The quadratic relationship between socioeconomic status and learning performance in China by multilevel analysis: Implications for policies to foster education equity

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The purpose of the present study is to explore the relationship between family socioeconomic status and mathematics performance on the base of a multi-level analysis involving a large sample of Chinese primary school students. A weak relationship is found between socioeconomic status and performance in the Chinese context. The relationship does not follow a linear, but a quadratic curve, implying that students from a disadvantaged family and higher socioeconomic background have a higher probability to attain higher mathematics scores. This can be explained on the basis of Chinese cultural beliefs about education, exams and social class mobility. Moreover, the aggregated socioeconomic status at the school level seems to moderate in the relation between individual SES and academic performance. This suggests that individuals from a disadvantaged family will achieve higher in the school with a higher family socioeconomic status than students who are enrolled in schools with a lower and average family socioeconomic status.

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1. Introduction

The relationship between socioeconomic status (SES) background and academic performance has received ample attention since the publication of the “Coleman Report” in 1966 (Coleman et al., 1966). Supported by a 150,000 student sample, the Coleman Report argues that students’ family socioeconomic status is much more important in predicting educational performance than are measured differences in school resources. A large body of empirical evidence is available about the relationship between SES and student performance in the context of the critical school subject of mathematics (Sirin, 2005; White, 1982). Findings in developed countries reveal that students with a high family SES perform better than students with a lower SES (Lee and Burkam, 2002; OECD, 2004; Wößmann, 2003). But, whether the relationship between SES and mathematics performance is different in other countries (developed or developing, with various cultural values) is still an open question when we consider contradictory research results (Baker et al., 2002; Heyneman and Loxley, 1982, 1983). As shown in the Third International Mathematics and Science Study (TIMSS), the influence of family socioeconomic status on educational performance is complex depending on the economical development level of a region (Schiller et al., 2002; Lockheed and Zhao, 1993). For example, it is argued that increasing economic development in the region may change the role of families and the educational stratification and its effect on performance (Baker et al., 2002). The complex situation brings us to the particular geographical context of the present study: China.

The question about the relationship between academic performance and students’ SES is central in discussions about educational quality improvement in China as a developing country. As a country with 9,596,961 km² area, the differences between developmental levels and the distribution of wealth varies heavily between different provinces (Brenner, 2001; Wang, 2003). Since the establishment of the P.R. China in 1949, governmental policies have resulted in a cultural context characterized by a high intergenerational mobility and a rapid urbanization (Deng and Treiman, 1997; Tamura et al., 1997). However, in 1949 China was faced with initially a poor population in both rural and urban areas (Chen, 2005). After the cultural revolution, the government adopted new policies that resulted in the development of a stronger economical and cultural autonomy in local regions from the late 1970s. In order to fight educational inequity, particular policies were installed to allow students from poor areas to have
access to better educational opportunities. From 1978, the “Gaokao” policy (China’s National Matriculation Tests Policies, NMTP) was re instituted to set a student’s achievement as the criterion for entrance to higher education (Agelasto and Adamson, 1998). Also, the increased possibilities for geographical mobility helped to fight unequal access to education. However, inequity between different provinces continues to exist because of differences in resources, transport conditions, etc. The Chinese government continues to make efforts for balancing the developmental levels of all regions and adopted this as a long term goal (Ministry of Education, MOE, 2010; Zeng et al., 2007). For example, considering the gap between educational opportunities in rural and urban areas, the government adopted the “Decision on Reforming and Developing Basic Education by State Council” (MOE, 2001, 2008). This resulted in closing down small primary schools with only three grades and with weak resources (called “jiaoxue dian”) and integrating them into bigger schools (called “zhongxin xiao”). These continuing efforts to fight educational inequity make it very interesting to explore the relationship between SES and student performance in mainland China and to focus on the impact of different development levels within the same culture.

In the Chinese context, available studies about the relationship between SES and performance have mainly focused on Hong Kong and Macau; regions with a rather high level of economic development (Liu and Lu, 2008; Park and Hannum, 2001). The limited available empirical studies on mainland China reveal that – when controlled for other factors – a higher family SES background has a positive but lesser impact on performance (Liu and Lu, 2008; Xue, 2007; Zuo, 1994). In their multiple regression analysis, Liu and Lu (2008) found that SES only explains 0.8% of student performance. Also, some studies point in particular at the impact of the educational level of the father having a significant positive relationship with mathematics performance (Park and Hannum, 2001). Other studies point at the decisive impact of the educational level of the mother (Park and Hannum, 2001). However, there are limitations to previous studies set in mainland China: samples were rather small or did not represent a variety of developmental regions/provinces; the SES indexes remained restricted, and the interaction between individual SES and school average SES was hardly considered.

In the present paper, we center on the mainland Chinese context to set up a comprehensive empirical study, while trying to further develop educational theory. This brings us to the research aims of the present study: (a) to construct a comprehensive SES index drawing on previous studies; (b) to explore the general relationship between SES and mathematics in P.R. China, considering different developmental levels of the region; and (c) to analyze the extent to which aggregated SES at the school level influences student mathematics performance, regardless of students different individual SES levels. The study builds on data gathered from 10,959 Chinese pupils enrolled in schools that are geographically located in five Chinese provinces with different economic developmental levels. The data used in the present study were gathered during a project, funded by the BOF (Bijzonder Onderzoeksfonds, meaning Special Research Funding) Project ‘Mathematics Education in China’ of Ghent University (Belgium). We collected the data from 20 schools in five Chinese regions in close collaboration with researchers from the Educational Bureau of Beijing Normal University and of South China Normal University.

2. Theoretical background

2.1. Measuring socioeconomic status

The way to define and measure socioeconomic status (SES) has changed a lot during recent years (Entwisle and Astone, 1994; McLoyd, 1998). As can be derived from Table 1, a variety of variables have been used in the literature to develop SES indexes. In the 1980s, SES indexes stressed family income, father’s educational level, mother’s educational level, and father’s occupational status or occupation type (White, 1982). In later studies, additional variables were added; such as home resources (Sirin, 2005), home atmosphere or context, number of books in the household, and other resources related to learning (Caldas and Bankston, 1997; OECD, 2004).

Since the 1990s, in addition to the individual students’ SES, aggregated SES measures also were developed to consider the impact at the level of the school and related contexts. This resulted in additional indexes, such as school SES-level and neighborhood SES-level (Brooks-Gunn et al., 1997; Sirin, 2005). The adoption of aggregated indexes is not generally accepted. Some researchers report that when family SES is controlled for, neighborhood SES only plays a minor role (Duncan et al., 2001; Sanbonmatsu et al., 2006).

Although available SES indexes seem to vary, most SES constructs seem to incorporate the following variables: parental educational level, parental occupation and home resources or wealth. Consequently, we also adopt this approach in the present study.

2.2. Varying impact of SES on mathematics performance

2.2.1. Family SES and academic performance

In the literature, family SES is consistently found to be a single strong predictor of educational outcomes (Fransoo et al., 2005). To explain this, researchers argue that parents from families with a low SES are less involved in their children’s schooling and give less support to the children as compared to parents from families with a higher SES, resulting in low academic achievement (Ho and Willms, 1996; Jeynes, 2003; Silinskas et al., 2010). Recently, the meta-analysis of both White (1982) and Sirin (2005) reveals that the direct relation between socioeconomic status and performance

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Overview of the variables constituting recent SES indexes.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authors</strong></td>
<td><strong>Individual</strong></td>
</tr>
<tr>
<td></td>
<td>Parental education</td>
</tr>
<tr>
<td>White (1982)</td>
<td>(\checkmark)</td>
</tr>
<tr>
<td>Duncan et al. (1994)</td>
<td>(\checkmark)</td>
</tr>
<tr>
<td>Brooks-Gunn et al. (1997)</td>
<td>(\checkmark)</td>
</tr>
<tr>
<td>Caldas and Bankston (1997)</td>
<td>(\checkmark)</td>
</tr>
<tr>
<td>Baer (1999)</td>
<td>(\checkmark)</td>
</tr>
<tr>
<td>Louis and Zhao (2002)</td>
<td>(\checkmark)</td>
</tr>
<tr>
<td>Sirin (2005)</td>
<td>(\checkmark)</td>
</tr>
<tr>
<td>OECD (2004) for PISA report</td>
<td>(\checkmark)</td>
</tr>
<tr>
<td>Olson et al. (2007) for TIMSS report</td>
<td>(\checkmark)</td>
</tr>
</tbody>
</table>
might be less strong as supposed. White's meta-analysis claimed that his meta-analysis reveals that the average correlation is .29 (studies set up between 1918 and 1975), while Sirin's meta-analysis claims a correlation value of .34 (studies set up between 1990 and 2000). They focus in their analysis on large within-group differences when studying the relationship between SES and performance. They also stress that the impact of family SES on performance differs largely depending on the economic development level of the region or country. Economical differences tend to result in different regional and school educational policies.

2.2.2. SES and performance: the moderating effect of school aggregated SES variables

In this context, little is known about how school level variables in a specific region moderate between family SES and mathematics performance (Peng and Hall, 1995). Previous studies show that higher levels of an aggregated school SES are related to an increase in student performance and in students with a different level of family SES (Perry and McConney, 2010). Researchers argue that the acquisition of values and goal-orientations within schools and the combined effect of students' attributes contribute to the changes in performance of all students (Alexander et al., 1979; Haller and Woelfel, 1972). In addition, other researchers stress that specific classroom variables mediate between SES and performance (Ayyyy et al., 2007). The latter explanation is adopted to refer to poorer student outcomes in rural schools as compared to schools in urban or suburban regions (Webster and Fisher, 2000). These authors explain that the geographical isolation and lower economical development restrict access to learning materials and other educational resources. Additionally, the developmental level of the region where schools are located can result in more or less advanced governmental educational policies (Marks, 2006). At present, hardly any empirical evidence is available to test the interaction between school SES and learners’ SES in the Chinese context (Liu and Lu, 2008).

3. Method

3.1. Sampling

In this study, mathematics performance data were obtained from 10,959 students, enrolled in grade one to grade six, from 20 schools. A multistage stratification sampling procedure was followed. These 20 schools are located in five Chinese regions reflecting different development levels; and are located in both rural and urban settings (see Table 2). Total school enrolment ranged from 318 to 897 students (M = 547.95, SD = 140.19). Sampling strata were based on the location of the school in a specific region. Within a school, grade level classes – in case parallel classes were present – were randomly chosen by the researchers after negotiations with the school principals. In total, 51.88% of the learners are male, 53.14% are enrolled in urban schools. Five economical development levels are distinguished, based on data about the regional gross domestic product (GDP). As a result, distribution of pupils in these regions is as follows: 27.58% in level 1, 15.07% in level 2, 19.88% in level 3, 16.22% in level 4 and 21.24% in level 5, respectively.

3.2. Variables

3.2.1. Dependent variables

3.2.1.1. Mathematics performance level. The items constituting our mathematics performance test were taken from a previous study in which a new mathematics test was developed, aligned with the most recent 2001 Chinese mathematics curriculum. The test, covering the mathematics curriculum from grade 1 to grade 6, was calibrated on the basis of item response theory. The design, development and calibration, involving 10,959 primary school learners, was carried out in May till November 2008. All the items and cases were calibrated on a continuum scale ranging from grade one to six. Reliability of the scales (Cronbach’s α) was reported to be high: for grade one to grade six respectively .94, .96, .95, .94, .94 and .93. Reported means are: – 1.24, –.89, .05, .18, .69, and .83. Mathematics standardized performance scores range from – 5.30 to 3.30 (M = .57, SE = .26).

3.2.2. Independent variables

3.2.2.1. Individual learner’s level SES. Based on our literature review, eight items were developed to collect data about SES indicators: father educational level, mother educational level, father’s job, mother’s job, ownership of a TV, refrigerator, washing machine and computer. In order to create a generic SES index, factor analysis was carried out including the eight SES-related items by programme Mplus 5.1. Information about the parents’ background was obtained from the schools with the support of the Educational Bureau. Information about wealth indicators was obtained via a questionnaire filled out by the parents.

In a first step, an exploratory factor analysis (EFA) was carried out by applying the WLSM method, able to deal with categorical data (Mplus5.1). The results suggest a two-factor structure in the SES variable. But, weak factor loadings were observed for both father and mother’s educational level; moreover these SES items loaded on both factors. They were therefore excluded from the further analysis. In a second step, a confirmatory factor analysis was carried out building on the two-factor solution. This two-factor structure resulted in satisfactory goodness-of-fit indexes (χ² = 158.45, df = 8, p-value < .00, CFI = .98, TLI = .97, RMSEA = .04). A first factor grouped SES variables focusing on parents’ occupation status; a second factor groups SES variables in relation to family wealth.

Table 2

<table>
<thead>
<tr>
<th>Grade</th>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
<th>Grade 6</th>
<th>Total</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>903</td>
<td>883</td>
<td>872</td>
<td>854</td>
<td>845</td>
<td>917</td>
<td>5274</td>
<td>48.12%</td>
</tr>
<tr>
<td>Male</td>
<td>954</td>
<td>972</td>
<td>933</td>
<td>977</td>
<td>906</td>
<td>943</td>
<td>5685</td>
<td>51.88%</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>869</td>
<td>863</td>
<td>874</td>
<td>838</td>
<td>836</td>
<td>855</td>
<td>5135</td>
<td>46.86%</td>
</tr>
<tr>
<td>Urban</td>
<td>988</td>
<td>992</td>
<td>931</td>
<td>995</td>
<td>913</td>
<td>1005</td>
<td>5824</td>
<td>53.14%</td>
</tr>
<tr>
<td>Total</td>
<td>1857</td>
<td>1855</td>
<td>1805</td>
<td>1833</td>
<td>1749</td>
<td>1860</td>
<td>10959</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Note a: Since the data have been collected from students and schools in urban and rural areas within five regions with different GDP levels, the indicators of urban/rural, and GDP were added from the start to the model. However, these variables at this additional level did not contribute in explaining variance in the model (Zhao et al., in press).*  
*Note b: The data was collected from pupils enrolled in the six primary school grades. It can be hypothesized that the influence of SES might be different according to the grade (Chiu and Ming Ming, 2010). Therefore, the interaction between grade and family SES was added to the model. This did not result in a significant improvement of the model. As a result, grade is not considered as a critical variable in the subsequent analyses.
Finally, according to the results of the factor analysis, a generic SES index was calculated, combining the items of the two factor structure: (1) learners’ SES based on their parents’ jobs; (2) learners’ SES based on the family’s wealth. And two independent variables: (3) parents’ educational level, including father educational level and mother educational level.

Parents’ educational level: Prior research about student achievement in primary schools has shown that father’s (FEL) and mother’s educational level (MEL) influence learners’ achievement (Alwin and Thornton, 1984). Parental educational level was coded as: no schooling experience (1), primary school graduate (2), junior school graduate (3), senior school graduate (4), pre-high school (5), high school graduate (6), and postgraduate or higher (7). This categorization fits educational levels resulting from the Chinese educational system.

Family SES_Job (FSES_J): With support of their parents or teachers, learners reported their parents’ job. These answers were coded into 26 categories (26 = highest level ranking) that reflect the classification scheme of Li (2005a,b) (see Appendix A). Her research was based on the Chinese context and provided a national valid estimate of job levels by using the calculation adopted in Lin’s studies (Lin and Xie, 1989; Lin and Ye, 1997). This is a higher number of levels as compared to the study of Xu (2000) study. Compared to Lu’s (2001) studies with 10 job levels, Li’s study provides more detailed information about the jobs and as such fits better with our study. The Spearman correlation between the ranking of Li (2005a,b) and Lu (2001) is .97 (p < .00), reflecting a high correlation between existing ranking/coding systems.

Family SES_J_Record: In view of some analyses (see Section 4.3), the job levels have been recoded into three categories, building on the distribution in job levels: lower 25%, middle 50% and higher 25% with the codes of FSES_J_low job group, FSES_J_middle job group and FSES_J_high job group, respectively. This will make it possible to study the interaction between individual level SES variables and aggregated school level SES variables.

Family SES_Wealth (FSES_W): This variable builds on the answers to four questions about wealth indicating property: ownership of a television, a refrigerator, a washing machine, and a computer.

Family SES_Wealth_Record (FSES_W_R): In view of analyses about interaction effects (see Section 4.3), this variable was also recoded into three categories, building on the distribution in ownership of the four different wealth indicators: lower 25%, middle 50% and higher 25% with the codes of FSES_low wealth group, FSES_middle wealth group and FSES_high wealth group, respectively.

3.2.2.2. School level SES. Two aggregated SES indexes were calculated at the school level: (1) the average parent’s socioeco-

nomic status of the learners attending this school, based on the father’s and mother’s occupational level (SCFSES_J) and (2) the average level of wealth of the children’s family in the school (SCFSES_W).

3.3. Data analysis

First, as explained above, both an exploratory (EFA) and confirmatory factor analysis (CFA) were carried out to develop fitting SES indexes (Mplus by WLSM methods).

Second, a multilevel analysis was applied to study the impact of variables at the school, class and student level on mathematics performance. Multilevel linear modeling overcomes major short-comings of single level regression analysis. Firstly, multilevel regression builds on iterative generalized least squares (IGLS) techniques to estimate the direct and cross-level effects for the hierarchical data. This is in sharp contrast to Ordinary Least Squares (OLS) regression techniques that overestimate the contextual and cross-level variables, and consequently are prone to Type I errors (Aitkin et al., 1981; Rowe, 1992). Secondly, multilevel regression allows us to estimate the fixed part and random effects to explain the variance in a model. Thirdly, multilevel analysis helps – in the present context – to study the influence of SES on mathematics performance considering school SES and the regional economical level.

4. Results

4.1. Descriptive analysis

In Table 3, we summarize the bivariate correlation coefficients reflecting the association between all variables in the present study (Kendall’s tau). The correlations between mathematics performance and parents’ occupational level (FSES_J, SCFSES_J) and family’s wealth (FSES_W, SCFSES_W) underscore the decision to include these variables in relation to the SES index. We observe strong correlations between the other variables in the study: SCFSES_J and SCSES_W (r = -.80), FEL and MEL (r = .63), FSES_J and FSES_W (r = -.59). Though the large correlation variables raise concerns about multi-collinearity, we decided to include these variables in the regression model. But, by entering and removing the variables one by one, we are nevertheless able to control the interaction between predictors.

4.2. Multilevel analysis of the relationship between SES variables and mathematics performance

4.2.1. The weak relationship between SES variables and mathematics performance

In this section, we focus on the model 0 to model 6 in Table 4. In Table 4, model 0 points at the null model without any predictors in the multilevel analysis. In total, 18.55% of the overall variance is explained by the school level, 39.52% of variance is explained at classroom level and 41.94% of the variance is explained at the individual learner level. The analysis results also reveal that the variance at these three levels is different from zero; implying that a three level multilevel analysis should be applied. In a first step,

<table>
<thead>
<tr>
<th>Variable</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Mean, σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH</td>
<td>.041**</td>
<td>.032**</td>
<td>.164**</td>
<td>.157**</td>
<td>.097**</td>
<td>.084**</td>
<td>.567 (1.113)</td>
</tr>
<tr>
<td>FEL</td>
<td>.702**</td>
<td>.373**</td>
<td>.353**</td>
<td>.387**</td>
<td>.323**</td>
<td>.3963 (1.417)</td>
<td></td>
</tr>
<tr>
<td>MEL</td>
<td>.370**</td>
<td>.952**</td>
<td>.486**</td>
<td>.492**</td>
<td>-.077 (1.375)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCFSES_J</td>
<td>.462**</td>
<td>.515**</td>
<td>.016 (1.65)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCFSES_W</td>
<td>.624**</td>
<td>.070 (2.828)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FSES_J</td>
<td>-.014 (3.19)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FSES_W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: p < .001.

MATH refers to the mathematics performance; FEL and MEL refer to father and mother education level; SCFSES_J refers to the aggregated indicator of parents’ occupation in school level; SCFSES_W refers to the aggregated indicator of parents’ wealth in school level; FSES_J refers to the indicator of parents’ occupation of family SES; FSES_W refers to the indicator of parents’ wealth of family SES.
father's educational level and mother's educational level were entered into the model. Compared to the null model, there is no significant improvement between models 1 and 2 after adding father's and mother's educational level (see Table 4; $x^2 = .225$, $df = 1, p = .635$; $x^2 = .005$, $df = 1, p = .944$).

Secondly, the indicators of parents' job level ($FSES_J$) and indicators of wealth ($FSES_W$) were entered in a subsequent model. As shown in Table 4, there is a significant improvement of the model 3 when the linear variable of indicator of parents' job ($FSES_J$) is added to the model. A second-order polynomial regression of parents' job ($FSES_J$) on mathematics performance reveals a highly significant U-shape relationship (see model 4; $x^2 = 12.936$, $df = 1, p < .001$).

Similarly, when a linear and 2-order polynomial function of indicator of family wealth ($FSES_W$) is conducted, the model of 5 and 6 improves significantly. Considering the polynomial variable family SES of parents' job, the linear variable of family wealth ($FSES_W$) significantly improves the model in model 5. When the two-order polynomial of family wealth ($FSES_W$) is added to model 6, this results also in a significant improvement from model 5, although the coefficient of the linear variable of family wealth ($FSES_W$) is now no longer significantly different from zero.

Though – consistently – a significant improvement in consecutive models can be observed, these models only account for 0.41% of the variance in mathematics performance at the individual learner level ($\chi^2 = .486$ vs. .484) (compare model 0 to model 6 in Table 4). This implies that the SES variables under study are not strong predictors of mathematics performance in primary school after controlling for school level variables.

### 4.2.2. The U-shaped relationship between SES variables and mathematics performance

Another interesting finding from our study is the U-shaped relationship between SES variables and performance in the
primary school. The relationship between mathematics performance and SES was not studied as a linear function, but as a quadratic one.

**Fig. 1** shows that the relationship between SES and mathematics performance is U-shaped. We observe that children with a higher mathematics performance can come from a higher family SES level or lower family SES level while the children with a very weak mathematics performance can also come from a middle SES family. Previous research in the Chinese setting stressed a linear relationship between family SES and mathematics performance (Chiu and Zeng, 2008). The present results are in conflict with these findings. However, the reason might be that the previous studies did not explore polynomial relationships. As *Fig. 1* shows, the results with the Chinese students reveal a different pattern: students with higher and lower family SES achieve higher as compared to students from a middle family SES background.

It is interesting to develop a better understanding of what these SES levels represent. We center first on the 2920 students who are expected to belong to the lowest 25% in math performance considering their parents' occupation. Their parents' job level (FSES_J) ranges from −3.729 to −1.656. About 45.34% of these parents are both workers (rank 19 in Appendix A) while 28.42% of these parents are both peasants (rank 21). The latter families represent more than 80% of the families in China (Li, 2005a). The present results reiterate an urgent problem for the government, since the children of this large group face a risk to attain a lower math performance level.

Second, we focus on the performance of students from the families with the 25% lowest SES considering the parents’ occupation (worker, peasant, bodily labor worker, servant and unemployed). As we can derive from *Fig. 1*, this is a rather small sample in our study (n = 472). A surprising result is found. These students achieve higher than students from a family with an average family job level. Nevertheless, these students are expected to attain means of .53 in mathematics performance which is still very weak compared to the higher achievers.

When we focus on the other SES component of wealth (FSES_W), we hardly distinguish varying levels in ownership of wealth indicators. Considering students with the lowest 25% performance, around 95% of these students’ family own a TV, refrigerator, washing machine and computer. For students attaining a score within the group of the highest 25% in mathematics performance, also these families own only one or two of these typical wealth equipments.

Students from families with an higher level of ownership of wealth indicators, have a larger probability to attain lower mathematics scores as compared to other students. Students with a relatively high family SES have fairly good family situation. It is conjectured that families with a higher SES background provide sufficient support for learners; such as a richer learning environment or a higher level of parent involvement in school related activities. Although students from a disadvantaged family SES background might receive less learning support from their parents, they nevertheless struggle to achieve better in primary school in order to compensate for their disadvantaged family situation. While attaining a higher performance level, these students can counter their disadvantaged family background and potentially attain a higher status in society. This can motivate them to learn harder and achieve higher from the start of the primary school. However, the short tail in *Fig. 1* also reveals that the final attainment level of learners at the lower side of the FSES_J axis will never be as high as the performance of learners belonging at the upper side of the FSES_J axis. This implies that the students with lowest family SES do not attain the same performance level as students with the highest family SES.

4.3. SES and mathematics performance: the moderator effect of school level aggregated SES indexes

4.3.1. The stronger effect of school level of FSES_J on mathematics performance

In this section, we focus on the model 7 to model 9 in *Table 4* that centers on the interaction between school effects and family effects on mathematics performance. When comparing model 6 with model 0 in *Table 4*, approximately 0.77% of the variance at the class level and about 0.41% variance at the school level is explained by SES related variables. Family SES seems to play a different role in these two models. This underpins the relevance to add an aggregated family SES variable to the models. In the models 7–9 in *Table 4*, we added the mean family SES level of pupils in the same school to the equation.

The average SES at the school level can impact student performance in a variety of ways. For instance, school administrators can make different efforts to improve conditions for learners with a disadvantaged SES background. Or, learners affect each other by bringing a richer cultural capital into the classroom, because of the language they speak, because the experiences they share, etc. In the multilevel analysis, both school level SES variables and learner level SES indicators will therefore be considered as predictors in the model. As can be derived from Table 4 (model 7), adding the school level SES variable – based on wealth indicators – does not result in a significant model improvement ($x^2 = 3.369$, $df = 1$, $p = .066$). But entering the school aggregated SES variable – based on the students’ parents’ job – does significantly improve the model ($x^2 = 4.301$, $df = 1$, $p = .038$). In model 8, about 18.06% variance at the school level is explained by the average SES of parents’ job at the school level. More concretely, in model 8, mathematics performance increases by .160 units when the FSES_J at school level increases with one unit. To summarize, when means of SES at school level are entered into the models, about 22.02% of the total variance in mathematics performance can be explained (.227 vs .177 see model 8 in *Table 4*) at the school level.

4.3.2. The moderator effect of school SES on mathematics performance

In this next step – while focusing on parents’ job level – we consider the interaction between school level SES and learner level SES. As explained earlier, for this purpose the SES indicator based on job level was recoded into three job levels: 87.78% of the students in the FSES_J low job group have parents with a job being lower than worker (rank 19); and, 83.67% of the students in the FSES_J high job group, have a father with a job higher than a less professional experts (rank 13, see Appendix A) and a mother with a job ranking from 4 to 26 (see Appendix A).

In model 9, the interaction between school aggregated SES and the recoded learner level variable is added. This results in a further significant improvement in model fit ($x^2 = 12.173$, $df = 2$, $p = .002$). As *Table 4* reveals, compared with learners from an middle SES family background, the interaction coefficient for learners from low SES family is −.043, being significantly different from zero in model 9. The interaction between school level SES and learner level SES based on parents’ occupation can also be represented in a graphical way.

**Fig. 2** shows how the mathematics performance of learners with a different level of SES, based on their parents’ job levels (recoded in three categories), varies according to the aggregated SES variable at school level.

The vertical axis represents a student’s math performance while the horizontal axis refers to a schools’ average SES. We focus in this figure on different students that study in a school with the same average school SES. These three students differ in their family SES (L, M, H representing a lower, middle or high family SES). The results are clear. Although the three students study in a school with
the same average family SES index, the student L with a lower family SES attains a lower mathematics performance as compared to student M with a middle high family SES. The latter attains a lower mathematics performance as compared to student H. The reverse is true when we consider the results from students in a school with an average SES score that is lower than .00. Students with a lower family SES outperform both students with a middle and high family SES.

The differences in the slopes of learners with a low, middle or high SES, based on their parents' job level, show the moderating effect of schools on individual learner’s family SES levels. The slope of the disadvantaged group with lower individual family SES is less steep as compared to the middle group and the advantaged group. This implies that the moderating effect is stronger for learners with a higher individual SES compared to the other two types of learners while increasing with the school's aggregated SES.

However, Fig. 2 only shows an ideal situation. In reality, – since the school level aggregated SES is based on the means of the learners’ family SES – schools with a lower SES will hold more students with lower family SES and vice versa. This implies that the analysis should be further refined to cater for the inequal representation of the different SES levels. This results in a revised version of the depiction as represented in Fig. 3. It is clear that the proportions of learners with a specific family SES group level are different in schools.

In Fig. 3, the slopes of the different groups of learners – considering their parents' job level – seem to partially overlap. When students with a lower SES family and students with an average SES family are enrolled at a school with a comparable aggregated SES, learners with a lower SES will attain higher mathematics score as compared to the learners with an average SES level (see Part A in Fig. 3). In contrast, when learners with a higher SES family and learners with an average SES family enter the same school, learners with a higher SES family will attain higher mathematics scores than the learners with a average family (Part B in Fig. 3). The higher the school aggregated SES, the higher performance of learners with a higher family SES. In general, these results replicate the quadratic relationship between SES and mathematics performance as discussed before.

5. Discussion and conclusions

5.1. Does the U-shape relationship between SES and mathematics performance result from governmental efforts or is it the artifact of cultural-historical variables? Implications for policies focusing on disadvantaged individuals

Building on the present research results, it is interesting to observe that SES of individual learners is not a strong predictor for mathematics performance in primary school. This is in line with other studies, set up in the Chinese context (Liu and Lu, 2008). But, this is clearly in contradiction to the findings in international studies (Fransoo et al., 2005; Huang, 2010). This means that learners with a lower and higher SES achieve better as compared to learners with a middle SES level. It is to be stressed that the latter group especially comprises learners with parents who are workers and peasants.

A variety of rationales can be presented to explain these specific findings within the Chinese context. First, we can refer to Confucian cultural values that play a role. A basic value embedded in Confucian culture encourages children to learn hard and work hard in order to attain a better position in society. This results in generational class mobility, and builds on a – hundred years old – tradition that students are selected on the base of their level of academic performance and not on their family background, also referred to as “Keju” (Entrance Examination for higher education). Whatever a student’s family background, students will get an opportunity at a higher occupation/job pending a high performance in examinations.

In contemporary society, this situation is still clearly observed in the time and effort spent for e.g., National Matriculation Tests Policies (“Gaokao”). Sociological studies reveal that in China there is an unusually high degree of generational and occupational mobility, and “openness” of the society (Blau and Ruan, 1990; Kracke, 1947; Parish, 1981; Wu, 2007). After 1949, the government carried out equity promotion policies for farmers and workers to break the barriers in generation and class mobility. These policies decreased the reproduction of the generation-locked occupational levels (Deng and Treiman, 1997; Lin and Bian, 1991). This openness in mobility encourages students with a disadvantaged family
background to achieve better in schools in order to attain a higher occupational level. This particular motivational impact on learning has also been reported by other studies; e.g., researchers report that the achievement motivation of Chinese students is higher as compared to the motivation of Western students (Biggs, 1997; Ginsburg and Bronstein, 1993). This cultural value and the subsequent adoption of compensatory policies seem to promote equity in society. Thus, the Chinese students seem to value schooling; though there are variation between the different type of students (Maslak et al., 2010). Anyhow, while claiming that cultural-historical variables play a role in relation to the U-shape in our results, we also have to recognize that Chinese governmental policies fostered a relative openness in society that maintains this cultural spirit. For example, the “Gaokao” examination policy in relation to the secondary education exams, continues to value learning performance of students with whatever family background (Li, 2009).

Although the cultural values and political policies can have a positive impact, it remains nevertheless clear that disadvantaged students still run a higher risk to encountering attainment difficulties. As we can derive from Fig. 1, a group of students performing well are from families where both parents only have a low physical labor job. On the one hand, without the academic support of the school and the parents, it is difficult to assure that these students continue to perform well during further education, such as middle schools, secondary schools and university. They might nevertheless meet learning difficulties or problems during a further phase in their school career. On the other hand, students who succeed to graduate from the university might also meet some problems in their “Quan Mian Fazhan” (education should be concerned with the full development of the students, such as intellectual, moral, physical, aesthetics and labor development, not only develop intellectual dimension and ignore the others) or “Gao Fen Di Neng” (higher performance in school but low ability to live in society). Academic performance is only one part of being prepared for future life. Governmental policies should pay more attention to these students at risk and provide continuous support. This is reflected in the “Planning of Mid-Long Term Education Reform and Development Program (2010–2020)” (CPC and State Council, 2010). The government highlights educational equity as a key principle and it promises that by 2020 the quality of compulsory education will be the same in all regions, ensuring that all school-aged children and adolescents have equal access to high quality education. Also, no child shall be allowed to drop out due to family related financial difficulties.

5.2. The impact of the school background and family background: implications for school development policies

The present study observed a very interesting moderating effect between school aggregated SES and individual family SES. But what level is predominant in this setting? This is difficult to answer, since the interaction seems to be complex. Compared to students with an average family SES background (reference group), students with a disadvantaged family SES background benefit more from their school setting as compared to students with an average family SES background. In a comparable way, students with a higher family SES background also benefit more from their school as compared to students with an average family SES background. This finding is in line with the results of previous studies claiming that school-level variables could account for an important part of the students’ achievement in primary schools (McEwan and Trowbridge, 2007). About 22.03% (227 vs. 177) of the variance at the school level can be explained by the school mean SES. This finding reconfirms that students with a disadvantaged family SES background can and should be supported with rich school resources and by their school peers. This is expected to result in a positive school climate that fosters learner motivation.

How does the school play such an important moderator role (See Fig. 4)? Building on a case, we can illustrate the above by considering on mathematics performance of learners from school 524 where a strong improvement in mathematics performance is observed in disadvantaged students. School 524 has developed in the aftermath of the “Decision on Reforming and Developing Basic Education by State Council” (MOE, 2001, 2008). In order to narrow the developmental gap between learners from rural and urban areas, the Ministry of Education decided to reconstruct district schools (in Chinese called “Ce Dian Bing Xiao”, that stops small primary schools and creates larger primary schools having more resources). In earlier days, in rural areas, small schools were set up that catered for rural students and only organized education for grades 1–3 (called “Jiaoxue Dian”). Building on the reform mentioned above, rural schools were redevelop into large rural schools. School 524 is an example of this endeavor. The Chinese government additionally invested in these schools. Although this reform also resulted in some problems (e.g., a raise in the fee for boarding in a larger school), these new schools have resulted in the improvement of academic performance of students with a disadvantaged SES family background (see Liu et al., 2010). Cases reflecting the impact of a higher average SES school level, are found in schools that have a stronger impact on performance of students with a higher individual SES background. Typical examples of these schools are school 333, 332, 612, 811 and 611 (See Part B in Fig. 4). These schools have a longstanding history and are mostly positioned in an urban setting. The process of urbanization in China has accelerated during recent years. This resulted in a massive transfer of labor forces from rural to urban contexts; additionally resulting in an improvement of family conditions. But, this does also cause a wider heterogeneity within schools in urban settings. In the present study we did not control for this within-country migration process and did therefore not ask whether students were from the local area or had migrated with their parents.

5.3. Conclusions, limitations and directions for future research

The present attempt to explore the relationship between the family socioeconomic status and mathematics performance resulted in particular results about the Chinese setting. Although studying the interrelation between SES and academic performance in primary schools is not new, the results of the present study differ in a number of ways from the results of available research. First, the quadratic relationship between SES and mathematics performance
is a particular finding that can partly be explained by particulars of the Chinese culture and educational policies. Moreover, our study explored the additional impact of school aggregated SES variables.

The present study also reflects some limitations. Firstly, the analysis approach was correlational in nature and thus cannot ground assumptions about causal directions between SES and mathematics performance. Also, the moderator impact of the school context cannot be explored in detail considering the correlation between school context and student family SES level. Another limitation is that the study did not focus on variables such as beliefs, attitudes or other motivational variables that are also mediators between family SES and mathematics performance. In the future, it is therefore interesting to study additional variables and to enter them in more complex multilevel models to explain mathematics performance.

Future research could also center more in detail on particular subgroups in the current large sample of learner: top performers versus weak performers in different school settings and how SES variables are impacted by contextual variables. The results bear clear policy implications in view of supporting students with disadvantaged family background. Firstly, we observe a complex combination of the ideological control approach resulting from communism, with the Confucian “guanxixue” and a tendency towards paternalism. This results in a new governance approach that protects the elites’ interest (Yi, 2011). This approach does not cater for the interest of the 80% of the population’s children that only attain a floor performance level. Considering the U-shape relation between SES and performance, more compensatory policies centering on students from disadvantaged families should be developed within schools, especially in urban areas where a larger gap is observed in family gains. The same applies to children from migrating families who are relocated in urban areas and suffer due to lack of schooling whereas they have the potential to achieve higher performance. Considering the huge level of urbanization in China, students from migrating families or with peasant-labor parents should be supported by special policies. Secondly, based on our observations about the moderating school effect, more policies should be issued that foster the development of “quality education” throughout all schools. While the “Key school policy” – established in the late 1970s – was efficient in making good use of limited resources at the start of China as a developing and poor country (Organization of Educational Yearbook in China, 1984), it is now time to introduce policies that balance the distribution of educational resources.

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Appendix A

Coding of career levels by Li (2005a,b).

Actually, in Li’s ranking, the first rank is the highest level. But in order to adopt a comparable vector direction as in other indexes, the reverse value in rank of a career level was computed (26 = highest to 26 = lowest) in the paper.

1. Official with high position in government
2. Professionals, such as professor or scientist
3. Official of the middle position in government, dean or head
4. Manager of enterprise, rector of the hospital or rector of the newspaper, or headmaster
5. Cadre in government of enterprise
6. Professional, such as the reporter, lawyer or teacher
7. The manager of the company and the manager in middle position
8. The staffs in police, law-office, judiciary, business administration, tax administration, such as policeman
9. Average staffs in the government of enterprise
10. The professional in the middle of hospital, engineer, economy
11. The owner of the company
12. Managers with the middle position in the enterprise or company, such as the manager of the workshop or the head of the factory
13. The professional with middle or lower position: nurse, technical worker, primary teachers, teachers in kindergarten
14. The staffs such as the lower level secretary or accountant in the enterprise
15. The staffs such as the cleaner, managers, operation person
16. The technical person who in the rural, such as the veterinarian, doctor in rural
17. The owner of the little store or private company
18. Staffs for service of business and service company, such as driver, barber, mail carrier
19. Worker, such as the workers in manufacture, include all the technical or not
20. The farmer: such as the fruit farmer or the fish farmer
21. The normal farmer and the fisher
22. Private worker, such as the butcher, packman, shoe-maker
23. The labor, porter (hammal), prospector, builder
24. Babysitter, servant
25. Loss of job
26. Unemployed

References


