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The Impacts of Highly Resourced Vocational Schools on Student Outcomes in China

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Abstract

Policymakers in developing countries have prioritized the mass expansion of vocational education and training (VET). This study examines whether the quality of VET in developing countries increases by investing greater resources per student. To achieve this goal, we examine the impacts of attending model schools (which have far more resources per student) on a range of student cognitive, non-cognitive, and behavioral outcomes. Using representative data from a survey of approximately 12,000 VET students from China, multivariate regression and propensity score matching analyses show that attending model vocational high schools do not benefit student outcomes, despite their substantially greater resources.

Key words: non-cognitive skills, school expenditure, student achievement, vocational education and training

JEL codes: I25, J24, O25

I. Introduction

A key challenge for policymakers in developing countries is to build human capital

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effectively, to promote sustainable economic growth. As these countries grow, their economies gradually shift from lower to higher value-added industries (Heckman and Yi, 2012). Higher value-added industries generally require employees with skills obtained at the level of high school or above (Autor et al., 1998). If the supply of workers with skills at the high-school level or above is inadequate, it is possible that the growth of higher value-added industries, and ultimately the growth of economies, may suffer (Hanushek and Woessman, 2012).

Policymakers in an increasing number of developing countries have made the expansion of vocational education and training (VET) a top priority to provide future generations of students with sufficiently high levels of skills. Since the early 2000s, developing countries such as Indonesia, Thailand, and Vietnam have greatly expanded vocational high-school enrollment (Ministry of National Education of Indonesia, 2006; Government of Vietnam, 2009; Ministry of Education of Thailand, 2012). Claiming that VET builds human capital and leads to economic growth, international organizations such as the Asian Development Bank (ADB) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) have also promoted the large-scale expansion of vocational high schools in developing countries (ADB, 2008; UNESCO, 2012).

Although many countries and international organizations have invested in the expansion of VET education, evidence from some countries suggests that the quality of VET is still poor. Studies suggest that the economic returns from attending VET schools are lower than those from receiving academic schooling in countries such as Suriname (Horowitz and Schenzler, 1999), Turkey (Hirshleifer et al., 2016), and Tanzania (Kahyarara and Teal, 2008). Evidence from China and Indonesia further demonstrates that VET students make no discernible skill gains in comparison with academic high-school students (Chen, 2009; Loyalka et al., 2015). Vocational high-school students in China, in fact, make few, if any, absolute gains in academic, vocational, or non-cognitive skills (Loyalka et al., 2015; Yi et al., 2018). Taken together, research suggests that VET fails to contribute to, or even detracts from, human capital development.

Faced with potentially low-quality VET, many policymakers from developing countries and from international development agencies have suggested that greater investment in VET schools is needed. The Organization for Economic Development and Cooperation (OECD) and the ADB, for example, have both recently recommended increasing resources per student in VET (Kuczera et al., 2011; ADB, 2014).

Whether increasing educational resources per student is enough to improve the quality of VET is, however, an open question. A large body of literature has examined this question in the context of academic schooling. Some studies find that increasing resources per student through specific investments and in specific contexts can positively impact student outcomes (Jackson et al., 2015). However, a strong current in the literature argues that merely increasing resources per student in academic schooling in developing countries is generally insufficient to improve student outcomes (Glewwe et al., 2011). These scholars argue, instead, that changing the way that schools are run – through improved organizational structures and incentives – is ultimately more important for improving school quality.

Evidence concerning the importance of school resources in the context of academic schooling is mixed but there may be reasons to believe that increasing resources per student is more important in the context of vocational education. First, as mentioned above, there are concerns that resources invested in VET in many developing countries are simply insufficient (Kuczera, et al., 2011; ADB, 2014). The literature on vocational education has also found consistently that the unit costs of vocational education are higher than for comparable academic education, especially in developing countries (Tsang, 1999). This cost differential is most often attributed to VET's need for expensive technical equipment (Dougherty, 1990) and the greater relative expense of hiring teachers with relevant technical experience (Tsang, 1999).

Despite these concerns, the question of whether increasing resources per student improves student outcomes in the context of vocational education has been largely unexamined. Only two published studies have examined the relationship between resources per student and student outcomes in VET (Arum, 1998; Maliranta et al., 2010). Both studies were conducted in developed countries (the US and Finland) and were focused exclusively on the impact of resources per student on students' labor market outcomes. We believe there is a lack of similar evidence from developing countries, because, as far as we are aware, there have been no large-scale, quantitative studies evaluating the impact of per student resources in VET in any developing country.

One approach for increasing per student expenditure, even in the face of limited resources, is to concentrate resources in a subset of model vocational schools (also referred to as centers of excellence). The ADB has touted this approach as a way to improve overall vocational school quality (ADB, 2014). In fact, the ADB and the German Federal Ministry for Economic Cooperation and Development (BMZ) are currently sponsoring projects to create model vocational schools in Indonesia and Vietnam (ADB, 2015; BMZ, 2017). The distinguishing feature of model schools is that they receive substantially higher government investments per student and thus have more resources to devote to the education of each student (ADB, 2015; BMZ, 2017). Evaluating the impact of attending model as compared to non-model schools can therefore serve as a proxy for evaluating the importance of increasing resources per student for student performance in vocational schools.

The goal of this study is to examine whether the poor quality of VET in developing countries is improved by increasing school resources per student. In particular, we investigate whether increasing school resources per student through the establishment of model schools has positive impacts on student (i) academic and vocational skills; (ii) non-cognitive traits / skills; (iii) (risky or negative) behaviors; (iv) self-reported satisfaction, and (v) post-schooling expectations.

To ascertain whether increasing resources per student can improve VET quality, we analyze representative data from a survey covering over 12,000 students from one province in China. We use multivariate regression and propensity score matching analyses to assess the impact of attending model vocational high schools on the full range of student outcomes. These outcomes include measures of academic and vocational skills, non-cognitive skills, risky behaviors (dropout, risky health behaviors, and Internet addiction), self-reported satisfaction with VET, and post-schooling expectations and aspirations.

The rest of the paper is organized as follows. Section II introduces the conceptual framework, study design, data collection, and statistical approach. Section III reports the results of our study. Section IV concludes.

II. Research design

1. Background on vocational education and training in China

To understand the extent to which increasing resources per student can improve the quality of VET in developing countries, we draw on China as a case study. We choose China in part because, like other developing countries in the Asia-Pacific Region, it has experienced a rapid transformation of its vocational education system over the past two decades. Between 1990 and 2011, annual investments in secondary vocational schooling increased sixfold (NBS, 1991, 2012). According to official statistics, as of 2012, vocational high-school enrollments had reached 20 million students (or 46 percent of all high-school students) (NBS, 2012). Recent statements by prominent government figures suggest that VET expansion will remain a key policy priority in China at least until December 2020 (Yao et al., 2017).

Despite these efforts to promote vocational schooling, research suggests that the quality of vocational schooling remains low in China. Studies have called into question the quality of vocational programs (Kuczera and Field, 2010). Loyalka et al. (2015) show that attending vocational high school leads to deteriorating academic skills and does not improve career-specific skills. Another study has documented troublingly high rates of student dropouts from China's secondary VET schools (Yi et al., 2015). All in all, research suggests that vocational high schools in China today, on average, may not be contributing to (or could even be detracting from) human capital development.

Perhaps aware of the low quality of vocational high schools in general, China's policymakers have recently begun to establish a set of model vocational high schools. Between 2010 and 2013, education officials invested approximately US$1.7 billion to establish 1,000 model vocational high schools (shifan xiao) across the country (MOE, 2014). When the policy was launched, VET schools were invited to apply for designation as model schools. Only schools that met a list of criteria demonstrating high-schooling quality were allowed to apply.[1] The 1,000 schools determined by official evaluators to have the highest schooling quality were selected to become model schools and given a one-time transfer of RMB10 million (approximately US$1.7 million), ostensibly to allow the schools to further increase schooling quality.[2] In light of this large transfer of school resources, we examine the differential impact of attending model and non-model VET schools as a proxy for the impact of those additional per student resources on student outcomes in VET.[3]

2. Conceptual framework

We draw on the theory of educational production to show why school resources may or may not improve student outcomes in VET schools. The literature on educational production starts from the fundamental assumption that the best metric for the quality of education is its ability to produce better educational outcomes for students (Levin, 1974). This sort of analysis is a basic tenet of economics but its application to education can be traced back to the "Coleman Report" (Coleman et al., 1966).

The production of educational outcomes relies on several inputs, including school resources. This idea is central to the following model proposed by Levin (1974) that serves as the basis for much of the research on education production:

$$A_{it} = g[F_{i(t)} \times S_{i(t)} \times P_{i(t)} \times O_{i(t)} \times I_{i(t)}], \qquad (1)$$

[1]Criteria considered include the extent to which a school was compliant with official education policy, the size of the campus, the value of existing school equipment, the student-teacher ratio, subjective evaluations of schooling quality, and the student employment rate, among other factors (MOE, 2010b).

[2]Model schools had a fair amount of discretion in how they allocated these funds over time. One of the contributions of this paper, as demonstrated in the results section, is that we document differences in resources per student between model and non-model schools.

[3]China's effort to build model VET schools is not unique. The ADB, for example, has been investing in creating and strengthening model VET schools in places like Vietnam (ADB, 2014) and Indonesia (ADB, 2015).

where A_{it} is a vector of educational outcomes for student i at time t; $F_{i(t)}$ is a vector of individual and family characteristics of student i up to time t; $S_{i(t)}$ is a vector of school resources relevant to the student i up to time t; $P_{i(t)}$ is a vector of peer characteristics of student i up to time t; $O_{i(t)}$ is a vector of other external factors (e.g. community) relevant to student i up to time t; and $I_{i(t)}$ is a vector of initial or innate endowments of student i at time t.

The primary goal of this paper is to assess the extent to which an increase in school resources results in an increase in A_{it} – the educational output that schooling is meant to produce. We define school resources to include all the factors that are determined by the school's budget, such as teacher quality, class size, school facilities, and technical equipment.[4] The literature suggests that the school resources that are relevant to the production of learning in vocational education are largely consistent with the key school resources for academic schooling, with a few notable additions (Tsang, 1999; Maliranta et al., 2010). For example, Tsang (1999) and Johnston et al. (2016) noted the importance of technical equipment and teacher enterprise experience for improving students' vocational skills. While the outputs to academic schooling have primarily been conceptualized in terms of student learning (Levin, 1974), there is a stronger trend in the vocational literature to focus on outcomes directly relevant to students' job prospects after VET (such as school completion rates and post-schooling labor outcomes) (Arum, 1998; Maliranta et al., 2010). In contrast, this study focuses on proximal student outcomes that are directly relevant to the development of human capital – pre-graduation changes in student academic and vocational skills, non-cognitive traits, negative behavior, self-reported satisfaction, and post-schooling expectations.

3. Sampling

In this study, we use representative, longitudinal survey data on a sample of VET schools from one province in central China to estimate the impact of attending model VET schools on educational quality. For the first step of our sampling procedure, we obtained a comprehensive list of all vocational programs in the province from the Provincial Department of Education. This list included the full name of each school, the contact information for the school principal, the number of students in the school, and whether the school was a model VET school. Based on this list, we focused on the seven

[4]Levin (1974, p. 5) notes that $S_{i(t)}$ "includes such school resources as the number and quality of teachers and other personnel, facilities, curriculum, and other inputs. These school inputs are of particular interest to economists in their quest for efficiency, for these resources represent the ones that are purchased by the school budget and for which resource allocation decisions can be made."

prefectures with the largest number of vocational high schools (590 schools across all seven prefectures). We then limited the list to vocational high schools with computing and digital control majors, which are the two most popular majors in the province and the country. These two majors account for 29 percent of the total number of VET degrees earned in the province. After restricting the list in this manner, 219 vocational high schools met our criteria.

Given that the impacts of China's 2005 School Merger Policy could potentially complicate our data collection, we felt it necessary to limit our sample further. Under this policy smaller schools are likely to be merged with more centrally located schools. We therefore limited our sample to vocational high schools that had at least 30 students in each grade in at least one of our two sample majors. From our list, 132 schools met this criterion.

We then contacted all 132 schools. We found that 14 of these original schools had been closed or merged within the past year. The final analytical sample therefore included students and principals in two majors in 118 schools, and 185 programs.[5] After we finalized this sample of schools, we cross-referenced our list of sample schools with the original list of schools that we obtained from the Provincial Department of Education at the start of our sampling protocol. Based on this official designation information, we determined that, out of the 118 schools enrolled in our sample, 21 were model schools and 97 were non-model schools.

Within each school, we randomly sampled two classes in each of our sample majors – one first-year class and one second-year class.[6] In some of our sample schools (52 out of 118 schools) there was either a computing or digital control major available (but not both), and therefore we only sampled one class in those schools. We surveyed all students in every randomly sampled class. In all, 12,081 students across 346 classes were included in the sample for our study.

4. Data collection

In October 2013, we conducted a baseline survey with sample school principals and students. The survey of the principals gathered information on school resources and subjective evaluations of school quality. In terms of the questions relating to school resources, the principals were asked to provide the values for school expenditure per student, government appropriation per student, the monetary value of teaching equipment per student, the monetary value of training equipment per student, the

[5] In the rest of the paper, a VET program refers to a specific major that is operating within a VET school.

[6] Vocational high schools in China consist of three grades, with first- and second-year students (equivalent to 10th and 11th grades) studying in school and third-year students spending most of their time out of school in formal internship.

number of computers used for teaching purposes per student, and the student-to-full-time-teacher ratio. To gather further information on school quality, principals were asked to estimate the tercile rankings (top, middle, or bottom) of their school in terms of student vocational skills, academic knowledge, and moral character, as compared with other schools in their prefecture.[7]

The baseline student survey included four blocks. The first block gathered basic information about student background characteristics. We asked students to report their gender, age, whether they were from a minority ethnic group, and whether their household registration status was rural or urban. We also asked students whether they ever attended academic high school and whether they had ever worked in the labor market before coming to the vocational high school. Several questions were directed at the enrollment status of students in VET, including the duration of time they had attended their current vocational high school, whether they were full-time students, and whether they were enrolled in five-year programs.[8] The survey also asked students to report the educational attainment of their parents and whether their parents had ever migrated. Finally, students were asked to fill out a checklist of household durable assets. We used principal components analysis, adjusting for the fact that the variables are dichotomous and not continuous, to calculate a single metric of socioeconomic status for each student (Kolenikov and Angeles, 2009). We conducted standard robustness tests to see whether the use of polychoric principal component analysis results in a viable socioeconomic status metric (Kolenikov and Angeles, 2009). First, we found that the first principal component explained a large proportion of the variance in the household asset variables, indicating that the metric reflects a common relationship underlying the resources (wealth). Second, the scoring coefficients on the first principal component for each asset indicator all run in the anticipated directions, meaning that the possession of assets indicates a higher first principal component score (wealth). Third, we found no evidence of clumping or truncation in the socioeconomic status metric.

The second block of the baseline student survey gathered information about three

[7]We also asked about the employment rates of past graduates. Most of the graduates were reported having found employment or been admitted to vocational college. It accords with the undersupply of medium-skilled labor in China (Li et al., 2012). But then the indicator could not be used measuring school quality since the indicator is lack of variation. Our analyses instead rely on relatively standard measures of school quality including value-added in a broad range of human capital outcomes and educational attainment.

[8]Vocational education and training programs are typically 3 years, after which students earn a VET high school degree. Certain VET schools offer students the option to complete both a VET high school degree and a technical college degree in 5 years. These are known as 5-year programs.

metrics of negative behavior. First, students were asked whether they had smoked or drank alcohol during the previous week. This was used to create a single metric of own risky behavior. Second, it was thought that some students might be more willing to report on the risky behavior of their peers, so students were also asked whether, during the previous week, they had seen their classmates engaging in any of the following risky behaviors: cheating on tests, talking back to the teacher, drinking alcohol, smoking, missing class, copying homework, fighting, or bullying others. We used polychoric principal component analysis, adjusting for the fact that the variables are dichotomous and not continuous, to calculate a single metric of peer risky behavior for each student. We also gathered information about Internet addiction using the Young Diagnostic Questionnaire (Young, 1998). This eight-item scale asks students about their thoughts and behavior related to the use of the Internet. The Young Diagnostic Questionnaire has been used to diagnose Internet addiction in similar populations of students in China (Su et al., 2011).

The third block of the survey gathered information about student non-cognitive traits. First, we measured student grit using the eight-item Short Grit Scale (Grit-S) validated in Duckworth and Quinn (2009). Grit can be understood as "perseverance and passion for long-term goals" and is accepted to be a strong and consistent predictor of academic and labor market outcomes (Duckworth et al., 2009). Second, we measured student conscientiousness using the corresponding items in a big-five personality trait scale developed by John et al. (2008). Finally, we measured student generalized self-efficacy using a ten-item scale that was validated in China (Zhang and Schwarzer, 1995).

The fourth block of the survey gathered information about student self-reported satisfaction with VET as well as their post-schooling expectations and aspirations. First, we asked students how satisfied they were with their VET program. We also asked students about their expectations after they graduate from their VET programs. Specifically, we asked them to estimate their expected monthly income 1 month after graduating, their expected monthly income 10 years after graduating, the likelihood that they will find employment 3 months after graduating, and the likelihood that they will be able to find a job relevant to their major 3 months after graduating. We also asked how likely they believed they would be to find employment if they drop out of their VET program. We then asked students what the highest level of education they hoped to complete was, to evaluate student aspirations.

In April 2014, we returned to our sample schools and conducted an endline survey. Our endline surveys for principals and students were similar to our baseline surveys, although we also collected information on student dropouts in the endline survey. To assess student dropouts, enumerators collected a list of all students in our sample class at the time of our baseline survey. Then, enumerators used this list to track students during the endline survey. Our enumerators marked each student on the baseline list as present, temporarily absent, transferred to another school, attending an internship, or dropped out, according to information provided by class monitors. If there was any question as to the status of an individual student, we verified the information with multiple classmates and the homeroom teacher in each class.

In addition to surveying students, we used standardized tests to assess their academic and vocational skills. Specifically, students took two standardized tests during both the baseline and endline surveys: one in math and one in their major subject. We used a multi-step procedure to construct the tests and ensure that they covered skills taught in vocational high schools. First, we developed our test content based on national and provincial curricula standards for vocational high schools. Then, we used official textbooks to collect a pool of exam questions. To verify that the questions were appropriate to test current curricula, vocational high-school teachers provided further content guidance. Then, we used this pool of items to create pilot tests that were conducted with over 1,000 VET students in September 2013. We used the results from the pilot testing and its analysis to filter out problematic items and create content-balanced tests. The final tests had a high degree of reliability (personal reliability of 0.7 to 0.8).

At all stages of surveying, tests were proctored by enumerators to discourage cheating and time limits were strictly enforced. The exam results were then normalized by subtracting the mean and dividing by the standard deviation of the respective exam score distribution. We normalized the exam results separately for computing and digital control majors, and for the baseline and endline exams.

5. Analytical approach

(1) Multivariate regression

Our analyses of the impacts of school resources on the educational outcomes of students rely on reduced form models of the educational production function in Equation (1). The reduced form models capture differences in school resources through an indicator that shows whether the school is a model school or not. The models also include factors that may be correlated with being a model school and the educational outcomes of students. For example, as policymakers select schools to become model schools based on their perceived quality, students in model schools may have better educational outcomes due to other factors. To avoid overestimating the impact of model schools on educational outcomes, we control for a rich set of individual, family background, and community-level variables.[9]

Our first type of analysis uses multivariate (ordinary least squares or OLS) regression. We conducted the multivariate regression analysis to examine the basic relationship between the treatment (attending a model versus a non-model vocational high school) and student outcomes, while controlling for observable covariates that may confound that relationship. The model specification for the OLS analysis is given in Equation (2):

$$Y_{ij} = \beta_0 + \beta_1 M_j + \beta_2' \boldsymbol{X}_{ij} + \varepsilon_{ij}, \tag{2}$$

where Y_{ij} represents the outcome variable of interest. Y_{ij} represents one of the outcome variables examined in this study. These outcome measures include academic skills, vocational skills, grit, dropout, peer risky behavior, own risky behavior, Internet addiction, self-reported satisfaction with one's VET program, and post-schooling expectations and aspirations (the four variables described in Section II.4). We do not examine the impact of attending model schools on postgraduate employment outcomes for two reasons. First, as mentioned, there is little variation in employment rates among students that attend vocational schools or even among junior high dropouts that do not attend vocational high school. Second, given China's projected transformation into a high-income country, it is highly likely that jobs in China's future economy will require cognitive and non-cognitive abilities obtained at the level of high school or higher. For this reason, we concentrate on the abilities that students are currently developing in vocational high schools (and which they will increasingly need in the next two decades).

M_j is a dummy variable for whether school j is a model school; this is a proxy for school resources $S_{i(t)}$ in Equation (1). We emphasize that the "model" designation primarily indicates that model VET schools have substantially greater resources per student and, secondarily, from the government's perspective, a better reputation for being a high-quality school. The government's management of VET schooling in China is much more laissez-faire than academic schooling, so the model designation is not associated with differential government regulations for how model and non-model VET schools should be run.

The term X_{ij} represents a vector of observable baseline covariates for student i in school j. These fall into the following seven categories (as described above in

[9]We do not include controls for peer characteristics in our analyses because, as shown in Figure 1, the distribution of incoming student ability (whether in vocational or academic skills) is virtually identical across model and non-model schools. We control for community-level factors by running analyses with prefecture fixed effects. The results from the analyses with prefecture fixed effects are not shown for the sake of brevity but are substantively identical to the analyses without prefecture fixed effects.

Section II.4): individual characteristics, cognitive scores (in academic and vocational skills), non-cognitive traits, education and work history, work expectations, family characteristics (socioeconomic status), and parent background.[10]

In the absence of omitted variable bias, the coefficient on M_j (β_1) would be the treatment impact of attending a model VET school on Y_{ij}. The reader may be concerned that we do omit school characteristics that are ostensibly related both to model school status and student outcomes. However, as previously mentioned, model VET schools are primarily defined by having more resources. We do not control for variables that are associated with the greater resources of being a model school (e.g. student-teacher ratio, expenses per student) as these are proxied by model school status. These characteristics, incidentally, are not, in the vast majority of cases, positively related to student outcomes in our OLS analyses. Moreover, by not controlling for other unobservable characteristics such as model schools' better reputation for quality (among policymakers, both before and after model school status), the coefficient on model school status, if anything, overstates the effect of resources per student. Finally, when we control for other pre-treatment (pre-model status) school characteristics, such as private versus public ownership, our substantive results do not change.[11]

(2) Propensity score matching

Despite controlling for a large and detailed set of variables, the OLS analyses may fail to limit the comparison only to model and non-model vocational high-school students with common characteristics (i.e., who share a region of common support). If the analytical sample also contains students that do not overlap on background characteristics, the assumption of linearity in our OLS analysis can produce biased estimates by extrapolating from the region of common support. To address the potential limitations of the OLS analysis, we conduct a second analysis that only compares students who overlap on baseline characteristics.

In our second analysis, we used propensity score matching to create a sample of model and non-model vocational high-school students that share similar baseline characteristics. Propensity score matching (as well as matching methods in general) allows researchers to use observational data to create samples of treatment and control observations that are as similar as possible in the distribution of pre-treatment covariates. Under the assumption that potential outcomes are independent of treatment assignment

[10]The full list of baseline characteristics is available from: https://stanford.app.box.com/s/gusgxnldy7rw3hahpxvxw2jxbbodcsg1.

[11]The results are not shown for the sake of brevity but are available from the authors upon request.

after conditioning on observable pre-treatment covariates (known as the ignorability or conditional independence assumption), matching on observable pre-treatment covariates seeks to remove confounding factors that prevent an unbiased estimate of the treatment effect.

We implement the propensity score-matching procedure in several steps. First, we select a wide range of student variables (occasionally polynomials and interactions of those variables) that are likely to be correlated with the treatment and outcome variables of interest. We estimate the propensity score by regressing vocational high-school attendance on these variables (using a logit model). Second, we adjust the parameters of the matching procedure including the ratio of treatment to control observations and whether we match with or without replacement. Third, we examine whether matching on propensity score, within the same major and the same county of residence, results in balance on a predetermined list of baseline characteristics.[12] We assume an acceptable level of balance is achieved when the lowest *p*-value from the balance tests exceeds 0.1 (Sekhon, 2006). If balance is not achieved, we adjust the logit model with new interaction terms and new polynomial terms, and then repeat the three steps. This iterative process continues until balance is achieved with enough matched observations.

We conduct these steps using the "Matching" package in R (Sekhon, 2011). Before implementing the matching procedure, we fix the estimation of interest, which in our case is the average treatment on the treated (ATT) and the loss criteria.[13] With regard to the loss criteria, we follow Sekhon's (2006) default setting, where loss is the minimum *p*-value observed across a series of balance tests performed on distributions of matched baseline controls. The tests are *t*-tests for the standardized difference in means between the treatment and control covariates as well as bootstrapped nonparametric Kolmogorov–Smirnov (KS) tests.

In our efforts to obtain matched samples that were balanced on baseline characteristics, we implemented the propensity score matching procedure numerous times (for each grade separately). The final propensity score for the grade 1 sample was created using the list of variables, polynomials, and interaction terms (available from: https://stanford.app.box.com/s/gusgxnldy7rw3hahpxvxw2jxbbodcsg1). The final propensity score for the grade 2 sample was created using the list of variables, polynomials, and interaction terms (available from: https://stanford.app.box.com/s/gusgxnldy7rw3hahpxvxw2jxbbodcsg1). The matching procedure for grade 1 produced

[12]The list is available from: https://stanford.app.box.com/s/gusgxnldy7rw3hahpxvxw2jxbbodcsg1.

[13]Ties are handled deterministically and "Abadie–Imbens" standard errors are estimated, see Sekhon (2011) for details.

a sample of students that was balanced across model and non-model VET schools on all observable covariates (available from: https://stanford.app.box.com/s/gusgxnldy7rw3hahpxvxw2jxbbodcsg1). The matching procedure for grade 2 produced a sample of students that was balanced across model and non-model VET schools on all observable covariates except two (available from: https://stanford.app.box.com/s/gusgxnldy7rw3hahpxvxw2jxbbodcsg1). After matching, grade 2 students in model schools were slightly more likely to be female (25 percent instead of 19 percent) and have spent slightly less time (approximately three calendar weeks) in their VET program. As explained below, we control for these (and other) baseline characteristics in our estimation of treatment effects. When combining both grades, the propensity score matching procedure yielded a final matched sample of 826 matched pairs (total sample size of 1,652).

After conducting propensity score matching, we run the same regression analyses as in Equation (1) on the matched set of students. This allows our results to be doubly robust due to the fact that the estimators are unbiased if either the matching procedure *or* the regression specification is specified correctly.[14]

Attrition did not bias our sample. Out of 12,081 students, 4,014 (33 percent) did not fill out a survey at the time of our follow-up survey (April 2014). Among these 4,014 students, many of them (1,469 students) had dropped out of school. Other students (1,594) were on internships, 28 had transferred to other schools, and 923 students were on sick leave and were not present at the follow-up study. To ensure that this attrition did not affect our survey results, we checked for balance among non-attrited students between model and non-model schools within our matched sample. We found that the sample of non-attrited students was well balanced across model and non-model schools (available from: https://stanford.app.box.com/s/gusgxnldy7rw3hahpxvxw2jxbbodcsg1). There are no significant differences in baseline characteristics between the two groups of students. To further ensure that attrition did not bias our results, we also used multiple imputation to deal with the missing data problem. We found consistent results across all analyses.

[14]Using Oster's (2019) method, we find that our regression results (on the matched data) are not sensitive to omitted variable bias. This is even after assuming: (i) a value of 0.7 for the R^2 of a hypothetical regression of the outcome on both observables and non-observables (this is more than three times larger than the R^2 of the regression of the outcome on observables, and as such, much higher than Oster's suggested value of 1.3 times); and (ii) a value of 0.5 for the relative strength of selection between unobservables and observables (a value that is reasonable given the large and diverse set of observables for which we control).

III. Results

Before estimating the impact of attending a model vocational high school on student outcomes, we examined how resources per student differed between model and non-model vocational high schools. We found that model schools did indeed have higher levels of resources per student than non-model schools. Specifically, average expenditure per student was 3,000 yuan higher (40 percent higher) in model than non-model VET schools (Table 1, row 1).

Table 1. Differences of school resources between model and non-model vocational high schools

	Non-model VET			Model VET			Difference
	Mean	SD	N	Mean	SD	N	
Expenditure per student (yuan)	7,534	10,017	87	10,552	14,189	20	3,012
Government appropriation per student (yuan)	5,441	7,677	84	8,144	11,488	20	2,703
Teaching materials per student (yuan)	5,477	8,174	89	8,429	10,005	20	2,952
Training equipment per student (yuan)	5,219	9,119	89	9,878	13,962	18	4,658
Computers per student (units)	0.33	0.39	89	0.39	0.49	18	0.06
Ratio of students to full-time teachers	40.9	162.7	91	18.9	13.3	20	–22.0

Source: Authors' survey.

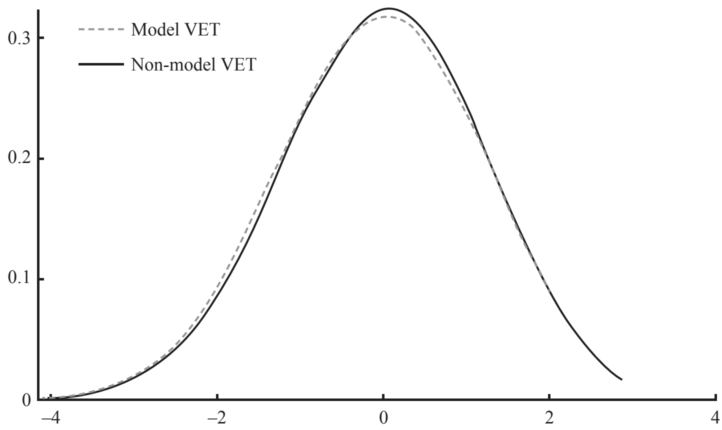
Notes: The slight difference in the number of observations (N) for each variable reflects a small degree of non-response. To ensure that this did not bias our results we used multiple imputation analysis to rerun the results for all principals and found consistent results. SD, standard deviation; VET, vocational education and training.

We also found that higher levels of resources followed higher expenditure per student at model schools. Specifically, we found that model schools had higher levels of government appropriations per student (2,703 yuan or 50 percent higher), more teaching materials (2,952 yuan or 54 percent higher), more training equipment per student (4,658 yuan or 89 percent higher), more computers per student (0.39 compared with 0.33), and substantially more teachers per student (a student to teacher ratio of 18.9 compared with 40.9) than non-model schools (Table 1, rows 2–6).

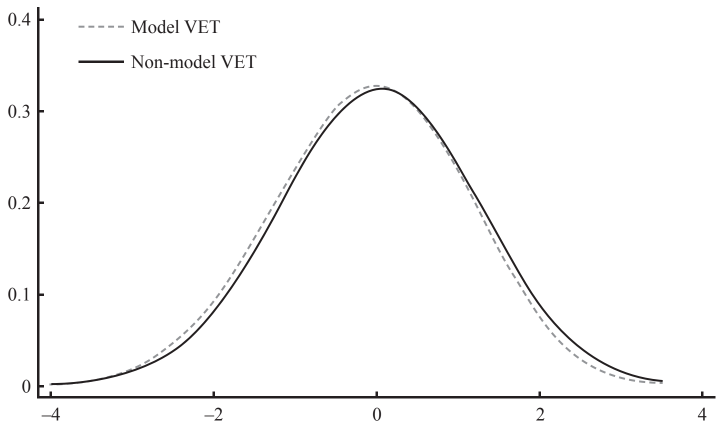
Despite higher levels of resources per student, model VET schools did not appear to attract students that were different from those that enroll in non-model schools. We found that there were no significant differences in baseline academic and vocational skills for first-year students attending model and non-model VET schools (Figure 1).

Figure 1. Baseline academic and vocational skills for first-year students attending model and non-model VET school

a. Distribution of baseline grade 1 math scores (*Z*-scores)



b. Baseline grade 1 computer scores (*Z*-scores)



Any discrepancy in student performance at the time of the the endline survey can therefore be attributed to the learning acquired during the school year.

The results from the multivariate (OLS) analysis show that there were no significant benefits associated with attending a model VET school in terms of skills, non-cognitive traits, or negative behaviors (Table 2).

In fact, vocational skills were slightly lower among model VET students and this result is significant at the 10 percent level. The magnitudes of all coefficients are also small –0.040 for academic skills, –0.107 for vocational skills, 0.045 for grit, and 0.015 for school dropouts.

Table 2. Impact of attending model school (OLS)

Variable	Academic skills	Vocational skills	Grit	School dropout	Peer risky behavior	Own risky behavior	Internet addiction
Model school	–0.040 (0.071)	–0.107* (0.058)	0.045 (0.055)	0.015 (0.017)	0.180 (0.140)	0.015 (0.021)	–0.024 (0.047)
Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cognitive scores	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Non-cognitive traits	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Education and work history	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Work expectations	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family conditions	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parent background	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grade dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	–0.886*** (0.194)	–0.696*** (0.204)	–3.481*** (0.189)	0.223*** (0.053)	–0.450* (0.227)	0.109 (0.070)	–1.858*** (0.177)
Observations	7,799	7,798	7,772	11,674	7,782	7,797	7,784
R^2	0.355	0.279	0.250	0.046	0.037	0.085	0.062

Source: Authors' survey.

Notes: *** and * represent significance at the 1 and 10 percent levels, respectively. Cluster-robust standard errors are in parentheses. The difference in the number of observations for each regression reflects non-response in the outcome variable due to attrition. Dropout does not result in significant differences in any of the baseline characteristics of non-attriting students across model and non-model schools. We also use multiple imputation to deal with missing data due to dropouts and find consistent results. OLS, ordinary least squares.

The finding that model VET students were not outperforming or behaving better than non-model VET students holds when we look at the difference in student self-reported satisfaction and post-schooling expectations between model and non-model school students. In the the OLS analysis, the coefficients are small and inconsistent in sign (Table 3).

None of the results are significant (even at the 10 percent level) for any difference in self-reported satisfaction and post-schooling expectations for students attending model and non-model schools. In short, despite attending schools with access to greater resources per student, students in model VET schools are not benefitting in terms of the outcomes evaluated here when compared to non-model students, and are even doing worse in one outcome (vocational skills). [15]

Table 3. Impact of attending model school on expectations for future employment and earnings (OLS)

Variable	Self-reported satisfaction with VET	Expected monthly income 1 month after VET graduation	Expected monthly income 10 years after VET graduation	Likelihood of employment 3 months after VET graduation	Highest educational aspiration is university or higher
Model school	0.005 (0.017)	–48.640 (58.564)	150.559 (565.319)	0.159 (1.089)	0.020 (0.021)
Individual characteristics	Yes	Yes	Yes	Yes	Yes
Cognitive scores	Yes	Yes	Yes	Yes	Yes
Non-cognitive traits	Yes	Yes	Yes	Yes	Yes
Education and work history	Yes	Yes	Yes	Yes	Yes
Work expectations	Yes	Yes	Yes	Yes	Yes
Family conditions	Yes	Yes	Yes	Yes	Yes
Parent background	Yes	Yes	Yes	Yes	Yes
Grade dummy	Yes	Yes	Yes	Yes	Yes
Constant	0.712*** (0.106)	1,092.007*** (224.147)	–3,643.885 (3,782.667)	17.703*** (4.779)	0.138 (0.105)
Observations	7,808	7,779	7,698	7,803	7,808
R^2	0.006	0.098	0.029	0.126	0.053

Source: Authors' survey.

Notes: *** represents significance at the 1 percent level. Cluster-robust standard errors are in parentheses. The difference in the number of observations for each regression reflects non-response in the outcome and is variable due to attrition. Attrition does not result in significant differences in any of the baseline characteristics of non-attriting students across model and non-model schools. We also used multiple imputation to deal with missing data due to dropouts and found consistent results. OLS, ordinary least squares.

The results from our propensity score matching analysis support the OLS results. There are no significant benefits in terms of student outcomes associated with attending model vocational high schools (versus non-model vocational high schools), implying that attending model schools has no significant impact on skills, non-cognitive traits, or risky behavior (Table 4).

[15]Our original principal survey also collected data on a proxy for teacher quality: the percentage of teachers at the school that had at least a 4-year undergraduate degree. We found no evidence of interaction effects (heterogeneous effects) on skills (academic, vocational, or non-cognitive) using this indicator, however. We did not examine heterogeneous effects by school type (e.g. public versus private) as the number of schools in some bins becomes very small (e.g. in the case of public versus private, there is only one private school that is a model school); any effect estimates would therefore be spurious and difficult to interpret.

Table 4. Impact of attending model school (matching)

Variable	Academic skills	Vocational skills	Grit	School dropout	Peer risky behavior	Own risky behavior	Internet addiction
Model school	0.045 (0.104)	–0.060 (0.093)	0.061 (0.072)	0.005 (0.026)	0.217 (0.192)	0.034 (0.035)	–0.090 (0.093)
Individual characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cognitive scores	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Non-cognitive traits	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Education and work history	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Work expectations	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family conditions	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parent background	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Grade dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	–1.034 (0.751)	–0.971 (0.875)	–4.765*** (0.555)	–0.073 (0.204)	–1.144 (0.913)	0.120 (0.237)	–2.479*** (0.585)
Observations	1,124	1,121	1,124	1,652	1,124	1,126	1,125
R^2	0.235	0.186	0.263	0.059	0.103	0.102	0.095

Source: Authors' survey.

Notes: *** represents significance at the 1 percent level. Cluster-robust standard errors are in parentheses. The difference in the number of observations for each regression reflects non-response in the outcome variable due to attrition. Attrition does not result in significant differences in any of the baseline characteristics of non-attriting students across model and non-model schools. We also use multiple imputation to deal with missing data due to dropouts and find consistent results.

Specifically, the coefficients are uniformly small and insignificant. For instance, the coefficients for academic skills and vocational skills are 0.045 and –0.060 respectively. The p-values (or t-ratios) imply that the results are statistically insignificant. The coefficient for school dropout is only 0.005 and insignificant. These results differ from the OLS results in that the vocational skills coefficient, while negative, is not statistically significant.

Likewise, according to the matching analysis, there is almost no evidence that attending a model vocational school positively impacts student self-reported satisfaction or post-schooling expectations. For example, student satisfaction with VET is not statistically different between model and non-model VET schools (Table 5, row 1).

We do find one significant impact from attending model schools. The matching analysis shows that students at model schools expect to earn higher incomes 1 month after graduating from VET than non-model school students (Table 5, row 2). This result is only significant at the 10 percent level, however. This suggests that students in model schools expect some labor market value from attending a model school. However, there is no significant association between model school attendance and long-term expectations of income (after 10 years), employment or education, suggesting that the benefits of model school attendance are short-lived at best (Table 5).

Table 5. Impact of attending model school on expectations for future employment and earnings (matching)

Variable	Self-reported satisfaction with VET	Expected monthly income 1 month after VET graduation	Expected monthly income 10 years after VET graduation	Likelihood of employment 3 months after VET graduation	Highest educational aspiration is university or higher
Model school	0.032 (0.035)	150.454* (89.607)	–434.347 (1,699.574)	1.737 (1.652)	–0.008 (0.040)
Individual characteristics	Yes	Yes	Yes	Yes	Yes
Cognitive scores	Yes	Yes	Yes	Yes	Yes
Non-cognitive traits	Yes	Yes	Yes	Yes	Yes
Education and work history	Yes	Yes	Yes	Yes	Yes
Work expectations	Yes	Yes	Yes	Yes	Yes
Family conditions	Yes	Yes	Yes	Yes	Yes
Parent background	Yes	Yes	Yes	Yes	Yes
Grade dummy	Yes	Yes	Yes	Yes	Yes
Constant	1.082*** (0.370)	–432.379 (757.383)	–18,786.079 (14,886.612)	25.065 (15.908)	0.559 (0.350)
Observations	1,128	1,123	1,105	1,128	1,128
R^2	0.049	0.145	0.058	0.178	0.067

Source: Authors' survey.

Notes: *** and * represent significance at the 1 and 10 percent level, respectively. Cluster-robust standard errors are in parentheses. The difference in the number of observations for each regression reflects non-response in the outcome variable due to attrition. Attrition does not result in significant differences in any of the baseline characteristics of non-attriting students across model and non-model schools. We also use multiple imputation to deal with missing data due to dropouts and find consistent results.

In summary, we find that students benefit little from attending model schools. Results from both OLS and propensity score matching analyses indicate that attending a model school has no significant, positive impact on student skills, non-cognitive traits, negative behavior, self-reported satisfaction, or post-schooling expectations. As mentioned above, schools were originally selected to become model schools and receive extra school resources based on their educational quality (as judged by the central government). We would therefore expect this cohort of schools to provide a higher quality education and have a more positive impact on student outcomes even without the additional funding provided to model schools. The fact that we find no evidence of a positive impact of attending model school is surprising.

Based on our finding that attending a model VET school does not lead to better student outcomes, we seek to understand the extent to which model VET principals in our sample recognize the lack of differences in quality between model and non-model schools. According to our data, model school principals were significantly more likely to rank their school in the top third of vocational high schools in their prefecture in terms of vocational skill, academic knowledge, and moral character (Table 6).

Table 6. Principal subjective evaluation of school quality ranking

Variable	Technical skill in the top tercile	Academic knowledge in the top tercile	Moral character in the top tercile
Model school	0.356*** (0.113)	0.271** (0.121)	0.183 (0.113)
Constant	0.594*** (0.047)	0.479*** (0.050)	0.667*** (0.047)
Observations	116	116	116
R^2	0.080	0.042	0.023

Source: Authors' survey.

Notes: *** and ** represent significance at the 1 and 5 percent levels, respectively. Cluster-robust standard errors are in parentheses.

The coefficients are large for all rankings (0.356 for vocational skills, 0.271 for academic knowledge, and 0.183 for moral character), and are significant at the 1 percent level for vocational skills and at the 5 percent level for academic knowledge. This indicates that VET principals generally believe that model schools are of higher quality across multiple dimensions, even though our results demonstrate that this is not the case.

The apparent ineffectiveness of the model school policy may be because model schools were only established recently in China (MOE, 2010a). Perhaps the increased resources available to model schools have yet to have an impact on school quality. However, because many model school principals do not recognize the lack of difference in school quality between model and non-model schools, this may suggest that being designated as a model school may, in fact, lead to inaccurate beliefs about school quality. This is potentially dangerous in that model school principals may not feel it necessary to continue to improve school quality.

IV. Conclusions

Our study shows that attending model schools does not result in any measurable benefit in terms of student outcomes. Both OLS and propensity score matching analyses suggest that attending a model vocational high school has little if any impact on improving student skills, non-cognitive traits, negative behavior, self-reported satisfaction, or post-schooling expectations. We also show that principals are unaware of the absence of positive impacts resulting from attending model VET schools: model VET school principals are more likely to believe their students are performing at the top of the distribution than non-model VET school principals. Our results suggest that increasing the resources per student is not enough to improve educational quality in vocational schools.

There is a large and well-developed literature on the impact of increased resources on student outcomes in academic schooling but this is the first large-scale, quantitative study, of which we are aware, to examine the impact of increased resources on VET student outcomes in the context of a developing country. Contrary to the notion that increasing resources per student might be particularly effective in the case of vocational education – either because investments in vocational education in developing countries have historically been inadequate or because providing high quality vocational education may be more resource intensive relative to providing high-quality academic education – our results suggest that increasing resources may not in itself be sufficient to drive true increases in school quality. Rather, our results call into question the strategy that has been advocated by governments and international organizations, which have assumed that increasing per student resources in vocational schools can improve educational quality (Kuczera et al., 2011; ADB, 2014). One potential limitation of the study, however, is that, at the time of our evaluation, the model school program had only been in existence for 3 years. It is possible that the model school program may have a significant long-run effect on student outcomes that is not captured by our study.

It is also possible that attending model schools has no impact on student outcomes because the entire vocational education system in China receives insufficient funding and resources. In other words, it is possible that the investments in China's model VET schools do not exceed the threshold that allows for impacts on student outcomes. However, evidence suggests this is unlikely to be the case in China. Research has found that vocational high schools in China typically meet official government benchmarks concerning inputs to education (including teacher qualifications and school facilities) (Yi et al., 2013). Official statistics also show that expenditure per student on VET high schools at the local level is slightly higher than for academic high schools (NBS, 2011). Given our findings that expenditure per student is 40 percent higher in model than non-model VET schools, it seems unlikely that investment is simply inadequate in these schools.

Rather, it is more likely that, to see true improvement in student outcomes, policymakers need to focus on improving the ways existing school resources are channeled by changing organizational structures and incentives within schools. For example, it may be possible to boost student outcomes by introducing school management reforms. It may also be possible to allocate VET school resources more effectively by implementing better monitoring and accountability procedures. Procedures that explicitly assess and tie student performance outcomes to rewards for teachers (such as teacher incentive pay) or schools (accreditation systems) exist in academic schooling around the world but are often lacking for VET (Field et al., 2009). Such procedures not only provide incentives to schools and individual teachers for improved performance, but also provide information to government, industry, and the public at large about which schools are of high quality. Indeed, reports on vocational education released by the OECD and the World Bank claim that improving monitoring and evaluation procedures is of vital importance (Field et al., 2009; Honorati and McArdle, 2013). More research is needed to understand whether implementing such monitoring and accountability procedures can improve the quality of VET in developing countries.

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