflecting girls' greater concerns about fairness if they are exposed to mixed-sex matches more regularly (i.e., attending a mixed-sex school). This finding restates the importance of the gender composition of environments for girls' competition. Meanwhile, boys in mixed-sex schools are also more concerned about fairness than others in single-sex schools. Seemingly, fairness is an important issue in mixed-sex environments regardless of a student's gender. However, the greater importance of trust on girls is reemphasized with the findings that the effect is consistently larger on girls than boys.

Another interesting finding is the effect of performance (math scores). Performance level is generally irrelevant to explaining one's willingness to compete. However, on several occasions, math scores have a significant effect but with the opposite direction of the effect between girls and boys. Math abilities enhance girls' competition in all-girls schools ($coeff._{competition} = +0.328$, or 8.2 p.p., see Column 1), but constrain boys' competition and participation in mixed-sex schools ($coeff._{competition} = -0.159$, or –4 p.p. and $coeff._{participation} = -0.397$, or –9.3 p.p., see Columns 4 and 8). Evidently, in gender-matching environments, high performing girls are more willing to compete possibly because girls can trust fair evaluation of their abilities more when boys are absent. By contrast, underperforming boys demonstrate a higher level of willingness to compete in mixed-sex environments. This could be because boys try to compensate for a low level of abilities with a high level of competitive attitudes when girls are present.

The results of the sub-sample tests provide empirical evidence for Hypothesis 3 as trust in the fairness of the rule plays a greater role for girls in mixed-sex competition than in single-sex one. Nonetheless, an important issue remains to be further discussed regarding the causality of the effect. The effect of trust may disappear in single-sex schools (inner-school competition) possibly for different reasons from the gender composition of competition. Single-sex schools may provide fairer environments due to better quality of instruction or school administration, as they tend to be more selective and resourceful than mixed-sex schools in many countries. In this case, the role of trust may be minimized in single-sex schools not because of gender-matching effects but because of better school quality that ensures fairer competition. However, this concern can be minimized in this analysis as the model explicitly controls for heterogeneous school quality by including school fixed effects (α_s in Equations 1–2) Moreover, the greater effect of trust on girls in mixed-sex schools remains consistent when competition takes place outside of school and therefore is less influenced by the quality of each respective school. Thus, school quality is less likely to affect the channel effect of gender-matching on trust in the fairness of competition perceived by girls.

5.3. ENDOGENEITY OF THE MODEL

While the potentially compounding effect of school quality that can affect the effect of trust is addressed in Section 5.2, the results may still be subject to endogeneity if individual attitudes of trust are correlated to other individual heterogeneity that is unobserved in this model – for instance, ethics or personal empathy for others that may influence one's trust and competition simultaneously. Therefore, whether such omitted variables are latent behind the effect of trust is required for a further examination.

To do so, an instrumental variable approach is applied by using an external variable that is exogeneous to individual students' unobserved characteristics but correlated to their attitudes of trust. The choice of the instrument is the average level of trust of the group who shares key characteristics: those who have the same gender, attend the same type of school in the same country, and have attained the same level of math scores ranging between +10 and –10 test-score points of one's own. The group average level of trust can capture variations in an individual trust level because an individual's attitudes of trust are likely to resemble those of their peer group. However, the group average level of trust, which excludes one's own trust level, is not directly correlated to a person's unobserved traits, and thus it can be qualified as an exogeneous variable.

The justification of the choice of the instrument is verified in the first stage regression presented in Table 4.1. The group average value of trust explains variations in individual trust level to a considerable extent (about 10–15 percent), and this effect is significant at 1–5 percent levels. In addition, the F-statistics display a high level of joint significance of the first stage model: F-stat. = 19.56~25.10, higher than the benchmark level of 10. This result strengthens the relevance of the group average variable as an instrument of individual trust level. Furthermore, the outcome of the Hansen test rejects the null-hypothesis that the group trust level is part of the structural model of individual competition ($0.37 < \text{p-value} < 0.51$, see Table 4.2), and therefore supports the exogeneity of the instrumental variable.

The second stage estimation that exploits exogeneous variations of trust is presented in Table 4.2. Accounting for the endogeneity of the trust variable does not alter the greater effect of trust on girls in mixed-sex competition – i.e., competition and participation in mixed-sex schools

(Columns 3 and 7) and competition outside of school (instrumental motivation, Columns 9 and 11). The magnitudes of the effect remain similar to the baseline results in Table 3. In single-sex competition (competition and participation in single-sex schools), the effect of trust is largely insignificant on both boys and girls, alike the findings presented in Table 3. What differs in this instrumental variable estimation is the effect of trust on boys in mixed-sex schools that loses its significance (Columns 4 and 8). This result strengthens the hypothesis that trust is more important for girls than boys when boys and girls compete together. On the other hand, the effect of trust remains positive on boys' instrumental motivation (Columns 10 and 12), although the effect becomes more moderate than the baseline findings. This can be inferred that competition outside of school requires trust in the fairness of the rule more strongly regardless of students' gender.

Overall, addressing the endogeneity of trust reiterates and bolsters the gender-asymmetric effect of trust in mixed-sex competition – trust is more important for girls, suggesting that they are more concerned about fairness when they compete with boys.

6. CONCLUSION

To address gender gaps in competition, this paper has examined whether gender-matching environments can promote girls' competition by increasing perceived fairness of competition. The analysis of the seven high-performing East Asian countries/economies shows that trust is an important determinant of girls' willingness to compete when they compete with boys. However, this effect of trust disappears in single-sex competition. This finding that girls are less concerned about fairness when they compete with other girls than competing with boys elucidates the channel of gender-matching environments as ensuring fairer competition for girls.

Today, promoting female talent is key to sustain growth and development in many countries, as improved female education – which is evident in East Asia – enables women to provide new sources of human capital for innovation. However, women are often shy away from competition because of persisting unequal treatment against them, resulting in loss of their human capital. Thereby, this study strives to inspire how female competition can be stimulated. The key finding that the effect of trust in the fairness of the rule is subject to gender composition of competition highlights the importance of female representation as a trust-ensuring condition, as proposed by Apicella et al. (2017) and Niederle and Yestrumskas (2008).

Focusing on competition in schools, this paper suggests gender-matching environments as a way to promote girls' willingness to compete. In future studies, it is certainly warranted to further investigate whether the effect of trust can still be channeled through gender-matching environments when it concerns competition among adults whose perceptions of fairness are more established than teenage students.

REFERENCES

Apicella, Coren, Elif Demiral, and Johanna Mollerstrom. 2017. No Gender Difference in Willingness to Compete When Competing against Self. *American Economic Review: Papers and Proceedings* 107: 36-40.

Autor, David, David Figlio, Krzysztof Karbownik, Jeffrey Roth and Melanie Wasserman. 2016. School Quality and the Gender Gap in Educational Achievement. *American Economic Review: Papers and Proceedings* 106: 289-295.

Booth, Alison. 2009. Gender and Competition. *Labour Economics* 16: 599-606.

Booth, Alison and Patrick Nolen. 2012(a). Gender Differences in Risk Behaviour: Does Nurture Matter? *Economic Journal* 122: 56-78.

Booth, Alison and Patrick Nolen. 2012(b). Choosing to Compete: How Different are Girls and Boys? *Journal of Economic Behaviour and Organization* 81: 542-555.

Boschini, Anne and Anna Sjögren. 2007. Is Team Formation on Gender Neutral? Evidence from Coauthorship Patterns. *Journal of Labor Economics* 25: 325-365.

Buchan, Nancy, Rachel T.A. Croson, and Sara Sonick. 2008. Trust and Gender: An Examination of Behavior and Beliefs in the Investment Game. *Journal of Economic Behavior and Organization* 68: 466-476.

Buser, Thomas, Muriel Niederle, Hessel Oosterbeek. 2014. Gender, Competitiveness, and Career Choices. *Quarterly Journal of Economics* 129: 1409-1447.

Chetty, Raj, Nathaniel Hendren, Frina Lin, Jeremy Majerovitz, and Benjamin Scuderi. 2016. Gender Gaps in Childhood: Skills, Behaviors, and Labor Market Preparedness. *American Economic Review: Papers and Proceedings* 106: 282-288.

Datta Gupta, Nabanita, Anders Poulsen, and Marie Claire Villeval. 2013. Gender Matching and Competitiveness: Experimental Evidence. *Economic Inquiry* 51: 816-835.

de la Rica, Sara, Juan J. Dolado, and Vanesa Llorens. 2008. Ceiling or Floors? Gender Wage Gaps by Education in Spain. *Journal of Population Economics* 21: 751-776.

Dohmen, Thomas and Armin Falk. 2011. Performance Pay and Multi-dimensional Sorting: Productivity, Preferences, and Gender. *American Economic Review* 101: 556-590.

Farre, Lidia and Francis Vella. 2013. The Intergenerational Transmission of Gender Role Attitudes and Its Implications for Female Labour Force Participation. *Economica* 80: 219-247.

Friedman-Sokuler, Naomi and Moshe Justman. 2016. Gender Streaming and Prior Achievement in High School Science and Mathematics. *Economics of Education Review* 53: 230–253.

Glaeser, Edward, David Laibson, Jose Scheinkman and Christine Soutter. 2000. Measuring Trust. *Quarterly Journal of Economics* 115: 811-846.

Gneezy, Uri, Muriel Niederle and Aldo Rustichini. 2003. Performance in Competitive Environments: Gender Differences. *Quarterly Journal of Economics* 118: 1049-1073.

Gneezy, Uri, Kenneth L. Leonard, and John A. List. 2009. Gender Differences in Competition: Evidence from a Matrilineal and a Patriarchal Society. *Econometrica* 77: 1637-1664.

González de San Román, Ainara and Sara de la Rica Goiricelaya. 2012. Gender Gaps in PISA Test Scores: The Impact of Social Norms and the Mother's Transmission of Role Attitudes. Institute for the Study of Labor (IZA) Discussion Paper No. 6338: Bonn.

Greif, Avner. 1989. Reputations and Coalitions in Medieval Trade: Evidence on Maghribi Traders. *Journal of Economic History* 49: 857-882.

Guiso, Luigi, Ferdinando Monte, Paola Sapienza and Luigi Zingales. 2008. Culture, Gender, and Math. *Science* 320: 1164-1165.

Kaufmann, Daniel, Aart Kraay and Massimo Mastruzzi. 2010. The Worldwide Governance Indicators: A Summary of Methodology, Data and Analytical Issues. World Bank Policy Research Working Paper No. 5430. Washington D.C.

Lee, Soohyung, Muriel Niederle and Namwook Kang. 2014. Do Single-sex Schools Make Girls More Competitive? *Economics Letters* 124: 474-477.

Niederle, Muriel and Lise Vesterlund. 2007. Do Women Shy Away from Competition? Do Men Compete Too Much? *Quarterly Journal of Economics* 122: 1065-1101.

Niederle, Muriel and Lise Vesterlund. 2010. Explaining the Gender Gap in Math Test Scores: The Role of Competition. *Journal of Economic Perspectives* 24: 129-144.

Niederle, Muriel and Lise Vesterlund. 2011. Gender and Competition. *Annual Review of Economics* 2011-3: 601-630.

Niederle, Muriel and Alexandra H. Yestrumskas. 2008. Gender Differences in Seeking Challenges: The Role of Institutions. NBER Working Paper 13922: Cambridge MA.

Nollenberger, Natalia, Nuria Rodriguez-Planas, and Almudena Sevilla. 2016. The Math Gender Gap: The Role of Culture. *American Economic Review: Papers and Proceedings* 106: 257-261.

Organization for Economic Cooperation and Development (OECD). 2012. Program for International Student Assessment (PISA). OECD: Paris.

Organization for Economic Cooperation and Development (OECD). 2014. PISA 2012 Technical Report. OECD: Paris.

Table 1. Descriptive Statistics

Table 1.1. Full sample

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Competition in Math Contests	12,123	1.31	0.64	1	4
Participation in Math Clubs	12,121	1.16	0.50	1	4
Instrumental Motivation	12,107	−0.26	0.98	−2.3	1.59
Female	12,123	0.48	0.5	0	1
Trust in the Fairness of the Rule	12,123	0.08	1.01	−3.11	2.16
Trustworthiness	12,123	−0.24	0.97	−2.79	1.45
Math Score	12,123	564	101	184	925
Confidence	12,123	−0.21	0.95	−2.18	2.26
Evaluation Aversion	12,123	2.98	0.91	1	4
Single-sex School	12,123	0.14	0.35	0	1
Mother's Job	12,123	2.95	1.31	1	4
Ethnic Background	12,123	0.77	0.42	0	1
Wealth	12,123	−0.57	0.78	−5.08	3.13
Cultural Possessions	12,123	−0.13	1.04	−1.51	1.27
Educational Resources	12,123	−0.20	0.99	−3.93	1.12

Table 1.2. Comparison between boys and girls

	Boys (n = 6,215)				Girls (n = 5,908)			
Variable	Mean	Std. Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
Competition	1.39	0.72	1	4	1.21	0.51	1	4
Participation	1.22	0.58	1	4	1.10	0.39	1	4
Instrumental Motivation	−0.16	1.00	−2.30	1.59	−0.35	0.96	−2.30	1.59
Trust	0.10	1.04	−3.11	2.16	0.06	0.97	−3.11	2.16
Trustworthiness	−0.26	0.96	−2.79	1.45	−0.22	0.98	−2.79	1.45
Math Score	569.46	104.05	207.83	924.84	558.41	97.24	183.99	912.30
Confidence	−0.03	0.94	−2.18	2.26	−0.40	0.92	−2.18	2.26
Evaluation Aversion	2.85	0.96	1	4	3.11	0.84	1	4
Single-sex School	0.12	0.32	0	1	0.16	0.37	0	1
Mother's Job	2.95	1.31	1	4	2.95	1.31	1	4
Ethnic Background	0.77	0.42	0	1	0.76	0.43	0	1
Wealth	−0.56	0.80	−5.08	3.13	−0.59	0.77	−5.04	3.11
Cultural Possessions	−0.23	1.04	−1.51	1.27	−0.03	1.03	−1.51	1.27
Educational Resources	−0.24	1.02	−3.93	1.12	−0.17	0.96	−3.93	1.12

Table 2. Competition, Trust, and Gender, full sample, nested model

	Multilevel Ordered Probit (AME)				Multilevel Linear	
DV	Competition		Participation		Motivation	
	(1)	(2)	(3)	(4)	(5)	(6)
Female	−0.162	−0.098	−0.114	−0.082	−0.187	−0.046
	(0.028)***	(0.013)***	(0.018)***	(0.012)***	(0.029)***	(0.025)***
Trust		0.018		0.021		0.214
		(0.007)***		(0.008)***		(0.007)***
Trustworthiness		0.01		0.003		0.025
		(0.006)*		(0.004)		(0.009)***
Math Score		−0.03		−0.225		0.017
(log)		(0.082)		(0.041)***		(0.204)
Confidence		0.236		0.119		0.481
		(0.035)***		(0.023)***		(0.019)***
Evaluation		−0.005		−0.001		0.119
Aversion		(0.019)		(0.011)		(0.027)***
Single-sex School		0.027		0.008		0.055
		(0.034)		(0.019)		(0.086)
Female*Single-		−0.016		−0.015		−0.037
-sex School		(0.034)		(0.026)		(0.066)
Mother's Job		0.002		0.001		−0.010
		(0.005)		(0.005)		(0.005)*
Ethnic		−0.033		−0.027		0.036
Background		(0.043)		(0.022)		(0.015)**
Wealth		0.005		0.008		−0.068
		(0.005)		(0.009)		(0.008)***
Cultural		0.033		0.019		−0.005
Possessions		(0.013)**		(0.005)***		(0.016)
Educational		0.022		0.021		0.066
Resources		(0.006)***		(0.009)**		(0.008)***
School Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Effects	Yes	Yes	Yes	Yes	Yes	Yes
Countries	7	7	7	7	7	7
Schools	1,020	1,020	1,020	1,020	1,020	1,020
Observations	12,123	12,123	12,133	12,133	12,139	12,139
Log Likelihood	−23,254	−10,456	−17,414	−8,249	−33,926	−14,455

Note: Random intercepts are applied. Parentheses are robust standard errors clustered at the individual level. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table 3. Competition, Trust, and Gender-matching School Environments, nested model

	Multilevel Ordered Probit (AME)								Multilevel Linear Regression			
DV	Competition				Participation				Motivation			
School Type	Single-sex Schools		Mixed-sex Schools		Single-sex Schools		Mixed-sex Schools		Single-sex Schools		Mixed-sex Schools	
Gender/Student	F	M	F	M	F	M	F	M	F	M	F	M
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Trust	0.010	0.007	0.023	0.012	−0.010	0.005	0.027	0.019	0.209	0.192	0.224	0.205
	(0.013)	(0.023)	(0.011)**	(0.005)**	(0.022)	(0.016)	(0.010)***	(0.010)*	(0.050)***	(0.042)***	(0.02)***	(0.014)***
Trustworthiness	0.023	−0.010	0.005	0.016	−0.007	−0.018	−0.002	0.011	0.008	0.058	0.020	0.026
	(0.004)***	(0.033)	(0.006)	(0.010)	(0.013)	(0.018)	(0.007)	(0.007)	(0.032)	(0.011)***	(0.013)	(0.020)
(log) Math Score	0.328	0.108	0.083	−0.159	−0.032	0.089	−0.058	−0.397	0.020	0.203	0.021	0.014
	(0.146)**	(0.267)	(0.093)	(0.072)**	(0.107)	(0.255)	(0.046)	(0.045)***	(0.330)	(0.338)	(0.238)	(0.195)
Confidence	0.152	0.322	0.174	0.287	0.065	0.124	0.083	0.154	0.550	0.554	0.450	0.485
	(0.018)***	(0.068)***	(0.029)***	(0.043)***	(0.01)***	(0.022)***	(0.025)***	(0.027)***	(0.044)***	(0.030)***	(0.017)***	(0.02)***
Evaluation	−0.040	0.028	−0.025	0.005	−0.029	−0.068	−0.008	0.012	0.187	0.097	0.106	0.120
Aversion	(0.023)*	(0.035)	(0.023)	(0.024)	(0.021)	(0.020)***	(0.008)	(0.018)	(0.044)***	(0.068)	(0.030)***	(0.03)***
Mother's Job	−0.002	−0.012	0.003	0.004	−0.006	−0.027	0.005	0.003	−0.038	−0.025	−0.007	−0.005
	(0.013)	(0.010)	(0.004)	(0.006)	(0.008)	(0.017)	(0.004)	(0.007)	(0.016)**	(0.010)**	(0.008)	(0.005)
Ethnic	−0.005	−0.340	−0.056	0.028	−0.024	−0.161	−0.017	−0.023	0.077	0.086	0.009	0.047
Background	(0.042)	(0.10)***	(0.021)***	(0.061)	(0.010)**	(0.057)***	(0.012)	(0.034)	(0.054)	(0.058)	(0.044)	(0.023)**
Wealth	−0.019	0.005	0.006	0.005	0.006	−0.023	0.015	0.002	0.029	−0.014	−0.092	−0.059
	(0.034)	(0.039)	(0.005)	(0.010)	(0.018)	(0.032)	(0.012)	(0.014)	(0.035)	(0.050)	(0.012)***	(0.02)***
Cultural	0.048	0.029	0.021	0.046	0.021	−0.010	0.013	0.031	−0.045	−0.038	0.006	−0.005
Possessions	(0.020)**	(0.035)	(0.015)	(0.011)***	(0.009)**	(0.016)	(0.007)*	(0.007)***	(0.042)	(0.036)	(0.023)	(0.014)
Educational	0.020	0.039	0.017	0.025	0.012	0.071	0.014	0.023	0.101	0.033	0.080	0.055
Resources	(0.010)**	(0.022)*	(0.011)	(0.006)***	(0.019)	(0.022)***	(0.011)	(0.011)**	(0.045)**	(0.051)	(0.013)***	(0.01)***
School Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Countries	7	7	7	7	7	7	7	7	7	7	7	7
No. Schools	83	67	843	854	83	67	843	854	83	67	844	855
Observations	968	743	4,940	5,472	968	743	4,946	5,476	968	744	4,947	5,480
Log Likelihood	−666.02	−754.98	−3,281.6	−5,381.7	−358.58	−662.31	−2,222.3	−4,496.3	−1,1895	−935.31	−5,743.7	−6,564.8

Note: Random intercepts are applied. Parentheses are robust standard errors clustered at the individual level. * $p < .10$, ** $p < .05$, *** $p < .01$.

Table 4. Competition, Trust, and Gender-matching School Environments, instrumental variable method

Table 4.1. First Stage Regression

DV	Individual Trust Level			
School Type	Single-sex Schools		Mixed-sex Schools	
Gender/Student	F	M	F	M
Group Average Level of Trust (IV)	0.65 (0.36)**	0.62 (0.33)**	0.79 (0.31)***	0.57 (0.25)***
Control Variables	Yes	Yes	Yes	Yes
Country Effects	Yes	Yes	Yes	Yes
School Effects	Yes	Yes	Yes	Yes
Countries	7	7	7	7
Schools	83	67	843	854
Observations	968	744	4,947	5,480
F-Statistics	21.33	19.56	25.10	20.49

Table 4.2. Second Stage Regression

DV	Competition				Participation				Motivation			
School Type	Single-sex Schools		Mixed-sex Schools		Single-sex Schools		Mixed-sex Schools		Single-sex Schools		Mixed-sex Schools	
Gender/Student	F	M	F	M	F	M	F	M	F	M	F	M
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Trust	0.015 (0.020)	0.012 (0.031)	0.024 (0.012)**	0.009 (0.006)	–0.014 (0.020)	0.011 (0.019)	0.031 (0.014)***	0.020 (0.017)	0.215 (0.115)**	0.219 (0.123)*	0.204 (0.10)**	0.095 (0.051)**
Control Var.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Countries	7	7	7	7	7	7	7	7	7	7	7	7
No. Schools	83	67	843	854	83	67	843	854	83	67	844	855
Observations	968	743	4,940	5,472	968	743	4,946	5,476	968	744	4,947	5,480
R^2	0.13	0.16	0.09	0.12	0.11	0.15	0.10	0.09	0.17	0.12	0.08	0.14
Hansen, p-value	0.39	0.40	0.41	0.43	0.51	0.38	0.49	0.42	0.45	0.37	0.38	0.50

Note: Parentheses are robust standard errors clustered at the individual level. * $p < .10$, ** $p < .05$, *** $p < .01$.

Appendix A. PISA Survey Questions
(that were used to construct variables in this paper)

A.1. Dependent Variables

- Competition in math contests
  How often do you participate in math competition? (always, often, sometimes, or never/rarely)

- Participation in math clubs
  How often do you participate in math clubs? (always, often, sometimes, or never/rarely)

- The Index of Instrumental Motivation in Math-related Careers
  How much do you agree with the following statements?
  – Math is worthwhile for work.
  – Math is worthwhile for career chances.
  – Math is important for future study.
  – Math helps to get a job.
  (strongly agree, agree, disagree, or strongly disagree)

A.2. Explanatory Variables

- Trust: The Index of Student-Teacher Relationship (evaluated by students)
  How much do you agree with the following statements?
  – You get along with teachers.
  – Teachers are interested.
  – Teachers listen to students.
  – Teachers help students.
  – Teachers treat students fairly.
  (strongly agree, agree, disagree, or strongly disagree)

- Trustworthiness: The Index of Teachers' Morale (evaluated by school heads)

  Think about the teachers in your school. How much do you agree with the following statements?

  – The morale of teachers in this school is high.

  – Teachers work with enthusiasm.

  – Teachers take pride in this school.

  – Teachers value academic achievements.

  (strongly agree, agree, disagree, or strongly disagree)

- Confidence: The Index of Self-concept in Math

  How much do you agree that you (are):

  – Not good at math.

  – Get a good grade in math.

  – Learn math quickly.

  – Find math to be one of the best subjects.

  – Understand difficult mathematics.

  (strongly agree, agree, disagree, or strongly disagree)

- Evaluation Aversion: Math anxiety

  How much do you agree that you worry about getting poor grades in math?

  (strongly agree, agree, disagree, or strongly disagree)