Joint Discussion Paper
Series in Economics

by the Universities of

Aachen · Gießen · Göttingen
Kassel · Marburg · Siegen

ISSN 1867-3678

No. 01-2017

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Nr. 2017/03

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Explaining Gender Differences in Confidence and Overconfidence in Math

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Updated in February 2018

Abstract: This paper investigates empirically how and why men and women are different in their confidence levels. In the analysis, confidence is disentangled into two dimensions: confidence in correct math knowledge and overconfidence in false knowledge. Using the data of the PISA test in math, the findings highlight that math abilities have different effects on boys and girls. Overall, math abilities increase confidence and decrease overconfidence. However, the positive effect on confidence is smaller for girls, and the negative effect on overconfidence is larger for them. This gender-asymmetric effect implies that well-performing girls are more constrained from gaining confident attitudes through their abilities, compared to well-performing boys. The empirical evidence further indicates that the gender-asymmetric effect of abilities can be explained by gender socialization that undermines womenӧs achievements and limit their opportunities.

Keywords: gender differences in confidence; gender gaps in math; gender-asymmetric effects of abilities; gender equality; gender socialization

JEL-codes: C31; I21; I24; J16; J24

Acknowledgements:

The author thanks participants of the Toyo-Marburg Institutional Economics and Economic Policy Workshop (Marburg, November 2016), the LEER Workshop on Education Economics (Leuven, March 2017), the International Association for Feminist Economics Annual Conference (Seoul, June 2017), the Korean Economic Association-Asian-Pacific Economic Association Conference (Seoul, July 2017), and the Kyungpook National University Economics Colloquium (Daegu, July 2017) for their helpful comments.

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1. Introduction

Gender inequality still persists today in many key areas of society, including higher education, employment, income, and political representation. Literature in the field of gender economics has addressed various causes of gender inequalityð from discriminatory treatment in families during childhood to institutional barriers against women and the social prejudice of limiting womenôs role. Among many causes, recent literature has come to focus on a crucial aspect of gender disparityð different choices men and women make in terms of their respective studies and professions. Empirical evidence shows that women often choose less prestigious career paths that are below their abilities, while men tend to seek educational and professional opportunities that offer higher incomes and social statuses (see Niederle and Vesterlund 2007 and 2010; Buser et al. 2014; Gneezy et al. 2003; Ifcher and Zarghamee 2016; Friedman-Sokuler and Justman 2016).

To this end, the literature has proposed womenôs lack of confidence as a main source of explaining gender differences in competitive choices of education and careers. For instance, Gneezy et al. (2003) argue that women underestimate their abilities compared to men, and they feel less competent in their abilities to solve problems. On the other hand, menôs overconfidence is a main determinant of their excessive participation in competition (Niederle and Vesterlund 2007; Buser et al. 2014). Men have a stronger preference for competition than women, partly due to them highly self-assessing their abilities (Ifcher and Zarghamee 2016). In contrast, women develop self-identities based on stereotypical gender roles and socially endorsed values that conflict with their professional identities and competitiveness (Cadsby et al. 2013). These works all convey one crucial observation; womenôs self-assessments are lower than the optimal level conditional on their abilities, while menôs self-evaluation is higher than what it should be given their abilities.

The current literature has well-established a link between gender gaps in confidence and competition by showing how men are more confident than women, which results in different choices and achievements between the genders in regard to competition. However, there is presently a gap in the literature regarding why men and women are different in their confidence-building (in other words, how confidence is determined differently between men and women). In this regard, this paper aims to further shed light on gender gaps in confidence through investigating the gender-asymmetric determinant of confidence. In unraveling such gender differences, this study focuses on compounding effects of gender and abilities, in that abilities are proposed to have heterogeneous effects on male and female confidence levels. One could surmise that higher abilities lead to a higher level of confidence and vice versa. However, the relationship between abilities and confidence may not be identical between the genders. In many societies, abilities of men and women are valued differently, and womenôs abilities are often denigrated or even stigmatized because highly talented women are seen as deviations from their socially assigned gender roles. Gneezy et al. (2003) point out that women often assess their abilities below menôs because of stereotyped gender identities, and thus gender differences in self-assessments are exaggerated beyond actual differences in abilities. Given the gender discriminatory social norms imposed on womenôs abilities, well-performing womenð who are indeed better qualified than their male counterpartsð are more likely negatively affected by such stereotyped beliefs. Hence, female abilities may not have as positive effects on womenôs confidence as male abilities do for menôs confidence.

To address this question empirically, this paper utilizes the survey and test results of the Programme for International Student Assessment (PISA, OECD 2012) for a micro-analysis of high school students from 65 countries/economies. The analysis focuses on the subject of math because success in this study is often crucial to determining educational and career achievements in areas that accompany higher payment and social recognition. In examining the gender-asymmetric effect of math abilities on confidence, confidence in math is disentangled into two dimensions: confidence in knowledge about correct math concepts; and overconfidence that refers to over-claiming oneôs knowledge about non-existent concepts. These two types are distinguished because justifiable confidence and over-claiming can produce notably different implications on study and career outcomes. As an example, Niederle and Vesterlund (2007) show that, due to their lack of confidence, high performing women tend to make a sub-optimal choice of not competing despite a high probability of winning the competition, whereas it is the overconfidence of underperforming men that prompts their excessive participation in competition. In other words, a high level of confidence can maximize the wining chances of well-qualified individuals, but a high level of overconfidence can exacerbate the loss of less qualified ones.

The empirical analysis of this paper derives the following findings. First, it shows that girls are not necessarily less confident than boys, but rather they are less overconfident. Second, the effect of math abilities (proxied with math scores as a performance-based ability measurement) is different between the genders. In general, math abilities increase confidence, while constraining overconfidence. However, there exists a further interaction effect of gender and math abilities that is negative for girls and positive for boys. This means that the positive effect of abilities on confidence is smaller for girls than boys, while the negative effect on overconfidence is larger for girls. Subsequently, the female advantage in confidence is smaller for well-performing girls than underperforming ones. Likewise, the female disadvantage in overconfidence is greater for girls with higher math scores.

These results highlight that girlsô abilities do not enhance their confidence as much as boysô. In this respect, this study corroborates the findings of Niederle and Vesterlund (2007) that top-performing girls are not necessarily more confident and they shy away from competition. A possible explanation for this is gender socialization, in that society undermines womenôs successes and is hostile towards highly gifted girls. With this argument, this study further examines a possible channel of generating such a gender socialization effect on confidence-building. The findings suggest that the societal conditions of gender inequality, which discredit womenôs accomplishments, channel the negative effect of female abilities on confidence. It is shown in this analysis that the negative interaction effect of female abilities turns positive when a country in question has an established record of ensuring gender equality (i.e. securing a more equal share of women in high-profile positions). However, the negative compounding effect is maintained in discriminatory countries against women. This finding asserts the importance of gender equality in sustaining female confidence. This is arguably because gender equality minimizes detrimental societal influences that undervalue womenôs abilities.

2. Gender Differences in Math: Descriptive Evidence from the PISA Data

The results of the PISA test show that female students underperform compared to male students in math and such a gender-based gap persists in most countries worldwide. In this section, descriptive statistics on math scores and other math-related indicators are presented and compared between male and female students, using the PISA data of 2012 (the 5^{th} survey).

First, a gender gap is evident in the outcomes of the math test. The PISA math test evaluates math proficiency levels in four sub-dimensionsð change and relationships, quantity, space and shape, and uncertainty and data (OECD 2014). In this test, boys outperform girls by 15.34 points. Specifically, male students, on average, achieved 491.20 points on a scale of 0 to 1,000, while the average score of female students is 475.86 (Figure 1.1). This difference indicates that female students attained less than 97 percent of the math score of their male counterparts.

Boys and girls are also different in their self-assessments on math knowledge, which correspond to confidence and over-confidence. These indicators are taken from the PISA survey questions on familiarity with math concepts and over-claiming on false concepts, respectively. 13 questions on familiarity with math concepts were aggregated into the óconfidence in mathô indicator and three questions on over-claiming are summed to compose the óoverconfidence in mathô indicator (for detailed information on the survey questions used here, see Table A.6). These variables are chosen to measure confidence and overconfidence in math because they reflect self-assessed beliefs about oneôs own knowledgeð the former is based on correct concepts and the latter false ones. Regarding familiarity with math concepts, students answered each of the 13 questions as to how well they know a certain concept with five options ranging from *never heard of it* (score 1) to *know it well, understand the concept* (score 5). Thus, the scale of the confidence in math indicator lies between a score of 13 (no confidence in any of the concepts) and 65 (full confidence in all of the concepts). For the three questions about over-claiming, students selected their answers among the same options (score 1 to 5), and the answers were aggregated to form the total scores of 3 (no over-claiming) to 15 (full over-claiming).

Figures 1.2 and 1.3 present the mean values of male and female overconfidence and confidence levels in math, respectively. The average value of male overconfidence is 5.05 on a 13-point scale, while for female students, it is 4.87 (Figure 1.2). This corresponds to a gender difference of 3.89 percent in overconfidence against girls. In contrast, confidence in math shows that girls are, on average, more confident, as illustrated by a mean value of 28.34 for girls and 28.04 for boys on a 53-point scale (Figure 1.3). This means that girlsô confidence level is about 1.1 percent higher than boysô. The size of the gender difference in confidence is, however, relatively small when compared to the one in overconfidence.

Confidence (and the lack of confidence) is alternatively measured by self-efficacy in math and anxiety towards math. The indicator of self-efficacy in math incorporates eight questions from the survey regarding the practical application of math knowledge such as reading a timetable and a graph, calculating discount rates, scales, and sizes, as well as solving equations. Students selected answers on a scale of 0 (not at all confident) to 3 (very confident) for each question and therefore the total scores of self-efficacy in math range from 0 (no self-efficacy) to 24 (full self-efficacy). Anxiety towards math is measured by using five questions. Students assessed their worries about math studies and grades. An answer to each question was chosen among four optionsð from strongly disagree (not worried at all, score 0) to strongly agree (very much worried, score 3). Thus, the total scores of anxiety towards math lie between 0 (no anxiety) and 15 (full anxiety). Using these alternative measurements, substantial gender gaps are evident. Figure 1.4 illustrates that the average score of boysô self-efficacy is 16.95 (on a 25-point scale), while that of girlsô is 15.62ð a gender difference of 8.54 percent against girls. The average level of girlsô anxiety towards math is, on the contrary, higher than that of boysô (see Figure 1.5): 7.86 versus 7.17 (on a 16-point scale) or a gender difference of 9.6 percent for girls.

Figures 1.6, 1.7, 1.8, and 1.9 present the gender-specific mean values of parental expectation, peer effects, interest, and instrumental motivation in math, respectively. The indicator of parental expectation measures how much parents care for their childôs math studies and the level is assessed by students. The variable of peer effects in math evaluates studentsô beliefs about their peer performance in math. The parental expectation and the peer effect indicators consist of three questions, respectively. Each answer is chosen on a scale of 0 (strongly disagree) to 3 (strongly agree). By summing the scores of the three questions, the total scores of each indicator range from 0 (no parental expectation/no peer effects) to 9 (full parental expectation/full peer effects). The indicator of interest in math measures how much students are interested in and enjoy math studies. Instrumental motivation in math captures studentsô self-assessments about the usefulness of math studies for their career development. Four survey questions were used to constitute each of these two indicators. Each question is answered on a scale of 0 (strongly disagree) to 3 (strongly agree), thus the aggregate scores of each indicator range from 0 (no interest/no instrumental motivation) to 12 (full interests/full instrumental motivation).

The gender difference in parental expectation is 0.19 points on a 10-point scale (Figure 1.6), in that boys assessed the expectation of their parents in math about 3 percent higher than girls. The difference in peer effects between the genders is rather trivial. The male mean value of the peer effect exceeds the female value by about 1 percent only (0.035 points on a 10-point scale, Figure 1.7). On the other hand, the gender differences in interest and motivation are comparatively large. The mean value of boys' interest is 6.06 (on a scale of 0 to 12), while it is 5.55 for girls (Figure 1.8). The difference of 0.51 points is equal to a gender gap of 9.2 percent against girls. Last, the gender difference in instrumental motivation in math is 0.41 points (on a scale of 0 to 12, Figure 1.9), in that boys rated the usefulness of math for their career more than girls by 5.3 percent.

Overall, Figure 1 shows substantial gender differences in math performance, self-assessments, interests, motivation, and math-related environments. The differences clearly suggest male-dominance in all dimensions except confidence in math abilities. With regard to confidence in math, girls express a slightly higher level of confidence in math concepts, but the size of the difference is smaller than most other indicators. Detailed information on the survey questions used for the indicators, as well as their descriptive statistics can be found in Tables A.5 and A.6.

3. Research Design

In this section, empirical models to investigate the questions of how and why boys and girls are different in their confidence and overconfidence in math are formulated and discussed. The baseline model is presented in Equations 1 and 1´ below.

$$\text{overconfidence}_i = \alpha + \beta_1 \text{female}_i + \beta_2 \text{math score}_i + M_i'\theta + X_i'\gamma + D_s + D_c + u_i \quad (1)$$

$$\text{confidence}_i = \alpha' + \beta'_1 \text{female}_i + \beta'_2 \text{math score}_i + M_i'\theta' + X_i'\gamma' + D_s + D_c + u'_i \quad (1')$$

For the empirical analysis, the PISA survey data (OECD 2012) is used to construct the dependent and independent variables. The dependent variables are a student's confidence and overconfidence levels in math (see Section 2 for detailed explanations on these two variables). Both variables take an integral form, ranging from 3 to 15 for overconfidence level and 13 to 65 for confidence. As the dependent variables are non-negative integral numbers, a negative binomial regression method is applied to estimate the model.

The independent variables of main interest are *female* and *math score*. *Female* is a dummy variable taking a value of 1 if student i is a female, and 0, otherwise. *Math score* is a PISA score in math that student i attained. This variable captures performance-based mathematical abilities of a student evaluated on a scale of 0 to 1,000. In the estimations, the *math score* variable takes two forms. First, it enters the model as a non-negative integral score assuming the linearity of the effect and then, it is transformed into a logarithm with the assumption that the effect may likely be concave.

Vector M includes studentsô attitudinal and interpersonal characteristics that are related to math studies. Four variables comprise M: studentsô interest in math, instrumental motivation, parental expectation, and peer effects. Section 2 above provides detailed information on these indicators. Vector X captures demographic and home characteristics of student i that likely influence his/her over-/confidence levels. Six variables are included in X: whether student i is cohabiting with his/her mother and the father, respectively, the educational levels of both parents[1] and their employment statuses.[2] These variables are taken into account in the model because family characteristics are important determinants of childrenôs personality and attitudes. In addition, the model also includes a dummy variable for each school, denoted as D_s, to reflect the effects of school environmentsð such as teachersô quality, school location, the type of school, and school-specific curriculum. Unobserved country heterogeneity that influences studentsô over-/confidence levelsð for instance, culture and social environmentsð is accounted for by including a dummy variable for each country, D_c. Remaining unobserved characteristics of student i are represented in the error term, *u*.

The baseline model in Equation 1 and 1´ imposes gender symmetry in the effect of abilities (*math score*). However, its effect may not be identical for both genders if society values male and female abilities differently, as discussed earlier. To identify potentially different effects of math scores between boys and girls, an interaction term of *female* and *math score* is introduced in the model. The model that relaxes the conditionality of gender-symmetric effects is presented below.

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[1] Educational levels are classified as: no completion of formal schooling, primary, lower secondary, upper secondary, and tertiary education (a higher score reflects higher education, a five-point scale of 0 to 4).

[2] Employment statuses are categorized as: working full-time, working part-time, not working but looking for a job, and not working and not looking for a job (a descending order, a four-point scale of 0 to 3).

$$\text{overconfidence}_i = \text{Ŭ} + \text{ɓ}_1\text{female}_i + \text{ɓ}_2\text{math score}_i + \text{ɓ}_3\text{female}_i\text{*math score}_i$$
$$+ M_i\text{´Ʉ} + X_i\text{´ş} + D_s + D_c + u_i \qquad (2)$$

$$\text{confidence}_i = \text{Ŭ}' + \text{ɓ}'_1\text{female}_i + \text{ɓ}'_2\text{math score}_i + \text{ɓ´}_3\text{female}_i\text{*math score}_i$$
$$+ M_i\text{´ Ʉ}' + X_i\text{´ş ´} + D_s + D_c + u\text{´}_i \qquad (2\text{´})$$

The newly added interaction term in Equations 2 and 2´ allows the effect of *math score* to vary between the genders. Specifically, the effect of *math score* is $\text{ɓ}_2 + \text{ɓ}_3$ ($\text{ɓ´}_2 + \text{ɓ´}_3$) for female students, while it is ɓ_2 (ɓ´_2) for their male counterparts. Thus, ɓ_3 (ɓ´_3) determines the size and direction of gender-asymmetric effect of math abilities on over-/confidence levels.

The question of whether math abilities have different effects on boys and girls is further examined by breaking down the sample by gender. The full sample is sub-grouped into boys and girls, and the model is estimated for each group, respectively. Then, the difference in the effect of *math score* between them is computed by comparing the coefficient of each group.

4. Gender Effects and Gender-asymmetric Effects of Math Abilities on Confidence and Overconfidence in Math

4.1. Baseline Results

The sample used for the regression analysis includes 243,334 high school students (118,979 boys and 124,355 girls) who took the PISA test in 2012.[3] The PISA test was administered to 15-year - old students in 65 OECD member and non-member countries and economies (see Table A.7 for the country list).

4.1.1. Overconfidence

Table 1 presents the results of the overconfidence model. Without the interaction effect of *female* and *math score*, the coefficient on *female* is negative, such that girls have a lower level of

[3] In the total sample of students who participated in the PISA test in 2012, one-third of the observations of each variable in the survey questionnaire are dropped out because of the rotated design of the survey. As assessment material exceeds the time allocated for the test, each student is administered a fraction of the full set of cognitive items in the survey and only one of the three background questionnaires (OECD 2012).

overconfidence than boys whose other conditions are equal. However, by introducing the interaction term (*female*math score*), the coefficient on *female* becomes positive, but the coefficient on the interaction is negative. Accordingly, the gender effect must be interpreted in relation to a girlǿs math score. To quantify the gender effect, the specification with a non-log math score (Column 4) is used because it provides a more straightforward interpretation. In Column 4, the coefficient on *female* is 0.0331 and *female*math score* is ï0.0001. Hence, the threshold level of a math score to generate a negative gender effect is 331. That means that for more than 90 percent of girls in the sample, their gender influences their overconfidence level negatively.

More importantly, the negative interaction effect implies that the negative gender effect becomes larger as a girlǿs math score increases. The changing marginal effect of *female* at different levels of math scores is presented in Table A.1 in detail (in addition, Figure 2 visualizes the changes). The average marginal effect computed here captures the averaged value of estimates $ß_1 + ß_3$ (in Equation 2) for each observation conditional on math scores. Specifically, when a girl has a math score of 395 (lowest 25 percent), her overconfidence level is 0.7 percent lower than that of boys in the same group. With a math score of 466 (sample mean), the gender gap in overconfidence increases to 1.1 percent. At a score of 540 (top 25 percent), it further increases to 1.4 percent, and 1.7 percent for the top 10 percent (a math score of 606). For the best performing group of the top 1 percent (a score of 708), the negative gender effect has the largest magnitude. Top performing girls have an overconfidence level that is 2 percent lower than boysô in the same rank. This gender gap of 2 percent is almost three times as large as that of the group in the lowest quartile. Evidently, the gender gap in overconfidence is greater for students in higher quartiles than those in lower quartiles in their math scores.

Furthermore, the effect of abilities is different between boys and girls. Without the interaction effect, the gender-symmetric effect of *math score* on overconfidence is negative: ï0.0005 (Column 3 in Table 1). By including the interaction term, the effect of math abilities remains negative, but the constraining effect in its absolute size becomes 25 percent larger for girls than boys (see Column 4). Specifically, increasing a math score by one-standard deviation decreases a girlǿs overconfidence by 1.7 percent of its standard deviation and a boyǿs by 1.35 percent. The gender-asymmetric effect of abilities is further evidenced in the sub-sample test of boys and girls separately. As presented in Table 2, the effect of *math score* is negative for both boys and girls, but the absolute value of the effect is larger for girls and this difference is significant at a 1 percent level (see the two-sample t-test shown at the end of the table).

4.1.2. Confidence

In contrast to the results of overconfidence, the gender effect is positive to girlsô confidence, independent of the functionality of the math score variable and the inclusion/exclusion of the interaction term (see Table 3). Without the interaction, being a girl increases her confidence level, but the magnitude of the effect is small ï an increase of 0.2 percent in its standard deviation. When the interaction effect of *female*math score* is included in the model, the positive effect of *female* remains, and the size of the effect increases to 1.25 percent of the standard deviation.

However, the interaction effect is negative, indicating that the size of the positive gender effect decreases as a girlôs math score increases. Table A.2 presents the average marginal effects of *female* estimated at different levels of math scoresð that is the averaged estimates, ϐ´$_1$ + ϐ´$_3$ in Equation 2´, of each observation conditional on math scores. While remaining positive at all levels of math scores, the positive marginal effect of *female* is declining in math scores. Specifically, for a girl ranked at the lowest quartile, her confidence level is about 2.1 percent higher than that of boys in the same rank. But this positive gender effect declines to 1.9 percent for girls in the highest quartile. For girls in the top 1 percent, the positive effect of *female* further decreases to 1.5 percentð a reduction of one-fourth compared to the effect on girls in the lowest quartile. Figure 3 graphically illustrates this declining marginal effect of *female* in math scores.

On the other hand, math abilities have a positive effect on confidence that is different from its negative effect on overconfidence. Under the assumption of gender-symmetry in the effect (Column 3 in Table 3), a one-standard deviation increase in the math score increases oneôs confidence level by 0.4 percent of its standard deviation. By introducing the interaction term of *female*math score*, however, the positive effect of *math score* increases to 0.45 percent for boys, while maintaining an effect of 0.4 percent for girls (Column 4). In other words, a higher math score enhances a boyôs confidence level by a substantially greater margin (12 percent) than it does for girls. This gender-asymmetric effect of math abilities is also reaffirmed by the sub-sample test (Table 4). The coefficient on *math score* is consistently larger for boys, and the difference is significant at 1ï 5 percent levels.

4.1.3. Other Determinants of Confidence and Overconfidence

In addition to the gender and gendered effects of abilities, personal attitudes, interpersonal environments, and demographic characteristics of students are important determinants of over-/confidence (see Tables 1 and 3). Interest and instrumental motivation in math increase both confidence and overconfidence levels of a student, while peer effects negatively affect them. Also, parental expectation in math increases their childrenꞌs confidence and overconfidence. Comparing the effects of the math-related factors between boys and girls (see Tables 2 and 4), instrumental motivation and peer effects have larger influences on boysô over-/confidence, and interest in math plays a more important role in shaping girlsô over-/confidence.

Among the demographic factors, parentsô education positively affects both confidence and overconfidence of their children (Tables 1 and 3). By contrast, the effect of parentsô employment is either insignificant or sometimes even negative. Living with a father increases both confidence and overconfidence levels of a student, while living with a mother constrains them. This finding reflects commonly assigned gender roles that parents play: masculine outgoingness vs. feminine modesty. In general, the demographic effects of parental characteristics are more important for girls than boys. Particularly in determining oneꞌs confidence level, all demographic factors influence girls to a larger degree than boys (Table 4). For overconfidence, on the other hand, the relative importance of such effects on each gender is heterogeneous (Table 2). Living with a mother, motherꞌs employment, and fatherꞌs education are more important for girls, while living with a father and motherꞌs education influence boys more.

4.2. Causality between Math Abilities and Over-/Confidence

The results so far present that math abilities explains oneꞌs confidence and overconfidence in math. Whether this relationship is causal requires further examination because the baseline model above is subject to endogeneity. Potential biases come from two sources. First, math scores and over-/confidence in math are likely to affect one another simultaneously. If this is the case, the estimated coefficients do not necessarily infer the direction of the effect that runs from math scores to over-/confidence. Second, the data utilizes information obtained through a self-assessment based survey. This process of data generation may yield systematic measurement errors if the self-reporting patterns are not random but associated with studentsô performance in math. Such a problem could lead to omitted variable biases. Hence, an instrumental variable approach is employed in this section to identify the causality between math abilities and confidence.[4]

For the IV analysis, different types of booklets used for the PISA math test are chosen as external instruments. 27 different booklets were used for the domain of the math test in 2012, and students were randomly assigned one of the booklets. While the PISA organizers tried to equalize the difficulty level of each booklet, there are non-trivial differences in the difficulty of the test that each booklet conveys. Therefore, variations in math scores reflect not only variations in math abilities but also types of booklets, to a considerable extent. With this in mind, one can surmise that the type of the booklet assigned to an individual student has explanatory power over his/her math score. The results of the first stage regressions shown in Table A.3 provide statistical evidence for this argument. In this test, 20 booklet dummies (*Book ID*) are used as external instruments, as 20 booklets were assigned to sampled students. Among the 20 excluded instruments, the coefficients on 15 variables are significant and all 20 instruments are jointly significant at a 1 percent level. The first stage results maintain that the booklets are good instruments for explaining variations in math scores.

Furthermore, as booklets are randomly distributed among students, the choice of booklet is not systematically associated with a studentôs unobserved characteristics that affect his/her over-/confidence level. The presumed exogeneity of the booklet variables is inspected using a Sargan test for identifying whether added instruments are correlated with the error term in the structural equation. The p-values for correctly accepting the null-hypothesis of no correlation lie between 0.11 and 0.38 in the overconfidence model (Table 5), and between 0.24 and 0.93 in the confidence model (Table 6). These results verify that the exogeneity of the external instruments

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[4] Yet, consistent estimators can still be produced given the large sample size (n = 243,334). With such a large sample size, the estimators converge to their true parametersð i.e., $\text{plim}_{n \rightarrow Ð}$ ɓ^$_k$ → ɓ$_k$ (Wooldridge 2013). However, an instrumental variable approach is applied here in order to ensure the robustness of the results in a more rigid way.

cannot be rejected at a conventional level of significance. With the conceptual and statistical justifications, the booklet variables are used to conduct two-stage IV estimations.

Tables 5 and 6 show the second stage results of estimating the overconfidence and confidence models, respectively, in that the math score and the interaction variables are instrumented by 20 booklet dummies (*Book ID*). The results largely confirm the baseline findings presented above. First, in Table 5, gender has a negative effect on girlsô overconfidence without the interaction term (Columns 1 and 2). By including the interaction effect (Columns 3 and 4), the coefficient on *female* becomes positive, but the interaction effect is negativeð supporting the baseline results. What is different from the baseline estimations is the predicted threshold of the math score at which the gender effect becomes negative. In the negative binomial model (Table 1), the predicted threshold score was 331, which corresponds to the lowest 10 percent. But, after accounting for the endogeneity of the model, the predicted threshold increases to a score of 478.6 (around the sample mean, see Column 4). This difference explains that reverse causality running from overconfidence to math scores is stronger for underperforming girls in math, and thus the negative gender effect disappears in this group after controlling for endogeneity.[5] However, for high performing girls, the IV results reaffirm the constraining effect of their gender on overconfidence. Moreover, this constraining effect becomes larger as their math score increases, as the interaction effect is negative. Likewise, the negative interaction effect further signifies that for girls whose math score is lower than 478.6, the positive gender effect declines as their math score becomes higher.

The IV estimations further support the gender-asymmetry in the effect of math abilities. In the full sample estimations, the effect of *math score* becomes positive for boys, while remaining negative for girls (i.e. $\beta_2 = +0.0126$ for boys; and $\beta_2 + \beta_3 =$ ï 0.0222 for girls, computed based on Column 4 of Table 5 following Equation 2 in Section 3). To verify the robustness of this finding, sub-sample estimations are conducted for boys and girls separately (see Columns 5ï8). In the sub-sample estimations, the effect of math abilities is negative for both boys and girls, but the negative effect is larger for girls than boys by 3.5ï8.3 percent. These results restate the gender-asymmetric effect of math abilities, such that math abilities constrain girlsô overconfidence to a

[5] Alternatively, this result might partially be driven by using different estimation techniques with different distribution assumptions (negative binomial vs. linear).

greater extent. But whether math abilities indeed increase boysô overconfidence as proposed by the IV full-sample estimations is inconclusive because this result is neither confirmed by the baseline nor by the sub-sample IV estimations.[6]

Second, the IV results of confidence are presented in Table 6. The positive effect of *female* and its negative interaction effect with *math score* remain consistent with the baseline findings. However, the threshold level at which the gender effect becomes negative is different. In the IV model, the effect of *female* is predicted to be negative when a girlôs math score reaches 488.7 (around the mean, see Column 4) or higher. In the baseline estimations, however, the threshold was 633ð top 5 percent. Accounting for the endogeneity of the model lowers the threshold of generating a negative gender effect, and therewith increases the pool of girls whose confidence is negatively affected by their gender. It appears that the relationship between math abilities and confidence is more endogenous for girls in the upper quartiles, and the negative gender effect on this group of girls is revealed through the IV estimations.

Further, the IV results corroborate the gender-asymmetric effect of math abilities on confidence. The results of the full sample show that the effect becomes negative for girls, while maintaining positive effect on boys (i.e. ϐ´$_2$ = +0.101 for boys; and ϐ´$_2$+ ϐ´$_3$ = **ï**0.077 for girls, computed based on Column 4 of Table 6 following Equation 2´ in Section 3). This finding provides stronger evidence for gender-asymmetry in the effect of math abilities than the baseline findings in Table 3. However, the negative effect of math abilities on girlsô confidence is not further supported by the sub-sample estimations. In the sample of girls, the effect loses its significance (Columns 5 and 6), while maintaining the positive, significant effect on boys (Columns 7 and 8). This evidence in the sub-sample models further endorses the gender-asymmetric effect of math abilities. However, whether the effect of math abilities is totally negative for girls is indecisive and thus, should be taken as suggestive only.

Overall, the IV results corroborate the negative interaction effect of *female* and *math score*. This implies: (i) math abilities have more positive effects on boysô confidence than girlsô; and (ii) the effect of being a female is less positive for outperforming girls than underperforming ones.

[6] A possible explanation for this inconsistency is that the IV results might be affected by imprecise estimations using instruments.

4.3. Test for Robustness: Alternative Measurements of Confidence

One may be concerned that the dependent variables used so far capture not only oneôs confidence level but also other dimensions of self-beliefs. This concern arises because of two issues that the measurements possibly encounter. First, students may (over)claim that they understand math concepts well, not because they are over-/confident with their knowledge but because they want to fulfill certain expectations imposed on them. For example, students may face societal and personal pressure to exhibit a high level of knowledge, and such pressure is likely different between boys and girls. This aspect is partially addressed by including parental expectation as an explanatory variable in the model. However, some other aspects from fulfilling expectationsð particularly, pressure from societal and teachersô expectationsð possibly remain unobserved. Second, the dependent variables may partly be affected by studentsô linguistic abilities. Math concepts described in the questions are phrased with one or two wordsð for example, óproper numberô and ódivisorôð and students are asked to answer whether they are familiar with them. If students have better sense for word choice and realize that certain words do not exist, their linguistic skills may constrain them from over-claiming with regard to false concepts. Such linguistic influences may create a systematic bias in gender differences in over-/confidence because girls generally outperform boys in language courses (for instance, a gender gap of 8 percent for girls in the PISA reading test, OECD 2012). In other words, girlsô arguably superior linguistic performance may prevent them from over-claiming.

To reduce potential noises encompassed in the over-/confidence variables, two additional measurements that also reflect oneôs confidence level are employed as alternative dependent variables. They are the indicators of self-efficacy in math and anxiety towards math. The self-efficacy indicator measures the self-assessed level of confidence about the practical usage of math skills. The anxiety indicator reflects psychological difficulties in math studies and is used as a measurement of the lack of confidence in math (see Table A.6 for detailed questions incorporated in each indicator). These indicators have an advantage that questions are formulated in plain language without technical terminologies so that linguistic sense or word choice is less likely to affect answers. Also, the self-efficacy questions address confidence more straightforwardlyð i.e., how much one is *confident* in doing a math-related task described in each question. Such a way of formulating questions reduces the possibility of oneô answer being influenced by other concerns outside of confidence (although these questions are admittedly not completely free of noises related to societal expectations and pressure disproportionally imposed on each gender). Furthermore, the questions used to construct the alternative indicators mirror different dimensions of confidence in math. The self-efficacy indicator inquires as to the practical application of math skills, in contrast to abstract math concepts comprised in the over-/confidence indicators. Also, the anxiety indicator assesses revealed psychological attitudes towards math, while the over-/confidence indicators measure the self-evaluated level of knowledge. Thus, applying these alternative indicators can minimize biases caused by relying on a measurement that captures a particular aspect of confidence.

Table A.4 shows the results of the estimations using the two alternative dependent variables.[7] First, Columns 1 and 2 present the results of self-efficacy in math. In general, being a female reduces oneô self-efficacy level. Furthermore, the interaction effect of *female* and *math score* is negative, magnifying the constraining gender effect on girlsô self-efficacy as their math score becomes higher. For instance, for girls in the lowest quartile with a math score of 395, their self-efficacy level is about 1 percent lower than boys in the same group. However, in the highest quartile with a math score of 540, this gender gap against girls increases to 1.3 percent (an increase of 30 percent). On the other hand, math abilities have a positive effect on oneô self-efficacy level in general. However, the effect is more positive for boys than girls; a one-standard deviation increase in the math score increases a boyô self-efficacy level by 13.1 percent of its standard deviation, while it does for girls by 12.4 percent only.

Second, being a female increases oneô anxiety towards math, in contrast to self-efficacy. Without considering the interaction effect (Column 3), a girlô anxiety level is marginally higher (0.3 percent) than a boyô on average. However, by including the interaction term (Column 4), the results disclose that underperforming girls indeed have a lower level of anxiety than underperforming boys, but after the threshold of a math score of 378, girls become more anxious than boys. This means that for most students except those in the lowest 20 percent in math scores,

[7] When the dependent variable is self-efficacy in math, a negative binomial estimation does not converge and, thus, an ordered probit method is applied and the marginal effects are calculated conditional on mean values. For the estimations of anxiety towards math, a negative binomial method is applied.

being a female increases oneôs anxiety towards math studies. Moreover, this gender effect is larger for high performing girls than others with lower scores. As an example, the anxiety level of median girls (with a math score of 466) is about 1 percent higher than that of boys in the same group. However, this gender difference increases to 3 percent for the best performing students with a math score of 708. Conversely, math abilities reduce oneôs anxiety towards math but to a lesser degree for girls than boys. For example, a one-standard deviation increase in the math score decreases boysô anxiety level by 4.91 percent of its standard deviation but for girls, it is 3.99 percent onlyð i.e. the effect is 23 percent smaller for girls.

As seen in this section, employing the alternative dependent variables does not alter the main findings of the gender-asymmetric effect of math abilities. Furthermore, it is consistently shown that the negative gender effect on girlsô confidence is more detrimental for better performing girls than underperforming ones.

5. Explaining the Gender-Asymmetric Effect of Math Abilities: Gender Socialization

The results presented above imply that math abilities do not boost female confidence the same as they do for male students. Girls become less (over)confident compared to boys when they are good at math. What can explain such a gender disparity in the role that math abilities play in determining oneôs confidence? Why does gender affect well-performing girls more negatively than underperforming ones, while this is exactly opposite for boys?

The findings so far a mechanism that leads high performing girls to underestimate their abilities. This is possibly because of societal stereotypes that denigrate womenôs talents and accomplishments (Cadsby et al. 2013). Under such stereotypes, the effect of female abilities may not be as positive as that of malesô. To investigate this issue, this section discusses and examines a plausible channel of gender socialization that discredits womenôs abilities.

The proposed channel is societal conditions of gender equality because societies with an established record of empowering women would give more equal credit to the accomplishments of female students, while more discriminatory societies undermine their successes. As discussed earlier, female gender creates the smallest positive effect on the confidence of the best performing girls and the largest negative effect on their confidence. One can surmise from this finding that societies in general are particularly hostile to women whose abilities are ranked above menös. Consequently, womenös high abilities would not have as much of a positive effect on their confidence as menös if society discredits the achievements of women and excludes highly capable women from being promoted to leadership positions.

To account for social environments in which the values of male and female abilities are not equally evaluated, the effect of female abilities (*female*math score*) is estimated conditional to the gender equality level of a country in this section. To do so, the indicator that measures the share of women in leading positions is used as a proxy of societal gender equality conditions. This variable encompasses the percent of legislators, senior officials in governments, and high-level managers in firms who are women ï the data taken from the World Development Indicators (Word Bank 2011). This gender equality indicator is particularly relevant for high-profile women because successful individuals (who are assumed to have been also as successful in school) fill such positions measured by this indicator. Thus, a higher share of females in lead positions indicates that a society values abilities of talented women and offers them fair opportunities to achieve professional success. Accordingly, students are sub-sampled based on their countriesô gender equality levels, and the models in Equations 2 and 2´ in Section 3 are estimated with the sub-sampled groups to find whether the gender-asymmetric effect of abilities varies depending on societal conditions of gender equality.

The full sample includes 65 countries/economies that are then divided into four groups by the quartile-rankings of countriesô female shares in high-profile positions: the 4th quartile (female share > 36 percent), the 3rd quartile (32 percent < female share < 36 percent), the 2nd quartile (29 percent < female share < 32 percent), and the 1st quartile (female share < 29 percent). The results of the sub-estimations are presented in Tables 7 (confidence) and 8 (overconfidence).[8]

The findings in Table 7 show that the effect of female abilities is heterogeneous conditional to the level of equal opportunities women are granted in a country. The interaction effect of female

[8] As most students who took part in the 2015 PISA test are from relatively high-equal, developed countries, those in the 4th quartile represent the majority of the sample.

abilities (*female*math score*) becomes positive to girlsô confidence when a country is ranked in the highest (4th) quartile of gender equality. This infers that in high-equal countries, the gender effect on girlsô confidence becomes more positive as their math score increases. However, this positive interaction effect loses its significance in upper-middle-equal countries (the 3rd quartile), and in low-equal countries (the 2nd and 1st quartiles), the interaction effect is negative (although insignificant). The lower part of Table 7 details how the marginal gender effect interacted with a girlôs math score varies across different gender equality levels of countries. Specifically, in high-equal countries, the positive gender effect on girlsô confidence increases from 1.20 (a female advantage of 2.2 p.p.) to 1.30 (that of 2.5 p.p.) as a girlôs math score changes from the lowest (a score of 395) to the highest (540) quartile. However, female abilities are not seen in such a positive light in other countries with lower levels of gender equality. In upper-middle-equal countries, the gender effect is widely insignificant regardless of girlsô math scores. In low-equal countries, the positive gender effect on girlsô confidence declines as their math score increases ï corresponding with the aggregate results presented in Tables 3 and A.2.

These results support the hypothesis that societal gender equality conditions indeed channel the gender-asymmetric effect of abilities. In more equal countries, girlsô abilities generate positive effects on their confidence because they can find fairer opportunities to utilize their talents to be promoted to high-profile positions. On the other hand, in countries where women are more discriminated against, girlsô abilities instead constrain their confidence, as their societies do not value female achievements.

In contrast, the outcomes of overconfidence are significantly different from those of confidence. The results in Table 8 show that in most countries, the gender effect on girlsô overconfidence becomes more negative as their math score increases ï except in the 2nd quartile (see the average marginal gender effects computed in the lower part of the table). This finding suggests that female abilities constrain girls from being overconfident mostly independent of countriesô gender equality levels. Hence, the gender-asymmetric effect of abilities on overconfidence cannot be explained by societal gender equality conditions. Different from the interactive mechanism of female abilities and gender equality with respect to confidence, female abilities widely suppress ungrounded confidence.

6. Conclusion

This paper offers empirical evidence suggesting that the effect of math abilities is moderated through gender. Girlsô abilities do not promote their confidence the same way as boysû Such a gender-asymmetric effect of abilities mirrors gender socialization, in that female achievements and potentials are undervalued. In this respect, this paper further shows that the gender-asymmetric effect of abilities is channeled through countriesô gender equality levels that reflect womenõs opportunities for promotion. With this finding, we can explain why girlsô abilities do not boost their confidence as much as boysô by gender discriminatory societal conditions, in which female abilities are less valued and where women are not granted equal opportunities to utilize their talents. In a future study, the channeling effect of gender equality could be further unraveled through a closer examination of gender norms and models that define and constrain womenõs roles in different societies.

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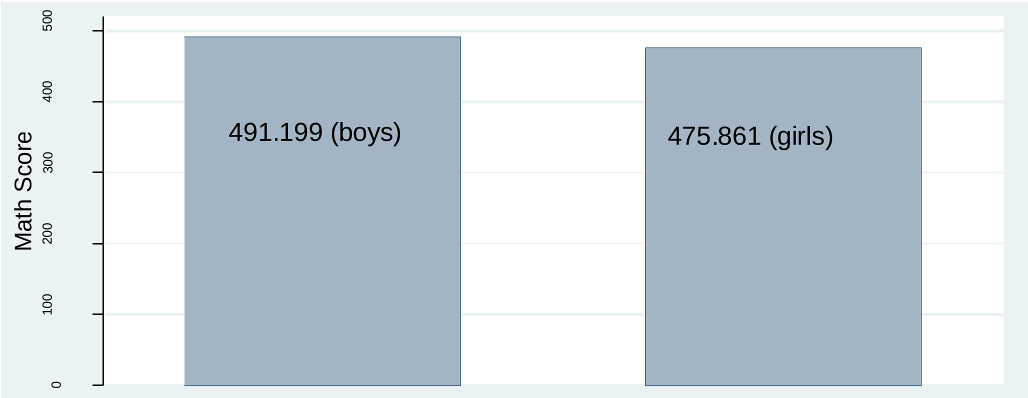
Figure 1. Gender Differences in Math

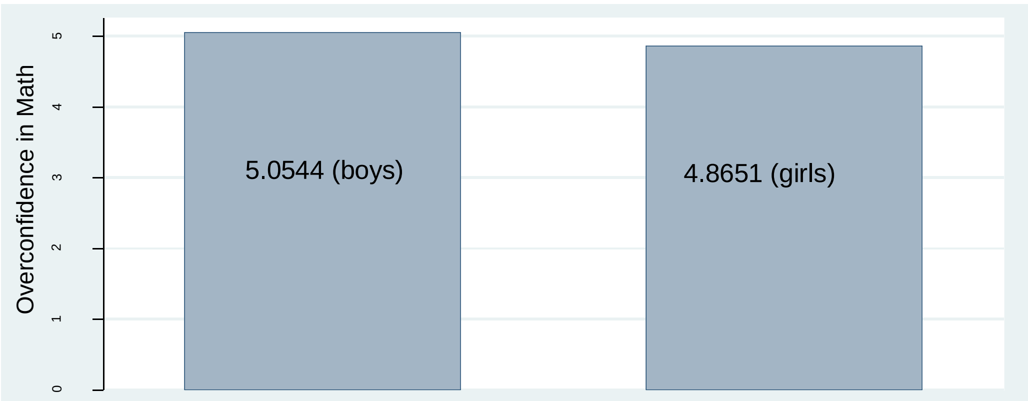
(Number of observations: boys = 118,979; girls = 124,355)

1.1. Math Score



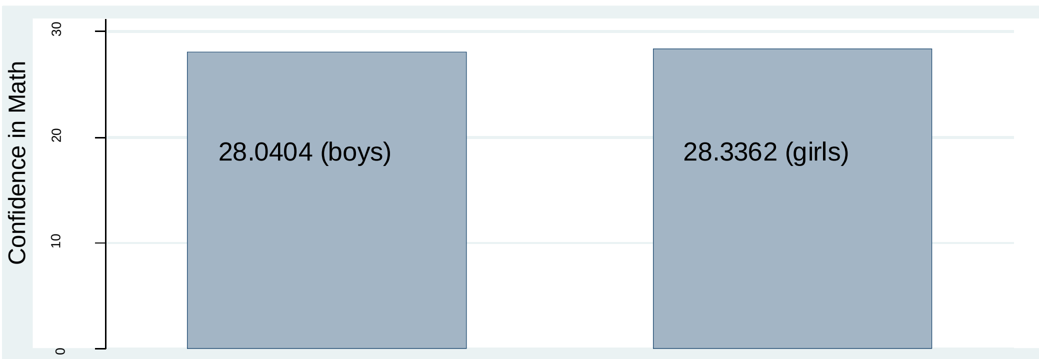
t-statistics (difference in mean, bï g) = 37.7983***

1.2. Overconfidence in Math



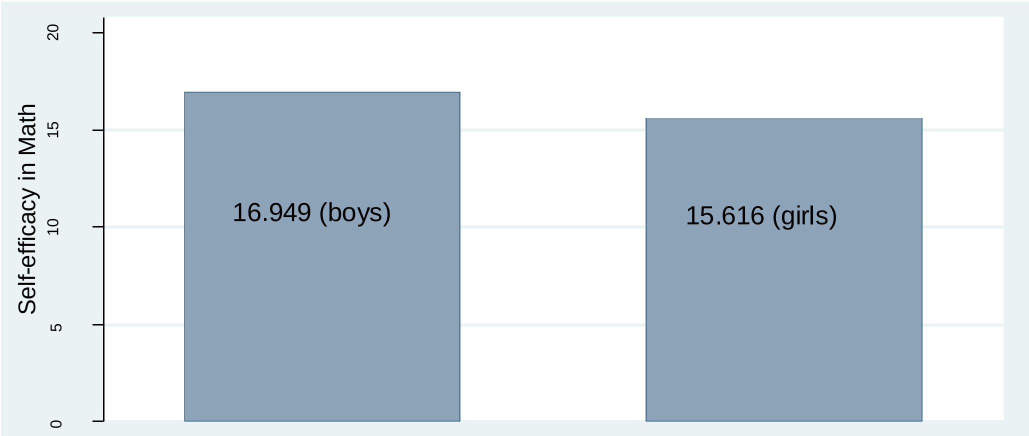
t-statistics (difference in mean, bï g) = 15.7640***

1.3. Confidence in Math



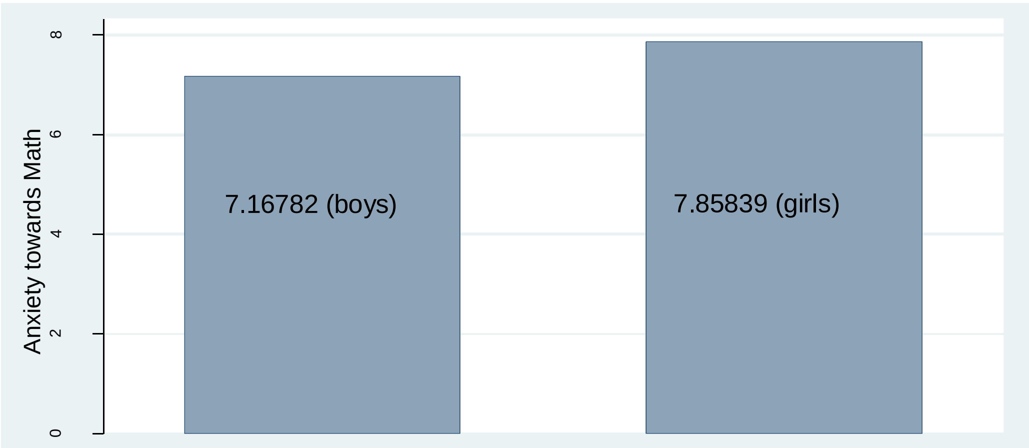
t-statistics (difference in mean, bï g) = –4.1531***

1.4. Self-efficacy in Math



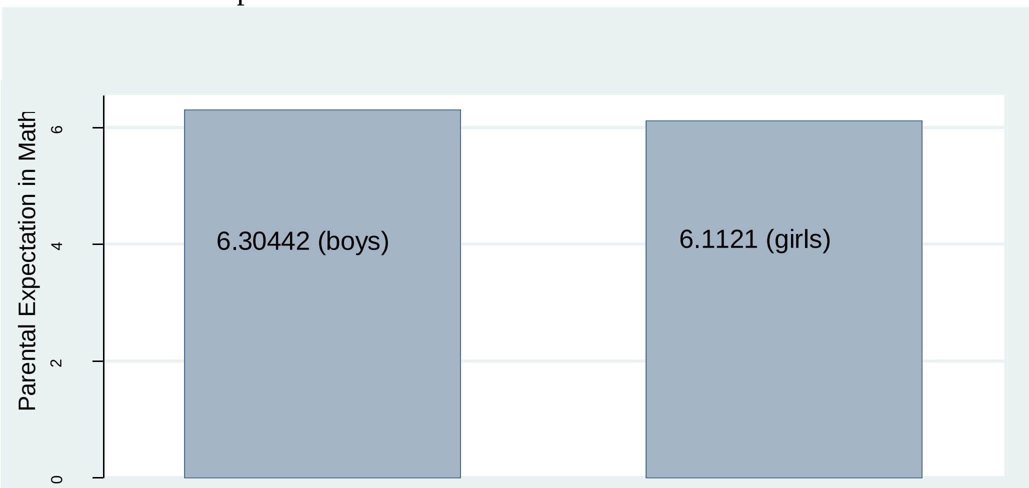
t-statistics (difference in mean, bï g) = 70.4956***

1.5. Anxiety towards Math



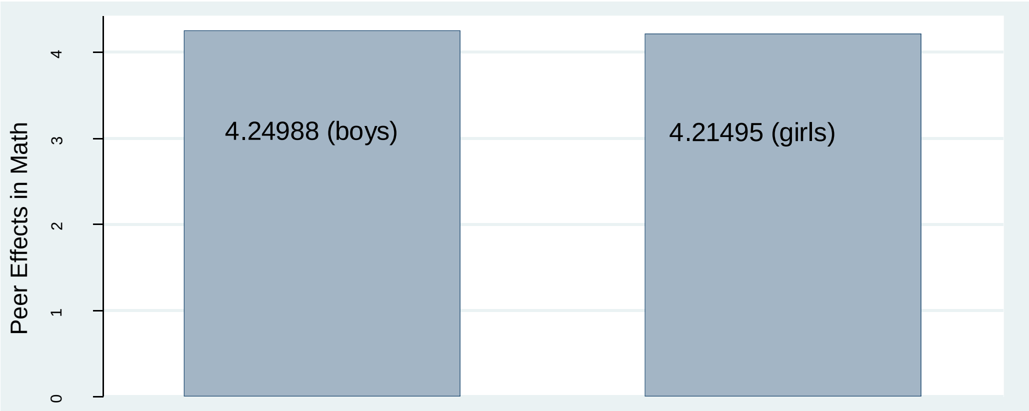
t-statistics (difference in mean, bï g) = ï 36.4197***

1.6. Parental Expectation in Math



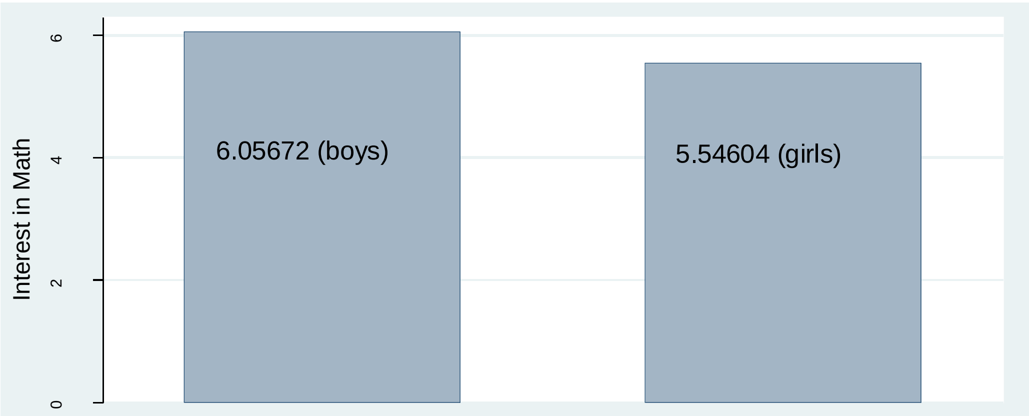
t-statistics (difference in mean, bï g) = 26.2027***

1.7.Peer Effects in Math



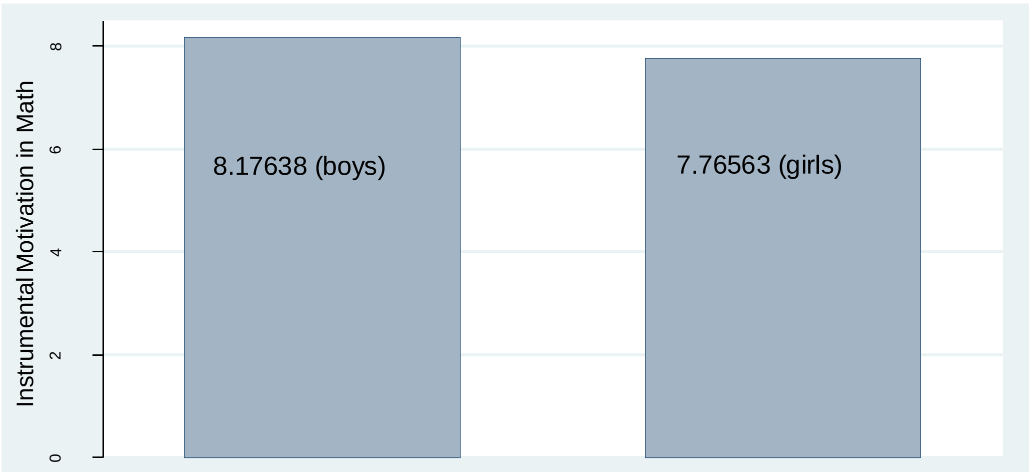
t-statistics (difference in mean, bï g) = 4.7832***

1.8.Interest in Math



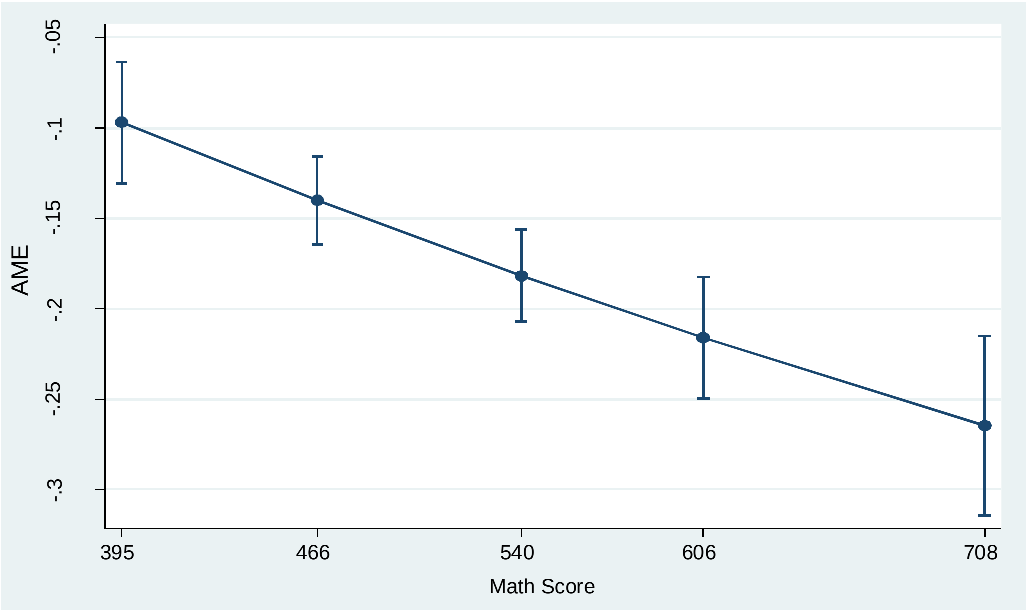
t-statistics (difference in mean, bï g) = 40.7894***

1.9.Instrumental Motivation in Math



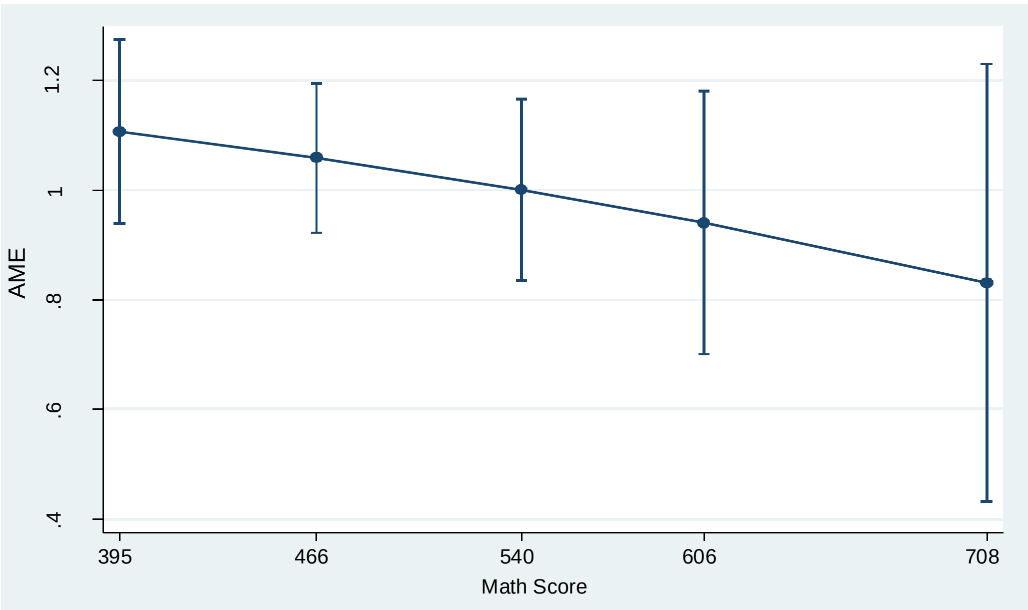
t-statistics (difference in mean, bï g) = 34.4203***

Figure 2. Average Marginal Gender Effects on GirlsôOverconfidence in Math at Different Levels of Math Scores



Note: 95 percent confidence level. The graph is drawn based on Column 4 in Table1.

Figure 3. Average Marginal Gender Effects on GirlsôConfidence in Math at Different Levels of Math Scores



Note: 95 percent confidence level. The graph is drawn based on Column 4 in Table 3.

Table 1. Overconfidence in Math, full sample, negative binomial regression

	(1)	(2)	(3)	(4)
Female	-0.0293	0.3119	-0.0299	0.0331
	(0.0024)***	(0.0684)***	(0.0024)***	(0.0119)***
Log Math Score	-0.2208	-0.1935		
	(0.0062)***	(0.0085)***		
Math Score			-0.0005	-0.0004
			(0.00001)***	(0.00002)***
Female*Log Math Score		-0.0555		
		(0.0111)***		
Female*Math Score				-0.0001
				(0.00002)***
Interest in Math	0.0150	0.0150	0.0153	0.0153
	(0.0005)***	(0.0005)***	(0.0005)***	(0.0005)***
Instrumental Motivation	0.0103	0.0102	0.0103	0.0102
	(0.0006)***	(0.0006)***	(0.0006)***	(0.0006)***
Peer Effect	-0.0178	-0.0177	-0.0177	-0.0177
	(0.0008)***	(0.0008)***	(0.0008)***	(0.0008)***
Parental Expectation	0.0222	0.0222	0.0220	0.0221
	(0.0008)***	(0.0008)***	(0.0008)***	(0.0008)***
Living with Mother	-0.0357	-0.0360	-0.0367	-0.0369
	(0.0061)***	(0.0061)***	(0.0061)***	(0.0060)***
Living with Father	0.0099	0.0099	0.0099	0.0099
	(0.0038)***	(0.0038)***	(0.0038)***	(0.0038)***
Mother's Education	0.0110	0.0112	0.0111	0.0113
	(0.0013)***	(0.0013)***	(0.0013)***	(0.0013)***
Mother's Employment	-0.0075	-0.0074	-0.0073	-0.0072
	(0.0010)***	(0.0010)***	(0.0010)***	(0.0010)***
Father's Education	0.0071	0.0071	0.0074	0.0074
	(0.0013)***	(0.0013)***	(0.0013)***	(0.0013)***
Father's Employment	-0.0007	-0.0007	-0.0005	-0.0005
	(0.0014)	(0.0014)	(0.0014)	(0.0014)
Country Effect	Yes	Yes	Yes	Yes
School Effect	Yes	Yes	Yes	Yes
Number of Observations	243,334	243,334	243,334	243,334
Wald Chi2	7,249.67***	7,300.46***	7,384.32***	7,443.46***

Note: The dependent variable is a studentôs level of overconfidence in math (measured on a scale of 3 to 15). Parentheses are robust standard errors clustered at the individual student level. * *p*< .10, ** *p*< .05, *** *p*< .001.

Table 2. Overconfidence in Math, sub-group sample by gender, negative binomial regression

	(1)	(2)	(3)	(4)
Sample	Girls	Boys	Girls	Boys
Log Math Score	-0.2320	-0.2105		
	(0.0085)***	(0.0089)***		
Math Score			-0.00053	-0.00047
			(0.00002)***	(0.00002)***
Interest in Math	0.0171	0.0130	0.0174	0.0134
	(0.0007)***	(0.0008)***	(0.0007)****	(0.0008)***
Instrumental Motivation	0.0094	0.0108	0.0094	0.0109
	(0.0008)***	(0.0009)***	(0.0008)***	(0.0009)***
Peer Effect	-0.0109	-0.0238	-0.0108	-0.0238
	(0.0011)***	(0.0011)***	(0.0011)***	(0.0011)***
Parental Expectation	0.0224	0.0219	0.0223	0.0217
	(0.0011)***	(0.0012)***	(0.0011)***	(0.0012)***
Living with Mother	-0.0423	-0.0297	-0.0433	-0.0306
	(0.0086)***	(0.0085)***	(0.0086)***	(0.0085)***
Living with Father	0.0074	0.0122	0.0075	0.0121
	(0.0053)	(0.0056)**	(0.0052)	(0.0056)**
Mother's Education	0.0085	0.0142	0.0086	0.0143
	(0.0018)***	(0.0019)***	(0.0018)***	(0.0019)***
Mother's Employment	-0.0099	-0.0047	-0.0095	-0.0045
	(0.0014) ***	(0.0014)***	(0.0014)***	(0.0014)***
Father's Education	0.0085	0.0054	0.0089	0.0058
	(0.0018)***	(0.0019)***	(0.0018)***	(0.0019)***
Father's Employment	-0.0019	0.0009	-0.0017	0.0011
	(0.0019)	0.0020	(0.0019)	(0.0020)
Country Effect	Yes	Yes	Yes	Yes
School Effect	Yes	Yes	Yes	Yes
Number of Observations	124,355	118,979	124,355	118,979
Wald Chi2	4,484.37***	2,813.93***	4,484.37***	2,873.04***
Two-sample t-test (H_0: coefficient on boysô math scoreï coefficient on girlsô math score = 0)				
Diff. (P-value)	0.0215***		0.00006***	

Note: The dependent variable is a studentôs level of overconfidence in math (measured on a scale of 3 to 15). Parentheses are robust standard errors clustered at the individual student level. * *p*< .10, ** *p*< .05, *** *p*< .001.

Table 3. Confidence in Math, full sample, negative binomial regression

	(1)	(2)	(3)	(4)
Female	0.0364	0.2209	0.0372	0.0633
	(0.0025)***	(0.0713)***	(0.0025)***	(0.0121)***
Log Math Score	0.3333	0.3481		
	(0.0064)***	(0.0087)***		
Math Score			0.0007	0.0008
			(0.00001)***	(0.00002)***
Female*Log Math Score		-0.0299		
		(0.0116)***		
Female*Math Score				-0.0001
				(0.00002)**
Interest in Math	0.0086	0.0086	0.0082	0.0082
	(0.0005)***	(0.0005)***	(0.0005)***	(0.0005)***
Instrumental Motivation	0.0161	0.0160	0.0161	0.0161
	(0.0006)***	(0.0006)***	(0.0006)***	(0.0006)***
Peer Effect	-0.0313	-0.0313	-0.0316	-0.0316
	(0.0008)***	(0.0008)***	(0.0008)***	(0.0008)***
Parental Expectation	0.0187	0.0187	0.0188	0.0188
	(0.0009)***	(0.0009)***	(0.0009)***	(0.0009)***
Living with Mother	-0.0157	-0.0158	-0.0130	-0.0131
	(0.0061)***	(0.0061)***	(0.0061)**	(0.0061)**
Living with Father	0.0189	0.0189	0.0193	0.0193
	(0.0040)***	(0.0040)***	(0.0040)***	(0.0040)***
Mother's Education	0.0104	0.0104	0.0106	0.0106
	(0.0014)***	(0.0014)***	(0.0014)***	(0.0014)***
Mother's Employment	-0.0079	-0.0078	-0.0080	-0.0079
	(0.0010)***	(0.0010)***	(0.0010)***	(0.0010)***
Father's Education	0.0101	0.0101	0.0099	0.0099
	(0.0013)***	(0.0013)***	(0.0013)***	(0.0013)***
Father's Employment	-0.0027	-0.0027	-0.0028	-0.0028
	(0.0014)**	(0.0014)*	(0.0014)**	(0.0014)**
Country Effect	Yes	Yes	Yes	Yes
School Effect	Yes	Yes	Yes	Yes
Number of Observations	243,334	243,334	243,334	243,334
Wald Chi2	10,439.56***	10,444.47***	10,600.83***	10,601.6***

Note: The dependent variable is a studentȏs level of confidence in math (measured on a scale of 13 to 65). Parentheses are robust standard errors clustered at the individual student level. * $p< .10$, ** $p< .05$, *** $p< .001$.

Table 4. Confidence in Math, sub-group sample by gender, negative binomial regression

	(1) Girls	(2) Boys	(3) Girls	(4) Boys
Log Math Score	0.3265	0.3390		
	(0.0091)***	(0.0091)***		
Math Score			0.00071	0.00073
			(0.00002)***	(0.00002)***
Interest in Math	0.0095	0.0078	0.0092	0.0074
	(0.0008)***	(0.0008)***	(0.0008)***	(0.0008)***
Instrumental Motivation	0.0159	0.0161	0.0159	0.0161
	(0.0008)***	(0.0009)***	(0.0008)***	(0.0009)***
Peer Effect	-0.0247	-0.0374	-0.0252	-0.0376
	(0.0011)***	(0.0011)***	(0.0011)***	(0.0011)***
Parental Expectation	0.0177	0.0197	0.0177	0.0199
	(0.0012)***	(0.0012)***	(0.0012)***	(0.0012)***
Living with Mother	-0.0209	-0.0105	-0.0179	-0.0081
	(0.0087)**	(0.0085)	(0.0087)**	(0.0084)
Living with Father	0.0212	0.0161	0.0216	0.0165
	(0.0056)***	(0.0058)***	(0.0056)***	(0.0058)***
Mother's Education	0.0106	0.0104	0.0109	0.0104
	(0.0019)***	(0.0019)***	(0.0019)***	(0.0019)***
Mother's Employment	-0.0094	-0.0060	-0.0095	-0.0061
	(0.0014)***	(0.0014)***	(0.0014)***	(0.0014)***
Father's Education	0.0114	0.0087	0.0113	0.0084
	(0.0019)***	(0.0019)***	(0.0019)***	(0.0019)***
Father's Employment	-0.0028	-0.0024	-0.0029	-0.0025
	(0.0019)	(0.0020)	(0.0019)	(0.0020)
Country Effect	Yes	Yes	Yes	Yes
School Effect	Yes	Yes	Yes	Yes
Number of Observations	124,355	118,979	124,355	118,979
Wald Chi2	4,961.67***	5,510.63***	5,023.01***	5,620.2***
Two-sample t-test (H_0: coefficient on boysô math scoreï coefficient on girlsô math score = 0)				
Diff. (P-value)	0.0125***		0.00002**	

Note: The dependent variable is a studentôs level of confidence in math (measured on a scale of 13 to 65). Parentheses are robust standard errors clustered at the individual student level. * *p*< .10, ** *p*< .05, *** *p*< .001.

Table 5. Overconfidence in Math, instrumental variable approach
Two-stage Least Squares, second stage

	Full Sample				Girls		Boys	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female	-0.1870	-0.1902	101.494	16.6529				
	(0.0127)***	(0.0127)***	(12.883)***	(2.1562)***				
Log Math Score	-2.9798		6.150		-3.0273		-2.9197	
	(0.1601)***		(0.959)***		(0.2120)***		(0.2450)***	
Math Score		-0.0062		0.0126		-0.0065		-0.0060
		(0.0003)***		(0.0020)***		(0.0005)***		(0.0005)***
Female*Log Math Score			-16.507					
			(2.092)***					
Female*Math Score				-0.0348				
				(0.0045)***				
Interest in Math	0.0868	0.0897	0.090	0.0907	0.0973	0.0997	0.0767	0.0801
	(0.0028)***	(0.0029)***	(0.003)***	(0.0034)***	(0.0038)***	(0.0038)***	(0.0042)***	(0.0043)***
Instrumental Motivation	0.0572	0.0565	0.025	0.0264	0.0471	0.0467	0.0659	0.0644
	(0.0029)***	(0.0029)***	(0.005)***	(0.0044)***	(0.0038)***	(0.0038)***	(0.0046)***	(0.0046)***
Peer Effect	-0.1296	-0.1252	-0.087	-0.0855	-0.0895	-0.0849	-0.1648	-0.1601
	(0.0051)***	(0.0049)***	(0.005)***	(0.0047)***	(0.0067)***	(0.0065)***	(0.0079)***	(0.0076)***
Parental Expectation	0.0993	0.0991	0.110	0.1118	0.0996	0.0999	0.0993	0.0986
	(0.0042)***	(0.0042)***	(0.005)***	(0.0048)***	(0.0055)***	(0.0055)***	(0.0063)***	(0.0063)***
Living with Mother	0.0305	-0.0051	-0.164	-0.1797	-0.0132	-0.0484	0.0674	0.0302
	(0.0365)	(0.0354)	(0.038)***	(0.0368)***	(0.0505)	(0.0492)	(0.0532)	(0.0513)
Living with Father	0.1136	0.1066	0.072	0.0713	0.0965	0.0910	0.1298	0.1210

	(0.0199)***	(0.0197)***	(0.023)***	(0.0224)***	(0.0267)***	(0.0265)***	(0.0301)***	(0.0298)***
Mother's Education	0.1088	0.1041	0.119	0.1135	0.0990	0.0938	0.1206	0.1170
	(0.0081)***	(0.0079)***	(0.011)***	(0.0101)***	(0.0111)***	(0.0109)***	(0.0118)***	(0.0116)***
Mother's Employment	-0.0031	-0.0042	0.001	0.0018	-0.0109	-0.0115	0.0065	0.0049
	(0.0058)	(0.0057)	(0.007)	(0.0073)	(0.0080)	(0.0080)	(0.0084)	(0.0083)
Father's Education	0.0848	0.0837	0.066	0.0660	0.0912	0.0900	0.0768	0.0757
	(0.0078)***	(0.0077)***	(0.008)***	(0.0082)***	(0.0104)***	(0.0104)***	(0.0117)***	(0.0116)***
Father's Employment	0.0251	0.0243	0.020	0.0210	0.0183	0.0180	0.0331	0.0318
	(0.0073)***	(0.0072)***	(0.008)**	(0.0083)**	(0.0099)*	(0.0098)*	(0.0107)***	(0.0106)***
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	243,334	243,334	243,334	243,334	124,355	124,355	118,979	118,979
Wald Chi2	5,959.36***	5,980.18***	4,944.98***	5,182.83***	3,591.41***	3,606.93***	2,270.15***	2,277.48***
Sargan Test (p-value)	0.1058	0.1090	0.3720	0.3827	0.2450	0.2158	0.2250	0.2490
Instrumented Variables	(log) math score		(log) math score & female*(log)math score		(log) math score		(log) math score	
External instruments	Book ID		Book ID		Book ID		Book ID	

Note: The dependent variable is a studentôs level of overconfidence in math (measured on a scale of 3 to 15). Parentheses are robust standard errors that are clustered at the individual student level. * *p*< .10, ** *p*< .05, *** *p*< .001.

Table 6. Confidence in Math, instrumental variable approach
Two-stage Least Squares, second stage

	Full Sample				Girls		Boys	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female	0.8160	0.8182	476.718	87.2195				
	(0.0733)***	(0.0735)***	(69.2941)***	(11.9052)***				
Log Math Score	2.0312		44.9294		0.6136		3.6145	
	(0.8826)**		(5.153)***		(1.1998)		(1.2991)**	
Math Score		0.0043		0.1014		0.0013		0.0074
		(0.0019)**		(0.0111)***		(0.0026)		(0.0027)**
Female*Log Math Score			-77.2588					
			(11.2533)***					
Female*Math Score				-0.1785				
				(0.0247)***				
Interest in Math	0.2969	0.2950	0.311	0.2993	0.3292	0.3287	0.2685	0.2645
	(0.0165)***	(0.0168)***	(0.0192)***	(0.0192)***	(0.0231)***	(0.0234)***	(0.0237)***	(0.0242)***
Instrumental Motivation	0.4879	0.4884	0.3364	0.3337	0.4664	0.4664	0.4964	0.4984
	(0.0174)***	(0.0174)***	(0.0253)***	(0.0252)***	(0.0238)***	(0.0238)***	(0.0260)***	(0.0258)***
Peer Effect	-1.0408	-1.0439	-0.8382	-0.8381	-0.8751	-0.8760	-1.1793	-1.1858
	(0.0283)***	(0.0275)***	(0.0255)***	(0.0258)***	(0.0381)***	(0.0371)***	(0.0424)***	(0.0409)***
Parental Expectation	0.4872	0.4874	0.5402	0.5535	0.4607	0.4607	0.5192	0.5199
	(0.0242)***	(0.0242)***	(0.0268)***	(0.0272)***	(0.0336)***	(0.0336)***	(0.0344)***	(0.0344)***
Living with Mother	0.4155	0.4401	-0.5130	-0.4680	0.3618	0.3686	0.4231	0.4721
	(0.1912)**	(0.1860)**	(0.1933)***	(0.1926)**	(0.2722)	(0.2660)	(0.2704)	(0.2614)*
Living with Father	0.7317	0.7365	0.5294	0.5519	0.8214	0.8224	0.6202	0.6321

	(0.1149)***	(0.1144)***	(0.1249)***	(0.1264)***	(0.1615)***	(0.1610)***	(0.1659)***	(0.1648)***
Mother's Education	0.4886	0.4918	0.5328	0.5365	0.5489	0.5499	0.4316	0.4368
	(0.0448)***	(0.0441)***	(0.0566)***	(0.0555)***	(0.0633)***	(0.0621)***	(0.0628)***	(0.0619)***
Mother's Employment	-0.0821	-0.0813	-0.0647	-0.0527	-0.0914	-0.0914	-0.0638	-0.0615
	(0.0332)**	(0.0330)**	(0.0397)	(0.0406)	(0.0473)*	(0.0471)*	(0.0467)	(0.0464)
Father's Education	0.4625	0.4633	0.3727	0.3696	0.5258	0.5260	0.3881	0.3901
	(0.0437)***	(0.0435)***	(0.0450)***	(0.0451)***	(0.0598)***	(0.0596)***	(0.0634)***	(0.0632)***
Father's Employment	0.0439	0.0446	0.0190	0.0258	0.0574	0.0574	0.0305	0.0325
	(0.0405)	(0.0404)	(0.0451)	(0.0457)	(0.0572)	(0.0572)	(0.0581)	(0.0579)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	243,334	243,334	243,334	243,334	124,355	124,355	118,979	118,979
Wald Chi2	7,389.96***	7,390.24***	6,802.40***	6,791.89***	3,459.47***	3,459.45***	3,984.29***	3,984.66***
Sargan Test (p-value)	0.5854	0.5586	0.9238	0.9345	0.4771	0.4772	0.2445	0.2401
Instrumented Variables	(log) math score		(log) math score & female*(log)math score		(log) math score		(log) math score	
External instruments	Book ID		Book ID		Book ID		Book ID	

Note: The dependent variable is a studentôs level of confidence in math (measured on a scale of 13 to 65). Parentheses are robust standard errors that are clustered at the individual student level. * *p*< .10, ** *p*< .05, *** *p*< .001.

Table 7. Channel of Gender-Asymmetric Effect of Abilities on Confidence

Societal Conditions of Gender Equality (Female Share in High-profile Positions)

Female Share	4th quartile (>36%)	3rd quartile (32Ь36%)	2nd quartile (29Ь32%)	1st quartile (<29%)
	(1)	(2)	(3)	(4)
Female	0.0685	-0.0206	0.0446	0.0376
	(0.0158)***	(0.0338)	(0.0360)	(0.0337)
Math Score	0.0008	0.0009	0.0008	0.0005
	(0.00002)***	(0.00005)***	(0.00005)***	(0.00005)***
Female*Math Score	0.00005	0.00005	-0.00003	-7.51e-06
	(0.00002)**	(0.00007)	(0.00007)	(0.00007)
Attitudinal and Interpersonal Characteristics	Yes	Yes	Yes	Yes
Demographic and Home Characteristics	Yes	Yes	Yes	Yes
Country Effect	Yes	Yes	Yes	Yes
School Effect	Yes	Yes	Yes	Yes
Number of Observations	136,959	32,754	35,148	38,473
Wald Chi2	6,348.29	1,900.95	1,728.90	2,105.31
Average Marginal Gender Effects on Girlsô Confidence at Different Levels of Math Scores (dy/dx w.r.t. : 1.Female)				
Math Score at	4th quartile (>36%)	3rd quartile (32Ь36%)	2nd quartile (29Ь32%)	1st quartile (<29%)
395	1.2049	0.0044	0.8635	1.0442
(lowest 25%)	(0.2955)***	(0.2191)	(0.2632)***	(0.5266)**
466	1.2663	0.0972	0.8631	1.0157
(average)	(0.1799)***	(0.1680)	(0.1964)***	(0.3131)***
540	1.2977	0.2070	0.8596	0.9973
(top 25%)	(0.1238)***	(0.1850)	(0.1991)***	(0.2121)***
606	1.3257	0.3173	0.8533	0.9769
(top 10%)	(0.0937)***	(0.2699)	(0.2840)***	(0.1803)***
708	1.3463	0.5131	0.8371	0.9575
(top 1%)	(0.1086)***	(0.4728)	(0.4995)*	(0.2418)***

Note: The dependent variable is a studentôs level of confidence in math (measured on a scale of 13 to 65). Parentheses in the upper part of the table are robust standard errors clustered at the individual student level. Parentheses in the lower part of the table (average marginal effects) are delta-method standard errors. * *p*< .10, ** *p*< .05, *** *p*< .001.

Table 8. Channel of Gender-Asymmetric Effect of Abilities on Overconfidence

Societal Conditions of Gender Equality (Female Share in High-profile Positions)

Female Share	4th quartile (>36%)	3rd quartile (32Ь36%)	2nd quartile (29Ь32%)	1st quartile (<29%)
	(1)	(2)	(3)	(4)
Female	0.0539	0.0211	-0.0750	-0.0105
	(0.0151)***	(0.0333)	(0.0361)**	(0.0322)
Math Score	-0.0004	-0.0001	-0.0004	-0.0004
	(0.00002)***	(0.00005)**	(0.00005)***	(0.00005)***
Female*Math Score	-0.0002	-0.00007	0.00006	-0.00005
	(0.00003)***	(0.00006)	(0.00007)	(0.00006)
Attitudinal and Interpersonal Characteristics	Yes	Yes	Yes	Yes
Demographic and Home Characteristics	Yes	Yes	Yes	Yes
Country Effect	Yes	Yes	Yes	Yes
School Effect	Yes	Yes	Yes	Yes
Number of Observations	136,959	32,754	35,148	38,473
Wald Chi2	4,115.88	1,165.43	697.85	1,836.24

Average Marginal Gender Effects on Girlsô Confidence at Different Levels of Math Scores
(dy/dx w.r.t. : 1.Female)

Math Score at	4th quartile (>36%)	3rd quartile (32Ь36%)	2nd quartile (29Ь32%)	1st quartile (<29%)
395	-0.0493	-0.2311	-0.2405	-0.1672
(lowest 25%)	(0.0216)**	(0.0456)***	(0.0489)***	(0.0459)***
466	-0.1058	-0.2521	-0.2152	-0.1812
(average)	(0.0166)***	(0.0321)***	(0.0327)***	(0.0309)***
540	-0.1604	-0.2735	-0.1902	-0.1947
(top 25%)	(0.0189)***	(0.0308)***	(0.0282)***	(0.0313)***
606	-0.2055	-0.2922	-0.1689	-0.2057
(top 10%)	(0.0250)***	(0.0412)***	(0.0371)***	(0.0431)***
708	-0.2690	-0.3204	-0.1378	-0.2212
(top 1%)	(0.0362)***	(0.0655)***	(0.0593)**	(0.0668)***

Note: The dependent variable is a studentõs level of overconfidence in math (measured on a scale of 3 to 15). Parentheses in the upper part of the table are robust standard errors clustered at the individual student level. Parentheses in the lower part of the table (average marginal effects) are delta-method standard errors. * $p< .10$, ** $p< .05$, *** $p< .001$.

Appendix

Table A.1. Average Marginal Gender Effects on Girlsô Overconfidence at Different Levels of Math Scores

Math Score at	dy/dx w.r.t. : 1.Female	95% Confidence Interval		Math Score at	dy/dx w.r.t. : 1.Female	95% Confidence Interval	
75	0.1415	0.0208	0.2622	395	-0.0969	-0.1303	-0.0634
	(0.0616)**			(lowest 25%)	(0.0171)***		
175	0.0587	-0.0302	0.1476	466	-0.1400	-0.1642	-0.1158
	(0.0454)			(average)	(0.0124)***		
275	-0.0163	-0.0770	0.0444	540	-0.1817	-0.2070	-0.1563
	(0.0310)			(top 25%)	(0.0130)***		
375	-0.0841	-0.1214	-0.0469	606	-0.2161	-0.2496	-0.1826
	(0.0190)***			(top 10%)	(0.0171)***		
475	-0.1453	-0.1690	-0.1215	708	-0.2645	-0.3142	-0.2149
	(0.0121)***			(top 1%)	(0.0253)***		
575	-0.2002	-0.2294	-0.1710				
	(0.0149)***						
675	-0.2495	-0.2937	-0.2052				
	(0.0226)***						
775	-0.2934	-0.3538	-0.2330				
	(0.0308)***						
875	-0.3325	-0.4081	-0.2569				
	(0.0386)***						

Note: The dependent variable is a studentôs level of overconfidence in math (measured on a scale of 3 to 15). Average marginal effects are calculated based on Column 4 in Table 1. Parentheses are delta-method standard errors. * *p*< .10, ** *p*< .05, *** *p*< .001.

Table A.2. Average Marginal Gender Effects on Girlsô Confidence at Different Levels of Math Scores

Math Score at	dy/dx w.r.t. : 1.Female	95% Confidence Interval		Math Score at	dy/dx w.r.t. : 1.Female	95% Confidence Interval	
75	1.2374	0.8148	1.6601	395	1.1062	0.9384	1.2740
	(0.2156)***			(lowest 25%)	(0.0856)***		
175	1.2094	0.8599	1.5589	466	1.0586	0.9225	1.1947
	(0.1783)***			(average)	(0.0694)***		
275	1.1702	0.9031	1.4372	540	1.0003	0.8346	1.1661
	(0.1362)***			(top 25%)	(0.0846)***		
375	1.1183	0.9356	1.3009	606	0.9403	0.7009	1.1798
	(0.0932)***			(top 10%)	(0.1222)***		
475	1.0520	0.9161	1.1879	708	0.8311	0.4325	1.2296
	(0.0693)***			(top 1%)	(0.2034)***		
575	0.9695	0.7686	1.1704				
	(0.1025)***						
675	0.8687	0.5261	1.2113				
	(0.1748)***						
775	0.7474	0.2241	1.2706				
	(0.2670)***						
875	0.6029	-0.1327	1.3385				
	(0.3753)***						

Note: The dependent variable is a studentôs level of confidence in math (measured on a scale of 13 to 65). Average marginal effects are calculated based on Column 4 in Table 3. Parentheses are delta-method standard errors. * $p < .10$, ** $p < .05$, *** $p < .001$.

Table A.3. Overconfidence and Confidence in Math, instrumental variable approach
Two-stage Least Squares, first stage

	Full Sample		Girls		Boys	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	log Math Score	Math Score	log Math Score	Math Score	log Math Score	Math Score
Number of Instruments	20	20	20	20	20	20
Number of Instruments with Single Significance Ờ	15	15	15	15	16	16
Joint Significance of All Instruments	1.4e+07***	816.45***	7.5e+06***	452.39***	6.9e+06***	353.16***
F-statistics	2,041.71***	2,237.9***	1,086.78***	1,178.78***	984.62***	1,074.48***
(restrictions/D.f)	(32/243,301)		(31/124,323)		(31/118,947)	
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
No. Observations	243,334	243,334	124,355	124,355	118,979	118,979

Note: Parentheses are robust standard errors that are clustered at the individual student level. * *p*< .10, ** *p*< .05, *** *p*< .001.
ỜThe coefficient on each instrument is not presented in the table but can be obtained by the author upon request.

Table A.4. Alternative Dependent Variables: Self-efficacy in Math and Anxiety towards Math

Dependent Variable	Self-efficacy in Math		Anxiety towards Math	
	(1)	(2)	(3)	(4)
Female	-0.2090	-0.0490	0.0462	-0.1134
	(0.0042)***	(0.0218)**	(0.0023)***	(0.0118) ***
Math Score	0.0060	0.0061	-0.0014	-0.0016
	(0.00003) ***	(0.00003)***	(0.00001)***	(0.00002) ***
Female*Math Score		-0.0003		0.0003
		(0.00004) ***		(0.00003) ***
Interest in Math	0.1082	0.1082	-0.0468	-0.0470
	(0.0010) ***	(0.0010) ***	(0.0005)***	(0.0005) ***
Instrumental Motivation	0.0193	0.0191	-0.0018	-0.0015
	(0.0011) ***	(0.0011) ***	(0.0006)***	(0.0006) ***
Peer Effect	0.0196	0.0198	0.0305	0.0302
	(0.0014) ***	(0.0014) ***	(0.0008)***	(0.0008) ***
Parental Expectation	0.0937	0.0938	0.0150	0.0149
	(0.0016) ***	(0.0016) ***	(0.0008)***	(0.0008) ***
Living with Mother	-0.0225	-0.0233	-0.0015	-0.0006
	(0.0107) **	(0.0107) **	(0.0055)	(0.0055)
Living with Father	0.0270	0.0270	-0.0127	-0.0127
	(0.0069) ***	(0.0069) ***	(0.0036)***	(0.0036) ***
Mother's Education	0.0204	0.0207	-0.0085	-0.0088
	(0.0023) ***	(0.0023) ***	(0.0012)***	(0.0012) ***
Mother's Employment	0.0134	0.0136	-0.0089	-0.0091
	(0.0017) ***	(0.0017) ***	(0.0009)***	(0.0009) ***
Father's Education	0.0283	0.0284	-0.0023	-0.0025
	(0.0023) ***	(0.0023) ***	(0.0012)**	(0.0012)**
Father's Employment	0.0171	0.0172	-0.0018	-0.0019
	(0.0024) ***	(0.0024) ***	(0.0012)	(0.0012)
Country Effect	Yes	Yes	Yes	Yes
School Effect	Yes	Yes	Yes	Yes
Number of Observations	238,996	238,996	118,946	118,946
Wald Chi2	99,015.96	98,932.37	28,299.37	28,176.36

Note: The dependent variable is a studentôs level of self-efficacy in math (measured on a scale of 0 to 24) for Columns 1 and 2 and the level of anxiety towards math (measured on a scale of 0 to 15) for Columns 3 and 4. Parentheses are robust standard errors clustered at the individual student level. * *p*< .10, ** *p*< .05, *** *p*< .001.

Table A.5. Descriptive Statistics

Variable	Observation	Mean	Std. Dev.	Min.	Max.
Math Score	243,334	483.3606	100.3481	75.7984	912.2994
Log Math Score	243,334	6.1582	0.2158	4.3281	6.8160
Overconfidence in Math	243,334	4.9577	2.9626	3	15
Proper number	243,334	1.9911	1.4497	1	5
Subjective scaling	243,334	1.4613	0.9861	1	5
Declarative fraction	243,334	1.5053	1.0438	1	5
Confidence in Math	243,334	28.1916	17.5681	13	65
Exponential function	243,334	1.7216	1.2442	1	5
Divisor	243,334	2.3990	1.7186	1	5
Quadratic function	243,334	2.2014	1.5935	1	5
Linear equation	243,334	2.3114	1.6706	1	5
Vectors	243,334	1.9946	1.4882	1	5
Complex number	243,334	1.9052	1.3625	1	5
Rational number	243,334	2.3464	1.6682	1	5
Radicals	243,334	2.3077	1.6746	1	5
Polygon	243,334	2.3798	1.7152	1	5
Congruent figure	243,334	2.0691	1.5541	1	5
Cosine	243,334	2.0919	1.6060	1	5
Arithmetic mean	243,334	2.0777	1.5693	1	5
Probability	243,334	2.3859	1.7042	1	5
Self-efficacy in Math	238,996	16.2668	4.6684	0	24
Using a train timetable	238,996	2.0682	0.8044	0	3
Calculating TV discount	238,996	2.1792	0.8092	0	3
Calculating square meters of tiles	238,996	1.9633	0.8739	0	3
Understanding graphs in newspapers	238,996	2.0915	0.8095	0	3
Solving equation 1	238,996	2.4042	0.7967	0	3
Distance to scale	238,996	1.7282	0.9162	0	3
Solving equation 2	238,996	2.1284	0.8972	0	3
Calculate petrol consumption rate	238,996	1.7038	0.8865	0	3
Anxiety towards Math	117,051	7.521849	3.260852	0	15
Worry that it will be difficult	118,499	1.7712	0.8337	0	3
Get very tense	118,054	1.3208	0.8666	0	3
Get very nervous	118,258	1.3156	0.8372	0	3
Feel helpless	118,243	1.2241	0.8434	0	3
Worry about getting poor grades	118,267	1.8958	0.9412	0	3

Interest in Math	243,334	5.7957	3.0977	0	12
Instrumental Motivation	243,334	7.9665	2.9498	0	12
Peer Effect	243,334	4.2320	1.8006	0	9
Parental Expectation	243,334	6.2061	1.8125	0	9
Mother's Education	243,334	3.0912	1.1475	0	4
Father's Education	243,334	3.0532	1.1268	0	4
Mother's Employment	243,334	1.8121	1.3015	0	3
Father's Employment	243,334	2.5461	0.9249	0	3
Living with Mother	243,334	0.9462	0.2256	0	1
Living with Father	243,334	0.8711	0.3350	0	1

Table A.6. Survey Questions

A.6.1. Dependent Variables

Questions: Overconfidence in math (over-claiming)

1. Proper number
2. Subjective scaling
3. Declarative fraction

Questions: Confidence in math (familiarity with math concepts)

1. Exponential function
2. Divisor
3. Quadratic function
4. Linear equation
5. Vectors
6. Complex number
7. Rational number
8. Radicals
9. Polygon
10. Congruent figure
11. Cosine
12. Arithmetic mean
13. Probability

Answers:

Never heard of it (score 1) / heard of it once or twice (score 2) / heard of it a few times (score 3) / heard of it often (score 4) / know it well, understand the concept (score 5)

Questions: Self-efficacy in math

1. Using a train timetable
2. Calculating TV discount
3. Calculating square meters of tiles
4. Understanding graphs in newspapers

5. Solving equation 1: 3x + 5 = 17
6. Distance to scale
7. Solving equation 2: 2(x + 3) = (x + 3)(x ï 3)
8. Calculate petrol consumption rate

Answers:

Not at all confident (score 0) / not very confident (score 1) / confident (score 2) / very confident (score 3)

Questions: Anxiety towards math

1. Worry that it will be difficult
2. Get very tense
3. Get very nervous
4. Feel helpless
5. Worry about getting poor grades

Answers:

Strongly disagree (score 0) / disagree (score 1) / agree (score 2) / strongly agree (score 3)

A.6.2. Explanatory Variables

Questions: Interest in math

1. Enjoy reading about mathematics
2. Look forward to lessons
3. Enjoy mathematics
4. Interested in mathematics

Questions: Instrumental motivation in math

1. Worthwhile for work
2. Worthwhile for career chances
3. Important for future study
4. Helps to get a job

Questions: Peer effect in math

1. Friends do well in mathematics
2. Friends work hard on mathematics
3. Friends enjoy mathematics tests

Questions: Parental expectation in math

1. Parents believe studying mathematics is important
2. Parents believe mathematics is important for career
3. Parents like mathematics

Answers:

Strongly disagree (score 0) / disagree (score 1) / agree (score 2) / strongly agree (score 3)

Table A.7. Country List

Albania, Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Kazakhstan, (South) Korea, Latvia, Liechtenstein, Lithuania, Luxembourg, Macao, Malaysia, Mexico, Montenegro, Netherlands, New Zealand, Norway, Peru, Poland, Portugal, Qatar, Romania, Russia, Serbia, China (Shanghai), Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Chinese Taipei, Thailand, Tunisia, Turkey, United Arab Emirates, United Kingdom, United States, Uruguay, Vietnam (65 countries and economies).