

DISCUSSION PAPER SERIES

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Simon Chang
Deborah A. Cobb-Clark
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Simon Chang

The University of Western Australia and IZA

Deborah A. Cobb-Clark

The University of Sydney, ARC Life Course Centre and IZA

Nicolás Salamanca

The University of Melbourne, ARC Life Course Centre and IZA

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IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Parents' Responses to Teacher Qualifications*

We identify the causal effect of teacher qualifications on parents' investments in their children. Exploiting a unique, high-stakes educational setting in which teachers are randomly assigned to classes, we show that parents react to more qualified teachers by increasing their financial investments in their children. The key mechanism is an increase in parents' belief that academic achievement is driven by student effort—for which financial investment is instrumental. However, higher teacher qualifications do not improve student test scores. This is likely due to a negative effect of teacher qualifications on students' belief in the importance of effort for academic achievement. Our findings uncover various family-wide behavioral reactions to teacher qualifications and highlight the intricacies in educational production within households.

JEL Classification: D10, I21, I24

Keywords: teacher quality, student achievement, parental investment, beliefs, school effort

Corresponding author:

Nicolás Salamanca
Melbourne Institute: Applied Economic & Social Research
University of Melbourne
111 Barry St.
Parkville, VIC 3010
Australia
E-mail: n.salamanca@unimelb.edu.au

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1. INTRODUCTION

Parents have a fundamental role in shaping children's life chances. Their decisions about the environment in which their children are raised, the people their children interact with, and the investments their children receive can have long-lasting consequences. There is no doubt that governments, communities, and schools also shape children's human development. Yet it is the family context that is paramount since parents' investment decisions to either compensate or reinforce any human capital disparities between children have the potential to undermine the public investment made in them (Becker & Tomes 1976).

Understanding this process is not easy. Parents' investment strategies depend on their own preferences, as well as on their beliefs and available resources. Theoretical predictions regarding parents' optimal investment strategies hinge on the assumptions that researchers make. Moreover, models in which parental investment in human capital is multidimensional predict that parents may simultaneously compensate along some dimensions while reinforcing along others (Yi et al. 2015). We also have little empirical guidance about the economic importance of the relationships between parents' investments and public inputs. Extensive research analyzes the role of family and school inputs in the production of educational achievement; yet most studies estimate policy parameters that simply subsume parental behavioral responses rather the underlying production function parameters that drive parents' behavior (see Todd & Wolpin 2003). Studies that do attempt to isolate parents' reaction to changes in school inputs yield mixed results (see Bonesrønning 2004; Gelber & Isen 2013; Pop-Eleches & Urquiloa 2013; Friedriksson et al. 2016).

Our objective is to shed light on the determinants of parents' investments by analyzing their behavioral responses to changes in the qualifications of their children's teachers. We do this by exploiting Taiwan's unique educational system—specifically, the legal requirement for schools to randomly assign teachers to classes—to identify the causal effect of teacher qualifications on the resources (i.e., money, time, and attention) that parents invest in their children. Our focus is on children's 'Dao Shi' (導師) (homeroom teachers) because Taiwan's cultural traditions and institutional arrangements give them a crucial role in not only providing classroom instruction, but also in supporting students' personal development (Chen & Astor 2009; Wei & Chen 2010; Taiwan Ministry of Education 2018). We also carefully investigate how parents' behavioral responses vary with their own socioeconomic status in recognition of the growing evidence that socioeconomic disadvantage limits not only financial resources, but also cognitive capacity, thereby altering decision-making (e.g., Shah et al. 2012; Mani et al.

2013; Mullainathan & Shafir 2013). Examining how low and high socioeconomic status parents respond is informative about the potential mechanisms driving parents' behavioral reactions. Finally, we use data on parents' and their children's beliefs about the drivers of academic achievement as well as data on student effort to inform our results. Effort and beliefs play a crucial role in explaining the motivation for parents' investments and, consequently, their likely impacts (see De Fraja et al. 2010; Boneva & Rauh 2018; Attanasio et al. 2019a,b; Dizon-Ross 2019).

We find that parents react to higher Dao Shi qualifications by making more financial investments of their own. Parents whose children are exogenously assigned to a Dao Shi with a post-graduate degree subsequently spend 5.5 percent of a standard deviation more on tutoring for their children; they do not, on average, alter the way they discipline their children, their warmth, or their time investments in response to teacher qualifications. Parent-teacher contact matters; parents increase their financial investments in response to higher qualifications only if they are in close contact with their child's Dao Shi. Highly educated parents also react more strongly to Dao Shi qualifications. They increase their financial investments in their children's tutoring by 16.3 percent of a standard deviation and there is also some evidence they become warmer parents. These responses are consistent with complementarity in private (parents') and public (teachers') investments in children (Fredriksson et al. 2016). We also show that higher Dao Shi qualifications strengthen parents' beliefs that student effort is a key driver of student academic achievement. This suggests that the increase in financial investments—which in this context is private tutoring—is an instrumental way for parents to increase their children's study effort.

We then show that Dao Shi qualifications have no effect on students' standardized test scores. This finding is in itself not surprising; many studies find no relation between teacher qualifications and student outcomes (e.g., Hanushek & Rivkin 2006; Hanushek 2011; Feld et al. in press), while private tutoring seems to have only small effects on students' academic performance (Kuan 2011). Using data on students' beliefs, we extend the literature by demonstrating that this finding may result from students becoming less motivated and reducing their study effort in response to more private tutoring. This would be consistent with other studies that find strategic interactions between the effort exerted by parents, schools, and students themselves (De Fraja et al. 2010).

Our work makes several important contributions to the literature. First, our focus on the qualifications and experience of Taiwanese teachers brings a new perspective to the small, but growing, literature investigating parental responses to exogenous variation in class size

(Bonesrønning 2004; Datar & Mason 2008; Friedriksson et al. 2012), school grants (Das et al. 2013), ability-based tracking (Fu & Mehta 2018), school access (Pop-Eleches & Urquiloa 2013), and Head Start (Gelber & Isen 2013). Unlike their counterparts in the United States, Taiwanese adolescents remain in the same class with the same cohort of students throughout middle school. Each class is randomly assigned a Dao Shi who—in Confucian tradition—will not only teach, but also guide and mentor them daily for up to three years. Dao Shi are expected to get to know each student personally, especially those experiencing disadvantage, and to use this relationship to support their students’ academic performance (Chen & Astor 2009). Dao Shi are also parents’ first port of call for discussing their children’s academic performance; they are available for parental phone calls outside of school hours and may visit students at home. Taiwan’s high-stakes educational setting allows us to estimate the causal effect of a persistent change in a key school input—teachers—on parents’ investments in their children, deepening our understanding of parents’ behavioral reactions to school inputs.

Second, we analyze a broader range of parental responses than has been considered before. Like others, we consider the way parents change the resource and time investments that they make in response to changes in school inputs. We also allow changes in teacher quality to influence the way that parents discipline and monitor their children. This is an important contribution to the emerging economics literature linking parenting practices and style to adolescent outcomes (see Cobb-Clark et al. 2019 for a review). In particular, we contribute to the broader discussion regarding the estimation of education production functions with mis-measured and omitted inputs (see e.g., Heckman & Pinto 2015) and to a deeper understanding of the way that parenting style might respond to school inputs (e.g., Doepke et al. 2019).

Third, we look at several conceptually important mechanisms that are typically not observed including teachers’ out-of-classroom tutoring, parents’ beliefs, and student effort. Many teachers in Taiwan engage in out-of-classroom tutoring which has the potential to influence the advice they give parents and confound the interpretation of our main results. Moreover, recent studies highlight the malleability of parents’ beliefs and demonstrate the importance of parents’ beliefs in driving their investments (Attanasio et al. 2019b; Dizon-Ross 2019). Consequently, we also analyze parents’ beliefs in order to understand which inputs parents consider to be important in the education production function and how changes in school inputs affect those views. Without this analysis, our initial results would seem to suggest that parents place an intrinsic value on private tutoring. Instead, it seems more likely that parents view tutoring as a useful tool to increase student effort.

Finally, we simultaneously explore children's compensating behavior in response to parental and school investments. Children's agency in the educational process makes it difficult to learn from reduced-form estimates; observed outcomes are the equilibrium result of not just parent and school interactions, but also of children's own choices (see e.g., Weinberg 2001; Lizzeri & Siniscalchi 2008; De Fraja et al. 2010). Analyzing children's behavior, therefore, becomes crucial when interpreting results. In our case, because we can analyze children's effort as well as their beliefs, we are able to provide evidence that student demotivation is a potential compensatory mechanism underlying the effect of teacher qualifications on student achievement.

The paper proceeds as follows. In Section 2, we review the previous literature which focuses on parents' responses to exogenous changes in school inputs. Our institutional setting and empirical strategy are described in Section 3 and our data are described in Section 4. In Section 5, we present our main results showing how teacher qualifications affect parents' investments. We explore some potential mechanisms underlying these effects in Section 6. In Section 7, we show the effect of teacher qualifications on children's academic achievement and reconcile these findings with our other results. Finally, our conclusions and suggested directions for future research are discussed in Section 8.

2. PREVIOUS LITERATURE

There is extensive evidence demonstrating that the link between additional resources (e.g., more per-student expenditure, higher teacher salaries, smaller class sizes, better peers) and improved educational outcomes is, at best, contentious. Some studies find positive effects, while others find zero or even negative effects (see Krueger 2003; Hanushek 2003, 2006; Houtenville & Conway 2008 for reviews). Caution is required when interpreting estimates of the effect of school inputs on children's educational achievement, however, if parents' behavioral responses have not been adequately controlled for (Datar & Mason 2008; Das et al. 2013; Albornoz et al. 2017). When parents decrease their investments in their children in response to an increase in school inputs, estimates of the school input-child output relationship are attenuated; when parents reinforce an increase in school inputs, estimates are overstated. Importantly, these biases arise irrespective of whether estimates are based on experimental or observational data (Fu & Mehta 2018).

Few studies examine the behavioral responses of parents to exogenous changes in school inputs. Those that do, find mixed results, as illustrated by research on parental reactions to class size. Bonesrønning (2004) provides evidence that parents spend less time helping with,

discussing, and monitoring their children's schoolwork as class size increases. Datar and Mason (2008) also find that increases in class size are associated with a decrease in parent-child interaction; but an increase in activities financed by parents and no change in parent-school interactions. Similarly, Friedriksson et al. (2012) conclude that parents across the socioeconomic spectrum respond to increased class size by moving their children into new schools; high-skill parents also provide more help with homework (Friedriksson et al. 2016). Thus, parents respond to changes in class size in complex ways—sometimes reinforcing and sometimes offsetting changes in school resources.

The same complexity is apparent when other school inputs are considered. Parents whose children are randomly assigned to Head Start increase their effort in reading to children, doing math activities, and ensuring that children spend time with non-residential fathers (Gelber & Isen 2013). Yet parents whose children are randomly admitted to a selective school reduce the extent to which they help with homework, volunteer at school, and pay for outside tutoring (Pop-Eleches & Urquiola 2013; Malamud et al. 2016). Das et al. (2013) study randomly allocated school grants and find that parents reduce educational expenditure on their children almost dollar for dollar when grants are anticipated, and make very little expenditure adjustment when grants are unanticipated.

Importantly, parents' beliefs matter for the investments they make (Boneva & Rauh 2018; Attanasio et al. 2019a), yet parents often have imperfect information about many aspects of the educational process (see Dizon-Ross 2019). This opens the door for parents to respond not only to changes in their children's school inputs, but also to new information about existing inputs. Greaves et al. (2019), for example, find that parents who receive good news about the quality of their children's school respond by reducing the time they invest in their children. Parents are also responsive to new information about their children's academic ability. Dizon-Ross (2019), for example, demonstrates that parents reallocate their educational investments when provided with accurate, easily understandable information about their children's academic performance. Not all interventions, however, are effective in shifting parents' beliefs (see Attanasio et al. 2019b). Moreover, the potential for parents' information to be imperfect implies that they may not know which of their investment options has the largest impact or even whether any of their investments will have a positive return. This uncertainty implies that parents may make mistakes when investing in their children's human development.

Finally, parents' investment choices will be constrained by the strategic interactions they have with their children. In particular, adolescents are best thought of as economic agents with independent preferences and the power to influence family outcomes. For this reason,

researchers often adopt a noncooperative game theoretic framework when modelling the interaction between parents and their adolescent children (e.g., Weinberg 2001; Burton et al. 2002; Hao et al. 2008; Lundberg et al. 2009). Rather than unilaterally determining outcomes, parents steer their children in the right direction through the child rearing practices they adopt. These practices include not only providing incentives (e.g., Weinberg 2001; Hao et al. 2008) and establishing boundaries (e.g., Cosconati 2009; Lundberg et al. 2009), but also the style of parenting adopted (e.g., Burton et al. 2002).¹

3. METHOD

3.1 *The Taiwanese Educational Setting*

Even if someone is your teacher for only a day, you should regard him like your father for the rest of your life.

- Chinese Proverb

The Taiwanese society shares the same Confucian values with the mainland of China regarding the role of teachers as both learned scholars providing knowledge essential for living, and moral figures setting role models for students to follow. Consequently, teaching is a highly regarded and relatively well-paid occupation in Taiwan (Fwu & Wang 2002).

Formal education in Taiwan is organized in a similar way to other OECD countries. Compulsory education consists of six years of primary school followed by three years of junior high school. Graduates of junior high school may leave the formal education sector or pursue further education in any of the following three tracks: 1) three-year senior high school; 2) three-year senior vocational school; or 3) five-year junior college. Senior high school is the most academically competitive and puts students on the pathway to a university education; vocational school and junior college tracks are vocational. Admissions to these tracks have typically been exam-based.² The exam scores obtained at the end of junior high school, therefore, reverberate throughout more advanced levels of education (Broaded 1997; Nuffic 2015).

There is considerable pressure for students to perform well on exams. As in other East Asian countries, education is highly valued in Taiwan; it is widely considered to be the best vehicle for upward social and economic mobility. Moreover, entrance exams often test knowledge not included in the school-based curriculum (Chou & Yuan 2011). This puts

¹ See Laferrère and Wolff (2006) and Doepke et al. (2019) for reviews.

² Taiwan began to adopt school admission policies which are less reliant on exams in 2014; however, examinations still feature prominently in the process used to assign students to school tracks.

pressure on Taiwanese students to enroll in after-school cram schools or study with private tutors to improve their admission scores for senior high school and university (Chou 2014). More than 50 percent of senior high school students in Taiwan attend cram schools, in most cases to keep up with the regular schoolwork (Taiwan Ministry of Education 2018). Cram schools are expensive. Taiwanese parents on average invest substantially more financial resources into their children's education (3-5 percent of household income) than their western counterparts (1- 2 percent of household income) (Lin & Lin 2012). Research suggests that cram schooling leads to small improvements in students' academic performance (Chen & Lu 2009; Kuan 2011; Liu 2012).

Taiwan performs well in international rankings of academic performance. Results from the OECD's 2015 Program for International Students Assessment (PISA), for example, rank Chinese Taipei students fourth in both math and science among the sixty-nine participating countries (OECD 2018). At the same time, there is evidence that this high academic performance may come at the cost of reduced student well-being. Taiwanese students' anxiety about their schoolwork is much higher than their counterparts elsewhere, while their physical activity and life satisfaction are much lower (OECD 2017).

Taiwanese students entering junior high school are organized into "classes"; these are groups of no more than 35 students who will study together from grades 7 to 9. Students are taught in a fixed classroom called their "homeroom" by different subject-specialist teachers who rotate in and out of the homeroom. Each class is also assigned a Dao Shi (homeroom teacher) who will remain with the class as it progresses through all three years of junior high school.³

The Dao Shi is a central figure in Taiwanese education, responsible for providing not only classroom instruction, but also guidance and education to students on daily life, study, career, behavior and physical and mental health (Taiwan Ministry of Education 2018, p. 7). Consistent with Confucian principles, Dao Shi are ideally not only teachers passing on knowledge, but also friends, mentors, and role models (see Taiwan Ministry of Education 2018). They have a broad remit, accepting responsibility for providing not only educational, but also personal guidance to students; communicating with parents both within and outside of

³ Teachers must possess a teacher certificate issued by the Taiwan Ministry of Education. The requirements to acquire a teaching certificate include: i) Bachelor's degree or higher; ii) a diploma from a pre-service teacher education program; iii) passing the teacher qualification examination; or iv) completion of a teaching internship with satisfactory performance. Teachers are free to apply to any school unless they receive government funding during their undergraduate training, in which case they are assigned to a school.

school hours; and establishing discipline policy. Thus, the Dao Shi has a great deal of influence over the entire course of a student's high school career.

3.2 Assignment of Dao Shi to Classes

Our identification strategy relies on Taiwan's unique institutional arrangements which result in the random assignment of students and Dao Shi to classes within schools. In 2001 when our cohort of interest entered junior high school, Dao Shi assignment was regulated by Article 3 in the *Implementation Guideline for Class Assignment of Junior High School Students*. These guidelines mandated that Dao Shi were to be assigned to incoming first-year junior high school classes by lottery. Moreover, the process assigning both students and Dao Shi to classes was required to be done publicly, permitting parents to attend. The resulting class assignments were then announced publicly and made available for verification for at least six months afterwards.⁴ This transparent lottery process results in the random assignment of Dao Shi with post-graduate qualifications (i.e., Masters degree or, less commonly, PhD) to students within each school. Still, we provide empirical evidence demonstrating the lack of systematic variation between Dao Shi qualifications, student characteristics, and family background in Section 4.3.

4. THE TAIWAN EDUCATIONAL PANEL SURVEY

4.1 Data and Estimation Sample

Our data come from the Taiwan Educational Panel Survey (TEPS) which is a nationally representative sample of approximately 20,000 students born in either 1988 or 1989. The TEPS sample was drawn via a multi-staged stratified, nested cluster sampling method.⁵ Multiple students are sampled within each school. For each student surveyed, a web of related people are also surveyed, including: the parents, the Dao Shi, three subject teachers (Chinese, English and Mathematics), the principal, and the director of academic affairs at their school. Thus, the TEPS data provide us with rich information about students' educational experiences. The first interview (wave 1) was conducted in September 2001, immediately after students began their first year in junior high school (7th grade); follow-up interviews (wave 2) took place in 2003 when students entered their third year (9th grade).

⁴ For details on Article 3 of the *Implementation Guideline for Class Assignment of Junior High School Students* see <https://edu.law.moe.gov.tw/LawContent.aspx?id=FL008358>. An enlightening video documenting the assignment of students to classes and to Dao Shi in Taoyuan City can be accessed at: https://www.youtube.com/watch?v=n1FNI_hxxk8. In 2004, Article 3 was superseded by Article 12 of the *Primary and Junior High School Act*.

⁵ For details about the sampling design see: <http://tepsb.nccu.edu.tw/download/TEPS-EnglishOverview.pdf>.

A students' exposure to a Dao Shi with post-graduate qualifications can be thought of as our treatment variable. Therefore, wave 1 is the pre-treatment period given that the assignment Dao Shi to classes had just taken place; while wave 2 is the post-treatment period given students had been exposed to their Dao Shi for three years.

The complete TEPS dataset has information on 20,055 students in wave 1 and 19,088 students in wave 2. There is little survey or item non-response in TEPS and, importantly, this non-response is not systematically related to the assignment of a Dao Shi with post-graduate qualifications. We retain observations with matched information on students, parents and teachers in both waves and drop observations ($n = 1,047$) for which the responding adult is neither the father or mother of the student (i.e., it is a step parent, grandparent, an older brother or sister, or any other relationship). The resulting estimation sample includes 18,008 student-parent observations taught by 1,236 different Dao Shi in 333 distinct schools.

Our estimation sample has similar characteristics to the TEPS sample (see Appendix Table B.1). At wave 1, students are 12 years old on average; 49 percent are girls and 50 percent belong to families with more than two children. The majority (88 percent) of these students' parents are married and 5 percent of them are an ethnic minority. On average, mothers are 39 years old and fathers are 42 years old; 13 percent of families have at least one parent who is college-educated; and the average family income is NT \$62,600 per month (approximately \$2,500 USD in 2019).

4.2 Outcome Measures

Parents' Investments

Our key outcomes capture four dimensions of parents' investments: money, time, discipline, and warmth. These parental investments are measured in waves 1 and 2; however, wave 2 only asked a subset of the items asked in wave 1. For each investment, we sum the answers to all items and then standardize each measure by subtracting the sample mean and dividing by the sample standard deviation.⁶ Below we describe our wave 2 measures of parents' investments; these are key outcomes we consider. We also construct wave 1 measures—which combine more items—which are used only in our balancing checks (see Section 4.3).

The primary and most costly financial investment parents make in their children's education is private tutoring (Chou & Yuan 2011; Chou 2014). We combine three items that

⁶ Details about the item selection and scale construction can be found in Appendix A. Appendix Table B.2 shows summary statistics of all the items used for constructing these scales. Our results are robust to using scales constructed through confirmatory factor analyses.

measure private tutoring (including attending cram schools): i) the number of semesters since entering junior high school that students undertake private tutoring; ii) the number of hours per week spent in private tutoring in the previous semester; and iii) the monthly expenditure on private tutoring in the previous semester. This forms our financial investment measure. On average, students are privately tutored over 3.1 semesters, and in the most recent semester they spent 3.8 hours a week and NT\$1,800 (2.9 percent of family income) per month on private tutoring. Private tutoring is the primary financial investment that parents make their children and it imposes a substantial financial burden on most families (Chou & Yuan 2011; Chou 2014).

Parents' time investments are measured by the number of days a week they have dinner together with their children. We include both mothers' and fathers' responses in our measure. On average, the parent who responds to the survey has dinner with their child 3.3 days a week and their partner, if present, has dinner with their child 3.2 days a week.

Parenting discipline combines 14 items measuring various facets of parental strictness, supervision, expectations, and use of punishment. Of these, 11 items measure whether either the child's mother or father supervises their daily routine, use of pocket money, schoolwork, diet, friends, and whether either parent is harsh when disciplining the child. The remaining three items measure whether parents have explicit (and high) academic requirements for their child, and whether they punish bad behavior by scolding or by expressing their disappointment. Over 81 percent of parents set strict rules for their children; 66 percent directly supervise their schoolwork; and 52 percent supervise their friend-making. Harsh discipline is also not uncommon: 31 percent of students report that their parents scold them and 11 percent of students report that their parents beat them over trivial matters. Parents also have high academic standards for their children, with 77 percent of parents setting explicit academic requirements and 10 percent demanding that their children are among the top five students in their class.

Parenting warmth combines six items measuring whether parents listen, encourage, support, and accept their children. On average, 62 percent of parents listen carefully to their children, 53 percent always comply with the child's requests, and 62 percent help their children the most when they suffer big setbacks. However, 27 percent of students report that their parents discourage them from having new ideas or trying new things.

Students' Test Scores

In each wave, all students in the TEPS sat a standardized achievement test aimed at assessing their ability to learn and apply knowledge. The test consists of 75 multiple-choice questions

covering general ability, mathematics, Chinese and English, and natural sciences. The questions were chosen from a test bank created by the TEPS research team which included adapted questions from international standardized tests such as the Program for International Standardized Assessment (PISA) as well as other questions developed by education and field experts in Taiwan. Each test was designed to be “curriculum-free” (therefore accessible for students in all schools) and to assess general knowledge and knowledge application rather than rote memorization.

Test results were analyzed by the TEPS research team who concluded that three distinct learning components could be identified from student responses: a comprehensive ability main component, and two subcomponents capturing analytical ability and mathematical ability. These components form the basis of the achievement measures used in our study.⁷

Our measures of parental investment and student test scores are strongly correlated with one another. In wave 1, the strongest correlation is between the parenting style measures of discipline and warmth ($\hat{r} = 0.48$) followed by the correlations between time investments and discipline and warmth parenting ($\hat{r} = 0.39$ and $\hat{r} = 0.37$). Financial investments and student test scores are also strongly correlated ($\hat{r} = 0.32$). These correlations are generally weaker in wave 2, likely because our parental investment measures combine fewer items and are therefore likely to be measured with more error. The autocorrelations in these measure across waves, however, are strong and range between 0.80 for test scores and 0.25 for parental discipline.

4.3 Identification and Balancing Checks

Our identification strategy relies on the mandated random assignment of students and Dao Shi to classes. The transparent and public nature of the assignment process gives us a great deal of confidence that within schools, the assignment of students to a Dao Shi with post-graduate qualifications is indeed random. Nonetheless, we conduct balancing tests to check if there are any systematic relationships between Dao Shi qualifications and the students’ demographic and family background characteristics.⁸

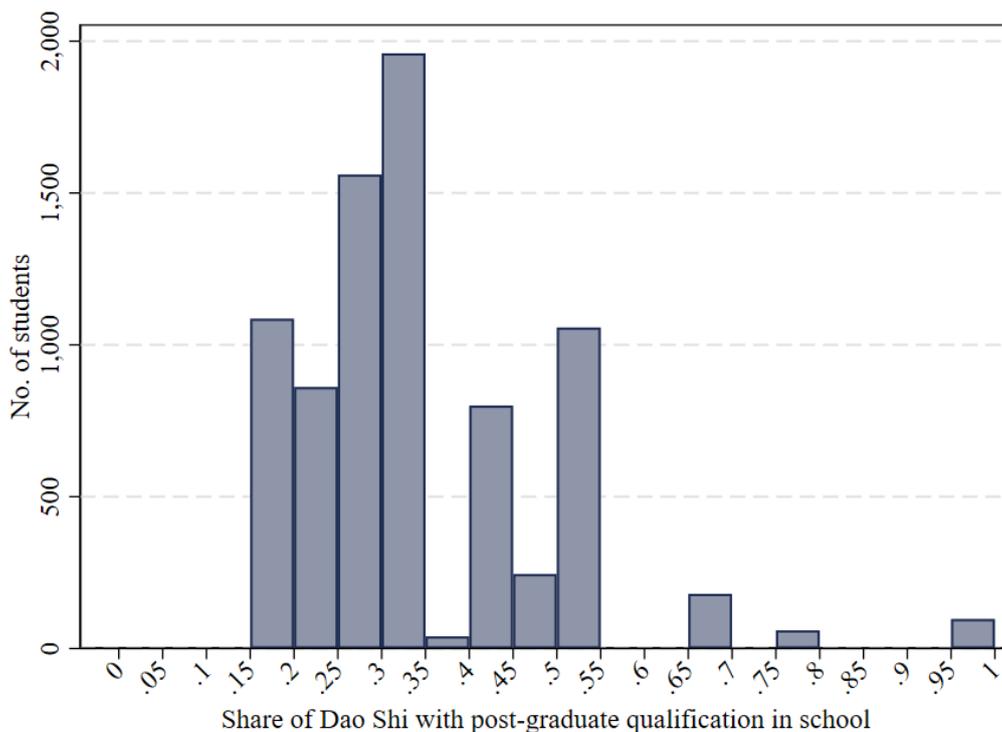
⁷ Specifically, the TEPS research team then developed measures of these three components using 3-parameter Item Response Theory (IRT) models. These models were then used to produce the standardized Bayesian posterior means of the three learning components which we use in our study. Item Response Theory models are discussed in detail in de Ayala (2009).

⁸ These tests are conducted using scales for parents’ investments and standardized test scores measured in the first wave of TEPS.

Our identifying variation comes from students who attend the same school, but are assigned to different classes and therefore to different Dao Shi, some of whom have post-graduate qualifications and some of whom do not. Overall, 13 percent of Dao Shi have post-graduate qualifications in our data, though the share of highly qualified Dao Shi varies substantially between schools. Approximately 60 percent of our sampled students attend schools in which there are no Dao Shi with post-graduate qualifications in our data; only 0.47 percent come from schools where all Dao Shi have post-graduate qualifications. As our specifications incorporate school fixed-effects, students attending schools in which there is no within-school variation in Dao Shi post-graduate qualifications do not contribute to identifying our estimates.

Figure 1 shows our identifying variation by plotting the distribution of the within-school share of teachers who have post-graduate qualifications. This distribution excludes schools in which none or all of the Dao Shi have post-graduate qualifications. Students have a 33 percent chance of being assigned to a class in which the Dao Shi has a post-graduate degree on average, but this chance varies across our sampled schools from as little as 15 percent to as much as 75 percent.

Figure 1. Number of Students by the School Proportion of Dao Shi with a Post-graduate Qualification



In order to verify that the assignment of teachers to students in our estimation sample is random, we conduct balancing tests. We test whether, within schools and on average, students assigned to a Dao Shi with a post-graduate degree have similar characteristics to students assigned a less qualified Dao Shi. To do this we estimate various versions of:

$$Y_{isc} = \beta \text{Postgraduate}_{sc} + \gamma_s + \varepsilon_{isc}, \quad (1)$$

where Y_{isc} is a characteristic of student i attending school s and assigned to class c within that school; these are measured at wave 1 (pre-assignment). Postgraduate_{sc} is a dummy that equals one if the Dao Shi assigned to class c has a post-graduate qualification, γ_s are school fixed effects which account for potentially correlated unobserved heterogeneity that is fixed at the school level, and ε_{isc} is an uncorrelated error term. We cluster our standard errors at the classroom level. Our coefficient of interest is β which captures within-school difference between students assigned to a Dao Shi with vs without a post-graduate qualification.

Figure 2. Within-School Differences in Student and Parent Characteristics in Wave 1 by Whether Students were Assigned to a Dao Shi with a Post-graduate Qualification

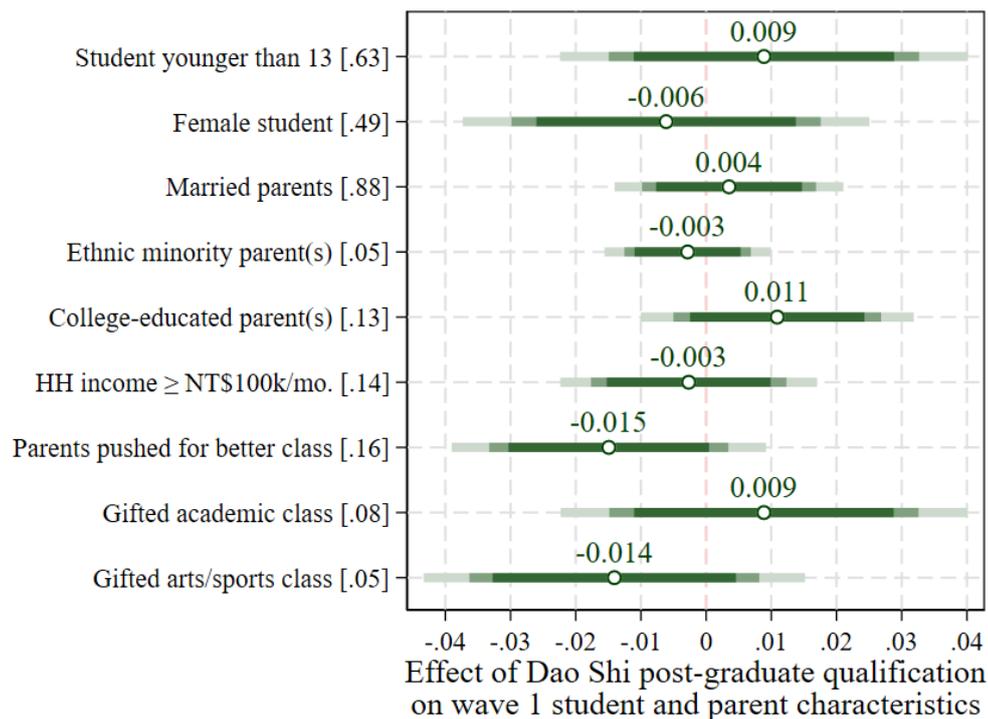


Figure 2 shows our estimates ($\hat{\beta}$) of the difference in the characteristics of students (and their parents) who are and are not assigned to a Dao Shi with a higher qualification. Each row plots the point estimate for a different characteristic, and the shaded colored bars correspond to 90, 95 and 99 percent confidence intervals for each estimate. To aid in interpretation of the magnitude of estimates, the numbers in square brackets show the unconditional mean for each

characteristic (e.g., 63 percent of students in wave 1 are younger than 13; 49 percent are female, and so on).⁹

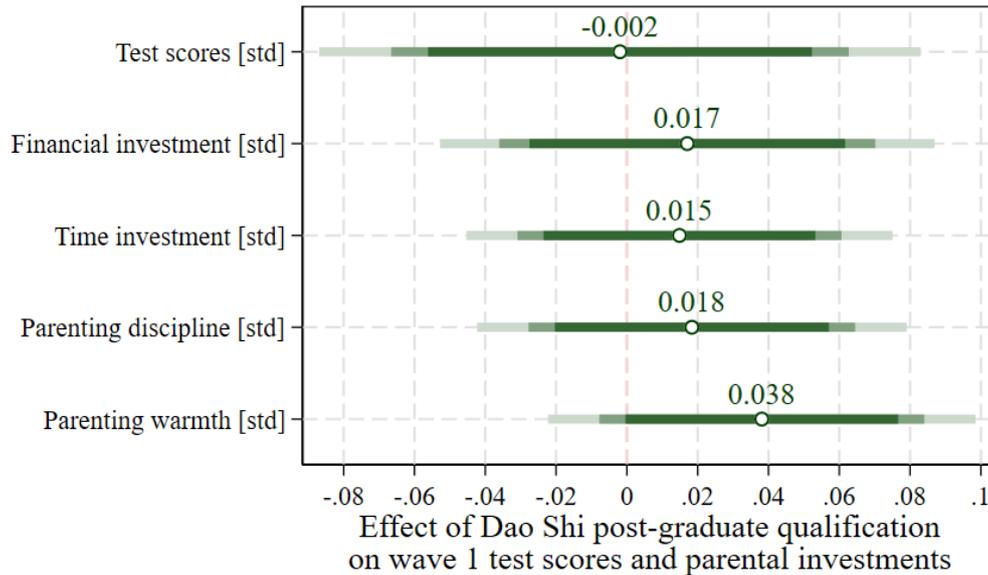
The results in Figure 2 demonstrate that students assigned to Dao Shi with post-graduate qualifications are not systematically different to other students in terms of their own or their parents' characteristics. The first two rows reveal that there is no relationship between Dao Shi qualifications and students' age or gender. Parents of students assigned to more qualified Dao Shi are also not different in terms of marital status, ethnicity, education, or income. Finally, students assigned to gifted classes because of their academic or arts/sports performance are not more or less likely to be taught by more qualified Dao Shi. The only borderline statistically significant difference shows that Dao Shi with post-graduate qualifications are 1.4 percentage points *less likely* to be assigned to students whose parents tried to influence their children's class assignment. These differences are economically tiny and accounting for them does not alter our main conclusions.

Two further conclusions emerge from our analyses. First, the lack of statistical differences is not due to low statistical power. Our standard errors are small and imply, for example, that we could reject an imbalance in the assignment probability of high-income students as small as 1.2 percentage points based on our 95 percent confidence interval. Second, a joint hypothesis test of these estimates (see e.g., Pei et al. 2019) suggests a balanced assignment. Regressing assignment to a highly qualified Dao Shi on all these characteristics and using an F-test to test their joint significance does not reject the null hypothesis of balanced assignment (p-value = 0.511).

We also consider whether the assignment of Dao Shi is related to student test scores or parental investments in wave 1. Figure 3 shows that students with higher standardized test scores are not more or less likely to be assigned to a Dao Shi with post-graduate qualifications. The parents of students assigned to a Dao Shi with a post-graduate also do not invest more financial resources or time in them, discipline them more strongly or show them more warmth. Perhaps the only exception, though not quite statistically significant, is that students assigned to highly qualified Dao Shi have parents that adopt a slightly warmer parenting style. None of our results presented below change if we account for these pre-assignment differences in scores and parental investments. And, as before, a F-test of joint significance reveals that these outcomes are balanced (p-value = 0.703).

⁹ In Appendix B we show the corresponding regression tables to Figure 2 and to all other figures in the paper.

Figure 3. Within-School Differences in Student Standardized Test Scores and Parents' Investments in Wave 1 by Whether Students were Assigned to a Dao Shi with a Post-graduate Qualification



Overall, these empirical results confirm that the assignment of Dao Shi with post-graduate qualifications to classes, and therefore students, within schools is random. This implies that if we estimate equation (1) and replace Y_{isc} with wave 2 outcomes that $\hat{\beta}$ identifies the causal effect of Dao Shi post-graduate qualifications. We consider these estimates in the next section.

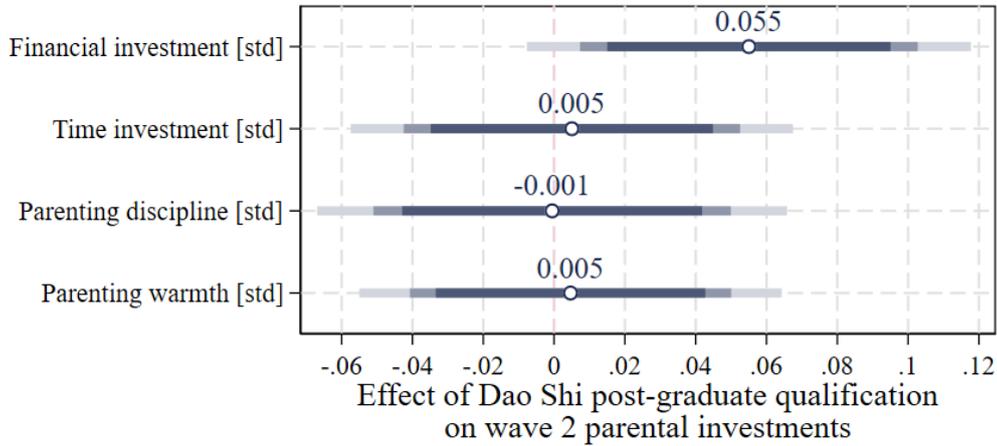
5. DAO SHI QUALIFICATIONS AND PARENTAL BEHAVIOR

5.1 Effects of Dao Shi Qualifications on Parents' Investments

Figure 4 shows the effect of being assigned a Dao Shi with post-graduate qualifications in wave 1 on parents' investments made between waves 1 and wave 2. We find that being assigned to a Dao Shi with a higher qualification increases parents' financial investments by 5.5 percent of a standard deviation (std. dev.). This effect size is moderate; it corresponds to approximately 14 percent of the gap in financial investments made between families in which neither parent is college-educated and families in which at least one parent has a college degree.

In contrast, there are no effects of having a Dao Shi with post-graduate qualifications on parents' time investments or the extent to which they adopt a parenting style that is characterized by strong discipline or warmth. Importantly, the lack of evidence for parental responses in these three investments is not driven by lack of statistical power; our standard errors are small. We can, for example, rule out an effect as small as 5 percent of a standard deviation in time investment based on our 95 percent confidence interval.

Figure 4. The Effect of Assignment to a Dao Shi with a Post-graduate Qualification on Parents' Investments in Wave 2



We then verify whether these results could be driven by confounders related to Dao Shi qualifications; that is, whether parents are responding to other Dao Shi characteristics correlated with their post-graduate qualifications. This would not change our main estimates but would require a more nuanced interpretation. Table 1, however, shows that Dao Shi with post-graduate qualifications have similar characteristics to their less qualified counterparts. There are two exceptions: post-graduate qualified Dao Shi are younger and less experienced than their colleagues without post-graduate qualifications. Since teacher age and experience are highly correlated, this suggests that parents' financial investment responses might not be the result of parents complementing higher Dao Shi qualifications but rather substituting for Dao Shi experience.¹⁰

Table 2 shows that controlling for Dao Shi teaching experience does not alter our conclusions. The estimated effect of Dao Shi qualifications on parents' financial investments is *larger* (0.066 std. dev.) when we control for Dao Shi experience than when we do not (0.055 std. dev., Figure 4). Thus, there is nothing to suggest that parents are responding to Dao Shi experience rather than to their qualifications. We also find that parents increase the financial investments they make in their children's education by 3.5 percent of a standard deviation when their children are assigned to a Dao Shi with one standard deviation more experience.

¹⁰ To test this hypothesis, we first construct a measure of Dao Shi teaching experience by adding up answers to several wave 1 items measuring Dao Shi experience as a teacher, as a junior high school teacher, and at their current school. We aggregate several items measuring experience to minimize measurement error, and we rescale it to have a mean of zero and standard deviation of one to make estimates more easily interpretable. We then re-estimate the effect of Dao Shi qualifications on parental investments controlling for this measure of Dao Shi teaching experience.

Table 1. Characteristics of Dao Shi With and Without a Post-graduate Qualification

<i>Dao Shi (in wave 1):</i>	Post-graduate degree (%)		Diff	
	Yes	No		
is older than 40	22	33	-10	**
has more than 10 years of experience teaching	23	36	-13	***
is female	69	76	-7	
is married	61	64	-4	
has children younger than 6 at home	29	24	5	
has dependent family member with disability	9	8	1	
is in good health	81	78	3	
is in school because it is near home	31	36	-5	
has worked in another school previously	70	70	1	
has not been certified as expert on some courses taught	51	59	-8	
spends > 7 hours per week grading	35	42	-7	
spends > 7 hours per week preparing for class	28	29	-1	
spends > 4 hours per week in one-on-one contact with students	28	28	0	
also works as after-school tutor	75	72	3	
teaches less than 15 classes per week	13	14	-2	
has some discretion in choosing teaching materials	52	58	-6	
has some discretion in choosing evaluation methods	18	16	2	
has some discretion in choosing teaching progress	38	40	-2	
regrets being a teacher	11	7	4	
regrets teaching in junior high school	29	25	4	
regrets teaching in that particular school	18	13	5	
Number of Dao Shi:	170	1,066	1,236	

Table 2. The Joint Effect of Dao Shi Post-graduate Qualifications and Teaching Experience on Parents' Investments and Parenting Style

Dependent variable =	Financial investment [std] (1)	Time investment [std] (2)	Parenting discipline [std] (3)	Parenting warmth [std] (4)
Dao Shi has a post-graduate qualification	0.066*** (0.0242)	0.007 (0.0244)	0.003 (0.0261)	0.009 (0.0233)
Dao Shi teaching experience [std]	0.035*** (0.0102)	0.005 (0.0093)	0.011 (0.0090)	0.015* (0.0091)
R-Squared	0.16	0.06	0.03	0.03
Schools (FE)	333	333	333	333
Classes (clust.)	1,236	1,236	1,236	1,236
Students (obs.)	18,007	18,007	18,008	18,008
Covariates	No	No	No	No

5.2 Heterogeneous Effects of Dao Shi Qualifications

To learn more about the potential drivers of parents' responses to Dao Shi qualifications, we investigate heterogeneity in the responses.

First, we consider the role of parent-teacher contact in parents' decision to increase financial investments in response to having a highly qualified Dao Shi. We expect parents who are in closer contact with their child's Dao Shi will react more strongly to Dao Shi qualifications. We construct a measure of parent-teacher contact using Dao Shi answers to the following question: "How many parents of the students in your class have you met since this semester began?". Potential responses range from "none" to "over 20 parents". Most Dao Shi have met at least some of the parents in the class with Dao Shi most frequently reporting they have met between 11 and 15 classroom parents. We define high parent-teacher contact using an indicator variable that equals one for Dao Shi who have met over 15 parents at the beginning of the semester. About 56 percent of children are assigned to such Dao Shi. We then estimate parental responses to Dao Shi post-graduate qualifications in both low- and high-contact classrooms separately.

Figure 5. Heterogeneous Effects of Assignment to a Dao Shi with a Post-graduate Qualification by Parent-Teacher Contact of Dao Shi

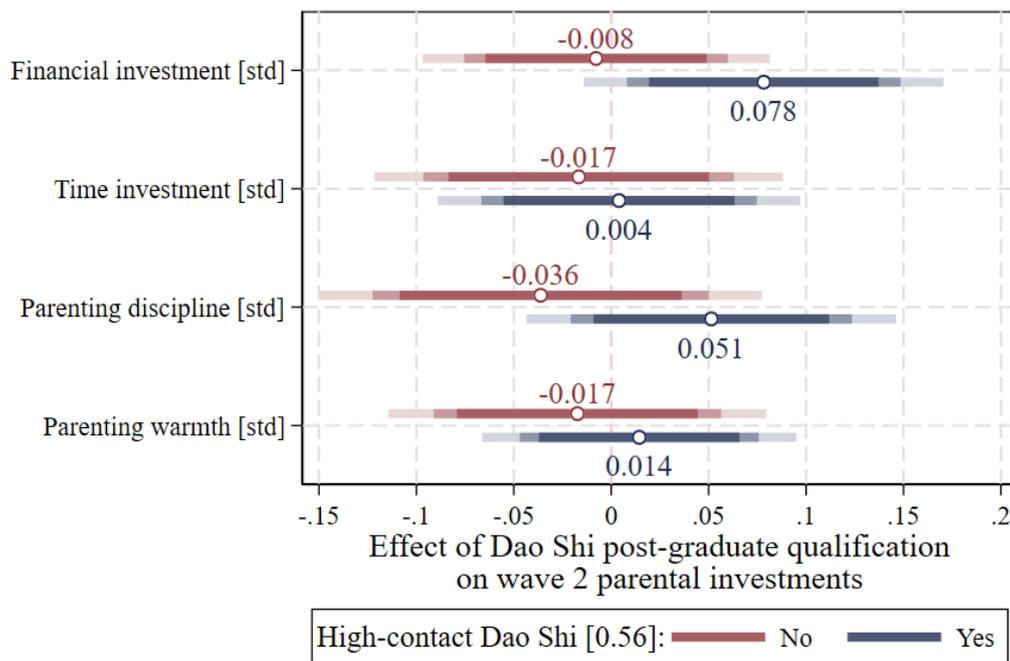


Figure 5 suggest that parents complement Dao Shi higher qualifications with more financial investments of their own *only* when there is a high level of parent-teacher contact. This highlights parent-teacher contact as a crucial driver of our main findings; when there is low parent-teacher contact there are no detectable effects of Dao Shi post-graduate qualifications on parental investments.

Second, we consider how the constraints that different families may face in optimizing their investments in their children’s educational achievement affect our results. Fredriksson et al. (2016), for example, show that skill-unconstrained (e.g., highly educated) parents will be more responsive to changes in school-based investments than partially skill-constrained parents, especially when inputs are complements.

We test how parents’ responses to the qualifications of their children’s Dao Shi vary with their own educational attainment. Specifically, we create an indicator that equals one for families in which either the mother or the father has a university undergraduate degree or higher. Thirteen percent of families in our estimation sample are classified as college-educated.

Figure 6. Heterogeneous Effects of Assignment to a Dao Shi with a Post-graduate Qualification by Parental Education

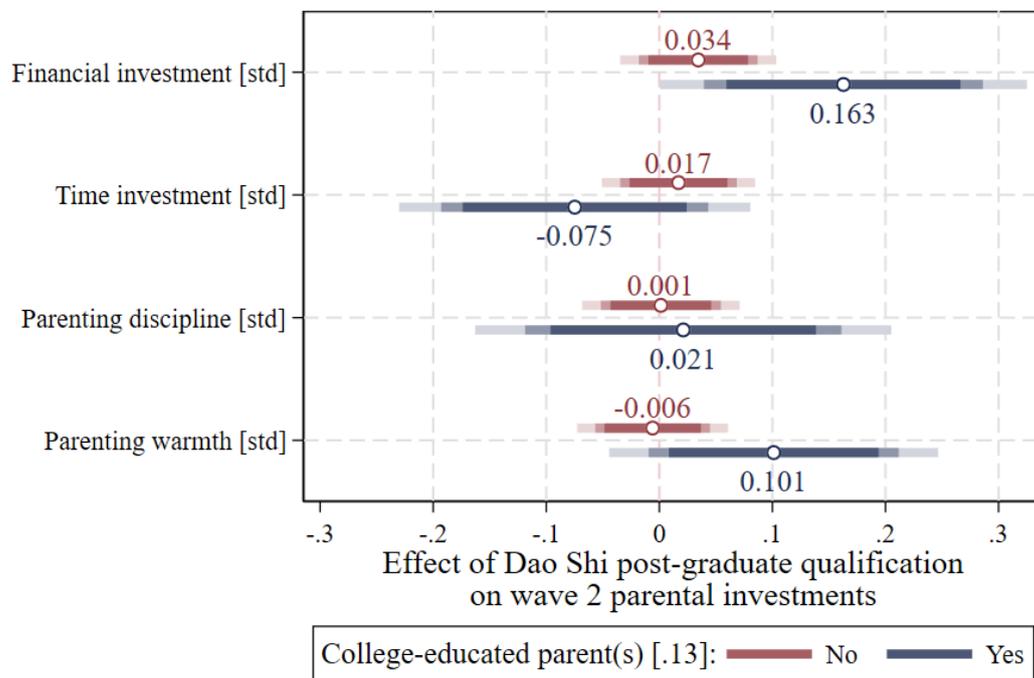


Figure 6 shows that it is college-educated parents who are responding to Dao Shi qualifications by changing their investments. If children in families with at least one college-educated parent are assigned to a highly qualified Dao Shi, their parents invest 16.3 percent of a standard deviation more financial resources in their education than do college-educated parents whose children do not have a highly qualified Dao Shi. This effect of Dao Shi qualifications among college-educated parents is a substantially larger estimated effect than the estimated effect for the sample as a whole (0.055 std. dev., see Figure 4). There is also some evidence that college-educated parents complement Dao Shi post-graduate qualifications by

increasing the warmth with which they parent (0.101 std. dev.). Consistent with Fredriksson et al. (2016), this result also fits a scarcity-based model of parenting in which higher-skilled parents have more attention available for their children (Cobb-Clark et al. 2019) since many of the components of parenting warmth are related to parental attention. In contrast, families in which neither parent has a college education do not change their parental investments in response to Dao Shi post-graduate qualifications.

Finally, we examine the possibility that differences in parents' financial resources available for children's education allows college-educated parents to invest more than others in response to higher teacher qualifications. College-educated parents typically earn more and may therefore be able to afford to invest more financial resources in their children's education. This would suggest that the heterogeneity in parents' responses associated with their education levels could be driven by income constraints rather than skill constraints. We estimate the effect of having a Dao Shi with post-graduate qualifications on parental investments for high-income and low-income families separately; defining high-income families as those with monthly family income over NT\$100,000. Thirteen percent of families in our sample are classified as high-income.

Figure 7. Heterogeneous Effects of Assignment to a Dao Shi with a Post-graduate Qualification by Family Income

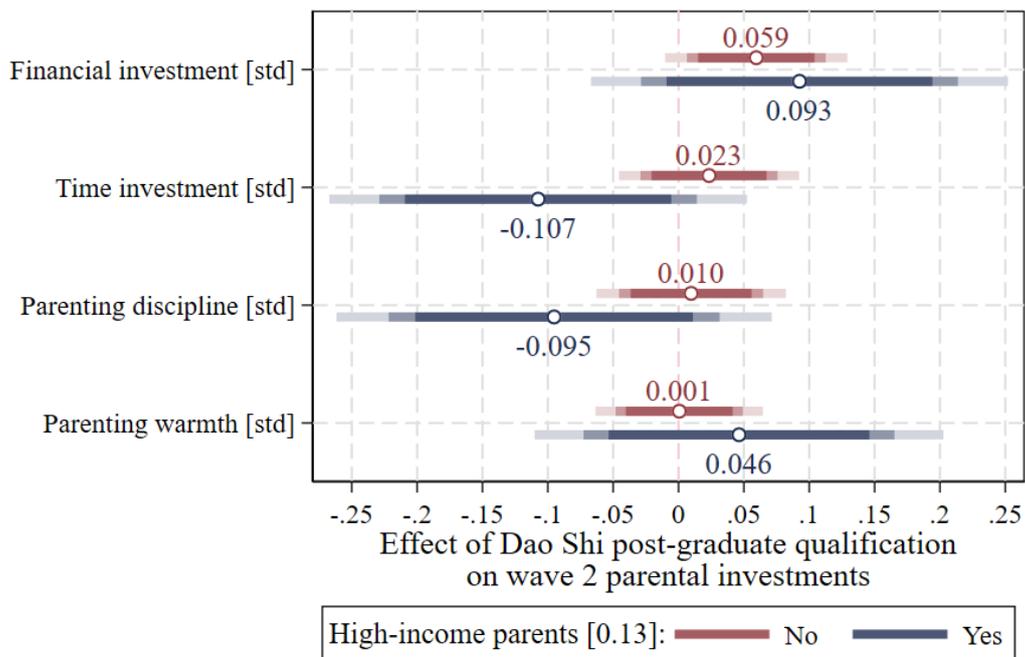


Figure 7 shows that high- and low-income parents respond in much the same way to the qualifications of their children's Dao Shi. Both types of parents complement Dao Shi post-graduate qualifications by making additional financial investments in their children's educations. This effect is not statistically significant for high-income parents, largely because we lose estimation precision due to the smaller number of high-income parents in our data. The lack of heterogeneity by parental income is consistent with parental investments being constrained by parental skill rather than by parental income. Consistent with this interpretation, we also find some evidence that high-income parents do substitute Dao Shi qualifications for their own time (0.107 std. dev.). This last result suggests that parents with a higher opportunity cost of time decide to spend more time at work (and therefore less time with their children) in response to their children being assigned to a more qualified Dao Shi. The Ricardian substitutivity implied by this result is consistent with previously documented effects of other school-based inputs on parents' time investments (Bonesrønning, 2004; Datar and Mason 2008; Friedriksson et al. 2012).

Taken together, our results indicate that parents respond to Dao Shi qualifications when they have the information (i.e. parent-teacher contact) and the skills (i.e. education) to do so. Parents' increased financial investment in response to higher teacher qualifications is consistent with parents believing in complementarities between Dao Shi qualifications and out-of-school tutoring in the production of student achievement.

6. MECHANISMS BEHIND PARENTS' BEHAVIORAL REACTIONS

In this section we explore the potential mechanisms behind our finding that parents increase their financial investments when their children are assigned to Dao Shi with post-graduate qualifications. Our measure of financial investment is largely composed of investments in private tutoring, including cram schooling. The mechanisms we consider should therefore explain why parents increase their investment in private tutoring when their child is assigned to a highly qualified Dao Shi and why this behavior is more apparent among college-educated parents and those with more teacher contact.

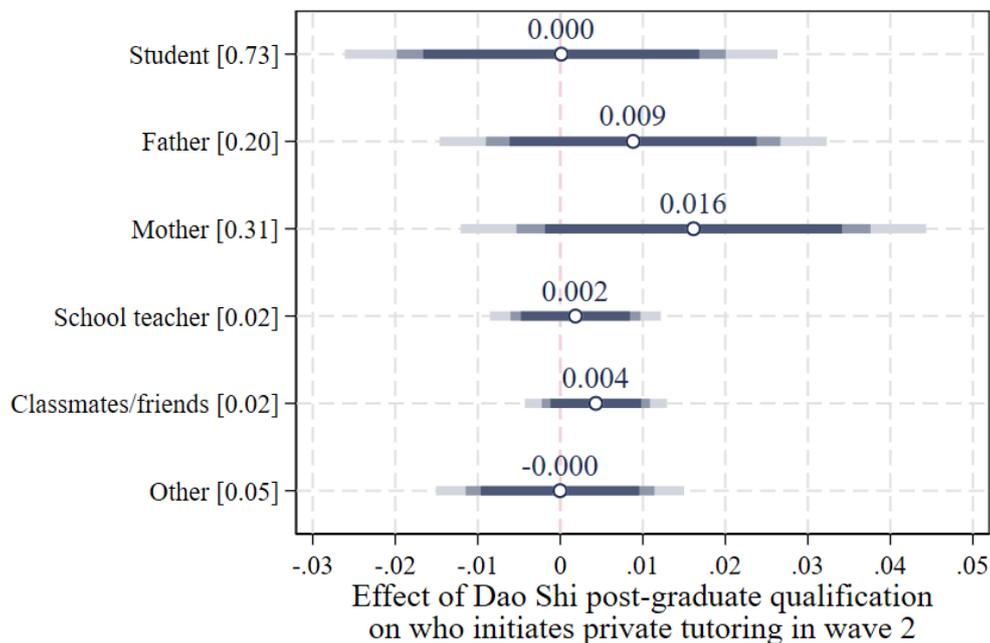
6.1 Direct Pressure from Dao Shi

Dao Shi themselves might have some agency in parents' investment decisions. Highly qualified Dao Shi, for example, may be more likely to privately tutor the students in their class and, therefore, pressure parents to enroll their children in after-school tutoring. Additionally, highly

qualified Dao Shi may hold stronger beliefs about the value of tutoring which could influence parents' own views on tutoring and as a result increase their financial investments.

To test whether this mechanism exists, we analyze the following survey question asked to students in wave 2: “During this semester in Year 3 (i.e. the third year in junior high), whose idea was it mainly to send you to after-school math lessons? (You may choose more than one option.)”. Math tutoring is an important component of the financial investments that parents make and responses to this question can be informative about who makes tutoring decisions in general. The answers to this question show that math tutoring decisions are almost always made by students (73 percent), followed by mothers (31 percent) and fathers (20 percent); whereas few are made by teachers (2 percent) or others (7 percent combined). Figure 8 shows that the person initiating math tutoring is not systematically related to whether children are assigned to a highly qualified Dao Shi or not. It is unlikely that highly qualified Dao Shi directly push for more tutoring.

Figure 8. The Effect of Assignment to a Dao Shi with a Post-graduate Qualification on the Person Initiating Math Tutoring Decisions



We can also reject the possibility that the increase in parents' financial investments is driven by Dao Shi with post-graduate qualifications who themselves provide private tutoring

and thus “capture” some of their classroom students as their own private pupils.¹¹ While 80 percent of the Dao Shi in our sample provide at least some private tutoring after school hours, Dao Shi with post-graduate qualifications are no more likely to tutor. Dao Shi with post-graduate qualifications tutor only 15 minutes more per week compared to less qualified Dao Shi and this difference is not statistically significant.

On balance, there is no evidence that Dao Shi with post-graduate qualifications are exerting disproportionate pressure on parents to make more financial investments in children’s after-school tutoring.

6.2 Parental Beliefs

Parents may increase their financial investments in response to a better qualified Dao Shi because they believe that higher Dao Shi qualifications result in better student test scores and they view Dao Shi qualifications and tutoring as complements in the education process.

We investigate this using information on parents’ beliefs about student achievement. In wave 2 parents are asked: “*In your opinion, a student's academic performance relates most to which of the following factors?*”. The potential responses are: “his/her parent(s)’ discipline”, “the quality of his/her teachers’ teaching”, “his/her class or friends”, “extracurricular tutoring”, “the student’s own effort”, or “the student’s talent”. Though multiple responses are allowed, the majority of parents choose only one.

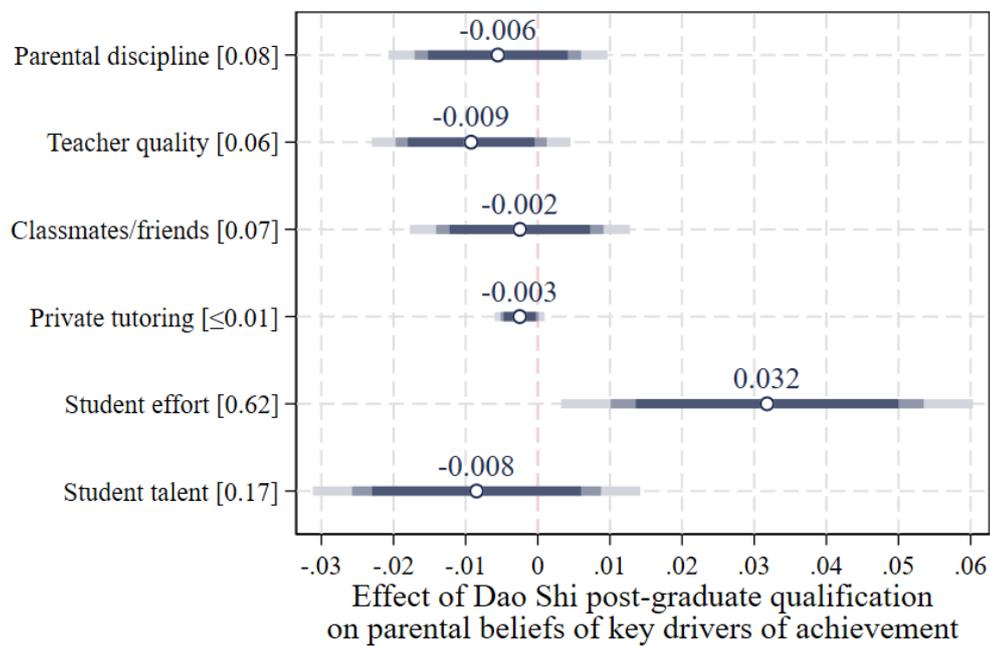
The distribution of parents’ responses is at odds with them believing that teachers’ post-graduate qualifications and that additional tutoring complements qualifications in improving student achievement. Only 6 percent of parents believe that teacher quality is a key to student achievement, and only 0.4 percent of parents believe that tutoring matters (see row square brackets in Figure 9). In addition, parents who believe teacher quality matters are not more likely to believe that private tutoring also matters. Figure 9 shows that, if anything, being assigned to a Dao Shi with better qualifications decreases parents’ beliefs that teacher quality or tutoring matter for student achievement. These results leave little scope for parents’ beliefs in teachers and tutoring to matter for parents’ investment decisions.

Why do parents increase their financial investments if they do not believe that tutoring is central to student achievement? One possibility is that parents believe that tutoring is instrumental in making their children put more effort into school. Previous studies have viewed

¹¹ The average Dao Shi spends 2.2 hours per week in private tutoring; 18 percent of Dao Shi spend over four hours per week in private tutoring.

parents' investments through the lens of the incentives they provide to children (e.g., Laferrère & Wolff 2006; Doepke et al. 2019), and the use of parental financial investments to solve the agency problems associated with children's effort provision is explicitly modeled by Weinberg (2001). It is also the case that Taiwan is “a society that emphasizes effort [...] as the basis of academic achievement, [and where] cram schooling has important cultural significance” (Kuan 2011, p.363).

Figure 9. The Effect of Assignment to Dao Shi with a Post-graduate Qualification on Parents' Beliefs of the Most Important Drivers of Academic Achievement



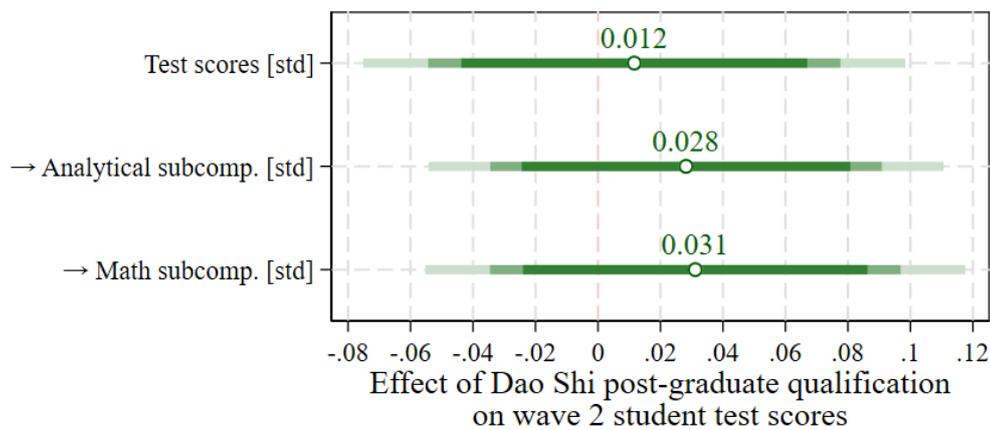
We consider the possibility that parents use tutoring to incentivize effort by examining how the assignment of a highly qualified Dao Shi affects parental beliefs. Figure 9 also shows that 62 percent of parents see student effort as the key determinant of student achievement and that these views are strengthened when their children are assigned to a Dao Shi with a higher qualification. This effect can simply reveal a direct impact of Dao Shi post-graduate qualifications on parental beliefs, but is also consistent with parents' believing in complementarities between Dao Shi qualifications and student effort.

7. DAO SHI QUALIFICATIONS AND STUDENT OUTCOMES

Despite the positive effect of Dao Shi qualifications on parent's financial investment, Figure 10 shows that being assigned to a more qualified Dao Shi does not improve students'

standardized test scores. The point estimates on overall test scores (0.012 std. dev.) and in the analytical (0.028 std. dev.) and mathematical (0.031 std. dev.) subcomponents of the test are not statistically different from zero at conventional levels. These effect sizes are economically small in the context of educational interventions generally (see Kraft 2018). Moreover, we also do not detect a positive effect of having a Dao Shi with a post-graduate degree on the financial investments of college-educated parents (Appendix Figure B.1), despite us having shown them to be the most responsive group of parents (Figure 6).

Figure 10. The Effect of Assignment to a Dao Shi with a Post-graduate Qualification on Students' Standardized Test Scores



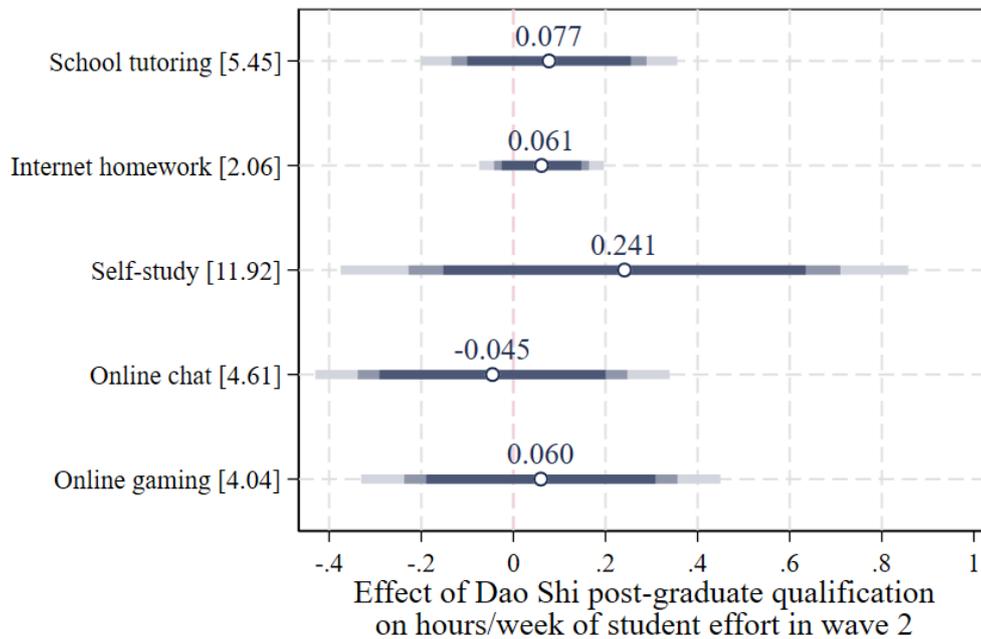
There are at least three possible explanations for finding no effect of Dao Shi qualifications on students' test scores. The first one is that more qualified Dao Shi do have a positive effect on student achievement, yet this effect is too small for us to detect. The positive point estimates in Figure 10 suggest this might be the case. This is also consistent with studies finding no effect of teacher qualifications on student achievement in other contexts (e.g., Hanushek & Rivkin 2006; Hanushek 2011; Feld et al., in press) as well as with previous evidence from Taiwan showing only small improvements in student math achievement from private tutoring (Kuan 2011).

The second possibility is that students compensate for the additional effort they put in private tutoring by decreasing their self-study time. However, Figure 11 shows that students with a highly qualified Dao Shi do not decrease their time spent in school tutoring, doing homework online, or in self-study, nor do they increase their online chatting or gaming.¹² There

¹² In addition to these results, Appendix Table B.12 also shows that better qualified Dao Shi do not affect students' initiative to take out-of-school tutoring, to take notes and make outlines for studying better, or to reduce leisure activities in preparation for exams.

is therefore no evidence that students' compensate for more study time in private tutoring with less study time elsewhere.

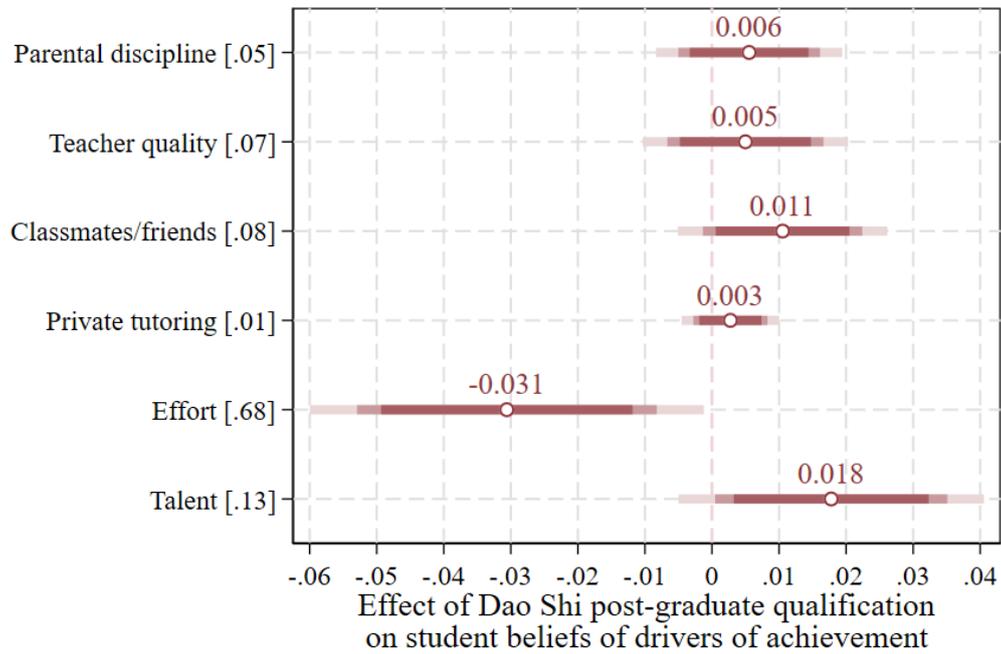
Figure 11. The Effect of Assignment to Dao Shi with a Post-graduate Qualification on Student Weekly Hours Spent on Different Activities



The third possibility is that the additional effort students put into private tutoring reduces their motivation when studying on their own, making additional tutoring ineffective in improving academic achievement. While we cannot directly test this hypothesis with our data, we show some indirect evidence for it in Figure 12. Students assigned to more qualified Dao Shi *decrease* their belief that effort is important for academic achievement. If we consider students' beliefs on the value of effort as an important part of motivation, these effects are consistent with a demotivating effect of the extra effort students must exert in private tutoring and could explain why more qualified Dao Shi have no effect on student achievement. At the same time, more qualified Dao Shi increase students' belief in talent and classmates/friends as drivers of achievement, both of which are less effort-driven.

Together, our findings in this section show that Dao Shi qualifications have, at most, a small effect on student achievement, and suggest that this may be because: i) both Dao Shi qualifications and financial investments in tutoring have small effects on achievement; or because ii) financial investments in tutoring demotivates students and makes this additional effort unproductive.

Figure 12. The Effect of Assignment to Dao Shi with a Post-graduate Qualification on Student Beliefs of the Most Important Drivers of Academic Achievement



8. CONCLUSIONS

The existing literature provides little empirical evidence on the contribution of parents' behavioral reactions to the investments that schools make in their children. Most studies estimate policy parameters that simply subsume the effects of parents' choices to either reinforce or ameliorate any disparities in school inputs. We analyze parents' behavioral responses to teacher qualifications in a unique high-stakes educational setting in which teachers are assigned to classrooms using a lottery. We focus on children's Dao Shi (homeroom teachers) because of their critical role in supporting not only students' learning, but also their personal and moral development as well.

Our key finding is that when children are assigned to Dao Shi with post-graduate qualifications, their parents respond by increasing their own financial investment in their children. Yet, in spite of this increase in financial investment, Dao Shi qualifications have no effect on student achievement. This leaves us with a puzzle. Why do parents increase their financial investments in response to better teacher qualifications if they do not increase test scores?

We believe that the answer lies in the views that parents and students hold regarding the importance of student effort for academic achievement. Dao Shi with higher qualifications strengthen parents' beliefs that effort is important and weaken students' beliefs in the importance of effort. Our results are consistent with parents using their own financial investments — which are largely in private tutoring — to ensure their children put effort in school in a way that suggests that parents believe effort to be more productive when their children's Dao Shi has higher qualifications. Students, on the other hand, might view this parental investment together with their luck of being assigned a highly qualified teacher as an opportunity to pay less effort (see De Fraja et al. 2010). In the end, teacher qualifications do not raise student effort leaving student achievement unchanged.

The first lesson from our paper is that measuring and analyzing belief data is important for understanding household reactions to school inputs. Without these data, our results would have been consistent with teacher qualifications increasing the effectiveness of parents' financial investments. Further evidence on this technical complementarity would have been provided by the heterogenous effects of parental education on investment choices which are also consistent with this interpretation (see Fredriksson et al. 2016). In contrast, our data reveal that parents do not think financial investments complement teacher qualifications; our belief measures rather suggest they believe that student effort complements teacher qualifications. This distinction is important since it drastically alters the insights that we gain about the education production function when we study parents' behavior. Observing student effort is also crucial for understanding the potential reasons that parental investments do not increase student achievement. That is, investments in private tutoring may have a demotivation effect— as measured via students' belief in the effectiveness of their effort.

The second lesson is that children's behavior, independent of their parents, can complicate the analysis of household-level behavior and its outcomes. A standard unitary household model in which parents and children are in perfect agreement on the goals they want to achieve and the way to achieve them would have been hard pressed to make sense of our data. Even a behavioral model that incorporates parental beliefs and imperfect information on the returns to multi-dimensional parental investments would fall short of providing a complete explanation. In addition to observing parent and student beliefs, the fact that we observe children's time allocation and that it remains unaffected by teacher qualifications is crucial for understanding why teacher qualifications and parents' financial investments did not increase student test scores.

Putting our findings together, we would argue that school inputs such as teacher qualifications may be important for student achievement, but evaluating their net impact on families is complicated. Initiatives that provide additional school resources need to be evaluated taking careful consideration of their impact within families. There are several key directions for future research. Direct measures of parents' and students' beliefs about the technology of educational achievement are likely to be crucial for understanding the mechanisms behind any behavioral responses. Better measures of beliefs will also be necessary to understand the nuanced role of parents' and children's incentives in human capital investments. Finally, our results point to the ineffectiveness of teacher qualifications in increasing student achievement even as they show that these do increase at least one form of parental investment. Additional research to uncover more effective options available to parents and schools for raising student achievement would be particularly valuable.

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APPENDIX A: DATA

This paper uses waves 1 and 2 of the Taiwan Educational Panel Survey (TEPS) for Junior High School students. Our analyses use the restricted access version of the data since we require school identifiers for our main models.

Our final dataset merges information from the following data files:

1. Wave 1 student survey file (version: w1_j_s_lv6_0)
2. Wave 2 student survey file (version: w2_j_s_lv6.1)
3. Wave 1 parent survey file (version: w1_j_p_lv6.0)
4. Wave 2 parent survey file (version: w2_j_p_lv6.0)
5. Wave 1 Dao Shi (homeroom teacher) survey file (version: w1_j_dt_lv6.1)
6. Wave 2 Dao Shi (homeroom teacher) survey file (version: w2_j_dt_lv6.1)
7. Wave 1 Dao Shi classroom assessment survey file (version: w1_j_dtc_lv6.2)
8. Wave 1 school staff survey file (version: w1_j_sch_ov6.0)

In wave 1, the complete TEPS dataset has information on 20,055 students, 19,779 parents, all arrayed in 1,244 classes in 333 schools. At the classroom level, there is also information on almost all Dao Shi as well as the Chinese, English and mathematics teachers. In wave 2, there is information on 19,088 students and 18,834 parents, arrayed in 1,938 classes – since some students change class between waves – in the same 333 schools. And again, at the classroom level there is information on almost all Dao Shi as well as the Chinese, English and mathematics teachers. After merging information from both waves, we keep 19,052 complete observations where there is some matched information on students, parents, classes and schools in both waves.

We then delete 1,047 observations from which the responding parent is neither the father nor the mother (i.e., it is a stepparent, adoptive parent, grandparent, elder brother or sister, or any other relationship) of the student in wave 2.

With these data, we then construct eight scales for parental money and time investments and for parental discipline and warmth, in waves 1 and 2. In Section 4.1 we briefly describe the items used to construct these scales and in Appendix Table B.2 we show summary statistics of all the items used to construct the final scales.

The question items in each of these scales were selected from a broader set of items measuring parent-child interactions in both waves of the survey. We originally categorized all candidate survey questions/items under the following mutually-exclusive categories: money investments, time investments, parental monitoring, parental warmth, engaged parenting, disciplining parenting, and consistent parenting, and parental agency. Initially we considered a total of 44 items from wave 1 and 34 items from wave 2 for our scale construction.

Based on this set of items, and after recoding them so they were increasing in each underlying construct, we took the following iterative approach for the construction and refinement of each scale:

1. We combined answering categories within each item to ensure each item had a non-negligible variation in each answering category.
2. We estimated a confirmatory Principal Component Analyses (PCA) without rotation with the items of each scale separately.
 - a. In this step we also constructed two separate scales: one scale based on the PCA loadings and another summative scale simply adding up the items in each category and ignoring missing item non-response in the sum. We used these two scales to assess whether the correlation between the first predicted component of the PCA and the summative scale was high at each iteration.
3. We assessed whether there was evidence for a first common component from the confirmatory PCA analyses. We then assessed which items had positive and meaningful PCA loadings on the first factor – typically using a 0.3 PCA loading threshold.
4. We carefully re-assessed the conceptual validity of the items with low PCA loadings in each construct. If upon re-assessment we viewed the item as redundant or not belonging to the core of the construct, we removed the item from the pool.
5. After removing unsuitable items, we returned to step 1. We repeated this process until our scales satisfied that (i) they were using all suitable available items in the data, (ii) all scale items were strongly loading on the first PCA component, (iii) all items were performing strongly and similarly in terms of their PCA loadings, and (iv) the correlation between the summative scale and the PCA index was very high.

During this iterative process we reduced the number of scales to the final eight (money and time investment, and disciplining and warmth parenting for waves 1 and 2) by recombining well-performing items from other categories and dismissing scales that were either not well

populated or highly-correlated with one another. We then took the summative scales as our final scales, standardizing them in their corresponding waves by subtracting their sample mean and dividing them by their sample standard deviation.

APPENDIX B: ADDITIONAL RESULTS

Table B.1. Summary Statistics of Key Variables in the First Wave of the TEPS

	Estimation sample	TEPS
<i>Mean of characteristic in wave 1:</i>		
Dao Shi has post-graduate qualification	0.13	0.13
Female student	0.49	0.48
Student age	12.40	12.41
Student has more than one sibling	0.50	0.50
Married parents	0.88	0.85
Ethnic minority parent(s)	0.05	0.06
Father's age	42.44	42.51
Mother's age	39.70	39.75
College-educated parent(s)	0.13	0.13
Family monthly income (NT\$)	62,674	62,504
Observations	18,008	20,055

Table B.2. Summary Statistics of All Items Used to Construct Summary Scales of Parental Investments in Both Waves of the TEPS

	Obs.	Mean	Std. Dev.	Min	Max
Money investment scales					
<i>Items from Wave 1:</i>					
Had private music tutor in primary school	17,856	0.22	0.41	0	1
Grades with private tutor in past	17,936	0.95	0.70	0	3
Had extracurr. art classes in primary school	17,867	0.66	0.48	0	1
Monthly expend. on class activities	17,864	1.09	0.96	0	5
Arranged child to study abroad	17,900	0.06	0.24	0	1
Earmarked savings for child education	17,901	0.64	0.48	0	1
Monthly expend. in academic activities (inc. tutoring)	17,874	3.19	1.90	1	6
Monthly expend. in extracurricular art classes	17,880	1.73	1.45	1	6
<i>Items from Wave 2:</i>					
Semesters with priv. tutoring in junior high school	17,837	2.20	1.23	1	6
Time per week in priv. tutoring this semester	17,775	2.28	1.39	1	5
Monthly expend. in private tutoring this semester	17,875	2.25	2.07	0	5
Time investment scales					
<i>Items from Wave 1:</i>					
When did family started helping with schoolwork	17,907	3.81	1.46	1	5
Freq. father volunteers/attends school activities	16,745	1.82	0.97	1	4
Freq. mother volunteers/attends school activities	17,122	2.16	1.07	1	4
Time spent waiting for parents to return home	16,983	3.99	1.33	1	5
Time spent with child everyday by parent	17,895	4.16	1.11	1	5
Time spent with child everyday by partner	16,967	3.69	1.38	1	5
Take child to bookstores or exhibitions	17,914	2.32	0.83	1	4
Take child to concerts, shows, dramas	17,914	1.57	0.76	1	4
Volunteer with child in community	17,912	1.39	0.70	1	4
<i>Items from Wave 2:</i>					
Parent has dinner with child 5 days a week	17,901	0.68	0.47	0	1
Partner has dinner with child 5 days a week	16,080	0.58	0.49	0	1
Discipline scales					
<i>Items from Wave 1:</i>					
Father checks homework & learning	17,401	2.82	1.00	1	4
Mother checks homework & learning	17,585	3.26	0.92	1	4
Father keeps strict discipline	17,016	2.85	0.83	1	4
Mother keeps strict discipline	17,275	2.95	0.80	1	4
Parents scold or punish for doing wrong	17,837	0.47	0.50	0	1
Parents know child's close friends	17,857	3.21	1.40	1	5
Parents know child's classmates	17,885	1.83	0.69	1	4
Discipline scales					
<i>Items from Wave 2:</i>					
Parents set strict rules in daily routine	17,936	0.81	0.39	0	1
Parents monitor use of pocket money	17,936	0.53	0.50	0	1

	Obs.	Mean	Std. Dev.	Min	Max
Parents supervise homework	17,936	0.66	0.47	0	1
Parents have strict demeanor	17,936	0.71	0.45	0	1
Parents strict about diet	17,936	0.76	0.43	0	1
Parents supervise choice of friends	17,936	0.52	0.50	0	1
Parents tell not to let them down	17,936	0.54	0.50	0	1
Parents have no tolerance for talk back	17,936	0.59	0.49	0	1
Parents scold over trivial matter	17,936	0.31	0.46	0	1
Parents beat over trivial matters	17,936	0.11	0.31	0	1
Parents keep strict discipline	17,936	0.70	0.46	0	1
Days per week parents have dinner with child	17,871	2.42	1.02	1	5
Parents scold or seriously punish child	17,911	2.87	0.68	1	4
Parents use disappointment/shame as punishment	17,909	2.96	0.87	1	4
Warmth scales					
<i>Items from Wave 1:</i>					
Father discusses future study/career with child	17,313	2.45	0.96	1	4
Father listens to child's thoughts & feelings	16,331	2.09	1.04	1	4
Mother discusses future study and career with child	17,528	2.84	1.00	1	4
Mother listens to child's thoughts & feelings	17,213	2.75	1.08	1	4
Father accepts child as is	17,171	3.22	0.73	1	4
Mother accepts child as is	17,491	3.35	0.70	1	4
<i>Items from Wave 2:</i>					
Parents listen carefully to child's ideas	17,936	0.62	0.49	0	1
Parents care and advise child	17,936	0.81	0.40	0	1
Parents discourage child's new ideas	17,936	0.27	0.45	0	1
Parents unconditionally give whatever child wants	17,936	0.54	0.50	0	1
Parents help child with problems and setbacks	17,936	0.63	0.48	0	1
Parents accept child as is	17,936	0.76	0.42	0	1

Table B.3. Within-School Differences in Student and Parent Characteristics in Wave 1 by Whether Students Were Assigned to a Dao Shi With a Post-graduate Qualification

Dependent variable =	Student younger than 13	Female student	Married parents	Ethnic minority parent(s)	College-educated parent(s)
	(1)	(2)	(3)	(4)	(5)
Dao Shi has a post-graduate degree	0.009 (0.0121)	-0.006 (0.0121)	0.004 (0.0068)	-0.003 (0.0049)	0.011 (0.0081)
Mean of dep. var.	0.62	0.49	0.88	0.05	0.13
SD of dep. var.	0.48	0.50	0.33	0.23	0.34
R-Squared	0.02	0.06	0.04	0.23	0.16
Students (obs.)	17,953	18,008	18,008	18,008	18,008
Schools (FE)	333	333	333	333	333
Classes (clust.)	1,236	1,236	1,236	1,236	1,236
Covariates	No	No	No	No	No

Dependent variable =	HH income > NT\$100,000/mo.	Parents pushed for better class	Gifted academic class	Gifted arts/sports class
	(6)	(7)	(8)	(9)
Dao Shi has a post-graduate degree	-0.003 (0.0076)	-0.015 (0.0093)	0.009 (0.0121)	-0.014 (0.0113)
Mean of dep. var.	0.13	0.16	0.08	0.05
SD of dep. var.	0.34	0.37	0.27	0.23
R-Squared	0.14	0.08	0.11	0.10
Students (obs.)	18,008	17,975	17,877	17,877
Schools (FE)	333	333	333	333
Classes (clust.)	1,236	1,236	1,236	1,236
Covariates	No	No	No	No

Table B.4. Within-School Differences in Student Standardized Test Scores and Parental Investments in Wave 1 by Whether Students Were Assigned to a Dao Shi With a Post-graduate Degree

Dependent variable =	Test scores (1)	Financial investment (2)	Time investment (3)	Parenting discipline (4)	Parenting warmth (5)
Dao Shi has a post-graduate qualification	-0.002 (0.0329)	0.017 (0.0271)	0.015 (0.0233)	0.018 (0.0235)	0.038 (0.0234)
Mean of dep. var.	0.00	0.00	0.00	0.00	0.00
SD of dep. var.	1.00	1.00	1.00	1.00	1.00
R-Squared	0.21	0.19	0.05	0.05	0.04
Students (obs.)	17,983	18,008	18,008	18,008	18,000
Schools (FE)	333	333	333	333	333
Classes (clust.)	1,236	1,236	1,236	1,236	1,236
Covariates	No	No	No	No	No

Table B.5. The Effect of Assignment to a Dao Shi With a Post-graduate Qualification on Parental Investments in Wave 2

Dependent variable =	Financial investment (1)	Time investment (2)	Parenting discipline (3)	Parenting warmth (4)
Dao Shi has a post-graduate qualification	0.055** (0.0243)	0.005 (0.0242)	-0.001 (0.0257)	0.005 (0.0231)
Mean of dep. var.	0.00	0.00	0.00	0.00
SD of dep. var.	1.00	1.00	1.00	1.00
R-Squared	0.16	0.06	0.03	0.03
Students (obs.)	18,007	18,007	18,008	18,008
Schools (FE)	333	333	333	333
Classes (clust.)	1,236	1,236	1,236	1,236
Covariates	No	No	No	No

Table B.6. Heterogeneous Effects of Assignment to a Dao Shi With a Post-graduate Qualification by Parent-Teacher Contact of Dao Shi

Dependent variable =	Financial investment (1)	Time investment (2)	Parenting discipline (3)	Parenting warmth (4)
<i>for low contact Dao Shi:</i>				
Dao Shi has a post-graduate qualification	-0.008 (0.0345)	-0.017 (0.0406)	-0.036 (0.0439)	-0.017 (0.0375)
Mean of dep. var.	-0.14	0.03	0.00	-0.04
SD of dep. var.	0.99	1.01	1.00	1.00
R-Squared	0.16	0.06	0.05	0.04
Students (obs.)	7,766	7,766	7,766	7,766
Schools (FE)	245	245	245	245
Classes (clust.)	526	526	526	526
Covariates	No	No	No	No
	(5)	(6)	(7)	(8)
<i>for high contact Dao Shi:</i>				
Dao Shi has a post-graduate qualification	0.078** (0.0357)	0.004 (0.0360)	0.051 (0.0367)	0.014 (0.0312)
Mean of dep. var.	0.11	-0.02	0.00	0.03
SD of dep. var.	0.99	0.99	1.00	1.00
R-Squared	0.16	0.08	0.04	0.04
Students (obs.)	9,974	9,974	9,975	9,975
Schools (FE)	270	270	270	270
Classes (clust.)	691	691	691	691
Covariates	No	No	No	No

Table B.7. Heterogeneous Effects of Assignment to a Dao Shi with a Post-graduate Qualification by Parental Education

Dependent variable =	Financial investment (1)	Time investment (2)	Parenting discipline (3)	Parenting warmth (4)
<i>for non college-educated parent(s):</i>				
Dao Shi has a post-graduate qualification	0.0344 (0.0268)	0.0170 (0.0263)	0.00135 (0.0270)	-0.00595 (0.0259)
Mean of dep. var.	-0.14	0.03	0.00	-0.04
SD of dep. var.	0.99	1.01	1.00	1.00
R-Squared	0.16	0.06	0.04	0.04
Students (obs.)	15,596	15,596	15,597	15,597
Schools (FE)	245	245	245	245
Classes (clust.)	1,236	1,236	1,236	1,236
Covariates	No	No	No	No
	(5)	(6)	(7)	(8)
<i>for college-educated parent(s):</i>				
Dao Shi has a post-graduate qualification	0.163** (0.0628)	-0.0748 (0.0602)	0.0212 (0.0713)	0.101* (0.0563)
Mean of dep. var.	0.11	-0.02	0.00	0.03
SD of dep. var.	0.99	0.99	1.00	1.00
R-Squared	0.24	0.2	0.15	0.14
Students (obs.)	2,411	2,411	2,411	2,411
Schools (FE)	245	245	245	245
Classes (clust.)	819	819	819	819
Covariates	No	No	No	No

Table B.8. Heterogeneous Effects of Assignment to a Dao Shi with a Post-graduate Qualification by Family Income

Dependent variable =	Financial investment (1)	Time investment (2)	Parenting discipline (3)	Parenting warmth (4)
<i>for household income of less than NT\$100,000/month:</i>				
Dao Shi has a post-graduate qualification	0.059** (0.0270)	0.023 (0.0267)	0.010 (0.0281)	0.001 (0.0248)
Mean of dep. var.	-0.06	0.01	0.00	-0.01
SD of dep. var.	1.00	1.01	1.00	1.01
R-Squared	0.16	0.06	0.03	0.04
Students (obs.)	333	333	333	333
Schools (FE)	1,235	1,235	1,235	1,235
Classes (clust.)	15,576	15,576	15,577	15,577
Covariates	No (5)	No (6)	No (7)	No (8)
<i>for household income greater than or equal to NT\$100,000/month:</i>				
Dao Shi has a post-graduate qualification	0.093 (0.0618)	-0.107* (0.0619)	-0.095 (0.0645)	0.046 (0.0606)
Mean of dep. var.	0.38	-0.05	-0.02	0.09
SD of dep. var.	0.93	0.96	1.00	0.96
R-Squared	0.23	0.21	0.15	0.14
Students (obs.)	304	304	304	304
Schools (FE)	873	873	873	873
Classes (clust.)	2,431	2,431	2,431	2,431
Covariates	No	No	No	No

Table B.9. The Effect of Assignment to a Dao Shi with a Post-graduate Qualification on the Person Initiating Math Tutoring Decisions

Dependent variable =	<i>person who initiated math tutoring:</i>		
	Student (1)	Father (2)	Mother (3)
Dao Shi has a post-graduate qualification	0.000 (0.0102)	0.009 (0.0091)	0.016 (0.0109)
Mean of dep. var.	0.73	0.21	0.31
SD of dep. var.	0.44	0.40	0.46
R-Squared	0.02	0.02	0.03
Students (obs.)	17,901	17,901	17,901
Schools (FE)	333	333	333
Classes (clust.)	1,236	1,236	1,236
Covariates	No	No	No

Dependent variable =	<i>person who initiated math tutoring:</i>		
	Teacher (4)	Classmates/friends (5)	Other (6)
Dao Shi has a post-graduate qualification	0.002 (0.0040)	0.004 (0.0033)	-0.000 (0.0058)
Mean of dep. var.	0.02	0.02	0.06
SD of dep. var.	0.14	0.14	0.23
R-Squared	0.04	0.02	0.03
Students (obs.)	17,901	17,901	17,901
Schools (FE)	333	333	333
Classes (clust.)	1,236	1,236	1,236
Covariates	No	No	No

Table B.10. The Effect of Assignment to Dao Shi with a Post-graduate Qualification on Parental Beliefs of the Most Important Drivers of Academic Achievement

Dependent variable =	<i>parents' belief of most important drivers of academic achievement:</i>		
	Parental discipline (1)	Teacher quality (2)	Classmates/friends (3)
Dao Shi has a post-graduate qualification	-0.006 (0.0059)	-0.009* (0.0053)	-0.002 (0.0059)
Mean of dep. var.	0.08	0.06	0.08
SD of dep. var.	0.27	0.24	0.27
R-Squared	0.02	0.02	0.02
Students (obs.)	333	333	333
Schools (FE)	1,236	1,236	1,236
Classes (clust.)	17,897	17,897	17,897
Covariates	No	No	No

Dependent variable =	<i>parents' belief of most important drivers of academic achievement:</i>		
	Private tutoring (4)	Student effort (5)	Student talent (6)
Dao Shi has a post-graduate qualification	-0.003* (0.0013)	0.032*** (0.0111)	-0.008 (0.0088)
Mean of dep. var.	0.00	0.62	0.17
SD of dep. var.	0.06	0.48	0.37
R-Squared	0.02	0.02	0.02
Students (obs.)	333	333	333
Schools (FE)	1,236	1,236	1,236
Classes (clust.)	17,897	17,897	17,897
Covariates	No	No	No

Table B.11. The Effect of Assignment to a Dao Shi with a Post-graduate Qualification on Students' Standardized Test Scores

Dependent variable =	Test scores	Analytical subcomponent	Mathematical subcomponent
	(1)	(2)	(3)
Dao Shi has a post-graduate degree	0.012 (0.0336)	0.028 (0.0319)	0.031 (0.0335)
Mean of dep. var.	0.00	0.00	0.00
SD of dep. var.	1.00	1.00	1.00
R-Squared	0.21	0.18	0.19
Students (obs.)	17,799	17,799	17,799
Schools (FE)	333	333	333
Classes (clust.)	1,236	1,236	1,236
Covariates	No	No	No

Table B.12. The Effect of Assignment to Dao Shi with a Post-graduate Qualification on Student Weekly Hours Spent on Different Activities

Dependent variable =	School tutoring (hours/week) (1)	Internet homework (hours/week) (2)	Willing to take out-of-school tutoring (3)	Self-study (hours/week) (4)
Dao Shi has a post-graduate qualification	0.077 (0.1079)	0.061 (0.0525)	0.010 (0.0126)	0.241 (0.2389)
Mean of dep. var.	5.43	2.07	0.40	11.88
SD of dep. var.	3.87	1.95	0.49	8.55
R-Squared	0.12	0.04	0.05	0.08
Students (obs.)	17,859	17,809	17,782	17,810
Schools (FE)	333	333	333	333
Classes (clust.)	1,236	1,236	1,236	1,236
Covariates	No	No	No	No

Dependent variable =	Makes outlines to study better (5)	Reduce leisure before exams (6)	Online chat (hours/week) (7)	Online gaming (hours/week) (8)
Dao Shi has a post-graduate qualification	-0.008 (0.0063)	-0.004 (0.0062)	-0.045 (0.1491)	0.060 (0.1512)
Mean of dep. var.	0.06	0.06	4.64	4.12
SD of dep. var.	0.25	0.24	5.76	6.31
R-Squared	0.03	0.03	0.03	0.04
Students (obs.)	17,743	17,775	17,903	17,886
Schools (FE)	333	333	333	333
Classes (clust.)	1,236	1,236	1,236	1,236
Covariates	No	No	No	No

Table B.13. The Effect of Assignment to Dao Shi with a Post-graduate Qualification on Student Beliefs of the Most Important Drivers of Academic Achievement

Dependent variable =	<i>students' belief of most important drivers of academic achievement:</i>		
	Parental discipline (1)	Teacher quality (2)	Classmates/friends (3)
Dao Shi has a post-graduate degree	0.00554 (0.00539)	0.00499 (0.00594)	0.0105 (0.00606)
Mean of dep. var.	0.054	0.070	0.077
SD of dep. var.	0.227	0.255	0.266
R-Squared	0.02	0.02	0.02
Students (obs.)	333	333	333
Schools (FE)	1,236	1,236	1,236
Classes (clust.)	17,897	17,897	17,897
Covariates	No	No	No

Dependent variable =	<i>students' belief of most important drivers of academic achievement:</i>		
	Private tutoring (4)	Student effort (5)	Student talent (6)
Dao Shi has a post-graduate degree	0.00275 (0.00282)	-0.0306** (0.0114)	0.0178* (0.00883)
Mean of dep. var.	0.013	0.681	0.131
SD of dep. var.	0.115	0.466	0.337
R-Squared	0.02	0.03	0.02
Students (obs.)	333	333	333
Schools (FE)	1,236	1,236	1,236
Classes (clust.)	17,897	17,897	17,897
Covariates	No	No	No

Figure B.1. The Effect of Assignment to a Dao Shi with a Post-graduate Qualification on Students' Standardized Test Scores by Parental Education

