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# The role of effort in understanding academic achievements: empirical evidence from China

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**Abstract**
From the perspective of comparative education, it has often been stressed that Chinese families hold high expectations on school achievement and believe in the pay-off of effort. However, the literature on the relationship between effort and academic achievement is limited. Individual effort is not widely considered a significant cause of educational disparities, which often is mainly attributed to structural and contextual factors, such as family socioeconomic status (SES). Using the China Education Panel Survey (CEPS 2013, 2014), this study examined the role of effort in affecting educational outcomes and investigated the interplay between effort and family socioeconomic status. The results showed that effort has a positive impact on academic performance, though to a lesser degree than family SES. The study also discovered that low-SES students tend to exert more effort than high-SES students and that the effect of effort is greater for low-SES students. These findings underlined the importance of individual effort for academic success, particularly for low-SES students, and suggested policies that aim at enhancing motivation and engagement.

**Keywords** Educational inequalities · Subjective effort · Objective effort · Socioeconomic status · Academic achievement

## Introduction

There is a consensus that inequalities in educational outcomes are not solely determined by structural and antecedent contextual elements. A considerable number of studies have examined family background, school resource allocation, and broader economic and social policies (Heckman, 2011; Kim et al., 2018), but these do not fully explain the observed achievement gap. Disparities in educational outcomes still persist among individuals with similar family origins and schooling (Egalite, 2016), possibly because of individual differences in their effort level (Alhadabi & Karpinski, 2020; Broer et al., 2019). This study aims to provide causal evidence on the role of effort in academic achievement and to consider the interactions between effort and circumstantial factors such as socioeconomic status.

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The relationship between circumstantial and effort-related factors affecting academic performance is complex and debatable (Roemer, 1998, 2002). On the one hand, the effort gap between individuals from disadvantaged families and those from favored backgrounds can lead to unequal educational outcomes (Weiner, 2010). On the other hand, individuals are believed to have control over their own determination and effort in the learning process (Price et al., 2010), meaning that differences in educational outcomes could be justifiable if disadvantaged individuals can improve their achievement through autonomous effort (Roberts et al., 2007). In that case, differences in the amount and quality of effort could perpetuate social inequality across generations, given its role in predicting academic achievement (Kautz et al., 2014).

It is widely recognized that there is a synergistic relationship between family socioeconomic status (SES), student effort, and academic achievement, where each factor may amplify the impact of the others (Wahlstrom et al., 2010). Ignoring any potential inequalities in effort would obscure the impact of social class on educational outcomes. Accordingly, this study aims to address the following research questions: (1) How does effort impact academic achievement, and what is the relative contribution of effort versus family SES in determining academic achievement? (2) Who exerts more effort, high-SES students or low-SES students? (3) Whether effort has a greater impact on academic achievement for low-SES students compared with high-SES students?

To address these research questions, I took advantage of the China Education Panel Survey (CEPS 2013, 2014). This survey provides detailed, student-level panel data that encompasses both subjective and objective measures of effort, academic performance, and family demographics (Wang, 2016). The panel structure of the dataset allows for leveraging within-student changes in effort over time, enabling the isolation of the causal impact of effort on academic achievement. Additionally, the utilization of the indigenized dataset offers insights into the unique educational challenges within the Chinese context.

Measuring effort in empirical research poses a challenge due to its subjective nature. To better understand the role of effort, I followed James Steele's (2020) theoretical approach and measured effort both in terms of amount and quality. Specifically, I differentiated between objective effort, which refers to the time spent on learning, and subjective effort, which refers to three self-reported indices of perceived effort (e.g., "I would try my best to finish even the homework I dislike").

Using regression analysis, I found that students who exhibit high subjective effort score 4.4% higher than observably similar students who exhibit low subjective effort. After further controlling for student fixed effects by leveraging within-student variation in effort, I discovered that improving the subjective effort from low to high level leads to a 3.6% increase in test scores. Additionally, increasing daily learning time by 1 h leads to a 2% improvement in academic achievement. I then compared the relative contribution of effort and family SES by sequentially adding effort and family SES proxies into the baseline model. Results showed that adding SES proxies improved the model fit more than adding effort measures. These findings suggest that although not as influential as family SES, effort does play a significant role in impacting academic performance.

Next, I investigated the differences in effort between high-SES and low-SES students. Through cross-student comparison, I found that high-SES students are 7.3% less likely to report exerting high subjective effort and spend 0.9 h less on studies than low-SES students. Moreover, I analyzed students' changes in effort from 2013 to 2014 by their SES group and found that a higher proportion of low-SES students improved their subjective effort (low-SES 19.9% *vs.* high-SES 13.6%) and learning time (low-SES 62.6% *vs.*

high-SES 56.8%) in 2014 relative to 2013. This further proves that low-SES students tend to be more hardworking in China (Liu, 2017).

In the last empirical task, I examined whether effort impacts low-SES students more than high-SES students. First, I added an interaction term between effort and family SES into the benchmark student-fixed effects model. The results suggest that effort has a smaller effect on test scores for high-SES students. To better understand the mechanism, I segmented the students into groups based on their change in effort and assessed the corresponding change in test scores from 2013 to 2014. For instance, I found that for high-SES students who spend more time on learning, the 95% confidence interval for their score increase is [2.1%, 2.6%], whereas, for low-SES students, the score improvement is between [2.9, 3.8%]. In contrast, for high-SES students who spend less time, the score change is between [−0.6, 1.0%], which is statistically insignificant, but for low-SES students, the change is between [−4.7, −4.1%]. In summary, exerting more (less) effort is more effective (counterproductive) for low-SES students.

This study builds on the effort literature by presenting empirical evidence of the impact of effort on academic achievements. Unlike most empirical literature in education that establishes correlational relationships, this study attempts to estimate the causal effect of effort on academic test scores by looking at within-student variation in effort while controlling for common factors shared by the student's cohort, which are captured by class-year fixed effects. The research findings have policy implications for the Chinese context, where the impact of effort on academic achievement is particularly emphasized (Guo et al., 2019), such as implementing incentives to reward effort for both students and parents.

In contrast to Spruyt's (2015) assertion that an individual's effort level is not contingent upon their inherent capabilities or backgrounds, this study substantiates that disparities in effort do exist between students from different socioeconomic backgrounds and those from lower-SES backgrounds tend to work harder. Most importantly, it provides empirical evidence that challenges the deficit discourse and supports the findings of McKay and Devlin's (2016) qualitative research. It demonstrates that even students who face significant circumstances-related obstacles can still achieve academic success through high levels of effort.

This study is structured as follows. The "Literature review and research questions" section clarifies the definition and measurement of effort, reviews literature relevant to its role in academic achievement, and discusses its relationship with family SES. The "Data and variables" section details the CEPS data and explains the construction of variables. The "Empirical design" section describes the empirical design, including methodological strategy, empirical results, and discussions. The last section presents the concluding remarks, potential policy implications, and research limitations.

## Literature review and research questions

### Definition and measurement of effort

Studies in social science have shown that effort is a complex concept. In economics, effort is typically defined as the amount of energy someone puts into a task in contrast to their inherent ability to perform it (Lakhani & Wolf, 2003). Measures of effort can be obtained through real-effort tasks, which evaluate people's behavior while they perform specific, observable tasks (Zipf, 2016). In education, effort is tied to the process of exercising

human "subjectivity," which is the commitment to utilizing physical and mental energy to achieve a certain goal or result (Bozick & Dempsey, 2010). In psychology, effort is seen as a subjective experience that refers to a person's engagement in challenging tasks that require executive functions (Levi et al., 2014), which enables individuals to exercise self-control during effortful tasks.

Steele (2020) offered a clear definition of effort during task performance and promoted a unified understanding across various disciplines by differentiating effort into two distinct forms: objective effort and subjective effort. Steele (2020) posited that "objective effort" is tangible and measurable actions that reflect the amount of energy or work invested in a task, such as the number of hours spent studying, the number of assignments completed, or scores on standardized tests of particular knowledge and skills to be learned or trained (e.g., Trautwein, 2007). On the other hand, "subjective effort" is the intangible and internal experiences and attitudes associated with a task or goal, such as self-efficacy, goal orientation, and intrinsic motivation (Hanushek et al., 2020; Moore & Picou, 2018).

This study adopts Steele's (2020) conceptualization of effort. Specifically, I consider the students' time spent on learning as an "objective effort." Meanwhile, I utilize three questions from the CEPS database that reflect students' conscious representation of their learning investment to measure student-perceived subjective effort. This enables the assessment of both the amount of energy or work invested in schooling and the students' internal experience and associated attitudes, providing a more holistic view of the role of effort and facilitating a better understanding of potential academic obstacles and successes.

### Importance of effort and its relationship with circumstance

The importance of effort in all stages of education has long been proven. According to Dweck (2002, 2010, 2016) and Carini et al. (2006), irrespective of the school quality or the students' socioeconomic background, success in education is impossible without putting in sustained effort. In line with others, Chunling Li (2015) observed that hard work is a central determinant of educational achievement in China, where it is prioritized over natural ability. Zhang et al. (2023) also contended that the public attributes academic success to effort but not necessarily talent or other inevitable factors, in particular not in China.

Nonetheless, the precise relationship between effort and academic achievement remains unclear. Woessmann et al. (2007) saw effort as relative to others and distinguishable from concepts such as ability and talent, while Chadi et al. (2019) considered it complementary or substitute. Chunli (2006) noted that compulsory education in China assumes the ability to be equally distributed among social classes, while effort is entirely regarded as a matter of individual free will. Glewwe et al. (2021) summarized that the lack of a clear understanding of the relationship between effort and academic achievement would hinder the potential effectiveness of approaches in enhancing educational production.

Given the contexts and sociocultural values in which Chinese students operate, examining the exact role of effort on academic achievement is essential. Thus, the first research question is as follows:

Q1: Does student effort positively affect academic achievement?

Furthermore, the impact of family background on academic success cannot be discounted in the Chinese context. Research has suggested that family socioeconomic status is one of the strongest predictors of student success (Gobena, 2018; Jia & Ericson,

2017). However, self-effort and hard work may be just as important in helping students reach their academic goals, despite coming from disadvantaged backgrounds (Wei et al., 2019). The emphasis on "hardship and hard work" in Chinese culture likely contributes to the perception that effort is a more important driver of success than family background (Li, 2010). Given that the specific contributions of family background and "hardship and hard work" to academic success are still inconclusive, a crucial question arises:

Q2: How does the contribution of exerting effort to academic success compare with that of family background in the Chinese context?

Notably, the debate between circumstantial and effort-related factors in determining academic performance is complex. Zimmermann (2013) argued that those with more privileged backgrounds have more resources at their disposal, leading to higher levels of effort, which in turn translates to improved academic performance. Similarly, Schunk (2008) believed that low family SES is often linked to lower levels of effort due to resource constraints and the misalignment of enculturation with societal expectations. This creates an uneven playing field, with those from disadvantaged backgrounds facing an effort gap that is often difficult to bridge, as Marks (2016) noted.

Fletcher and Wolfe (2016) found a similar link between family SES, academic achievement, and effort levels in the Chinese context. While meritocracy assumes that circumstances, such as parental social class, do not influence "merit" (i.e., ability and effort), Liu (2018) believed family SES and school environment influence that effort through ability grouping or tracking. This aligns with the findings of Wang and Li (2018) and Zhang et al. (2020), who concurred that disadvantaged children are likely to experience less parental attention, resources, and activities that would otherwise provide them with the opportunity to devote extra effort to their studies.

Given the evidence, it is meaningful to examine the effort disparities between groups to better understand the relationship between circumstances and effort. Accordingly, the following research question is proposed:

Q3: Do students from disadvantaged backgrounds exhibit greater effort than their more privileged peers?

Most importantly, existing research results for China have never necessitated that relatively disadvantaged children are doomed to underachievement and low effort levels (Li et al., 2021; Zhao & Chen, 2022). As Price et al. (2010) and Gielnik et al. (2015) maintained that students are capable of controlling, or at least partially controlling, their own level of effort, which could lead to improved and more equal educational outcomes, regardless of family background. McKay and Devlin (2016) suggested that even if socioeconomically privileged students tend to have superior performance when extrinsic measures are applied, those from disadvantaged backgrounds could achieve similar or even better results with a greater level of effort and dedication.

Hence, this study will examine whether effort may compensate for the outcome inequalities faced by disadvantaged groups (Lefranc et al., 2008), as well as how this may vary among individuals. The relevant research question is established as follows:

Q4: Does effort have a greater impact on low-SES students' academic achievement than high-SES students?

## Data and variables

### Data source

I leverage panel data from the China Education Panel Survey (CEPS 2013, 2014). The data was collected using a stratified, multi-stage, probability-proportional to size sampling method. Moreover, this dataset comprises information on approximately 30,000 students from 112 schools in 28 provinces, which is nationally representative. To construct the estimation sample, I drop missing values for all relevant variables and remove extreme values so that outliers do not drive the results. The final sample has a total of 24,974 observations. Detailed summary statistics are presented in Table 1.

### Measures and summary statistics

### Dependent variable

***Academic achievement*** I use students' Chinese, Mathematics, and English total exam scores to measure academic achievement. The data were obtained from official school records to minimize measurement errors that might result from self-reporting. As the summary statistics in Table 1 show, the average score is 236 points (52.4% of the total score of 450 points). I take a log transformation of the total scores to make the distribution more normal and the results easier to interpret. The distribution of log-transformed scores in Fig. 1 indicates that a proportion of students scored low grades.

**Table 1** Summary statistics

| Variable | Mean | SD | Min | Max |
|---|---|---|---|---|
| Academic achievement (total scores) | 236.30 | 74.40 | 0 | 440 |
| Log (total score) | 5.40 | 0.38 | 1.79 | 6.09 |
| Effort | | | | |
| Subjective effort (high = 1) | 0.24 | 0.43 | 0 | 1 |
| Objective effort (hours of study time) | 9.83 | 3.01 | 0 | 16 |
| Family SES | | | | |
| High-SES | 0.28 | 0.45 | 0 | 1 |
| Family income | 2.81 | 0.60 | 1 | 5 |
| Parental education level | 4.15 | 2 | 1 | 9 |
| Controls | | | | |
| Gender (female = 1) | 0.48 | 0.51 | 0 | 1 |
| Family structure (non-only child = 1) | 0.56 | 0.52 | 0 | 1 |
| Health | 4.14 | 0.87 | 1 | 5 |
| Household registration type (urban = 1) | 0.46 | 0.49 | 0 | 1 |
| Cognitive skills (cognition test scores) | 13.90 | 8.13 | 0 | 35 |
| Parental educational expectation | 6.96 | 1.58 | 1 | 9 |
| Student educational expectation | 6.89 | 1.76 | 1 | 9 |
| N | 24,974 | | | |

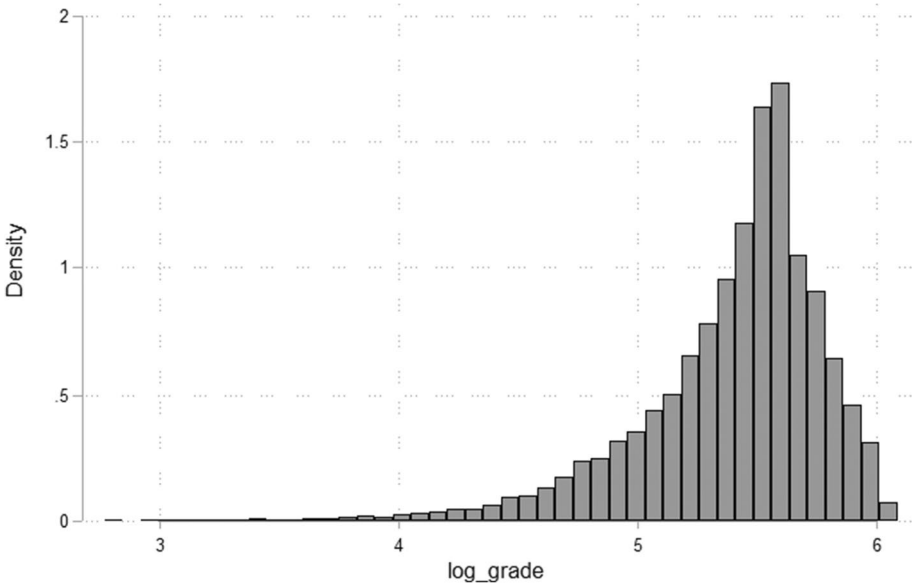


**Fig. 1** Log (total scores)

## Key independent variables

***Subjective effort*** To measure subjective effort, I extract information from three students' self-reported questions concerning their perceptions of effort: "I would try my best to go to school even if I was not feeling very well or I had other reasons to stay at home," "I would try my best to finish even the homework I dislike," and "I would try my best to finish my homework, even if it would take me quite a long time." These three categorical variables share the same Likert scale varying from 1 (strongly disagree) to 4 (strongly agree). Higher values imply a higher level of perceived effort. The indicator *subjective effort* would equal 1 if the student demonstrated a high level of perceived effort by answering 4 (strongly agree) to all three questions and 0 otherwise. 24.4% of students reported strong agreement with three effort-related questions, indicating a high level of subjective effort.

***Objective effort*** Similar to previous research (Van de Pol et al., 2015), I use the average daily learning time spent by the students, both in and outside of school hours, as a measure of objective effort. On overage, students spent 9.8 h per day on studies.

***Family SES*** Two proxies capture family SES: family income (1 (very poor) to 5 (very rich)) and parental education level (1 (none) to 9 (master's degree or higher)). Xing et al. (2021) noted that, in China, education carries high prestige, while family income grants material privileges and authority. Thus, I construct an indicator of SES based on family income and parental education. *High-SES* is defined as a value of 1 if the student's family income is 4 (somewhat rich) or greater or if the student's parental education level is 7 (junior college degree) or higher. Otherwise, the value will be set to 0. Following this

definition, 27.9% of students come from a high-SES family with parents who are college-educated or economically rich.

## Control variables

***Basic demographics*** I set the following demographic variables as control variables: gender (male = 0, female = 1), family structure (only child = 0, non-only child = 1), health condition (1 = very poor to 5 = very good), and house registration type (rural = 0, urban = 1). Summary statistics regarding all the variables are presented in Table 1. 51.8% of the sample are male students, and 48.2% are female students. 56% of the students have siblings.

***Cognitive skills*** Cognitive skills are essential for learning and academic success and are typically measured by gauging the number of questions students answer correctly on cognitive ability tests (Kautz et al., 2014). Higher scores on these tests indicate higher cognitive ability levels. In this study, CEPS administered a cognitive ability test of 35 questions to the sampled junior high school students. On average, the students correctly answered 14 out of the 35 questions.

***Educational expectation*** The (student and parental) educational expectations are important academic achievement predictors and could potentially affect students' effort. The educational expectations were measured by asking both students and parents to select one of 9 categories, ranging from dropping out of junior high school (1) to obtaining a doctoral degree (9). According to Table 1, the expectations of both parents and students are very similar.

## Correlation matrix

Table 2 presents the correlation matrix for all variables. While correlation does not necessarily imply causation, it does reveal patterns that are of interest to us. The matrix shows that test scores positively correlate with both subjective and objective effort. On average, students who put in a more subjective effort achieve 12.7% higher scores than those who put in less effort. Furthermore, increasing study time by 1 h is associated with a 3% increase in scores.

In addition, *High-SES* is positively correlated with test scores, with a correlation coefficient of 18.8%. This indicates a strong relationship between SES and educational outcomes. *High-SES* is also highly correlated with both *family income* and *parental education*, suggesting that it captures a great deal of the variation in these factors. *High-SES* negatively correlates with both subjective effort (corr coef = −0.03) and objective effort (corr coef = −0.60), implying that students from higher-SES backgrounds are 3% less likely to exert subjective effort and spend 0.6 h less on studies daily.

Overall, the correlation analysis indicates a positive relationship between effort and educational achievement, a positive correlation between family SES and test scores, and a negative correlation between family SES and effort. In the next section, I will employ more rigorous econometric methods to deepen our understanding of these relationships.

**Table 2** Correlation matrix

| | Log (total score) | Subjective effort | Objective effort | High-SES | Family income | Parental education | Gender | Family structure | Health | Household | Cognitive skill | Parental expectation | Student expectation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Log (total score) | 1 | | | | | | | | | | | | |
| Subjective effort | 0.127 | 1 | | | | | | | | | | | |
| Objective effort | 0.0308 | 0.3170 | 1 | | | | | | | | | | |
| High-SES | 0.188 | −0.0381 | −0.6017 | 1 | | | | | | | | | |
| Family income | 0.119 | −0.0181 | −0.0146 | 0.376 | 1 | | | | | | | | |
| Parental education | 0.232 | −0.0429 | −0.0642 | 0.729 | 0.252 | 1 | | | | | | | |
| Gender | 0.185 | 0.0768 | 0.0473 | 0.00430 | 0.0101 | 0.00220 | 1 | | | | | | |
| Family structure | −0.159 | −0.0393 | −0.0431 | −0.322 | −0.185 | −0.383 | 0.0784 | 1 | | | | | |
| Health | 0.0686 | 0.0774 | 0.00210 | 0.0931 | 0.129 | 0.112 | −0.0164 | −0.0960 | 1 | | | | |
| Household | 0.161 | 0.0214 | 0.0607 | 0.384 | 0.198 | 0.448 | 0.0118 | −0.389 | 0.0838 | 1 | | | |
| Cognitive skill | 0.224 | 0.0549 | 0.272 | 0.123 | 0.0845 | 0.162 | −0.00940 | −0.116 | 0.0788 | 0.109 | 1 | | |
| Parental expectation | 0.410 | 0.112 | 0.0390 | 0.196 | 0.0683 | 0.241 | 0.0527 | −0.121 | 0.118 | 0.132 | 0.156 | 1 | |
| Student expectation | 0.368 | 0.128 | 0.0479 | 0.185 | 0.0768 | 0.216 | 0.0641 | −0.125 | 0.0599 | 0.137 | 0.160 | 0.493 | 1 |

## Empirical design

### Does student effort positively affect academic achievement?

In this sub-section, I use various strategies to examine the causal effect of effort on academic achievement. In the last section, the correlation matrix reveals that subjective and objective effort positively correlates with learning results. Nevertheless, the simple correlation suffers from omitted variable bias. Any potential confounding variables would prevent us from obtaining causal impacts of effort. For example, students in a good class have better teaching resources and thus perform better (Burke & Sass, 2013). At the same time, students in a good class usually have stronger peer effects and are more willing to put effort into their studies. Hence, regressions without controlling for class fixed effects would be biased. To reduce the risk of bias, I first use OLS and control for student characteristics and class-year fixed effects. In my preferred model, I employ a student-fixed effects model by controlling for student and class-year fixed effects. I also use a random effect model as a robustness check.

The complete estimation model is:

$$\log(total\ scores)_{ict} = \beta Effort_{ict} + \gamma_{ct} + \delta \boldsymbol{X}_{ict} + \alpha_i + \varepsilon_{ict} \tag{1}$$

where $\log(total\ scores)_{ict}$ is log of the total score of student $i$ in class $c$ in year $t$. As detailed above, I measure a student's effort by two proxies *subjective effort* and *objective effort*. $\gamma_{ct}$ is class-year fixed effects which captures test difficulty, grading criterion, teaching quality, and other common factors shared by their peers. $\boldsymbol{X}_{ict}$ is a vector representing other control variables as introduced in the previous section. $\alpha_i$ is the student fixed effects which captures all time-invariant characteristics of students. Controlling for students' fixed effects allows us to leverage within-student variations from 2013 to 2014 to isolate the causal effect of effort.

Table 3 presents all the estimation results. In model 1, I include all the controls and class-year fixed effects and performed OLS estimation. The estimated coefficient of *subjective effort* is 0.047 (std.err = 0.003), suggesting that students with high subjective effort on average achieve 4.7% higher scores than observed similar students who exhibit low subjective effort. The difference is statistically significant at the 0.1% level. In model 2, I include both objective and subjective measures of effort and employed the same estimation method as in model 1. The coefficient of *subjective effort* (0.044 with a standard error of 0.003) is similar to the estimate in model 1. The coefficient of *objective effort* is 0.02 (std.err = 0.001), which means spending 1 more hour on studies is associated with a 2% increase in academic performance. It should be noted that those estimates may not have a causal interpretation.

In models 3 and 4, I further include student-fixed effects. The estimated effect of subjective effort is reduced from 0.044 (std.err = 0.003) in model 2 to 0.035 (std.err = 0.003) in model 4, suggesting that model 2 overestimates the true effect of subjective effort due to omitted variable bias. After controlling for student fixed effects, the estimates reveal that students who improve (lower) their subjective effort from 2013 to 2014 on average have a 3.5% increase (decrease) in test scores. In model 4, the effect of objective effort remains as 0.02 (std.err = 0.001) as in model 2. Increasing the study time by 1 h leads to a 2% increase in test scores. I also specify a random effect model in the last two columns. The estimated coefficient of *subjective effort* is 0.037 (std.err = 0.004), ranging between the OLS estimate of 0.044 (std.err = 0.003) and FE estimate of 0.035 (std.err = 0.004). The

**Table 3** Regression estimates of effort on academic achievements

| Model<br>Dep Var: Log (total scores) | (1)<br>OLS | (2)<br>OLS | (3)<br>FE | (4)<br>FE | (5)<br>RE | (6)<br>RE |
|---|---|---|---|---|---|---|
| Subjective effort (high = 1) | 0.047*** | 0.044*** | 0.036*** | 0.035*** | 0.039*** | 0.037*** |
| | (0.003) | (0.003) | (0.003) | (0.004) | (0.004) | (0.004) |
| Objective effort | | 0.02*** | | 0.02*** | | 0.03*** |
| | | (0.001) | | (0.001) | | (0.001) |
| Gender (female = 1) | 0.105*** | 0.107*** | | | 0.123*** | 0.126*** |
| | (0.003) | (0.003) | | | (0.005) | (0.005) |
| Family structure | −0.003 | −0.003 | | | 0.062*** | −0.060*** |
| | (0.004) | (0.004) | | | (0.005) | (0.005) |
| Health condition | 0.000 | 0.001 | 0.001 | 0.001 | 0.004 | 0.003 |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Household registration type | −0.002 | −0.003 | | | 0.034*** | 0.033*** |
| | (0.004) | (0.004) | | | (0.004) | (0.004) |
| Cognitive skills | 0.021*** | 0.021*** | 0.003*** | 0.003*** | 0.014*** | 0.015*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Parental educational expectation | 0.044*** | 0.043*** | 0.011*** | 0.011*** | 0.041*** | 0.041*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Student educational expectation | 0.028*** | 0.028*** | 0.000 | 0.001 | 0.022*** | 0.023*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Class-Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Student FE | No | No | Yes | Yes | No | No |
| *N* | 24,974 | 24,974 | 24,974 | 24,974 | 24,974 | 24,974 |
| $R^2$ | 0.634 | 0.638 | 0.947 | 0.946 | - | - |

This table provides the results of six different models (1–6) that estimate the relationship between various independent variables and the dependent variable "Log (total score)." Models 1 and 2 are pooled OLS models. Models 3 and 4 are student fixed effects (FE) models. Models 5 and 6 are random effects (RE) models. Standard errors, shown in parentheses, are clustered at the class level

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

effect of objective effort is 0.03, slightly higher than OLS and FE results. Different model specifications lead to a similar conclusion: effort matters for academic performance, and its effect size is non-negligible.

While the primary focus is on the causal effects of effort and not on the model fit, $R^2$ can still provide insight into the factors that explain variation in test scores. In model 2, all included covariates and class-year fixed effects explain 63.7% of the variation in students' academic achievements. Including class-year fixed effects absorbs much of the total variation, suggesting that environment (class) matters for academic success. If further including student fixed effects in model 4, the $R^2$ becomes 94.6%. Almost all the variation in scores can be explained by time-invariant student characteristics and the environment (class).

Table 3 also uncovers meaningful relationships between several control variables and academic achievement. For instance, in model 1, the coefficient of gender is 0.105 (std. err = 0.003), indicating that female students, on average, score 10.5% higher than their male counterparts after controlling for the gender gap in effort. This may be due to various factors, such as differences in learning styles or socialization practices (Lau et al., 2010). Furthermore, living in urban areas and belonging to a multi-child family have no significant

impact on school performance. Moreover, both parental and student expectations are positively correlated with test scores, with a coefficient of 0.04 (std.err = 0.001) and 0.02 (std.err = 0.001), respectively, in model 1, in line with previous research (e.g., Xia, 2020).

Table 3 underscores the importance of cognitive skills as a predictor of test scores as well. In model 1, its estimated coefficient is 0.021 (std.err = 0.001), indicating that students with high cognitive abilities achieve higher exam scores. Specifically, a 1-point increase in cognition test scores is associated with a 2.1% increase in academic test scores. This finding is consistent with previous research highlighting the effect of cognitive skills on academic achievement, where it serves as the foundation for knowledge acquisition and learning (e.g., Pellegrino & Hilton, 2012).

### Does family SES have greater impact than effort on academic achievement?

Effort positively affects students' academic achievements, but it does not mean effort is more important than family background in impacting their performance. In this sub-section, I investigate which matters more, effort or family SES.

Table 4 summarizes the relative contribution of effort or family SES variables in the regression to the overall model fit. In the baseline model, the log of total scores is regressed on all controls and class-year fixed effects, yielding an $R^2$ of 0.620. Adding measures of subjective and objective efforts in model 2 increases the $R^2$ by 0.018 (2.9%) relative to the baseline model. Model 3 further includes family SES proxies (family income and parental education level), which increases the model fit by 0.044 (7.1%). This exercise suggests that including family SES explains more variation in student academic performance than including effort.

An alternative approach to examine which factor is more important is to compare their effect sizes. However, since these factors are measured using different scales, direct comparison is not feasible. I thus normalize all variables to enable comparability. In Table 5, the normalized log of total scores is regressed on the normalized effort, family SES, and other control variables. Results reveal that the family SES proxies have a larger effect size than effort measures.

These findings suggest that family SES is crucial in determining academic success and that effort alone may not suffice in overcoming the barriers faced by low-SES students, which aligns with Golley and Kong (2018). However, this does not imply that effort is inconsequential, and students from low-SES families could not profit from putting more

**Table 4** Relative contribution of effort *vs.* family SES to academic achievement

| Dep Var: Log (total scores) | (1) | (2) | (3) |
|---|---|---|---|
| Predictors | Baseline controls | Baseline controls + effort measures | Baseline controls + SES proxies |
| $R^2$ | 0.620 | 0.638 | 0.664 |
| $R^2$ increase relative to baseline | - | 0.018 (2.9%) | 0.044 (7.1%) |

The respective incremental adjustments to $R^2$ demonstrate the relative importance of effort measures and family SES proxies. Model 1 only includes controlled variables (as detailed in Table 1) with a class-year fixed effect, while model 2 further includes effort measures (objective and subjective effort), and model 3 further adds SES proxies (family income and parental education level)

**Table 5** Comparative effects of effort and family SES on academic achievement

| | (1) | (2) |
|---|---|---|
| Dep Var | Standardized log (total score) | Un-standardized log (total score) |
| Standardized variable | | |
| High subjective effort | 0.117*** | |
| | (0.000) | |
| Objective effort | 0.013* | |
| | (0.022) | |
| Family income | 0.139*** | |
| | (0.000) | |
| Parental education level | 0.211*** | |
| | (0.000) | |
| Un-standardized variable | | |
| High-SES | | 0.101*** |
| | | (0.000) |
| Controls | Yes | Yes |
| Class-Year FEs | Yes | Yes |
| *N* | 24,974 | 24,974 |
| $R^2$ | 0.674 | 0.659 |

Controlled variables are detailed in Table 1. Standard errors, presented in parentheses, are clustered at the class level

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

effort into learning. In the following sub-sections, I will examine whether low-SES students work harder and whether increased effort could help bridge the achievement gap.

## Do students from disadvantaged backgrounds exhibit greater effort than their more privileged peers?

To investigate the effect difference between high-SES and low-SES students, I estimate the following model:

$$\text{Effort}_{ict} = \beta high\ SES_{ict} + \gamma_{ct} + \delta \boldsymbol{X}_{ict} + \varepsilon_{ict} \tag{2}$$

The variable of interest is $high\ SES_{ict}$, which takes a value of 1 if the student comes from a high SES family, and 0 otherwise. I also include class-year fixed effects $\gamma_{ct}$ and other controls $\boldsymbol{X}_{ict}$. Student-fixed effects cannot be included since students' family SES status rarely changes within such a short timeframe. If student effort is measured by a binary variable (*subjective effort*), a linear probability model (LPM) is used, and if effort is measured by the length of working time, an OLS model is estimated.

Table 6 reports the estimation results. In the LPM, the coefficient of the *High-SES* is − 0.073 (std.err = 0.001), suggesting that high-SES students are 7.3% less likely to be in the high subjective effort group than low-SES students. A similar pattern can be observed in model 2, where the coefficient of the *High-SES* is − 0.902 (std.err = 0.005). On average, students from high-SES backgrounds spend 0.9 fewer hours on their studies than observably comparable students from less privileged families. The $R^2$ values for model 1 and

**Table 6** Regression estimates of the relationship between effort and family SES

| Model | (1)<br>LPM<br>Subjective effort | (2)<br>OLS<br>Objective effort |
|---|---|---|
| High-SES | −0.073*** | −0.902*** |
| | (0.001) | (0.005) |
| | (0.002) | (0.012) |
| Controls | Yes | Yes |
| Class-year FE | Yes | Yes |
| *N* | 24,974 | 24,974 |
| $R^2$ | 0.299 | 0.313 |

Controlled variables are detailed in Table 1. Standard errors, reported in parentheses, are clustered at the class level

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

model 2 are 0.299 and 0.313, respectively, suggesting that circumstances (family and school) only explain around 30% of the variation of students' effort and that probably a larger proportion of variation in effort might be explained by individual traits.

Table 6 shows that low-SES students exert more effort in their studies than their high-SES peers. In China, this trend could be attributed to high parental and student aspirations for tertiary education (Wei et al., 2019), sociocultural values emphasizing the importance of "hardship and hard work" (Li, 2010), and the intense pressure created by the highly competitive high school admissions process (Hansen & Woronov, 2013). Under such circumstances, students from disadvantaged backgrounds may feel compelled to achieve more and surpass their "usual" effort level to be more competitive.

## Does effort have a greater impact on academic performance for low-SES students than for high-SES students?

In this sub-section, I will explore two approaches to investigate whether effort could potentially narrow the achievement gap between high-SES and low-SES students. The first approach involves running an interaction effect model, as shown below:

$$Effort_{ict} \times High\_SES_i + \gamma_{ct} + \delta \boldsymbol{X}_{ict} + \alpha_i + \varepsilon_{ict} \tag{3}$$

where $\beta_1$ captures the effect of effort on test scores for low-SES students, and $\beta_2$ captures the effect difference for high-SES students compared with low-SES students. $High\_SES_i$ is absorbed by student fixed effect and cannot be separately estimated. The remaining terms are same as Eq. (1).

Table 7 presents the differences. In column 1, the interaction between *subjective effort* and *High-SES* is negative (coef = −0.024, std.err = 0.015), meaning that compared with low-SES students, exerting high subjective effort leads to 2.4% fewer scores in tests relative to exerting low effort. In column 2, the interaction between *objective effort* and *High-SES* is also negative (coef = −0.037, std.err < 0.000). The marginal effect of learning time on scores is 3.7% less for high-SES students. These results prove that increased effort has a larger impact on low-SES students.

For the second approach, I divide the students into two groups based on their family SES status: high-SES and low-SES. Within each group, I further classify students into

**Table 7** Effects of effort on academic achievement between low-SES and high-SES groups

| | (1) | (2) |
|---|---|---|
| Dep Var: Log (total scores) | | |
| Subjective effort | 0.035*** | |
| | (0.000) | |
| Objective effort | | 0.016*** |
| | | (0.000) |
| Subjective effort × High-SES | −0.024* | |
| | (0.015) | |
| Objective effort × High-SES | | −0.037*** |
| | | (0.000) |
| Controls | Yes | Yes |
| Class-Year FE | Yes | Yes |
| Student FE | Yes | Yes |
| *N* | 24,974 | 24,974 |
| $R^2$ | 0.908 | 0.899 |

The coefficient of High-SES is absorbed by student FE and therefore not presented in the table. Controlled variables are detailed in Table 1. Standard errors, indicated in parentheses, are clustered at the class level.

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

four sub-groups based on their subjective effort levels in 2013 and 2014. The four sub-groups are (1) consistently low effort, (2) consistently high effort, (3) decreased effort, and (4) increased effort. For students in each sub-groups, I obtain the 95% confidence interval for the academic performance change: log (total score in 2014)/log(total score in 2013). This exercise allows for a granular examination of the differences in effort level over time between high-SES and low-SES students.

Table 8 displays the percentage of students in each sub-group and their corresponding interval estimates of total score changes. Most students in 2014 maintained their effort status from 2013, with 72.9% of high-SES students and 69.9% of low-SES students remaining in the same effort category. Notably, a higher proportion of low-SES students progressed in their effort level compared to high-SES students, with 19.9% of low-SES students working harder in 2014 compared to 13.7% of high-SES students. Moreover, a smaller proportion of low-SES students transitioned from high-effort status to low-effort status (10.1%) compared to high-SES students (13.4%). This observation echoes our previous finding that students from low-SES backgrounds tend to work harder.

The second and most important observation based on Table 8 is that effort matters more for low-SES groups. Focusing on those who switched their effort status (last 2 columns), the test scores change by $[-1.7\%, -0.1\%]$ for high-SES students who lowered their effort level, but change by $[-5.7\%, -4.0\%]$ for low-SES students who worked less hard. Similarly, the test scores change by [1.3%, 2.0%] for high-SES students who improved their effort level and change by [2.8%, 3.3%] for low-SES students who put more effort into their studies. These comparisons suggest that effort matters more for low-SES students. If low-SES students work harder, they enjoy a larger marginal effect in scores than high-SES students. However, if they shirk, their academic performance will decline to a larger degree than high-SES students.

**Table 8** Within-student decomposition regarding changes in subjective effort from 2013 to 2014

| | | Low effort → Low effort | High effort → High effort | High effort → Low effort | Low effort → High effort |
|---|---|---|---|---|---|
| High-SES students | % of students<br>(95% score increase CI) | 66.4% (−0.7%, 0.3%) | 6.5% (−1.0%, 1.1%) | 13.4% (−1.7%, −0.1%) | 13.7% (1.3%, 2.0%) |
| Low-SES students | % of students<br>(95% score increase CI) | 64.9% (−1.3%,0.8%) | 5.0% (−0.4%, 1.3%) | 10.1% (−5.7%, −4.0%) | 19.9% (2.8%, 3.3%) |

The 95% CIs are confidence intervals for total score improvement from 2013 to 2014. For example, the 95% CI for low-SES students who had a low effort in 2013 but had a high effort in 2014 is (2.8%, 3.3%), meaning that those students' test score increases by 3.05% ((2.8 + 3.3)/2) with a CI (2.8%, 3.3%) from 2013 to 2014

**Table 9** Within-student decomposition regarding changes in objective effort from 2013 to 2014

| | | Hours of study time increase | Hours of study time decrease |
|---|---|---|---|
| High-SES students | % of students (95% score increase CI) | 56.8% (2.1%, 2.6%) | 43.2% (−0.6%, 1.0%) |
| Low-SES students | % of students (95% score increase CI) | 62.6% (2.9%, 3.8%) | 37.4% (−4.7%, −4.1%) |

The 95% CIs are confidence intervals for total score improvement from 2013 to 2014. For example, the 95% CI for low-SES students who spent an increase in working time relative to last year is (2.9%, 3.8%), meaning that those students' test score increases by 3.35% ((2.9 + 3.8)/2) with a CI (2.9%, 3.8%) from 2013 to 2014

Table 9 shows similar exercises for objective effort (hours of study time). Since working time is a continuous variable, I divide students into 2 groups based on whether they spent more or less time studying in 2014 compared to 2013. The pattern is similar: (1) more students in the low-SES group spent more time in studies in 2014 and (2) the marginal effect of effort is larger for low-SES students. If students decreased their study time, the test score would be changed by [−4.7%, −4.1%] for low-SES students, but the score remained unchanged for high-SES students as the 95% CI [−0.6%, 1.0%] cross 0. One possible explanation is that high-SES students may have other resources or better time management skills to compensate for the reduced study time (Bacher-Hicks et al., 2021; Chiu & Chow, 2015).

To summarize, students from high-SES families tend to exert a lower level of subjective effort or spend less time studying, but this does not significantly affect their academic performance. In contrast, students from low-SES families who exert more subjective effort or spend more time studying experience a substantial increase in academic achievement, demonstrating that effort is particularly crucial for those from disadvantaged backgrounds. Although students from low-SES families may face additional barriers, such as limited access to educational resources, socioeconomic pressures, or a lack of family and community support compared to their high-SES peers (Liu, 2019), they can still attain academic success with unwavering effort, even in the face of adversity.

## Conclusions

This study demonstrates that student effort has a meaningful influence on academic achievement. Results also showed that family SES indeed has a greater impact on academic success than student effort. However, this does not suggest that effort should be disregarded or that students from low-SES backgrounds cannot improve their performance through hard work. These findings highlight the ongoing educational inequalities and the necessity for targeted interventions for low-SES students. Additionally, it was found that low-SES students exert more effort than their high-SES peers and benefit more from the increased effort, as it results in a larger improvement in academic performance. This emphasizes that increased effort can help to level the educational playing field for low-SES students and that family SES should not be perceived as an insurmountable barrier to academic success.

Furthermore, it was also discovered that decreased effort has a larger negative impact on the performance of low-SES students. This further indicates that it is crucial to emphasize the potential of utilizing student effort as an intervention to facilitate equitable educational outcomes for those from disadvantaged backgrounds.

These findings have important implications for policymakers. Some strategies particularly addressed to students from low SES families might include the following:

1. Providing awareness about the importance of the effort to help students to recognize the value of their hard work
2. Providing resources for disadvantaged students, such as tutoring, homework help centers, and after-school study programs to help them to increase their working time
3. Offering parental support and education to parents from low SES backgrounds on how to improve their children's learning effort

Additionally, it is important to acknowledge the potential limitations of relying on self-reported effort measures, as participants may not accurately report their effort due to factors such as social desirability bias, memory bias, or lack of self-awareness. As such, the results of this study should be interpreted with caution and considered within the specific context of the study. Longitudinal studies with more expansive data and research conducted in other cultures and countries are necessary to increase the external validity of the results.

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**Declarations**

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I confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed.
I confirm that I have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing I confirm that I have followed the regulations of my institutions concerning intellectual property.
I understand that the Corresponding Author is the sole contact for the Editorial process (including Editorial Manager and direct communications with the office). I am responsible for submissions of revisions and final approval of proofs. I confirm that I have provided a current, correct email address which is accessible by the Corresponding Author (xinjin@zedat.fu-berlin.de).

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*Current themes of research*

Xin JIN's research investigates how learning motivations rooted in social origins (intrinsic and extrinsic motivation) impact goals, self-efficacy, and self-regulated learning.

*Most relevant publications*

No previous publications.