Author/s:
Chang, S;Cobb-Clark, DA;Salamanca, N

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Parents' Responses to Teacher Qualifications

Simon Chang[a•], Deborah A. Cobb-Clark[b‡•], and Nicolás Salamanca[c‡•]

[a] The University of Western Australia
[b] The University of Sydney
[c] The University of Melbourne
[•] Institute of Labor Economics (IZA)
[‡] ARC Centre of Excellence for Children and Families over the Life Course

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Abstract

We identify the causal effect of children being assigned to more highly qualified teachers on their parents' investments. Exploiting a unique setting in which teachers are randomly assigned to classes, we show that parents respond to more qualified teachers by increasing their children's private tutoring. A potential mechanism is an increase in parents' belief that achievement is driven by student effort—for which tutoring is instrumental. Teacher qualifications are unrelated to test scores, however. Instead, they weaken students' beliefs that effort is important for achievement, suggesting that private tutoring may have a demotivating effect on students. We conclude that family-wide behavioral reactions are important in educational production.

Keywords: Teacher quality; Student achievement; Parental investment; Beliefs; School effort
JEL Codes: D10, I21, I24

Contact Author: Nicolás Salamanca (n.salamanca@unimelb.edu.au), Melbourne Institute: Applied Economic & Social Research. Level 5, FBE Building, 111 Barry St., University of Melbourne, Parkville, VIC 3010, Australia. Chang: Economics UWA Business School, The University of Western Australia (M251), 35 Stirling Highway, WA 6009, Australia. Cobb-Clark: Level 5, Social Sciences Building University of Sydney, Camperdown, NSW 2006, Australia. We thank Boer Xia for her excellent research assistance and the Survey Research Data Archive (SRDA) in Taiwan, especially Wan-wen Su, for facilitating our analyses of the Taiwan Education Panel Survey. We thank Alexandra de Gendre, Jan Feld, and Johannes Kunz for their helpful comments, and Melisa Bubonya, Abraham Chigavazira, and Tiffany Ho and Hebe Williams for their excellent research assistance. This research was supported by the University of Melbourne Early Career Researcher Grant Scheme [project number CE140100027] and the Australian Research Council through the Centre of Excellence for Children and Families over the Life Course [project number CE200100025]. The Centre is administered by the Institute for Social Science Research at The University of Queensland, with nodes at The University of Western Australia, The University of Melbourne and The University of Sydney. This paper uses data from the Taiwan Educational Panel Survey (Restricted Access Data) (R010001) [data files: w1_j_s_lv6_0, w2_j_s_lv6.1, w1_j_p_lv6.0, w2_j_p_lv6.0, w1_j_dt_lv6.1, w2_j_dt_lv6.1, w1_j_dtc_lv6.2, w1_j_sch_ov6.0]. Available from Survey Research Data Archive, Academia Sinica. doi:10.6141/TW-SRDA-R010001-1. License number: SRDAR012018001. Declarations of interest: none. The views expressed herein are solely those of the authors.

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' 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 and reinforce 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 than considering the underlying production function parameters that drive parents' behavior (see Todd & Wolpin 2003). Studies that do attempt to isolate parents' reactions to changes in school inputs yield mixed results (see Bonesrønning 2004; Gelber & Isen 2013; Pop-Eleches & Urquiloa 2013; Fredriksson 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. Our motivation for focusing on teacher qualifications is twofold. First, teacher credentials matter for student achievement. This is particularly true in the case of math and reading achievement (Clotfelter et al. 2007; Croninger et al. 2007; Myrberg 2007) and when credentials are subject- or age-specific rather than general (Clotfelter et al. 2010; Coenen et al. 2018; Harris & Sass 2011). Second, although little of the variation in teacher quality is explained by observable characteristics such as education or experience (Rivkin et al. 2005), teachers' qualifications may, nonetheless, be used by parents to infer teacher quality. This is likely to be particularly true in Taiwan where a culture of "credentialism" implies that, for most parents, success is achieved through their children pursuing higher education degrees which allow them to obtain

a more elite social status (see Lin & Lin 2012). In this context, it would not be surprising for parents' to be particularly focused on the credential held by their child's teachers.

We exploit 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 key parental investments and parent-child interactions. 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 & Avi Astor 2009; Wei & Chen 2010; Taiwan Ministry of Education 2018). We also 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. 2019; Dizon-Ross 2019; Attanasio et al. forthcoming). Finally, we 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 socioeconomic status is linked to parents' investment choices is informative about the potential mechanisms driving families' behavioral responses to changes in school inputs.

We find that parents respond to higher Dao Shi qualifications by increasing the financial investments they make in their children. Parents whose child is exogenously assigned to a Dao Shi with a post-graduate degree subsequently spend NT$3,100 (approximately 7 percent) more on tutoring for their child in the first two years of junior high school. This response makes sense in the Taiwanese context, where 'cram schools' are central for children's education (Chou 2014) and a very popular and readily available way for parents to invest in their children's educational development. Parents do not, on average, alter their time investments, the way they discipline their child, or their parental warmth in response to teacher qualifications. We then show that higher Dao Shi qualifications strengthen parents' beliefs that student effort is a key driver of academic achievement. This suggests parents view tutoring as instrumental to increase their child's study effort, perhaps more so than schooling.

Dao Shi qualifications, however, 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. 2020) while private tutoring seems to have only small effects on students' academic performance (Kuan 2011). We argue that child agency is important for understanding the weak relationship between school inputs and student outcomes. Specifically, we show that students' beliefs in the effectiveness of their own effort fall in response to higher Dao Shi qualifications. This could reflect a type of effort crowding out, where students who receive private tutoring indeed exert extra effort but also reduce their own intrinsically motivated effort. Effort crowding out as a mechanism is consistent with other studies that find strategic interactions between the effort exerted by parents, schools, and students themselves (De Fraja et al. 2010).

Finally, we explore the heterogeneity in parents' responses to Dao Shi qualifications. We find that parent-teacher contact matters; parents increase their children's tutoring in response to higher qualifications only if they are in close contact with their child's Dao Shi. Highly educated and high-income parents also react more strongly to Dao Shi qualifications, consistent with complementarity in private (parents') and public (teachers') investments in children (see also Fredriksson et al. 2016).

Our work makes several important contributions to the literature. First, our focus on the qualifications of Taiwanese teachers brings a new perspective to the growing literature investigating parental responses to exogenous variation in class size (Bonesrønning 2004; Datar & Mason 2008; Fredriksson et al. 2012), school grants (Das et al. 2013), ability-based tracking (Fu & Mehta 2018), school access (Cullen et al. 2006; Pop-Eleches & Urquiloa 2013), parental support (Barrera-Osorio et al. 2020), and Head Start (Gelber & Isen 2013). Moreover, our unique context adds richness to the existing literature by shining a light on the role of highly engaged teachers operating in a high-stakes educational setting. Unlike their counterparts in the United States, Taiwanese adolescents remain in the same class with the same cohort of students and the same Dao Shi 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 & Avi 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 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 look at the way parents change the key resource and time investments they make in response to changes in school inputs. However, 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 mismeasured 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). Importantly, we provide the first casual estimates of the effect of school inputs on parents' and students' beliefs.

Third, we examine 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 (Dizon-Ross 2019; Attanasio et al. forthcoming; Biroli et al., in press). 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 research findings. In our case, we analyze both children's effort as well as their beliefs, allowing us to provide evidence that a reduction in students' motivation is likely to be a compensatory mechanism which limits the influence of teacher qualifications on student achievement.

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) exploit child fixed-effect-instrumental-variable models and find that increases in class size are associated with a decrease in parent-child interaction, an increase in activities financed by parents, and no change in parent-school interactions. Exploiting rules regarding class size, Fredriksson 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 (Fredriksson et al. 2016). Thus, parents respond to changes in class size in complex ways—sometimes reinforcing and often offsetting changes in school resources.

The same complexity is apparent when other school inputs are considered. 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. Berniell and Estrada (2020) also show that parents react to expected school disadvantage by increasing their time investments and choosing a better school for their children. Yet Barrera-Osorio et al. (2020) find that neither additional funds for parent associations nor additional information to parents resulted in increased educational

achievement. Cullen et al. (2006) show that, while lottery access to better schools does cause parents to discuss class- and school-related issues with their children more often, it also reduces their help with homework. Gelber and Isen (2013) further show that parents whose children are randomly assigned to Head Start also increase their effort in reading to children, doing math activities, and ensuring that children spend time with non-residential fathers, though interpreting this evidence is complicated by the fact that Head Start targets both parents and schools.

Importantly, parents' beliefs matter for the investments they make (Boneva & Rauh 2018; Attanasio et al. forthcoming; Biroli et al. in press), 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. 2019). 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; see Laferrère and Wolff 2006; Doepke et al. 2019 for reviews).

3. METHOD

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

3.1 The Taiwanese Educational Setting

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.[1] 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 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

[1] 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.

resources in 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.[2]

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 school hours, and establishing discipline policy.[3] Thus, the Dao Shi has a great deal of influence over the entire course of a student's high school career.

[2] 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.

[3] In addition to their regular classroom teaching duties, schools generally mandate specific work arrangements and responsibilities for Dao Shi. These involve not only administrative tasks (e.g., taking the roll, approving leave, supervising study periods), but also discipline and pastural care (e.g., monitoring mental health, behavior, performance) involving their students. Dao Shi are responsible for daily communication with parents through students' "communication books" (see Appendix Figure B1) and for maintaining contact through parent meetings, home visits, and after-hours phone calls. Importantly, they are also expected to take a key role in supporting students' personal development.

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*.[4] 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 openly, permitting parents to attend. The resulting class assignments were then announced publicly and made available for verification.[5] 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. We provide extensive evidence demonstrating the lack of systematic variation between Dao Shi qualifications and students' characteristics, family background, and test scores as well as pre-assignment parental investments in Appendix C.[6]

We estimate the following model

$$\mathrm{Y_{isc}} = \beta \mathrm{Postgraduate_{sc}} + \delta X_{sc} + \gamma_s + \varepsilon_{isc}, \quad (1)$$

where $\mathrm{Y_{isc}}$ is an outcome measured in wave 2 for student i attending school s and assigned to class c within school s. $\mathrm{Postgraduate_{sc}}$ is a dummy that equals one if the Dao Shi assigned to class c in wave 1 has a post-graduate qualification, X_{sc} are controls for Dao Shi age and experience, 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 model error term. We cluster our standard errors at the classroom level.

[4] For details on Article 3 see: https://edu.law.moe.gov.tw/LawContent.aspx?id=FL008358. In 2004, Article 3 was superseded by Article 12 of the *Primary and Junior High School Act*.

[5] The lottery used to assign students to classes is highly regulated. The responsibility for randomly assigning incoming students and Dao Shi to classes rests with school committees that include the principal and teacher, parent, and community representatives. The date and venue of the lottery is public information, and all Dao Shi are expected to attend in person. Department of Education inspectors also attend in order to supervise the random assignment process on site. Results of the lottery are made public for at least 15 days; written records are required to be kept for at least three years. The assignment lottery is a key performance indicator for schools and their principals; both are subject to penalties if lottery rules are violated. For more information see, for example, https://law.tycg.gov.tw/LawContent.aspx?id=GL002100&KeyWord).

[6] Specifically, we provide evidence that assignment to Dao Shi with post-graduate qualifications is as good as random within schools in Appendix C. Moreover, we also demonstrate that, with the exception of teacher experience, all other teacher characteristics show balanced assignment across student and family characteristics. This evidence provides strong support for our quasi-experimental design. Although our institutional context provides us no conceptual reason to believe that Dao Shi are selected with respect to experience, we cautiously refrain from interpreting effects of teacher experience as causal.

Given our maintained assumption that treatment is randomly assigned, our coefficient of interest β captures the causal effect of students being assigned to a Dao Shi with post-graduate qualifications on outcome Y_{isc}. To the extent that parents cannot perfectly observe the qualifications of their child's Dao Shi, we expect our estimates to be understated due to attenuation bias.

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.[7] 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 (7^{th} grade); follow-up interviews (wave 2) took place in 2003 when students entered their third year (9^{th} grade).

A student's 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 of 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.

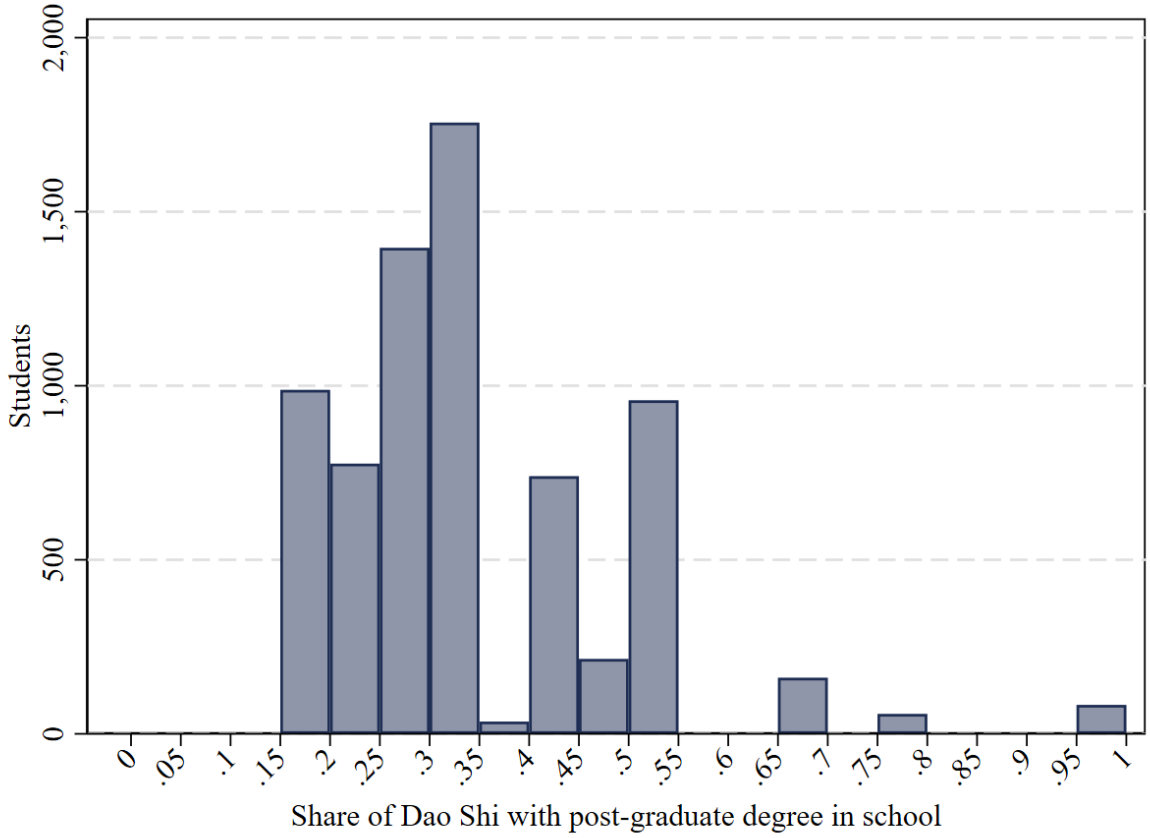
The complete TEPS dataset has information on 20,055 students in wave 1 and 19,088 students in wave 2. There is little survey or item non-response in TEPS and, importantly, this non-response is not systematically related to the assignment of a Dao Shi with post-graduate qualifications. We retain observations with matched information on students, parents, and teachers in both waves and drop 1,047 observations for which the responding adult is not the father or mother of the student. 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 overall TEPS sample (see Appendix Table B1). 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

[7] For details about the sampling design see: http://tepsb.nccu.edu.tw/download/TEPS-EnglishOverview.pdf.

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. In 13 percent of families, there is at least one parent who is college-educated and the average family income is NT$62,600 per month (approximately $2,800 current USD).

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



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. In our estimation sample, 13 percent of Dao Shi have post-graduate qualifications, although 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 0.5 percent attend schools in which all Dao Shi have post-graduate qualifications. As our estimation models include 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.

The characteristics of Dao Shi with and without post-graduate qualifications are shown in Appendix Table B2. With two exceptions, Dao Shi with post-graduate qualifications have similar characteristics to their less qualified counterparts. Post-graduate qualified Dao Shi are younger and less experienced than their colleagues without post-graduate qualifications. Consequently, all estimation results control for Dao Shi age and experience.

Figure 1 shows our identifying variation by plotting the distribution of the within-school share of teachers who have post-graduate qualifications, excluding those 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; however, this probability varies across our sampled schools from as little as 15 to as much as 75 percent.

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, though typically using fewer items in wave 2 than in wave 1. Our key outcomes are various parental investments measured in wave 2.[8]

In Taiwan, schooling is free in both public and private junior high schools and associated fees amount to less than NT$6,000 (around $270 USD) on average. The primary financial investment that parents make in their children is private tutoring which imposes a substantial financial burden on most families (Chou & Yuan 2011; Chou 2014).[9] Our data include three items that capture private tutoring (including attending cram schools): i) the number of semesters that students have received private tutoring since entering junior high school; 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. 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. We combine the information in these items into a measure of the total amount spent in tutoring during the

[8] Details about the item selection and measure construction can be found in Appendix A. Appendix Table A1 shows summary statistics of all the parental investment items used in this paper. Our results are robust to using scales constructed through confirmatory factor analyses.

[9] We are unaware of any data source that would allow us to compare tutoring expenditures as a share of family income across countries. However, data from the Trends in International Mathematics and Science Study in 1999 show that in terms of most hours of private tutoring for junior high school students, Taiwan ranks 8th out of 34 countries globally and is similar to other Asian and Eastern European countries. Assuming small wage differences on average and for private tutors, this would imply that private tutoring is similarly taxing for households across these countries.

first two years of junior high school. On average, families spend NT$44,800 on private tutoring over these years. The average expenditure is almost NT$81,000—well over a month's earnings—among those families who ever hired a private tutor.

Parents' primary time investment is their daily interactions with their children which in many families with adolescents happens largely around dinnertime. Having dinner together allows parents to stay in touch with their children's school experiences and social life. Previous evidence indicates there are positive returns to "dinnertime" measures of parental effort in improving adolescent well-being through, for example, greater educational achievement, better mental health, reduced substance abuse, and less delinquency (Houtenville & Conway 2008; Price 2008; Cunha & Heckman 2009; Musick & Meier 2012). Our measure of parental time investments is therefore the number of days a week they have dinner together with their child. We combine both mothers' and fathers' responses in our measure. On average, the parent who responds to the survey has dinner with their child 4.1 days a week and their partner, if present, has dinner with their child 3.9 days a week. Half of parents have dinner with their child every day. We combine the dinner days of parent and partner into a measure of the total amount of parent-days at dinner time per week (so that e.g., a child having dinner with both parents every day would have 14 parent-days of dinnertime a week). The average child has 7.5 parent-days of dinner time each week.[10]

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

[10] One shortcoming in this measure is that it does not capture time spent with children at other times, particularly the weekends. Unfortunately, no such measures are available in wave 2. However, we suspect these other time investments are highly correlated with parental dinnertime: our dinner time measure in wave 2 is positively correlated with parent- and child-reported measures of time spent together in wave 1, as well as with parent-child activities that would usually take place in weekends (such as going to bookstores, exhibitions, concerts, and community volunteering together).

and 10 percent demanding that their children are among the top five students in their class. There is no natural unit for combinations of these items, so we opt for constructing a standardized scale for parenting discipline by summing all items and then rescaling the sum by subtracting its mean and dividing it by its standard deviation.

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. Like parenting discipline, we construct a standardized scale for parenting warmth by summing all these items and rescaling the sum by subtracting its mean and dividing it by its standard deviation.

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 main component measuring comprehensive ability, and two subcomponents capturing analytical ability and mathematical ability. These components form the basis of the achievement measures used in our study.[11]

Several of our measures of parental investment and student test scores are correlated with one another in wave 2. The strongest correlation is between tutoring and test scores ($\hat{r}$ = 0.32) followed by the correlation between parenting discipline and warmth ($\hat{r}$ = 0.25). Parenting discipline is also mildly correlated to tutoring and dinner time days ($\hat{r}$ = 0.11 for

[11] 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).

both). The autocorrelations between these measures and their wave 1 counterparts across waves are strong and range between 0.25 for parental discipline and 0.80 for test scores. Moreover, many student and parent characteristics are also correlated with our measures of parental investments. Girls receive less discipline and more warmth, for example. There are also differences in tutoring and dinners associated with ethnicity and family structure, while higher income and more educated parents are less likely to discipline their children (see Appendix Table B3). Overall, this supports the view that all our parental investment measures have high information content.

5. DAO SHI QUALIFICATIONS AND PARENTAL INVESTMENTS

Table 1 shows the effect of being assigned a Dao Shi with post-graduate qualifications in wave 1 on parents' investments made between waves 1 and 2. We find that being assigned to a Dao Shi with a higher qualification increases parents' investments in private tutoring by NT$3,162 ($p$ = 0.006) over the first two years in junior high school. Including an extensive set of additional student, parent, and teacher characteristics to this regression does not alter this result (see Appendix Table B3).[12]

Table 1. The Effect of Having a Dao Shi with a Post-graduate Qualification on Parents' Investments

Dependent variable =	Tutoring (total NT$)	Dinner time (parent-days/week)	Parenting discipline	Parenting warmth
	(1)	(2)	(3)	(4)
Dao Shi post-graduate degree	3162.295***	0.009	0.000	0.014
	(1140.752)	(0.070)	(0.027)	(0.024)
Mean of dep. var.	44,792	7.52	0.00	0.00
SD of dep. var.	48,174	2.80	1.00	1.00
R-Squared	0.15	0.06	0.03	0.03
Schools (FE)	126	126	126	126
Classes (clust.)	494	494	494	494
Students (obs.)	6,946	6,992	6,998	6,998

*OLS coefficients with cluster-robust standard errors at the class level in parentheses. All regressions control for Dao Shi age and years of experience as teacher. Number of schools, classes, and students reflect the effective sample size (i.e., obs. that contribute to the identification of our effect of interest) as described in Miller et al. (2019). The complete estimation sample includes data from up to 333 schools, 1,236 classes, and 18,008 students. *, **, and *** mark estimates statistically different from zero at the 90, 95 and 99 percent confidence level.*

[12] Our measure of tutoring is censored since 44 percent of children do not take any private tutoring, and 16 percent of children are at the maximum measured expenditure in tutoring of NT$120,000. Accounting for this censoring using a tobit model leads to a Dao Shi qualifications effect of NT$7,875 (std. err. = NT$2,878). In a similar manner, our measure of family dinner time is censored since 43 percent of children have dinner with both parents every day. Accounting for this censoring leads to an effect of -0.047 (std. err. = 0.119).

This effect size is modest in absolute terms, corresponding to 7 percent of the average tutoring expenditure and 5 percent of the average family monthly income. The literature provides very little guidance on the determinants of parental investments in tutoring making it difficult for us to benchmark our estimates against previous evidence. Our effect size is comparable in magnitude, for example, to the compensating investment in private lessons that Australian parents make in children who are measured to be 7.6 percent of a standard deviation lower in cognitive ability (Nicoletti & Tonei 2020). It is large, however, relative to the estimated effect of a one percent change in family income on private tutoring expenditures in China (Liu & Bray 2017) and Hong Kong (Bray et al. 2014).

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, our standard errors are small, which means that the lack of evidence for parental responses in these three investments is not driven by lack of statistical power. We can, for example, rule out an effect as small as 0.19 parent-days of dinner time a week based on an ex-post Minimum Detectable Effect (MDE) calculation.[13]

6. MECHANISMS BEHIND PARENTS' BEHAVIORAL REACTIONS

In this section we explore the potential mechanisms behind our finding that parents increase private tutoring when their children are assigned to Dao Shi with post-graduate qualifications. Disentangling the mechanisms driving this parental behavior can give us unique insights into the reasons that parents (and their children) complement educational inputs. We first consider and rule out the possibility that this behavior is purely driven by direct pressure from Dao Shi themselves—in which case we could not have hoped to learn much about parents' and children's own motivations through our estimates.

We then explore the possibility that parents' own beliefs about the determinants of educational achievement drive them to make these complementary investments (see e.g., Fredriksson et al. 2016). This is not a simple exercise; there are many determinants of educational achievement, parents will have (subjective) beliefs about all of them, and direct measures of beliefs around input complementarity are rare to nonexistent. Nevertheless, we make full use of the TEPS data to provide evidence that suggests parental beliefs in

[13] Appendix Table B4 shows the effects of having a Dao Shi with post-graduate qualifications on all the individual measures of parental investment we consider in our data.

complementarities in the education production function (though in effort rather than tutoring) could indeed be driving their investment choices.

Throughout this section we analyze mechanisms by estimating variations of Equation (1), regressing each measure on Postgraduate_{sc}, our indicator for being assigned to a Dao Shi assigned who has a post-graduate qualification, controlling for school fixed effects as well as Dao Shi age and experience.

6.1 Direct Pressure from Dao Shi

Dao Shi themselves may 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 about and, therefore, spending on tutoring.

To investigate this possibility, we analyze responses to 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 likely to be an important part of overall tutoring for adolescents, making their responses to this question informative about who is actually making tutoring decisions in general.

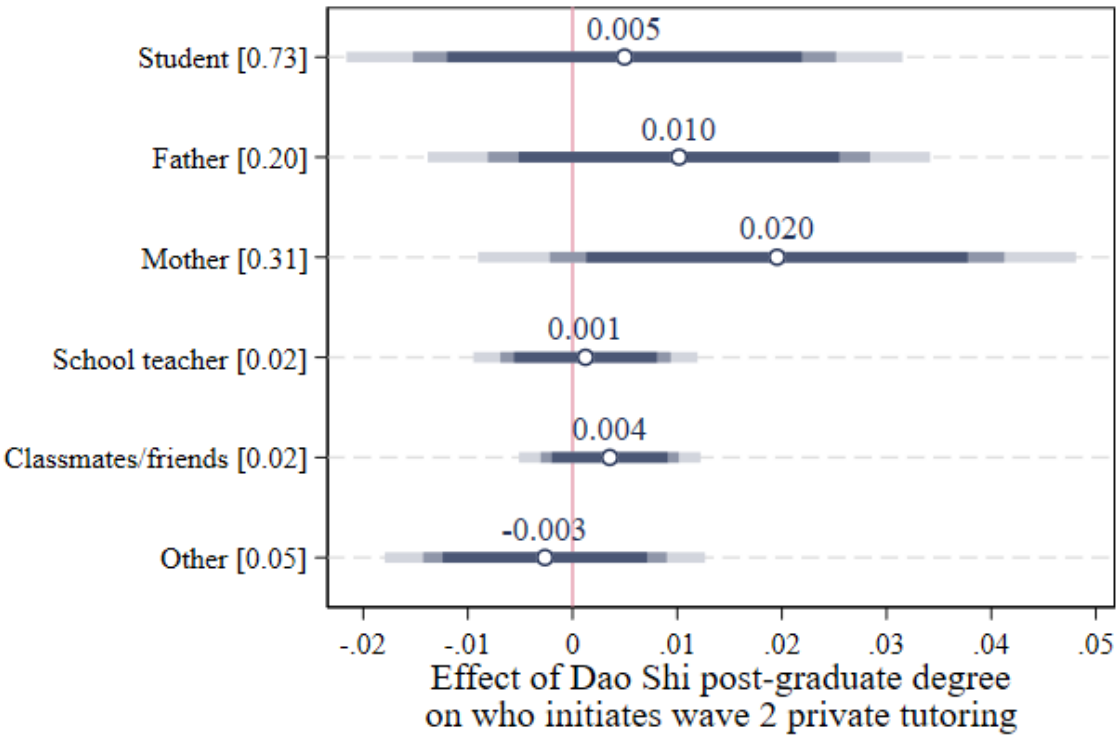
The effects of having a Dao Shi with a post-graduate qualification on recommendations regarding junior high school math tutoring are shown in Figure 2. Each row plots the point estimate for a different person, and the shaded colored bars correspond to 90, 95, and 99 percent confidence intervals for each estimate. To aid in interpretation of the magnitude of estimates, the numbers in square brackets show the unconditional mean for each outcome (e.g., 73 percent of the time students themselves initiate tutoring in wave 2).[14] The answers to this question show that math tutoring decisions are almost always made by students, followed by mothers (31 percent), then fathers (20 percent); whereas very few are made by teachers (2 percent) or others (7 percent combined). Moreover, the results show 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.

It is also unlikely that the increase in tutoring is driven by Dao Shi with post-graduate qualifications who themselves provide private tutoring and thus "capture" some of their

[14] We provide the estimates underlying this and all other figures in this paper in Appendix Tables B5 through B9.

classroom students as their own private pupils.[15] 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 than their less educated counterparts, with only a statistically insignificant 15 minute tutoring time differential in favor of post-graduate qualified Dao-Shi.

Figure 2. The Effect of Having a Dao Shi with a Post-graduate Qualification on the Person Initiating Math Tutoring Decisions



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

6.2 Parental Beliefs

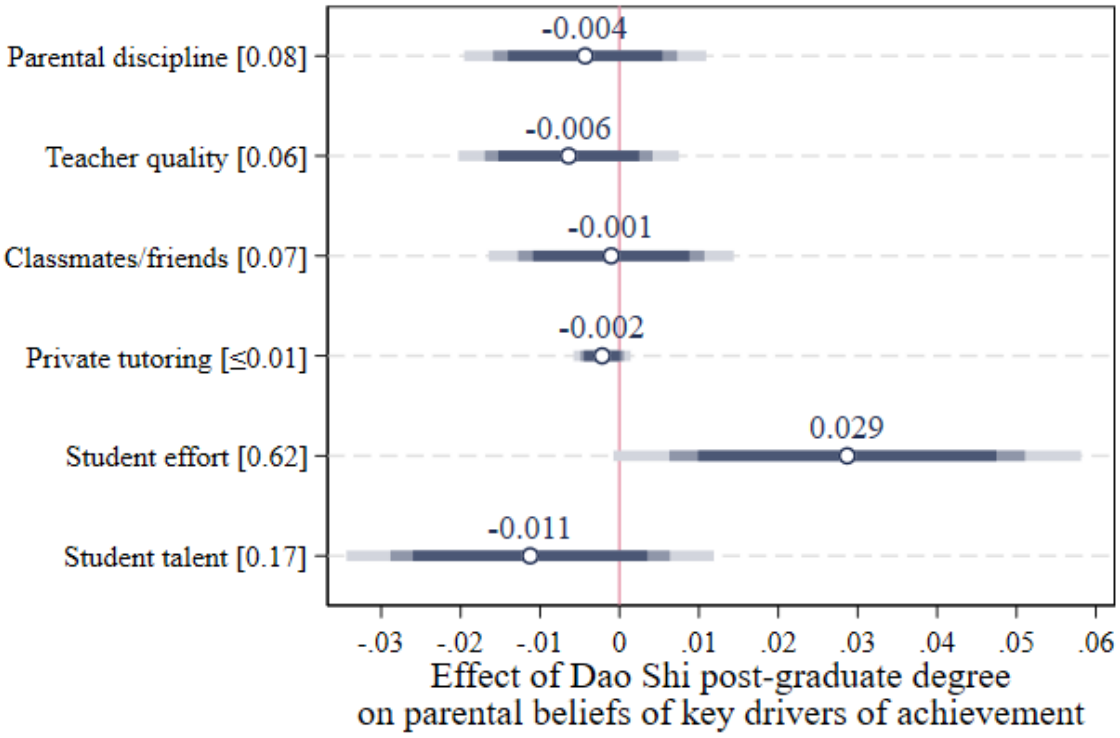
Parents may increase their tutoring investments in response to a better qualified Dao Shi because they believe that higher Dao Shi qualifications result in greater student test scores and they view Dao Shi qualifications and tutoring as complements in the education process.

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

We investigate this possibility 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, most parents choose only one.

Given the stated question, it is unclear whether our measure is capturing parents' beliefs about the *marginal* or the *average* return to each of these drivers of academic achievement. It is difficult to determine which interpretation is more plausible; however, we find no evidence that parental beliefs exhibit decreasing marginal returns as would be expected under a marginal return interpretation of our measure. Beliefs in study effort effectiveness do not decrease as study or homework hours increase; neither do beliefs in parental discipline fall as parents impose stricter discipline on their children or beliefs in private tutoring decline as expenditures in tutoring increase. This suggests when parents answer this question, they are reporting their beliefs about the average return to each driver of academic achievement.

Figure 3. The Effect of Having a Dao Shi with a Post-graduate Qualification on Parents' Beliefs of the Most Important Drivers of Academic Achievement



The distribution of responses is at odds with a widespread belief that, in and of themselves, teacher quality and private tutoring improve academic achievement. Only 6 percent of parents believe that teacher quality is a key to student achievement, and less than 1 percent of parents believe that tutoring matters (see row square brackets in Figure 3). In addition, the data are also inconsistent with parents believing that teacher quality and tutoring complement each other in the production of educational achievement. Parents who believe teacher quality matters are no more likely to believe that private tutoring also matters. If anything, being assigned to a Dao Shi with better qualifications slightly decreases parents' beliefs that teacher quality or tutoring matter for student achievement. These results leave little scope for parents' beliefs in the direct value of teachers and tutoring for parents' investment decisions.

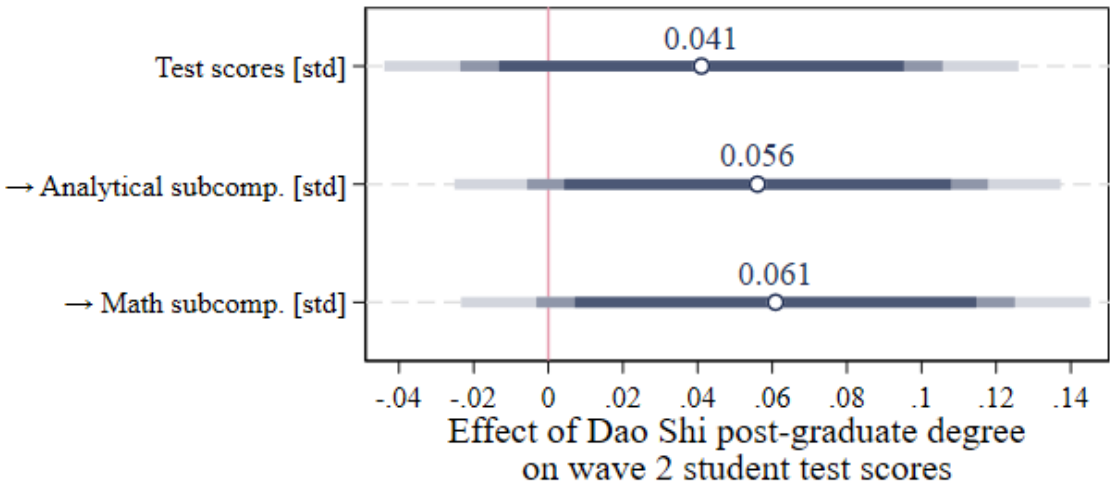
Why then do parents invest more in tutoring if they do not believe it is central to student achievement? One possibility is that parents believe that tutoring is instrumental in making their children put more effort into school. Previous studies have viewed parents' investments through the lens of the 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). The role of private tutoring as an instrument to ensure effort is particularly likely in the Taiwanese context, where 'cram schools'—補習班 or *buxiban*, the chief source of private tutoring—are widely attended by children in junior high schools (Chou 2014). Children study in these schools until as late as nine in the evening, often receiving instruction in regular school subjects. For many parents, private tutoring is a way to ensure their child will put in the long study hours that many of their peers do. 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 3 is indeed consistent with the view that parents may use tutoring to incentivize effort. It shows that most parents (62 percent) 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 ($p = 0.012$). This effect can simply reveal a direct impact of Dao Shi post-graduate qualifications on parental beliefs, yet parents' believing in complementarities between Dao Shi qualifications and student effort would also render this result consistent with the impact of Dao Shi qualifications on tutoring.

7. DAO SHI QUALIFICATIONS AND STUDENT OUTCOMES

Despite the positive effect of Dao Shi qualifications on investments in tutoring, being assigned to a more qualified Dao Shi does not improve students' standardized test scores (see Figure 4). The point estimates on overall test scores (0.041 std. dev., p = 0.213) and in the analytical (0.056 std. dev., p = 0.075) and mathematical (0.060 std. dev., p = 0.063) 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, despite them being the most responsive group of parents (see Table 3 below).

Figure 4. The Effect of having a Dao Shi with a Post-graduate Qualification on Students' Standardized Test Scores

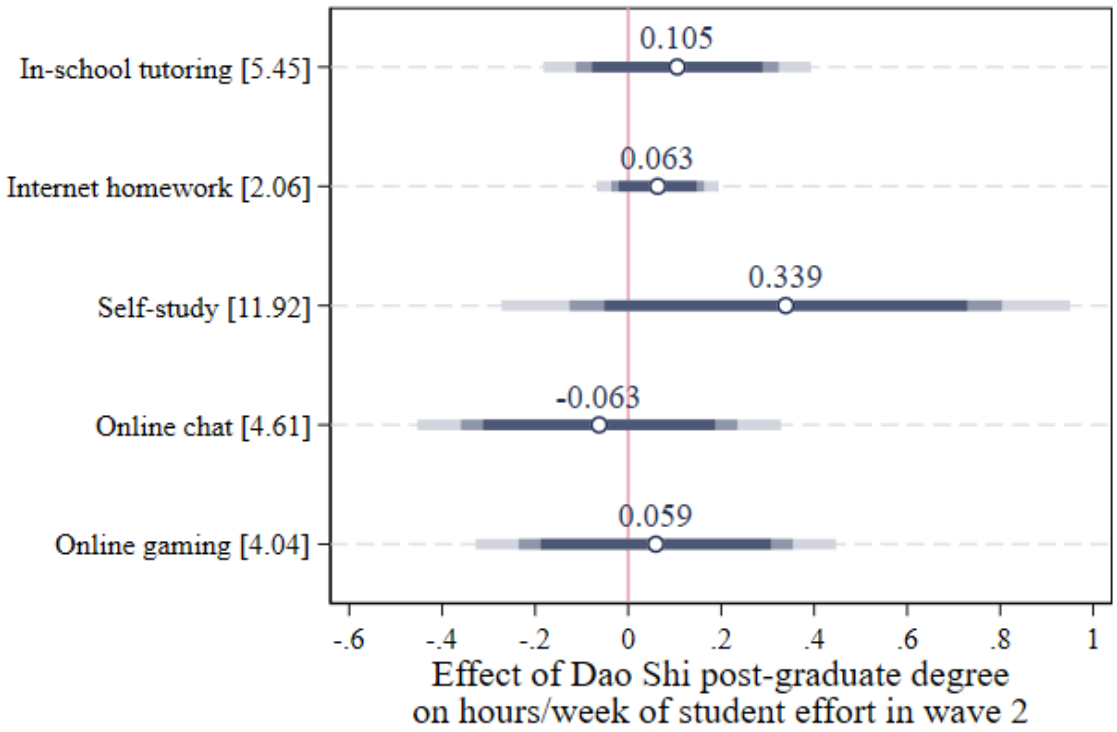


There are at least three possible explanations for the lack of a relationship between Dao Shi qualifications and students' test scores. The first one is that more qualified Dao Shi do have a positive effect on student achievement (and some of this result may be driven by tutoring), yet this effect is too small for us to detect. The positive point estimates and relatively large confidence intervals in Figure 4 suggest this might be the case. In fact, back-of-the-envelope calculations which combine the effect on tutoring in Table 1 with the returns of tutoring on scores from a cumulative value-added model, suggest the effect of Dao Shi qualifications on scores through tutoring is merely 0.4 percent of a standard deviation—well within the confidence intervals in Figure 4. The lack of an effect on scores 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. 2020), as well as with previous evidence

from Taiwan showing only small improvements in student math achievement as a result of private tutoring (Kuan 2011).

The second possibility is that students compensate for the additional effort they put in private tutoring by decreasing their own study time. However, Figure 5 shows that students with a highly qualified Dao Shi do not decrease their time spent in in-school tutoring, doing homework online, or in self-study, nor do they increase their online chatting or gaming.[16] There is therefore no evidence that students' compensate for more study time in private tutoring with less study time elsewhere.

Figure 5. The Effect of Having a Dao Shi with a Post-graduate Qualification on Student Weekly Hours Spent on Different Activities

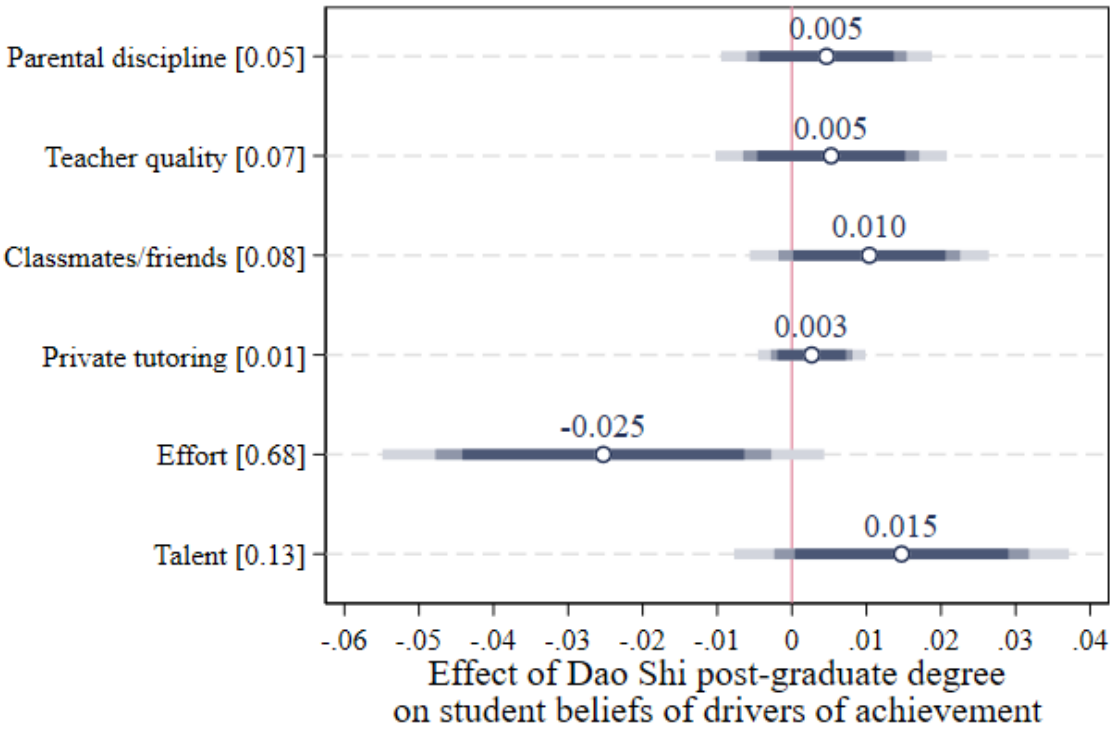


The third possibility is that the additional effort students put into private tutoring reduces their motivation when studying on their own, making additional tutoring ineffective in improving academic achievement. While we cannot directly test this hypothesis with our data, we show some indirect evidence for it in Figure 6. Students assigned to a more qualified Dao Shi decrease their belief that effort is important for academic achievement. To the extent that

[16] In addition to these results, Appendix Table B8 also shows that better qualified Dao Shi do not affect students' willingness to take out-of-school tutoring, to take notes and make outlines for studying better, or to reduce leisure activities in preparation for exams.

students' beliefs regarding the value of effort are an important part of their motivation, these findings are consistent with a demotivating effect of the extra effort students must exert in private tutoring. This would then explain why more qualified Dao Shi have no effect on student achievement. At the same time, being assigned to a more qualified Dao Shi increases students' beliefs in talent and classmates/friends as drivers of achievement, both of which are less effort-driven.

Figure 6. The Effect of Having a Dao Shi with a Post-graduate Qualification on Student Beliefs of the Most Important Drivers of Academic Achievement



These results are also consistent with students differentiating between intrinsically and extrinsically motivated effort. Students may view effort driven by their own intrinsic motivation as their own, in contrast to extrinsically motivated effort which is driven by e.g., private tutoring. Parents' contracting out effort through private tutoring would, in a sense, be achieving their goal of ensuring students pay extra effort but at the cost of crowding out their intrinsically motivated effort, and these opposing effects could eventually cancel out any achievement gains. Similar crowd out effects are both theoretically and empirically important (e.g., Falk & Kosfeld 2006; Gneezy et al. 2011).

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 private tutoring have small effects on achievement; or ii) additional private tutoring demotivates students or crowds out their own effort, eventually making private tutoring unproductive for academic achievement.

8. HETEROGENEOUS EFFECTS OF DAO SHI QUALIFICATIONS

Finally, we investigate the potential drivers of parents' investment responses to Dao Shi qualifications by analyzing heterogeneity in the responses of key subgroups of parents. For these analyses we estimate a version of Equation (1) where we fully interact Postgraduate_{sc} and Dao Shi age and experience with our measures of parent-teacher contact, parental education, and parental income. To facilitate interpretation, we then calculate three sets of average marginal effects for each one of our heterogeneous effect analyses from this interacted regression. These analyses ask a lot of our data, so we interpret results as suggestive evidence.

Table 2. Heterogeneous Effects of Having a Dao Shi with a Post-graduate Qualification by Likely Parent-Teacher Contact of Dao Shi

Dependent variable =	Tutoring (total NT$)	Dinner time (parent-days/week)	Parenting discipline	Parenting warmth
	(1)	(2)	(3)	(4)
Effect of Dao Shi post-graduate degree when Dao Shi likely has:				
Low contact with parents	1169.096	0.091	-0.073*	-0.002
	(1665.331)	(0.113)	(0.042)	(0.041)
High contact with parents	4026.225***	-0.056	0.042	0.021
	(1451.994)	(0.091)	(0.033)	(0.030)
F-test difference (p-value)	0.187	0.312	0.033	0.653
R-Squared	0.15	0.06	0.04	0.04
Schools (FE)	126	126	126	126
Classes (clust.)	487	487	487	487
Students (obs.)	6,852	6,898	6,904	6,904

*Average marginal effects derived from fully interacted models of Dao Shi post-graduate degree, age and experience with parent contact, parental education and family income. Cluster-robust standard errors at the class level in parentheses. Number of schools, classes and students reflect the effective sample size (i.e., obs. that contribute to the identification of our effect of interest) as described in Miller et al. (2019). The complete estimation sample includes data from up to 333 schools, 1,236 classes, and 18,008 students. ***, ** and * mark estimates statistically different from zero at the 90, 95 and 99 percent confidence level.*

First, we consider the role of parent-teacher contact in parents' decisions to invest in additional private tutoring in response to their child being assigned a highly qualified Dao Shi. We expect parents who have closer contact with their child's Dao Shi to react more strongly to Dao Shi qualifications. We construct a measure of likely parent-teacher contact using Dao Shi

responses to the following question which is asked shortly after Dao Shi assignment: "*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*". Even at the beginning of junior high school, 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 classify parents who will likely have high parent-teacher contact going forward 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.

Table 2 suggests that parents complement Dao Shi higher qualifications with more private tutoring of their own *only* when they have a Dao Shi who will likely have a high level of parent-teacher contact. When there is little parent-teacher contact, there are no detectable effects of Dao Shi post-graduate qualifications on tutoring. The sizable disparity in the estimated effect for these two groups of parents points to parent-teacher contact as an important mechanism behind our main findings, though our point estimates are not significantly different at conventional levels ($p = 0.187$) due to the limited power in this split-sample analysis.

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.

We find that university-educated parents respond more starkly to Dao Shi qualifications by changing their private tutoring investments (see Table 3). If children in families with at least one university-educated parent are assigned to a highly qualified Dao Shi, their parents invest more than twice as much in tutoring than parents with no university education, though again our estimates across subgroups are too noisy to detect significant differences ($p = 0.361$) at conventional levels. In addition, there is weak evidence that university-educated parents spend less time having dinner with their children when they have a Dao Shi with post-graduate qualifications than when they do not. One possibility is that parents with a higher opportunity cost of time decide to spend more time at work (and therefore make it home less often for

dinner 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 & Mason 2008; Fredriksson et al. 2012).

Table 3. Heterogeneous Effects of Having a Dao Shi with a Post-graduate Qualification by Parental Education

Dependent variable =	Tutoring (total NT$) (1)	Dinner time (parent-days/week) (2)	Parenting discipline (3)	Parenting warmth (4)
Effect of Dao Shi post-graduate degree when parents have:				
Less than university education	2193.765*	0.054	-0.012	0.004
	(1223.434)	(0.076)	(0.027)	(0.027)
University education or higher	6548.306**	-0.289*	0.015	0.058
	(3101.720)	(0.167)	(0.064)	(0.054)
F-test difference (p-value)	0.200	0.055	0.687	0.362
R-Squared	0.15	0.06	0.04	0.04
Schools (FE)	126	126	126	126
Classes (clust.)	487	487	487	487
Students (obs.)	6,852	6,898	6,904	6,904

*Average marginal effects derived from fully interacted models of Dao Shi post-graduate degree, age, and experience with parent contact, parental education, and family income. Cluster-robust standard errors at the class level in parentheses. Number of schools, classes, and students reflect the effective sample size (i.e., obs. that contribute to the identification of our effect of interest) as described in Miller et al. (2019). The complete estimation sample includes data from up to 333 schools, 1,236 classes, and 18,008 students. *, **, and *** mark estimates statistically different from zero at the 90, 95 and 99 percent confidence level.*

Finally, we examine the possibility that differences in the financial resources that parents have available for children's education allow 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 money in their children's education. This would suggest that the heterogeneity in parents' responses associated with their education levels may be driven by income as well as 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.

Table 4 shows that high- and low-income parents respond in much the same way as university and non-university educated parents to the qualifications of their children's Dao Shi. Low-income parents complement Dao Shi post-graduate qualifications by making additional investments in their children's tutoring. High-income parents do the same, although this effect

is not statistically significant likely due to the lack of estimation precision given the small number of high-income parents in our data. And, consistent again with Ricardian substitution in time investments, we also find evidence that high-income parents do substitute Dao Shi qualifications for the time they spend with their children.

Table 4. Heterogeneous Effects of Having a Dao Shi with a Post-graduate Qualification by Family Income

Dependent variable =	Tutoring (total NT$) (1)	Dinner time (parent-days/week) (2)	Parenting discipline (3)	Parenting warmth (4)
Effect of Dao Shi post-graduate degree when family income is:				
Less than NT$100k/month	2329.646*	0.048	-0.008	0.005
	(1191.943)	(0.077)	(0.028)	(0.025)
At least NT$100k/month	5651.945*	-0.251	-0.009	0.046
	(2895.421)	(0.164)	(0.061)	(0.062)
F-test difference (p-value)	0.282	0.095	0.989	0.525
R-Squared	0.15	0.06	0.04	0.04
Schools (FE)	126	126	126	126
Classes (clust.)	487	487	487	487
Students (obs.)	6,852	6,898	6,904	6,904

*Average marginal effects derived from fully interacted models of Dao Shi post-graduate degree, age, and experience with parent contact, parental education, and family income. Cluster-robust standard errors at the class level in parentheses. Number of schools, classes, and students reflect the effective sample size (i.e., obs. that contribute to the identification of our effect of interest) as described in Miller et al. (2019). The complete estimation sample includes data from up to 333 schools, 1,236 classes, and 18,008 students. *, **, and *** mark estimates statistically different from zero at the 90, 95 and 99 percent confidence level.*

Taken together, our results indicate that parents respond to Dao Shi qualifications when they have the information (i.e., high parent-teacher contact), the skills (i.e., education), and the resources (i.e., income) to do so.

9. CONCLUSIONS

Very little is known about 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 reinforce 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 into school and suggest 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 could have been attributed to a technical complementarity between teacher qualifications and financial investments in education. That is, parents would have been seen as increasing their expenditure on private tutoring because those investments are more effective once their children are assigned a highly qualified Dao Shi. The heterogenous effects of parental education on investment choices would have lent further support to this technical complementarity interpretation (see Fredriksson et al. 2016). In contrast, our results reveal that parents do not think financial investments complement teacher qualifications; rather our belief measures indicate 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 students' study habits and beliefs about 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 demotivating 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 understanding their net impact on families is complicated. School inputs may shift intra-family dynamics and resource allocations in ways that are hard to predict, especially when children are old enough to have meaningful agency in their lives. 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. First, 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. This is not uncommon; other experimental interventions that change parents' behavior have also failed to translate into child achievement (see e.g., Barrera-Osorio et al. 2020). Additional research to uncover more effective options available to parents and schools for raising student achievement would be particularly valuable. Second, 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. Future studies which validate—or refute—parental beliefs as the channel linking school inputs to parents' educational investments would be useful. Success in this endeavor is likely to hinge on the development of beliefs measures that can accommodate the nuanced role of parents' and children's incentives in human capital investments. Finally, despite the richness of our data, we have nonetheless been unable to investigate all conceptually plausible mechanisms linking parents' and schools' educational investments. The investigation of numerous other potential mechanisms awaits future research.

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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 and 19,779 parents, arrayed in 1,244 classes across 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 4.2 we briefly describe the items used to construct these scales and in Appendix Table A1 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, 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.

Table A1. 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
Private tutoring from Wave 2:					
Semesters with priv. tutoring in junior high school	17,837	2.2	1.2	1	6
Time per week in priv. tutoring this semester	17,775	2.3	1.4	1	5
Monthly expend. in priv. tutoring this semester	17,875	2.3	2.1	0	5
Financial investments from Wave 1:					
Had private music tutor in primary school	17,856	0.2	0.4	0	1
Grades with private tutor in past	17,936	1.0	0.7	0	3
Had extracurr. art classes in primary school	17,867	0.7	0.5	0	1
Monthly expend. on class activities	17,864	1.1	1.0	0	5
Arranged child to study abroad	17,900	0.1	0.2	0	1
Earmarked savings for child education	17,901	0.6	0.5	0	1
Monthly expend. in academic activities (inc. tutoring)	17,874	3.2	1.9	1	6
Monthly expend. in extracurricular art classes	17,880	1.7	1.5	1	6
Dinner time with parent(s) from Wave 2:					
Parent has dinner with child 5 days a week	17,901	0.7	0.5	0	1
Partner has dinner with child 5 days a week	16,080	0.6	0.5	0	1
Time investments from Wave 1:					
When did family started helping with schoolwork	17,907	3.8	1.5	1	5
Freq. father volunteers/attends school activities	16,745	1.8	1.0	1	4
Freq. mother volunteers/attends school activities	17,122	2.2	1.1	1	4
Time spent waiting for parents to return home	16,983	4.0	1.3	1	5
Time spent with child everyday by parent	17,895	4.2	1.1	1	5
Time spent with child everyday by partner	16,967	3.7	1.4	1	5
Take child to bookstores or exhibitions	17,914	2.3	0.8	1	4
Take child to concerts, shows, dramas	17,914	1.6	0.8	1	4
Volunteer with child in community	17,912	1.4	0.7	1	4
Parenting discipline from Wave 2:					
Parents set strict rules in daily routine	17,936	0.8	0.4	0	1
Parents monitor use of pocket money	17,936	0.5	0.5	0	1
Parents supervise homework	17,936	0.7	0.5	0	1
Parents have strict demeanor	17,936	0.7	0.5	0	1
Parents strict about diet	17,936	0.8	0.4	0	1
Parents supervise choice of friends	17,936	0.5	0.5	0	1
Parents tell not to let them down	17,936	0.5	0.5	0	1
Parents have no tolerance for talk back	17,936	0.6	0.5	0	1
Parents scold over trivial matter	17,936	0.3	0.5	0	1
Parents beat over trivial matters	17,936	0.1	0.3	0	1
Parents keep strict discipline	17,911	2.9	0.7	1	4
Parents use disappointment/shame as punishment	17,909	3.0	0.9	1	4

	Obs.	Mean	Std. Dev.	Min	Max
Parental discipline from Wave 1:					
Father checks homework & learning	17,401	2.8	1.0	1	4
Mother checks homework & learning	17,585	3.3	0.9	1	4
Father keeps strict discipline	17,016	2.9	0.8	1	4
Mother keeps strict discipline	17,275	3.0	0.8	1	4
Parents scold or punish for doing wrong	17,837	0.5	0.5	0	1
Parents know child's close friends	17,857	3.2	1.4	1	5
Parents know child's classmates	17,885	1.8	0.7	1	4
Parenting warmth from Wave 2:					
Parents listen carefully to child's ideas	17,936	0.6	0.5	0	1
Parents care and advise child	17,936	0.8	0.4	0	1
Parents discourage child's new ideas	17,936	0.3	0.5	0	1
Parents unconditionally give whatever child wants	17,936	0.5	0.5	0	1
Parents help child with problems and setbacks	17,936	0.6	0.5	0	1
Parents accept child as is	17,936	0.8	0.4	0	1
Parenting warmth from Wave 1:					
Father discusses future study/career with child	17,313	2.5	1.0	1	4
Father listens to child's thoughts & feelings	16,331	2.1	1.0	1	4
Mother discusses future study and career with child	17,528	2.8	1.0	1	4
Mother listens to child's thoughts & feelings	17,213	2.8	1.1	1	4
Father accepts child as is	17,171	3.2	0.7	1	4
Mother accepts child as is	17,491	3.4	0.7	1	4

APPENDIX B: ADDITIONAL TABLES AND FIGURES

Figure B1. An Example of the 'Communication Book' Used by Dao Shi to Maintain Contact with Parents on a Daily Basis

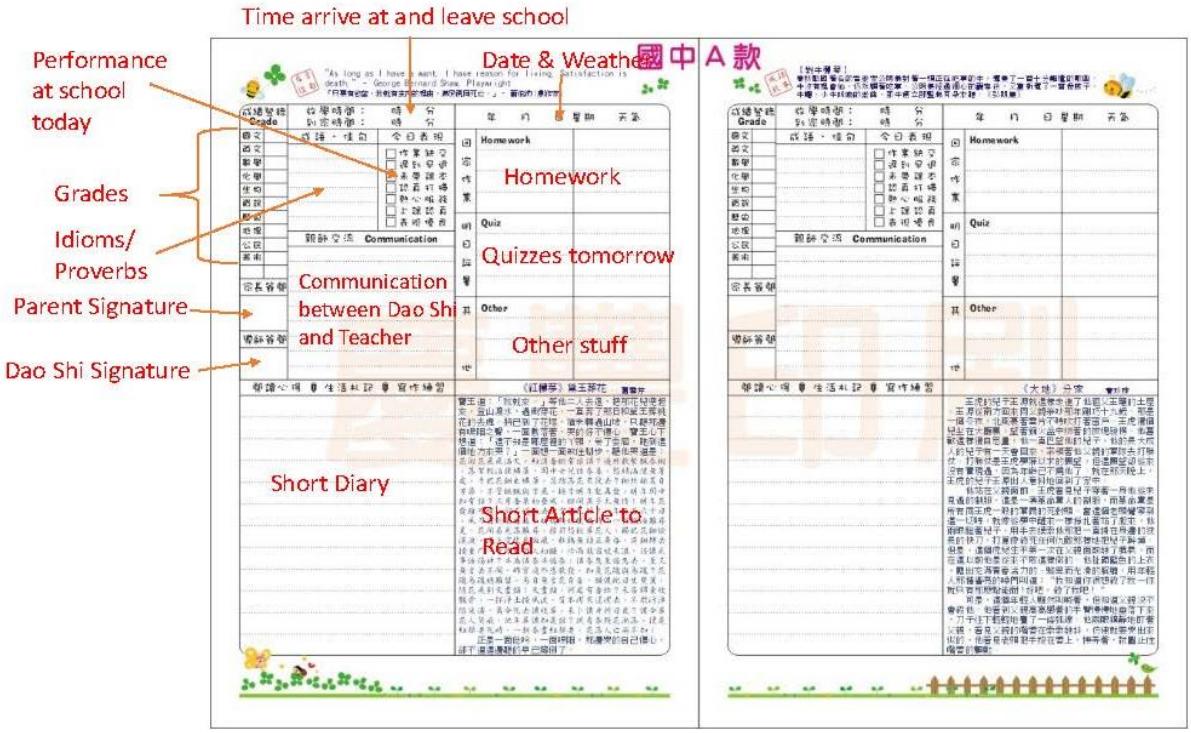

Table B1. Summary Statistics of Key Variables in the First Wave of the TEPS

		Estimation sample		
	TEPS	Overall	Switchers	Non-switchers
Mean of characteristic in wave 1:				
Dao Shi has post-graduate qualification	0.13	0.13	0.33	0.01
Female student	0.48	0.49	0.48	0.49
Student age	12.41	12.40	12.40	12.41
Student has more than one sibling	0.50	0.50	0.49	0.51
Married parents	0.85	0.88	0.89	0.87
Ethnic minority parent(s)	0.06	0.05	0.06	0.05
Father's age	42.51	42.44	42.55	42.37
Mother's age	39.75	39.70	39.79	39.64
College-educated parent(s)	0.13	0.13	0.14	0.13
Family monthly income (NT$)	62,504	62,674	63,873	61,896
Observations	20,056	18,008	7,082	10,926

Means for each variable. "Switchers" refer to observations from schools where some, but not all, Dao Shi have postgraduate qualifications. "Non-switchers" refer to observations from schools where either all or no Dao Shi have postgraduate qualifications. Only switchers contribute to the identification of our effect of Dao Shi postgraduate qualifications, as described in Miller et al. (2019).

Table B2. Characteristics of Dao Shi With and Without a Post-graduate Qualification

In wave 1, Dao Shi:	has post-graduate degree:			
	Yes	No	Diff.	
is older than 40	23	36	-13	***
has more than 10 years of experience teaching	22	33	-10	**
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	2	
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	-1	
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	

*Mean and mean differences by group in percentage points. *, **, and *** mark mean differences statistically different from zero at the 90, 95 and 99 percent confidence level.*

Table B3. The Effect of Having a Dao Shi with a Post-graduate Qualification on Parents' Investments, with Extensive Additional Controls

Dependent variable =	Tutoring (total NT$) (1)	Dinner time (parent-days/week) (2)	Parenting discipline (3)	Parenting warmth (4)
Dao Shi post-graduate degree	2190.405**	-0.031	0.002	-0.007
	(1037.785)	(0.066)	(0.027)	(0.024)
Dao Shi age in years	11.753	-0.003	-0.000	0.002
	(101.051)	(0.006)	(0.003)	(0.002)
Dao Shi years of teaching exp.	132.680**	-0.001	0.001	0.001
	(64.405)	(0.004)	(0.002)	(0.001)
Student and parent characteristics				
Student young for cohort	-169.331	0.046	0.023	-0.029*
	(635.295)	(0.039)	(0.015)	(0.015)
Female student	-135.424	0.012	-0.074***	0.124***
	(675.270)	(0.040)	(0.016)	(0.015)
Ethnic minority student	-12057.519***	-0.372***	0.059*	-0.001
	(1374.127)	(0.120)	(0.036)	(0.039)
Student in gifted academic class	2624.972**	0.038	0.015	-0.013
	(1284.501)	(0.073)	(0.032)	(0.027)
Student in gifted arts class	-7913.331***	-0.133	-0.078**	0.007
	(1370.486)	(0.085)	(0.038)	(0.034)
Two-parent household	7334.588***	2.508***	0.126***	0.031
	(980.239)	(0.070)	(0.025)	(0.025)
University-educated parent(s)	-159.587	-0.000	-0.164***	-0.043*
	(1111.838)	(0.063)	(0.026)	(0.024)
High-income family	1104.447	-0.181***	-0.097***	-0.031
	(1127.107)	(0.068)	(0.025)	(0.025)
Dao Shi characteristics				
Female	22.016	-0.011	0.050***	0.012
	(811.918)	(0.051)	(0.019)	(0.017)
Married	-1035.665	0.074	-0.018	-0.018
	(864.096)	(0.049)	(0.021)	(0.019)
In good health	1117.793	-0.078	0.012	-0.003
	(910.666)	(0.048)	(0.020)	(0.017)
Not teaching subject of expertise	-158.770	-0.084*	-0.012	-0.029*
	(804.348)	(0.046)	(0.019)	(0.017)
Works as tutor after school	1115.039	0.008	0.013	-0.005
	(900.190)	(0.050)	(0.022)	(0.020)
Has low teaching load	169.610	-0.015	0.066***	-0.004
	(1181.920)	(0.063)	(0.025)	(0.025)
Regrets becoming a teacher	-1993.022	0.083	-0.046	0.065**
	(1268.821)	(0.074)	(0.032)	(0.026)
Wave 1 investments [std.]				
Money investments	19991.280***	-0.115***	0.103***	0.051***
	(370.769)	(0.023)	(0.009)	(0.009)
Time investments	99.491	0.638***	0.021**	0.080***
	(364.542)	(0.023)	(0.009)	(0.008)
Discipline	2186.814***	0.050**	0.222***	0.012
	(404.497)	(0.024)	(0.009)	(0.009)
Warmth	435.163	0.016	-0.003	0.233***
	(381.132)	(0.022)	(0.009)	(0.008)

Dependent variable =	Tutoring (total NT$) (1)	Dinner time (parent-days/week) (2)	Parenting discipline (3)	Parenting warmth (4)
F-test joint significance (p-values):				
Student and parent	<0.001	<0.001	<0.001	<0.001
Dao Shi	0.362	0.187	0.00657	0.175
Wave 1 investments	<0.001	<0.001	<0.001	<0.001
Mean of dep. var.	44,926	7.51	0.00	0.00
SD of dep. var.	48,173	2.80	1.00	1.00
R-Squared	0.31	0.23	0.11	0.12
Schools (FE)	126	126	126	126
Classes (clust.)	486	486	486	486
Students (obs.)	6,773	6,816	6,821	6,821

*OLS coefficients with cluster-robust standard errors at the class level in parentheses. Number of schools, classes, and students reflect the effective sample size (i.e., obs. that contribute to the identification of our effect of interest) as described in Miller et al. (2019). The complete estimation sample includes data from up to 333 schools, 1,236 classes, and 18,008 students. *, **, and *** mark estimates statistically different from zero at the 90, 95 and 99 percent confidence level.*

Table B4. The Effect of Assignment to a Dao Shi with a Post-graduate Qualification on All Parental Investment Measures in Wave 2

	Effect of Dao Shi with a post-graduate degree		Mean of dep. var.	Students (obs.)
	Coef.	Std. err.		
Dependent variables (in rows)				
Private tutoring:				
Monthly expend. in tutoring this semester	86.934**	(41.0086)	1,828	7,057
Semesters with tutoring in junior high school	0.100*	(0.0525)	3.144	7,053
Hours/week in tutoring this semester♠	0.191*	(0.1066)	3.78	7,027
Hourly price for tutoring♠	3.188	(68.8788)	2,396	3,928
Dinner time with parent(s):				
Parent weekly dinner days with child	0.004	(0.0343)	4.17	7,063
Partner weekly dinner days with child	-0.036	(0.0440)	3.74	6,425
Parent(s) have dinner with child 5+ days a week♠	-0.014	(0.0129)	0.50	7,060
Parenting discipline:				
Parents set strict rules in daily routine	0.019**	(0.0091)	0.81	7,082
Parents monitor use of pocket money	0.004	(0.0126)	0.53	7,082
Parents supervise homework	0.006	(0.0118)	0.66	7,082
Parents have strict demeanor	0.001	(0.0103)	0.71	7,082
Parents strict about diet	0.011	(0.0103)	0.75	7,082
Parents supervise choice of friends	0.000	(0.0117)	0.52	7,082
Parents tell not to let them down	0.025**	(0.0125)	0.54	7,082
Parents have no tolerance for talk back	0.003	(0.0116)	0.59	7,082
Parents scold over trivial matter	-0.004	(0.0113)	0.31	7,082
Parents beat over trivial matters	-0.003	(0.0077)	0.11	7,082
Parents keep strict discipline	-0.005	(0.0105)	0.70	7,082
Parents make strict academic requirements	0.026	(0.0225)	2.36	6,892
Parents scold or seriously punish for misbehavior	-0.025	(0.0157)	2.87	7,065
Parents use disappointment/shame as punishment	-0.050**	(0.0225)	2.96	7,064
Parenting warmth:				
Parents listen carefully to child's ideas	0.010	(0.0107)	0.62	7,082
Parents care and advise child	0.005	(0.0091)	0.81	7,082
Parents discourage child's new ideas	-0.005	(0.0102)	0.27	7,082
Parents unconditionally give whatever child wants	-0.018	(0.0116)	0.54	7,082
Parents help child with problems and setbacks	0.009	(0.0113)	0.62	7,082
Parents accept child as is	0.006	(0.0098)	0.76	7,082
Baumrind's parenting styles:				
Authoritative♠	-0.001	(0.0094)	0.17	7,082
Authoritarian♠	0.001	(0.0096)	0.25	7,082
Permissive♠	-0.006	(0.0094)	0.16	7,082
Distant♠	0.006	(0.0121)	0.42	7,082

*♠ marks measures not included in indices. OLS coefficients with cluster-robust standard errors at the class level in parentheses. Number of schools, classes, and students reflect the effective sample size (i.e., obs. that contribute to the identification of our effect of interest) as described in Miller et al. (2019). The complete estimation sample includes data from up to 333 schools, 1,236 classes, and 18,008 students. *, **, and *** mark estimates statistically different from zero at the 90, 95 and 99 percent confidence level.*

Table B5. The Effect of Assignment to a Dao Shi with a Post-graduate Qualification on the Person Initiating Math Tutoring Decisions

Dependent variable =	*person who initiated math tutoring:*		
	Student	Father	Mother
	(1)	(2)	(3)
Dao Shi post-graduate degree	0.005	0.010	0.020*
	(0.010)	(0.009)	(0.011)
Mean of dep. var.	0.73	0.21	0.31
R-Squared	0.02	0.02	0.04
Schools (FE)	126	126	126
Classes (clust.)	494	494	494
Students (obs.)	6,964	6,964	6,964
Dependent variable =	*person who initiated math tutoring:*		
	Teacher	Classmates/friends	Other
	(4)	(5)	(6)
Dao Shi post-graduate degree	0.001	0.004	-0.003
	(0.004)	(0.003)	(0.006)
Mean of dep. var.	0.02	0.02	0.06
R-Squared	0.04	0.02	0.03
Schools (FE)	126	126	126
Classes (clust.)	494	494	494
Students (obs.)	6,964	6,964	6,964

*OLS coefficients with cluster-robust standard errors at the class level in parentheses. All regressions control for Dao Shi age and years of experience as teacher. Number of schools, classes and students reflect the effective sample size (i.e., obs. that contribute to the identification of our effect of interest) as described in Miller et al. (2019). The complete estimation sample includes data from up to 333 schools, 1,236 classes, and 18,008 students. *, **, and *** mark estimates statistically different from zero at the 90, 95 and 99 percent confidence level.*

Table B6. 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 =	*parents' belief of most important drivers of academic achievement:*		
	Parental discipline	Teacher quality	Classmates/friends
	(1)	(2)	(3)
Dao Shi post-graduate degree	-0.004	-0.006	-0.001
	(0.006)	(0.005)	(0.006)
Mean of dep. var.	0.08	0.06	0.08
R-Squared	0.02	0.02	0.02
Schools (FE)	126	126	126
Classes (clust.)	494	494	494
Students (obs.)	6,952	6,952	6,952
Dependent variable =	*parents' belief of most important drivers of academic achievement:*		
	Private tutoring	Student effort	Student talent
	(4)	(5)	(6)
Dao Shi post-graduate degree	-0.002	0.029**	-0.011
	(0.001)	(0.011)	(0.009)
Mean of dep. var.	0.00	0.62	0.17
R-Squared	0.02	0.02	0.02
Schools (FE)	126	126	126
Classes (clust.)	494	494	494
Students (obs.)	6,952	6,952	6,952

*OLS coefficients with cluster-robust standard errors at the class level in parentheses. All regressions control for Dao Shi age and years of experience as teacher. Number of schools, classes, and students reflect the effective sample size (i.e., obs. that contribute to the identification of our effect of interest) as described in Miller et al. (2019). The complete estimation sample includes data from up to 333 schools, 1,236 classes, and 18,008 students. *, **, and *** mark estimates statistically different from zero at the 90, 95 and 99 percent confidence level.*

Table B7. 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 post-graduate degree	0.041	0.056*	0.061*
	(0.033)	(0.031)	(0.033)
Mean of dep. var.	0.00	0.00	0.00
SD of dep. var.	1.00	1.00	1.00
R-Squared	0.21	0.19	0.19
Schools (FE)	126	126	126
Classes (clust.)	494	494	494
Students (obs.)	6,905	6,905	6,905

*OLS coefficients with cluster-robust standard errors at the class level in parentheses. All regressions control for Dao Shi age and years of experience as teacher. Number of schools, classes, and students reflect the effective sample size (i.e., obs. that contribute to the identification of our effect of interest) as described in Miller et al. (2019). The complete estimation sample includes data from up to 333 schools, 1,236 classes, and 18,008 students. *, **, and *** mark estimates statistically different from zero at the 90, 95 and 99 percent confidence level*.

Table B8. The Effect of Assignment to Dao Shi with a Post-graduate Qualification on Student Effort Spent on Different Activities

Dependent variable =	In-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 post-graduate degree	0.105	0.063	0.012	0.339
	(0.111)	(0.051)	(0.013)	(0.237)
Mean of dep. var.	5.43	2.07	0.40	11.90
R-Squared	0.12	0.04	0.05	0.08
Schools (FE)	126	126	126	126
Classes (clust.)	494	494	494	494
Students (obs.)	6,952	6,927	6,916	6,931
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 post-graduate degree	-0.008	-0.006	-0.063	0.059
	(0.006)	(0.006)	(0.152)	(0.150)
Mean of dep. var.	0.07	0.06	4.63	4.11
R-Squared	0.03	0.03	0.04	0.04
Schools (FE)	126	126	126	126
Classes (clust.)	494	494	494	494
Students (obs.)	6,916	6,928	6,964	6,959

*OLS coefficients with cluster-robust standard errors at the class level in parentheses. All regressions control for Dao Shi age and years of experience as teacher. Number of schools, classes, and students reflect the effective sample size (i.e., obs. that contribute to the identification of our effect of interest) as described in Miller et al.(2019). The complete estimation sample includes data from up to 333 schools, 1,236 classes, and 18,008 students. *, **, and *** mark estimates statistically different from zero at the 90, 95 and 99 percent confidence level.*

Table B9. The Effect of Assignment to Dao Shi with a Post-graduate Qualification on Student Beliefs of the Most Important Drivers of Academic Achievement

	students' belief of most important drivers of academic achievement:		
Dependent variable =	Parental discipline	Teacher quality	Classmates/friends
	(1)	(2)	(3)
Dao Shi post-graduate degree	0.005	0.005	0.010*
	(0.005)	(0.006)	(0.006)
Mean of dep. var.	0.05	0.07	0.08
R-Squared	0.03	0.03	0.02
Schools (FE)	126	126	126
Classes (clust.)	494	494	494
Students (obs.)	6,952	6,952	6,952
	students' belief of most important drivers of academic achievement:		
Dependent variable =	Private tutoring	Student effort	Student talent
	(4)	(5)	(6)
Dao Shi post-graduate degree	0.003	-0.025**	0.015*
	(0.003)	(0.011)	(0.009)
Mean of dep. var.	0.01	0.68	0.13
R-Squared	0.02	0.03	0.02
Schools (FE)	126	126	126
Classes (clust.)	494	494	494
Students (obs.)	6,952	6,952	6,952

*OLS coefficients with cluster-robust standard errors at the class level in parentheses. All regressions control for Dao Shi age and years of experience as teacher. Number of schools, classes, and students reflect the effective sample size (i.e., obs. that contribute to the identification of our effect of interest) as described in Miller et al. (2019). The complete estimation sample includes data from up to 333 schools, 1,236 classes, and 18,008 students. *, **, and ***mark estimates statistically different from zero at the 90, 95 and 99 percent confidence level.*

Table B10. Adjusted P-values to Control for Familywise Error Rate on All Outcomes

	p-value of the coefficient of Dao Shi post-graduate degree on each row outcome		
	Unadjusted	Bootstrap	Romano-Wolf
Parental Investments:			
Tutoring (total NT$)	***0.006***	***0.010***	***0.026***
Dinner time (parent-days/week)	0.902	0.900	0.988
Parenting discipline	0.993	0.994	0.994
Parenting warmth	0.543	0.518	0.902
Initiator of math tutoring:			
Student	0.630	0.642	0.950
Father	0.275	0.322	0.778
Mother	0.078	0.064	0.378
Teacher	0.766	0.782	0.950
Classmates/friends	0.291	0.300	0.778
Other	0.656	0.644	0.950
Parent beliefs in driver of achievement:			
Parental discipline	0.465	0.496	0.720
Teacher quality	0.235	0.232	0.606
Classmates/friends	0.861	0.850	0.850
Private tutoring	0.117	0.124	0.450
Student effort	***0.012***	***0.010***	**0.070**
Student talent	0.210	0.198	0.606
Test scores:			
Test scores	0.213	0.232	0.232
Analytical subcomponent	**0.075**	**0.076**	0.106
Mathematical subcomponent	**0.063**	**0.070**	**0.096**
Margins of student effort:			
In-school tutoring (hours/week)	0.344	0.356	0.892
Internet homework (hours/week)	0.212	0.246	0.814
Willing to take out-of-school tutoring	0.346	0.356	0.892
Self-study (hours/week)	0.153	0.180	0.758
Makes outlines to study better	0.202	0.212	0.814
Reduce leisure before exams	0.343	0.356	0.892
Online chat (hours/week)	0.680	0.684	0.892
Online gaming (hours/week)	0.693	0.676	0.892
Student beliefs in driver of achievement:			
Parental discipline	0.397	0.382	0.698
Teacher quality	0.382	0.402	0.698
Classmates/friends	**0.095**	**0.096**	0.386
Private tutoring	0.341	0.352	0.698
Student effort	***0.028***	***0.018***	0.140
Student talent	**0.091**	**0.084**	0.386

Original, bootstrapped and corrected p-values for our main results using Romano and Wolf's (2007) step-down procedure for controlling for familywise error rate in multiple hypotheses testing implemented using Clarke et al.'s (2019) rwolf *Stata package. The bootstrap procedure within resamples schools and clusters at the class level, estimates regression with school fixed effects and controls for Dao Shi age and experience. Each set of outcomes is treated as a separate family. P-values smaller than 0.10 are shown in bold and smaller than 0.05 in bold and italics.*

APPENDIX C: BALANCING IN OUR QUASI-EXPERIMENTAL DESIGN

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.

In our balancing tests we check whether, within schools, 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:

$$P_{isc} = \theta \text{Postgraduate}_{sc} + \tilde{\gamma}_s + \tilde{\varepsilon}_{isc}, \quad \text{(C1)}$$

where P_{isc} is a (pre-assignment) characteristic of student i attending school s and assigned to class c within that school measured at wave 1. Postgraduate_{sc} is a dummy that equals one if the Dao Shi assigned to class c has a post-graduate qualification, $\tilde{\gamma}_s$ are school fixed effects which account for potentially correlated unobserved heterogeneity that is fixed at the school level, and $\tilde{\varepsilon}_{isc}$ is an uncorrelated error term. We cluster our standard errors at the classroom level. Our balancing coefficient θ captures within-school differences P_{isc} between students assigned to a Dao Shi with vs without a post-graduate qualification.

The results in Table C1 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 columns in the top panel 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.

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 2.1 percentage points based on an ex-post Minimum Detectable Effect calculation. Second, a joint hypothesis test of these estimates suggests a balanced assignment (see e.g., Pei et al. 2019). 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 ($p = 0.511$).

Table C1. Balancing Tests of Student and Parent Pre-determined Characteristics on Having a Dao Shi with a Post-graduate Degree

Dependent variable =	Student younger than 13 (1)	Female student (2)	Married parents (3)	Father younger than 40 (4)	Ethnic minority parent(s) (5)
Dao Shi post-graduate degree	0.009	-0.006	0.004	-0.014	-0.003
	(0.0121)	(0.0121)	(0.0068)	(0.0103)	(0.0049)
Mean of dep. var.	0.62	0.49	0.88	0.26	0.05
R-Squared	0.02	0.06	0.04	0.05	0.23
Students (obs.)	126	126	126	126	126
Schools (FE)	500	500	500	500	500
Classes (clust.)	7,063	7,082	7,082	6,863	7,082
Dependent variable =	College-educated parent(s) (6)	HH income > NT$100,000/mo. (7)	Parents pushed for better class (8)	Gifted academic class (9)	Gifted arts/sports class (10)
Dao Shi post-graduate degree	0.011	-0.003	-0.015	0.009	-0.014
	(0.0081)	(0.0076)	(0.0093)	(0.0121)	(0.0113)
Mean of dep. var.	0.13	0.13	0.16	0.08	0.05
R-Squared	0.16	0.14	0.08	0.11	0.10
Students (obs.)	126	126	126	126	126
Schools (FE)	500	500	500	500	500
Classes (clust.)	7,082	7,082	7,069	7,033	7,033

*OLS coefficients with cluster-robust standard errors at the class level in parentheses. Number of schools, classes, and students reflect the effective sample size (i.e., obs. that contribute to the identification of our effect of interest) as described in Miller et al. (2019). The complete estimation sample includes data from up to 333 schools, 1,236 classes, and 18,008 students. *, **, and ***mark estimates statistically different from zero at the 90, 95 and 99 percent confidence level.*

We also explore whether the assignment of Dao Shi is related to student test scores or parental investments in wave 1. To do this we consider balancing across the wave 1 test score measures described in Section 4.2, as well as on four summative scales of parental investments in money and time and parental discipline and warmth. These four summative scales are constructed similarly to the discipline and warmth scales also described in Section 4.2 yet they include different items from their wave 2 counterparts (see Appendix Table A1 for summary statistics). Notably, in wave 1 we have access to more measures of parents' money and time investments in their children. As for our wave 2 discipline and warmth scales, we rescale these four wave 1 scales by subtracting their mean and dividing by their standard deviation to ease the interpretation of our balancing tests.

Table C2 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 degree also do not invest more financial resources

or time in them, discipline them more strongly, or show them more warmth. As before, a F-test of joint significance reveals that these outcomes are balanced ($p = 0.703$).

Table C2. Balancing Tests of Student Test Scores and Parental Investments on Assignment to 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 post-graduate degree	-0.002	0.017	0.015	0.018	0.038
	(0.0329)	(0.0271)	(0.0233)	(0.0235)	(0.0234)
Mean of dep. var.	0.00	0.00	0.00	0.00	0.00
R-Squared	0.21	0.19	0.05	0.05	0.04
Students (obs.)	126	126	126	126	126
Schools (FE)	500	500	500	500	500
Classes (clust.)	7,079	7,082	7,082	7,082	7,079

*OLS coefficients with cluster-robust standard errors at the class level in parentheses. Number of schools, classes and students reflect the effective sample size (i.e., obs. that contribute to the identification of our effect of interest) as described in Miller et al. (2019). The complete estimation sample includes data from up to 333 schools, 1,236 classes, and 18,008 students. *, **, and ***mark estimates statistically different from zero at the 90, 95 and 99 percent confidence level.*

Finally, we conduct a wider-range balancing test by regressing 10 different Dao Shi characteristics on the 15 student and parent pre-assignment characteristics we considered above (i.e., our 10 pre-assignment characteristics, student test scores, and the four scales of parental investments) and test the joint statistical significance of all pre-assignment variables as predictors of each Dao Shi characteristic. The teacher characteristics we test include our key measure of Dao Shi post-graduate qualification, as well as dummies marking differences in gender, age, marital status, health, experience, expertise in the courses being taught, whether they provide after-school tutoring, lecture load, and feelings of regret about being a teacher. We chose these as the most likely Dao Shi characteristics to lead to systematic sorting into classes since they are visible to principals and/or parents, they could be associated with student performance at school, or could influence the Dao Shi's own eagerness to be assigned to particular classrooms.

The F-test p-values at the bottom of Table C3 shows that, with the exception of teacher experience, there is no evidence of systematic assignment of Dao Shi to students. Given the legal requirements for random assignment documented in Section 3.2, the circumstantial documentation of the assignment process we have collected, and the results of all our previous balancing tests, we are not overly concerned about systematic assignment of Dao Shi to students based on experience. Nevertheless, we choose to err on the side of caution and not view student assignment to more experienced Dao Shi as a natural experiment.

Overall, these balancing results support our maintained assumption that the assignment of Dao Shi with post-graduate qualifications to classes, and therefore students, within schools is random. This implies that estimates $\hat{\beta}$ from equation (1) in Section 3.2 identify the causal effect of Dao Shi post-graduate qualifications on outcomes Y_{isc}.

Table C3. Balancing Tests of Dao Shi Characteristics on Student Pre-Assignment Characteristics, Test Scores, and Parental Investments

Dependent variable =	Dao Shi characteristics in wave 1									
	Post-graduate degree	Female	Older than 40	Married	In good health	>10 years of experience	Not expert on course taught	After-school tutor	<15 weekly lectures	Regrets being teacher
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Student characteristics in wave 1:										
Younger than 13	0.002	0.005	-0.004	0.000	-0.005	0.012**	0.000	-0.003	0.004	-0.004
	(0.004)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.003)
Female	-0.003	0.009*	0.011**	0.001	-0.006	0.003	-0.003	0.007	-0.004	0.003
	(0.004)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)	(0.004)	(0.004)
Married parents	0.001	-0.007	0.005	0.007	-0.012	-0.003	0.001	0.002	-0.000	-0.003
	(0.006)	(0.009)	(0.009)	(0.009)	(0.008)	(0.009)	(0.009)	(0.008)	(0.006)	(0.005)
Father younger than 40	-0.005	0.012**	0.007	0.009	-0.002	0.008	-0.006	-0.006	-0.003	-0.007**
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.004)	(0.003)
Ethnic minority parent(s)	-0.005	-0.005	-0.012	-0.030**	0.005	-0.020	0.003	-0.009	-0.007	0.003
	(0.011)	(0.015)	(0.013)	(0.015)	(0.011)	(0.013)	(0.014)	(0.012)	(0.010)	(0.007)
College-educated parent(s)	0.009	-0.007	0.007	0.008	0.002	0.020**	-0.008	0.007	-0.004	-0.003
	(0.007)	(0.009)	(0.009)	(0.009)	(0.008)	(0.009)	(0.009)	(0.009)	(0.007)	(0.006)
HH income > NT$100,000/mo.	-0.005	-0.003	-0.008	0.013	-0.006	-0.009	-0.006	-0.010	-0.003	0.007
	(0.006)	(0.008)	(0.009)	(0.009)	(0.008)	(0.008)	(0.009)	(0.008)	(0.006)	(0.005)
Parents pushed for better class	-0.011*	-0.024***	0.024***	0.014	0.018**	0.032***	0.009	0.004	-0.005	0.001
	(0.006)	(0.009)	(0.009)	(0.009)	(0.008)	(0.009)	(0.008)	(0.007)	(0.006)	(0.005)
Gifted academic class	0.007	0.007	-0.013	-0.027	0.024*	-0.006	-0.009	0.023*	-0.005	0.005
	(0.015)	(0.019)	(0.016)	(0.019)	(0.014)	(0.017)	(0.015)	(0.014)	(0.009)	(0.013)
Gifted arts/sports class	-0.028	-0.008	0.005	-0.023	-0.002	0.046	-0.027	-0.008	0.010	0.010
	(0.020)	(0.028)	(0.034)	(0.032)	(0.027)	(0.031)	(0.033)	(0.031)	(0.021)	(0.018)
Test scores	-0.002	-0.001	0.008*	0.005	0.001	0.006	0.000	0.004	0.003	0.001
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
Financial investment	0.003	0.003	0.002	0.001	0.000	0.009***	-0.002	0.001	-0.000	-0.003
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)
Time investment	0.000	0.003	0.004	-0.002	-0.001	0.004	-0.006*	0.002	0.004	-0.003*
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
Parenting discipline	0.001	-0.001	0.001	-0.001	-0.002	-0.006**	-0.004	0.002	-0.006**	-0.001
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
Parenting warmth	0.003	0.001	-0.004	0.001	0.002	0.002	0.006**	-0.008***	0.000	-0.000
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)

Dependent variable =	Dao Shi characteristics in wave 1									
	Post-graduate degree	Female	Older than 40	Married	In good health	>10 years of experience	Not expert on course taught	After-school tutor	<15 weekly lectures	Regrets being teacher
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
F-test joint significance (p-value)	0.456	0.183	0.136	0.189	0.426	0.009	0.663	0.401	0.625	0.172
Mean of dep. var.	0.13	0.75	0.31	0.63	0.78	0.46	0.59	0.73	0.14	0.08
R-Squared	0.3	0.29	0.39	0.35	0.29	0.42	0.42	0.4	0.37	0.29
Students (obs.)	126	126	126	126	126	126	126	126	126	126
Schools (FE)	500	500	494	494	495	500	500	494	499	494
Classes (clust.)	6,793	6,793	6,712	6,713	6,725	6,793	6,793	6,708	6,778	6,711

*OLS coefficients with cluster-robust standard errors at the class level in parentheses. Number of schools, classes, and students reflect the effective sample size (i.e., obs. that contribute to the identification of our effect of interest) as described in Miller et al. (2019). The complete estimation sample includes data from up to 333 schools, 1,236 classes, and 18,008 students. *, **, and *** mark estimates statistically different from zero at the 90, 95, and 99 percent confidence level.*