ISSN: 2148-9955

International Journal of Research in Education and Science (IJRES)

www.ijres.net

Participation Patterns and Effectiveness of Out-of-School Time Mathematics Classes

Ming Yin
Rice University, United States of America

To cite this article:

Yin, M. (2020). Participation patterns and effectiveness of out-of-school time mathematics classes. *International Journal of Research in Education and Science (IJRES), 6*(3), 501-520.

The International Journal of Research in Education and Science (IJRES) is a peer-reviewed scholarly online journal. This article may be used for research, teaching, and private study purposes. Authors alone are responsible for the contents of their articles. The journal owns the copyright of the articles. The publisher shall not be liable for any loss, actions, claims, proceedings, demand, or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of the research material. All authors are requested to disclose any actual or potential conflict of interest including any financial, personal or other relationships with other people or organizations regarding the submitted work.

International Journal of Research in Education and Science
Volume 6, Issue 3, Summer 2020 ISSN: 2148-9955

Participation Patterns and Effectiveness of Out-of-School Time Mathematics Classes

Ming Yin

Article Info

Article History

Received:
07 March 2020

Accepted:
19 June 2020

Keywords

Out-of-school time
Mathematics
Participation patterns
Effectiveness
Shanghai

Abstract

Although shadowed by the institutionalization of contemporary schooling, out-of-school time and space encompass a variety of learning possibilities and are socially organized to enable and maintain educational privileges for some students but not for others. Out-of-school time (OST) curricular instructions have been expanding globally and more visible in East Asia. Relying on multilevel ordered logistic regression and generalized propensity score analysis; this study investigated the participation patterns and effectiveness of OST mathematics education in Shanghai, China. Family socioeconomic background and opportunity-to-learn indices of mainstream schooling were found to strongly link to participation in OST mathematics education. Higher socioeconomic status and more household resources were associated with higher likelihood of participating in OST mathematics education. Negative school-level opportunity-to-learn indices, such as problematic classroom disciplinary climate and insufficient mathematics instructional time, correlated with greater odds of OST mathematics participation. In addition, this study found a significant relationship between OST mathematics learning and mathematics study behaviors, with higher intensity of OST mathematics instruction triggering more positive study ethics and habits. Yet, no significant association between OST mathematics education and PISA mathematics achievement was identified. These findings profoundly illuminated the multi-layered interconnections between formal schooling and OST education and contributed to the discussions about structures of educational equality during out-of-school time.

Introduction

Schooling has been the most common time and space for learning, but the true definition of education reaches beyond that (McCombs, Whitaker & Yoo, 2017). Generated by growing student population and heightened competition in education, out-of-school time (OST) learning emerges to offer curricular and non-curricular educative experiences for students when they are not in schools (McCombs, Whitaker & Yoo, 2017). OST learning is mostly achievement (or examination) oriented, fee-based (either family funded or government subsidized), and organized by families, communities, or specialized companies and organization (Bray & Lykins, 2012; Park, Buchmann, Choi & Merry, 2016). Similar to the significance of schooling, out-of-school time and space of learning is socially produced and producing, organized to enable and maintain educational privileges for some students and families but not for others (Gadsden & Dixon-Román, 2016).

OST curricular learning has become a global phenomenon, so much so that it is rapidly growing as an institutionalized part of education in a wide array of societies. The private dimension of OST curricular instructions is often referred to as shadow education in the field of comparative and international education (Baker & LeTendre, 2005; Bray, 1999). By its very nature of aiming at academic achievement, OST curricular learning encompasses strong implications for (in)equalities. Slow learners can use some curricular OST education to keep up with their peers and further develop their self-esteem, intrinsic value of learning, and sense of achievement (Bray & Lykins, 2012). On the negative side, access to OST education is usually highly dependent upon family socioeconomic status (McCombs et al., 2017). It is documented that the highest-income families spend almost seven times more on enrichment OST activities for their children (McCombs et al., 2017). The spending gap certainly creates an opportunity gap. There are also concerns that OST curricular instructions might impact the fair and accurate appraisal of students' performance by assessment systems and corrupt the teaching/learning effectiveness within the regular classrooms (Bray, 2017; Bray & Lykins, 2012).

Given these contexts, this study focused on this important but often overlooked realm of education. The interjection of OST curricular instructions into the debate over cross-national achievement makes these educational activities, and the reasons large numbers of students take them, central to discussions about educational equality, efficiency, and national levels of academic competitiveness (Baker, Akiba, LeTendre & Wiseman, 2001; National Research Council, 1999). Prior research on OST education predominantly focused on its effect on academic performance, but with problematic design and inconclusive results. Less documented is the ways in which OST curricular education intersects with characteristics of formal schooling and the outcomes beyond academic achievement.

As a gateway course for individual and national human capital development, mathematics is the most popular subject in the OST education sector, yet rarely specifically discussed in the OST education literature. East Asia has long traditions of tutoring and is the part of the world in which private OST curricular instructions has been most visible and the most extreme in mimicking formal school forms (Bray & Lykins, 2012). This study sought to understand who selected and participated in OST mathematics learning, and how OST curricular learning became a plausible mechanism for educational inequalities, using the top mathematics performer in the Programme for International Student Assessment (PISA) 2012 as a case study.

OST Curricular Learning in China

Landscape

This study selected one exemplary society, Shanghai China, to understand the important domains of education beyond the time-space of schooling. Specifically, Shanghai was the top performer in PISA 2012; Shanghai has a lively sector of out-of-school education; and Shanghai has been witnessing dynamic social changes that can transform educational experiences. Existing literature about the scale of OST education in mainland China has predominantly focused on the household-funded academic domain.

However, it is important to note there are also OST classes provided by schools, free of charge, and taking place within the space of schooling. Some schools, particularly in higher grade levels or in senior secondary schools, tend to keep offering instructions to students in the evening or during the weekends (Liu & Bray, 2017). The extent to which students receive out-of-school time instructions within their own schools matters to the time and energy they can devote to out-of-school learning beyond the school walls. A study reported less in-school supplemental instruction led to more out-of-school tutoring in lower grades in China due to more free time outside of schools (Chu, 2009).

In addition to academic OST classes, non-academic educative activities and opportunities that could cultivate learning habits and interests were also desired by parents until academic tutoring gradually replaced the demand in the secondary stage (Liu & Bray, 2018). A study focusing on primary and lower secondary levels drew on ethnographic data to show the changing patterns of demand by individual parents at different time points. Parental choices on private tutoring were impacted by not only cost and availability of time but also children's academic performance, children's different stages of schooling, and education system reforms (Liu & Bray, 2018). The demand may expand or reduce their demand over time, change balances between academic and non-academic tutoring, and switch between different types and providers of tutoring (Liu & Bray, 2018).

Specific to household-funded OST education, a nationwide representative sample, the 2010 China Family Panel Studies baseline survey, indicated that 24.2 percent of sampled students had received privately funded tutoring during the previous year while 75.8 percent had not (Liu & Bray, 2017). The 2012 and 2014 iterations recorded increased participation rates of 24.6 percent and 29.8 percent, respectively. Among the students who received tutoring, the average annual expenditure reached CNY1290 (US$210) (Liu & Bray, 2017). But the actual expenditure as well as the probability of privately funded tutoring varied by household registration system (urban or rural *hukou*), school locations (provincial capitals, ordinary cities or small towns), school types (key schools or average school), household income, parental education level, and students' expectations about future educational levels (Liu & Bray, 2017).

Effects of OST Curricular Instructions

The effectiveness of OST curricular instructions on educational outcomes has been inconclusive. Xue and Ding (2008) found a negative correlation between expenditures on tutoring and tutees' academic achievement, while

Lei (2005) concluded a positive association between the two among Grade 12 students. Y. Zhang's (2011) study found, among the high school students in Jinan Shandong, the effectiveness of tutoring on college entrance exams varied by subjects. Tutoring had a small but statistically significant effect on mathematics test scores, but no statistically significant impact on Chinese test scores. Beyond affecting test scores, OST education, particularly the non-academic domain that tutored sports, music, and interpersonal relationships, was speculated to develop children's self-esteem and sense of achievement (Bray & Lykins, 2012).

Though always playing a supplementary role, OST curricular learning has strong implications on the quality and efficiency of mainstream education - schooling (Dang & Rogers, 2008; Southgate, 2009; W. Zhang & Bray, 2016). Lee (2013) illustrated that private tutoring helped Korean students become more attentive. Other scholars concerned OST learning could cause boredom and rebellion and occupy the time that could have been spent on other extracurricular activities (Bray, 2017; Hussein, 1987; Nanayakkara & Ranaweera, 1994). However, far less research has explored the potential effects of OST learning on student engagement in school and attitudes toward learning (Bray, 1999).

One methodological difficulty in evaluating the effect of OST curricular instructions with cross-sectional data has been the endogeneity or selection bias of OST education. Students who participate in OST education can differ from those who do not in many ways (Bray, 2010). Rosenbaum and Rubin (1983) defined sample selectivity as a violation of the strongly ignorable treatment assignment. Merely applying the Ordinary Least Square (OLS) approach will end up with inflated slope and asymptotical bias (Kennedy, 2003). This study employed the conceptual framework of ecological model of human development to illustrate the nature of endogeneity of OST curricular education.

Conceptual Framework: Ecological Model of Human Development

Empirical research that examines the driving forces of OST curricular instructions (e.g., Bray et al., 2014) has commonly referred to the five hierarchical levels (society/education system, community/family, school, classroom and individual level), based on the Bronfenbrenner's (1994) ecological model theory. This conceptual framework substantially informed the present study's research design and aligned well with the development of OST mathematics education.

Micro-level Factors

The micro-level system focuses on activities, social roles, and interpersonal relations experienced by an individual. A number of studies explored the ways in which individual characteristics were related to the participation in academic OST education. The prime functionality of OST curricular instructions is to supplement academics. Therefore, previous academic records are important predictors of the probability of participation (Park et al., 2016). In understanding the motivations and goals, previous literature crucially differentiated between (1) remedial lessons designed to help students meet coursework requirements in formal schooling and (2) enrichment-oriented lessons designed to boost achievement for students already performing well in formal schools (Baker & LeTendre, 2005). Test scores, class/school rankings, and students'/parents' perceived dissatisfaction with the schools (considering some might have higher expectation and aspiration) were considered to influence family's investment decisions in OST curricular classes (Liu & Bray, 2017).

Beyond cognitive factors, individual attitudes, beliefs, and behaviors have also played substantial roles in students' interest and response to academics in general (Organisation for Economic Co-operation and Development [OECD], 2014). For example, students who admitted that they were highly anxious and felt tense and afraid of mathematics tended to avoid mathematics related activities and practices and eventually had low achievement on mathematics performance (Pitsia, Biggart & Karakolidis, 2017; Goetz, Cronjaeger, Frenzel, Lüdtke, & Hall, 2010; Stankov & J. Lee, 2014). Attitudes, as an evaluative disposition towards a subject comprised of cognitive, affective, and behavioral aspects, which can in turn predict knowledge level, affective reactions, and behavior prepositions (Pitsia et al., 2017), have been conceptually linked with students' engagement in school activities, their school experiences, and their dedication to schooling, in a positive relationship (OECD, 2014).

Study ethics, such as persistence, concentration, attention, preparedness, is another crucial indicator of student engagement and learning outcomes (Cheung, Sit & Mal, 2015). These skills can enhance students' capacity to integrate skills, attitudes, and behaviors to deal effectively and ethically with daily tasks and challenges (OECD, 2015). The model of motivational dynamics (MMD) provides a perspective on student engagement with schoolwork that highlights student participation in learning activities for the development of resilience, coping, and learning (Cheung et al., 2015). However, relationships between these non-cognitive factors and OST curricular instructions have not yet been well reported by the literature (Bray et al., 2014).

Students' demographic characteristics are an important set of factors to the participation of OST education. Generally, racial/ethnic minorities have been, in differing contexts, less likely to participate in OST academic activities (Edwards, 2020; Bray et al., 2014). Most ethnic minorities have resided in sparsely populated regions with lower economic development, which faced a double disadvantage of poorer educational infrastructure and lower ability to afford the costs of schooling, let alone the out-of-school options (Liu & Bray, 2017).

Gender is another important consideration, but the relationship varies by context. Some literature (Aslam & Atherton, 2011; Nath, 2008) indicated that parents were more likely to invest in boys' OST learning because males were more likely to seek the types of employment that required educational qualifications. Yet research in South Korea (S. Kim & J-H. Lee, 2010) found lower tutoring expenditures for males than for females. Empirical studies in China did not find consistent relationships between gender and private tutoring (Liu & Bray, 2017).

As mentioned earlier, literature suggested a strong relationship between family socioeconomic status and family-funded OST education participation (Xue & Ding, 2008; Yin, 2018; Y. Zhou & Wang, 2015). High-status families can facilitate their children's participation in private OST curricular instructions simply because they are able and willing to invest in education. These parents tend to be more involved in their children's education, from finding a quality instructor to monitoring their progress with the instructor (Park et al., 2016).

Other family factors, such as the number of siblings (Dang & Rogers, 2008) and family structure (Southgate, 2013), have also been mentioned in literature but needs more investigation (Park et al., 2016). Dang and Rogers (2008) argued that children in large families received less tutoring than children in small families. In Mainland China, with decreased family size and increased household incomes, parents can concentrate their resources on the only child to support his or her academic development (Bray & Lykins, 2012).

Meso-level Factors

The meso system is associated with the links and processes taking place between two or more settings containing the individual, such as the relations between home and school. When the mainstream education system is perceived to be of poor quality and offers a limited capacity of the opportunity to learn (OECD, 2014), parents and students may be motivated to seek out additional forms of academic learning in the private OST market (Bray, 1999; Dang & Rogers, 2008). Factors such as teacher quality (Dang, 2007), student-teacher ratios (J-H. Kim & Chang, 2010), class size (Bray & Lykins, 2012) and teacher corruption (Liu & Bray, 2017) were documented to correlate with satisfaction with teachers and schools, which could shape the participation of OST education.

Institutional policies have also influenced the supply and demand of OST curricular instructions. Chinese schooling system has been highly stratified due to the concentrated efforts of growing elite public schools (known as key schools). These schools select high-achieving students through examinations, recruit the best teachers, receive favorable government funding, and construct enviable school facilities (W. Zhang & Bray, 2016). Many parents have resorted to private OST education in the hope that it will secure their children's success in the admission to key upper secondary schools through high-stake examinations (such as the Senior High School Entrance Examination (*Zhongkao*) and the College Entrance Examination (*Gaokao))* (W. Zhang & Bray, 2016).

Macro-level Factors

Macro-level factors are the ones driven by the overarching pattern of micro-, and meso-systems characteristics of a given culture or subculture such as belief systems, lifestyles, opportunity structure (Bronfenbrenner, 1994), At the societal level, scholars have often referred to the influence of Confucian heritage culture to explain the prevalence of OST education in East and Southeast Asia, in which are considered as the Confucian Heritage Culture (CHC) countries (Bray & Lykins, 2012; Kwok, 2001). CHC usually represents a high respect for education, stresses diligence and effort as factors for future success, and strongly believes in the significant role of education and meritocracy in upward mobility (Mason, 2014). Seth (2002) mentioned that such underlying belief might escalate to education fever or obsession in these societies.

Performance and credentials obtained from advanced schooling are firmly believed to be the sole determinant of future employment opportunities and standards of living. As a result, parents and teachers are known to attach great importance to the education and achievement of their children and students (Leung, 1998). Even in Asian immigrant communities of non-CHC countries, studies have found East Asian American students are the most likely to use commercial learning center–based tutoring (Byun & Park, 2012). M. Zhou (2012) found the private tutoring enterprises serving children and youth were an outgrowth of ethnic enclave economy in the Chinatown and Koreatown of Los Angeles.

Moreover, the confluence of Confucian cultural heritage and the institutional structure of credentialism has helped preserve the examination subculture in CHC societies (Mason, 2014). To succeed in numerous exams, Watkins and Biggs (1996) argued the process of CHC learning was through repeated observations, practices, memorization of empirical examples, and reflection until fully grasping the knowledge. Such learning styles provided demand for additional instructions outside of regular schooling hours as it provided the space for extra exercises. But caution is needed to solely rely on CHC to explain complex contemporary issues such as OST education due to its incapability to account for the effects of rapid social change in many CHC countries (O'Dwyer, 2016).

The subject of mathematics has been the most popular one in OST education market due to its role as a gateway course for individual and national human capital development (mathematics was the most tutored subject based on PISA 2012). This study strategically designed to first analyze the participation patterns of OST mathematics education among 15-year-old students in Shanghai. Findings were leveraged to evaluate the effectiveness and externality of OST mathematics education on cognitive and non-cognitive outcomes. The focus of one academic subject of OST education enabled a more precise application of the theory and a more accurate investigation of the participation determinants, so as to better account for selection bias. In all, this study was guided by two research questions:

a. Who are more likely to participate in higher intensities of OST mathematics education?
b. How does OST mathematics learning impact mathematics achievement and study behaviors?

Method

Data

The present study relied on analyzing secondary data – the Shanghai samples of PISA 2012. PISA is a worldwide study initiated by the Organization for Economic Co-operation and Development (OECD) to assess 15-year-old school pupils' scholastic performance on mathematics, science, and reading. The major domain of the PISA 2012 survey was mathematics, meaning a greater emphasis was given to issues of teaching and learning mathematics. The PISA assessments take a literacy perspective, focusing on the extent to which students can apply the knowledge and skills to real-world tasks and challenges (OECD, 2014).

In addition to the main assessment, students also answered a background questionnaire, which sought information about themselves, their homes and their schools and learning experiences (OECD, 2014). Non-cognitive outcomes, explanation of students' intentions, and behaviors related to mathematics and classroom teaching, were particularly included in PISA 2012 (OECD, 2014). School principals and parents were given questionnaires to evaluate school system and the learning environment or provide information on their perceptions of and involvement in their child's education (OECD, 2014). Out of 5,177 sampled Shanghai students, 3,436 students with valid information on out-of-school time mathematics education were included in the main analyses.

PISA adopted the two-stage stratified sampling design. The first-stage sampling units consisted of individual schools having 15-year-old students. Once schools were selected to be in the sample, 15-year-old students within sampled schools were randomly selected. In addition to random sampling, survey weights were incorporated into the analyses due to varying selection probability of the students. School, grade and student non-response adjustments were taken account into trimming the final student weights. A replication methodology, Balanced Repeated Replication (BRR) with Fays method, was employed to estimate the sampling variances of PISA parameter estimates (OECD, 2014). The PISA 2012 questionnaires included not only cognitive assessment but numerous items on student characteristics, student family background, student perceptions, and school characteristics. Meaningful indices were constructed through the scaling of items and the singular scale scores were estimates of latent traits derived through Item Response Theory scaling of dichotomous or Likert-type items (OECD, 2014).

Variables

Three dependent variables have been generated from the research questions. In the PISA 2012 student questionnaire, OST mathematics education participation was obtained the question: "*How many hours do you typically spend per week attending out-of-school lessons in mathematics?"* Further instruction of the question is "These are only lessons in subjects that you are also learning at school, which you spend learning extra time on outside of school hours. They may be given at your school, at your home or somewhere else". Students could choose from five categories. The distribution is demonstrated in Figure 1. This variable was further transformed and entered as a treatment variable for the second research question. After examining its distribution, a reasonable cutoff point for obtaining a similar amount of cases for each dose was between level 3 and level 4. Therefore, level 4 and level 5 were combined and four categories were finalized.

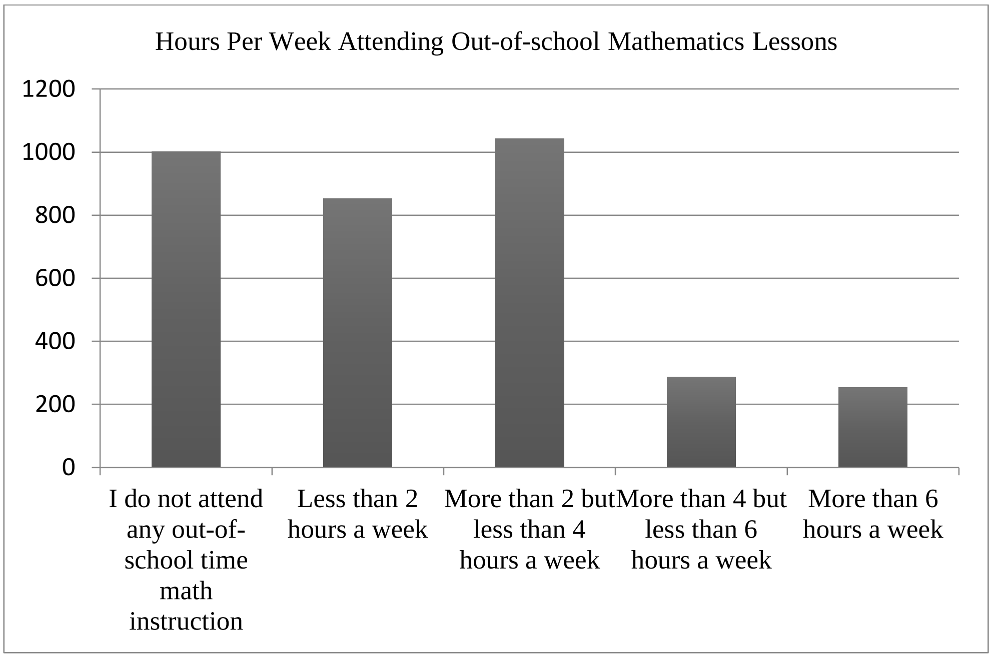

Figure 1. Out-of-School Mathematics Lessons in Shanghai

The second dependent variable was mathematics performance, which assessed students' capacity to formulate, employ, and interpret mathematics in a variety of contexts (OECD, 2014). Notably, the test design for the PISA 2012 was based on a variant of matrix sampling (using different sets of items and different assessment modes) where each student was administered a subset of items from the total item pool (OECD, 2014). Since not all students took the identical sets of items, it is inappropriate to use any statistic based on the number of correct responses in reporting the survey results. When responding to a set of items requires a given skill, the response patterns should show regularities that can be modeled using the underlying commonalities among the items. This regularity could be used to characterize students as well as items in terms of a common scale, even if students took different sets of items (OECD, 2014). This approach made it possible to describe distributions of performance in a population or subpopulation and to estimate the relationships between proficiency and background variables (OECD, 2014).

To increase the accuracy of the measurement, PISA used plausible values (PVs) – which were multiple imputations – drawn from a posteriori distribution by combining the item response theory (IRT) scaling of the test items with a latent regression model using information from the student context questionnaire in a population model (OECD, 2014). Using item parameters anchored at their estimated values from the international calibration, the instrument contained five plausible values of mathematics performance, which were random draws from the marginal posterior of the latent distribution for each student (see OECD 2014). PVs were not actual test scores but a set of numbers that maximally captured the variability of one's mathematics achievement and contained random error variance components.

The third dependent variable, mathematics study behaviors, was a construct created in the main survey, which evaluated students' study behaviors occurred during mathematics learning. In PISA 2012, most questionnaire items were designed to be combined in some way to measure latent constructs that cannot be observed directly. Mathematics study behaviors were measured by a survey question: "*Thinking about the mathematics you do for school, to what extent do you agree with the following statements?*" Nine items, with the response categories ranged from "strongly agree" to "strongly disagree", were used to create the scale scores. The estimates of latent trait mathematics study behaviors were derived through Item Response Theory (IRT) scaling of the Likert-type items (OECD, 2014). All items were reversed, so the higher score corresponded to the higher level of positive study behaviors.

The key explanatory variables were structured into blocks at two levels, informed by the two-stage sampling approach (OECD, 2014). At the student level, student demographics, mathematics/cognitive characteristics, and family socioeconomic status were included. At the school level, teacher and school quality indicators were also added in the analyses (Betts & Shkolnik, 2000). The opportunity-to-learn indices (OECD, 2014), including ratings of classroom disciplinary climate, mathematics teacher support and teacher assessment behavior collected at the student level, were considered as contextual information of schools (OECD, 2014). Hence, individual students' ratings of these variables were aggregated and centered on the group mean at the school level (Lüdtke, Marsh, Robitzsch, Trautwein, Asparouhov, & Muthén, 2008). Mathematics class time per week was log-transformed due to its extensive range. Variances of influence factor of the independent variables were checked. No values exceeded the rule of thumb 2.5 so no multicollinearity was detected. Most of the covariates were missing for less than 5 percent of the analysis samples, except for mathematics anxiety, classroom disciplinary climate, mathematics teacher support, and mathematics extracurricular activities in school. Missing data of the covariates were imputed using chained equations in Stata informed by the analysis variables, a small number of auxiliary variables and complex survey design. Missingness of the OST mathematics education variable reached about 30 percent but it was essential to include dependent variable in the imputation model to best match the observed data (SSCC, 2012). Although the imputing values of OST mathematics education were not included in the main analyses, a fully imputed dataset with 5,177 samples was analyzed as a sensitivity test. Nested nature of the data was unable to address in the imputation process, given the limitation of the statistical package. Given the small magnitude of level two variance, multiple imputations were conducted without differentiating between level one and level two indicators. There might be implications of underestimating level-two coefficients. The estimates of ten imputed data files were aggregated from the multiply imputed data using Stata's MI prefix.

Analytical Approaches

Building upon the research questions, this study proposed two hypotheses: (1) Students with certain characteristics (i.e., higher family status and suboptimal academic record) and studying in certain schools (i.e., less competitive schools, poor teaching faculty, and negative learning environment) were more likely to participate in higher intensities of OST mathematics education; (2) OST mathematics learning could positively impact mathematics achievement and study behaviors.

Analyzing the Participation Patterns of OST Mathematics Education

To identify the participation patterns of OST mathematics education among 15-year-old students in Shanghai, ordered logistic regression models were used. Ordered logistic regression estimated a single odds ratio that summarized the association of OST mathematics education across all levels of the outcome (Long, 1997). Two-level modeling was employed to investigate the contribution of both student and school-level variables in explaining variance in the participation of OST mathematics education. Although the between-school variation was modest (Intra-Class Correlation = 0.04), a multilevel analytical approach was necessary given the design effect (Lai & Kwok, 2015), the sampling procedure (OECD, 2014), and the conceptual framework of the study. A few variables (gender and grade repetition) violated the proportional odds/parallel lines assumption of ordered logistic regression. Alternative methods were considered, such as generalized ordered logistic regression that was less restrictive with the assumption (Williams, 2016).

However, this method was unable to capture the nested nature of the data. Given the purpose was to detect the overall direction of each predictor and the violation was originated from only two variables that were not the primary interest, this study still chose to utilize two-level ordered logistic regression to understand the associations between OST mathematics education and different levels of predictors. Logistic regression and the following multinomial logit model were served as robust checks.

For building multilevel models, a stepwise approach was adopted, starting from the simpler model with only student-level predictors to including school-level ones. This approach was suggested by Raudenbush and Bryk (2002). Due to modest between-school variation, the study considered random intercept models only. Wald tests were performed to test the joint significance of the coefficients of newly added blocks of variables given the nonlinearity nature of the models, so as to determine a best-fitting model (Guo, 2005). School-level weights and adjusted student-level weights that summed to the effective sample size of their corresponding second-level were incorporated (Rabe-Hesketh & Skrondal, 2006).

Evaluating the Effectiveness of OST Mathematics Education

The study employed Imbens' (2000) generalized propensity score (GPS) method to assess the influence of different intensities (dosages) of OST mathematics education on PISA performance and study behaviors. Variables showing statistically significant associations with OST mathematics education participation were included in the multinomial model as predictors. Literature (Hong & Raudenbush, 2006) suggested that exploiting the multilevel structure in at least one stage of propensity score-weighting analysis could greatly reduce bias for estimating average treatment effect. Considering the magnitude of within-school variation was modest, this study accounted for clustering effect in the stage of outcome analysis with ordinary least squares (OLS) weighted regression.

Generalized propensity scores for all students were calculated from the predicted probabilities following the estimation of the multinomial model. Because the treatment variable, OST mathematics education, had four categories, each sample would have four propensity scores. The inverse of the propensity score of dose category each participant actually received was the weight for outcome analysis. Data balancing issue was re-diagnosed by checking whether each covariate imposed a significant impact on the assignment of each dosage.

Next, mathematics performance and mathematics work behaviors were entered as the outcome variables in the weighted OLS regression, with the highest dosage "more than 4 hours of OST mathematics education per week" being the reference group. Final student-level weights used in the OLS regression were the multiplication of adjusted student-level weights and the weights obtained from generalized propensity score analyses, along with the school-level weights (Ridgeway, Kovalchik, Griffin & Kabeto, 2015). For comparison, non-weighted OLS regression models were included. Sensitivity analyses, including logistic regression and binary propensity score analysis, were followed to check for consistency.

Results

Participation Patterns

Based on PISA 2012, 30 percent of sampled Shanghai students reported no participation in any OST mathematics education, while approximately 50 percent reported more than 2 hours per week of attendance in some types of OST mathematics classes. Regression modeling further revealed the associations between the predictors and proportional odds ratios of each level (see Table1). Family socioeconomic characteristics exhibited a very influential role in the participation of OST mathematics education.

Across four models, one standard deviation increase in family economic, social and cultural status was significantly related to about 1.2 times the odds of using more OST mathematics education. One standard deviation higher in the unit of home educational resource was associated with 1.2 times greater the odds of having more OST mathematics education. These pieces of evidence confirmed earlier hypothesis. Regarding gender and preschool education, female students and more than one year of early childhood education were positively associated with the intensity of OST mathematics education participation.

At the school level, opportunity-to-learn indices in the mainstream sector were importantly associated with the likelihood of participating in OST mathematics education. One more standard deviation of negative classroom disciplinary climate, as demonstrated in Model 3 and 4, was associated with 1.8 times greater the odds of participating in more OST mathematics education. Additionally, one standard deviation increase in log mathematics time was associated with 2.3 times the odds of more OST mathematics education.

Table 1. Ordered Logistic Regression Results

Variables	Model 1	Model 2	Model 3	Model 4
Student Level -- Demographics				
Gender (Ref: female)	.83 (.08)*	.84 (.09)*	.83 (.08)*	.82 (.08)*
Student Level – Family Characteristics				
Sibling (Ref: none)	.90 (.10)	.97 (.11)	.98 (.11)	.97 (.11)
Economic, social & cultural status	1.26 (.05) ***	1.21 (.05) ***	1.17 (.05) **	1.19 (.05) ***
Home educational resources	1.19(.04) ***	1.15 (.04) ***	1.15 (.04) ***	1.15 (.04) **
Family Structure (Ref: single parent)				
Two parents	1.25 (.14)	1.22 (.14)	1.23 (.13)	1.21 (.13)
Other	1.26 (.23)	1.34 (.24)	1.34 (.24)	1.23 (.24)
Student Level – Academic Standings				
Mathematics anxiety		.97 (.06)	.98 (.06)	.98(.06)
Grade repetition (Ref: no repetition)		.84 (.16)	.83 (.16)	.78^{+} (.16)
Preschool education (Ref: no education)				
One year		1.14 (.26)	1.17 (.27)	1.17(.27)
More than 2 years		1.77 (.24) *	1.79 (.24) *	1.75 (.24) *
School Level – Mathematic Teacher Quality				
Disciplinary climate			1.75 (.15) ***	1.36 (.16)*
Teacher support		.	.80 (.25)	.90 (.23)
Teacher assessment			1.43 (.21)	1.21 (.21)
School Level –School Characteristics				
Class size				1.01 (.01)
Weekly class time				2.34 (.20) ***
Ability group (Ref: no grouping)				
For some classes				.75 (.25)
For all classes				.73 (.25)
School type (Ref: private school)				1.17 (.17)
School selectivity (Ref: high selectivity)				
Not selective				.91 (.14)
Somewhat selective				.82 (.15)
Mathematics extension courses offered (Ref. none)				
Either enrichment and remedial				.97 (.24)
Both enrichment and remedial				.99 (.25)
Residual Variances				
Category 1	-1.02 (.16)***	-.53 (.29)	-.15 (.33)	-.85 (.65)
Category 2	.06 (.15)	.56 (.27)*	.95 (.32)**	.24 (.65)
Category 3	1.69 (.15)***	2.20 (.29)***	2.58 (.34)***	1.88 (.66)**
Category 4	2.51 (.15)***	3.02 (.30)***	3.4 (.34)***	2.70 (.67)***
Var (School)	.14 (.04)**	.13 (.04)**	.07 (.03) **	.07 (.03)

Note: *p < .05, **p < .01, ***p < .001 (two-tailed test). Regression estimates were weighted and standard errors were adjusted for the complex survey design. Each cell contained incidence-rate ratios (exponentiated ordered logistic regression coefficients) and standard errors (in parentheses). For the results of school-level variances, coefficients and standard deviations were reported.

Previous hypothesis about low school quality and negative learning environment associated with higher probability of OST mathematics instructions is confirmed. Level-two variances decreased as more predictors were included, indicating a better fit with more blocks of explanatory variables added. As a robust check, logistic regression of a binary outcome, whether students received OST curricular instructions or not, was examined. Similar to previously discussed results, gender, family socioeconomic status, home educational resources, grade repetition at the individual level, class size, weekly class time, and ability grouping at the school level were significantly associated with the participation of OST mathematics education (see Table 2). Results of the models with OST mathematics education imputed were also similar to previously discussed ones.

Table 2. Logistic Regression Results

Variables	Odds Ratio (Standard Error)
Gender (Ref: female)	.70 (.06)**
Sibling (Ref: none)	.87 (.10)
Economic, social & cultural status	1.15 (.06)**
Home educational resources	1.21 (.06)***
Family Structure (Ref: single parent)	
Two parents	1.28(.18)
Other	1.18 (.35)
Mathematics anxiety	.97 (.05)
Grade repetition (Ref: no repetition)	.63 (.09)**
Preschool education (Ref: no education)	
One year	1.05 (.24)
More than 2 years	1.15 (.24)
Disciplinary climate	1.15 (.17)
Teacher support	.86 (.21)
Teacher assessment	1.18(.26)
Class size	1.01 (.01)*
Weekly class time	2.82 (.58)***
Ability group (Ref: no grouping)	
For some classes	.64(.14)*
For all classes	.72(.16)
School type (Ref: private school)	.97(.17)
School selectivity (Ref: high selectivity)	
Not selective	.95(.17)
Somewhat selective	.90(.17)
Mathematics extension courses offered (Ref. none)	
Either enrichment and remedial	.94(.22)
Both enrichment and remedial	.87(.21)
Residual variance	.01 (.01)***
Var (School)	.28 (.07)

*p < .05, **p < .01, ***p < .001 (two-tailed test).

Effectiveness

Previous findings confirmed that students who participated in OST mathematics education were different from those who did not in many aspects, such as family background, teachers' instructional quality, and learning environment of the attending schools. With GPS adjustment, gender, socioeconomic status, family structure, preschool education, grade repetition, mathematics anxiety, classroom disciplinary climate, in-class formative mathematics assessment, and school selectivity were significant predictors of PISA mathematics performance. The association between OST mathematics class participation and PISA mathematics performance was, however, insignificant (see Table 3). Students' math performance did not vary significantly across different intensities of OST mathematics class participation. The hypothesis, thus, could not be justified. On the other hand, OST mathematics education under the GPS adjusted model was significantly associated with student's mathematics study behaviors (see Table 4). The relationship was in the same direction as the hypothesis and was in a linear fashion, though not all significant: more hours of participating in OST mathematics instructions were related to more demonstrated efforts and more positive study behaviors.

In addition to the main analyses, some other models worth mentioning. The regression models without GPS adjustment showed a smaller magnitude of the association on all contrasts. Some relationships were opposite from previously discussed findings. Such discrepancies indicated the extent to which bias might be induced if no corrective procedures were used regarding selectivity. Bivariate correlation coefficients between different doses of OST mathematics education and the outcome variables were provided to aid interpretability. OST mathematics class participation was not significantly associated with PISA mathematics performance at any dosages. However, the correlation between no OST mathematics lessons and study behaviors was significant and negative, indicating a strong divide on the development of positive mathematics study behaviors between none and any participation of OST mathematics education. Compared to no OST mathematics education, attending OST mathematics classes more than 4 hours per week was significantly correlated with developing positive mathematics study behaviors. These correlational patterns confirmed previously-discussed findings.

Table 3. Regression Analysis with and without PS Adjustment

Covariate	**Estimated Regression Coefficient (Robust SE)**	
	Without PS Adjustment	With PS Adjustment
Student Level – Demographics		
Gender	8.41 (2.76)**	11.40 (3.87)**
Student Level – Family Characteristics		
Index of Socioeconomic Status	7.84 (1.83)***	10.71 (2.49)***
Family Structure	-9.50 (4.27)*	-11.69 (6.20)
Student Level – Academic Standings		
Grade Repetition	-52.76 (4.74)***	-58.11 (8.05)***
Mathematics Anxiety	-18.10 (1.44)***	-13.54 (1.91)***
Preschool Education	22.66 (3.04)***	15.53 (4.74)***
School Level – Mathematic Teacher Behaviors		
Disciplinary Climate	75.49 (10.07)***	75.07 (11.30)***
In-class Assessment	-54.05 (11.08)***	-54.07 (12.37)***
School Level –School Quality		
School Type	-15.78 (4.88)***	-17.21 (4.87)***
School Selectivity	15.34 (5.92)**	14.43 (5.36)**
Mathematics Teacher-Student Ratio	-.04 (3.21)*	-.04 (.03)
Mathematics Extracurricular Activities in School	-.25 (3.31)	3.88 (4.56)
Dosage of treatment (Ref. more than 4 hours of OST mathematics education per week)		
Never	3.52 (3.25)	8.57 (5.80)
0-2 hours per week	-.67 (4.58)	1.59 (5.93)
2-4 hours per week	1.27 (4.29)	2.78 (5.55)
Residual Variance	534.16 (28.68)***	549.95 (33.81)***
Random Effects		
Random Intercept Variance	30.08 (2.63)	30.81 (2.98)
Observations	3436	3436

*** p< .001, ** p< .01, * p< .05, two-tailed test.

Table 4. Regression Analysis of Dosage of OST Mathematics Education on Mathematics Study Behaviors with and without PS Adjustment

Covariate	**Estimated Regression Coefficient (Robust SE)**	
	Without PS Adjustment	With PS Adjustment
Student Level – Demographics		
Gender	-.27 (.04)***	-.32 (.06)***
Student Level – Family Characteristics		
Index of Socioeconomic Status	.04 (.03)	.05 (.04)
Family Structure	.13 (.06)*	.18 (.08)*
Student Level – Academic Standings		
Grade Repetition	-.11 (.05)*	-.13 (.08)
Mathematics Anxiety	-.34 (.02)***	-.33 (.04)***
Preschool Education	.01 (.04)	.01 (.06)***
School Level – Mathematic Teacher Behaviors		
Disciplinary Climate	.21 (.03)***	.21 (.03)***
In-class Assessment	.30 (.02)***	.29 (.03)***
School Level –School Quality		
School Selectivity	.06 (.03)	.07 (.04)
Dosage of treatment (Ref. more than 4 hours of OST mathematics education per week)		
Never	-.13 (.05)*	-.12 (.07)
0-2 hours per week	-.03 (.05)	-.06 (.09)
2-4 hours per week	.04 (.05)	-.01 (.09)
Residual Variance	.16 (.20)	.15 (.24)
Random Effects		
Random Intercept Variance	.08 (.02)	.10 (.04)
Observations	3436	3436

*** p< .001, ** p< .01, * p< .05, two-tailed test.

Propensity score weighted models with binary outcomes (OST mathematics class participation vs. none) as well as a fully imputed dataset were checked as sensitivity analyses (see Table 5). When collapsing OST mathematics participation into a binary condition, its associations with mathematics performance and study behaviors were demonstrated in greater magnitude. Parameter estimates of OST mathematics participation became statistically significant for both outcomes. For the fully imputed dataset, the relationships between OST mathematics education and PISA mathematics performance remained insignificant across all doses. The highest dose - more than 4 hours per week - was significantly influential to positive study behaviors, compared to none or 0-2 hours of weekly OST mathematics education. The results demonstrated commonalities with previous findings.

Table 5. Regression Analysis of Binary Outcome

Covariate	**Estimated Regression Coefficient (Robust SE)**	
	Mathematics Performance	Study Behaviors
Student Level – Demographics		
Gender	30.41 (11.34)**	-.21 (.11)*
Student Level – Family Characteristics		
Index of Socioeconomic Status	20.56 (5.84)**	.02 (.07)
Family Structure	-10.87 (9.11)	.15 (.12)
Student Level – Academic Standings		
Grade Repetition	-71.78 (13.32)***	-.17 (.13)
Mathematics Anxiety	-16.51 (7.92)*	-.05 (.13)
Preschool Education	13.34 (8.25)	.19 (.15)
School Level – Mathematic Teacher Behaviors		
Disciplinary Climate	70.97 (11.79)***	.49 (.12)***
In-class Assessment	-45.34 (16.94)**	-.08 (.15)
School Level –School Quality		
School Type	-1.40 (7.57)	--
School Selectivity	26.96 (10.11)**	.02 (.08)
Mathematics Teacher-Student Ratio	-.04 (.02)*	--
Mathematics Extracurricular Activities in School	9.44 (9.66)	--
OST Mathematics Education	-24.04 (10.85)*	.20 (.12)
Residual variance	478.25 (47.56)***	-.41 (.71)

*** p< .001, ** p< .01, * p< .05, two-tailed test.

Discussion

Participation Patterns and Capital Theory of Education

For both theoretical and methodological purposes, the present study was designed to investigate the participation patterns of OST mathematics education first. Echoed with the conceptual framework, the findings demonstrated that there were multilevel factors associated with the likelihood and intensity of OST mathematics education participation. Among other determinants, family-level characteristics stood out. Students from families with high socio-economic status and more home educational resources were more likely to devote more time in OST mathematics instructions. High-status families have been more likely to ensure the best educational opportunities for their children, starting from the fullest participation of preschool education (Y. Zhou & Wang, 2015). As such, the length of early childhood education was considered as an indirect indicator of family socioeconomic status and was found to be also positively correlated with the participation of OST mathematics education, resonating with the relationships from direct measures.

The implication of a tight linkage between family status and OST mathematics education reached beyond the research question about participation patterns. PISA indices of family socio-economic status and home educational resources together captured the information on household economic capital (in the forms of family wealth and parental occupation) and possession of dominant culture capital (in the forms of parental education and educational resources) (OECD, 2014). The indices were commonly linked to academic achievement and utilized to create the socio-economic gradient of a country, which evaluated how equitable was the educational system or the lack thereof (Lagravinese, Liberati & Resce, 2017). Although the PISA 2012 instrument did not distinguish free or fee-based OST mathematics education in the survey, the tight linkages between family-level characteristics and the participation patterns of OST math learning implied that such particular activity were actively selected and predominantly funded by families in Shanghai, particularly the higher status ones.

Some nonsignificant relationships also helped illuminate the nature of OST mathematics learning in Shanghai. The nonsignificant associations between academic characteristics and OST mathematics education suggested that OST mathematics education in Shanghai could serve both remedial and enrichment purposes to a similar extent because there was no evidence on whether academically struggling students or high achievers participated more. This evidence echoed Liu and Bray's (2017) study, which found perceived academic pressure was not a strong indicator of participation in tutoring. However, in another East Asian context, Byun (2010) uncovered that among Korean students, higher achievers spent more on shadow education than low achievers, suggesting that higher achievers were more likely to use shadow education. Though the association between academic characteristics and participation was not significant in this study, attention is needed for the possibility that OST mathematics education would exacerbate rather than reduce the already existing achievement gaps caused by unequal ascribed resources.

The study found gender was another significant individual-level predictor with surprising nuances. Female students in Shanghai were more likely to participate in (higher intensities) of OST mathematics instruction than male counterparts. This finding, in conjunction with the one-child policy, which might change possible gender discrimination, counter-argued with the narrative and assumption that households have been prioritizing boys' educational resources. This finding contradicted with Y. Zhang's (2011) study about Jinan, China, where she found no gender gap in mathematics tutoring. China is a large country with great diversity so the contexts are important for understanding such contradiction. As China's most prosperous city, it is possible that when the overall income level increases for Shanghai families, along with the demographic policy, there has been a strong tendency for females to work harder or target academic achievement more strongly (Bray et al., 2014).

Furthermore, participation and intensity of OST mathematics education were significantly associated with the opportunity-to-learn indices of mainstream schooling, such as schoolteacher's classroom management capabilities, feedback-providing styles, and in-class support. From the economics perspective, underdevelopment of formal schools, low quality of teaching faculty, and poor management of regular schooling could trigger dissatisfaction which served as a market reaction and facilitate the development of OST education (Baker et al., 2001; Bray, 1999; Bray et al., 2014; Liu & Bray, 2017). This finding has also revealed an important layer of the interconnection between mainstream schooling and OST curricular learning.

Effectiveness

Regarding its effectiveness, this study found no significant associations between OST mathematics education and student PISA mathematics performance. PISA 2012, however, did not collect more information on the content, quality, or modes of OST mathematics education. Here some possible explanations are provided. The OST mathematics instructions were typically targeted at certain examinations (i.e., *zhongkao* and *gaokao*) rather than an academic literacy assessment like PISA (note PISA tested students' real-world application skills but not the extent to which they mastered any specific curriculums). In an educationally advanced region like Shanghai where most families tended to highly value education, it is also possible that a number of students using OST mathematics instructions just for peer pressure rather than necessarily needing extra instructions on either academic or non-academic grounds. Aggregately, the not-so-perfect match between OST mathematics instruction and academic needs could lessen the magnitude of OST education's influence on academic outcomes.

Although different from what was assumed, a number of studies on OST learning revealed small or insignificant effects on academic performance when the endogeneity issue was addressed. For instance, Suryadarma and colleagues (2006) used the proportion of classmates taking extra courses as an instrument variable and found no impact of additional classes on fourth graders' academic achievement in Indonesia. Using birth order as the instrumental variable, Kang (2007) and Choi (2007) revealed private tutoring was not a statistically significant predictor of academic achievement or college attendance in Korea. Kuan (2011) employed propensity score matching and concluded that there were small gains from tutoring among Grade nine students in Taiwan. Also in Korea, Byun (2014) used propensity score matching and evaluated the effects of a variety of OST educational activities, yet found only cram schooling had a significant positive effect on academic achievement. Using the same sets of data and analytical approaches, Lee (2013) and Ryu and Kang (2013) all reported small magnitude of effects on middle school students' academic achievement, particularly after taking the annual costs of private tutoring into consideration.

By also focusing on the associations between OST mathematics learning and non-cognitive skill development, this study uniquely explored another layer of the interconnection between OST education and mainstream schooling. Significantly, attendees of OST mathematics classes gained progress in developing sound work ethics and habits, which might translate into positive academic outcomes in a longer term. Education in the Chinese society is established upon a cultural ideology that stresses effort, diligence, and perseverance (S.W. Kim, Brown, E.J. Kim & Fong, 2018).

Teachers, parents and students believe academic success results primarily from study habits consisting of self-discipline, an endurance of hardship, steadfastness, concentration and perseverance toward a single goal in spite of setbacks. Kim et al. (2018) proposed such a belief system as the cumulative and habitual nature in the Chinese cultural concept of learning. The authors contended the less well-off children were sometimes more likely to be portrayed with these qualities as ideal learners (Kim et al., 2018). Because it was predominantly consumed by the better-off in Shanghai, high socioeconomic students might take advantage of OST education to foster positive work ethics and study behaviors in the hope of eventually improving academic achievement.

Pursuing the Prizes of Education through OST Curricular Learning

As the expansion of OST curricular instructions is becoming global, this study provided strong evidence on the participation patterns and effectiveness of OST mathematics learning in a high-performing and competitive education system. All findings, both the statistically significant and insignificant ones, were instructive to illuminate the understanding of OST mathematics education in the Shanghai context. The participation patterns in Shanghai were related to unique sociocultural forces, such as the assessment structure and the institutionalized characteristics of the education system.

In China, the power of tests and scores has been so magnified that a student is evaluated by his or her performance in several high-stake examinations. The stratification function of high-stake examinations has heightened the urgency to invest in any activities that can boost exam scores among many parents. Unlike the countries that have developed school choices and high-quality private schools, limited capacities of elite public schools would keep pushing prosperous Chinese parents to seek for academic enrichment or remediation opportunities in the OST private sector.

With a particular focus on equality, this study found OST education might exacerbate educational disparities in Shanghai. Findings about the participation patterns implied that OST education might be a mechanism that sanctioned the hereditary transmission of capitals. Capital-rich families are well-aware of the importance of education's institutionalized outcomes, such as credentials and diplomas. These parents are financially capable of investing in education and engaged in the social networks that value education and contain the information of all types of quality educational resources. As such, it is observed that well-educated and higher socioeconomic status parents are often more involved in children's education and tend to intentionally orchestra children's out-of-school time activities than their low-status counterparts (Lareau, 2003).

As Bourdieu (1986) put out, the more the official transmission of capital was prevented or hindered, the more the effects of the clandestine circulation of capital in the form of cultural capital became determinant in the reproduction of the social structure. As public schooling aims to level the playing field and serves as a ladder for social mobility, the learning and developmental resources and experiences that occur outside of the time and space of schooling become deliberate education strategies of the higher-status families (Dixon-Román, 2012). Thus, the structure of educational inequality is not solely constructed by schooling, but also by OST resources, institutions, and programs, which are spatially organized and symbolically accessible to the socially and economically advantaged families (Dixon-Román, 2012).

Revisiting the increasingly capital-intensive OST education industry, the findings of this study call for careful attention from Shanghai educators and parents. Literature (Liu & Bray, 2017; Simon, 1972) documented the ways in which parents' rationality may be bounded by uncertainties and incomplete information about alternatives and parents may sometimes simply follow peers rather than making active independent choices. As mentioned above, a potentiality behind the insignificant relationship between OST mathematics education and PISA performance might be OST curricular classes being consumed as a temporary remedy to the psychological unease of parents and students from peer pressure and the stress of high-stakes examinations, rather than actual academic needs (W. Zhang & Bray, 2016). Unnecessary investment on the OST sector driven by education fever might induce collateral damages to the efficiency of the mainstream sector. Considering OST curricular learning as a predominantly examination-oriented activity, experts must reconsider the goal and justifiability of current examination system, as well as the scope these exams test.

Conclusion

As education expands to larger population, competition to high-quality educational opportunities also intensifies. Resources and practices that are perceived to alter academic achievement could be rapidly institutionalized into education (Baker & LeTendre, 2005; Benavot, Cha, Kamens, Meyer & Wong, 1991; Mori & Baker, 2010). Out-of-school time learning has been one distinct example. This study added to the policy-relevant portfolio of educational (in)equalities beyond the time and space of schooling. The tight linkages between social origins and the likelihood of taking up different intensities of OST mathematics education exposed the possibility in which OST curricular instructions exacerbate educational inequalities along socioeconomic lines in the Shanghai context. Wealthy families are able and willing to make use of their financial and social advantages to augment children's education through investing in OST educational resources. Education policies and practices that aim to address educational disparities should not overlook the disparities induced by unequal access to OST education. A potential policy agenda should recognize OST education's favorable externalities and incorporate some public components (i.e., governmental assistance) to low-performing and low-income students to boost equality. In Japan, for instance, the government subsidized tutoring and made such services available to a broader host of families and students, after accepting its use was normative and beneficial, (Baker et al., 2001).

Although adopted a new methodology in researching the effectiveness of OST curricular instructions with cross-sectional data – propensity score analysis in combination with dosage, this study has limitations, mostly driven by the instrument. PISA 2012 did not provide a precise definition of OST education, either accounted for a durable process of OST learning or a possibly much broader range of modes comparing to regular schooling (Bray & Kobakhidze, 2014). Although focusing on mathematics enabled the inclusion of the most relevant predictors and improved the model fit, the survey itself did not consider how OST education in other subjects could potentially interfere with the time available for OST mathematics lessons. This study did correct the selection bias based on the observed characteristics of students and schools by the propensity score technique. Caution is needed for the unmeasured variability related to self-selection into the use of a particular form of OST education. The measurement relied heavily on students' responses and perceptions, which might also increase the risk of bias due to the lack of parents' and teachers' perspectives.

In spite of these limitations, PISA 2012 has been a rich dataset thanks to its complex structure, rigorous design, and the greater emphasis on measuring teaching and learning mathematics. PISA is also a valid data source to understand the phenomenon of OST curricular learning in a broader sense and how such activities shape learning in one economically, socially and educationally unique context. Thus, this study contributes to the field by identifying the multi-layered interconnections between OST education and mainstream schooling: mainstream schooling's quality is one of the key incentives of increased participation of OST curricular learning; on the other hand, OST education enables the development of positive study habits and ethics that could benefit mainstream schooling outcomes. Policy efforts that intend to shape students' non-cognitive skills could consider out-of-school time interventions that take place at families, neighborhoods, or communities.

References

Aslam, M. & Atherton, P. (2011). *The "shadow" education sector in India and Pakistan: The determinants, benefits and equity effects of private tutoring.* Presentation at the UKFIET (United Kingdom Forum for International Education and Training) Conference, University of Oxford.

Baker, D. P. (2014). *The schooled society: The educational transformation of global culture*. Stanford: Stanford University Press.

Baker, D. P., Akiba, M., LeTendre, G. K., & Wiseman, A. W. (2001). Worldwide shadow education: outside-school learning, institutional quality of schooling, and cross-national mathematics achievement. *Educational Evaluation and Policy Analysis*, *23*(1), 1-17.

Baker, D. P. & LeTendre, G. K. (2005). *National differences, global similarities: world culture and the future of schooling*. Stanford: Stanford University Press.

Benavot, A., Cha, Y., Kamens, D., Meyer, J. W., & Wong, S. (1991). Knowledge for the masses: World models and national curricula, 1920-1986. *American Sociological Review, 56*(1), 85-100.

Betts, J. R., & Shkolnik, J. L. (2000). The effects of ability grouping on student achievement and resource allocation in secondary schools. *Economics of Education Review*, *19*(1), 1–15.

Blau, D. M. (1999). The effect of income on child development. *Review of Economics and Statistics, 81*(2), 261-276.

Bourdieu, P. (1986). The forms of capital. In J. G. Richardson (Ed.), *Handbook of theory and research for the sociology of education* (pp. 241-258). New York: Greenwood Press. (Original work published 1983)

Bourdieu, P., & Passeron, J. C. (1979). *The inheritors: French students and their relation to culture* (R. Nice, Trans.). Chicago: University of Chicago Press. (Original work published 1964)

Bray, M. (1999). *The Shadow Education System: Private Tutoring and its Implications or Planners*. Paris: UNESCO International Institute for Educational Planning. Fundamentals of Educational Planning No. 6.

Bray, M. (2010). Researching shadow education: Methodological challenges and directions. *Asia Pacific Education Review, 11*(1), 3-13.

Bray, M. (2017). Schooling and its supplements: Changing global patterns and implications for comparative education. CIES Presidential Address. *Comparative Education Review, 61*(3), 469-491. https://doi.org/10.1086/692709

Bray, M., & Kobakhidze, M. N. (2014). Measurement Issues in Research on Shadow Education: Challenges and Pitfalls Encountered in TIMSS and PISA. *Comparative Education Review*, *58*(4), 590–620. https://doi.org/10.1086/677907

Bray, M., & Lykins, C. R. (2012). *Shadow education: private supplementary tutoring and its implications for policy makers in Asia*. Mandaluyong City, Metro Manila, Philippines: Asian Development Bank.

Bray, M., Zhan, S., Lykins, C., Wang, D., & Kwo, O. (2014). Differentiated demand for private supplementary tutoring: Patterns and implications in Hong Kong secondary education. *Economics of Education Review*, *38*, 24–37. https://doi.org/10.1016/j.econedurev.2013.10.002

Bronfenbrenner, U. (1994). Ecological models of human development. *International Encyclopedia of Education, 3*(2), 1643-1647.

Byun, S. (2010). Does policy matter in shadow education spending? Revisiting the effects of the high school equalization policy in South Korea. *Asia Pacific Education Review*, *11*(1), 83–96. https://doi.org/10.1007/s12564-009-9061-9

Byun, S. (2014). Shadow Education and Academic Success in Republic of Korea. In H. Park & K. Kim (Eds.), *Korean Education in Changing Economic and Demographic Contexts* (pp. 39–58). Singapore: Springer Singapore. Retrieved from http://link.springer.com/10.1007/978-981-4451-27-7_3

Byun, S. Y., & Park, H. (2012). The Academic Success of East Asian American Youth: The Role of Shadow Education. *Sociology of Education*, *85*(1), 40–60. https://doi.org/10.1177/0038040711417009

Cheung K., Sit, P., & Mal, S. (2015, July). *The effects of work ethics and attributions to failure on Mathematical literacy performance: A study of learning characteristics of academic resilient students in Shanghai, Singapore, Hong Kong, Taiwan and Korea.* Paper presented at the meeting of the International Group for the Psychology of Mathematics Education (PME 39), Hobart, Australia.

Choi, H. (2007). *Does private tutoring help advancement to higher education*? (Working Paper 2007-1). Seoul: Korea Labor Institute.

Chu, H. (2009). The Impact of Family Background and Personal Characteristics on the Participation in Supplementary Education in China. *Education Research Monthly 12*, 22–27 [in Chinese].

Coleman, J. S. (1988). Social capital in the creation of human capital. *The American Journal of Sociology, 94*, S95-S120.

Dang H. A. (2007). The determinants and impact of private tutoring classes in Vietnam. *Economics of Education Review, 26*(6), 683–98. https://doi.org/10.1016/j.econedurev.2007.10.003

Dang, H. A., & Rogers, F. H. (2008). The growing phenomenon of private tutoring: does it deepen human capital, widen inequalities, or waste resources? *The World Bank Research Observer, 23*(2), 161–200. doi:10.1093/wbro/lkn004

Davies, S. & Aurini, J (2006). The franchising of private tutoring: a view from Canada. *The Phi Delta Kappa, 88(*2), 1123–28.

Deloitte (2014). *Report on the diversification of China's education industry*. China Research and Insight Center. Deloitte China. Retrieved from https://www2.deloitte.com/content/dam/Deloitte/cn/Documents/technology-media-telecommunications/deloitte-cn-tmt-deloitte2014educationindustryreport-en-220514.pdf

Dixon-Román, E. (2007). *The mystery of inequity: modeling the influence of intergenerational access on intellective competence* (Unpublished doctoral dissertation). Fordham University, New York.

Dixon-Román, E. (2012). Introduction: social space and the political economy of education conceived comprehensively, in Dixon-Román, E. & Gordon, E. W. (eds.). *Thinking comprehensively about education: spaces of educative possibility and their implications for public policy* (pp.1-13). New York, NY: Routledge/Taylor & Francis.

Duncan, G. J., & Brooks-Gunn, J. (1997). *Consequences of growing up poor*. New York, NY: Russell Sage.

Eckler, R. (2015, April 12). The new tutor dynasty: tutors aren't just for underachieving kids anymore. They're the new normal. *Macleans*. Retrieved from http://www.macleans.ca/education/the-new-tutor-dynasty

Edwards, T.G. (2020). *Closing the gap of the educational needs of homeless youth*. I. Sahin & M. Shelley (Eds.). Monument, CO, USA: ISTES Organization.

Fan, Y. L. (2012). *A research on supplementary tutoring of junior students in Taiyuan* (Masters Thesis), Shanxi University of Finance and Economics, Shanxi. [in Chinese]

Fang, C, & Feng, X. (2008). Family background and academic achievements: a study of stratum differences in compulsory education. *Zhejiang Social Science, 24*(8), 47–55.

Gadsden, V. L., & Dixon-Román, E. J. (2017). "Urban" Schooling and "Urban" Families: The Role of Context and Place. *Urban Education, 52*(4), 431–459. https://doi.org/10.1177/0042085916652189

Goetz, T., Cronjaeger, H., Frenzel, A. C., Lüdtke, O., & Hall, N. C. (2010). Academic self-concept and emotion relations: Domain specificity and age effects. *Contemporary Educational Psychology, 35*, 44–58. http://dx.doi.org/10.1016/j.cedpsych.2009.10.001.

Guo, S. (2005). Analyzing grouped data with hierarchical linear modeling. *Children and Youth Services Review, 27*(6), 637–652. https://doi.org/10.1016/j.childyouth.2004.11.017

Hartmann, S. (2013). Education 'home delivery' in Egypt: Private Tutoring and social stratification," in Bray, M., Mazawi, A., & Sultana, R. (eds.), *Private tutoring across the Mediterranean: Power dynamics, and implications for learning and equity* (pp. 57-75). Rotterdam: Sense

Hong, G., & Raudenbush, S. W. (2006). Evaluating kindergarten retention policy: A case study of causal inference for multilevel observational data. *Journal of the American Statistical Association*, *101*(475), 901–910.

Hussein, M.G.A (1987). Private tutoring: a hidden educational problem. *Educational studies in mathematics, 18*(1), 91-96.

Jiang, Y., Song, J., Lee, M., & Bong, M. (2014). Self-efficacy and achievement goals as motivational links between perceived contexts and achievement. Educational Psychology: *An International Journal of Experimental Educational Psychology, 34*(1), 92–117. http://dx.doi.org/10.1080/01443410.2013.863831.

Kang, C. (2007). *Does money matter? the effect of private educational expenditures on academic performance: Evidence from exogenous variation in birth order*. (Working Paper No. 0704). National University of Singapore. Retrieved from http://www.fas.nus.edu.sg/ecs/pub/wp/wp0704.pdf

Karakolidis, A., Pitsia, V., & Emvalotis, A. (2016). Examining students' achievement in mathematics: A multilevel analysis of the Programme for International Student Assessment (PISA) 2012 data for Greece. *International Journal of Educational Research, 79,* 106–115. http://dx.doi.org/10.1016/j.ijer.2016.05.013.

Kennedy, P. (2003). *A guide to econometrics* (5th ed.) Cambridge: MIT Press.

Kim, J. (2007). *Factors influencing the participation of Korean high school students in private tutoring activities under the implementation of the high school equalization policy* (Doctoral dissertation). The Pennsylvania State University, PA. Retrieved from https://etda.libraries.psu.edu/paper/7973/3279

Kim, J-H & Chang, J. (2010). Do governmental regulations for cram schools decrease the number of hours students spend on private tutoring? *KEDI Journal of Education Policy 7*(1), 3–21

Kim, J-H & Park, D. (2010). The determinants of demand for private tutoring in South Korea. *Asia Pacific Education Review. 11*(3), 411–21

Kim, S. & Lee, J-H. (2010). Private Tutoring and Demand for Education in South Korea. *Economic Development and Cultural Change 58*(2), 259–296.

Kim, S. W., Brown, K.-E., Kim, E. J., & Fong, V. L. (2018). "Poorer children study better": how urban Chinese young adults perceive relationships between wealth and academic achievement. *Comparative Education Review*, *62*(1), 84–102.

Kirby, P. (2016). *Shadow schooling: Private tuition and social mobility in the UK*. London: The Sutton Trust.

Kuan, P. Y. (2011). Effects of Cram Schooling on Mathematics Performance: Evidence from Junior High Students in Taiwan. *Comparative Education Review*, *55*(3), 342–368. https://doi.org/10.1086/659142

Kwok, P. (2001). Local knowledge and value transformation in East Asian mass tutorial schools. *International Education Journal*, *2*(5), 86–97.

Lagravinese, R., Liberati, P., & Resce, G. (2017). *How does economic social and cultural status affect the efficiency of educational attainments? a comparative analysis on PISA results*. (Departmental Working Papers of Economics). University Roma Tre. https://doi.org/10.13140/rg.2.2.16746.31684

Lai, M. H. C., & Kwok, O. (2015). Examining the Rule of Thumb of Not Using Multilevel Modeling: The "Design Effect Smaller Than Two" Rule. *The Journal of Experimental Education*, *83*(3), 423–438. https://doi.org/10.1080/00220973.2014.907229

Lareau, A. (2003). *Unequal childhoods: class, race, and family life*. Berkeley: Univ. Calif. Press

Lee, J. (2009). Universals and specifics of math self-concept, math self-efficacy, and math anxiety across 41 PISA 2003 participating countries. *Learning and Individual Differences, 19,* 355–365. http://dx.doi.org/10.1016/j.lindif.2008.10.009.

Lee, J., & Stankov, L. (2013). Higher-order structure of noncognitive constructs and prediction of PISA 2003 mathematics achievement. *Learning and Individual Differences, 26*, 119–130. http://dx.doi.org/10.1016/j.lindif.2013.05.004.

Lee, J. Y. (2013). *Private tutoring and its impact on students' academic achievement, formal schooling and educational inequality in Korea* (Doctoral dissertation). Retrieved from https://academiccommons.columbia.edu/doi/10.7916/D8K64R8K

Lei, W. P. (2005). Expenditure on private tutoring for upper secondary students: Determinants and policy implications. *Education and Economy*, *1*, 39-42. [in Chinese]

Leung, F. K. S. (1998). The implications of Confucianism for education today. *Journal of Thought*, *33*(2), 25-36.

Li, Z., & Qiu, Z. (2018). How does family background affect children's educational achievement? Evidence from Contemporary China. *The Journal of Chinese Sociology*, *5*(1). https://doi.org/10.1186/s40711-018-0083-8

Lin, J. (1999). *Social transformation and private education in China*. New York: Praeger.

Liu, J., & Bray, M. (2017). Determinants of demand for private supplementary tutoring in China: findings from a national survey. *Education Economics*, *25*(2), 205–218. https://doi.org/10.1080/09645292.2016.1182623

Liu, J., & Bray, M. (2018). Evolving micro-level processes of demand for private supplementary tutoring: patterns and implications at primary and lower secondary levels in China. *Educational Studies*, 1–18. https://doi.org/10.1080/03055698.2018.1555452

Long, J. S. (1997). *Regression Models for Categorical Dependent Variables*. Thousand Oaks, CA: Sage Publications.

Lüdtke, O., Marsh, H. W., Robitzsch, A., Trautwein, U., Asparouhov, T. & Muthén, B. (2008). The multilevel latent covariate model: A new, more reliable approach to group-level effects in contextual studies. *Psychological Methods*, *13*(3), 203-229. http://dx.doi.org/10.1037/a0012869

Ma, H. X. (2011). *The status and influence factors of private tutoring of urban lower secondary school students: A case study in Gansu Province.* (Masters Thesis), Northwest Normal University, Lanzhou. [in Chinese]

Majumdar, M. (2014). *The shadow school system and new class divisions in India*. London: Max Weber Stiftung

Mason, M. (2014). Culture and educational outcomes in "Confucian heritage" societies in Asia. *Revue Internationale D'éducation de Sèvres*. Retrieved from https://ries.revues.org/3812

Maynes, M. J. (1985). *Schooling in Western Europe: A social history*. Albany: State University of New York Press.

McCombs, J., Whitaker, A., & Yoo, P. (2017). *The Value of Out-of-School Time Programs*. Santa Monica, CA: RAND Corporation. Retrieved from https://www.rand.org/pubs/perspectives/PE267.html.

Meyer, J. W. (1977). The effects of education as an institution. *American Journal of Sociology*, 55–77.

Mislevy, R. J. & Sheehan, K. M. (1987), Marginal Estimation Procedures, in A.E. Beaton (ed.), *The NAEP 1983-84 Technical Report, National Assessment of Educational Progress* (pp. 293-360), Princeton: Educational Testing Service.

Mori, I. & Baker, D. P. (2010). The origin of universal shadow education: What the supplemental education phenomenon tells us about the postmodern institution of education." *Asia Pacific Education Review*, *11*(1): 36-48.

Morony, S., Kleitman, S., Lee, Y. P., & Stankov, L. (2013). Predicting achievement: Confidence vs self-efficacy, anxiety, and self-concept in Confucian and European countries. *International Journal of Educational Research, 58,* 79–96. http://dx.doi.org/10.1016/j.ijer.2012.11.002.

Nath, S. R. (2008). Private supplementary tutoring among primary students in Bangladesh. *Educational Studies* *34*(1):55–72.

Nanayakkara, G. L. S., & Ranaweera, M. (1994). Impact of private tuition and the educational challenges of the 21st century. *Sveriges Riksbank Economic Review [The People's Bank, Colombo]*, *20* (2 & 3), 11–14, 17.

National Research Council. (1999). *High Stakes: Testing for tracking, promotion, and graduation*. Washington, DC: National Academy Press.

O'Dwyer, S. (2016) Deflating the 'Confucian Heritage Culture' thesis in intercultural and academic English education, *Language, Culture and Curriculum, 30*(2), 198-211.

OECD. (2014). *PISA 2012 Technical Report*. OECD Publishing, Paris. Retrieved from https://www.oecd.org/pisa/pisaproducts/PISA-2012-technical-report-final.pdf

OECD. (2015). Skills for Social Progress: The Power of Social and Emotional Skills, OECD Skills Studies, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264226159-en

Park, H., Buchmann, C., Choi, J., & Merry, J. J. (2016). Learning beyond the school walls: Trends and implications. *Annual Review of Sociology, 42*, 231-252.

Pitsia, V., Biggart, A., & Karakolidis, A. (2017). The role of students' self-beliefs, motivation and attitudes in predicting mathematics achievement: A multilevel analysis of the Programme for International Student Assessment data. *Learning and Individual Differences*, *55(C)*, 163–173. https://doi.org/10.1016/j.lindif.2017.03.014

Rabe-Hesketh, S., & Skrondal, A. (2006). Multilevel modelling of complex survey data. *Journal of the Royal Statistical Society, A*(169), 805–827.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models* (2nd ed.). Thousand Oaks: Sage.

Ridgeway, G., Kovalchik, S. A., Griffin, B. A., & Kabeto, M. U. (2015). Propensity Score Analysis with Survey Weighted Data. *Journal of Causal Inference*, *3*(2), 237-249. https://doi.org/10.1515/jci-2014-0039

Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, *70*(1), 41-55.

Rubin, D. (1980). Bias Reduction Using Mahalanobis-Metric Matching. *Biometrics*, *36*(2), 293-298. doi:10.2307/2529981

Rubin, D.B. (1987), *Multiple Imputation for Nonresponse in Surveys*, John Wiley & Sons, New York.

Ryu, D., & Kang, C. (2013). Do private tutoring expenditures raise academic performance? Evidence from middle school students in South Korea. *Asian Economic Journal. 27*(1), 59–83.

Seaton, M., Parker, P. D., Marsh, H. W., Craven, R. G., & Yeung, A. S. (2014). The reciprocal relations between self-concept, motivation and achievement: Juxtaposing academic self-concept and achievement goal orientations for mathematics success. *Educational Psychology: An International Journal of Experimental Educational Psychology, 34*(1), 49–72. http://dx.doi.org/10.1080/01443410.2013.825232.

Seth, M. J. (2002). *Education Fever: Society, politics, and the pursuit of schooling in South Korea*. Honolulu: University of Hawai'i Press.

Shen, H. (2008). An investigation on factors influencing private supplementary tutoring at the level of compulsory education. *Economics of Education Research*, (*Peking University) 6*(3), 1-10.[in Chinese]

Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research*, *75*(3), 417–453.

Simon, H. A. (1972). Theories of Bounded Rationality. In C. B. McGuire & R. Radner (eds). *Decision and Organization* (pp. 161–176). Amsterdam: North-Holland Publishing Company.

Southgate, D. E. (2009). Determinants of shadow education: a cross-national analysis. Doctoral dissertation. The Ohio State University.

Southgate D. E. (2013). Family capital: a determinant of supplementary education in 17 nations. In J. Aurini, S. Davies & J. Dierkes (eds). *Out of the shadows: The global intensification of supplementary education*, (pp. 245–58). Bingley, UK: Emerald Group.

SSCC (Social Science Computing Cooperative) (2012) *Multiple imputation in Stata: examples*. Social Science Computing Cooperative. University of Wisconsin Madison. Retrieved from https://www.ssc.wisc.edu/sscc/pubs/stata_mi_ex.htm

Stankov, L. (2013). Noncognitive predictors of intelligence and academic achievement: An important role of confidence. *Personality and Individual Differences,* *55*(7), 727–732. http://dx.doi.org/10.1016/j.paid.2013.07.006.

Stankov, L., & Lee, J. (2014). Quest for the best non-cognitive predictor of academic achievement. Educational Psychology: *An International Journal of Experimental Educational Psychology*, *34*(1), 1–8. http://dx.doi.org/10.1080/01443410.2013.

Stevenson, D. L., & Baker, D. P. (1992). Shadow education and allocation in formal schooling: Transition to university in Japan. *American Journal of Sociology*, *97*(6), 1639–1657. Retrieved from http://www.jstor.org/stable/2781551

Sun, Z., Liu, Z., & Sun, B. (2009). Family, school, and children's academic achievements—based on the study of rural areas in Gansu Province. *Journal of Beijing Normal University (Social Science Edition), 37*(5), 103–115.

Suryadarma, D., Suryahadi, A., Sumarto, S. & Rogers, F. H. (2006). Improving Student Performance in Public Primary Schools in Developing Countries: Evidence from Indonesia. *Education Economics*, *14*(4), 401-429.

Tang, L. J. (2009). *Factors influencing participation in private tutoring at the level of compulsory education - Based on the survey and analysis in Wuhan and Shenzhen. (*Masters Thesis), Huazhong Normal University, Wuhan. [in Chinese]

Tsang, M. C., Ding, X. H., & Shen, H. (2010). Urban-rural disparities in private tutoring of lower-secondary students. *Education and Economics*, *2*, 7-11. [in Chinese]

Watkins, D., & Biggs, J. (Eds.). (1996). *The Chinese learner: Cultural, psychological and contextual influences.* Hong Kong: Centre for Comparative Research in Education/Camberwell, Vic.: Australian Council for Educational Research.

Williams, R. (2016). Understanding and interpreting generalized ordered logit models. *The Journal of Mathematical Sociology*, *40*(1), 7–20. https://doi.org/10.1080/0022250X.2015.1112384

Xue, H. P., & Ding, X. H. (2008). An empirical study on private tutoring for students in urban China. *Economics of Education Research (Peking University), 6*(1), 1-14. [in Chinese]

Yin, M. (2018) Moving from rural to urban: urbanization and its implications for educational equality and equity in China. In B. Grant, C. Liu, & L. Ye (eds) *Metropolitan Governance in Asia and the Pacific Rim* (pp. 143-162). Springer, Singapore.

Zhang, Y. (2011). *The determinants of national college entrance exam performance in China – With an analysis of private tutoring* (Doctoral dissertation). Retrieved from https://academiccommons.columbia.edu/doi/10.7916/D8MP5978

Zhang, W. (2013). *Private supplementary tutoring received by grade 9 students in Chongqing, China: determinants of demand, and policy implications.* Pokfulam, Hong Kong SAR: The University of Hong Kong.

Zhang, W. & Bray, M. (2016). Shadow education: The rise and implications of private supplementary tutoring." in Guo, S. & Guo, Y (eds.), *Spotlight on China: Changes in education under China's market economy* (pp. 85-99). Rotterdam: Sense Publishers.

Zhang, Y., & Zhang, Z. (2006). Guanxi and organizational dynamics in China: a link between individual and organizational levels. *Journal of Business Ethics*, *67*(4), 375–392. https://doi.org/10.1007/s10551-006-9031-7

Zhou, M. (2012). The ethnic system of supplementary education: lessons from Chinatown and Koreatown, Los Angeles, in Dixon-Roman, E. & Gordon, E. W (eds.), *Thinking comprehensive about education: spaces of educative possibility and their implications for public policy* (pp. 65-81). New York: Routledge.

Zhou, Y., & Wang, D. (2015). The Family Socioeconomic Effect on Extra Lessons in Greater China: A Comparison between Shanghai, Taiwan, Hong Kong, and Macao. *The Asia-Pacific Education Researcher*, *24*(2), 363-377. https://doi.org/10.1007/s40299-014-0187-0

Author Information

Ming Yin, Ph.D.
Rice University
Houston Education Research Consortium
6100 Main Street MS 258 Houston, Texas 77005
United States
Contact e-mail: *mingyin@rice.edu*