**Understanding the progress in mathematics of Chinese adolescents: Significant impacts from the socioeconomic status and the academic expectations of primary caregivers**

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**Highlights:**

* SES and PCG academic expectations relate to Chinese adolescents’ math progress
* SES is internalized within math progress: Links to early attainment shape progress
* Higher expectations are associated with less social stratification in mathematics

**Abstract**

Past research has found socioeconomic status (SES) and the academic expectations of primary caregivers (PCGs) to be important predictors of students’ attainment in mathematics. However, their effects might not be universal across cultures. Further, there exists conflicting evidence on how SES and academic expectations impact maths attainment together and over time. This study aimed to provide new empirical evidence on both issues by examining the maths attainment of a cohort of Chinese adolescents (n=1,407) over a 5-year period (2010-2014) and how maths attainment was related to SES and PCG academic expectations. Multilevel Structural Equation Modeling revealed that both SES and PCG academic expectations exerted positive effects on maths progress. Over time, the effect of SES became increasingly internalized within past maths attainment. Further, higher academic expectations from PCGs lessened the difference in maths attainment between students from lower and higher SES families when the studied cohort was at their youngest.

**Keywords:** mathematics progress; socioeconomic status; academic expectations; adolescence

1. **Introduction**

In education, the importance of social background in academic attainment has been well documented (e.g. Coleman & Hopkins, 1966; Checchi, 2008; Lucas, 2001; Reardon, 2011). One particular area of academic achievement, students’ maths attainment, has been consistently associated with their family’s Socioeconomic Status (SES; e.g., Sirin, 2005; White, 1982). For example, a recent meta-analysis of 58 studies concluded that among different academic outcomes, it was with maths attainment that SES was most strongly associated (effect size=0.35; Sirin, 2005). Further, SES has also been linked with maths progress (e.g., Sylva, Melhuish, Sammons, Siraj-Blatchford, & Taggart, 2004).

A number of mechanisms have been proposed to explain the association between SES and math attainment/progress and these include: Student/pupil self-regulation (Evans & Rosenbaum, 2008); Student/pupil Motivation (Kriegbaum and Spinath, 2016); Home learning experiences (Dearing et al., 2012); Parental academic expectations (Davis-Kean, 2005); and Family health (Barr, 2015). However, despite such strong evidence of association and mechanisms, the effects of SES on maths attainment are known to vary across ethnicities and school locations (Sirin, 2005). Moreover, recent empirical evidence has identified a more nuanced relationship between SES and maths attainment is possible in non-western cultural contexts (e.g., Cheng & Hsu, 2016; Zhao, Valcke, Desoete, & Verhaeghe, 2012). Such findings emphasize the importance of cultural context when investigating the effects of SES on maths attainment and prompts further research from non-western cultural contexts.

Alongside SES, parental academic expectation is another factor that has been consistently shown to predict maths attainment in existing literature (e.g., Cao, Bishop, & Forgasz 2007; Fan & Chen, 2001; Mullis et al., 2012). Many studies have found positive correlations (e.g., Davis-Kean, 2005; Peng & Hill, 1995; Smith, 1991), while others longitudinal effects, i.e., prior parental expectations positively predicted children’s later maths attainment (e.g., Froiland & Davison, 2016; Froiland, Peterson, & Davison, 2013; Grossman, Kuhn-McKearin, & William, 2011). Potential mechanisms explaining this association include the Social-Cognitive Theory (Bandura et al., 1996; 2001) and the Expectancy-Value Theory (Eccles & Wigfield, 2002; Eccles, Wigfield & Schiefele, 1998; Simpkins, Fredricks & Eccles, 2012). High academic expectations from parents help children achieve better maths attainment by increasing children’s perceived academic self-efficacy (Social-Cognitive Theory) and/or by increasing children’s own expectations or motivational beliefs of future attainment through a process of socialization (Expectancy-Value Theory). Again, however, despite significant positive relationships being found in many studies others paint a more nuanced picture. For example, race and ethnicity have been shown to moderate the effects of parental expectations (Yamamoto & Holloway, 2010) while others (Campbell, 2005; Cao et al., 2007) have underlined the importance of cultural context in whether and how parental academic expectations relate to their children’s maths attainment.

As might be expected then, *how* SES and parental academic expectations work together to affect children’s maths learning has also been explored in the literature. For example, the Wisconsin Model of Status Attainment (Sewell, Haller, & Ohlendorf, 1970; Sewell, Haller, & Portes, 1969) argues for a meditational relationship, where higher SES exerts its effect on children’s learning outcomes via elevated parental academic expectations. This model, and therefore this mediational approach subsequently featured in many later studies (e.g., Bandura, Barbaranelli, Caprara, & Pastorelli, 1996; Davis-Kean et al., 2003; Keith et al., 1998; Marjoribanks, 1977; Zhan, 2006). However, an alternative relationship, one of interaction (for definitions of mediation and interaction see Hall & Sammons, 2013), has also been suggested in which SES and parental academic expectations exert a combined effect on students’ maths attainment (e.g., Trusty, Plata & Salazar, 2003). For example, Tsui (2005) studied 1,021 eighth-graders in China and found that parents had high academic expectations for their children and that such high expectations mitigated the relationship between low-income Chinese families and adolescents’ maths performance in standardized tests. Considering that the relationship between SES and parental academic expectations has been alternatively identified as positive and strong (Fan & Chen, 2001), modest (Froiland & Davison, 2014; Froiland & Davison, 2016; Marcenaro-Gutierrez & Lopez-Agudo, 2017), and weak (Carpenter, 2008; Froiland, Peterson & Davison, 2013), it is not surprising to find the currently conflicting evidence regarding how SES and parental expectations affect maths attainment with more research being required.

Given its social, cultural and educational differences to the west and the interest generated by cross-national studies and rankings from international large-scale assessments (e.g. PISA, TIMSS), China constitutes an important new context within which to examine the relationships of SES, parental expectations, and students’ maths learning. Though not as fully researched as in the international context, a recent meta-analysis of Chinese studies also found SES to be positively related to maths attainment (Wang, Li, & Li, 2014). However, two studies within this reported non-linear associations (Cheng & Hsu, 2016; Zhao, Valcke, Desoete, & Verhaeghe, 2012). In terms of parental expectations and math attainment, there are fewer studies than those linking SES and math attainment, but these report a significant positive relationship ( Phillipson & Phillipson, 2007; Tsui, 2005; Zhang, 2016). However, when it comes to how SES and parental academic expectations work together to affect students’ maths attainment in China, there is a dearth of equivalent empirical evidence. One exception is Tsui’s study (2005) mentioned above, however this was limited by its use of a cross-sectional dataset and a sample from only one Chinese city.

This study aimed to fill the above gap in the literature. It used a large sample from a longitudinal national Chinese survey to conduct an analysis as to whether SES and primary caregiver’s (PCG) academic expectations were related to adolescents’ attainment and long-term progress in maths. Answers to three research questions were sought:

1. How is socioeconomic status (SES) related to Chinese adolescents’ maths attainment over a five-year period (where students were aged 10-15 years at baseline)?

2. How are primary caregiver (PCG) academic expectations related to Chinese adolescents’ maths attainment over a five-year period (where students were aged 10-15 years at baseline)?

3. How do SES and PCG academic expectation work together to affect Chinese adolescents’ maths attainment over a five-year period (where students were aged 10-15 years at baseline)?

**2. Methods**

**2.1 Data**

The data for this study came from the *China Family Panel Studies* (CFPS), a longitudinal (biennial) survey launched in 2010 by Peking University that tracks 14,960 households from 635 communities in 162 counties within 25 provinces (see Xie, 2012). The CFPS sample is regarded to be broadly representative of the population of mainland China (for details see Xie & Hu, 2014). The CFPS was considered appropriate for the purpose of this study as it is the only national longitudinal survey in China that administers standardized maths tests to all sampled individuals aged 10 and above (Liu & Xie, 2015).

Within the CFPS, individuals aged 16 and above answer the ‘Adult Questionnaire’ and those below 16 answer the ‘Child Questionnaire’. Two forms of the ‘Child Questionnaire’ exist: A proxy-report by an adult family member for ages 0-15 and a self-report by those aged 10-15. As a result, there are two sources of information for the age group of 10 to 15 years. The self-report data were considered more reliable (and thus preferred over proxy-report) in this investigation which follows existing practice by the CFPS team (Xie, 2012).

**2.2 Sample**

The CFPS sample used in this investigation (hereafter the Study Sample) included 1,407 adolescents (aged 10-15 in 2010, rising to 14-19 in 2014) who completed maths tests in all three waves of testing over this period (2010, 2012 & 2014), with information on PCG academic expectation, SES and demographics collected in 2010. Ethical permission for this study came from the Departmental Research Ethics Committee of the Department of Education, University of Oxford, and the Institutional Review Board of the Peking University Human Research Protection Program.

During interviews with children (aged 15 and below), the CFPS required adult proxy respondents to be, “the main guardians living with the children interviewed, who take the most care of them and know the best about them” (Xie, 2012: p.33). The concept of PCG was adopted in this study to describe the adult proxy respondent. As such, the PCG could be a mother, a father, or another adult family member in the absence of both mother and father.

**2.3 Measures**

*2.3.1 Maths attainment in 2010, 2012 and 2014*. The CFPS uses two maths tests in rotation to measure participants’ maths attainment (Xie, 2012) but both are administered individually with each participant during household interviews. In the first test, participants answer a set of 24 maths problems randomly drawn from a pool of four sets, each with similar difficulty level. The problems included ‘addition, subtraction, multiplication, division, exponents, logarithms, trigonometric functions, sequence, permutation and combination’ (Xie, 2012: 56). They were arranged from easiest to hardest and participants would start from different entry points based on their highest levels of education. Those with a highest educational level of primary school and below would start from the first problem; those with junior middle school education would start from the fifth problem; and those with senior high school education would start from the thirteenth problem. The test continued until the participant failed to answer three consecutive problems. The question number of the most difficult problem that the participant had answered correctly would be the test score, which ranged from 0 to 24. If there were no correct answer, the question number of the problem prior to the entry problem would be the participant’s score. This form of test was used in both 2010 and 2014, with 2014 using a different set of problems from 2010 for the same participant in order to avoid repetition. Original test scores (0-24) were used for 2010. In 2014 a slight adjustment was adopted to the administration of the test. It allowed respondents to answer easier questions if they failed to answer their starting question correctly. For the purpose of consistency, this study used the 2014 maths score (0-24) that the CFPS calculated to be comparable to the 2010 score (with fixed starting point according to one's educational level).

The second form of test, which was used in 2012, involved a two-stage number reasoning test as shown in Figure 1. Participants were randomly allocated to group A or group B tests, which were equally difficult and each contained 15 number series problems. During the first stage, participants would answer the first three problems in their allocated group of problems. The number of correct answers from this first stage, i.e., 0, 1, 2 or 3, would then determine which set of three problems they would need to answer in the second stage. For example, those with zero correct answers from stage one would need to answer the first set of three problems in the second stage, while those with one correct answer from stage one would answer the second set of three problems in the second stage. The four sets of three problems in stage two were ranked in level of difficulty. The final score was a reflection of the total number of correct answers in the two stages. The CFPS provided two scores for the maths test in 2012, “a Guttman score, based on original questions, and a W-score, based on the Rasch model of Item Response Theory” (Qiong et al., 2015: p.8). Given the fact that the W-score had equal intervals and thus better measurement properties than the ordinal Guttman score, this study used the W-score, in accordance with recommendations from the CFPS (Huang, Xie, & Xu, 2015).

[Insert Figure 1 here]

*2.3.2 Socioeconomic Status (SES)*. This study measured (household) SES at baseline (2010) as a continuous latent construct. It was computed through reflective Confirmatory Factor Analysis (CFA) based on three indicators: highest adult educational attainment, highest adult occupational status, and family income per capita. If the primary caregiver was a parent, highest adult educational attainment and highest adult occupational status simply referred to highest parental educational attainment and highest parental occupational status. If the primary caregiver was not a parent, then the parent(s)’ and the primary caregivers’ educational attainment and occupational status were compared and the higher values were used.

1. Highest adult educational attainment was measured via the number of years in formal education on a scale from 0 to 22, with longer years indicating higher attainment. In the CFPS dataset, years of education were converted from educational level (8 categories from, ‘illiterate/semi-illiterate’ through to, ‘doctoral degree’; Xie, 2012).

2. Highest adult occupational status was a continuous measure ranging from 16 to 90, with a higher score indicating a higher occupational status based on the International Socio-Economic Index of Occupational Status (ISEI; Ganzeboom & Treiman, 1996).

3. Family income per capita. This indicator was measured via an existing variable in the 2010 CFPS dataset—adjusted net family income per capita. The CFPS adjusted for rural family income as it was underestimated due to non-inclusion of the value of self-consumed produce for rural families ( Xie, Zhang, Huang, Xu, & Xu, 2012).

*2.3.3. PCG academic expectation*. This was measured on a 0-100 point scale through an open-ended question in the adult-reported ‘Child Questionnaire’: “What is the average score out of a total of 100 that you expect your child to obtain this/next semester?”

*2.3.4 Demographics.* Based on past research investigating the drivers of maths attainment in the international research literature and within Chinese contexts, the effects of eight contextual demographic factors were accounted for in this study: Adolescent’s age in years; Gender (male=1; female=0); Ethnicity (Han=1; minority/non-Han=0); School grade (1 to 12); PCG (non-parent as primary caregiver=1; parent as primary caregiver=0); Hukou (non-agricultural Hukou=1; agricultural Hukou or no registration=0); Boarding (boarding=1; Non-boarding=0); Class size. Similar factors are controlled for in other papers analyzing the CFPS data (e.g., Wu, 2015; Liu & Xie, 2015).

**2.4 Analytic approach**

The CFPS used a clustered design to select its sample (a mean of 2.99 individuals nested within each community, 9.08 per county, and 56.28 per province). It was therefore essential to account for possible clustering effects in these analyses. Intra-class correlations (ICCs) were calculated to determine whether a multilevel model was necessary for analyzing the nested data. Following Hox (2010), it was only nesting at the community-level that consistently showed large ICCs (>15%) in maths attainment across all years of testing (2010, 2012, 2014) to warrant the need for statistical modelling.

Aggregated multilevel (controlling for community clustering) Structural Equation Modeling (MSEM) was used to examine the developmental impacts of SES and PCG academic expectations on adolescents’ maths progress over five years between ages 10-15 to ages 14-19 (see Figure 2). The pathways in Figure 2 illustrate both direct and indirect effects of SES and PCG academic expectations on maths attainment at each testing point. The term ‘total effects’ is used to refer to the combination of direct and (total) indirect effects. Figure 2 also illustrates the interaction effects between PCG academic expectations and SES that were modeled to test Research Question 3.

[Insert Figure 2 here]

The MSEM analyses were conducted using Mplus 7.4. Maximum likelihood estimation with robust standard errors was used to produce unbiased estimates in cases of non-normality. To facilitate comparison and interpretation, all continuous variables used in this study were z-scored a priori. Missing values were estimated using the maximum likelihood estimation. The CFPS calculated weights to correct for multi-stage sampling design and non-response, including panel weights for longitudinal studies. To ensure sample representativeness, panel weights for all testing years were used in the MSEM analysis.

1. **Results**

**3.1. Descriptive statistics**

Table 1 describes the characteristics of the 3,360 adolescents aged 10 to 15 years who were originally recruited into the 2010 baseline survey. Two groups of adolescents are compared in Table 1: those who were included in the Study Sample (n=1,407) and those who were excluded (n=1,953) because the CFPS did not have a record of their maths test scores across *all* three data sweeps in 2010, 2012 and 2014. Descriptive statistics are presented for all observed variables used in this analysis. The statistical comparisons between the two groups show that, on average, the Study Sample was a significantly older group attending higher grades at school, with more boys, Han students, and non-agricultural Hukou holders. As a result of the large attrition over time, consequences for the representativeness of the sample need to be clarified.

[Insert Table 1 here]

Using the 2010 census data (National Bureau of Statistics of China, 2011), Table 2 compares the Study Sample to its underlying population—all mainland Chinese children aged 10-15 in 2010—in three key demographic statistics: gender, ethnicity (Han vs. non-Han) and Hukou (i.e., local household registration, being either agricultural or non-agricultural). The figures in Table 2 show that the Study Sample was broadly representative of the Chinese population of 10-15 year olds in 2010 in terms of gender and ethnicity, with a slight oversampling of girls and the Han ethnic group. Due to unavailability of Hukou-by-age census data, the types of Hukou of the sampled children were compared with those of the entire Chinese population from the 2010 census in Table 2. The Study Sample is shown to slightly oversample non-agricultural Hukou holders.

[Insert Table 2 here]

Table 3 presents the statistical correlations between maths attainment, the three indicators of SES and PCG academic expectations. Strong and positive correlations (p<0.01) were found between maths attainment in different years. Significant relationships were also manifested between all three components of SES and maths attainment (p<0.01). Regarding PCG academic expectations, no significant relationship was shown with maths attainment in 2010. However, as adolescents aged this relationship became significant and increased in magnitude. Higher expectations from primary caregivers were significantly correlated with better maths attainment in both 2012 and 2014 (p<0.01), with even stronger correlation in 2014 than in 2012.

[Insert Table 3 here]

**3.2. Structural Equation Modeling**

This study implemented the MSEM shown in Figure 2 through a two-stage statistical procedure. First, a model without the interaction effects (SES × PCG academic expectations) was run to obtain estimates of both direct and total indirect effects. The results of the goodness-of-fit (GOF) indices from this first model suggested strong model fit (Chi-square [χ2]=43.40, p<0.01; Root Means Square Error Approximation [RMSEA] = 0.02; Confirmatory Fit Index [CFI] = 0.98; Tucker Lewis Index [TLI] = 0.95; Akaike Information Criterion [AIC]=40951.88; Bayesian Information Criterion [BIC] =41534.54). Second, a model was run which added the interaction effects to the model (SES × PCG academic expectations). This prevented absolute GOF indices from being returned (χ2, RMSEA, CFI, and TLI). However, the two comparative GOF indices (AIC, BIC) *were* returned and these were found to have altered to a negligible extent (AIC=40292.17 [within 2%]; BIC=40888.95 [within 2%]). This means that the model fit did not change sizably across the two stages of estimation and that the final MSEM model fitted the data well (enabling trust-worthy interpretation of results). This second model accounted for 63.90% of the variation in maths scores in 2010, 21.70% in 2012, and 29.60% in 2014.

***3.2.1. The impact of SES on Chinese adolescents’ maths attainment***

Figure 3 shows the total, direct and (total) indirect effects of SES on Chinese adolescents’ attainment and progress in maths from ages 10-15 to ages 14-19. SES had a significant net effect (B=0.14 standard deviations [SDs], p<0.05) on maths attainment in 2010. As the students aged, SES continued to significantly predict the progress that they made in maths. From 2010 to 2012, SES had both a significant direct effect (B=0.48, p<0.001) and a significant (total) indirect effect (B=0.04, p<0.05) on adolescents’ gains in maths. In contrast, between 2012 and 2014, SES affected progress in maths mainly through indirect pathways (via earlier effects on attainment; B=0.19, p<0.001), rather than through a direct impact (B=0.12, p>0.05). Given the significant associations between maths attainment over time (see Table 3), these findings suggest that the effects of SES on Chinese adolescents’ progress in maths may be ‘developmentally internalized’ (e.g. Sammons et al., 2013) over time.

### *3.2.2. The impact of PCG academic expectations on Chinese adolescents’ maths attainment*

Figure 4 shows the total, direct and (total) indirect effects of primary caregivers’ academic expectations on Chinese adolescents’ attainment and progress in maths from ages 10-15 to ages 14-19. PCG academic expectations had significant effects only on the adolescents’ gains in maths attainment from 2012 to 2014 (B=0.15 SDs, p<0.001). During this period, PCG academic expectations exerted their impact on Chinese adolescents’ progress in maths through a direct influence (B=0.14, p<0.001) rather than a non-direct effect ([total] indirect: B=0.01, p>0.05). These findings suggest that PCG academic expectations can have an increasing effect on the progress in maths that is made by Chinese adolescents during any two-year period between 12-17 years of age and 14-19 years of age.

### *3.2.3. The interaction between SES and PCG academic expectations as both impact Chinese adolescents’ maths attainment*

Table 4 presents the (effect) sizes and significance of the interaction effects between SES and PCG academic expectations as both (statistically) impact maths attainment.

[Insert Table 4 here]

Table 4 shows that the hypothesized interaction effects between SES and PCG academic expectations were only significant for maths attainment in 2010 (B=-0.18, p<0.01), but not for gains in attainment either from 2010 to 2012 or from 2012 to 2014. This means that SES and PCG academic expectation worked together to influence maths attainment in 2010 (when the sample was at its youngest: 10-15 years of age). Figure 5 illustrates this combined effect using the increasingly popular Johnson-Neyman technique, a procedure developed by Johnson & Neyman (1936) to plot interactions between two continuous variables without a need for the assumption of homogeneity of regression slopes usually required for ANCOVA (Clavel, 2015).

[Insert Figure 5 here]

Figure 5 illustrates that the relationship between SES and Chinese 10-15 year-olds’ maths attainment is partially dependent upon the academic expectations of their primary caregivers. The downward trend of the plot indicates that greater academic expectations from primary caregivers meant weaker associations between SES and adolescents’ maths attainment. This means that for 10-15 year-olds from low SES (socioeconomically disadvantaged) families, if their primary caregivers held higher academic expectations then this had the potential to result in maths attainment scores that were more similar to their higher SES peers.

The disadvantage-mitigating role that may be played by primary caregivers’ academic expectations is to be further supported by examining two different parts of the graph shown in Figure 5. First, when academic expectations from primary caregivers were low or just above average (less than +0.3 SDs), Chinese 10-15 year-olds from higher SES families performed better in maths than those from more disadvantaged backgrounds. Second, when academic expectations from primary caregivers were high (greater than +0.3 SDs), Chinese 10-15 year-olds performed more or less the same in maths irrespective of their family SES.

1. **Discussion**

This investigation aimed to provide new empirical evidence regarding the extent to which the progress in maths demonstrated by adolescents in China was related to the socioeconomic status (SES) of their families and the academic expectations of their primary caregivers (PCGs). Overall, this study found that both SES and PCG academic expectations exerted positive effects on maths attainment for adolescents who aged from 10-15 years in 2010 to 14-19 years in 2014. Analyses further revealed that the effect of SES became increasingly internalized (within past maths attainment) as these students aged and that the effects of SES and PCG academic expectations worked together: higher academic expectations lessened the difference in average maths attainment between students from lower and higher SES families.

The linear and positive link between family SES and 10-15 year-olds’ maths attainment found in this study is consistent with previous international findings (Sirin, 2005; White, 1982). When compared with a western country such as the UK (Sammons et al., 2012, 2014; Siraj-Blatchford et al., 2011) this study found an even bigger long-term effect of family SES in shaping adolescents’ maths learning in the Chinese context. This builds on existing literuatre in highlighting the potential disadvantages children from low SES families face when learning maths and points to a need for early intervention (Reardon, 2011; Sammons et al., 2013). With its widening socioeconomic gap (Yang, Huang, & Li, 2009), China should take heed of the potential implications for its children’s learning of mathematics.

Compared with SES, PCG academic expectations played a less immediately apparent role in shaping how the sampled Chinese adolescents progressed in maths between 2010 and 2014. Academic expectations were not significantly associated with 10-15 year-olds’ maths attainment, nor did they predict progress over the next two years. However, having higher academic expectations from primary caregivers at ages 10-15 did help students make more progress during any two-year period between 12-17 years of age and 14-19 years of age. The long-term effect during this particular phase of Chinese students’ life might be explained by the processes in the Chinese secondary education system. In China, high schools are selective, especially those “key high schools” that boast higher admission rates to universities (e.g., Lin & Zhang, 2006). Admission to them depends on students’ scores in a standardized exam at the end of junior high schools (Simon, 2000). In an effort to enter (good) high schools, adolescents face increasing academic competition since their entry into junior high schools (at around age 12 years; Stevenson & Lee, 1996). As they move up grade levels and progress towards the national college entrance examination called *Gaokao* (at around age 18 years), the competition becomes more intense. To better prepare their children, a very common approach taken by Chinese parents is to hire private tutors and give children out-of-school lessons (Lee, Baker, & Stevenson, 2016; Zhang, 2014). Another common response among Chinese parents is to get more involved in their children’s studies, including indirect involvement such as watching them study and emphasizing the importance of education (Kim & Fong, 2013). Past research has linked improved progress in maths to both responses (e.g., Zhao, 2015), which are speculated to have been the experiences of the sample studied here.

As the first longitudinal investigation to use a large-scale Chinese sample to explore the relationship between PCG academic expectations and adolescents’ maths attainment, this study confirms findings in some western studies about long-term effects of parental expectations (Fan & Chen, 2001; Keith et al., 1998; Grossman, Kuhn-McKearin, & William, 2011). However, it also challenges others that have found linear associations between higher PCG academic expectations and higher maths attainment (e.g., Mullis et al., 2012; Neuenschwander, Vida, Garrett & Eccles, 2007). This sheds light on the relevance of cultural context in understanding if and how PCG expectations impact maths attainment, though it should be noted that the measurement of academic expectations differed across studies (expected grade versus expected highest level of education), which has, as yet, unknown substantive implications.

This study also found high PCG academic expectations to reduce the negative impact of low family SES on maths attainment when the studied cohort was at their youngest (aged 10-15 years). This lends support to the interaction relationship found in some studies (e.g., Trusty et al., 2003; Tsui, 2005) while challenging past literature within the frameworks of the Expectancy-Value Theory and the Social Cognitive Theory in which parental expectations were proposed to mediate effects of SES on maths attainment (Eccles, 1993; Bandura et al., 1996). On one hand, this points to the importance of disadvantaged families holding high expectations for their children in education, as this can partially offset the consequences of social disadvantage from affecting their 10-15 year-olds’ maths attainment. On the other hand, the protective role that can be played by high academic expectations was only apparent when the studied adolescents were at their youngest age. *No* interaction was evident between family SES and PCG expectations on maths progress over the next four years. The message from this finding is that for students from disadvantaged family backgrounds, high PCG expectations are of greatest help when adolescents are younger. This is in keeping with findings regarding the Heckman Curve (Heckman, 2008), which emphasizes the importance of early interventions for disadvantaged children in alleviating inequalities later in life. Of course, it will also be necessary for future researcher to explore the extent to which these newly identified PCG effects vary between parental and non-parental PCGs.

Despite its novel findings, this study also had several limitations regarding the data used and the statistical analyses adopted. The first limitation concerns representativeness. The CFPS is a household-level survey, which means that the adolescents studied were just one part of the sampled cohort. Therefore, it is difficult to claim that the number of 10-15 year-olds recruited in the CFPS at baseline (n=3,360), though considerable, is large enough to accurately represent the 93 million Chinese 10-15 year-olds in 2010 (National Bureau of Statistics of China, 2011). Furthermore, there was large attrition over time. As a result, among the 10-15 year-olds originally recruited to the CFPS in 2010 (n=3,360), more adolescents had to be excluded (n=1,953) than included (n=1,407) in this study. The final Study Sample, though broadly representative of its underlying population in terms of gender and Hukou, was not able to claim representativeness for each of the 55 Non-Han ethnicities or for large urban regions like Beijing or Tianjin, which were not included by the CFPS as one of the “large provinces” to produce representative provincial subsamples[[1]](#footnote-1). Future research is needed to address these gaps in data coverage.

A second limitation involves the lack of information within the CFPS conerning the adolescents’ schools and teachers plus their own expectations for academic achievements. Though limited, existing evidence from Educational Effectiveness Research (EER) conducted in the Chinese context has suggested that around 20% to 30% of Chinese students’ attainment is linked to differences between schools rather than to other differences (e.g. between families and/or individuals). Such school effects include factors such as teacher qualifications, years of teaching experience, and teacher expectations (Thomas & Peng, 2011). However, as a household-level survey, the CFPS provides no information on teacher or school-level factors, leaving educational effects largely unexplained in this study. Similarly, student expectations were not measured in the CFPS and thus were not included in the analytical model. According to both Expectancy-Value Theory and Social-Cognitive Theory, parent expectations exert some of their effect on maths development via student expectations. Not controlling for student expectations is a weakness in the current analysis and should be addressed in future data collection and analysis.

A third limitation concerns two measures used in this study: maths attainment and PCG’s acaemic expectations. The correlations between maths attainment at three time points are relatively low compared with findings in other contexts (e.g., Sammons et al., 2014). This may be a result of examining a cohort instead of a fixed age. However, given two different maths tests were used in the CFPS (with the same test for 2010 and 2014, and a different test for 2012), the low correlations may also indicate that the CFPS tests were not measuring the same aspects of maths attainment. The 2012 number series test focused on numerical reasoning and problem solving while the 2010 and 2014 test focused on various forms of computation and calculation (Huang, Xie, & Xu, 2015). It is for this reason that statistical growth modelling was not used to capture progress over time. The consequences of this limitation (different tests potenitally explaining different correlations) will best be evalauted through a follow-up study using repeated measures to produce results with more validity and utility towards achieving a better understanding of the drivers of Chinese adolescents’ progress in maths. However, currently the CFPS is the only national longitudinal survey in China that has administered standardized maths tests to individuals aged 10 and above (Liu & Xie, 2015) which means that the CFPS is currently the only resource available to conduct national longitudinal analyses of individual Chinese adolescents’ math progress.

Regarding the measure of PCG academic expectations, it should be pointed out that there are two common ways of measuring parental academic expectations: one involves asking parents to report the highest level of education they expect their children to achieve, whereas the other involves asking parents to estimate their children’s grades in the near future (Yamamoto & Holloway, 2010). The CFPS adopted the second approach and readers should bear this in mind when comparing findings from this study with other studies where this variable is measured differently. Past research also suggests the possibiltiy that PCG expectations may mediate the effects of SES on math attainment as well as interact with it (e.g. the Wisconsin Model of Status Attainment; Sewell, Haller, & Ohlendorf, 1970; Sewell, Haller, & Portes, 1969). This we would have explored had there have been longitudinal data on PCG expectations for SES to influence prior to subsequent associations with maths attainment. This is certainly a possibility (perhaps as a form of moderated mediation or perhaps ‘Airbag Moderation’; Hall et al., 2018) and is one that we encourage future research to explore.

In summary, the results from this study stress the importance of SES in shaping Chinese adolescents’ learning of maths, and suggest that a short-term mitigating role may be played by greater primary caregivers’ academic expectations. The study offers new empirical evidence from a non-western context to the body of literature on motivations of achievement.

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Table 1. *Sample description and comparison of age 10-15 CFPS adolescents: Participants versus exclusions (continued)*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Measures | Included (n=1,407) | | Excluded (n=1,953) | | | | Statistic comparison | |
| n | % or mean±SD | | n | % or mean±SD | Statistic | | *pa* |
| Maths attainment in 2010 | 1407 | 12.94±3.67 | | 1953 | 11.02±4.63 | t (3358)=2.79 | | \*\* |
| Maths attainment in 2012 | 1407 | 533.94±25.971 | | 564 | 526.78±28.13 | t (1969)=-3.32 | | \*\* |
| Maths attainment in 2014 | 1407 | 16.63±5.16 | | 662 | 12.59±6.02 | t (2067)=-10.45 | | \*\*\* |
| Socioeconomic status: |  |  | |  |  |  | |  |
| Highest adult educational attainment | 1401 | 8.97±3.62 | | 1934 | 7.38±4.30 | t (3332)=-6.60 | | \*\*\* |
| Highest adult occupational status | 1155 | 34.89±14.20 | | 1606 | 30.89±12.53 | t (2807)=2.52 | | \* |
| Family income per capita | 1297 | 7974.38±8338.95 | | 1650 | 7243.00±10337.59 | t (2893)=-0.51 | |  |
| PCG academic expectation | 1383 | 91.26±9.27 | | 1905 | 89.60±10.44 | t (3290)=-3.98 | | \*\*\* |
| Age (year) | 1407 | 12.97±1.43 | | 1953 | 12.61±1.73 | t (3358)=3.92 | | \*\*\* |
| Gender | 1407 |  | | 1953 |  | χ2 [1]=8.11 | | \*\* |
| Female | 707 | 50.30% | | 923 | 47.30% |  | |  |
| Male | 700 | 49.70% | | 1030 | 52.70% |  | |  |
| Ethnicity | 1407 |  | | 1953 |  | χ2 [1]=15.35 | | \*\*\* |
| Han | 1274 | 90.50% | | 1701 | 87.10% |  | |  |
| Non-han | 133 | 9.50% | | 252 | 12.90% |  | |  |
| Hukou | 1402 |  | | 1951 |  | χ2 [1]=10.20 | | \*\* |
| Agricultural or no registration | 940 | 67.00% | | 1591 | 81.50 % |  | |  |
| Non-agricultural | 462 | 33.00% | | 360 | 18.50% |  | |  |

(continued)

Table 1. *Sample description and comparison of age 10-15 CFPS adolescents: Participants versus exclusions (continued)*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Measures | Included (n=1,407) | | Excluded (n=1,953) | | | Statistic comparison | |
| n | % or mean±SD | | n | % or mean±SD | Statistic | *pa* |
| School grade | 1403 | 6.51±1.68 | | 1948 | 5.84±1.91 | t (3350)=1.52 | \*\*\* |
| Primary caregiver | 1407 |  | | 1953 |  | χ2 [1]=14.01 | \*\*\* |
| Parent | 1201 | 85.40% | | 1559 | 79.80% |  |  |
| Non-parent | 206 | 14.60% | | 394 | 20.20% |  |  |
| School Boarding status | 1407 |  | | 1951 |  | χ2 [1]=10.06 | \*\* |
| Non-boarding | 1106 | 55.80% | | 1148 | 58.80% |  |  |
| Boarding | 622 | 44.20% | | 803 | 41.20% |  |  |
| Class size | 1394 | 49.59±15.23 | | 1932 | 47.26±17.74 | t (3326)=2.91 | \*\* |

*Note. PCG = primary caregiver.*

*a Results obtained from Independent Sample T-tests for continuous variables and Pearson Chi-square tests for nominal variables.*

*b The statistical comparisons were made on raw data with no use of panel weights.*

*\* p<0.05, \*\* p<0.01, \*\*\* p<0.001.*

Table 2. *Gender, ethnicity and Hukou of 10-15 year-olds in the Study Sample (n=1,407) and the 2010 Chinese census*

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | Sample % | 2010 Census % |
| Gender | Total | 100.00 | 100.00 |
|  | Male | 49.70 | 53.58 |
|  | Female | 50.30 | 46.42 |
| Ethnicity | Total | 100.00 | 100.00 |
|  | Han | 90.50 | 89.04 |
|  | Non-Han[[2]](#footnote-2) | 9.50 | 10.27 |
| Hukou | Total | 100.00 | 100.00 |
|  | Non-agricultural | 32.80 | 29.14 |
|  | Agricultural | 66.80 | 70.86 |
|  | No registration/not applicable | 0.30 | - |

Table 3. *Correlations between maths attainment, indicators of SES (attainment, occupation, income), and the academic expectations of primary caregivers*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Maths attainment in 2010 | Maths attainment in 2012 | | Maths attainment in 2014 | Highest adult educational attainment | Highest adult occupational  status | Family income per capita |
| Maths attainment in 2012 | 0.27\*\* | - | | - | - |  | - |
| Maths attainment in 2014 | 0.41\*\* | 0.41\*\* | | - | - | - | - |
| Highest adult educational attainment | 0.13\*\* | 0.30\*\* | | 0.23\*\* | - | - | - |
| Highest adult occupational status | 0.16\*\* | | 0.26\*\* | 0.18\*\* | 0.55\*\* | - | - |
| Family income per capita | 0.08\*\* | | 0.11\*\* | 0.09\*\* | 0.35\*\* | 0.42\*\* | - |
| PCG academic expectation | 0.02 | | 0.07\* | 0.18\*\* | 0.09\*\* | 0.11\*\* | 0.08\*\* |

*Note*. PCG = primary caregiver.

*\* p<0.05, \*\* p<0.01, \*\*\* p<0.001.*

Table 4. *Main effects of, and interaction effects between SES and the academic expectations of primary cargivers as they relate to Chinese adolescents’ attainment and (value-add) progress in mathematics*

|  |  |  |  |
| --- | --- | --- | --- |
|  | Statistical effects (Unstandardized Beta Effects, B standard deviations) | | |
| Impacts upon… | Main effect of SES | Main effect of PCG  academic expectation | Statistical interaction |
| …Maths attainment in 2010 | 0.14\* | 0.04 | -0.18\*\* |
| …Maths (value-add) progress from 2010 to 2012 | 0.52\*\*\* | 0.00 | 0.07 |
| …Maths (value-add) progress from 2012 to 2014 | 0.31\*\*\* | 0.15\*\*\* | 0.01 |

*Note*. SES = socioeconomic status; PCG = primary caregiver; *\* p<0.05, \*\* p<0.01, \*\*\* p<0.001;* “(value-add) progress” refers to estimations of the statistical effect of SES and PCG academic expectations on maths attainment simultaneous with the statistical effect of maths attainment at the previous measurement point (for more details on this technique see Meyer, 1997; McCaffrey et al. 2004)

Figure 1. *The 2012 maths test in the China Family Panel Studies*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Stage 1 | |  |  | Stage 2 |  |  |  |  |
|  |  |  |  | Group A: D204-D206 | |  |  |  |
|  |  |  |  | Group B: D224-D226 | |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | Random allocation |  |  | Group A: D207-D209 | |  |  |  |
| Group A: D201-D203 | |  |  | Group B: D227-D229 | |  |  | Final score |
| Group B: D221-D223 | |  |  |  |  |
|  |  |  |  | Group A: D210-D212 | |  |  |  |
|  |  |  |  | Group B: D230-D232 | |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  | Group A: D213-D215 | |  |  |  |
|  |  |  |  | Group B: D233-D235 | |  |  |  |

Note: CA is short for correct answers.

Figure 2. *Stylized illustration of the Structural Equation Model (SEM) specified to test the developmental impacts of socioeconomic status (SES) and primary caregiver’s academic expectation on the mathematics progress of a cohort of Chinese adolescents over five years*

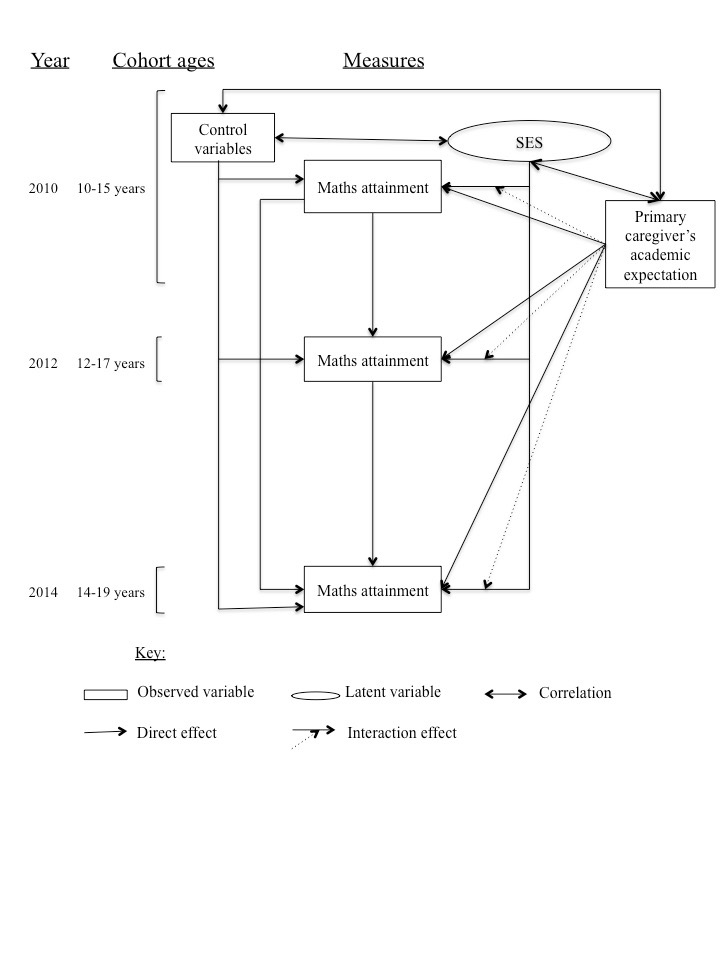


Figure 3. *The value-added total effects of SES on Chinese adolescents’ attainment and progress in mathematics*

*\* p<0.05, \*\* p<0.01, \*\*\* p<0.001*. *Note: The total indirect effects operate via earlier impacts on attainment.*

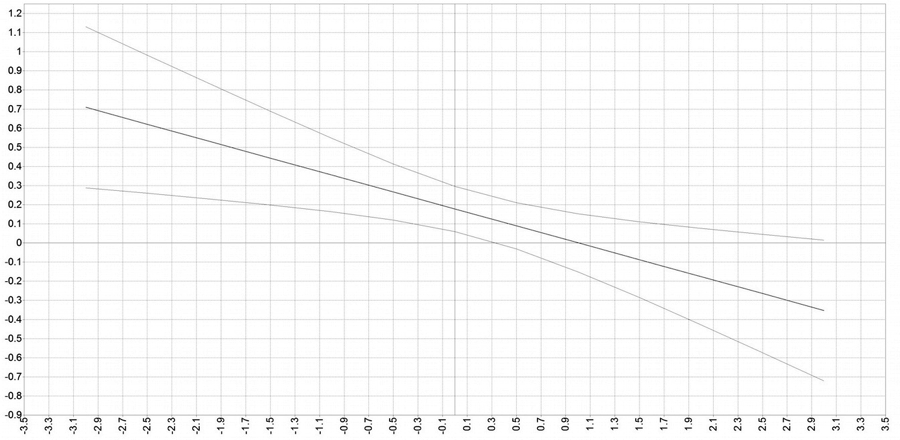
Figure 4. *The value-added total effects of primary caregiver’s academic expectation on Chinese adolescents’ attainment and progress in mathematics*

*\* p<0.05, \*\* p<0.01, \*\*\* p<0.001*. *Note: The total indirect effects operate via earlier impacts on attainment.*

Figure 5. *The adjusted effect of socioeconomic status (SES) on Chinese 10-15 year-olds’ maths attainment - variation of effect according to the level of primary caregiver’s (PCG) academic expectation.*

Primary Caregiver’s Academic Expectation

Adjusted Effect of SES on Maths Attainment in 2010



*Note: The adjusted effect of SES, as shown in the Y-axis, refers to the effect of SES on Chinese 10-15 year-olds’ maths attainment after adjusting for the effect of PCG academic expectations. The straight plot line in between two curved lines represents values of the adjusted effect of SES that corresponds to the observed continuum of PCG academic expectations. The two curved lines represent 95% confidence bands around the adjusted effect of SES on Chinese 10-15 year-olds’ maths attainment.*

**Online Supplementary Material. Full results from the two aggregated Multilevel Structural Equation Models featured in this paper**

The full results from the two aggregated multilevel Structural Equation Models that returned the results of this paper are presented in Tables Ap2 and Ap3 (standardised regression coefficients, covariances, and proportions of variances explained in statistically dependent measures). Within these, “ON” is shorthand for ‘statistically dependent upon’ and, “WITH” is shorthand for ‘statistically covarying with”. The contents of Table Ap1 permit these two results tables to be understood by matching the variables within to their matching measured concept.

**Table Ap1.** Descriptions and variable labels for the measures featuring in the aggregated multilevel Structural Equation Models of this paper

|  |  |
| --- | --- |
| **Variable** | **Description** |
| SES | Socioeconomic Status of households. A continuous reflective latent measure from highest (household) adult educational attainment, highest (household) adult occupational status, and family income per capita |
| ZPEDU | Highest (household) adult educational attainment (ZPEDU) |
| ZPOCC | Highest (household) adult occupational status (ZPOCC) |
| ZFAMINC | Family income per capita (ZFAMINC) |
| ZPAR\_EXP | Primary Care Giver (PCG) academic expectations |
| SESXPEX | The two-way (latent) statistical interaction specified between SES and ZPAR\_EXP |
| ZMATH10 | CFPS Math test score in 2010 |
| ZMATH12 | CFPS Math test score in 2012 based on Item Response Theory |
| ZMATH14 | CFPS Math test score in 2014 |
| ZAGE | Adolescent’s age (years) |
| GENDER | Child Gender (male=0; female=1) |
| ETH | Ethnicity (Han=1; minority/non-Han=0) |
| ZGRADE | School grade (1-12) |
| HUKOU | Hukou (non-agricultural Hukou=1; agricultural Hukou or no registration=0) |
| BOARD | School boarding (boarding=1; Non-boarding=0) |
| ZCSIZE | Class size in school (number of students) |
| PCG | PCG (non-parent as primary caregiver=1; parent as primary caregiver=0) |

*Note: the Z prefix in variable names denotes that (grand mean) Z-scoring took place prior to the specification of the Structural Equation Models. This was to ease model convergence and to facilitate the subsequent specification of the SES by PCG academic expectation latent interaction variable*

**Table Ap2.** Full results from the aggregated multilevel Structural Equation Model that excluded the interaction effect (SES × PCG academic expectations) to obtain estimates of both direct and total indirect effects

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Standardized regression coefficients and covariances** | | | | |
| **Variable** | **Estimate (Est.)** | **Standard Error (S.E)** | **Est./S.E.** | **Two-Tailed P-Value** |
| SES | BY |  |  |  |
| ZPEDU | 0.787 | 0.029 | 27.55 | <0.001 |
| ZPOCC | 0.707 | 0.04 | 17.843 | <0.001 |
| ZFAMINC | 0.430 | 0.051 | 8.436 | <0.001 |
|  |  |  |  |  |
| ZMATH10 | ON |  |  |  |
| SES | 0.111 | 0.045 | 2.48 | 0.013 |
|  |  |  |  |  |
| ZMATH12 | ON |  |  |  |
| SES | 0.376 | 0.068 | 5.543 | <0.001 |
|  |  |  |  |  |
| ZMATH14 | ON |  |  |  |
| SES | 0.091 | 0.07 | 1.29 | 0.197 |
|  |  |  |  |  |
| ZMATH14 | ON |  |  |  |
| ZMATH10 | 0.268 | 0.051 | 5.265 | <0.001 |
| ZMATH12 | 0.287 | 0.035 | 8.103 | <0.001 |
| ZAGE | 0.018 | 0.064 | 0.276 | 0.783 |
| GENDER | -0.062 | 0.032 | -1.93 | 0.054 |
| ETH | 0.018 | 0.037 | 0.478 | 0.632 |
| ZGRADE | 0.027 | 0.076 | 0.35 | 0.726 |
| HUKOU | 0.011 | 0.056 | 0.19 | 0.849 |
| BOARD | 0.012 | 0.042 | 0.288 | 0.773 |
| ZCSIZE | 0.004 | 0.035 | 0.114 | 0.909 |
| PCG | 0.012 | 0.035 | 0.347 | 0.729 |
| ZPAR\_EXP | 0.142 | 0.033 | 4.294 | <0.001 |
|  |  |  |  |  |
| ZMATH12 | ON |  |  |  |
| ZMATH10 | 0.255 | 0.064 | 3.959 | <0.001 |
| ZAGE | -0.093 | 0.104 | -0.902 | 0.367 |
| GENDER | 0.061 | 0.038 | 1.627 | 0.104 |
| ETH | 0.116 | 0.06 | 1.919 | 0.055 |
| ZGRADE | 0.033 | 0.093 | 0.353 | 0.724 |
| HUKOU | -0.174 | 0.053 | -3.302 | 0.001 |
| BOARD | -0.046 | 0.045 | -1.038 | 0.299 |
| ZCSIZE | 0.056 | 0.038 | 1.474 | 0.140 |
| PCG | -0.001 | 0.041 | -0.032 | 0.975 |
| ZPAR\_EXP | -0.007 | 0.045 | -0.153 | 0.878 |
|  |  |  |  |  |
| ZMATH10 | ON |  |  |  |
| ZAGE | 0.103 | 0.067 | 1.532 | 0.126 |
| GENDER | 0.003 | 0.029 | 0.095 | 0.924 |
| ETH | -0.010 | 0.024 | -0.413 | 0.679 |
| ZGRADE | 0.683 | 0.067 | 10.14 | <0.001 |
| HUKOU | 0.021 | 0.037 | 0.566 | 0.571 |
| BOARD | -0.012 | 0.026 | -0.484 | 0.628 |
| ZCSIZE | 0.018 | 0.021 | 0.859 | 0.390 |
| PCG | 0.036 | 0.028 | 1.293 | 0.196 |
| ZPAR\_EXP | 0.044 | 0.058 | 0.761 | 0.447 |
|  |  |  |  |  |
| ZPAR\_EXP | WITH |  |  |  |
| SES | 0.124 | 0.047 | 2.651 | 0.008 |
|  |  |  |  |  |
| ZAGE | WITH |  |  |  |
| SES | -0.128 | 0.041 | -3.144 | 0.002 |
|  |  |  |  |  |
| GENDER | WITH |  |  |  |
| SES | 0.039 | 0.047 | 0.835 | 0.404 |
|  |  |  |  |  |
| ETH | WITH |  |  |  |
| SES | 0.146 | 0.074 | 1.966 | 0.049 |
|  |  |  |  |  |
| ZGRADE | WITH |  |  |  |
| SES | 0.092 | 0.049 | 1.877 | 0.061 |
|  |  |  |  |  |
| HUKOU | WITH |  |  |  |
| SES | 0.626 | 0.036 | 17.39 | 0.000 |
|  |  |  |  |  |
| BOARD | WITH |  |  |  |
| SES | -0.07 | 0.061 | -1.161 | 0.246 |
|  |  |  |  |  |
| ZCSIZE | WITH |  |  |  |
| SES | 0.216 | 0.053 | 4.048 | <0.001 |
|  |  |  |  |  |
| PCG | WITH |  |  |  |
| SES | -0.082 | 0.050 | -1.637 | 0.102 |
|  |  |  |  |  |
| ZAGE | WITH |  |  |  |
| ZPAR\_EXP | -0.142 | 0.032 | -4.457 | <0.001 |
|  |  |  |  |  |
| GENDER | WITH |  |  |  |
| ZPAR\_EXP | -0.059 | 0.041 | -1.417 | 0.157 |
| ZAGE | -0.036 | 0.035 | -1.034 | 0.301 |
|  |  |  |  |  |
| ETH | WITH |  |  |  |
| ZPAR\_EXP | 0.208 | 0.065 | 3.205 | 0.001 |
| ZAGE | 0.035 | 0.04 | 0.862 | 0.389 |
| GENDER | -0.02 | 0.048 | -0.423 | 0.672 |
|  |  |  |  |  |
| ZGRADE | WITH |  |  |  |
| ZPAR\_EXP | -0.030 | 0.040 | -0.746 | 0.456 |
| ZAGE | 0.809 | 0.018 | 43.981 | <0.001 |
| GENDER | -0.077 | 0.038 | -2.017 | 0.044 |
| ETH | 0.153 | 0.042 | 3.628 | <0.001 |
|  |  |  |  |  |
| HUKOU | WITH |  |  |  |
| ZPAR\_EXP | 0.091 | 0.041 | 2.205 | 0.027 |
| ZAGE | -0.057 | 0.039 | -1.46 | 0.144 |
| GENDER | 0.011 | 0.038 | 0.29 | 0.772 |
| ETH | 0.094 | 0.049 | 1.944 | 0.052 |
| ZGRADE | 0.131 | 0.044 | 2.984 | 0.003 |
|  |  |  |  |  |
| BOARD | WITH |  |  |  |
| ZPAR\_EXP | -0.078 | 0.042 | -1.857 | 0.063 |
| ZAGE | 0.302 | 0.041 | 7.446 | <0.001 |
| GENDER | -0.075 | 0.039 | -1.918 | 0.055 |
| ETH | 0.086 | 0.048 | 1.804 | 0.071 |
| ZGRADE | 0.366 | 0.039 | 9.269 | <0.001 |
| HUKOU | -0.082 | 0.057 | -1.425 | 0.154 |
|  |  |  |  |  |
| ZCSIZE | WITH |  |  |  |
| ZPAR\_EXP | -0.015 | 0.035 | -0.443 | 0.658 |
| ZAGE | 0.155 | 0.04 | 3.891 | <0.001 |
| GENDER | -0.032 | 0.044 | -0.734 | 0.463 |
| ETH | 0.025 | 0.034 | 0.735 | 0.463 |
| ZGRADE | 0.241 | 0.042 | 5.673 | <0.001 |
| HUKOU | 0.150 | 0.051 | 2.924 | 0.003 |
| BOARD | 0.190 | 0.044 | 4.266 | <0.001 |
|  |  |  |  |  |
| PCG | WITH |  |  |  |
| ZPAR\_EXP | -0.040 | 0.051 | -0.776 | 0.437 |
| ZAGE | 0.028 | 0.04 | 0.686 | 0.492 |
| GENDER | 0.018 | 0.044 | 0.418 | 0.676 |
| ETH | 0.013 | 0.044 | 0.299 | 0.765 |
| ZGRADE | 0.03 | 0.043 | 0.702 | 0.483 |
| HUKOU | -0.002 | 0.045 | -0.042 | 0.967 |
| BOARD | -0.011 | 0.044 | -0.251 | 0.802 |
| ZCSIZE | -0.071 | 0.044 | -1.605 | 0.108 |
| **Standardised total, total indirect, specific indirect, and direct effects** | | | | |
| Effects from SES to ZMATH12 | | | | |
| Total | 0.404 | 0.065 | 6.182 | <0.001 |
| Total indirect | 0.028 | 0.013 | 2.194 | 0.028 |
| Specific indirect |  |  |  |  |
| ZMATH12 |  |  |  |  |
| ZMATH10 |  |  |  |  |
| SES | 0.028 | 0.013 | 2.194 | 0.028 |
| Direct |  |  |  |  |
| ZMATH12 |  |  |  |  |
| SES | 0.376 | 0.068 | 5.543 | <0.001 |
|  |  |  |  |  |
| Effects from ZPAR\_EXP to ZMATH12 | | | | |
| Total | 0.004 | 0.048 | 0.092 | 0.927 |
| Total indirect | 0.011 | 0.015 | 0.750 | 0.453 |
| Specific indirect |  |  |  |  |
| ZMATH12 |  |  |  |  |
| ZMATH10 |  |  |  |  |
| ZPAR\_EXP | 0.011 | 0.015 | 0.750 | 0.453 |
| Direct |  |  |  |  |
| ZMATH12 |  |  |  |  |
| ZPAR\_EXP | -0.007 | 0.045 | -0.153 | 0.878 |
|  |  |  |  |  |
| Effects from SES to ZMATH14 | | | | |
| Total | 0.236 | 0.067 | 3.527 | <0.001 |
| Total indirect | 0.146 | 0.028 | 5.261 | <0.001 |
| Specific indirect |  |  |  |  |
| ZMATH14 |  |  |  |  |
| ZMATH10 |  |  |  |  |
| SES | 0.030 | 0.013 | 2.296 | 0.022 |
| ZMATH14 |  |  |  |  |
| ZMATH12 |  |  |  |  |
| SES | 0.108 | 0.025 | 4.384 | <0.001 |
| ZMATH14 |  |  |  |  |
| ZMATH12 |  |  |  |  |
| ZMATH10 |  |  |  |  |
| SES | 0.008 | 0.004 | 2.098 | 0.036 |
| Direct |  |  |  |  |
| ZMATH14 |  |  |  |  |
| SES | 0.091 | 0.070 | 1.290 | 0.197 |
|  |  |  |  |  |
| Effects from ZPAR\_EXP to ZMATH14 | | | | |
| Total | 0.155 | 0.040 | 3.890 | <0.001 |
| Total indirect | 0.013 | 0.023 | 0.561 | 0.575 |
| Specific indirect |  |  |  |  |
| ZMATH14 |  |  |  |  |
| ZMATH10 |  |  |  |  |
| ZPAR\_EXP | 0.012 | 0.015 | 0.781 | 0.435 |
| ZMATH14 |  |  |  |  |
| ZMATH12 |  |  |  |  |
| ZPAR\_EXP | -0.002 | 0.013 | -0.153 | 0.878 |
| ZMATH14 |  |  |  |  |
| ZMATH12 |  |  |  |  |
| ZMATH10 |  |  |  |  |
| ZPAR\_EXP | 0.003 | 0.004 | 0.746 | 0.456 |
| Direct |  |  |  |  |
| ZMATH14 |  |  |  |  |
| ZPAR\_EXP | 0.142 | 0.033 | 4.294 | <0.001 |
| **Proportions of variation explained (r-square)** | | | | |
| **Variable** | **Estimate (Est.)** | **Standard Error (S.E.)** | **Est./S.E.** | **Two-Tailed P-Value** |
| ZMATH10 | 0.622 | 0.030 | 20.601 | <0.001 |
| ZMATH12 | 0.213 | 0.038 | 5.575 | <0.001 |
| ZMATH14 | 0.299 | 0.030 | 10.133 | <0.001 |
| ZPEDU | 0.319 | 0.045 | 13.775 | <0.001 |
| ZPOCC | 0.500 | 0.056 | 8.921 | <0.001 |
| ZFAMINC | 0.185 | 0.044 | 4.218 | <0.001 |

*Note: the Z prefix in variables denotes that (grand mean) Z-scoring took place prior to the specification of the Structural Equation Models. This was to ease model convergence*

**Table Ap3.** Full results from the aggregated multilevel Structural Equation Model that included the interaction effect (SES × PCG academic expectations)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Standardized regression coefficients and covariances** | | | | |
| **Variable** | **Estimate (Est.)** | **Standard Error (S.E)** | **Est./S.E.** | **Two-Tailed P-Value** |
|  |  |  |  |  |
| SES | BY |  |  |  |
| ZPEDU | 0.776 | 0.028 | 27.291 | <0.001 |
| ZPOCC | 0.698 | 0.039 | 18.019 | <0.001 |
| ZFAMINC | 0.432 | 0.053 | 8.220 | <0.001 |
|  |  |  |  |  |
| ZMATH10 | ON |  |  |  |
| SES | 0.138 | 0.045 | 3.071 | 0.002 |
| SESXPEX | -0.137 | 0.055 | -2.507 | 0.012 |
|  |  |  |  |  |
| ZMATH12 | ON |  |  |  |
| SES | 0.362 | 0.074 | 4.909 | <0.001 |
| SESXPEX | 0.056 | 0.046 | 1.210 | 0.226 |
|  |  |  |  |  |
| ZMATH14 | ON |  |  |  |
| SES | 0.085 | 0.075 | 1.138 | 0.255 |
| SESXPEX | 0.007 | 0.039 | 0.179 | 0.858 |
|  |  |  |  |  |
| ZMATH14 | ON |  |  |  |
| ZMATH10 | 0.267 | 0.054 | 4.904 | <0.001 |
| ZMATH12 | 0.285 | 0.036 | 8.004 | <0.001 |
| ZAGE | -0.012 | 0.064 | -0.195 | 0.845 |
| GENDER | -0.060 | 0.033 | -1.827 | 0.068 |
| ETH | 0.014 | 0.038 | 0.378 | 0.706 |
| ZGRADE | 0.057 | 0.070 | 0.817 | 0.414 |
| HUKOU | 0.004 | 0.057 | 0.062 | 0.951 |
| BOARD | 0.007 | 0.043 | 0.175 | 0.861 |
| ZCSIZE | 0.010 | 0.036 | 0.276 | 0.783 |
| PCG | 0.016 | 0.036 | 0.428 | 0.669 |
| ZPAR\_EXP | 0.146 | 0.033 | 4.484 | <0.001 |
|  |  |  |  |  |
| ZMATH12 | ON |  |  |  |
| ZMATH10 | 0.264 | 0.068 | 3.863 | <0.001 |
| ZAGE | -0.117 | 0.109 | -1.072 | 0.284 |
| GENDER | 0.073 | 0.038 | 1.933 | 0.053 |
| ETH | 0.118 | 0.060 | 1.987 | 0.047 |
| ZGRADE | 0.058 | 0.094 | 0.614 | 0.539 |
| HUKOU | -0.179 | 0.054 | -3.323 | 0.001 |
| BOARD | -0.048 | 0.045 | -1.071 | 0.284 |
| ZCSIZE | 0.047 | 0.037 | 1.269 | 0.205 |
| PCG | -0.014 | 0.042 | -0.336 | 0.737 |
| ZPAR\_EXP | 0.009 | 0.042 | 0.220 | 0.826 |
|  |  |  |  |  |
| ZMATH10 | ON |  |  |  |
| ZAGE | 0.119 | 0.066 | 1.813 | 0.070 |
| GENDER | 0.003 | 0.028 | 0.120 | 0.904 |
| ETH | -0.019 | 0.023 | -0.839 | 0.402 |
| ZGRADE | 0.662 | 0.066 | 10.025 | <0.001 |
| HUKOU | 0.016 | 0.036 | 0.431 | 0.666 |
| BOARD | -0.005 | 0.025 | -0.186 | 0.852 |
| ZCSIZE | 0.022 | 0.021 | 1.045 | 0.296 |
| PCG | 0.046 | 0.028 | 1.655 | 0.098 |
| ZPAR\_EXP | 0.032 | 0.041 | 0.786 | 0.432 |
|  |  |  |  |  |
| ZPAR\_EXP | WITH |  |  |  |
| SES | 0.097 | 0.054 | 1.807 | 0.071 |
|  |  |  |  |  |
| ZAGE | WITH |  |  |  |
| SES | -0.144 | 0.041 | -3.501 | <0.001 |
|  |  |  |  |  |
| GENDER | WITH |  |  |  |
| SES | 0.057 | 0.049 | 1.170 | 0.242 |
|  |  |  |  |  |
| ETH | WITH |  |  |  |
| SES | 0.143 | 0.076 | 1.871 | 0.061 |
|  |  |  |  |  |
| ZGRADE | WITH |  |  |  |
| SES | 0.082 | 0.050 | 1.646 | 0.100 |
|  |  |  |  |  |
| HUKOU | WITH |  |  |  |
| SES | 0.629 | 0.035 | 17.932 | 0.000 |
|  |  |  |  |  |
| BOARD | WITH |  |  |  |
| SES | -0.077 | 0.062 | -1.251 | 0.211 |
|  |  |  |  |  |
| ZCSIZE | WITH |  |  |  |
| SES | 0.208 | 0.054 | 3.819 | <0.001 |
|  |  |  |  |  |
| PCG | WITH |  |  |  |
| SES | -0.096 | 0.046 | -2.082 | 0.037 |
|  |  |  |  |  |
| ZAGE | WITH |  |  |  |
| ZPAR\_EXP | -0.143 | 0.032 | -4.492 | <0.001 |
|  |  |  |  |  |
| GENDER | WITH |  |  |  |
| ZPAR\_EXP | -0.059 | 0.041 | -1.446 | 0.148 |
| ZAGE | -0.034 | 0.035 | -0.968 | 0.333 |
|  |  |  |  |  |
| ETH | WITH |  |  |  |
| ZPAR\_EXP | 0.209 | 0.065 | 3.213 | 0.001 |
| ZAGE | 0.034 | 0.041 | 0.837 | 0.403 |
| GENDER | -0.022 | 0.048 | -0.450 | 0.653 |
|  |  |  |  |  |
| ZGRADE | WITH |  |  |  |
| ZPAR\_EXP | -0.030 | 0.040 | -0.738 | 0.460 |
| ZAGE | 0.814 | 0.018 | 44.504 | <0.001 |
| GENDER | -0.081 | 0.039 | -2.091 | 0.037 |
| ETH | 0.154 | 0.042 | 3.643 | <0.001 |
|  |  |  |  |  |
| HUKOU | WITH |  |  |  |
| ZPAR\_EXP | 0.083 | 0.043 | 1.942 | 0.052 |
| ZAGE | -0.069 | 0.040 | -1.729 | 0.084 |
| GENDER | 0.015 | 0.039 | 0.390 | 0.697 |
| ETH | 0.092 | 0.049 | 1.867 | 0.062 |
| ZGRADE | 0.122 | 0.045 | 2.710 | 0.007 |
|  |  |  |  |  |
| BOARD | WITH |  |  |  |
| ZPAR\_EXP | -0.079 | 0.042 | -1.869 | 0.062 |
| ZAGE | 0.300 | 0.041 | 7.338 | <0.001 |
| GENDER | -0.082 | 0.038 | -2.132 | 0.033 |
| ETH | 0.084 | 0.048 | 1.754 | 0.079 |
| ZGRADE | 0.359 | 0.040 | 8.909 | <0.001 |
| HUKOU | -0.089 | 0.059 | -1.515 | 0.130 |
|  |  |  |  |  |
| ZCSIZE | WITH |  |  |  |
| ZPAR\_EXP | -0.015 | 0.035 | -0.436 | 0.663 |
| ZAGE | 0.158 | 0.040 | 3.956 | <0.001 |
| GENDER | -0.022 | 0.044 | -0.507 | 0.612 |
| ETH | 0.027 | 0.035 | 0.782 | 0.434 |
| ZGRADE | 0.244 | 0.043 | 5.693 | <0.001 |
| HUKOU | 0.149 | 0.053 | 2.843 | 0.004 |
| BOARD | 0.197 | 0.044 | 4.466 | <0.001 |
|  |  |  |  |  |
| PCG | WITH |  |  |  |
| ZPAR\_EXP | -0.040 | 0.051 | -0.790 | 0.430 |
| ZAGE | 0.031 | 0.041 | 0.750 | 0.454 |
| GENDER | 0.018 | 0.044 | 0.400 | 0.689 |
| ETH | 0.009 | 0.045 | 0.203 | 0.840 |
| ZGRADE | 0.025 | 0.044 | 0.566 | 0.571 |
| HUKOU | -0.004 | 0.045 | -0.088 | 0.930 |
| BOARD | -0.025 | 0.043 | -0.581 | 0.561 |
| ZCSIZE | -0.078 | 0.045 | -1.721 | 0.085 |
| **Proportions of variation explained (r-square)** | | | | |
| **Variable** | **Estimate (Est.)** | **Standard Error (S.E.)** | **Est./S.E.** | **Two-Tailed P-Value** |
| ZMATH10 | 0.639 | 0.027 | 23.472 | <0.001 |
| ZMATH12 | 0.217 | 0.042 | 5.195 | <0.001 |
| ZMATH14 | 0.296 | 0.030 | 10.005 | <0.001 |
| ZPEDU | 0.603 | 0.044 | 13.646 | <0.001 |
| ZPOCC | 0.488 | 0.054 | 9.009 | <0.001 |
| ZFAMINC | 0.187 | 0.045 | 4.110 | <0.001 |

*Note: the Z prefix in variables denotes that (grand mean) Z-scoring took place prior to the specification of the Structural Equation Models. This was to ease model convergence and to facilitate the specification of the SES by PCG academic expectation latent interaction variable (SESXPEX)*

1. The CFPS chose to oversample in five regions, including Guangdong, Gansu, Liaoning, Henan, and Shanghai, with a special provision made for the only municipality in the five regions, Shanghai. The CFPS called these five oversampled regions the ‘large provinces’, with each treated as a separate stratum. Subsamples from the ‘large provinces’ were representative at the provincial level so that provincial comparison could be made. The selection of the ‘large provinces’ was based on regional representation, with the five chosen regions located in the south, west, north, center and east of Chinese mainland respectively and showing diversity in levels of economic development. The remaining 20 provinces/municipalities, including Beijing and Tianjin, were collapsed into one single group of ‘small provinces’ by the CFPS and treated as the sixth stratum. More details on sampling procedures in the CFPS can be found in Xie and Lu (2015). [↑](#footnote-ref-1)
2. The Study Sample included only 15 non-Han ethnic groups from a total of 55 ethnic minorities who live in China. As a result, the underlying population of this study did not include the 40 ethnic minorities not covered in the Study Sample. Due to the small numbers of cases, the 15 ethnic minorities are presented here as a single group ‘Non-Han’. [↑](#footnote-ref-2)