
Am I the Big Fish? The Effect of Ordinal Rank on Student Academic Performance in Middle School

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Abstract

Using a randomized sample of middle school students from China, this paper investigates the causal effect of the ordinal rank on students' academic performance. In addition, this paper provides the first direct evidence on the relationship between the objective ordinal rank and the rank perceived by students, as well as the impact of the *self-perceived* rank on students' academic attainments. The results indicate that both the objective and self-perceived ordinal rank has a positive and salient effect on students' test scores. The effects are seemingly heterogeneous by students' relative ability, gender, and the size of classrooms. Taking advantage of the very detailed survey questions on students, parents, and teachers, a large set of potential mechanisms are examined in the paper.

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I Introduction

It is well known that relative achievement can affect individual outcomes. In the educational setting, the ordinal academic rank of a student may affect the student's academic achievement through various channels, such as a student's self-confidence, parental expectations, effort provision, etc. Surprisingly, evidence on how students' relative achievement affect their educational outcomes are rare.¹ Exceptions are a handful of recent papers which shed light on the impact of ordinal academic (or ability) rank of students on their educational outcomes. In general, these studies found that a student's ordinal rank at school has a positive effect on the student's future academic achievement. In other words, their findings indicate an adverse effect of peers' achievement on a student's own achievement. For example, using data from England, [Murphy and Weinhardt \(2018\)](#) showed that the ordinal academic rank of primary school students has a positive impact on those students' test scores later in middle school. They found that achieving a higher rank in a specific subject in primary school increases a student's confidence in studying and the possibility of continuing to study that subject in secondary school. [Denning et al. \(2018\)](#) used data from public school students in Texas and found that a higher 3rd grade academic rank predicts better educational and labor market outcomes for the students.

Similarly, using data on high school students in the U.S., [Elsner and Isphording \(2017\)](#) found that a higher ability rank in high school leads to a higher propensity of high school completion and college attendance for a student through a number of channels including self-expectation, self-confidence, and teachers' input. In another paper, [Elsner and Isphording \(2018\)](#) showed that the ordinal rank in high school also affects students' behaviors. Specifically, they found that having a higher ordinal ability rank in a high school cohort leads

¹It has been corroborated by evidence found in the education literature that peer's achievement is negatively correlated with a student's own academic self-concept, known as the Big-Fish-Little-Pond-Effect (BFLPE). See [Marsh et al. \(2008\)](#); [Seaton, Marsh and Craven \(2009\)](#) as examples.

to less smoking, less drinking and a lower propensity of having unprotected sex or engaging in physical fights.²

In this paper, I investigate the causal effect of the ordinal ability rank on students' future academic performance. I confirm the findings of previous studies employing data on middle school students from China, which is the first evidence from a developing country. The present paper considerably improves in two aspects in comparison to other works in the literature. First, I employ a randomized sample to eliminate the concern regarding student sorting. Intuitively, strong students would want to enroll in better schools and classes with a higher average student quality. In this scenario, the estimates will be attenuated towards zero. To address this problem, I exploit data on students who were randomly assigned to classrooms to prevent the estimates from being contaminated by the potential downward-bias caused by self-selection and sorting. Second, the current paper extends the literature by providing examinations of a particularly rich set of potential mechanisms. Specifically, taking advantage of the very detailed survey questions on students, parents, and teachers, I am able to examine potential channels including students' self-confidence and self-expectations, parental expectations and investments, inputs from peers at school, teachers' inputs and attitudes towards the students, the impact from friends and the quality of friends, and students' own effort provision and time spent on leisure.

More importantly, I extend the literature by providing the first direct evidence on the relationship between the objective ordinal rank and the rank perceived by students, as well as the impact of the *self-perceived* rank on students' academic attainments. It is crucial to understand these for several reasons. First of all, ideally, information on the self-perceived rank of students is needed if the ordinal rank affects students' academic achievement through the channel of intrinsic beliefs, such as self-confidence, self-expectations, and understanding

²Also see [Bertoni, Nisticò et al. \(2018\)](#); [Goulas and Megalokonomou \(2015\)](#); [Tincani \(2017\)](#); [Cicala, Fryer and Spenkuch \(2017\)](#); [Elsner et al. \(2018\)](#); [Jalava, Joensen and Pellas \(2015\)](#) for more evidence on the impact of students' rank concerns on academic performance.

of own ability. In this case, what matters is how students believe their ranks to be. Second, if the ordinal rank affects students' performance via exposing students to the different environment at school among schoolmates and teachers, a preferred measure of the rank should be the student's rank perceived by his/her peers and teachers. Yet, such information is usually not available. Under such circumstances, the student's self-perceived rank is plausibly a better proxy for the rank perceived by the student's peers and teachers because they form their perceptions of an individual student's rank in the same environment. Third, if the effect of the ordinal rank on a student's educational outcomes is through parental expectations and investments, the desired measure of the rank is the parent-perceived rank, which is more likely to be formed directly based on students' self-perceived rank.³ To my knowledge, a subjective measure of the ordinal rank of the students was not available among previous papers in the literature.⁴ The present paper fills the gap in the literature.

The main findings of the present paper are as fourfold. First, the results suggest that the ordinal rank has a positive and significant impact on middle school students' future test scores in Math, Chinese and English. Specifically, an one standard deviation increase in a student's ordinal rank leads to 0.08, 0.06, and 0.05 of a standard deviation increase in the test scores in Math, Chinese, and English, respectively. The magnitude of the effects is largely consistent with those reported in [Murphy and Weinhardt \(2018\)](#).

Second, I find seemingly heterogeneous effects of the ordinal rank on students' test scores by students' ordinal rank, gender, and class size. For instance, the results suggest that in comparison to students whose ability ranks are among the lowest 20 percent in the class, all

³When testing this channel, taking advantage of the novel survey questions about the parent-perceived rank of the students, I include both the ranks perceived by students and parents.

⁴Rare exceptions that shared similar spirits are [Azmat and Iriberry \(2010\)](#), [Azmat et al. \(2016\)](#), and [Trautwein et al. \(2009\)](#). Specifically, [Azmat and Iriberry \(2010\)](#) and [Azmat et al. \(2016\)](#) found that providing students the information on their relative performance in school would affect the students' educational performance in the short run. They found a positive effect on high school students but a negative one on college students. In the education literature, [Trautwein et al. \(2009\)](#) showed that a student who believed that his/her Mathematics class has a higher standing in comparison to other classes in their school reported higher Mathematics self-concept than his/her classmates who perceived a lower standing of their class.

other students have higher Math scores. But the effect seems to be the largest for students in the fourth quintile of the ability rank. The results also show that female students' Math scores are more considerably affected by their ordinal rank than male students. In addition, the results show that the impact of the ordinal rank on test scores are generally larger for students who study in a big class.

Third, the results suggest the objectively measured ordinal ranks of students are positively and strongly correlated with the self-perceived rank. It indicates that students are aware of their "true" ordinal rank in the class. Conditional on students' objective ordinal ranks, the self-perceived rank still has a salient and positive impact on future test scores of middle students. Specifically, A one standard deviation increase in the self-perceived rank leads to 0.20, 0.17, and 0.22 of a standard deviation increase in test scores in Math, Chinese, and English, respectively. The results do not alter even after controlling for students' characteristics, family background, personality traits, and teachers' inputs.

Fourth, the self-perceived rank has considerable power in explaining almost all the potential mechanisms discussed above. Meanwhile, the ordinal rank can only predict students' confidence in learning math, friend quality, and effort provision. The results indicate that in comparison to the ordinal rank, the self-perceived rank is a dominant determinant of students' future test scores through various channels.

Besides extending the literature on the impact of the ordinal rank on students' academic performance (eg. [Murphy and Weinhardt \(2018\)](#); [Denning et al. \(2018\)](#); [Elsner and Isphording \(2017, 2018\)](#); [Bertoni, Nisticò et al. \(2018\)](#); [Goulas and Megalokonomou \(2015\)](#); [Tincani \(2017\)](#); [Cicala, Fryer and Spenkuch \(2017\)](#); [Elsner et al. \(2018\)](#)), the present paper also fits in the broad literature which investigate the impact of relative achievement on various individual outcomes, including subjective well-being (eg. [Card et al. \(2012\)](#); [Clark, Frijters and Shields \(2008\)](#); [Clark and Senik \(2010\)](#); [Senik \(2009\)](#); [Ferrer-i Carbonell \(2005\)](#); [Yu \(2019\)](#)), self-esteem and self-concept (eg. [Marsh et al. \(2015\)](#); [Morse and Gergen \(1970\)](#); [Collins](#)

(1996); Vogel et al. (2014)), labor market outcomes (O'Reilly III, Main and Crystal (1988); Boivie, Bednar and Barker (2015); Lazear and Rosen (1981); Malcomson (1986); Kale, Reis and Venkateswaran (2009)), health (eg. Yngwe et al. (2003); Morin (2006)) and performance in different types of contests and tournaments (eg. Genakos and Pagliero (2012); Boudreau, Lakhani and Menietti (2016)). In line with the findings in these studies, I find a positive and strong effect of relative achievement on an individual's outcomes, in the setting of education.

The present paper also contributes to the vast literature on peer effects in education. Peer effects in education have been addressed in a large body of literature in economics.⁵ While evidence of positive peer effects on student academic performance in different levels of education has been provided (see, for example, Duflo, Dupas and Kremer (2011); Hoxby (2000); Sacerdote (2001); Hanushek et al. (2003); Vigdor and Nechyba (2007); Whitmore (2005); Carman and Zhang (2012); Lavy, Paserman and Schlosser (2012); Zimmerman (2003); Stinebrickner and Stinebrickner (2006); Carrell, Fullerton and West (2009), some studies found negligible or even negative peer effects (eg. Antecol, Eren and Ozbeklik (2016); Foster (2006); Lavy, Silva and Weinhardt (2012); Imberman, Kugler and Sacerdote (2012)). One possible explanation of the mixed results found in these papers is that peer effects are nonlinear, and students at different achievement and/or ability levels are affected by their peers differently (see, for example, Lavy, Silva and Weinhardt (2012); Burke and Sass (2013); Imberman, Kugler and Sacerdote (2012); Sacerdote (2001)). The results of the present paper suggest that when a student is (or feels that he/she is) exposed to peers with higher abilities and/or better performance, the student experiences an adverse peer effect due to obtaining (perceiving) a lower rank among peers. Hence, this paper provides an angle to explain the negligible or negative peer effect found in a number of recent papers. Moreover, the findings of the current paper also confirms the non-linear peer effect found in some previous

⁵The debate on the impact of peer effects on student performance mainly originated from influential works of Coleman (Coleman et al. (1966); Coleman (1968)).

studies (eg. [Burke and Sass \(2013\)](#); [Imberman, Kugler and Sacerdote \(2012\)](#); [Lavy, Silva and Weinhardt \(2012\)](#); [Jackson \(2013\)](#)).

The rest of the paper is organized as follows. Section II describes the data. Section III and Section IV present the empirical strategy and estimation results, respectively. Potential mechanisms are examined in Section V. In Section VI, I discuss the correlation between the objectively measured ordinal rank and students' self-perceived rank. I also investigate the impact of the self-perceived rank on students' academic performance conditional on the objective ordinal ranks. Section VII concludes.

II Data

I exploit data from the 2013-2014 and 2014-2015 waves of the China Education Panel Survey (CEPS) for the analyses. The CEPS is the first and largest nationally representative longitudinal survey of middle school students in China, which contains rich information on students' demographic characteristics and test scores in school. The sampling design of the CEPS is based on randomly selecting 4 schools from each of the 28 districts, counties or cities which are randomly picked after the first-stage stratification by average educational level and intensity of population mobility. Once a school is selected, two classrooms from the 7th grade and two from the 9th grade in that school are randomly selected for the survey.⁶ CEPS surveyed students in the 7th grade and 9th grade in the 2013-2014 wave and conducted a follow-up survey for the 7th grade students one year later in the 2014-2015 wave. I employ data on the 7th grade students whose information is available in both waves of the CEPS to estimate the impact of a student's contemporaneous self-percieved ordinal rank on his/her future academic performance. To mitigate the concern of students sorting, I restrict the sample to 7th grade students who were randomly assigned to classrooms when they entered

⁶All students in the selected classrooms are surveyed.

middle school and who stayed in the same class when they went into the 8th grade.⁷

The outcome variables are students' mid-term test scores in the subjects of Math, Chinese, and English in the 8th grade.⁸ The test scores are provided by the principals or headteachers.⁹ The main explanatory variable is students' objectively measured ordinal ability rank. I construct students' objective percentile ordinal rank within a classroom based on their cognitive ability test scores provided by the CEPS. The cognitive ability test is a standard test designed to test students' cognitive abilities in language, figure, and space as well as calculation and logic.¹⁰ Students were asked to take the cognitive ability test in both waves of the survey. Because the outcomes are students' mid-term exam scores when they were in grade 8, I construct students' ordinal ranks using their scores in the ability test taken in grade 7 to build a connection between previous rank and future outcomes. To make students' ordinal ranks comparable across classrooms and schools, I follow [Elsner and Isphording \(2017\)](#) and [Murphy and Weinhardt \(2018\)](#) and construct students' *percentile* ranks using the following equation:¹¹

⁷All 7th grade students took the follow-up survey, therefore, there is no attrition due to students dropping out of the CEPS study. Some students, however, switch into another class when they entered the 8th grade. I show in Appendix Table A2 that the propensity of switching to another class is not correlated with a student's self-perceived or objective ordinal rank. Hence, dropping those students who switched classes do not alter the results. I also drop minority students due to their different background in culture, language, education and cognitive ability (153 Obs.), and over/under-age students (147 Obs.). Including these students do not alter the results as shown in Table 4.

⁸Math, Chinese, and English are the "main" courses for middle school students in China. Usually, each of the courses will account for 150 points out of the 750-point full marks in the High School Entrance Examination at province level which is the sole determinant of the level of a high school a student can achieve. Therefore, test scores in these 3 subjects are particularly critical for middle students in China.

⁹In Chinese primary and middle schools, a headteacher (chief teacher) of a class not only teaches a subject but also takes care of all matters in that class. A headteacher usually serves one class until students in that class graduate.

¹⁰Alternatively, one may construct students' ordinal ranks based on their GPA. Students' Cognitive ability is preferred than their GPA, however, mainly for two reasons. First, cognitive ability test scores are comparable across schools and classrooms since the cognitive ability test is a standard test for all students in the sample. On the contrary, students' GPA is generally incomparable across schools due to the heterogeneous difficulty of the exams, different grading policies, etc. Second, GPA measures the performance of students at school. It is obviously correlated with unobservable characteristics of the students, such as motivation, effort, etc. Controlling for these unobservables would be critical in estimating the GPA rank on students' future performance. In fact, the GPA rank could be a potential channel via which the ordinal ability rank affects students' future academic achievement.

¹¹There are three major advantages of building students' ranks within the class: 1) class sizes are usually

$$ObjPercentileRank_{i,c} = \frac{RawRank_{i,c} - 1}{N_c - 1} \quad (1)$$

In equation (1), $RawRank_{i,c}$ and N_c are student i 's raw rank in class c and the class size, respectively. Students' raw ranks range from 0 to N_c , where 0 stands for the lowest rank and N_c stands for the highest. Therefore, students' objective percentile ranks, $ObjPercentileRank_{i,c}$, are approximately uniformly distributed from 0 to 1 indicating the lowest rank to the highest. Students with the same ability in the same class are assigned with the same rank.

Table 1 presents the summary statistics of the main variables employed in the study. Around 49% of the students are female. The sample contains 58% single child. Among the test scores in Math, Chinese and English, Chinese scores have the largest mean of 84.8 points and the smallest standard deviation of 19.4. The ordinal ability rank has a mean of 0.5 and a standard deviation of 0.3. The sample contains 3,311 students from 92 classes in 49 schools.

III Empirical Strategy

III.A Identification

The identification strategy relies on the idiosyncratic variations in students' ordinal rank determined by the variations in the composition of students' ability across classrooms. Consider a restrictive case where class size and the average ability of students in class A and B are the same, but the distributions of students' abilities are different in these two classes, as shown in Figure 1. There are two ladders indicating the ordinal ability rank and ability

big in Chinese middle schools which provides enough variation in ranks; 2) students may be more aware of their ranks in class but not in the whole grade; 3) educational outcomes such as test scores are more comparable within class because of systematic differences across classes. Results are similar if ranks are built within a school grade instead of a class.

scores of students from class A and class B with the ability scores measured on a 0-100 points scale. Both class A and B have 7 students with a mean ability of 50 points. As depicted in the figure, with an ability score of 70, student i will be ranked the No. 1 in class A, but the student would be ranked the 3rd in class B. This shows that students from different classes would have different within-class ability ranks, even when they have the same ability and their classes have the same size and average ability of students. Hence, the variations in the ordinal ranks of the students are plausibly exogenously determined conditional on students' ability.

I estimate the following equation to investigate the effect of the ordinal rank on a student's future academic outcomes,

$$TestScore_{ics} = \alpha_1 + \beta_1 Rank_{ic} + f(Ability_{ic}) + \chi_{ic} + \eta_c + \sigma_{ics} \quad (2)$$

where $TestScore_{ics}$ signifies the test score of student i from classroom c in subject s obtained in the 8th grade. For the ease of interpretation of the results, the test scores are standardized by classroom and subject to have a mean of 0 and standard deviation of 1.¹² $Rank_{ic}$ measures student i 's ordinal rank in classroom c . Following [Elsner and Isphording \(2017\)](#), I control for the 4th-order polynomial of a student's cognitive ability to allow for a non-linear relationship between test scores and the ability of the student.^{13,14}

χ_{ic} denotes a vector of covariates, including a student's age, gender, single child status, family economic condition, educational level of parents and residence status. η_c stands for

¹²I estimate equation 2 for the subjects of Math, Chinese, and English, separately.

¹³As shown in Table 4, the results do not alter when alternative orders of the polynomial are employed in the regressions.

¹⁴I control for students' cognitive ability tested in the 8th grade to better predict the academic performance of the students in the 8th grade and to reduce the problem of multicollinearity between the objective rank (constructed using the 7th-grade ability) and cognitive ability test scores. As shown in the Appendix Table A2, controlling for students cognitive ability tested in the 7th grade do not substantially change the results. But models including the 7th grade cognitive ability of students are exposed to severe multicollinearity problem with very high Variance Inflation Factors (VIF) of the ability rank and the ability score (much higher than 10).

school-cohort fixed effects. Because all the students in the working sample are in the same grade, the school-cohort fixed effects are equal to school fixed effects. Therefore, I use school fixed effects to indicate school-cohort fixed effects hereafter. Because students are randomly assigned to classrooms within schools, I control for school fixed effects to capture mean differences across schools. As an alternative specification, I control for classroom fixed effects and find no change in the results (shown in Table 3). σ_{ics} is the error term.

Challenges to Identification

There are potential challenges to identifying the causal link between the ordinal rank and students' test scores. One challenge is individual-level omitted variables, such as unobservable personality traits of the students, which are determinants of students' academic achievement. These omitted variables can also indirectly affect students' ordinal rank since the ordinal rank is constructed based on students' cognitive ability scores. For instance, a student with a high level of self-esteem is likely to achieve a higher score in the cognitive ability test as well as better academic performance in school. These omitted variables, however, do not bias the estimates of the ordinal rank because the ordinal rank is exogenously determined conditional on students' cognitive ability and on being in a specific school, and in all the analyses I control for student ability.¹⁵ The CEPS contains abundant information of students' personal characteristics, including information on students' self-confidence, self-esteem, etc. Therefore, in addition to students' characteristics and family background, I also control for a set of covariates which gauge students' academic performance in the past (a proxy for motivation and effort), self-esteem, and the level of self-confidence to furtherly mitigate the concern of potential confounders at the individual level.

Specifically, in equation (2) I control for students' test scores in the 7th grade, which are proper proxies for students' motivation and effort in study.¹⁶ To account for more of

¹⁵More discussions can be found in [Elsner and Isphording \(2017\)](#), Section IV.D.

¹⁶Note that it is also possible that students' performance in the 7th grade functions as a mechanism instead of an omitted variable in my setting. In other words, students' ordinal ability ranks could be pre-determined

the students’ academic achievement in the past, I include in χ_{ic} three variables measuring if the student went to kindergarten, for how many times the student repeated a grade in primary school, and how many grades the student skipped in primary school. To account for students’ self-esteem and self-confidence, I control for a number of indicators which signify if the student thinks that he/she was articulate, was a quick learner, and if the student was always able to respond quickly. As shown in Table 3, results do not alter with or without controlling for all the personal characteristics, including measurements of students’ personality traits. The results support that omitted variables should not bias the estimates.¹⁷

Because both a student’s academic performance and ordinal rank can be affected by the abilities of the student’s peers, potential peer effects might drive the results. To address this concern, I control for the left-over (excluding a student’s own ability) average peer ability and the average student ability in the class in two alternative specifications, respectively. As shown in Table 3, the results keep intact in comparison to the baseline results. I implement more robustness checks to examine if the results are sensitive to different specifications or to the restrictions on the sample. The results are consistent under all the robustness checks.

Measurement error can be another source of bias. I discuss more about measurement error later in Section IV.C and show that measurement error could cause a downward-bias or no impact on the estimates.

III.B *Validity of the Randomized Sample*

One more potential source of bias is student sorting. If students self-select into different schools conditional on their expected rank in the school, the estimated effect on the ordinal

and then affect students’ test scores in the 7th grade.

¹⁷It is worth noting that the ordinal rank and students’ academic performance might be also associated with factors such as parental expectations and teachers’ inputs. While these factors are important, they fall into the category of *mechanisms* rather than omitted variables. In other words, parents and teachers react to the information on students’ ordinal rank and thus affect students’ academic performance. Therefore, behaviors of parents and teachers are channels through which the ordinal rank affect students’ test scores. See the Online Appendix of [Elsner and Ipsfording \(2018\)](#) for more discussion.

rank on students' academic performance might be biased. As discussed below, in China students compete for scarce positions in good middle schools and high schools to increase their chances of eventually going to a good university. Under such circumstances, strong students tend to have a lower rank on average and the coefficients of the ordinal rank tend to be underestimated. To prevent the estimates from being contaminated by potential bias caused by student sorting, I focus on students randomly assigned to classrooms. Because the information on the composition of students in class is not available to students or parents when students are randomly assigned to classrooms, the concern of sorting students based on the composition of peer abilities is eliminated.

In the Chinese education system, primary school students go to different middle schools based on the location of their *hukou*.¹⁸ In an increasingly large number of schools, students are randomly assigned to different classes when they enroll (7th grade). This procedure is strongly supported by the Ministry of Education of China to improve equality in educational resources and quality for all students in the compulsory education stage.¹⁹

I closely follow [Gong, Lu and Song \(2018\)](#) to restrict the sample to schools where students are randomly assigned to classrooms when they enroll, based on several conditions.²⁰ Following [Gong, Lu and Song \(2018\)](#); [Antecol, Eren and Ozbeklik \(2016\)](#), I test for the validity of randomization by examining whether a student's demographic characteristics, family background, as well as academic and non-cognitive measures in primary school (predetermined before classroom assignment in middle school) are correlated with various classroom characteristics.²¹ If students were randomly assigned to classrooms, I should find insignif-

¹⁸*Hukou* can be simply understood as a certificate of residency. It is usually regulated that a civilian is a legal residency of a county or an area in a city.

¹⁹See [Gong, Lu and Song \(2018\)](#) for more details of the random assignments procedure.

²⁰Specifically, I restrict the sample to schools which fulfill three conditions: 1) the principal of the school reports that students are randomly assigned to classrooms when they enroll; 2) students are not re-assigned when the current semester starts; 3) all headteachers in the same grade in a school report that students were not assigned to classrooms based on their test scores.

²¹Details of the variables are presented in [Table 1](#).

icant associations between characteristics of students and classrooms. In all regressions, school fixed effects are controlled since the random assignment is within the school-grade level. Because the dataset lacks a direct measure of students' academic outcomes such as test scores pre-middle school, I use the students' self-perceived rank in the last year of primary school as a proxy for pre-determined test scores. In addition, I include three variables that measure how many times a student repeated a grade in primary school, the total number of grades a student skipped in primary school and whether a student attended kindergarten, respectively.

The results of these tests are reported in Table 2. The dependent variables in column 1 to 4 in Table 2 are a headteacher's gender dummy, headteacher's teaching experience, the average and standard deviation of peers' ability scores in the 7th grade, respectively. The results suggest that these classroom specific characteristics are not correlated with predetermined characteristics of students. At the bottom of Table 2, I also present the F statistics of tests of joint significance. All the tests fail to reject that null hypothesis of joint insignificance. Therefore, the results support the validity of sample randomization. Following [Lim and Meer \(2017a,b\)](#), I implement an alternative approach to test sample randomization by comparing the mean of student characteristics by the headteacher gender and comparing the mean of teacher characteristics by student gender. In all the tests, the p -values are always large and none of the pairs of means is significantly different. The results are shown in Table A1.

Because the random assignment was implemented at the school-grade level, one may still concern that parents of students with high abilities may prefer to enroll students into a school with lower average peer ability so that their child can have a higher rank. This is not likely to be the case in this paper for two main reasons. First, the Compulsory Education Law of China implemented in 1986 regulated that a student must go to a junior middle school based on the location of the student's *hukou*. Therefore, when primary school students have

graduated, they have limited freedom of choosing among different middle schools, and this limitation reduced the likelihood of selecting schools. Second, the competition for education resources is severe among students in China due to limited resources and large cohort sizes at all different levels of education. In addition, high schools and universities accept students almost solely based on students’ test scores in standardized provincial and national level tests, respectively. Therefore, in order to get access to better educational resources (to increase test scores), including better teacher quality and equipment in school, parents compete to enroll their children into better middle schools where the majority of education resources are gathered and where students have a much higher performance in tests on average.^{22,23,24}

Taken all together, the results confirmed the randomness of the sample. In addition, even if there were cases where parents were able to select better schools for students, this would attenuate the estimates towards zero. In this case, the estimates tend to underestimate the effect and can be treated as a lower bound of the true effect.

IV Estimation Results

IV.A *Baseline Results*

Table 3 presents the results obtained from estimating equation (2) using various specifications. The summary statistics of the variables are reported in Table 1. The dependent

²²Similarly, [Ding and Lehrer \(2007\)](#) suggested that keen competition for high-ranked high schools in China is common.

²³In a recent paper using data from China, [Hoekstra, Mouganie and Wang \(2018\)](#) showed that the higher return of attending better high schools in China is driven by the better teacher quality.

²⁴[Zheng, Hu and Wang \(2016\)](#) showed that the premium in housing price of “within-zone housing” (a house within a school attendance zone of a key primary school) is around \$350 (2,266 Yuan) per square meter in comparison with housing out of the school zones in 2011 in Beijing. They also mentioned that a small number of out-of-zone parents paid extra “admission fee” to enroll their children into Key Primary Schools in Beijing. The average amount of the fee was around \$20,000 (130,000Yuan). This suggests that parents, in fact, are willing to spend a large amount of money to send their children to a good school with a higher average quality of students. Moreover, [Hastings, Kane and Staiger \(2009\)](#) found that parents prefer schools with a higher average peer performance using data from elementary and middle school students in North Carolina.

variables are students' mid-term test scores in the subjects of Math, Chinese, and English in the 8th grade. The main explanatory variable is students' ordinal ability rank in the 7th grade. All outcomes are standardized by the classroom to have a mean of zero and a standard deviation of 1. A quartic polynomial of students' ability is included in all regressions. Standard errors are clustered at the classroom level.

In general, the results suggest that the ordinal rank in the 7th grade has a salient and positive impact on a student's test scores in all three subjects in the 8th grade. The effect of the ordinal rank is the largest on Math scores while English scores are affected by the ordinal rank the least. Comparing the results in columns 1 and 2, controlling for student characteristics and family background do not alter the effect of the ordinal rank on Math scores, and it even increases the effects on test scores in Chinese and English. All the coefficients are statistically significant at 1% level. The results suggest that if a student's ordinal rank increases from the lowest in the class to the highest, his/her test scores will increase by 0.25, 0.23, and 0.19 of a standard deviation in the subjects of Math, Chinese, and English, respectively. In other words, a one standard deviation (0.3) increase in a student's ordinal rank leads to 0.08 (0.3×0.25), 0.07 (0.3×0.23), and 0.06 (0.3×0.19) of a standard deviation in the test scores in Math, Chinese, and English, respectively. The results are largely comparable to those reported in [Murphy and Weinhardt \(2018\)](#).

In column 3, I additionally control for the average student ability in the class to capture the impact from average peer ability. The results are unchanged in comparison to the baseline results presented in column 2. Employing the average student ability assumes that peer effects are identical for each student within a class. This assumption might be implausible because students at different levels of cognitive ability are exposed to a different level of average peer ability as well. Allowing for student-specific average peer ability, I calculate the average peer ability for each student excluding the student's own ability. Controlling for this left-over average peer ability allows for the peer effect to vary for each student. The results

are reported in column 4 in Table 3. The results remain intact. In the last column in Table 3, I control for classroom fixed effects to capture any mean differences across classrooms. The inference is not altered. It is worth noting that the goodness of fit almost does not change despite the changes in specifications. Taken all together, the results suggest that the estimated effects of the ordinal rank on students' test scores are consistent.

IV.B *Heterogeneity Effects of Ordinal Rank*

In the baseline analyses, I assume that the effect of self-perceived rank is linear. To allow the effect of the self-perceived rank to be non-linear, I re-estimate equation (2) but replacing the $Rank_{ic}$ with a set of dummies which indicate quintiles in which a student's within-class rank falls. The omitted category is students whose rank belong to the lowest quintile in the class. I report the results in Figure 2. For the ease of comparing the magnitude of the effects on students in each category, the coefficients of the rank dummies, as well as the 90% and 95% confidence intervals, are shown in the figures.

The results suggest a seemingly non-linear effect of the ordinal rank on the middle school students' test scores in all three subjects. In Figure 2a, the results suggest that in comparison to students whose ability ranks are among the lowest 20 percent in the class, all other students have higher Math scores. The effect seems to be the largest for students in the fourth quintile of the ability rank. For students whose ranks fall in the first to the third quintiles, the effects are close to linear. In Figure 2b, the results indicate that there is no significant difference in the Chinese scores between students from the fifth and fourth quintiles of the ability rank. In comparison, students whose rank fall into the top 40% - 60% in the class have about 0.1 of a standard deviation higher scores in the subject of Chinese. The effects are smaller when a student's rank increases from the third quintile to higher quintiles. Figure 2c depicts the effects of the ordinal rank on test scores in English. The results again suggest no considerable difference in English scores for students whose rank fall into the fifth and fourth quintiles

in the class. Interestingly, the results also suggest that in comparison to students with the lowest ability rank, those whose rank fall into the top 40% - 60% and 60% - 80% have about the same test scores in English.

To furtherly test whether the effect may differ by gender, I estimate the effect for male and female students separately. The results obtained from estimating equation (2) for male and female subsamples are shown in Figure 3. For example, in Figure 3a, the outcome is test scores in Math. The figure clearly shows that the effects of the ordinal rank differ by gender. The results show that female students' Math scores are more considerably affected by their ordinal rank than do male students. While a higher ability rank leads to a higher score in Math for female students, male students tend to have similar scores except for those whose ability ranks are among the top 20% in the class. Figure 3b show that male students whose ordinal ranks are in the top 40% in the class have a higher test score in Chinese in comparison to other students, the effect is only statistically significant for female students in the top quintile of the ability rank. Figure 3c shows that the ordinal rank has a positive and significant effect on improving test scores in English for male students in the first, second, and third quintiles in the ordinal rank. And the effect is smaller for students in the top quintile than for students in the second or third quintile. Differently, the results suggest that in comparison to female students in the lowest quintile in the ordinal rank, the ordinal rank does not improve female students' scores in English unless the student is among the top 20% in cognitive ability in the class.

I also examine the potential heterogeneity of the effect by class size. I divide the classes into "small class" and "big class" subsamples using a threshold of 45 students, which is the median class size in the sample. The effects of ordinal rank on test scores by class size are shown in Figure 4. According to Figure 4, the effect of the self-perceived rank on test scores are again non-linear. It seems that the effect of the ordinal rank on test scores are always the largest for students in the 3rd quintile. In addition, the figures show that the effects are

generally larger for students who study in a big class.

IV.C *Robustness Checks*

Alternative Specifications

In addition to estimating equation (2) employing various specifications as shown in Table 3, I implement more robustness checks as discussed below. First, I test if the results are sensitive to controlling for different functional forms of students' cognitive ability, their ordinal rank in the primary school, and to the restrictions imposed on the sample. The results of the tests are presented in Table 4. Baseline results (from column 2 in Table 3) are reported in column 1 in Table 4 for comparison.

a) In each of columns 2 to 4 in Table 4, I replace the quartic function of students' cognitive ability with a linear, quadratic, and cubic function of student ability, respectively. It is clear that the results do not alter controlling for different functional forms of student ability in the equation.

b) It is possible that the estimates of the students' ordinal rank in the 7th grade, in fact, reflect the impact of students' rank in the past on their test scores. To test if omitted past rank may potentially bias the estimates, I re-estimate equation (2) by also controlling for students' self-perceived rank for the 6th grade (the last year in primary school). The results are reported in column 5 in Table 4. The estimates are slightly smaller than those obtained from the baseline regressions but remain significant both economically and statistically.

c) In the baseline estimations, the working sample was restricted to students who are not minorities and who are in normal school age. As a robustness test, I include all the dropped observations and re-estimate equation (2). The results are shown in columns 6 of Table 4. The coefficients are largely consistent with the baseline results.

Measurement Error

Another source of bias is measurement error. For instance, if a student had bad luck and performed poorly in the cognitive ability test, we would observe a lower ability in the data of the student than his/her true ability. Intuitively, if students' academic performance is affected by the observed ability rank but not the true ability rank, then the estimated rank effect is not biased by measurement error. If students' test scores are affected by the true ability rank instead of the observed rank, measurement error will either attenuate the estimates towards zero against finding an effect or has no impact on the estimates. A detailed derivation is provided in the Appendix IX.A. Employing a Monte Carlo experiment, [Murphy and Weinhardt \(2018\)](#) and [Elsner and Isphording \(2018\)](#) confirmed that potential measurement errors in the (ability) test scores in constructing the ordinal ranks of students would either attenuate the estimates towards zero or have a negligible impact on the estimates.

Attrition

Moreover, I examine if attrition is likely to drive the results. As mentioned in Section II, I dropped students who switched to a different class when they entered the 8th grade. Biases in the estimates may arise if the switching is correlated with students' ordinal rank.²⁵ Following [Elsner and Isphording \(2017\)](#) and [Elsner and Isphording \(2018\)](#), I build an attrition dummy variable to indicate if a student was dropped from the working sample due to switching classes. I regress the attrition dummy on the ordinal rank controlling for all the covariates from equation (2). As shown in the Appendix Table A3, the results suggest that the attrition dummy is uncorrelated with the ordinal rank of the students. Therefore, attrition is not likely to bias the results.

²⁵Also as mentioned in Section II, all the 7th grade students took the follow-up CEPS survey after entering the 8th grade. Therefore, there is no classic attrition problem in the sample. Here, I define "attrition" as being dropped from the sample because of switching classes.

V Mechanisms

In this section, I investigate abundant potential channels through which the ordinal ranks affect a student's test scores. A great advantage of the CEPS dataset is that it provides very detailed information on students' self-confidence and self-expectations, effort provision, parental expectations and inputs, impacts from teachers and schoolmates, as well as information on the behaviors and the attitudes toward study of students' friends. As a result, I am able to improve the literature by disentangling a very rich set of mechanisms.

Association between the Ordinal Rank and Students' Self-Perceived Rank

It is critical to understand the correlation between the ordinal rank and the self-perceived rank of the students. The importance lies in the subtle fact that potential mechanisms, such as self-confidence and self-expectations, are not valid mechanisms unless students' ranks are observable or perceivable to the students. In other words, the self-perceived rank is an intermediate that connects the ordinal ranks and factors such as students' self-confidence, parental inputs, etc. Therefore, the self-perceived rank also functions as a major channel. Taking advantage of the novel information on students' self-perceived rank, I provide the first evidence to show the correlation between the ordinal rank and students' self-perceived rank. As shown below, the strong positive association between the two ranks suggest that students are well aware of their ordinal rank.

The CEPS data contain direct information on students' self-perceived rank. Specifically, in the 2013-14 wave of CEPS, students were asked to rate their contemporaneous academic rank in class (in grade 7) on a 5-point scale. Students were asked to answer the following question: "Currently, how is your rank in study in your class?" Students can choose an answer among 1. "among the lowest," 2. "between the lowest and median," 3. "median," 4. "between the highest and median", and 5. "among the highest."

To investigate the association between students' "true" ordinal rank and self-perceived

rank, I re-estimate equation (2) using students' self-perceived rank as the dependent variable. As shown in column 1 in Table 5, the ordinal ability rank is strongly and positively correlated to students' self-perceived rank, conditional on students' ability. Specifically, a one standard deviation increase in the ordinal rank leads to around one-fifth of a standard deviation increase in the self-perceived rank. The results reported in column 1 in Table 5 indicate that the middle school students in the sample are aware of their ordinal rank in class, although the self-perceived rank may not perfectly reflect the ordinal ranks.²⁶ In columns 2 and 3, I re-estimate using subsamples for male and female students, respectively. I found no evidence of heterogeneity in the association between the self-perceived rank and the ordinal ranks by gender.

In the rest of Section V, I examine a large set of potential mechanisms. I regress potential mechanisms on both the ordinal ability rank and self-perceived ranks in the regressions. As a preview of the results, the ordinal ability rank almost has no explaining power on any of the outcomes. Meanwhile, the coefficients of the self-perceived rank are significant in most of the regressions. The results suggest that the ordinal rank can be understood as a proxy of students' self-perceived rank, and the self-perceived rank is what actually has an impact on students' academic achievement through various channels. In all analyses, I allow the self-perceived rank to be non-linear to better understand how the potential mechanisms work for students in different categories.

Self-Confidence and Self-Expectations of Middle School Students

It is possible that achieving a higher rank raises a student's self-confidence and/or own expectations for him/herself which in turn improves the student's academic performance. The CEPS data contain information on middle school students' self-confidence. Specifically,

²⁶Causes of imperfect reflections might include measurement errors in the self-perceived rank, imperfectly revealed information on students' ability rank in class, and students' personality traits. Also note that, based on the design of the survey question on the self-perceived rank, the corresponding variable reflects more about students' perception regarding their relative performance in study rather than relative ability.

the surveyed students were asked to report their level of agreement to the following statement: “I am usually confident in finishing a mission that needs to be done.” Students can choose an answer among 1. “completely disagree,” 2. “disagree,” 3. “agree” and 4. “completely agree.” In addition, the students were asked if they feel that it is hard to study Math, Chinese and English. Possible answers range from “I feel that it is very hard to study Math/Chinese/English” to “I feel that it is not hard at all to study Math/Chinese/English”. Another interesting survey question asks the students to report their own feeling about their appearance. Answers range from “very ugly” to “very beautiful.” I employ students’ answers to these questions to measure students’ self-confidence.

Moreover, students were asked to report their desired highest degree of education they would like to achieve and their desired type of occupation in the future. I construct an indicator to denote that a student expects to have at least a college degree in the future. I also construct a dummy variable to indicate that a student has strong career ambition.²⁷ All of these questions were asked to the students when they were in the 8th grade.

I regress these outcomes on both the ordinal ability rank and the self-perceived ranks. In all regressions, the omitted category of the self-perceived rank consists of students who perceived a rank at the class median. The control variables are taken from equation (2). I report the results in Table 6A. In columns 1 through 3, the results show that self-perceived ordinal rank has a positive and significant effect on a student’s confidence in learning Math, Chinese and English. The effects differ mildly for students in different categories of subjective rank. For example, in column 1, the effect seems relatively larger for students who perceived a below-median than those who perceived an above-median rank. The objective ability rank has a positive effect and significant effect on a student’s confidence in studying math, but no influences on a student’s confidence in studying Chinese or English.

²⁷It takes a value of 1 if a student expects to have a job as a leader or officer in national/government institutions, a scientist, an engineer, a doctor, a programmer, a pilot, an astronaut or an executive in a company.

Similarly, the results in columns 4 through 6 show a positive impact of self-perceived ordinal rank on a middle school student's confidence in solving problems, own expectations for their educational and occupational achievement for the future. For instance, if a middle school student perceived that his/her rank in the 7th grade jumped from the bottom of the class to class median, the student's propensity of expecting a college or higher degree increases by around 20 percentage points. If a student felt that his/her rank jumped from class median to the top, the propensity of expecting a college or higher degree will increase another 8 percentage points for the student. Meanwhile, the ability rank is correlated with neither of the self-expectation outcomes.²⁸

In the last column in Table 6A, the results suggest that in comparison to students' who perceived an average rank in class, those who perceived to have the highest rank in class are more likely to feel him/herself to be beautiful. On the contrary, if a student believes that his/her rank is the lowest in the class, the student is more likely to feel that he/she is ugly.

Parents' Perceived Rank and Parental Expectations

Parents' expectations are strong determinants of students' academic achievement (eg. Brooks-Gunn, Linver and Fauth (2005); Furstenberg et al. (1999)), and parental expectations are often influenced by their children's academic performance (eg. Yamamoto and Holloway (2010); Englund et al. (2004)). In this subsection, I examine how parental expectations react to students' ordinal ranks. Ideally, I should obtain a measure of students' rank that is observable to parents, which should be the norm based on which parents form their expectations for their children's future achievement. Fortunately, the parents' survey of the CEPS contains novel information regarding parents' perceived academic rank of their kids

²⁸Elsner and Isphording (2017) found that students with a higher objective ordinal rank are around 8.2 percentage points more likely to go to college in the future. As a test, I drop subjective ordinal ranks from the equation and find similar the coefficient of the objective ordinal rank. Specifically, I find that students with a higher objective ability rank in class are 9 percentage points higher in expecting to go to college in the future. The coefficient of the objective ability rank becomes insignificant, however, when subjective ordinal ranks are included in the equation estimated. This indicates a much stronger impact of subjective rank on self-expectation than that of the objective rank.

in class. Hence, I am able to investigate how parental expectations and inputs change based on their perception of their children's ordinal rank.

I construct an indicator to denote that parents expect their children to have at least a college degree. I also construct an indicator to denote that parents expect their children to have a job as a leader or officer in national/government institutions, a scientist, an engineer, a doctor, a programmer, a pilot, an astronaut or an executive in a company. Another outcome I consider is a parent-reported requirement on their children's academic performance in school. Potential answers range from "top 5 in class" to "no special requirement".

I re-estimate equation (2) using parents' expectations for their children as the outcomes. Moreover, I add parents' perceived ordinal rank of their children to the equation as extra explanatory variables. I expect a stronger effect of parents' self-perceived rank on parents' expectations than that of students' self-perceived ranks.

Column 1 in Table 6B reports the impact of ordinal ranks on parents' expectations for their children's educational achievement in the future. In general, the results indicate that if a student perceives a lower rank in class, the student's parents have a lower propensity of expecting the student to get at least a college degree. The results also suggest that parents' expectations for their children's educational achievement react more strongly to parents' own perceived rank of the children than to the children's self-perceived rank. This is consistent with the hypothesis that parents react more to their own perception. Results shown in column 2 suggest that parents' expectations for their children's occupational achievement is correlated with the subjective ranks perceived by the children but less significantly with the rank perceived by parents.

In column 3, the dependent variable measures parents' requirement for their children on academic performance in class. The variable is measured following an ascending order on a 4 points scale where a higher value signifies a higher requirement for the students on study. The results indicate that parents have a higher requirement on their children's

performance if they believe that their children have a higher rank in class. Similarly, a higher self-perceived rank by the students themselves also leads to a higher requirement on study from their parents. The objective ordinal rank has a coefficient indifferent from zero in all three regressions.

Lastly, results shown in columns 4 and 5 suggest no significant differences in the time and money spent by parents on students regardless of their ability rank or self-perceived rank.

Different Environment in School

Another potential channel is the school environment a student is exposed to. This channel is especially important when a student's rank is observable to his/her schoolmates and teachers. It is plausible that a student with a higher rank in class will receive more support from teachers (eg. [Pop-Eleches and Urquiola \(2013\)](#); [D'Este and Einiö \(2018\)](#)), and the student is also likely to be treated differently by peers (eg. [Cicala, Fryer and Spenkuch \(2017\)](#)).

In the CEPS, students were asked if they agree that they are treated nicely by most of their classmates, if they usually attend activities organized by class or school, if they feel close to people in their school, and if they feel bored in school. Potential answers range from “completely disagree” to “completely agree.” I re-estimate the model in equation (2) using these self-reported feelings about classmates and at school as the dependent variables. The results are shown in Table 6C. In column 1 of Table 6C, the results suggest that a student's self-perceived rank has a positive impact on peers' attitude towards the student. In column 2, the results suggest that a higher self-perceived rank leads to more participation in class and school activities, but the coefficients are only statistically significant for students with the highest and the lowest self-perceived rank. The effect is the most salient for students who perceived to have performed among the worst in study in the class. Results in columns 3 and 4 suggest that a higher self-perceived rank leads to a higher propensity of feeling comfortable at school. In comparison to students who perceived a median rank in the class,

students whose perceived rank is between the median and the best are about 8 percentage points higher in the propensity of feeling close to people in school. In addition, students with the highest (lowest) perceived ranks are more (less) likely to feel bored at school.

The CEPS also surveyed students regarding how they are treated by teachers. Specifically, students were asked if their Math/Chinese/English teacher often pay attention to them, ask them to answer questions, or praise them. I investigate if students' ordinal rank affects the way they were treated by the teachers. The results are presented in Table 6D. As shown in Panel A Table 6D, in comparison to the omitted group, students with the highest self-perceived ranks in the 7th grade are more often noticed and asked to answer questions in class by their teachers. On the contrary, students who perceived the lowest rank are less often noticed or asked to answer questions by all their teachers in Math, Chinese and English. Results in the Panel B in Table 6D show that students with a higher self-perceived rank are more likely to be praised by their headteacher and subject teachers, and they are less likely to be criticized by teachers.

The ordinal ability rank, on the other hand, is not significantly correlated with any of the outcomes in Table 6C and Table 6D. This, to some extent, indicates that teachers and schoolmates do not react to the "true" rank but ranks perceived by the students.²⁹

Friendship and Problematic Behaviors

An additional channel is social interactions with friends. It is possible that students self-select into different groups of peers with different peer quality based on their own ordinal ranks, and students' behaviors may furtherly be affected by their peers within a specific

²⁹It is plausible because, in a situation where the information regarding students' relative performance in study is revealed, teachers and students in the same class are exposed to the same information. If such information is not supposed to be revealed, students and their schoolmates should again have similar perceptions regarding the relative performance of other students and their own. Under such circumstance, teachers lack incentives to rank students on their own. Therefore, teachers might have a similar amount of information as the students to form their opinions on students' ordinal rank. As a result, the self-perceived rank should dominate the objectively measured ranks in affecting the behaviors of teachers and peers. Replacing the ability rank with the GPA rank leads to similar results.

group. I construct two indexes to gauge the quality of friends of a student as well as the number of problematic behaviors a student engaged in during the preceding year of the CEPS survey.³⁰ In Table 6E, the results show that students with a higher self-perceived rank have higher quality friends. Similarly, students with a higher self-perceived ordinal rank are less likely to engage in problematic behaviors in school. The results are largely in line with [Elsner and Isphording \(2018\)](#); [Cicala, Fryer and Spenkuch \(2017\)](#) who suggest that students with a higher ordinal rank are less likely to be friends with students who engage in risky behaviors. The ordinal ability rank is also positively and significantly correlated with friend quality.

Effort Provision

Lastly, I examine whether students with a higher ordinal rank make more efforts to study. Specifically, I test if a student's academic rank in class is correlated with his/her time spent on doing homework or entertainment during weekdays and weekends.³¹ The results are reported in Table 6F. The results in column 1 and 4 show that in comparison to students whose self-perceived rank is about the median rank in the class, students in other categories made the same amount of effort in doing homework. The only exception is the group of students who perceived themselves to have the lowest rank in class. These students with the lowest self-perceived rank spent significantly less time doing homework on both weekdays and weekends. Moreover, the results in Table 6F provide some evidence of a positive correlation between students' self-perceived rank and time spent on watching TV or playing computer games. The results indicate that a lower self-perceived rank leads to a reduction in effort provision among students but an increase in time spent on leisure.

It is interesting to note that students' objective ability rank is negatively correlated to the time spent on homework but positively correlated with the time spent on playing computer games. The results suggest that students treat effort as a complement for their educational

³⁰Components of the two indexes are described in the Appendix Section [IX.B](#).

³¹The dependent variables are measured in an ascending order where a higher value stands for a higher amount of time spent.

achievement.³²

VI The Correlation between the Self-Perceived Rank and Test Scores

As discussed above, the self-perceived rank is essential in determining students' future academic performance. In fact, students' self-perceived rank is likely to dominate the objective ranks as a determinant of academic achievement. Therefore, it is important to know how students' performance is affected by their self-perceived rank, given the same objective rank in ability and GPA. Previous studies were not able to examine the connections between students' self-perceived rank and academic achievement due to the lack of data. Here, I employ the information on students' self-perceived rank provided by the CEPS to examine the potential relationship between students' self-perceived rank and test scores. Specifically, I regress students' test scores on the self-perceived rank controlling for a quartic polynomial function of student ability, students' test scores in the 7th grade, and school fixed effects. In addition, I control for the objective ability rank and GPA rank of the students to account for any other impact from the objective ranks on students' test scores. The results are reported in column 1 in Table 7. The results indicate a positive and significant correlation between students' self-perceived rank and test scores in all three subjects. A one standard deviation increase in the self-perceived rank leads to 0.20, 0.17, and 0.22 of a standard deviation increase in test scores in Math, Chinese, and English, respectively.

Are Omitted Personal Confounders A Problem?

One obstacle to finding a causal effect of the self-perceived rank on test scores of the students is the potential endogeneity problem caused by omitted variables. To be specific,

³²Sharing the same spirit, [Pop-Eleches and Urquiola \(2013\)](#) found that parents reduce efforts if their children attend a better school.

because the self-perceived rank is a subjective measure, it is likely to be correlated with students' personality traits which also affect students' test scores. For example, a student who has high self-esteem may be more likely to report a high rank. Meanwhile, the high level of self-esteem may also lead to a better academic outcome of the student. In this case, the estimates of self-perceived rank will be overestimated. It is also possible that relatively weaker students tend to over-report their rank while relative stronger students are more likely to be humble and report a low rank. In this case, the estimates tend to underestimate the true effect.

To address this concern, I first show a simple visualization of the distribution of the self-perceived rank. I depict the fractions of each category of the self-perceived rank in Figure 5. Less than 10% of the students perceived to be among the lowest ranked in the class, while slightly more than 10% of students believed that they fall into the group with the highest rank in the class. The rest of the students reported a rank of "below median", "median", and "above median". The percentage of students fall into each of the three categories is 21%, 29%, and 33%, respectively.³³ It seems that the top and the bottom categories are somewhat underreported. If that is the case, the figure provides evidence in favor of the second situation where stronger students tend to underreport their rank and weaker students tend to overreport the rank, and the omitted personality is likely to cause a downward bias.³⁴

To furtherly mitigate the concern of unobservable personality traits and provide an estimate closer to a causal finding, I control for students' characteristics, including a series of measurement of personality traits and past academic achievement, as well as family background in the regressions. The results are presented in column 2 in Table 7. After controlling

³³For the sake of saving space in the figure, I label the five categories differently from those in the text. But the five categories are the same as those used in the main analyses.

³⁴But one needs to interpret the figure with caution. Because students may have different definitions or standards for being in a specific rank category, it is hard to make a precise conclusion on whether or how much the self-perceived rank deviates from students' objective rank.

for students' characteristics and personality traits, the coefficient of the self-perceived rank keeps intact when the outcome is Math scores, and the estimates even slightly increase when the dependent variables are test scores in Chinese and English.

Taken all together, the results suggest that the omitted personal confounders are not likely to drive the results. In fact, the findings show that if the unobservable personality traits may bias the estimates, they would attenuate the estimates towards zero against finding an effect.

First-Order Difference in Self-Perceived Academic Rank

As an alternative method to address the potential endogeneity problem caused by unobservable personality traits of the students, I exploit the 1st-order difference between the self-perceived rank in the 7th and 6th grade of the students to identify variations in the changes in self-perceived rank.³⁵ Using the difference between the two self-perceived ordinal ranks reported by students at the same time as the independent variable will eliminate the bias caused by unobservable personality traits and provide a consistent estimate, assuming that these personality traits are correlated with students' self-perceived rank in the 6th and 7th grade in an identical way.³⁶ The coefficient of the 1st-order difference estimates the impact of the difference in student i 's self-perceived rank between grade 7 and 6 on his/her future academic outcomes. Although the interpretation of the coefficient differs from that of the self-perceived rank in the main analyses, the results are still informative to show how

³⁵Students were asked to report their self-perceived rank and the class size when they were in the 6th grade (the last year in primary school) in cardinal. Based on this information, I build a self-perceived rank of the students for grade 6. Specifically, I equally divide the 6th grade subjective percentile ranks of students into quintiles indicating ranks ranging from "bad" to "good" so that the 6th grade rank is comparable to 7th grade rank. For example, if a student's self-perceived rank falls into the lowest 20% of the class, I indicate it as "bad"; on the contrary, if a student's self-perceived rank falls into the highest 20% of the class, I indicate it as "good". The other 3 categories are "below median", "median" and "above median" which contain students whose self-perceived rank in grade 6 are within 20-40%, 40-60%, and 60-80%, respectively. Then I subtract the rank in the 6th grade using that in the 7th grade to measure the change in self-perceived rank of students. Note that the assumption made here is that the raw five categories of the self-perceived rank in the 7th grade also indicate the 5 quintiles in the distribution of students' self-perceived ranks, respectively.

³⁶A formal deduction on the consistency of the estimates is presented in the Appendix Section [IX.C](#)

changes in self-perceived ordinal rank affect the outcomes of interest. The results can be treated as a piece of collateral evidence to support the main findings.

I replace the 7th grade subjective rank with the changes in the self-perceived rank between grade 7 and grade 6 in equation (2). Values of the 1st order difference in the two ranks range from -4 to 4. I truncate the variable on both ends and construct it into 6 dummy variables. The omitted category is students who perceived to have a 3 or 4-point drop (having a value of -3 or -4) in their ranks between grade 6 and 7. Although lots of variations are lost when calculating the 1st order difference, I still find significant estimates as shown in the Appendix Table A4.³⁷ The results show that, in comparison with students who perceived a 3 to 4 point drop in ordinal rank between grade 6 and 7, other students are in general have a higher test score in Math. The estimates are less significant when the outcome is test scores in Chinese or English, but all the coefficients remain positive and large. Although the interpretation of the coefficients of the 1st order difference is different from that in the main analyses, the results are supportive to the baseline results that subjective rank has a salient and positive effect on test scores of the middle school students. The results also show a positive and significant relationship between the ability rank and students' test scores in the 8th grade.

Accounting for Impact from Teachers

Another obstacle to identifying a causal link between the self-perceived rank and test scores is teachers' behaviors, such as their attitudes towards a student, which may affect both the student's perceived rank and performance in study. To account for the impact from teachers' behaviors, I control for a number of variables measuring the teacher's gender and teaching experience, and whether the Math (Chinese/English) teacher often asked the student questions or often praised the student in the class.³⁸ As shown in column 3 in Table 7, adding all these control variables into the equation does not alter the results.

³⁷Around 80% of the values of the 1st order difference fall into the 0 or -1 category.

³⁸All these factors capturing teachers' behaviors are reported by the students in the 7th grade when the self-perceived ranks were reported.

Measurement error may also bias the results. Similar to the discussion on potential measurement error in the ability test scores in Section IV.C, measurement error on the self-perceived rank should either do not affect the estimates or introduce a downward bias to the estimated effects.

VII Conclusion

In this paper, I investigate the impact of the ordinal rank of middle school students on their test scores in Mathematics, Chinese and English using a randomized sample from China. I found a positive and salient effect of the ordinal rank on students' test scores. The effects are heterogeneous by students' objective ability rank, gender, and the size of the class. The effects also differ by subject. Taking advantage of the novel information on students' self-perceived academic rank in class, I provide the first direct evidence showing that middle school students' self-perceived ordinal rank also has a positive and salient effect on their test scores in a later year in middle school. The results indicate that students are well aware of their objective ordinal rank in the class.

I examine a large number of channels through which the objective and self-perceived ranks may affect students' academic performance. The results suggest that perceiving a higher rank raises a student's confidence in study and expectations on his/her own educational and occupational achievement in the future. A student with a higher perceived rank also receives more support from parents, teachers, and classmates. I also find some evidence showing that students with a higher rank are more likely to be friends with higher quality peers. In addition, students who believe that they are among the worst students significantly reduce effort provision and increase their time spent on entertainment.

The findings in the present paper imply that ability tracking would hurt low ability students but benefit high ability students, which would furtherly widen educational inequality

among students. As a result, these findings are, to some extent, against student tracking and segregation which would reveal substantial information on students' relative ability or performance. Although students with a higher ability may benefit from ability tracking, those who are assigned to a relatively "worse" group would be hurt much more heavily in various aspects, including motivation, self-concept and self-expectations, supports from family and teachers, etc., and eventually educational achievement.³⁹

One limitation of the paper is that, due to the lack of data, I am only able to study the short term effect of the ordinal ranks on those middle school students from China. In Section VI, I provide evidence to show that the correlation between the self-perceived rank and students' test scores are consistent using various approaches. It remains, however, for future studies to investigate what causes students to form different perceptions on their ranks conditional on the true ability rank and GPA rank.

³⁹Some previous studies have also shown that student tracking and segregation are harmful to students' achievement (see, for example, [Duflo, Dupas and Kremer \(2011\)](#); [D'Este and Einiö \(2018\)](#); [Guyon, Maurin and McNally \(2012\)](#); [Fu and Mehta \(2018\)](#)).

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VIII Figures and Tables

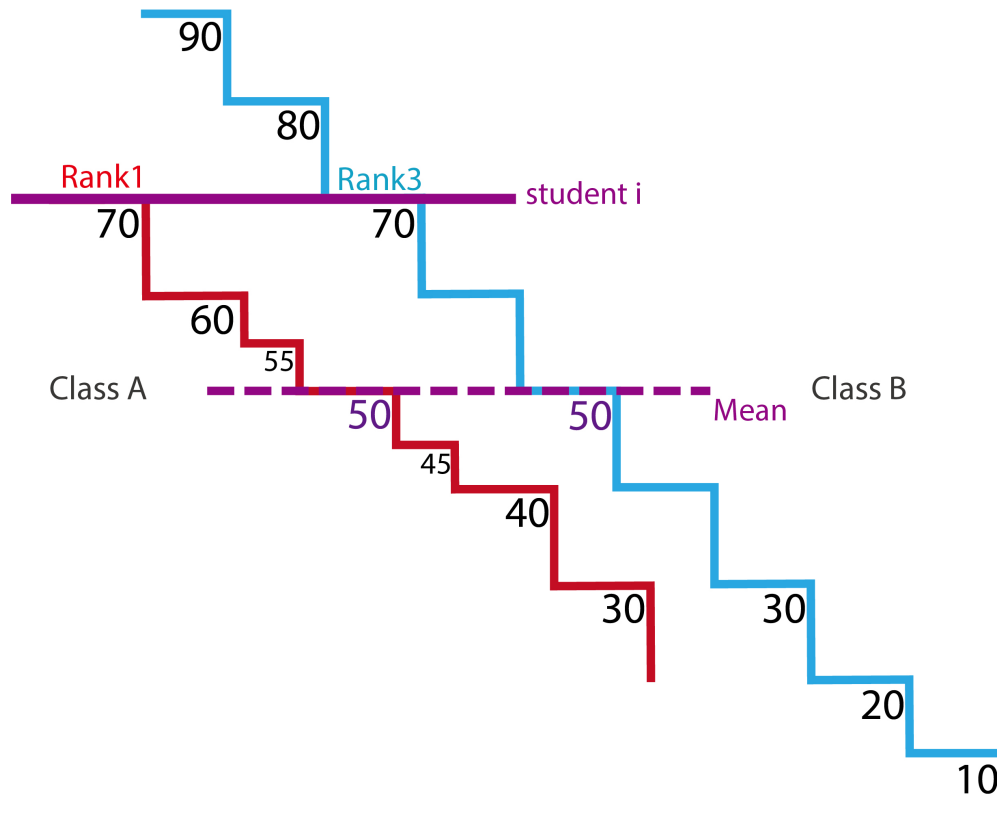
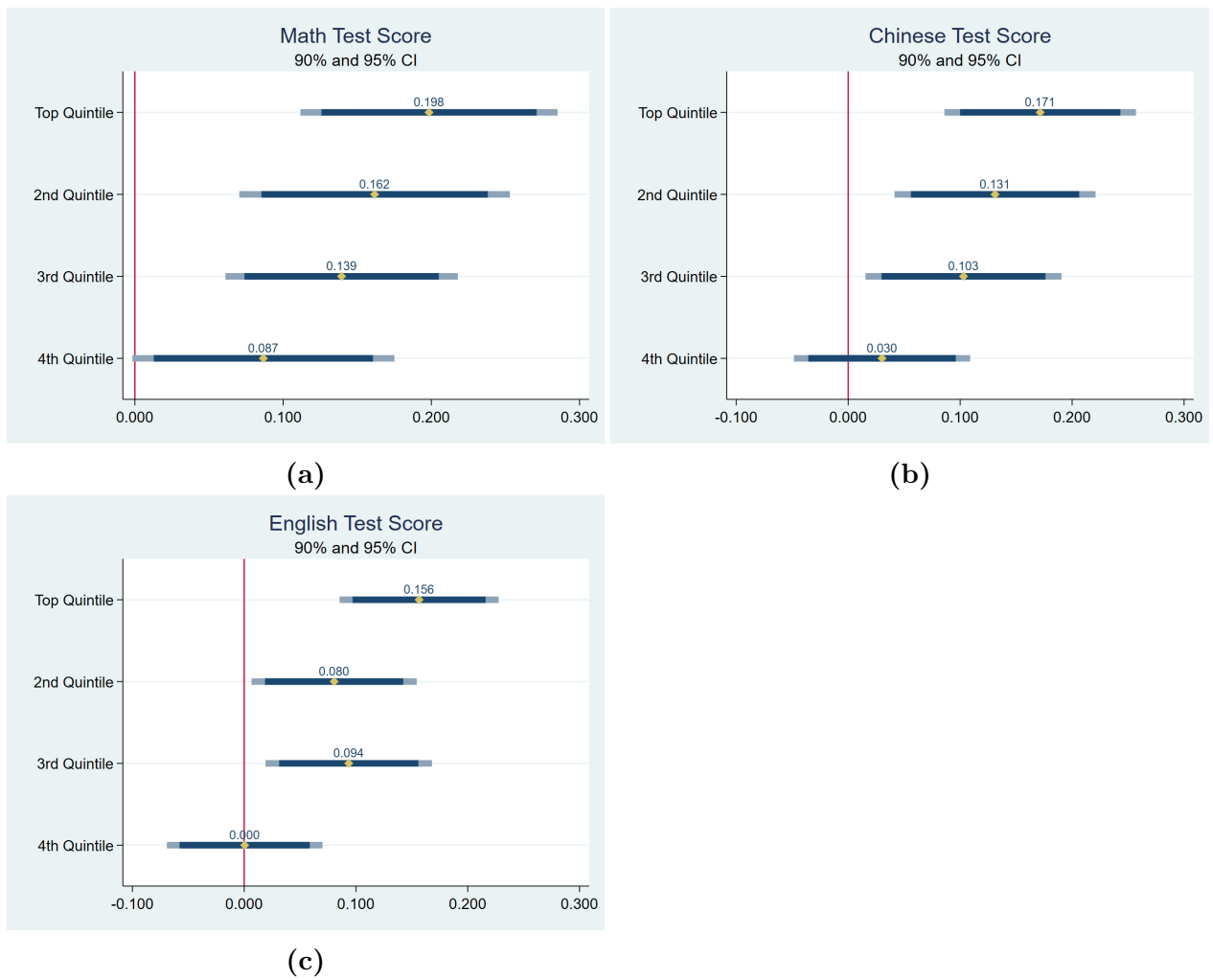
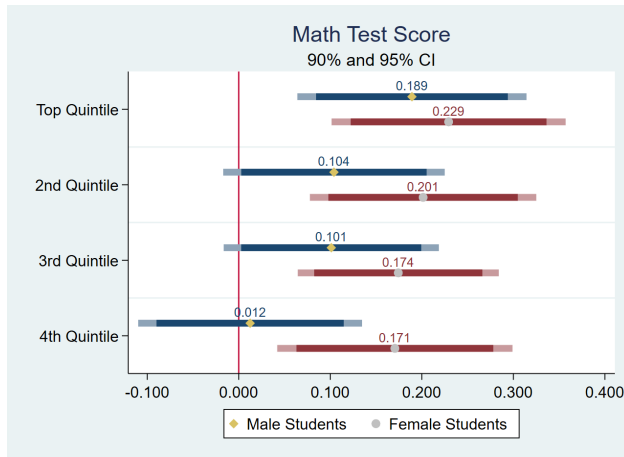


Figure 1: Variation in Ordinal Ability Rank for Students with the Same Ability

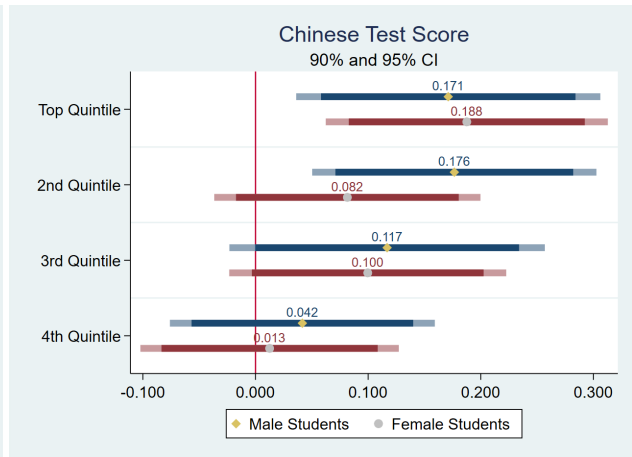


Note: The omitted category of the ability rank contains students whose rank are among the lowest 20% in the class. The numbers labelled above the confidence intervals are the coefficients of the rank dummies. 90% and 95% confidence intervals are depicted with dark blue and light blue, respectively.

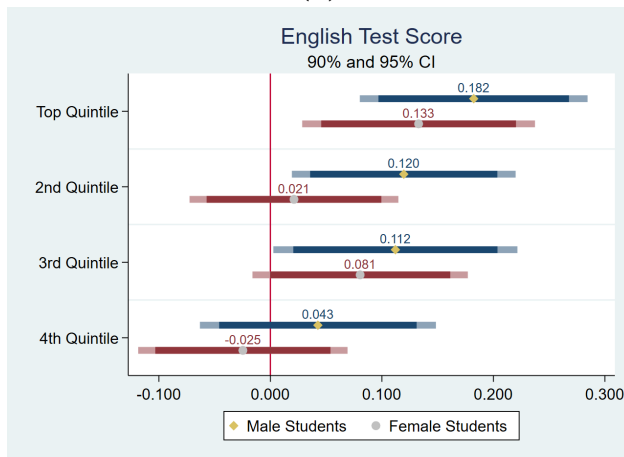
Figure 2: Heterogeneous Effect of the Self-Perceived Rank



(a)



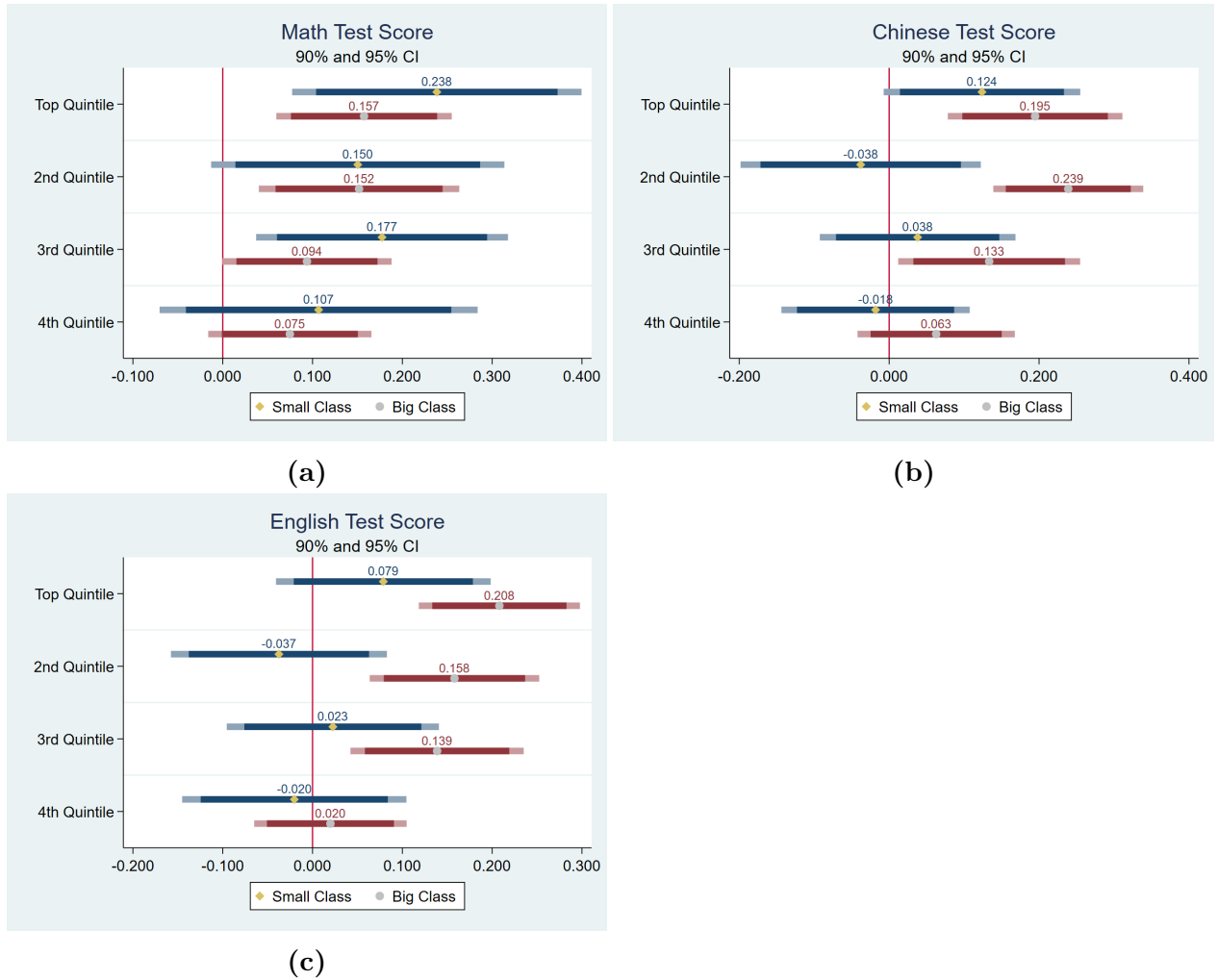
(b)



(c)

Note: The omitted category of the ability rank contains students whose rank are among the lowest 20% in the class. The numbers labelled above the confidence intervals are the coefficients of the rank dummies. 90% and 95% confidence intervals are depicted with dark blue (red) and light blue (red), respectively.

Figure 3: Heterogeneous Effect of the Self-Perceived Rank by Gender



Note: The omitted category of the ability rank contains students whose rank are among the lowest 20% in the class. The numbers labelled above the confidence intervals are the coefficients of the rank dummies. 90% and 95% confidence intervals are depicted with dark blue (red) and light blue (red) for students in a small (big) class, respectively.

Figure 4: Heterogeneous Effect of the Self-Perceived Rank by Class Size

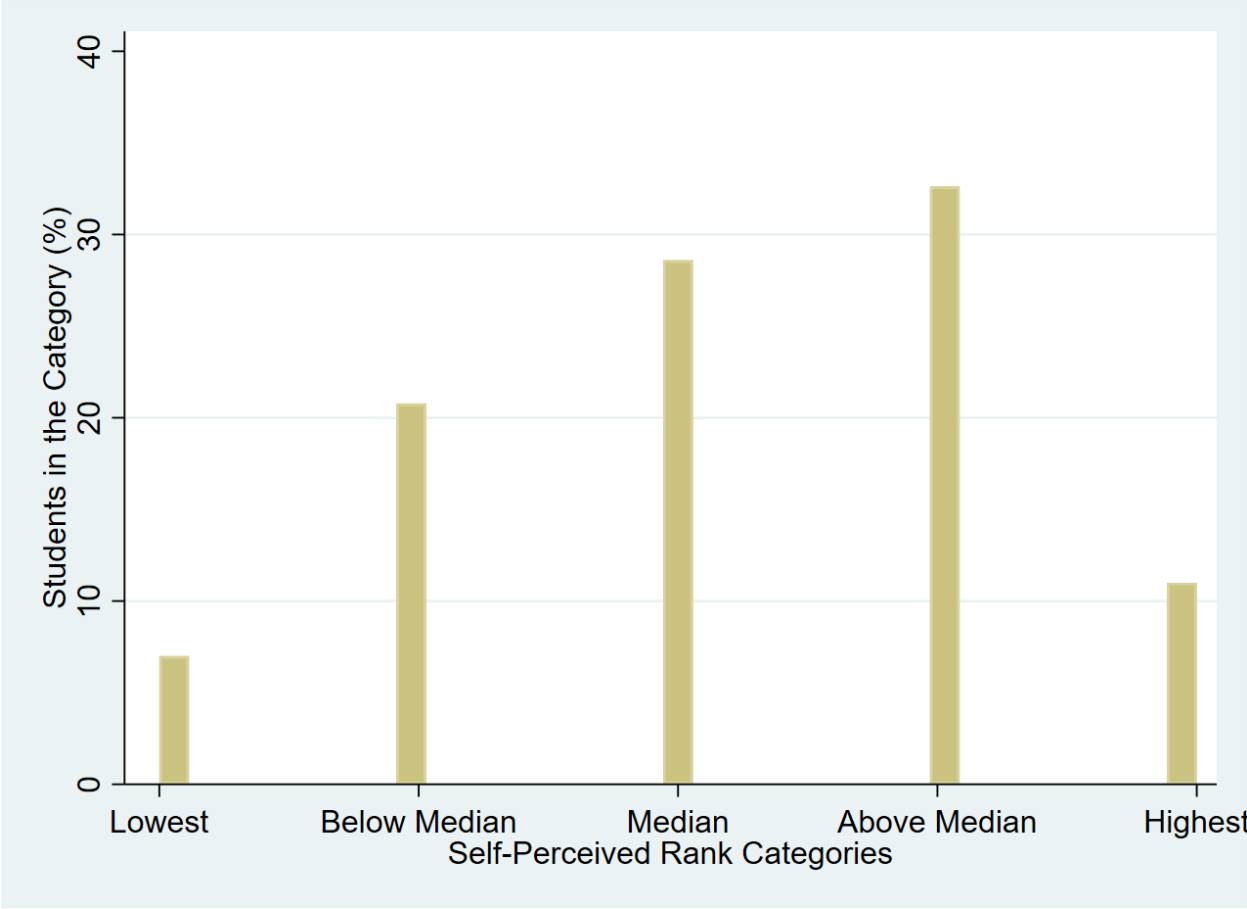


Figure 5: The Distribution of Self-Perceived Rank

Table 1: Summary Statistics

<i>Variables</i>	Mean	Std. Dev.	N
<i>Student Academic Outcomes</i>			
8 th Grade Math Score	79.6	32.0	3,311
8 th Grade Chinese Score	84.8	19.4	3,311
8 th Grade English Score	78.2	30.2	3,311
<i>Outcomes for Testing Randomization</i>			
Female Head Teacher	0.71	0.46	3,311
Experience of Head Teacher	2.54	0.62	3,311
Average Peer Cognitive Ability	0.20	0.47	3,311
SD. Peer Cognitive Ability	0.75	0.12	3,311
<i>Ordinal Rank</i>			
Ability Rank	0.50	0.30	3,311
7 th GPA Rank	0.49	0.29	3,311
7 th Grade Self-Perceived Rank	3.20	1.10	3,301
6 th Grade Self-Perceived Rank	0.68	0.23	2,972
<i>Individual Characteristics and Family Attributes</i>			
8 th Grade Cognitive Ability Score	0.44	0.79	3,311
7 th Grade Math Score	80.5	25.1	3,311
7 th Grade Chinese Score	80.6	16.1	3,311
7 th Grade English Score	85.7	26.6	3,311
Female	0.49	0.50	3,292
Age	12.8	0.69	3,311
Rural Residency	0.39	0.49	3,082
Single Child	0.58	0.49	3,311
Father College Degree	0.23	0.42	3,219
Mother College Degree	0.20	0.40	3,222
Family Econ Condition Before Primary School	2.88	0.55	3,218
<i>Student Pre-Middle School Academic Measures</i>			
Times of Repeating A Grade in Primary School	0.08	0.32	3,308
Number of Grades Skipped in Primary School	0.02	0.27	3,308
Student Attended Kindergarden	0.87	0.34	3,289
<i>Student Pre-Middle School Self-Esteem and Self-Concept</i>			
I Am Curious About New Knowledge: Curious	3.52	0.77	3,181
I Am Articulate : Articulate	3.22	0.79	3,177
I Respond Quickly : Quick Responder	3.14	0.77	3,182
I Learn Quickly : Quick Learner	3.12	0.80	3,159

Table 2: Validity of Randomization

<i>Variables</i>	(1) Female Head Teacher	(2) Experience of Head Teacher	(3) Average Peer Cog. Ability	(4) SD. Peer Cog. Ability
Female	-0.002 (0.009)	-0.016 (0.012)	-0.010 (0.010)	0.001 (0.002)
Age	-0.021 (0.013)	0.018 (0.011)	0.017 (0.011)	-0.002 (0.003)
Rural Residency	-0.019 (0.018)	0.010 (0.028)	-0.009 (0.017)	0.001 (0.004)
Single Child	-0.011 (0.011)	0.009 (0.023)	-0.011 (0.011)	0.004 (0.003)
Student Attended Kindergarden	0.011 (0.026)	0.009 (0.027)	0.007 (0.017)	-0.003 (0.005)
6th Grade Subj. Rank	0.026 (0.042)	0.080 (0.055)	0.047 (0.054)	-0.008 (0.007)
Times of Repeating A Grade in Primary School	-0.014 (0.022)	-0.005 (0.021)	-0.037 (0.028)	0.005 (0.004)
Number of Grades Skipped in Primary School	0.006 (0.036)	0.056 (0.048)	-0.003 (0.021)	-0.008 (0.007)
Curious	0.001 (0.009)	-0.000 (0.009)	0.006 (0.008)	-0.001 (0.002)
Articulate	-0.010 (0.011)	0.003 (0.013)	0.001 (0.007)	-0.000 (0.002)
Quick Responder	0.015 (0.015)	-0.004 (0.014)	0.000 (0.008)	0.000 (0.004)
Quick Learner	0.010 (0.009)	0.005 (0.010)	-0.005 (0.005)	-0.000 (0.002)
Mother College Degree	0.028 (0.021)	-0.037 (0.028)	-0.013 (0.018)	0.009* (0.005)
Father College Degree	-0.004 (0.017)	0.030 (0.022)	0.007 (0.014)	-0.004 (0.005)
Family Econ Condition Before Primary School	-0.000 (0.016)	-0.007 (0.012)	-0.010 (0.014)	0.002 (0.003)
<i>Test for Joint Significance</i>				
F Stat	1.42	1.10	1.30	0.61
p-value	0.18	0.38	0.24	0.85
School Fixed Effects	✓	✓	✓	✓
N	2,478	2,478	2,478	2,478

The 6th-grade subjective rank has been constructed as within-class percental rank. Standard errors are clustered at the school level and reported in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: The Impact of the Ordinal Rank on Test Scores of Middle School Students

	(1)	(2)	(3)	(4)	(5)
Dependent Variables:					
Test Score in Math	0.252*** (0.045)	0.247*** (0.052)	0.245*** (0.052)	0.242*** (0.053)	0.237*** (0.053)
Test Score in Chinese	0.193*** (0.044)	0.230*** (0.050)	0.227*** (0.051)	0.222*** (0.051)	0.220*** (0.052)
Test Score in English	0.157*** (0.035)	0.192*** (0.042)	0.190*** (0.042)	0.188*** (0.042)	0.190*** (0.042)
Covariates:					
Student Ability 4 th Order Polynomial	✓	✓	✓	✓	✓
School Fixed Effect	✓	✓	✓	✓	✗
Student Characteristics & Family Background	✗	✓	✓	✓	✓
Classroom-Average Ability	✗	✗	✓	✗	✗
Average Peer Ability (Excluding Own Ability)	✗	✗	✗	✓	✗
Classroom Fixed Effect	✗	✗	✗	✗	✓
Adjusted R²:					
Test Score in Math	0.57	0.57	0.57	0.57	0.56
Test Score in Chinese	0.50	0.51	0.51	0.51	0.50
Test Score in English	0.68	0.69	0.69	0.69	0.69
<i>N</i>	3,311	2,717	2,717	2,717	2,717

The dependent variables are standardized scores in the 8th grade with a mean of 0 and standard deviation of 1. The explanatory variable of interest is the ordinal ability rank in the 7th grade. Standard errors are clustered at the classroom level and reported in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Robustness Checks

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variables:						
Test Score in Math	0.247*** (0.052)	0.248*** (0.052)	0.248*** (0.052)	0.247*** (0.052)	0.229*** (0.052)	0.280*** (0.052)
Test Score in Chinese	0.230*** (0.050)	0.229*** (0.051)	0.228*** (0.051)	0.229*** (0.051)	0.172*** (0.050)	0.195*** (0.049)
Test Score in English	0.192*** (0.042)	0.192*** (0.041)	0.194*** (0.041)	0.193*** (0.042)	0.162*** (0.043)	0.179*** (0.041)
Covariates:						
Baseline Estimates (for Comparison)	✓	✗	✗	✗	✗	✗
Student Ability (Linear)	✗	✓	✗	✗	✗	✗
Student Ability (Quadratic)	✗	✗	✓	✗	✗	✗
Student Ability (Cubic)	✗	✗	✗	✓	✗	✗
Rank in Primary School	✗	✗	✗	✗	✓	✗
Including Minorities and Under/Over-Age Students	✗	✗	✗	✗	✗	✓
School Fixed Effect	✓	✓	✓	✓	✓	✓
Student Characteristics	✗	✓	✓	✓	✓	✓
<i>N</i>	2,717	2,717	2,717	2,717	2,478	2,794

The dependent variables are standardized scores in the 8th grade with a mean of 0 and standard deviation of 1. The explanatory variable of interest is the ordinal ability rank in the 7th grade. Standard errors are clustered at the classroom level and reported in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Association between the Objective Ability Rank and Self-Perceived Rank

	(1)	(2)	(2)
	All	Male	Female
Ability Rank	0.672*** (0.061)	0.682*** (0.091)	0.679*** (0.092)
Mean of the Dependent Variable	3.24	3.08	3.40
Std. Dev. of the Dependent Variable	1.10	1.14	1.04
Student Characteristics	✓	✓	✓
Student Ability 4 th Order Polynomial	✓	✓	✓
School Fixed Effects	✓	✓	✓
<i>N</i>	2,711	1,346	1,365

The dependent variables are students' self-perceived rank on a 5-point scale, and a higher value indicates a better self-perceived rank. All regressions include a full set of controls as in Table 3 (gender indicator dropped in columns 2 and 3). Standard errors are clustered at the classroom level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6A: Self-Confidence, Self-Expectations and Ordinal Ranks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
<i>Variables</i>	Feel Easy to Study Math	Feel Easy to Study Chinese	Feel Easy to Study English	Confident in Solving Problems	Expected to Go To College	Strong Career Ambition	Student Thinks Him/Herself Beautiful
Ordinal Ability Rank	0.145** (0.061)	-0.052 (0.049)	-0.076 (0.069)	-0.088 (0.055)	0.037 (0.029)	0.007 (0.034)	-0.087* (0.044)
<i>Self-Perceived Ordinal Rank</i>							
Subj. Rank among the Highest	0.358*** (0.055)	0.145*** (0.054)	0.528*** (0.063)	0.192*** (0.060)	0.079*** (0.023)	0.110*** (0.032)	0.123** (0.052)
Subj. Rank between the Highest and Median	0.189*** (0.041)	0.064* (0.035)	0.239*** (0.043)	0.110*** (0.037)	0.041** (0.019)	0.056*** (0.021)	0.003 (0.032)
Subj. Rank between the Lowest and Median	-0.268*** (0.041)	-0.091** (0.040)	-0.421*** (0.041)	-0.075 (0.047)	-0.172*** (0.025)	-0.055** (0.026)	-0.032 (0.038)
Subj. Rank among the Lowest	-0.377*** (0.077)	-0.242*** (0.066)	-0.648*** (0.081)	-0.218*** (0.074)	-0.196*** (0.046)	-0.144*** (0.045)	-0.142** (0.057)
Student Characteristics	✓	✓	✓	✓	✓	✓	✓
Student Ability 4 th Order Polynomial	✓	✓	✓	✓	✓	✓	✓
School Fixed Effects	✓	✓	✓	✓	✓	✓	✓
N	2,707	2,706	2,706	2,708	2,599	2,430	2,696

The dependent variables are self-confidence and self-expectations reported by students. The omitted category of the self-perceived rank contains students who perceived to have a rank at the class median. Standard errors are clustered at the classroom level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6B: Parental Expectations and Ordinal Ranks

<i>Variables</i>	(1) Parental Expectations on Education	(2) Parental Expectations on Career	(3) Requirement on Study from Parents	(4) Time Inputs on Study from Parents	(5) Spending on Extra Curricula
Ordinal Ability Rank	0.089 (0.093)	-0.008 (0.036)	0.028 (0.050)	-0.013 (0.338)	-0.243 (0.248)
<i>Students' Self-Perceived Ordinal Rank</i>					
Subj. Rank among the Highest	0.120 (0.124)	0.008 (0.044)	0.310*** (0.070)	-0.486 (0.323)	0.262 (0.386)
Subj. Rank between the Highest and Median	0.009 (0.079)	-0.021 (0.033)	0.158*** (0.041)	-0.225 (0.193)	0.071 (0.198)
Subj. Rank between the Lowest and Median	-0.230** (0.098)	-0.088*** (0.033)	-0.132** (0.050)	0.605 (0.410)	-0.073 (0.234)
Subj. Rank among the Lowest	-0.569*** (0.172)	-0.126*** (0.046)	-0.382*** (0.076)	-0.410 (0.483)	0.091 (0.351)
<i>Parents' Self-Perceived Ordinal Rank</i>					
Subj. Rank among the Highest	0.394*** (0.129)	0.048 (0.052)	0.162* (0.082)	0.285 (0.463)	-0.372 (0.354)
Subj. Rank between the Highest and Median	0.250*** (0.074)	0.032 (0.027)	0.215*** (0.042)	0.018 (0.184)	-0.101 (0.206)
Subj. Rank between the Lowest and Median	-0.320*** (0.097)	0.006 (0.030)	-0.179*** (0.043)	-0.352 (0.349)	-0.022 (0.256)
Subj. Rank among the Lowest	-0.420*** (0.152)	-0.094** (0.046)	-0.253*** (0.068)	0.111 (0.688)	-0.327 (0.302)
Student Characteristics	✓	✓	✓	✓	✓
Student Ability 4 th Order Polynomial	✓	✓	✓	✓	✓
School Fixed Effects	✓	✓	✓	✓	✓
<i>N</i>	2,547	2,561	2,541	1,427	2,396

The dependent variables are variables measuring parental expectations, parents' requirements on study, and parental inputs. The dependent variables and the parent-perceived ordinal ranks are all reported by parents. The omitted category of the self-perceived rank contains students who perceived to have a rank at the class median and whose parents perceived a rank at the class median for the children. Standard errors are clustered at the classroom level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6C: Students' Ordinal Ranks and Relationship with Classmates

<i>Variables</i>	(1) Classmates Are Friendly	(2) Often Participates in Class & School Activities	(3) Feels Close to People in School	(4) Feels Bored at School
Ordinal Ability Rank	0.068 (0.049)	-0.079 (0.066)	0.031 (0.062)	0.082 (0.067)
<i>Self-Perceived Ordinal Rank</i>				
Subj. Rank among the Highest	0.064 (0.050)	0.117** (0.052)	0.090 (0.061)	-0.136*** (0.046)
Subj. Rank between the Highest and Median	0.066* (0.038)	0.026 (0.044)	0.080* (0.043)	-0.019 (0.042)
Subj. Rank between the Lowest and Median	-0.077 (0.048)	-0.049 (0.047)	-0.034 (0.050)	0.010 (0.045)
Subj. Rank among the Lowest	-0.221*** (0.074)	-0.189** (0.085)	-0.121 (0.076)	0.157* (0.081)
Student Characteristics	✓	✓	✓	✓
Student Ability 4 th Order Polynomial	✓	✓	✓	✓
School Fixed Effects	✓	✓	✓	✓
<i>N</i>	2,706	2,705	2,702	2,705

The dependent variables are students' feelings about their classmates and their experience at school. The omitted category of the self-perceived rank contains students who perceived to have a rank at the class median. Standard errors are clustered at the classroom level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6D: Ordinal Ranks and Teachers' Activities in the Class

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A:						
Teacher's Activities in Class	Often Noticed by Math Teacher in Class	Often Noticed by Chinese Teacher in Class	Often Noticed by English Teacher in Class	Often Asked to Answer Answer Questions by Math Teacher	Often Asked to Answer Answer Questions by Chinese Teacher	Often Asked to Answer Answer Questions by English Teacher
Ordinal Ability Rank	0.085 (0.062)	0.040 (0.061)	-0.016 (0.070)	0.016 (0.065)	0.012 (0.069)	-0.088 (0.065)
Self-Perceived Ordinal Rank						
Subj. Rank Very Good	0.119* (0.060)	0.209*** (0.064)	0.169*** (0.064)	0.041 (0.073)	0.287*** (0.056)	0.250*** (0.060)
Subj. Rank Good	-0.035 (0.036)	0.019 (0.035)	-0.012 (0.043)	-0.042 (0.039)	0.061* (0.036)	0.076* (0.042)
Subj. Rank Bad	-0.073 (0.047)	-0.054 (0.041)	-0.138*** (0.047)	-0.087* (0.050)	-0.057 (0.042)	-0.166*** (0.047)
Subj. Rank Very Bad	-0.346*** (0.070)	-0.289*** (0.072)	-0.387*** (0.084)	-0.406*** (0.076)	-0.323*** (0.078)	-0.458*** (0.078)
Student Characteristics	✓	✓	✓	✓	✓	✓
Student Ability 4 th Order Polynomial	✓	✓	✓	✓	✓	✓
School Fixed Effects	✓	✓	✓	✓	✓	✓
N	2,710	2,709	2,711	2,705	2,709	2,701
Panel B:						
Teachers' Praises and Criticisms:	Often Praised by Math Teacher	Often Praised by Chinese Teacher	Often Praised by English Teacher	Often Praised by the Head Teacher	Often Criticized by the Head Teacher	
Ordinal Ability Rank	0.006 (0.064)	-0.036 (0.065)	-0.092 (0.063)	-0.014 (0.059)	-0.055 (0.064)	
Self-Perceived Ordinal Rank						
Subj. Rank Very Good	0.378*** (0.062)	0.360*** (0.060)	0.422*** (0.057)	0.443*** (0.057)	-0.116* (0.059)	
Subj. Rank Good	0.101*** (0.036)	0.120*** (0.037)	0.105*** (0.039)	0.152*** (0.036)	-0.119*** (0.045)	
Subj. Rank Bad	-0.089* (0.049)	-0.049 (0.044)	-0.141*** (0.045)	-0.015 (0.043)	0.050 (0.047)	
Subj. Rank Very Bad	-0.273*** (0.080)	-0.177** (0.078)	-0.320*** (0.076)	-0.136* (0.071)	0.211*** (0.074)	
Student Characteristics	✓	✓	✓	✓	✓	
Student Ability 4 th Order Polynomial	✓	✓	✓	✓	✓	
School Fixed Effects	✓	✓	✓	✓	✓	
N	2,711	2,709	2,704	2,706	2,700	

The dependent variables measure how students are treated by teachers in class. The omitted category of the self-perceived rank contains students who perceived to have a rank at the class median. Standard errors are clustered at the classroom level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6E: Friendship, Problematic Behaviors, and Ordinal Ranks

<i>Variables</i>	(1) Friend Quality Index	(2) Problematic Behavior Index
Ordinal Ability Rank	0.039* (0.020)	0.033 (0.035)
<i>Self-Perceived Ordinal Rank</i>		
Subj. Rank Very Good	0.031 (0.019)	-0.076** (0.033)
Subj. Rank Good	0.027** (0.013)	-0.040* (0.022)
Subj. Rank Bad	-0.029* (0.017)	0.054** (0.027)
Subj. Rank Very Bad	-0.075** (0.031)	0.109** (0.051)
Student Characteristics	✓	✓
Student Ability 4 th Order Polynomial	✓	✓
School Fixed Effects	✓	✓
<i>N</i>	2,690	2,662

The dependent variables in column (1) is an index measuring the quality of a student's five best friends. The dependent variable in column (2) gauges the propensity for a student to engage in problematic behaviors. The components of these two indexes are reported in the Appendix Section IX.B. The omitted category of the self-perceived rank contains students who perceived to have a rank at the class median. Standard errors are clustered at the classroom level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6F: Ordinal Rank and Effort Provision

	(1)	(2)	(3)	(4)	(5)	(6)
	Time Spent on Homework on Weekdays	Time Spent on Watching TV on Weekdays	Time Spent on Playing Computer Games on Weekdays	Time Spent on Homework on Weekends	Time Spent on Watching TV on Weekends	Time Spent on Playing Computer Games on Weekends
Ordinal Ability Rank	-0.139* (0.082)	-0.031 (0.100)	0.002 (0.105)	-0.002 (0.069)	0.041 (0.079)	0.168* (0.086)
<i>Self-Perceived Ordinal Rank</i>						
Subj. Rank Very Good	-0.004 (0.076)	-0.102 (0.084)	-0.129 (0.085)	0.074 (0.077)	-0.107 (0.085)	-0.153* (0.079)
Subj. Rank Good	0.052 (0.045)	-0.123* (0.066)	-0.158** (0.064)	0.017 (0.048)	-0.055 (0.056)	-0.116* (0.065)
Subj. Rank Bad	0.014 (0.050)	0.184** (0.071)	0.094 (0.073)	-0.022 (0.049)	0.123* (0.073)	0.123* (0.062)
Subj. Rank Very Bad	-0.240** (0.100)	0.114 (0.135)	0.085 (0.120)	-0.288*** (0.074)	0.317*** (0.116)	0.231* (0.127)
Student Characteristics	✓	✓	✓	✓	✓	✓
Student Ability 4 th Order Polynomial	✓	✓	✓	✓	✓	✓
School Fixed Effects	✓	✓	✓	✓	✓	✓
<i>N</i>	2,708	2,708	2,704	2,708	2,706	2,706

The dependent variables are variables measuring students' effort provision on study. The omitted category of the self-perceived rank contains students who perceived to have a rank at the class median. Standard errors are clustered at the classroom level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: The Impact of the Self-Perceived Rank on Test Scores of Middle School Students

	(1)	(2)	(3)
Dependent Variables:			
Test Score in Math	0.175*** (0.021)	0.175*** (0.022)	0.179*** (0.022)
Test Score in Chinese	0.156*** (0.024)	0.164*** (0.025)	0.167*** (0.026)
Test Score in English	0.200*** (0.024)	0.205*** (0.024)	0.196*** (0.023)
Covariates:			
Student Characteristics	✗	✓	✓
Teachers' Characteristics and Attitudes Towards Students	✗	✗	✓
Student Ability 4 th Order Polynomial	✓	✓	✓
School Fixed Effect	✓	✓	✓
<i>N</i>	2,686	2,686	2,686

The dependent variables are standardized scores in the 8th grade with a mean of 0 and standard deviation of 1. The explanatory variable of interest is the self-perceived rank in the 7th grade. Standard errors are clustered at the classroom level and reported in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

IX Appendix

Table A1: Differences in Mean Characteristics

<i>Student Characteristics</i>	<i>By Teacher Gender</i>		<i>By Student Gender</i>	
		<i>p-value</i> (1)	<i>Teacher Characteristics</i>	<i>p-value</i> (2)
Female		0.88	Female	0.83
Age		0.19	Age	0.54
Rural <i>Hukou</i>		0.29	Marital Status	0.39
Single Child		0.95	Highest Education	0.18
Attended Kindergarten		0.56	Graduating from a Normal University	0.88
Rank in Primary School		0.27	Teaching Experience	0.41
Repeating a Grade in Primary School		0.40	Taught in Other Schools	0.67
Number of Grades Skipped in Primary School		0.93		
Curious		0.52		
Articulate		0.74		
Quick Responder		0.12		
Quick Learner		0.11		
Mother College Degree		0.18		
Father College Degree		0.49		
Family Economic Condition		0.85		

This table reports the differences in the mean of student characteristics by teacher gender in column 1, and the differences in the mean of teacher characteristics by student gender in column 2. *p*-values are reported. The means are the residuals after regressing the characteristics variables on school fixed effects because students were randomly at the grade-school level.

Table A2: The Impact of the Ordinal Rank on Test Scores of Middle School Students Using An Alternative Cognitive Ability Measure

	(1)	(2)	(3)
	Math Score	Chinese Score	English Score
Ordinal Rank	0.164*	0.269***	0.143**
	(0.093)	(0.097)	(0.071)
Student Characteristics	✓	✓	✓
Teachers' Characteristics and Attitudes Towards Students	✓	✓	✓
Student Ability 4 th Order Polynomial	✓	✓	✓
School Fixed Effect	✓	✓	✓
<i>N</i>	2717	2717	2717

The dependent variables are standardized scores in Math, Chinese, and English in the 8th grade with a mean of 0 and standard deviation of 1 in columns 1 through 3, respectively. The explanatory variable of interest is the self-perceived rank in the 7th grade. In the main analyses, I employ a student's cognitive ability score obtained in the 8th grade to better predict the test scores in the 8th grade and reduce the problem of multicollinearity between the objective rank (constructed using the 7th-grade ability) and cognitive ability scores. Here, I employ the ability rank constructed using students cognitive ability test scores obtained when they were in the 7th grade. While the high correlation between the ability rank and the ability test scores tend to considerably raise the standard errors of the estimates and make the estimates unreliable, the coefficients of the ability rank are still significant and largely consistent with the main results. Standard errors are clustered at the classroom level and reported in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A3: The Relationship between Ordinal Ranks and Switching Classes

	(1) Attrition
<i>Self-Perceived Ordinal Rank</i>	
Ordinal Rank	-0.004 (0.003)
Student Characteristics	✓
Student Ability 4 th Order Polynomial	✓
School Fixed Effects	✓
<i>N</i>	2,850

The dependent variable is a dummy indicating if a student is dropped out of the sample due to switching to another class when entering the 8th grade. Standard errors are clustered at the classroom level and reported in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A4: Robustness Checks: First Difference in Self-Perceived Ranks

	(1)	(2)	(3)
	Math	Math	Math
Δ Rank=-2	0.286*** (0.079)	0.046 (0.096)	0.015 (0.080)
Δ Rank=-1	0.321*** (0.086)	0.258*** (0.082)	0.132* (0.074)
Δ Rank=0	0.330*** (0.083)	0.214** (0.083)	0.195*** (0.070)
Δ Rank=1	0.251** (0.096)	0.142 (0.090)	0.089 (0.083)
Δ Rank=2	0.269** (0.129)	0.113 (0.105)	0.147 (0.108)
Student Characteristics	✓	✓	✓
Student Ability 4 th Order Polynomial	✓	✓	✓
Class Fixed Effects	✓	✓	✓
<i>N</i>	2,473	2,473	2,473

The omitted category of subjective rank contains students whose perceived rank dropped by 3 or 4 points (on a 5-point scale) since grade 6. Standard errors are clustered at the classroom level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

IX.A The Impact of Measurement Error on the Estimated Effect of the Ordinal Rank on Students' Test Scores

The initial measurement error appears in the observed ability test scores in CEPS. As a consequence, ability ranks are constructed based on the observed ability test scores (with measurement error). It would be difficult to analyze the bias analytically due to the complications in the mapping rules (determined by the mapping function, the distributions of students' abilities, and the magnitude of the bias). Intuitively, one may simply assume that there is measurement error in the observed ability ranks of students.⁴⁰

For simplicity and without losing generality, I assume that to investigate the effect of the ordinal ability rank on students' test scores, the following equation is going to be estimated:

$$Y_i = \alpha_2 + \beta_2 Rank_i^* + \omega_i \quad (3)$$

where $Rank_i^*$ is a student's true ability rank. The $Rank_i^*$ cannot be observed, however, due to measurement error. Instead, the observed ability rank is $Rank_i$.

Assume that the measurement error can be denoted as:

$$\tau_i = Rank_i^* - Rank_i \quad (4)$$

In addition, τ_i is assumed to follow a normal distribution of $N(0, \sigma^2)$. Therefore, one can only estimate the following equation and estimate the coefficient of the $Rank_i$:

$$Y_i = \alpha_2 + \beta_2 Rank_i + (\omega_i - \beta_2 \tau) \quad (5)$$

There are two situations to be considered. In the first situation, I assume that the

⁴⁰The online appendix of [Elsner and Isphording \(2018\)](#) show results obtained using Monte Carlo experiments which generate measurement error in students' ability scores to assess the bias.

measurement error is not correlated with the observed ability rank but correlated with the true ability rank. In other words, $Cov(Rank_i, \tau) = 0$ is assumed to hold. In this case, one can obtain an unbiased β_2 by estimating equation (5) because the combined error term $(\omega_i - \beta_2\tau)$ is uncorrelated with the explanatory variable $Rank_i$, although the standard errors increase. In the second situation, I assume that the measurement error is uncorrelated with the true rank but correlated with the observed rank. In other words, $Cov(Rank_i^*, \tau) = 0$ is assumed to hold. We have,

$$Cov(Rank_i^*, \tau) = E(Rank_i^*\tau) - E(Rank_i^*)E(\tau) = E(Rank_i^*\tau) = 0 \quad (6)$$

Given equation (6), we can get,

$$Cov(Rank_i, \tau) = E(Rank_i\tau) - E(Rank_i)E(\tau) = E(Rank_i^*\tau + \tau^2) = E(\tau^2) = \sigma^2 \neq 0 \quad (7)$$

Again, one can obtain the rank effect by estimating equation (5). The estimated, $\hat{\beta}_2$, can be expressed as,

$$\hat{\beta}_2 = \frac{Cov(Y_i, Rank_i)}{Var(Rank_i)} = \dots = \beta_2(1 - \frac{\sigma^2}{Var(Rank_i)}) < \beta_2 \quad (8)$$

Therefore, in this case, the estimate will be attenuated towards zero.

IX.B Survey Questions on Friendship and Problematic Behaviors

The CEPS survey asked students about their best friends. Specifically, students were asked to nominate 5 of their best friends. In addition, they were asked to answer the following 20 questions:

Do Your Five Best Friends Mentioned (in the Previous Question) Fulfill the Following Situations? Choose from "None of them are like this", "One or two of them are like this" and "Many of them are like this".

1. Have a very high grade. 2. Study very hard. 3. Want to go to college. 4. Escape from classes and/or skip classes. 5. Punished by the school because of violating school rules. 6. Engage in Fights. 7. Smoke and/or drink Alcohol. 8. Often go to net-bar and/or video game room. 9. Have a boyfriend or girlfriend. 10. Drop out of school.

I construct the friend quality index as the average of students' answers to these 10 questions.

In the Past Year, Did You Ever Have the Following Behaviors? Choose from "Never", "Several times", "Sometimes", "Often" and "Always".

1. Talk billingsgate. 2. Quarrel. 3. Engage in Fights. 4. Bully other students. 5. Being irascible. 6. Could not focus. 7. Escape from classes and/or skip classes. 8. Plagiarize other students' homework and/or cheat in exams. 9. Smoke and/or drink Alcohol. 10. Go to net-bar and/or video game room.

I construct the problematic behavior index as the average of students' answers to these 10 questions.

IX.C Consistent Estimate of the 1st-Order Difference in the Self-Perceived Rank between Grade 7 and 6

Without losing generality, consider a simple setting where I aim to estimate the impact of students' self-perceived ordinal rank in grade 7 on their academic outcomes in the future as shown in equation (9).

$$Y_i = \alpha_3 + \beta_3 7^{th}GradeSubj.Rank_i + \mu_i \quad (9)$$

In equation(9), Y_i represents the academic outcome of student i . β_3 is the coefficient of interest which measures the impact of subjective ordinal rank of student i on his/her academic outcomes. β_3 is biased if the error term μ_i contains an unobservable personality trait θ , which deviates the subjective ordinal rank from the true ordinal rank observed by the student. To eliminate the bias caused by θ , I take advantage of the two self-perceived ordinal rank in different grades reported by students in the CEPS. In CEPS, students were asked to report their self-perceived ordinal rank in the 6th and 7th grade in the same survey. In other words, the students reported these two subjectively measured ordinal rank at the same time. Therefore, it is plausible to assume that if personality trait θ affects self-perceived ordinal rank, it should affect the two ranks in the same way. Hence, I express the correlation between θ and students' self-perceived ordinal rank in equation (10) and (11).

$$6^{th}GradeSubj.Rank_i = \zeta_1 + \delta\theta_i + \rho Observed6^{th}GradeRank_i + \epsilon_i \quad (10)$$

$$7^{th}GradeSubj.Rank_i = \zeta_2 + \delta\theta_i + \rho Observed7^{th}GradeRank_i + v_i \quad (11)$$

Equation (10) suggests that a student's self-perceived ordinal rank in grade 6 is determined by the student's rank in grade 6 observed by the student. The self-perceived ordinal rank is also correlated with personality trait θ , and δ is a coefficient measuring the correlation.

Similarly, equation (11) presents the correlation between a student's self-perceived rank in grade 7, the student's truly observed rank in grade 7 and personality trait θ . Letting (11) – (10), I have the difference in self-perceived ordinal rank in grade 6 and 7 for student i as shown in equation (12).

$$\Delta \text{Subj.Rank}_i = \zeta_2 - \zeta_1 + \rho \Delta \text{ObservedRank}_i + v_i - \epsilon_i \quad (12)$$

Equation (12) shows that the difference in the two subjective ranks is no longer correlated with personality trait θ . In one of the robustness checks, I replace $7^{\text{th}} \text{GradeSubj.Rank}_i$ in equation (9) with $\Delta \text{Subj.Rank}_i$ and estimate equation (13).

$$Y_i = \alpha_4 + \beta_4 \Delta \text{Subj.Rank}_i + \phi_i \quad (13)$$

The consistent estimate β_4 estimates the impact of the difference in student i 's self-perceived rank in grade 7 and 6 on his/her future academic outcomes. Although the interpretation of β_4 slightly differs from that of β_1 in the main analyses, the results are still informative showing how changes in self-perceived ordinal rank affect the outcomes of interest.