The Impact of Vocational Education on Students' Academic Outcomes: Evidence from the Dominican Republic

Isabella Haegg
Advisor: Christopher Neilson

Submitted to Princeton University
Department of Economics
In Partial Fulfillment of the Requirements of the A.B. Degree

April 30, 2020

Acknowledgements

I would like to thank Professor Christopher Neilson for all of his support, guidance, and insight throughout these past two years, which has culminated in the most rewarding academic experience of my time at Princeton. I also thank all those within the Ministry of Education and the students, teachers, and principals of the Dominican Republic who have been vital in informing my findings.

I am so grateful for Professor Jennifer Jennings, who has been an invaluable and incredible mentor for this thesis and throughout my Princeton career, and for Professor Beth Bogan, who fostered my love for economics and public policy.

The analysis in this thesis would be nothing without Oscar Torres-Reyna, the STATA master and extremely patient and all-knowing answerer of my data questions. I also thank Tsreing Wangyal Shawa for his help with the geospatial mapping that informed my analysis.

Thank you to my brilliant friends and professors who have made my time at Princeton truly amazing and full of laughter and learning. These relationships will last a lifetime.

There are no words to thank my parents for their unconditional support and love. I could not be luckier to have you two as inspiration for all I aspire to be.

Abstract

In this thesis, I examine the impact of vocational secondary education on students' academic outcomes in a developing country, the Dominican Republic, and estimate the returns to public investment in vocational high school. Using an empirical strategy similar to that of Card (1993), which uses variation in school proximity as an instrumental variable to evaluate the returns to schooling, I find attending vocational high school relative to academic high school boosts the average student's 12^{th} grade standardized test scores by up to 0.4 standard deviations. I identify substantially larger impacts for certain school and student profiles, including poorer and lower-scoring male students. Further, I find vocational high school increases the probability of on-time graduation and likelihood of college application, and boosts students' college admission test scores by 0.3 standard deviations. From fieldwork conducted in the Dominican Republic, where I surveyed a range of vocational high schools and interviewed policymakers within the Ministry of Education, I identify five main organizational and operational factors that contribute to these vocational high schools' success: managerial autonomy, curriculum and classroom design, hiring practices and teacher quality, school climate, and student body composition. While creating these conditions necessitates greater investment relative to academic high school, I find the benefit of an average vocational high school's impact on a student's 12^{th} grade standardized tests alone translates to a net present value of RD$28,252 per student. These findings contribute to the slim literature on the causal impacts of vocational education in developing countries and suggest that the Dominican Republic's strategy of investing in vocational education has increased human capital.

Contents

List of Figures

List of Tables

1 Introduction

There has been a revived interest in vocational education since the turn of the 21st century, particularly amongst developing countries, as a key tool to build human capital and address nationwide skill shortages. The World Bank and UNESCO have advocated for vocational education in developing countries to boost economic growth and reduce poverty (Nilsson, 2010), and vocational high school has been prioritized in emerging economies, such as China, Brazil, Chile, and Indonesia, to reengage students in the formal education system and ease the school to work transition for vulnerable youth (Loyalka et al., 2015). While over the past decade, developing countries have increased funding for vocational secondary education, often at the expense of traditional academic high school, there is little consensus on its impact on educational outcomes. Some scholars have found that vocational education can increase student test scores and student engagement (Brunner et al., 2019; Carbonaro, 2005), reduce student dropout levels (Kemple and Willner, 2008), and increase the probability of high school graduation and college attainment (Dougherty, 2018; Aizenman et al., 2017), yet opponents argue vocational education is too specific and hinders further educational attainment (Hanushek et al., 2011), can be detrimental to the economic growth of developing countries (Loyalka et al., 2015), and is not cost effective relative to general academic education (Almeida et al., 2015).

Further, there is little empirical evidence surrounding the effectiveness of vocational high school in improving cognitive skills among students, especially in comparison to academic high school. The varying conditions and nation-specific institutions under which vocational training has been implemented, as well as the difficulty in eliminating selection bias for the students who self-select into vocational education, has led to mixed conclusions. Studies based on international tests, such as the Program for International Student Assessment (PISA), have shown that students in vocational high school have lower levels of general skills than students in academic high school. However, data surrounding the PISA is limited, as detailed student background characteristics are not included, and the data is cross-sectional and not longitudinal, limiting the ability to test the causal impacts of attending vocational high school over academic high school or the contribution of vocational high school to students' educational outcomes (Loyalka et al., 2015). Literature analyzing the returns to vocational education in developing

countries, particularly in Latin America, is scarce and mostly non-causal. Experimental literature is mixed, with some finding negative impacts on grades and skill attainment in comparison to the regular academic track (Camargo, 2018; Loyalka et al., 2015), while others have found positive impacts on years of education, likelihood of dropout, probability of graduation, and employability (Kugler et al., 2015; Attansio et al., 2015; Elacqua et al., 2019; Field et al., 2019). The heterogeneity of vocational secondary education, both between and within countries, as well as the challenge of overcoming selection bias, complicates the ability to draw uniform conclusions about the impact of vocational education on students' academic outcomes.

In this thesis, I examine the impact of vocational high school on students' schooling outcomes in a developing country, the Dominican Republic, and estimate the returns to public investment in vocational high school. First, I assess the profiles of students who select into vocational school over academic high school. Then, I estimate the impact of attending a vocational versus academic high school on students' academic outcomes, including their years of high school attainment, probability of high school dropout, on-time graduation, and graduation, 12^{th} grade standardized test scores, probability of application and enrollment in college, and college application test scores. I subsequently estimate the heterogenous impacts of attending vocational versus academic high school on students' standardized test scores for various school and student profiles. Then, based on fieldwork conducted in the Dominican Republic, I qualitatively evaluate the organizational and educational inputs that differentiate vocational high schools and their performance in the context of decentralized school management. Finally, I estimate the returns to public investment in vocational high school over academic high school.

To accomplish these aims, I conduct analyses using student-level longitudinal data on more than 700,000 students in the Dominican Republic, where increased public investment in vocational secondary school has become an essential component of national policies to increase educational and skill attainment amongst graduates. In 2012, President Danilo Medina launched his "Educational Revolution," which doubled the education budget to 4% of the country's GDP. A major focus of these reforms has included the country's *politécnicos*, vocational secondary schools that serve as an alternative to traditional academic high schools, or *liceos*. The Dominican Republic's Ministry of Education has created a national program to promote the expansion of vocational education, including building new *politécnicos*, constructing hundreds of new *politécnico* classrooms, and converting *liceos* into *politécnicos*. Using an

estimation strategy similar to that of Card (1993), which uses variation in school proximity as an instrumental variable to estimate the returns to schooling, I find attending vocational high school relative to academic high school boosts students' 12th grade standardized test scores by up to 0.4 standard deviations, with substantially larger impacts for certain school and student profiles, including poorer and lower-scoring male students. This aggregate impact on scores from 8th to 12th grade is on par with the impacts of some of the most successful charter schools, which range from an annual boost of 0.1-0.25 standard deviations in certain subjects (Cohodes, 2018). Further, I find *politécnicos* increase the probability of on-time graduation and likelihood of college application, and boost students' college admission test scores by 0.3 standard deviations.

I then turn to exploring the mechanisms that may explain *politécnicos'* greater effectiveness. From fieldwork conducted in the Dominican Republic, where I surveyed a range of *politécnicos* and interviewed policymakers within the Ministry of Education, I identify five main organizational and operational factors that have been empirically demonstrated to enhance efficiency and equity in educational systems and that contribute to *politécnicos'* success: managerial autonomy, curriculum and classroom design, hiring practices and teacher quality, school climate, and student body composition. While these *politécnico* inputs necessitate greater investment, with *politécnicos'* per capita transfer expenditures equaling 3 times those of *liceos* and per capita teacher salary expenditures 1.5 times those of *liceos*, I find the academic benefits of an average *politécnico's* impact on a student's 12th grade standardized tests alone translates to a net present value of RD$28,252 per student.

In sum, this thesis causally identifies the impact of vocational high school on students' academic outcomes within a developing country, contributing to the ambivalent and slim literature on the educational impact of vocational high school. Further, it identifies crucial educational inputs that can help explain the differential impact of vocational education over academic education, and estimates the returns to marginal investment in vocational education. My findings are important for Dominican Republic policymakers after almost a decade of heterogenous educational reform, as neither the profiles of the students attending these *politécnicos* nor the impact that *politécnicos* have on students' educational outcomes has been analyzed within the country. Further, there is great diversity amongst *politécnicos* in inputs such as infrastructure, managerial autonomy, public funding, teacher quality, and classroom instruction. Therefore, it is critical for the growth of the Dominican Republic's educational system and

economy to better understand the profiles of the students attending *politécnicos*, the profiles of the most successful *politécnicos*, the impact *politécnicos* have on students' outcomes, and the net present value of a *politécnico* education over a *liceo* one. My findings suggest the promotion of vocational schooling as a substitute for academic schooling is beneficial to building human capital in the Dominican Republic, and may also generalize to similar developing Latin American countries, as well.

The next section presents a background on the educational system in the Dominican Republic, including details of the country's policies under the Educational Revolution and the *politécnico* model. Then, Section 3 discusses the academic impacts of *politécnicos*, including my findings for enrollment, dropout, years of schooling, graduation, 12^{th} grade standardized test scores, and college outcomes, as well as the results of my fieldwork on the differentiating educational inputs that contribute to *politécnicos'* impact on schooling outcomes. Section 4 analyzes the implications of public financing for the Dominican Republic's educational system, presenting a background on the country's school funding approach and findings of spending treatment effects and estimated returns to investment. Concluding remarks are offered in Section 5.

2 Background

2.1 Structure of Educational System

In the Dominican Republic, the Ministry of Education is the body of the Executive Branch charged with administering its public education at the primary and secondary levels and supervising its private schools. The public education system serves more than 80% of the nation's school-aged population, made up of 18 regions and 120 educational districts (Caraballo et. al, 2016). Public schools in the Dominican Republic are centrally funded by the state, and the Dominican Republic's expenditures in education have been low by international standards, particularly in secondary education.

In terms of school governance, school administration falls into four types: public schools administered by the Ministry, public schools administered by a private group, semi-official schools, and private schools (Scheker, 2007). Public schools administered by the Ministry are under the control of the state, and the Ministry's offices decide and control all aspects of the administration of public schools. The

Ministry appoints and hires school personnel, from principals to teachers to maintenance staff, sets salaries, establishes curriculum, provides equipment and materials, and carries out any necessary maintenance (Scheker, 2007). Public schools administered by a private group, as are half of all *politécnicos*, are usually associated with a religious order. While this type of school receives public funds, these schools are given great administrative latitude; the institution that administers the school appoints the principal, as opposed to the Ministry, and the director further has freedom to select teachers (Scheker, 2007). Private schools have the freedom to independently make all administrative decisions, including how to spend their funds and which personnel to appoint, and charge tuition as their main source of financing. Semi-official schools, while very rare and not legally a part of the structure of school administration as of the Plan Decenal, are private schools run by Catholic congregations that serve low-income students and charge tuition, but the Ministry pays the salary of some of their personnel (Scheker, 2007). All schools are still regulated by Law 66-97 and must follow the basic national curriculum standards, the official school calendar, and, until 2017, had to administer the *Pruebas Nacionales* (PN), or national tests, at the end of basic and secondary education, in grades 8 and 12.

Until 2017, the educational system was made up of the initial level, the primary level, which lasted six years, from age 8 until 14, and the secondary level, which lasted four years, from age 14 to 18. The secondary level was divided into two two-year cycles; the first cycle was common for all students, while the second cycle comprised three modalities students chose between: General, Technical-Professional, and Arts. As stated in Law 66-97, the General Modality offered by *liceos* contains "more deep knowledge that allows students to strengthen their foundations to enter university with success." The Technical-Professional Modality offered by *politécnicos* allows students to obtain general and professional training for entry into higher education or qualified professions, focusing on three main sectors of the Dominican economy: services, industry, and agriculture (OECD, 2012). The modality in Arts, which is much less common, seeks to equip students with the creative skills for arts-related occupations, focusing on four major orientations: music, visual arts, performing arts, and applied arts (OECD, 2012). By 2017, schools had changed to a new academic structure, which broke primary and secondary education into six years each, divided into two cycles of three years. According to the Director of Educational Quality Assessment of the Ministry of Education, this change was made to align with the international standardized classification of educational levels. The first cycle of secondary education now lasts three

years and is common amongst all students; the second level of the cycle has a duration of three years and takes place in the Academic, Technical-Professional, or Arts modality (Ministerio de Educación, 2019). In order to graduate from secondary school, students still must pass the PN, upon which students gain their high school diploma and can advance to university.

2.2 Educational Revolution

In the years leading up to the Educational Revolution in 2012, the Dominican Republic lagged behind Latin American countries in many educational indicators. Enrollment in secondary education, which had improved from 28% in 2003 to over 50% in 2012, still left half of eligible students out of the system (Caraballo et al., 2016). According to a World Bank report (2006), underperformance in the Dominican Republic's educational sector was a result of low levels of spending, subpar facilities, outdated curriculum, poor teacher quality, management inefficiencies, bottlenecks in the supply of secondary schools, and limited access for students in rural areas. Additionally, the OECD (2012) identified major socioeconomic and geographic inequalities in the provision of primary and secondary education, as only 21% of students from low-income households were enrolled in high school, compared to 70% of students from the highest-income households, which led to high dropout and repetition rates at the secondary level. Even though the country conducted evaluations at the local and regional level, students did not participate in rigorous evaluations from global international organizations, such as the PISA tests (Caraballo et al., 2016).

While Law 66-97 mandates the government spend 4% of its GDP on education, the government did not comply during the majority of the 2000s. From 1989 to 2009, the Dominican Republic was the Latin American country that invested the least in public education, with 78% of third grade students failing to achieve a basic level of competence in reading, and 90% of students performing below the basic math level (The World Bank, 2015). Even those who completed 12 years of school began college at a 6th grade reading level (Manning, 2014). Public spending on education was just 2% of GDP, and expenditure per student decreased by 13% on average between 2007 and 2011 (Caraballo et al., 2016). This accumulated deficit and progressive deterioration of the equality of education led to a social movement demanding compliance with the law. In 2011, teachers campaigned to increase government

spending on public education to the required 4%. At the time, the monthly salary for teachers fell below the basic monthly shopping basket as defined by the Dominican Central Bank and was half that of the average university-educated worker (Manning, 2014). Voters convinced all presidential candidates in 2012 to commit in writing to double the pre-university education budget if elected.

Since being elected, President Danilo Medina has kept his promise to "turn education into a pillar of the Dominican welfare state," with the Dominican Republic becoming the first country in the Caribbean to undertake a major overhaul of its educational system (Danilo Presidente, 2018). Since 2012, the education budget has grown from RD$60 billion, or US $1.1 billion, to RD$175 billion, or US $3.2 billion, in 2019, and investment per student has grown from RD$20,000 in 2012 to more than RD$92,000 in 2019 (Ministerio de Educación, 2019). Medina's Ministry has embarked on major education reform measures, vowing to increase educational access by constructing new schools and classrooms and heavily investing in teacher training and hiring.

The Ministry also extended the school day to eight hours from five across all schools. Before 2012, students only learned for under three of the five hours during a typical school day (Manning, 2014). From 2012 to 2020, the percentage of initial, primary, and secondary students enrolled in schools with an extended school day increased from 0.5% to 72%, allowing 1.6 million students to receive 8 hours of teaching and have 3 guaranteed daily meals (Gómez, 2020). Teachers and coordinators were further trained through workshops, tutorials, and other support structures in modifying instruction in accordance with the extended school day. From 2012 to 2019, the Ministry constructed 24,000 new classrooms, equivalent to 50% of the total classrooms built in the previous decades, to bring its total classroom count to 51,000. More than 22,000 of those classrooms implemented the extended school day policy (Ministerio de Educación, 2019). Thanks to this expansion, the coverage rate increased to 93% for primary school and 71% for secondary school in 2018 (Ministerio de Educación, 2019)

A set of educational policies were passed to professionalize the teaching force and support teachers' training and development (Ministerio de Educación, 2019). Specifically, the Ministry of Education has published professional standards for teachers' performance, developed a robust teacher career framework, including induction, recruitment, evaluation, and certification, and developed regulations for universities and teacher-training institutes to change the way teachers are trained (The World Bank, 2018). In 2011, the budget allocated for teacher training was US $5.9 million, which increased to US $25.7

million in 2012 and to US $84.9 million in 2019 (Ministerio de Educación, 2019). A resolution was passed in 2015 to regulate the development of teacher training programs in the Dominican Republic, with a new curriculum based on enhanced professional and performance standards. This reform called for a minimum of four days of face-to-face classroom time at the university, as well as practice in school classrooms, overseen by an experienced instructor (Saavedra and Baron, 2018). Further, teaching students who attend universities that comply with the new regulations receive scholarships so they do not need to work to support themselves while in school, and, in order to address the need for greater technical expertise at the secondary level, secondary school teachers are now trained in their respective subjects, with a focus on pedagogy (Saavedra and Baron, 2018).

The Dominican Republic also made the admission process to enter teacher training institutions and the public teaching career more competitive. For university admission, all students are required to take the Orientation and Academic Measurement Test, or POMA, passed by 35-40% of students. For an education degree, specifically, this test is supplemented by an admissions test that measures Spanish language proficiency and mathematics, passed by only 16% of those who passed the POMA (Saavedra and Baron, 2018). Further, for teachers to enter the public teaching career after university, they must undergo a rigorous competitive selection process. The Ministry administers a test for prospective teachers in biannual "competitions," and has significantly raised the standards to only hire the top teacher candidates for public schools. While the average number of applicants who take the teacher entry exam has increased 8 fold – from 6,575 in 2012 to over 50,000 in June 2019 (Acento, 2019) – only 15-30% of those who apply to be public school teachers are typically selected and placed in primary and secondary schools, in contrast to the 100% approval rate in 2006 (Saavedra and Baron, 2018). Further, a country-wide teacher performance evaluation was implemented in 2017. In 2019, almost 84,000 teachers were evaluated. While only 3.90% ranked as Excellent, with 23.90% Competent, 35.10% Basic, and 38.10% Needs Improvement, the nation-wide evaluation process was an important step to bring greater accountability to the system and provide performance incentives to teachers (Ministerio de Educación, 2019).

Lastly, the average salaries for initial and basic education teachers increased by 97% from 2012, and the average salary of secondary school teachers increased by 103%, from US $546 monthly in 2012 to US $1,107 monthly in 2018 (Ministerio de Educación, 2019). This increase in wages made teachers' salaries competitive with those of comparable professionals – a significant feat, as by the turn of the 21st

century, teachers' real wages were equivalent to 20% of the salary they received in 1966: a factor that exacerbated teacher dropout rates and contributed to the loss of prestige of the teaching profession (Carabello et al., 2016).

Despite these concerted efforts of the Medina presidency, the availability and quality of education in the Dominican Republic still lags behind that of many similar countries, and students' academic progress has been slim. Medina's Educational Revolution has seen improvements in students' performance on the *Pruebas Nacionales*, with gains observed in Mathematics and Social Science. However, in comparison to other low and middle income countries, the Dominican Republic ranks at the 32nd percentile in access to education and at the 68th percentile in learning, as measured by the primary school net enrollment rate and youth literacy rate, respectively (Educational Policy Data Center, 2018). According to the World Economic Forum's Global Competitive Index, the net secondary school enrollment rate is 66.55%, having grown little from 62.49% in 2012 at the beginning of Medina's presidency (World Economic Forum, 2019). For youth of secondary school age who are not participating in the educational system, 18% of females and 21% of males are out of school, with the biggest disparity in enrollment seen between the poorest and richest youth, as 9% in the richest quintile of secondary school age are out of school compared to 36% of those in the poorest quintile (Education Policy Data Center, 2018).

The most recent results from the 2018 PISA test were dismal for the Dominican Republic. The results showed on average, students in the Dominican Republic are five years behind a student in an OECD country in reading, mathematics, and science (Gropello et al., 2019). Not only did the Dominican Republic show declining Reading and Math scores since 2015, the first year students were administered the test, but the Dominican Republic ranked the lowest among 77 PISA-participating countries in Math and Science, and second lowest in Reading. Reforming the educational system is still top of mind for the Dominican Republic's citizens. In the World Bank's 2019 Country Survey, the largest proportion of respondents, 45%, indicated the most important development priority in the Dominican Republic was education, up from 29% in 2016 (The World Bank Group, 2018a).

On other international measures, the quality of the educational system has increased slightly since the beginning of Medina's presidency, currently ranking 90th out of 140 countries (World Economic Forum, 2019). Educational indicators of mean years of schooling, quality of vocational training, skillset of graduates, school life expectancy, ease of finding skilled employees, and critical thinking in teaching

have all increased, showing tangible improvement from the efforts of the government and its partners to increase youth training (World Economic Forum, 2019). Indeed, one of the main focuses of the Dominican Republic's educational reform has been to ensure academic coherence with private sector demands, primarily through expanding the coverage of *politécnicos*. The Minister of Education, Andrés Navarro, has said that students enrolled in *politécnicos* have greater possibilities to enter the labor force and to continue on to university than those enrolled in *liceos* (Ministerio de Educación, 2018a), and the Ministry pledged as one of its main educational goals for 2021 to "prioritize the connection between education and employment through technical-professional education" (Ministerio de Educación, 2019).

2.3 *Politécnico* Model

Since the early 1970s, researchers, employers, and other private sector representatives have argued that the Dominican Republic needs a coherent and coordinated system of technical and vocational training in order to ensure an adequately trained workforce to promote the country's economic development (Amargós, 2016). While the majority of students attend traditional academic high schools known as *liceos*, geared towards university admission, the programs offered in *politécnicos* prepare students for particular professions, educating students in subjects ranging from agriculture to nursing to graphic design. Public *politécnicos* are independent from regular public schools, but receive public funding and are under the oversight of the Ministry of Education. Not only do *politécnicos* differ from *liceos* by their curriculum, but they also have certified professional-technician teachers and specialized laboratories and workshops in order to provide training in occupational specialties. Further, many *politécnicos* differ from *liceos* in their ability to select their teachers based on character and competence independent of political considerations, and occasionally select students based on their commitment to learn. In its review of national policies for education in 2008, the OECD was impressed by the 55 *politécnicos* it surveyed in the Dominican Republic. Unlike the public education centers in low income areas that were in need of maintenance, the OECD found the *politécnicos* were well maintained. The OECD team suggested *politécnicos* could serve as models for new approaches to school governance and complement *liceos* by successfully serving students in high poverty areas (OECD, 2008).

The Ministry has channeled significant resources towards expanding the provision of vocational education in the Educational Revolution, specifically by converting public *liceos* into *politécnicos* and constructing new *politécnicos*. The Ministry more than doubled the amount of *politécnicos* from 2012 to 2019 to 272 in total, which boosted *politécnico* enrollment by 89% (Ministerio de Educación, 2019). With the Ministry of Education's support of *politécnicos*, Navarro has stated that his goal is for 80% of secondary school graduates to be fully technically trained (Ministerio de Educación, 2018a). Navarro has described requests from leaders in the communities he visits for the construction of *politécnicos*, demonstrating the conviction that vocational training is the best way to develop the Dominican Republic's young people (Ministerio de Educación, 2018a).

The Ministry has focused on developing multisectoral policies and promoting partnerships with the public and private sector to create closer linkages between *politécnicos*, higher education, and the labor force. These policies have included an agreement to support entrepreneurship and the development of microenterprises in *liceos* and *politécnicos*, as well as an agreement to promote the establishment and development of *politécnicos* near the Dominican Republic's various duty-free industrial parks, or *zonas francas*, where over 165,000 jobs are generated by 665 companies (Ministerio de Educación, 2018c). The business associations that represent these zones, the Asociación Dominicana de Zonas Francas (ADOZONA) and the Consejo Nacional de Zonas Francas de Exportación (CNZFE), have committed to support *politécnicos* with the contribution of machinery and qualified technical personnel and the guarantee to prioritize hiring *politécnico* graduates (Ministerio de Educación, 2018c). An additional example of an alliance between the private sector and *politécnicos* has been the formation of the Business Initiative for Technical Education (IEET) by the Ministry of Education and IMCA, a Caterpillar dealer in the Dominican Republic. As described by the Executive Director of the IEET, IEET has worked with 22 *politécnicos* over the last seven years in order to address IMCA's labor shortage by creating and placing qualified technicians within IMCA, redesigning *politécnico* Math and Science courses to include real-world problems and providing greater professional development for teachers. According to the Executive Director, 60% of IMCA technicians come from the program, and the training period for graduates as new hires was reduced from 18 months to 3 months. The university Instituto Tecnológico de Las Americas (ITLA) has also partnered with the Ministry of Education to develop a joint program to strengthen vocational secondary education, which will include the construction of 28 *politécnico*

classrooms and the transformation of *liceos* into *politécnicos* in the areas surrounding ITLA, strengthening the connection between vocational high school and higher education (Ministerio de Educación, 2018b).

In 2018, the Ministry announced its Program of Support for Vocational Education and Technical Training, in collaboration with the European Union and the Spanish Agency for International Cooperation. The European Union pledged US $12.5 million in budgetary support, as well as US $5.5 million in technical assistance to strengthen vocational education and training and help implement the National Qualifications Framework (Presidencia de la República Dominicana, 2018). The Ministry passed the National Qualifications Framework in 2019, which aims to integrate and coordinate the subsystems of national education and training, particularly within *politécnicos*, and improve the transparency and quality of qualifications of students at each educational level in relation to the labor market. The Minister of the Presidency, Gustavo Montalvo, described the National Framework of Qualifications as the "second component of the Educational Revolution," by putting "students and the skills they master at the center of public policy. This will allow a graduate to find work more easily, and also to continue studying at higher levels without greater difficulty" (Presidencia de la República Dominicana, 2019).

3 Academic Impacts

3.1 Literature Review

There is no scholarly consensus on the impact of vocational high school on students' educational outcomes, especially in comparison to academic high school. Experimental literature surrounding vocational high school education in the United States shows no impact or slight positive impacts on test scores (Kemple and Snipes, 2000; Dougherty, 2018; Brunner et al., 2019), as well as a reduction in high school dropout rates, an increased likelihood of graduation, an increased likelihood of college enrollment, and higher employment rates and wages (Kemple and Snipes, 2000; Dougherty, 2018; Brunner et al., 2019). However, these findings may not be applicable to a developing Latin American country like the Dominican Republic.

Literature that estimates the impact of vocational high school education on academic achievement in a country similar to the Dominican Republic is slim, and is often non-causal. Using a lottery of

scholarships to attend private technical education in Brazil, Camargo (2018) finds a negative impact on grades for male students who enroll in vocational education over the regular academic track. Also in Brazil, Elacqua et al. (2019) exploit a discontinuity in the probability of enrolling in vocational high school to estimate its causal effect on standardized test scores, dropout, and repetition rates. Comparing vocational high schools with academic schools with similar characteristics, they find no differences in terms of achievement but significantly lower dropout rates. Other close points of comparison in existing literature to the Dominican Republic's *politécnicos* are those analyzing Colombia's vocational training program for disadvantaged youth. Kugler et al. (2015) examine the spillover formal education effects of a randomized vocational program in Colombia and find vocational training lottery winners are more likely to complete secondary school one year after training participation, yet find no effects of training on secondary school completion after two years of training participation. Kugler et al. (2015) also find training lottery winners are more likely than losers to enroll in formal tertiary education between 3 and 8 years after training participation and are more likely to remain enrolled in college five years after training participation, suggesting vocational training skills complement and beget formal education skills of participants. They find this complementarity in the Colombia program is strongest amongst applicants with a high baseline of educational attainment (Kugler et al., 2015). Attansio et al. (2015) find winners of this lottery had 0.315 more years of education and a probability of graduating from high school 10 percent higher than the control group.

In a smaller subsidized training program that took place in the Dominican Republic, known as *Juventud y Empleo*, a random sample of low-income youth in urban areas between 2001-2005 received several weeks of classroom instruction before being placed in an internship at a private sector firm. Card et al. (2007) find no evidence of a positive effect on employment, finding a marginally significant impact on hourly wages and no significant impact on the employability of trainees. Analyzing the same program, Acevedo et al. (2017) find that while male and female participants reported increased expectations for improved employment and livelihoods after completing the program, only female participants experienced improved labor market outcomes in the short run; for males, the program resulted in negative short run-effects on labor market outcomes. Acevedo et al. (2017) find any impacts on employment outcomes disappeared in the long run for females and males, although females exhibited higher levels of personal skills.

Of greatest interest and most similarity to the Dominican Republic's secondary school system of *liceos* and *politécnicos* are China and Mongolia's vocational educational systems. Loyalka et al. (2015) find that the expansion of vocational schooling as a substitute for academic schooling may be detrimental to the economic growth of developing countries. In a similar fashion to the Dominican Republic, students in China are asked to choose a schooling "track" at the end of junior high school: vocational high school or academic high school. Loyalka et al. (2015) find vocational schools in China do not adequately prepare students at the greatest risk of dropout, as students who are low income and low ability in vocational high school dropout more than the higher income and ability students. They find that relative to academic high school students, vocational students are losing in specific and general skills, are more likely to drop out of high school, and even when vocational students are compared to the worst academic high school students, attending a vocational high school reduces general skills and does not lead to gains in specific skills over academic high school. However, in contrast to these findings, Field et al. (2019) conducted a public lottery to allocate scarce slots for students who applied to Mongolia's oversubscribed vocational secondary schools, finding admission to vocational schools leads to significantly higher employment and increased earnings for women due to their greater acquisition of skills in specific trades and increased employment opportunities in high paying sectors. In conclusion, the dearth of literature examining the causal effects of vocational education, especially in a developing country context, is further complicated by the heterogeneity of vocational educational systems within and between countries, leading to conflicting conclusions about the impact of vocational education.

3.2 Data

There is a need for empirical analysis of the Dominican Republic's *politécnicos*, especially in light of the aforementioned conflicting literature. With data obtained by Christopher Neilson and his team from the Ministry of Education, I have assembled a student-level panel including five cohorts of 721,386 students in the Dominican Republic graduating 8^{th} grade from 2010-2014. Available variables include their gender; age; 8^{th} grade and 12^{th} grade GPAs in Spanish, Math, Social Science, and Natural Science; 8^{th} grade and 12^{th} grade *Prueba Nacional* (PN) scores in Spanish, Math, Social Science, and Natural Science; identification of the school they were enrolled in from 2010-2018 if applicable;

classification of the school they were enrolled in as urban or rural, public or private, and extended day; the high school's classification as a *politécnico* or *liceo*; high school graduation year; the student's high school concentration; longitude and latitude of their middle school and its associated wealth, education, and employment levels, as well as the longitude and latitude of their high school and its associated wealth, education, and employment levels.

To this panel, I linked the college application test scores, or POMA scores, of individual students from 2014-2017 from 40 different university-level data sets, as well as college matriculation data from 2014-2018 from the Ministry of Education. I received additional school-level data from the Ministry of Education, including the year a *politécnico* was founded or a *liceo* was converted into a *politécnico*, whether a *politécnico* or *liceo* was associated with a religious order, and whether a *politécnico* was authorized or a converting *politécnico*.

3.2.1. Variables

GPA and National Tests (PN): The student-level data includes their GPA in 8th and 12th grade if applicable, scored from 46-69 across Spanish, Math, Social Science, and Natural Science. The data also includes the student's 8th grade and 12th grade PN scores if applicable in Spanish, Math, Social Science, and Natural Science, with a minimum score of 0 and a maximum score of 30 per section.[1] The curriculum for grades 9 and 10 were the same for all students, but grades 11 and 12 were different between the general modality offered by *liceos* and the technical modality offered by *politécnicos*. The PN in 12th grade administered to *politécnico* students thus evaluated the first two years of learning, while the PN in 12th grade administered to *liceo* students evaluated all four years (Ministerio de Educación, 2019). As a result, while the difficulty of the test is the same for both *politécnico* and *liceo* students according to the Director of the Educational Quality Assessment of the Ministry of Education, there are slight differences in content. The Spanish section of the 12th grade PN was identical for both sets of students with 55 questions; however, the PN for *politécnico* students differed slightly in the Math, Natural Science,

[1] After the 2017-2018 school year with the change to the educational structure, the PN tests are no longer administered to 8th graders, and instead administered after the first three years of the secondary cycle, or in 9th grade, and after the last three years of the secondary cycle, or in 12th grade. My data corresponds to the former educational system, where students took the PN during the last year of the primary school cycle, and again during the last year of the secondary school cycle.

and Social Science sections, where each section had five questions fewer than the PN sections for *liceo* students, for a total of 45 questions in the Math section, 45 in Natural Science, and 50 in Social Science. These five question deficiencies are due to the omission of certain content in each section; unlike *liceo* students, *politécnico* students were not tested on calculus in the Math section, not tested on organic chemistry in Natural Science, and not tested on the Dominican Republic's history in Social Science, as these topics are covered in the last two years of the general education cycle. Therefore, even though these content differences are slight, I focus mainly on the 12th grade Spanish PN scores when reporting my findings. A student's 12th grade PN scores typically count for 30% of their graduation requirements, with their high school GPA comprising the other 70%.

College entrance tests (POMA): The data also includes POMA test scores from 2014-2017 for students who applied to 40 different universities. Article 59 of Law 139-01, passed in 2012, established the POMA as a mandatory diagnostic test all students must take to be admitted to a university, made up of six sections with 15 questions each: Verbal, Math, Perceptive Structures, Natural Sciences, Social Sciences, and Human Behavior (Secretaria de Estado de Educación Superior, 2012). If a student receives a failing score, below 400, they require remedial courses upon matriculation.

Municipality socioeconomic status: The municipality wealth level is calculated as a function of the wealth, education, and employment level of the municipality's population. I take the municipality wealth level of a student's middle school to be the student's assumed wealth level, as there are many more middle schools than high schools and these middle schools are more geographically dispersed, so the socioeconomic status of the location of a student's middle school will more likely align with the socioeconomic status of the student's household. While this is an imperfect measure of a student's socioeconomic status, it is such a central variable that I concluded a noisy measure is preferable to no measure at all. I use the wealth level of the municipality of a high school's location as the high school's associated wealth level, as well.

School founding dates: As mentioned, on the school level, I have information on the year a *politécnico* was founded from 2013-2018. Because my data consists of 8th graders graduating from 2010-2014, I can therefore look at *politécnicos* that were founded in 2013 and 2014 to exploit differences in choice sets and distance over time: there are 5 such *politécnicos* founded in 2013, and 4 in 2014. Each school also is classified according to whether it offers an extended day for eight hours of daily instruction,

or not, meaning five daily hours. I also obtained information from the Ministry of Education about whether a *politécnico* or *liceo* was managed under a religious order, as well as whether a *politécnico* was authorized, meaning it had the appropriate infrastructure, curriculum, and personnel to be deemed a *politécnico*, or if it was a converting *politécnico*, meaning the school was a *liceo* undergoing the process of being converted to a *politécnico*, which could include introducing different vocational tracks, hiring certified technicians, or constructing a laboratory. While the Ministry has said it aims for 80% of *politécnicos* to be properly equipped with workshops and laboratories by the 2020-21 school year, these converting *politécnicos* lack the infrastructure an authorized *politécnico* has.

Distance: I additionally have created a variable that calculates the distance of the closest *politécnico* to a student's middle school in kilometers, as well as the closest *liceo* to a student's middle school in kilometers. Because of the opening of 9 new *politécnicos* in 2013 and 2014, this given distance to the closest *politécnico* varies for some students over time. Other distance-related variables include the number of closer *liceos* to a student than the nearest *politécnico*, and whether or not the closest school to a student is a *politécnico*.

3.2.2. Data Preparation

I compiled and filtered data of POMA tests administered by each university on a monthly basis from 2014-2017. Because some students were identified by a university-given ID rather than their national ID for various test dates and thus could not be linked to the panel, a large number of test scores were removed from the sample. Ultimately, the cleaned data had scores for 148,429 students, identified by their national ID. Using a crosswalk to match the national ID to the student's deidentified ID in the panel, I matched the POMA test scores of 31,596 students. There is little reason to believe these matching issues may affect my results in a way that would distort representation of *politécnico* students or *liceo* students, as the student scores that could not be matched were randomly spread across universities and test dates. I additionally matched a data set from the Ministry of Education of the college matriculation of students and the colleges they enrolled in from 2014-2018 to 110,601 students in my panel. I linked any school-level data received from the Ministry of Education to the panel based on the school's ID.

From the distance variable of the closest *politécnico* to a student's middle school in a given year, I created a variable that represents the distance squared to the nearest *politécnico*, a dummy variable that equals 1 if a *politécnico* is the closest secondary school to a student's middle school and 0 if not, as well as a dummy variable that equals 1 if a *liceo* is within 2 km to a student's middle school and 0 if not. I created six other dummy variables that take on the value of 1 if the nearest *politécnico* is within 0-1 km of a student's middle school, 1-2 km of a student's middle school, 2-3 km of a student's middle school, 3-4 km of a student's middle school, 4-5 km of a student's middle school, and 5-6 km of a student's middle school, respectively.

I also divided the wealth level of the municipality of the student's middle and high school into quintiles, with 1 indicating the lowest wealth level and 5 corresponding to the highest wealth level. I created enrollment quintiles on the high school level, with 1 indicating the lowest grade size and 5 the highest. I further created quintiles of wealth levels and enrollment comparing just *politécnicos* to each other and just *liceos* to each other. For *politécnicos* specifically, I created quintiles of the number of degrees they offer, with 1 corresponding to the lowest number of degrees offered and 5 the highest.

I created a dropout variable equaling 1 if a student did not graduate high school and was not enrolled in high school by 2018, and 0 if the student graduated high school or was enrolled in 2018. I calculated total enrolled years of high school for each student by counting the number of years they were matriculated in a high school from 2010-2018. I created an on-time graduation variable equaling 1 if the student graduated high school in 4 or fewer years, and 0 if the student graduated high school in greater than 4 years. Lastly, on the student level, I created quintiles for the student's PN scores for each subject, with 1 corresponding to the lowest scoring quintile for a given subject and 5 the highest, which is what I use to segment the students by their academic achievement levels.

3.2.3. Summary Statistics

I first report summary statistics for my data, which follows five cohorts of 721,386 students from their 8th grade graduation in 2010, 2011, 2012, 2013 and 2014 until 2018. As presented in Table 1, 11% of students enrolled in one of the 181 *politécnicos* for 9th grade, and 89% of students enrolled in one of the 2,426 *liceos*. 44,211, or 6%, of these students never enrolled in high school by 2018. Figures 6-8

illustrate the geospatial mapping of middle schools, *politécnicos*, and *liceos*. All three types of schools are concentrated in the main cities of the Dominican Republic, with *politécnicos* and *liceos* clustering in Santo Domingo and Santiago, especially. *Liceos* are much more geographically dispersed than *politécnicos* and closer to a given middle school in more remote areas, due to their greater number. While *politécnicos* are more concentrated in urban cities than *liceos*, Figure 8b illustrates where *politécnicos* were opened in 2013 and 2014, indicating geographic heterogeneity in the availability of new *politécnicos*. As Figure 9 shows, some of these *politécnicos* were opened in educationally dense zones, such as in Santo Domingo. Within the three kilometer radius of the new *politécnico*, there are 20 *liceos* and 26 middle schools. As Figure 10 illustrates, however, some of these *politécnicos* were opened in areas with more limited coverage, such as in Neiba. Within the three kilometer radius of that new *politécnico*, there is only one *liceo* and eight middle schools. Table 2 illustrates how the opening of these new politécnicos slightly increased the number of middle schools and students that have the option of a *politécnico* within 0-1 kilometers or 1-2 kilometers.

Still, while 75% of students have a *liceo* within one kilometer of their middle school, only 37% of students have a *politécnico* within one kilometer. Figure 11 suggests that distance is a significant factor in determining enrollment in a *politécnico*. Of all students with a *politécnico* within 1 km of their middle school, 17% enroll in a *politécnico*. This concentration decreases from 9% if the closest *politécnico* is within 1-2 km to 2% once the nearest *politécnico* is 6-7 km away. Figure 12 also suggests that the number of closer *liceos* is related to students' enrollment in a *politécnico*. Of the students whose closest school to their middle school is a *politécnico*, 30% enroll in a *politécnico*, and of those with an alternative of 1 closer *liceo*, 19% of students enroll in a *politécnico*. This proportion decreases to 4% for students with greater than five closer *liceos*.

As presented in Table 1, students are not randomly assigned to *politécnicos* based on their wealth or demonstrated academic achievement, with *politécnicos* made up of wealthier and higher performing students than *liceos*. The skew of the average 8th grade PN quintile for students in *politécnicos* versus *liceos* varies, as the most represented quintiles for students in *politécnicos* are the highest two, while for *liceos*, students are most represented in the two lowest scoring quintiles. As presented in Table A1, both male and female students enrolled in *politécnicos* have higher 8th grade GPAs across Spanish, Math, Social Science, and Natural Science, as well as higher 8th grade PN scores across all four subjects

than male and female students in *liceos*. 6,255 of students are missing the location data of their middle school and thus do not have an associated wealth level. For the rest of the students, the wealth quintile with the highest representation amongst the enrolling classes of *politécnicos* is the third quintile, while the largest proportion for *liceos* comes from the first, or poorest quintile. The poorest quintile is represented in the *liceo* student body at twice the rate of the *politécnico* student body, making up 22% of students in comparison to *politécnicos'* 11%. Overall, the student body is more skewed towards the lowest three wealth quintiles in *liceos* and the middle three quintiles in *politécnicos*.

There is substantial variation between *politécnico* profiles, as well. 42% of *politécnicos* are authorized, while 41% are converting. The remaining *politécnicos* were not classified as either by the Ministry of Education. 38% of *politécnicos* were classified by the Ministry as associated with a religious order, in comparison to 5% of *liceos*, and 19% of *politécnicos* were classified as religious and authorized. *Politécnicos* offer an average of 5.52 concentrations, and of the 34 *politécnico* degrees represented in the panel, Accounting and Finance, Computing, Nursing, and Marketing were the most popular degrees, enrolling 26%, 25%, 10%, and 7% of students, respectively. Accounting and Finance, Nursing, and Marketing are female dominated, with females representing 71%, 88%, and 76% of students in those concentrations. As Amargós (2016) noted, the gender distribution in *politécnico* degrees tends to follow traditional gender differences based on the cultural characteristics of Dominican society, which has the potential to reproduce gender biases of both students' training and their valuation in the labor market.

Beyond differences in the profiles of enrolling students between *politécnicos* and *liceos*, there are also substantial differences in students' academic outcomes. 21% of the students who enrolled in *politécnicos* dropped out before reaching 12th grade and were not reenrolled by 2018, compared to 37% of the students who enrolled in *liceos*. In total, 2% of students who graduated from a *politécnico* took longer than 4 years to graduate, versus 13% of students who graduated from a *liceo*. A larger percentage of students in *politécnicos* than in *liceos* obtained a high enough weighted average of their PN exams and GPA to graduate 12th grade, and a higher percentage of *politécnico* students applied to college. A higher proportion of *politécnico* students who took the POMA passed it, and a higher proportion of *politécnico* students enrolled in college than *liceo* students: 28% versus 20%. As presented in Table A1, *politécnico* students also have higher average 12th grade GPAs and 12th grade PN scores across all four subjects and take less time to reach 12th grade than students in *liceos*. This greater 8th grade and 12th grade score

distribution of *politécnico* students in comparison to *liceo* students, as evidenced in Figures 1-5, persists across gender and wealth levels. As evidenced in Figures 13-16, scaled POMA scores are also skewed towards the higher end of the distribution for *politécnico* students than *liceo* students across gender, wealth levels, and academic achievement. Table A1 demonstrates both males and females in *politécnicos* have higher raw POMA scores across all sections than males and females in *liceos*. These differences in outcomes between students in *politécnicos* and *liceos*, some of which might be expected based on their differential composition, motivates a causal design.

3.3 Methodology

3.3.1. Enrollment Models

I examine the relationship between students' characteristics and their decision to enroll in a *politécnico* using a linear probability model, following a similar strategy to that of Ahn and McEachin (2017). In order to examine observable differences between students who enroll in a *politécnico* over a *liceo*, the empirical specification is:

$$Y_{it} = X_{it}\beta + D_{it}\delta + \alpha_t + \varepsilon_{it} \tag{1}$$

where Y_{it} represents the *politécnico* enrollment choice of individual i at time t ($Y_{it} = 1$) versus a *liceo* ($Y_{it} = 0$). D_{it} represents a vector of 8th grade GPA scores and PN scores in the areas of Spanish, Math, Social Science, and Natural Science. X_{it} represents a vector of student characteristics, including the gender of the student (equaling 1 if the student is a female and 0 if the student is a male), the wealth quintile of the municipality of their middle school, whether they attended a public middle school (equaling 1 if it was public and 0 if it was private), whether the closest school to their middle school is a *politécnico* (equaling 1 if there is one and 0 if there is not), the distance from the student's middle school to the closest *politécnico*, and the distance squared to the nearest *politécnico*. Time α_t fixed effects are included in order to isolate students' enrollment decisions over time, as well as an idiosyncratic student-level error term ε_{it}. In order to account for within-school correlation that would influence both a student's attained education and their decision to enroll in a *politécnico*, I use 8th grade school-level clustered standard errors. Because my dependent variable Y_{it} is binary, I also estimate a logistic regression model

with the same aforementioned specifications. To aid in interpretability, I report coefficients as marginal effects.

While where *politécnicos* are being built might not be exogenous, as they may be built in higher-poverty areas in order to enhance access to education or in higher-resource areas where government officials can lobby for increased educational investment, there is variation not only in the municipality wealth levels of existing *politécnicos* but in the *politécnicos* constructed in 2013 and 2014: one was constructed in a municipality in the lowest wealth quintile, two in municipalities in the second lowest quintile, one in a municipality in the third, two in municipalities in the second highest wealth quintile, and three in the highest wealth quintile. Thus, variation in *politécnico* availability over time conditional on the same poverty level helps separately identify the role of availability interacted with poverty for enrolling students.

Enrollment with Distance Binary Variables

Figure 11 illustrates a clear downward trend in the percentage of students who enroll in *politécnicos* the farther a *politécnico* is from a student's middle school, with the steepest drop off in enrollment from 0-1 kilometers to 1-2 kilometers. To more closely examine the relationship between a middle school's distance to a *politécnico* and a student's decision to enroll, I break down distance into six dummy variables of 0-1 km, 1-2 km, 2-3 km, 3-4 km, 4-5 km, and 5-6 km to the nearest *politécnico*. In order to examine observable differences between students who enroll in a *politécnico* based on how far their middle school is from a *politécnico*, the empirical specification is:

$$Y_{it} = X_{it}\beta + D_{it}\delta + \alpha_t + \varepsilon_{it} \tag{2}$$

where Y_{it} represents the *politécnico* enrollment choice of individual i at time t ($Y_{it} = 1$) versus a *liceo* ($Y_{it} = 0$). D_{it} represents a vector of GPA scores and 8$^{\text{th}}$ grade PN scores in the areas of Spanish, Math, Social Science, and Natural Science. X_{it} represents a vector of student characteristics, including the gender of the student, the wealth quintile of the municipality of their middle school, whether they attended a public middle school, and the six aforementioned dummy variables which take on a value of 1 if a student's middle school is within 0-1 km, 1-2 km, 2-3 km, 3-4 km, 4-5 km, or 5-6 km of the nearest *politécnicos*. Time α_t fixed effects are included to isolate students' enrollment decisions over time, as

well as student-level error term $\varepsilon_{it.}$. In order to account for within-school correlation that would influence both a student's attained education and their decision to enroll in a *politécnico*, I use 8th grade school-level clustered standard errors. As above, because dependent variable Y_{it} is binary, I also estimate a logistic regression model with the same aforementioned specifications. I report coefficients as marginal effects. I also estimate the OLS and logistic regression models a second time for the subset of students who have a *liceo* within 2 kilometers in order to more closely examine the distance determinants of *politécnico* enrollment in light of a nearby alternative.

3.3.2. 2SLS Academic Impacts Model

In order to determine the effects of attending *politécnicos* versus *liceos* on student outcomes, including the years enrolled in high school, probability of high school dropout, standardized 12th grade PN scores, probability of graduating on time, probability of graduation, probability of college application, probability of POMA failure, standardized POMA scores, and probability of enrolling in college, I conduct a two-stage least squares regression analysis. I instrument distance and distance squared from the student's middle school to the nearest *politécnico* to eliminate selection bias in a student's decision to enroll in a *politécnico* due to their distance from the school. My empirical strategy builds off of Card's (1993) analysis, which uses variation in college proximity as an instrumental variable to estimate the returns to schooling.

In my first stage regression, I estimate a regression of a student's decision to enroll in a *politécnico* on distance and distance squared, using these predicted values to perform the second stage regression of a student's enrollment in a *politécnico* on their educational outcomes. Proximity to a *politécnico* can serve as a legitimate instrument, as it represents an exogenous determinant of a student's decision to enroll in a *politécnico*, but it has no direct effect on the aforementioned outcomes. Therefore, following the exogeneity assumption of IV analysis, conditional on a student's characteristics, their distance to a *politécnico* influences their academic outcomes through the student's decision to attend a *politécnico* over a *liceo* (Loyalka et al., 2015). By controlling for sources of endogeneity, such as student covariates (as described in my linear probability analysis) and baseline covariates of a student's middle school that would impact the education they received, the distance IV should be uncorrelated with factors that

would affect the relationship between *politécnico* attendance and student outcomes, and I am thus able to isolate the effect of the *politécnico*. I began with a first stage equation to predict *politécnico* enrollment V_{it} (equaling 1 if a student enrolled and 0 if they did not):

$$V_{it} = D_{it}\beta + Z_{it}\lambda + X_{it}\gamma + \alpha_t + \varepsilon_{it} \tag{3}$$

where X_{it} is a vector of control variables based on the characteristics of the student and the municipality of their middle school: the student's 8th grade GPA and 8th grade PN scores across all four subjects, their gender, the wealth quintile of their municipality, and whether they attended a public middle school. D_{it} is an instrumental variable of distance to the nearest *politécnico*, and Z_{it} is the other instrumental variable of distance squared to the nearest *politécnico*. Time α_t fixed effects are included to isolate students' enrollment decisions over time, as well as student-level error term ε_{it}.

My second stage estimates are given by:

$$Y_{it} = \hat{V}_{it}\delta + X_{it}\eta + \alpha_t + \varepsilon_{it} \tag{4}$$

where Y_{it} is the outcome of the years enrolled in high school, probability of dropout, standardized 12th grade PN scores, probability of on-time graduation, probability of high school graduation, probability of college application, probability of POMA failure, standardized POMA scores, and probability of enrolling in college. X_{it} is the same vector of controls described above, $\hat{V}_{it}$ is the predicted outcome of *politécnico* enrollment from the first stage regression, and ε_{it} is the student level error term. Time α_t fixed effects are included, and I cluster standard errors at the high school level. This method allows me to isolate the effect of vocational school attendance using δ. It also allows me to determine the student-level predictors of 12th grade academic performance using the associated η for the significant covariates in X_{it}.

I limit my analysis to students who stayed within the same school from the time they enrolled to the time they graduated; 50% of students who enrolled in a *politécnico* and 35% of students who enrolled in a *liceo*. However, for the outcome of the years enrolled in high school, I look at the total number of years students were enrolled throughout the time frame of my panel, even if they switched schools, and I cluster errors at the level of the high school they enrolled in. For dropout and high school graduation, I also expand my analysis to all students who enrolled in high school for 9th grade, clustering

errors at the enrolled high school level. For on-time graduation, I exclude students who graduated 8th grade in 2014, since those students have an on-time graduation rate of 100%.

I further this 2SLS analysis, using the same controls as above, for four different profiles of *politécnicos*: authorized, converting, religious, and authorized religious, comparing the impact of each *politécnico* subset over *liceos*. I additionally examine the heterogenous impacts of these *politécnico* profiles on 12th grade standardized Spanish PN scores for specific male and female student profiles by wealth quintile, 8th grade achievement quintile, and public versus private middle school attendance. I further examine the impacts of these *politécnico* profiles on male and female students' 12th grade standardized Spanish PN scores for varying high school profiles by wealth quintile, enrollment quintile, public or private classification, religious order classification, and extended day offering.

3.3.3. Additional Specifications

Effect of *Politécnico* and *Liceo* Profiles on Student Outcomes

In order to make comparisons within the *politécnico* sector and within the *liceo* sector, I break down *politécnicos* based on their authorized status, if they are private or public, offer an extended day, or are run by a religious order, as well as their grade size quintile, wealth quintile, and quintile of the number of degrees they offer to see if these factors significantly impact the 12th grade PN scores of a student already enrolled in a *politécnico*. I do the same for *liceos*, yet only comparing them amongst enrollment and wealth quintiles, as well as if they are private or public, if they are run by a religious order, and if they offer an extended day. I limit this analysis to students who stayed within the same school from the time they enrolled to the time they graduated. It should be specified here that these enrollment and wealth quintiles, calculated separately for just *politécnicos* and just *liceos*, are thus slightly different from the overall wealth and enrollment quintiles used in the 2SLS model for all high schools. My empirical specification for both analyses is:

$$Y_{it} = G_{it}\delta + X_{it}\beta + V_{it}\gamma + \alpha_t + \varepsilon_{it} \tag{5}$$

where Y_{it} is the outcome of standardized 12th grade PN scores, $G_{it}$is the gender of the student, and X_{it} is the vector of controls of student characteristics, including the student's 8th grade PN scores and 8th

grade GPA, as well as the wealth quintile of the municipality of their middle school and whether their middle school was a public school. V_{it} is the vector of high school characteristics of authorized status (equaling 1 if the school is authorized and 0 if not), private (equaling 1 if the school is private and 0 if not), extended day (equaling 1 if the school offers an extended day and 0 if not), religious order (equaling 1 if the school is associated with a religious order and 0 if not), grade size quintile, wealth quintile, and degree quintile for *politécnicos* and private, extended day, and religious order status, as well as wealth quintile and grade size quintile for *liceos*. ε_{it} is the student level error term. Time α_t fixed effects are included, and I use robust standard errors.

3.4 Results

3.4.1. Enrollment

The results of this model for the five cohorts of 8th graders from 2010-2014 are displayed in Table 3. The OLS model indicates that, controlling for all student and municipality level characteristics, for every increase in one kilometer of the distance between the student's middle school and the nearest *politécnico*, the student is 0.9% points less likely to enroll. The positive and significant coefficient of distance squared suggests that the relationship between enrollment and distance is not perfectly linear, as to be expected. If the closest high school to a student is a *politécnico*, they are 19.2% points more likely to enroll, and attending a public middle school increases likelihood of *politécnico* enrollment by 2.6% points. Increases in a student's 8th grade GPA and 8th grade PN across all subjects all increase the likelihood of *politécnico* enrollment. Students from the second and third wealth quintile are more likely to enroll in a *politécnico* than a student from the poorest quintile, and students of later cohorts are all more likely to enroll in *politécnicos* than students from the 2010 cohort.

The logistic regression shows very similar results. An increase in distance to the closest *politécnico* is more of a deterrent to *politécnico* enrollment in the logistic model, decreasing the probability of enrollment by 2.1% points for every additional kilometer. The positive coefficient of distance squared, 0.1%, again pulls up this relationship at the far end of the distribution of a student's distance to the nearest *politécnico*. Having the closest high school to a student's middle school be a *politécnico* increases their odds of enrolling by 8.8% points, and having attended a public middle school increases likelihood

of enrollment by 5.4% points. While the OLS model did not show gender as a significant factor influencing *politécnico* enrollment, the logistic regression model shows females are 0.5% points more likely to enroll than males. Higher GPAs across all subjects except Math, which has a positive yet statistically insignificant relationship, and higher PN scores across all subjects increase the probability a student will enroll in a *politécnico*. Controlling for these academic characteristics, students from the second, third, and fourth socioeconomic quintiles are 1.3%, 1.3%, and 0.3% points more likely to enroll than students from the poorest quintile. However, students from the wealthiest quintile are 2.7% points less likely to enroll than students from the poorest. Similar to the OLS model, students of later cohorts are all more likely to enroll in *politécnicos* than students from the 2010 cohort.

Enrollment with Distance Binary Variables

As reported in Table 4, both the OLS and logistic regression models demonstrate a decreased likelihood in *politécnico* enrollment as distance increases; beyond 2-3 km, the OLS model shows a statistically insignificant relationship between the distance dummy variables and *politécnico* enrollment. The magnitudes of the impact of distance on enrollment are larger for the logistic regression model. The logistic model indicates that having a *politécnico* within one kilometer of the student's middle school increases their likelihood of enrollment by 16.7% points, with this impact declining as the closest *politécnico* is farther away: 9.8% points for 1-2 km, 7.3% for 2-3 km, 9.0% for 3-4 km, and 4.6% for 4-5 km. When the closest *politécnico* is 5-6 km away, the impact becomes negative and students' likelihood of enrollment decreases by 1.5% points. Table 4 further reports the probability of *politécnico* enrollment if students have a *liceo* within 2 kilometers of their middle school. Again, the outcomes of the OLS and logistic models are similar, with the OLS showing no significant relationship beyond 2-3 km, and the logistic displaying larger magnitudes. The magnitudes of the dummy distance variables for the logistic model when a *liceo* is within 2 kilometers are slightly smaller than in the previous logistic model, indicating that having an alternative of a *liceo* close by weakens the chances a student will enroll in a *politécnico*, and as the nearest *politécnico* becomes further away, students are less likely to enroll in light of their nearby option of a *liceo*.

3.4.2. Dropout, Years of Schooling, and Graduation

Table A2 in the Appendix presents the reduced form of the impact of *politécnicos* on a student's dropout rate, on-time graduation rate, probability of graduation, and the years of high school attendance, controlling for the gender of the student, their 8th grade GPA, their 8th grade standardized test scores, whether they attended a public school or not, and their wealth quintile. The logistic model estimates students who enroll in a *politécnico* over a *liceo* are 6% points less likely to drop out, 1.5% points more likely to graduate on time, 5.8% points more likely to graduate, and the OLS model predicts 0.218 more years of high school education for *politécnico* students.

The 2SLS results presented in Table 5 indicate that this strategy yields an upwardly-biased estimate of the impacts of enrolling in a *politécnico* on a student's probability of dropout, total years of high school, and graduation rate. The IV results show a positive but statistically insignificant impact of enrolling in a *politécnico* on a student's years of high school attendance and probability of high school graduation, and a negative but statistically insignificant impact on a student's probability of dropping out of high school. It should be restated here that these analyses, unlike subsequent ones, were not limited to students who stayed at the same school for all four years – only students who enrolled in and attended a *politécnico* for their 9th grade year, in order to account for subsequent exiting from the school system. Thus, due to the frequency of students switching out of or into schools, the impact of attending a *politécnico* for at least one year could be distorted.

Table 5 shows a larger impact than the reduced form of *politécnicos* on on-time graduation, with *politécnicos* increasing the probability of a student graduating in 4 or fewer years by 4.5% points. As presented in Table 6, the magnitude of this increased likelihood of on-time graduation is larger for authorized *politécnicos* at 6.0% points, as well as for *politécnicos* associated with a religious order at 5.7% points. The coefficients for converting *politécnicos* and authorized religious *politécnicos* are positive but statistically insignificant.

3.4.3. Prueba Nacional Scores

Table A3 in the Appendix presents the reduced form of the impact of *politécnicos* on a student's educational outcomes controlling for the gender of the student, their 8th grade GPA and PN scores, their

wealth quintile, and whether they attended a public school in 8th grade, estimating increases of 0.250 standard deviations for a student's 12th grade Spanish PN score, 0.204 standard deviations for Math, 0.206 standard deviations for Social Science, and 0.149 standard deviations for Natural Science. The IV results presented in Table 7 suggest that this OLS estimation strategy yields a downward-biased estimate of the impact of *politécnicos* on a student's 12th grade PN scores, showing statistically significant increases in scores across Spanish, Social Science, and Natural Science of 0.367, 0.224, and 0.244 standard deviations respectively, and a positive but statistically insignificant increase in Math scores of 0.218 standard deviations. The IV estimators for the impact of a *politécnico* are 46.8% greater for Spanish than the uncorrected OLS estimate, 8.7% greater for Social Science, and 63.8% greater for Natural Science. This understatement of the impacts of *politécnicos* suggests those students selecting into *politécnicos* are unobservably academically "worse" than other students beyond their scores and wealth levels of their middle schools, aligning with Card's (1994) finding that instrumental variable estimates that affect the schooling choices of children from relatively disadvantaged backgrounds, such as college proximity, will often exceed corresponding OLS estimates.

Beyond *politécnico* attendance, Table 7 also shows significant increases to a student's score based on their middle school wealth quintile, with higher wealth quintiles associated with an advantage over lower wealth quintiles. Higher 8th grade PN scores across all subjects are also associated with higher standardized 12th grade PN scores across all subjects, and the majority of higher 8th grade GPAs are associated with higher 12th grade scores, yet these magnitudes are much smaller in comparison to wealth quintile and *politécnico* attendance. Further, despite controlling for all academic factors and wealth quintiles, being a female is associated with a negative impact on 12th grade standardized scores, by as much as -0.158 standard deviations in Math, illustrating perhaps a deficiency in secondary education in preserving the relative gains females made in middle school.

Table 8 illustrates the impacts of various *politécnico* profiles - authorized, converting, religious, and authorized religious - on standardized 12th grade PN scores. Table 8 shows authorized *politécnicos* boost Spanish scores by 0.505 standardized deviations, religious *politécnicos* by 0.541 standard deviations, and authorized religious *politécnicos* by 0.676 standard deviations. A similar pattern is observed in Math scores. Unlike *politécnicos* overall, authorized *politécnicos*, religious *politécnicos*, and authorized religious *politécnicos* have significant and positive impacts on Math scores of 0.401, 0.469, and 0.623

standard deviations, respectively. For Natural Science, authorized *politécnicos*, religious *politécnicos*, and authorized religious *politécnicos* have significant and positive impacts on scores, increasing in magnitude: 0.432, 0.469, and 0.625 standard deviations, respectively. For Social Science, authorized *politécnicos* and religious *politécnicos* have positive impacts of 0.369 and 0.382 standard deviations. Converting *politécnicos* have a positive but statistically insignificant impact over *liceos* on standardized scores across all subjects. It should be reemphasized here that while the same level of difficulty is preserved, the Math, Natural Science, and Social Science sections differ by 5 questions between *politécnico* and *liceo* students; going forward in this analysis, therefore, only Spanish scores will be analyzed.

Table 9 reports the impact of *politécnico* profiles – all *politécnicos*, authorized *politécnicos*, converting *politécnicos*, religious *politécnicos*, and authorized religious *politécnicos* – on standardized 12th grade Spanish PN scores for differing student profiles, segmenting students by gender, wealth quintile, 8th grade academic achievement, and if they attended a public or private school in 8th grade. Each cell represents the coefficient of *politécnico* attendance for a single 2SLS regression as specified above, using different subsets of the data corresponding to the student's and school's profile. For *politécnicos* overall, males receive a bigger boost in their standardized 12th grade Spanish PN scores than females: 0.507 versus 0.280 standard deviations. This gender disparity persists for authorized *politécnicos*, converting *politécnicos*, religious *politécnicos*, and authorized religious *politécnicos*. Authorized religious *politécnicos* have the largest impact on males and females, as well as the largest gender disparity amongst all *politécnico* profiles, with impacts on 12th grade Spanish PN scores of 0.998 standard deviations for males and 0.485 standard deviations for females. Religious *politécnicos* have the second largest impact, followed by authorized *politécnicos*. Unlike the other *politécnico* profiles, converting *politécnicos* have a statistically insignificant impact over *liceos* on the Spanish scores of females. Converting *politécnicos* have a larger impact on males than *politécnicos* overall, boosting their Spanish scores by 0.663 standard deviations.

These gender differences are even more pronounced when segmenting students by wealth quintiles. Students from the lowest three wealth quintiles receive an increase in Spanish scores over a *liceo* of 0.477 standard deviations for *politécnicos* overall, with males receiving a boost of 0.694 standard deviations, versus 0.341 for females. Students from the two highest wealth quintiles receive an increase in scores 51% greater than students from the three lowest quintiles for *politécnicos* overall. The gap between males and females is smaller for these wealthier students, with males receiving a boost of 0.820

standard deviations, and females 0.661 standard deviations. However, these differences by wealth quintile differ for other profiles of *politécnicos*. Authorized *politécnicos*, religious *politécnicos*, and authorized religious *politécnicos* have larger impacts on males from lower wealth quintiles than males from higher wealth quintiles, with authorized *politécnicos* boosting scores by 1.002 standard deviations for males of low wealth quintiles versus 0.890 standard deviations for males of high wealth quintiles, religious *politécnicos* 1.136 standard deviations versus 0.753, and authorized religious *politécnicos* 1.467 standard deviations versus 1.335. These more magnified impacts on students from the lowest three wealth quintiles suggest these *politécnicos* potentially address inequalities by socioeconomic status in the educational system. Authorized religious *politécnicos* have the most magnified impacts on males and females in both low and high wealth quintiles. Religious *politécnicos* have the second largest impact for students in the lowest wealth quintiles, followed by authorized *politécnicos*, and authorized *politécnicos* have the second largest impacts on students in the highest wealth quintiles, followed by religious *politécnicos*. Converting *politécnicos* have no significant impacts on students from the wealthiest quintiles, but have larger impacts on males and females of lower wealth quintiles than *politécnicos* overall, boosting their scores by 0.986 and 0.391 standard deviations, respectively.

Table 9 also examines the impact of *politécnico* profiles on standardized 12th grade Spanish PN scores for lowest scoring students, indicated by their 8th grade Spanish PN score being in the lowest two quintiles, and highest scoring students, indicated by their 8th grade Spanish PN score being in the highest two quintiles. For *politécnicos* overall, lowest scoring students receive a slightly larger boost in their scores in comparison to students overall as indicated in Table 7, yet smaller than highest scoring students: 0.371 versus 0.381 standard deviations. The lowest scoring males receive a larger boost than the highest scoring males, however: 0.593 standard deviations in comparison to 0.465. Lowest scoring females do not receive any statistically significant boost from *politécnicos*, although highest scoring females receive a boost of 0.337 standard deviations. For the other *politécnico* profiles, lowest scoring females do not receive any significant increase in scores over the lowest scoring females in *liceos*. For authorized *politécnicos*, religious *politécnicos*, and authorized religious *politécnicos*, however, lowest scoring males receive a significant boost in standardized 12th grade Spanish PN scores and a markedly larger one than highest scoring males: 0.948 versus 0.605 standard deviations for authorized *politécnicos*, 1.181 standard deviations versus 0.576 for religious *politécnicos*, and 1.645 versus 0.727 standard deviations for

authorized religious *politécnicos*. These more magnified impacts for lower scoring students suggest these *politécnicos* potentially address academic achievement inequalities. Converting *politécnicos* have no significant impacts for highest scoring students.

Lastly, Table 9 reports the impact of *politécnico* profiles on students who attended private middle schools and public middle schools. None of the *politécnico* profiles have a significant impact over *liceos* on students who attended private middle schools. *Politécnicos* overall boost the scores of students who attended a public middle school by 0.343 standard deviations over students enrolled in *liceos* who attended a public middle school, with more magnified impacts of 0.481 standard deviations for males and 0.256 standard deviations for females. Authorized religious *politécnicos* have the most magnified impacts on males and females who attended public middle school, boosting males' scores by 0.953 standard deviations and females' scores by 0.418 standard deviations. Religious *politécnicos* have the second largest impact for students who attended public middle school, followed by authorized *politécnicos*.

Table 10 illustrates the impact of the five aforementioned *politécnico* profiles on standardized 12th grade Spanish PN scores for differing high school profiles, segmenting schools by wealth quintile, grade size quintile, religious order classification, extended day offering, and classification as public or private. Each cell represents the coefficient of *politécnico* attendance for a single 2SLS regression as specified above, using different subsets of the data corresponding to the high school's profile. Because location data is not available for some *politécnicos* and *liceos*, this subset of data is more constrained on the socioeconomic level: 58 *politécnicos* and 615 *liceos* located in the lowest three wealth quintiles, and 102 *politécnicos* and 838 *liceos* located in the highest two wealth quintiles. For all aforementioned school specifications, converting *politécnicos* have no significant impact on students' outcomes, except converting public *politécnicos* boost male students' scores by 0.490 over public *liceos*, and converting *politécnicos* that offer an extended day boost male students' scores by 0.368 standard deviations over males who attend a *liceo* that offers an extended day.

Students attending *politécnicos* located in one of the three lowest high school wealth quintiles see an increase in their Spanish scores of 0.313 standard deviations over students attending *liceos* located in the lowest three high school wealth quintiles. Males specifically receive an increase of 0.388 standard deviations, and females 0.259 standard deviations. Authorized *politécnicos* in one of the three lowest wealth quintiles boost their students' scores by 0.477 standard deviations over *liceos* in the three lowest

wealth quintiles, with more magnified effects for males and no significant impact for females, and religious *politécnicos* boost their students' scores by 0.526 standard deviations, with larger impacts of 0.661 standard deviations for males and 0.437 for females. Authorized religious *politécnicos* in the lowest three wealth quintiles boost males' scores by 0.825 standard deviations, with no significant impact on females' scores.

Politécnicos located in the highest two highest high school wealth quintiles have more magnified impacts over *liceos* located in the two highest high school wealth quintiles. *Politécnicos* overall in the highest two wealth quintiles boost students' scores by 0.405 standard deviations, authorized *politécnicos* by 0.477 standard deviations, religious *politécnicos* by 0.466 standard deviations, and authorized religious *politécnicos* by 0.670 standard deviations. Only *politécnicos* overall and authorized *politécnicos* located in the highest two wealth quintiles have a significant impact on females' scores: 0.275 standard deviations and 0.325 standard deviations, respectively. *Politécnicos* overall located in the highest two wealth quintiles boost males' scores by 0.639 standard deviations, authorized *politécnicos* by 0.745 standard deviations, religious *politécnicos* by 0.717 standard deviations, and authorized religious *politécnicos* by 1.056 standard deviations.

In comparing schools of the lowest three quintiles in enrollment, students attending *politécnicos* see a significant increase over *liceos* in their Spanish scores: 0.259 standard deviations overall, with an increase of 0.350 standard deviations for males and no significant boost for females. Authorized *politécnicos* in the lowest three quintiles of enrollment boost males' scores by 0.467 standard deviations, and religious *politécnicos* boost males' scores by 0.438 standard deviations. *Politécnicos* across all profiles with enrollment in the highest two quintiles boost students' scores over *liceos* with enrollment in the highest two quintiles: 0.574 standard deviations for *politécnicos* overall, 0.756 for authorized *politécnicos*, 0.950 for religious *politécnicos*, and 1.048 for authorized religious *politécnicos*. These impacts are more magnified for males: 0.780, 1.045, 1.312, and 1.503 standard deviations, respectively, and smaller for females: 0.451, 0.587, 0.741, and 0.793 standard deviations. No private *politécnicos* across all profiles are associated with a significant boost in students' scores over private *liceos*; however, as shown in Table A4 in the Appendix, public *politécnicos* boost students' Spanish scores over private *liceos* by 0.295 standard deviations. Public *politécnicos* across all profiles boost students' scores over public *liceos*: 0.326 standard deviations for *politécnicos* overall, 0.450 for authorized *politécnicos*, 0.510 for religious

politécnicos, and 0.586 for authorized religious *politécnicos*. These impacts again are more magnified for males: 0.454, 0.659, 0.737, and 0.900 standard deviations, respectively. Only public *politécnicos* overall, authorized *politécnicos*, and religious *politécnicos* have a significant impact on females' scores over public *liceos*: 0.247, 0.325, and 0.376 standard deviations.

All *politécnico* profiles that offer an extended day boost students' scores over *liceos* that offer an extended day: 0.290 standard deviations for *politécnicos* overall, 0.416 for authorized *politécnicos*, 0.437 for religious *politécnicos*, and 0.554 for authorized religious *politécnicos*. These impacts again are more magnified for males – 0.362, 0.518, 0.532, and 0.699 standard deviations, respectively – and smaller for females: 0.246, 0.354, 0.380, and 0.469, respectively. The two *politécnico* profiles that are associated with a religious order also boost students' scores over *liceos* associated with a religious order. Religious *politécnicos* boost students' scores by 0.524 standard deviations, with 0.731 standard deviations for males and 0.398 standard deviations for females. Authorized religious *politécnicos* have more magnified impacts: 0.655 for all students, 0.966 for males, and 0.471 for females.

Effect of *Politécnico* and *Liceo* Profiles on Student Outcomes

Table 11 reports the impact of various *politécnico* profiles on 12th grade standardized PN scores. When *politécnicos* are compared amongst themselves, segmented by authorized status, private classification, religious order association, extended day classification, as well as wealth quintiles, grade size quintiles, and degrees offered quintiles, certain *politécnico* profiles outperform others. Authorized status is only associated with higher standardized Natural Science scores, and private classification is associated only with higher standardized Spanish scores. Being run by a religious order is associated with higher scores across all subjects: 0.140 standard deviations for Spanish, 0.292 standard deviations for Math, 0.189 standard deviations for Social Science, and 0.176 standard deviations for Natural Science. *Politécnicos* that offer an extended day also outperform *politécnicos* that do not, associated with an increase of 0.182 standard deviations for Spanish, 0.160 for Math, 0.115 for Social Science, and 0.088 for Natural Science. I find *politécnicos* in the highest quintile of degrees are associated with an increase in students' Spanish scores over *politécnicos* in the lowest quintile of degrees, yet no other degree quintiles are associated with significant impacts in other subjects.

Somewhat surprisingly, *politécnicos* of higher wealth quintiles underperform *politécnicos* of the lowest wealth quintile. *Politécnicos* in the second wealth quintile are associated with a decrease in

students' Math scores by 0.235 standard deviations over *politécnicos* in the poorest wealth quintile, a decrease of 0.208 standard deviations in the third, a decrease of 0.179 standard deviations in the fourth, and a decrease of 0.169 standard deviations in the fifth. Higher wealth quintiles are not associated with any other significant impacts over the poorest quintile on scores in other subjects, except *politécnicos* in the second quintile are associated with a decrease of 0.180 standard deviations in Social Science over *politécnicos* in the poorest quintile, and *politécnicos* in the third are associated with a decrease of 0.110 standard deviations in Social Science over *politécnicos* in the poorest. For grade size quintiles, higher quintiles outperform the lowest quintile across all subjects. *Politécnicos* in the largest quintile of enrollment outperform the lowest quintile by 0.311 standard deviations for Spanish, 0.125 standard deviations for Math, 0.175 standard deviations for Social Science, and 0.105 standard deviations for Natural Science. *Politécnicos* in the second largest quintile of enrollment outperform the lowest quintile by 0.114 standard deviations for Math, 0.099 standard deviations for Social Science, and 0.126 standard deviations for Natural Science. Lastly, *politécnicos* in the third quintile of enrollment outperform the lowest quintile by 0.200 standard deviations for Math, 0.103 standard deviations for Social Science, and 0.124 standard deviations for Natural Science.

By controlling for the characteristics of *politécnicos* and students' academic and middle school characteristics, I isolate how females fare in comparison to males in *politécnicos*. The scores of females in comparison to males differ the least in Spanish with a -0.087 standard deviation differential. The score differences are more pronounced for Math, Social Science, and Natural Science with values of -0.205, -0.203, and -0.167 standard deviations, respectively.

Table 12 reports the impact of various *liceo* profiles on standardized 12^{th} grade PN scores. Like *politécnicos*, when *liceos* are compared amongst themselves, segmented by private classification, religious order association, extended day classification, and wealth and grade size quintiles, certain *liceo* profiles outperform others, yet sometimes in different ways than *politécnico* profiles. Unlike *politécnicos*, private *liceos* outperform public *liceos* in Spanish, Math, and Social Science. Similarly to *politécnicos*, *liceos* associated with a religious order and *liceos* offering an extended day also universally outperform *liceos* without those classifications across all subjects, highlighting the significance of co-management and greater instructional hours.

While some *politécnicos* located in wealthier quintiles underperform *politécnicos* located in the poorest quintile, *liceos* of the wealthiest quintile universally outperform *liceos* of the poorest quintile and of a much larger magnitude. Though the finding that *politécnicos* in high wealth quintiles exhibit a larger increase in scores over *liceos* in high wealth quintiles yet some *politécnicos* in high wealth quintiles underperform *politécnicos* in low wealth quintiles and some *liceos* in high wealth quintiles outperform *liceos* in low wealth quintiles seems initially incongruous, this finding can partially be explained by the slightly different wealth quintile segmentation for the overall comparison versus the within sector comparison, as well as the greater relative significance of enrollment in differentiating *politécnico* performance, as higher enrolling *politécnicos* are more concentrated in wealthier areas. Students enrolled in a *liceo* of the wealthiest quintile are associated with an increase in scores over students enrolled in a *liceo* of the poorest quintile across Spanish, Math, Social Science, and Natural Science of 0.035, 0.217, 0.208, and 0.299 standard deviations, respectively. *Liceos* with higher enrollment are also associated with higher scores than *liceos* in the lowest quintile of enrollment, across the third and fourth quintiles for all subjects, the second for all subjects except Spanish, and the fifth for all subjects except Social Science. The magnitude of the association between higher enrollment quintiles and scores in *liceos* is smaller than that of *politécnicos* across all subjects, perhaps indicating that enrollment size is more significantly correlated with academic performance in *politécnicos* than *liceos*.

Further, the difference in scores between females and males is less pronounced for *liceos* than *politécnicos*. Like *politécnicos*, the scores of females in comparison to males differ the least in Spanish with a -0.064 standard deviation differential. The score differences are larger for Math, Social Science, and Natural Science with values of -0.154, -0.168, and -0.123 standard deviations, respectively. While the differential between males and females is largest in *politécnicos* for Math, the differential is largest for *liceos* in Social Science.

3.4.4. POMA Scores and College Enrollment

The IV results presented in Table 13 show *politécnicos* boost students' probability of applying to college by 5.4% points, reduce their probability of failing the POMA by 10.1% points, and boost their

total standardized POMA score by 0.294 standard deviations. *Politécnicos* also have a positive but statistically insignificant impact on students' likelihood of enrolling in college.

For probability of college application, being a female is associated with a 4.3% point greater likelihood of applying to college, as are higher 8th grade GPAs across all subjects and 8th grade PN scores in Spanish and Social Science. Attending a public school in 8th grade is associated with a 3.7% point decrease in likelihood of college application, and higher 8th grade PN Math scores are also associated with a reduced likelihood of college application. Lastly, students from the second highest wealth quintile are associated with a 1.9% point increase in probability of application over the lowest wealth quintile, and the third highest wealth quintile a 1.6% point increase. As shown in Table 15, other *politécnico* profiles are associated with a positive impact on the probability of college application, yet these impacts are not significant, except for religious *politécnicos*. Religious *politécnicos* boost students' probability of college application by 7.5% points over *liceos*.

While females are more likely to take the POMA, they are also more likely to fail the POMA, associated with a 6.8% point higher likelihood of failing than males when controlling for all academic characteristics. Higher 8th grade GPAs in Spanish and Math, as well as higher 8th grade PN scores in Spanish and Social Science are also associated with decreased likelihood of failing the POMA. Additionally, all wealth quintiles are associated with a decreased likelihood of POMA failure over the lowest quintile. As presented in Table 15, authorized *politécnicos* and religious *politécnicos* have more magnified impacts on the decreased likelihood of POMA failure: 11.6% points, and 12.2% points, respectively. Converting *politécnicos* and authorized religious *politécnicos* also have negative yet statistically insignificant impacts. Because passing the POMA is often a prerequisite to college admission, these results indicate *politécnicos* may increase the likelihood of college admission, as well.

The gender penalty is large and significant for standardized total POMA scores. The main effect of being female is associated with a decrease of 0.270 standard deviations, almost as large as the magnitude of the *politécnicos'* impact. Having attended a public middle school is also associated with a decrease of 0.145 standard deviations, while higher 8h grade GPAs in Spanish and Math, as well as higher 8th grade PN scores across all subjects, are associated with an increase in POMA scores. Further, the third, fourth, and fifth wealth quintiles are associated with higher standardized POMA scores over the lowest wealth quintile. Certain *politécnico* profiles have more magnified impacts on total standardized

POMA scores, as evidenced in Table 15. Authorized *politécnicos* boost students' total POMA scores by 0.386 standard deviations over *liceos*, religious *politécnicos* by 0.367 standard deviations, and authorized religious *politécnicos* by 0.477 standard deviations. Converting *politécnicos* have a positive but statistically insignificant impact.

Table 14 presents the impact of *politécnicos* on the six POMA subscores of Verbal, Math, Perceptive Structures, Natural Science, Social Science, and Human Behavior. *Politécnicos* have a significant impact on Verbal, Math, and Social Science scores, boosting them by 0.278, 0.377, and 0.208 standard deviations, respectively. Table 14 also demonstrates a sizeable gender penalty for females across all subscores, for as large as 0.276 standard deviations in Math. Having attended a public middle school is also associated with a decrease in scores across all subscores, by as much as 0.176 standard deviations for Verbal. Higher 8^{th} grade PN scores and higher 8^{th} grade GPAs are associated with higher POMA subscores, as are higher wealth quintiles. Table 15 presents the impact of various *politécnico* profiles on the three significant POMA subscores. Authorized *politécnicos* and religious *politécnicos* boost students' Verbal scores over *liceos* by 0.321 and 0.324 standard deviations, while converting *politécnicos* and authorized religious *politécnicos* are associated with positive but statistically insignificant impacts. Authorized *politécnicos* boost students' Math scores by 0.539 standard deviations, converting *politécnicos* by 0.675, religious *politécnicos* by 0.473, and authorized religious *politécnicos* by 0.679. Lastly, authorized *politécnicos* and religious *politécnicos* have more magnified impacts over *liceos* on students' Social Science POMA scores - 0.291 and 0.318 standard deviations– while converting *politécnicos* and authorized religious *politécnicos* have positive but statistically insignificant impacts.

3.5 Discussion

My findings are in line with policymakers' increased emphasis on *politécnicos*, as *politécnicos* significantly boost students' 12^{th} grade standardized test scores, increase students' probability of on-time graduation and college application, reduce students' probability of failing college admissions tests, and boost students' standardized college admissions test scores.

Politécnicos overall increase students' 12^{th} grade standardized test scores by almost 0.4 standard deviations in Spanish, with these differences even more marked for certain student and school profiles.

Beyond enrolling higher scoring students, *politécnicos* are more also more likely to enroll females; some *politécnicos* are associated with historically feminized professions and enroll high fractions of women, which may explain higher female enrollment in *politécnicos* on average. Females are universally significantly and positively impacted by *politécnicos* over *liceos* for all aforementioned outcomes, albeit by lesser magnitudes than males. These academic impacts are significant, as increases in female education boost average GDP, annual GDP growth rates, and wages later in life. If previous estimates hold in this context, these positive benefits are passed down to the next generation, as for each additional year of a mother's education, the average child attains an extra 0.32 years of schooling (Bourne, 2014) - a ripple effect that could help feed greater increases in educational attainment for the Dominican Republic's population.

Further, while converting *politécnicos* do not exhibit significant impacts over *liceos*, authorized *politécnicos*, religious *politécnicos*, and authorized religious *politécnicos* all exhibit more magnified impacts, with some results even suggesting reductions in inequality. Religious, authorized, and authorized religious *politécnicos*, for example, boost males' Spanish scores from the lowest wealth quintiles more than males from the highest wealth quintiles, and have more magnified impacts on lowest scoring males than highest scoring males.

Politécnicos located in the highest two wealth quintiles outperform *liceos* of those quintiles by a larger magnitude than the lowest three quintiles. Further, *politécnicos* with higher enrollment outperform high enrollment *liceos* by a larger magnitude than those in the lower three quintiles of enrollment. *Politécnicos* associated with a religious order also have a large impact over *liceos* associated with a religious order, boosting males' Spanish scores by up to 1 standard deviation. While a higher percentage of *politécnicos* offer an extended day than *liceos* – 72% in comparison to 18% of *liceos* - they also universally outperform *liceos* that offer an extended day, boosting students' scores by up to 0.6 standard deviations for authorized religious *politécnicos*. In comparisons within the *politécnico* sector, I find that being associated with a religious order and offering an extended day are associated with large increases in test scores across all four subjects, as is being in the highest quintile of enrollment.

Politécnicos achieve these academic successes while increasing the likelihood students graduate in 4 or fewer years and increasing students' probability of applying to college and passing the college admissions exam, the POMA. This increased likelihood of passing the POMA suggests *politécnico*

students are perhaps more likely to be admitted to college, as well, as passing the POMA is one of a few requirements for college admission. *Politécnicos* exhibit impacts on students' POMA scores of similar magnitudes to their impacts on students' 12^{th} grade PN scores, with larger impacts for certain profiles of *politécnicos* and subscores. For example, authorized religious *politécnicos* boost students' POMA Math scores by 0.7 standard deviations, and religious *politécnicos* boost POMA Verbal scores by 0.3 standard deviations.

These academic impacts are on par with analysis of the most successful charter schools' returns – a notable feat, as *politécnicos* are not entirely academically focused and additionally equip their students with a vocational skill they can transfer to the job market. In order to determine what is driving the success of *politécnicos*, I travelled to the Dominican Republic to supplement my analysis with qualitative fieldwork. My preliminary hypothesis centered around five dimensions – management, curriculum, teachers and hiring practices, school climate, and student body composition – for which I will review the relevant academic literature for in the next section.

3.5.1. Inputs to Education Literature Review

As mentioned, public *politécnicos* are given quite a degree of autonomy, and, while they receive funding and oversight from the Ministry, many are managed by a private group, such as those associated with a religious order. Bloom et al. (2014) find higher management quality, as observed in four broad dimensions of operations, monitoring, target setting, and people management, is strongly associated with better standardized test scores; specifically, autonomous government schools like *politécnicos* have significantly higher management scores than regular government schools and private schools. Bloom et al. (2014) find half of the difference between the management scores of these autonomous government schools and of regular government schools is accounted for by differences in leadership of the principal and better governance. Eskeland and Filmer (2007) further find a positive relation between school autonomy in management and student test scores in Argentina.

Politécnicos deliver their curriculum differently, emphasizing group and project-based work. Group work, which allows for students to practice critical-thinking, communication, and problem solving-skills, has been shown to result in positive academic outcomes for students, ranging from enhanced

self-esteem to higher grades to greater knowledge retention and problem-solving abilities (Slavin, 1991; Preszler, 2009; Freeman et al., 2014; Johnson et al., 2014). In their study of drivers of student performance in Latin America, Chaia et al. (2017) find students who received a blend of inquiry-based learning, where students play an active role and engage in experiments, and teacher directed instruction, where the teacher explains and demonstrates concepts before opening the class up to discussion, had the best student outcomes. If all students experienced this blend, Chaia et al. (2017) predict average PISA scores in Latin America would rise by 19 points, the equivalent of over half a school year of learning. An additional differentiator between *politécnicos* and *liceos* is their number of instructional hours. As evidenced in my data, 72% of *politécnicos* are classified as offering an extended day, versus 18% of *liceos*. Chaia et al. (2017) find increasing the school day in Latin America improves outcomes; across Latin America, PISA science outcomes increase 3.7% for every 30 minutes of additional daily classroom instruction.

Additionally, teacher hiring and retention practices differ between *politécnicos* and *liceos*, as some *politécnicos* have greater freedom to hire and dismiss teachers. Fuchs and Woessman (2007) and Woessman et al. (2009) find students perform significantly better in schools that have autonomy in personnel decisions, including hiring and firing teachers and methods of instruction. Robin and Sprietsma (2003) and Naper (2010) also find autonomy in teacher hiring heightens school effectiveness. Additionally, *politécnico* teachers have more professional experience as technicians, which may be correlated with greater quality. Research suggests that teacher quality is the most impactful school input affecting students' academic performance, with teachers estimated to have two to three times the impact of any other educational input, including facilities, services, and leadership (Opper, 2019). High-quality teachers greatly enhance students' educational outcomes, from college attendance to lifetime earnings (Chetty et al., 2014). Lastly, due to the *politécnicos'* need to instruct students in general academic subjects as well as a technical concentration, there is a high level of instructional collaboration in order to ensure coherent and coordinated delivery of all academic subjects. Collaboration among teachers has been found to boost teaching effectiveness (Graham, 2007), and instructional quality (Jackson and Bruegmann, 2009; Hochweber et al., 2012), positively impacting student achievement (Lee and Smith, 1996; Borko, 2004; Louis et al., 2010; Dumay et al., 2013, Goddard et al., 2010).

Further, the association of many *politécnicos* with a religious order may influence school climate and classroom discipline. School climate encompasses the unwritten atmosphere and characteristics of a school, including its values, norms, goals, teaching and learning practices, and relationships among students and teachers (National School Climate Council, 2007). In their review of 206 studies on school climate, Thapa et al. (2013) find the body of research continuously attests to school climate's importance and impact on social, emotional, intellectual, and physical safety, positive mental health and development, healthy relationships, higher graduation rates, higher academic achievement, and higher teacher retention. Additional research has shown in schools where students perceive better structure, fair discipline, and more positive student-teacher relationships, the probability and frequency of behavioral problems is lower and performance is enhanced on writing and numeracy tests (Gregory and Cornell, 2009; Wang et al., 2010; Maxwell et al., 2017). Consistent enforcement of school rules and the availability of caring adults has been classified in academic literature as "structure and support" (Gregory et al., 2010); structure and support has been linked to lower suspension rates (Gregory et al., 2011) and marked improvements in students' test scores (Fonagy et al., 2005).

Lastly, it is evident from the data that *politécnicos* differ in student body composition, made up of a higher percentage of high-scoring students and females than the *liceo* student body. Lavy and Schlosser (2007) find a higher proportion of female peers lowers the level of classroom disruption and violence, improves inter-student and student-teacher relationships, increases students' overall satisfaction in school, and lessens teachers' fatigue. Peer effects have a powerful influence on students' achievement; Hoxby (2000) finds an exogenous change of 1 point in peers' reading scores raises a student's own score between 0.15 and 0.4 points, and both males and females perform better in math in classrooms that are more female. Additionally, those who seek out and select into *politécnicos* may be more motivated than their *liceo* counterparts. Chaia et al. (2017) finds student mindsets have almost double the predictive power of socioeconomic background on student PISA scores in Latin America. Students with "good motivation calibration" scored 14% higher on the science test than poorly calibrated ones, controlling for socioeconomic status, location, and type of school. Particularly in poorly performing schools, students in the lowest socioeconomic quartile with high motivation performed better than those in the highest socioeconomic quartile with low motivation (Chaia et al., 2017). Thus, having a high level of

intrinsic motivation has the ability to not only boost the student's performance, but also the performance of their peers through positive peer effects.

3.5.2. Fieldwork Findings

In order to understand the measures and academic inputs that are driving *politécnicos'* success, I conducted fieldwork within Santo Domingo in the Dominican Republic. I visited and interviewed principals, teachers, and adult students at five schools – private high-income, high-enrollment, high-achieving *liceo* A; private middle-income, low-enrollment, high-achieving religious *politécnico* B; public low-income, middle-enrollment, high-achieving religious *politécnico* C; public middle-income, high-enrollment, high-achieving religious *politécnico* D; and public low-income, high-enrollment, low-achieving *politécnico* E. I selected these schools based on their students' average performance on the *Pruebas Nacionales* and on their socioeconomic, enrollment, and public/private diversity. As appended in Section 9.2, I developed different surveys for directors and teachers based off of the principal and teacher questionnaires for the Schools and Staffing Survey and designed a survey for students based off of the student questionnaire for the US High School Longitudinal Study. I asked directors about the profiles of their students, the organization of their school and its day-to-day operations, educational content and classroom strategies, and their students' post-graduation plans. I surveyed teachers about their classroom composition and strategies, their attitudes towards teaching and their future career, the engagement of their students, and the professional development and support they received. I asked 18-year-old students about their reasons for enrolling, their academic day-to-day, what distinguishes a *politécnico* education from a *liceo* education, their self-perceptions, and their vision for their post-graduation plans.

I conducted 32 total interviews and 8 total classroom observations in 5 schools. At school A, I interviewed the school's academic counselor; at school B, I interviewed the director of the high school, the academic coordinator, four teachers and fifteen students, and observed two classrooms; at school C, I interviewed the subdirector and three teachers, and observed two classrooms; at school D, I interviewed the vice chancellor, the director of the high school and two teachers, and observed two classrooms; at school E, I interviewed the academic coordinator, one student, and observed two classrooms. In addition, I interviewed policymakers and private sector individuals involved with *politécnico* administration and

education, including the Vice Minister of Education, the Minister of Economy, Planning, and Development, the Director of the Educational Quality Assessment of the Ministry of Education, a principal researcher in the Dominican Institute for the Evaluation and Research of Educational Quality (IDEICE), the Executive Director of the Business Initiative for Technical Education (IEET), the Director of Financial Programing and Economic Studies in the Ministry of Education, a budget analyst in the Ministry of Education, the Head of the Economic Studies Department of the Ministry of Education's Office of Educational Planning and Development, and another member of the Office of Educational Planning and Development. My study was approved by the Princeton IRB, Protocol #12100. All participants were adults who signed a consent form, ensuring their permission to audio record.

When policymakers and public officials were asked why there was a relative push towards investing in *politécnicos* during the Educational Revolution, all cited a general belief that *politécnico* graduates were better prepared academically, as evidenced by standardized test results and by national awards given to meritorious students, more prepared for college, and thus viewed more favorably by universities, and believed to be more employable by the private sector. As the Minister of Economy, Planning, and Development said, "*Politécnicos* are very popular in communities. They will always ask for a *politécnico*, roads, water treatment plants, and hospitals." He added, "Rich families mostly end up sending their students to bilingual schools, but for less wealthy students, a *politécnico* is like a private school. It's more aspirational." Yet according to policymakers and the administrators I interviewed, many of the schools converted to *politécnicos* during the Educational Revolution were not "real *politécnicos*," or associated with "high quality." As one policymaker said: "They just change the name without changing the teachers or investing in machinery." Indeed, for a school to be classified as a converting *politécnico*, all it has to offer is a technical degree, and not a differentiated style of instruction or a laboratory. According to one policymaker, "When you look at these new *politécnicos*, you see they offer a technical degree in accounting, marketing, and administration. Why? Because they don't need equipment, unlike mechanical engineering or telecommunication." As described in Section 3, these converting *politécnicos*, unlike authorized *politécnicos*, have no significant impact over *liceos*. Through my interviews and surveys, I identified differences among five main categories that can help explain *politécnicos'* superior performance: management, curriculum and classroom design, hiring practices and teacher quality, school climate, and student body composition. Many of these key inputs can be implemented by

liceos or converting *politécnicos* without necessitating large investments in infrastructure. My findings are in line with literature surrounding the educational production function and inputs to the educational process that are associated with superior student achievement (Hanushek, 2008).

Managerial autonomy

Primarily, *politécnicos* enjoy a great deal of managerial autonomy, which has a number of implications for the inputs identified above. This autonomy is mainly due to the fact that many *politécnicos* are co-managed by a private group, usually by a religious organization, allowing them to operate with more independence than traditional publicly-funded schools. The Director of the Educational Quality Assessment of the Ministry of Education said it is this concept of independent ownership that leads to *politécnicos'* higher academic quality and efficiency in day-to-day operations. The religious order or private group decides who is the director of the school, not the Ministry of Education, and this director is able to apply their unique vision and management style to the long-term strategy of the school. As the vice chancellor of school D said, "We operate like and offer a private education while being a public institution." Further, the more years the *politécnico* has been in operation and the more years of demonstrated academic success, the more latitude they are given by the Ministry due to their "reputation and history" said the vice chancellor of school D. Being associated with a religious order increased this autonomy, she added: "Our conception of students' ethical well-being also helps our credibility." Co-management is seen at the *liceo* level, as well; as demonstrated in Table 12, *liceos* associated with a religious order outperform their non-comanaged counterparts. This managerial autonomy has a number of implications surrounding curriculum, teacher and student body composition, and the school's climate, marked by greater discipline and accountability.

Curriculum

Politécnicos differ from *liceos* in their curriculum and course design. Of students' 40 hours of weekly class time, 50-60% is devoted to technical content. This need to balance their workload between conventional subjects and their technical concentrations teaches students to manage their time efficiently, according to the director of school B. The words *politécnico* teachers most often associated with a *politécnico* education were teamwork, collaboration, and entrepreneurship. *Politécnico* students said the words they associated with a *politécnico* education were skill, preparation, ability, professionalism, creativity, as well as competition, with one student saying, "The competitiveness in the technical courses

pushes us to be better, because you don't want to be left behind. When it's time to participate, most of us are always active."

Teachers in *politécnicos* have greater freedom to design their own course plans, which adhere to the objectives and general subject matter decided by the Ministry of Education, yet heavily incorporate project-based learning and group work. Teachers at school B, C, and D described how, while the Ministry of Education offers them conceptual and procedural methodologies for each modality, teachers are able to add what they want to that base, with a high degree of independence as long as they meet the Ministry's parameters.

Teachers would introduce new concepts and lead discussion before having students implement these new learnings in group-based projects or other hands-on exercises. As one teacher at school C said, "They're not just sitting in the classroom. In workshops, they have to operate machinery in groups, simulating actual work within a company." Indeed, working in groups on tangible, long-term projects, whether it be building an air conditioner or a functional website, were heavily emphasized in the *politécnicos* I surveyed. In school B, students completed a final project throughout their last year of high school, and teachers described how past students told them their university thesis was not nearly as challenging or involved as their *politécnico* project. In school C, students have to create fictious companies for their final projects. Beyond project-based learning, group work was very emphasized in all the *politécnicos* I surveyed. Students in school B emphasized how they helped each other out when they had questions before asking the teacher for additional guidance. Certain students in *politécnico* classrooms in school B were also voted to leadership positions by their classmates, such as President, Vice President, and Secretary, conferring additional independence and classroom management responsibility upon the student. In school A, the high-performing *liceo*, classes were heavily lecture-based, with minimal to no emphasis on project-based learning or group work.

The Executive Director of IEET said that, unlike the academic content of *liceos*, which is more abstract, this type of highly contextual academic content is more motivating for students, as they know this knowledge will be directly applicable for their future profession: "He doesn't get bored in the classroom, because he knows what he's learning is applicable for his future. It's more fun to play with electricity than study religion," she said. Because of this practicality of the academic content, therefore, students engage more actively and deeply with their course work. As one student said, "Something that

I will never forget is the content they taught us in math, as it will help you in everything later in life, like knowing how to apply a discount at the supermarket or how amortization works. If I think of trying to calculate the diagonal of that door, I say, 'It's a rectangle, divide it into 2 triangles and apply Pythagoras.'" The success of this hands-on learning can be conditional on a *politécnico's* facilities. School E, citing insufficient financial support from the Ministry of Education, lacked Internet, basic technological equipment, and tools for their workshops, which caused their Computing and Electronics offerings to suffer.

An additional differentiator of the *politécnico* curriculum is mandated internships of up to 360 total hours with local businesses, further deepening the relationship between the private sector and *politécnicos* and empowering students with professional skills. The director at school B said some students continued their internships through university and went to work full-time at the enterprise after graduation. As the director of the high school of school D said, these internships ensured "permanent contact with the private sector." School D additionally worked closely with private enterprises to continually update their curriculum to ensure it was relevant and applicable for the labor market.

This range and depth of coursework in *politécnicos* is also due to the greater length of instructional time in *politécnicos*. Because *politécnicos* must satisfy general education requirements while also equipping students with a technical degree, they historically have had longer school days than *liceos*, operating for eight hours rather than in four hour shifts as was standard practice in *liceos* due to their limited infrastructure. While the length of the school day was extended after the Educational Revolution country wide, the Executive Director of IEET described how *liceos* were challenged to fill this extra time efficiently, something *politécnicos* have done since their inception. While some *politécnicos* have offered classes to *liceo* directors on how to organize their schedules in accordance with the extended school day, the Executive Director of IEET said in her visits to *liceos*, she often finds many instructional hours unfilled. As the vice-chancellor of school D described it, "One hour of class here is equivalent to almost two hours of class in a *liceo*. It is much more intense, and less time is wasted. We've had extended school hours since we were founded. In the other schools after noon, there are practically no classes, no workshops. It's simply free time."

Teacher quality and practices

I also found through my fieldwork that *politécnicos* employ teachers who are perceived to be

more skilled, as teachers are required to have experience as trained technicians. While *liceo* teachers are assigned by the Ministry, *politécnico* teachers are professionals licensed in the relevant technical concentration they teach, from computing, to tourism, to engineering. "This means he knows less about teaching, but he knows more about what he knows, so that teacher delivers a better experience," said the Executive Director of IEET. According to the vice chancellor of school D, "The level of teacher preparation in *liceos* is a bit questionable. They don't have the same level of mastery; we are able to select a high level of teachers. Here, the professors who teach agronomy were once agronomists. The professors who teach mechanics were mechanists."

Another factor enhancing teacher quality in *politécnicos* is the greater autonomy of *politécnicos* to hire or dismiss teachers. The educational system in the Dominican Republic is highly nationalized, with personnel matters, including employment and salary, decided by the Ministry of Education. While the Ministry of Education assigns teachers to each educational center, co-managed *politécnicos* have the possibility to propose or select teachers (Araneda et al., 2018). Even though they can't expel teachers, as teachers assigned by the Ministry of Education are members of the teachers' union, because of the autonomy afforded by private management, some *politécnico* directors have the freedom to "accept" teachers they want and "return" teachers they do not for the district to place the teacher at another school. The subdirector of school C said in addition to the teacher selection competitions held by the Ministry, the school conducts psychological tests, interviews, and class sessions for their teacher candidates, yet "once the teacher is appointed, to fire him is not very possible." However, the vice chancellor of school D said, "We are freelancers hiring teachers. While their salary comes from the Ministry, we decide which professors who are going to teach at our institution. If they do not fit, we are able to say, 'Thank you very much, but we need another,' and the Ministry places them somewhere else." School E, not associated with a religious order, said they had no say in their teacher hires, who are placed by the Ministry based on their grade in the teacher competitions.

The *politécnicos* I surveyed also heavily emphasized professional collaboration, performance evaluation, and continuous feedback for their teachers in the aims of enhancing teacher quality. Teachers in school B received annual teacher training courses, which included innovative teaching strategies, and subsequent evaluation workshops and supervision throughout the school year to assess how they applied these strategies. Constant and systematic teacher supervision and evaluation was heavily emphasized in

politécnicos, not only to ascertain teachers are in accordance with the Ministry's requirements, but also to monitor a teacher's aptitude and improvement. In schools C and D, students evaluate teachers annually, as do coordinators of a teacher's specific technical modality, and improvement plans are created with the teacher's input. The best performing teachers in school B are awarded a cash bonus and recognition in a yearly prize. Additionally, there was a high degree of collaboration amongst teachers in *politécnicos* in designing their lesson plans. Teachers in school B, school C, and school D designed their lesson plans in accordance with the school's management team and with the input of other teachers.

The teachers in schools B, C, and D described high levels of motivation and satisfaction in their ability to impact their students' lives, describing examples of students who reached out to them from university and beyond to thank them for their impact. They said their main goals for their students were to be independent and critical thinkers, as well as to display high levels of grit and initiative. When asked about the differences between teaching in a *politécnico* versus a *liceo*, teachers in school B said teaching in *politécnicos* is more demanding. They said *politécnico* teachers require greater preparation and training and must frequently update their lesson plans with contemporary issues, as *politécnico* curriculum is highly contextual and practical.

School climate

Another aspect that contributes to *politécnicos'* performance is a more intangible factor: school climate. *Politécnicos* have been cited for their greater emphasis on discipline, perhaps as a result of the strong religious ordinance many of them are founded under. "Religious orders give a structure, an organization, and a discipline that other schools don't have. Parents like that, because they feel more confident that their children will go, they will learn, and they will not miss class," said the Director of the Educational Quality Assessment of the Ministry of Education.

The administrators of *politécnicos* continuously asserted the importance of rules and norms, and emphasized the support systems provided to students who struggle to abide by the rules. The word "discipline" was mentioned in every *politécnico* as a primary differentiator and as fundamental to the success of *politécnicos* over *liceos*. Said the vice chancellor of school D, "There is a stronger institutional discipline, and therefore the personal discipline of each student is greater." The subdirector of school C said teachers set this example of discipline: "The staff has a behavior that is very different from that of *liceo* teachers. We are very demanding in terms of student's conduct and responsibility, especially since

they work with machines, which requires a high level of security and care." The director of school B said absenteeism and tardiness was not problem in their classrooms due to their "many administrative controls," as the third time a student is late, they must go home, which is such a disruption to students and their families that it never happens. If a student is struggling behaviorally, the director of school B meets with them individually; if they fail to improve, she meets with the student's parent. "In addition to the stimulus they have to enter university and the job market, they also have the stimulus of a director who cares about them and wants the best for them," said a teacher from school B. In school D, punctuality is of the utmost importance, and students cannot leave class without authorization; if students are struggling behaviorally, the school puts them in touch with psychologists. A school B administrator emphasized that beyond the academic focus, the "spiritual part" is heavily emphasized in school B, with the school bringing in religious and psychology specialists to "help us with the process of shaping behaviors." As a result, school B reported they had no dropout or expulsion, even after receiving students from private *liceos* who had failed out. While low performing school E said dropout rates were 0, they cited absenteeism as a serious problem, due to the difficult family situations of their students and occasional student apathy.

Student composition

The results of my enrollment model show females, as well as students with higher 8th grade PN test scores and higher 8th grade GPAs, are more likely to enroll in a *politécnico*. Some *politécnicos* have the ability to select their students due to oversubscription. Because the coverage of *politécnicos* is so low in comparison to the supply of *liceos*, some have designed mechanisms to choose students due to high demand. This is not by any means true of all *politécnicos*, but two of the three public *politécnicos* I visited – school C and D - employed some mechanism of student selection. School C has an admissions exam, interview, psychological test, and parental interview as part of its admissions process. In school D, they implement a test covering Spanish and Math as part of their admissions process. They offer 13 weeks of free reinforcement classes every Sunday to prepare for the test, and use performance on the test as one of their admissions criteria. The demand for a *politécnico* education exists within schools as well: school B is made up of primary and secondary school, which offers three *politécnico* degrees and one general academic degree; 75% of their primary school students choose to enroll in a *politécnico* degree. Some of the factors these schools select on are not controlled for in my analysis, such as students'

psychological tests and interview skills, and the inclusion of admissions exams in some cases could contribute to the higher scores of enrolled students and bias the predictors of enrollment. However, these selection methods are also employed by high-performing *liceos*. As illustrated in Table A4, when I compare public *politécnicos* to private *liceos*, which all have rigorous selection process and can only be afforded by families of higher socioeconomic statuses, *politécnicos* still boost students' 12th grade PN Spanish scores over *liceos* by 0.3 standard deviations. Further, for *politécnicos* that receive funding from the Ministry, their processes of selection favor factors such as poverty and the complexity of a student's home life over a student's academic performance, in order to provide greater opportunity to marginalized students and address educational inequities (Araneda et al., 2018). As the vice chancellor of school D said, "Our number one admissions criteria is to cover the most needy and students who need a technical education the most. We also privilege students who seem like they have potential to improve; not those with the best scores, but those who demonstrate a willingness to learn."

By nature of even applying to a *politécnico*, most students have a high degree of intrinsic motivation. The Executive Director of IEET described how some students are deterred from applying to a *politécnico*, because they hear it is more work and demands more hours of class time. Said the academic coordinator of school E, "If they are a low performing child, they never think that they can go to a *politécnico* with the amount of homework and technical assignments." Agreed one policymaker, "There's self-selection as long as *politécnicos* are associated with more difficulty and demand of time. They get the hard-working students." My fieldwork findings suggest that students that study at *politécnicos* do have a high degree of motivation and self-assurance. The vice chancellor of school D said the "number one factor distinguishing our students is their motivation." Part of this motivation is fostered by students' assurance that they will have better job and university prospects with a *politécnico* degree. When asked why they applied, students from school B said they chose a *politécnico* to "have more concrete experience and be afforded more opportunities in life." Another student from school B said, comparing the results of her brother's friends who went to *politécnicos* versus *liceos*, she saw "the most successful people were *politécnico* graduates. I'm very proud to have decided to go to a *politécnico*, because I've been taught things I didn't believe I could master, such as developing applications and a web page. It is something I feel I can take advantage of my whole life."

Teachers from school B reiterated that students were more immersed in the academic process and displayed a higher level of responsibility and engagement, partly attributed to the demands of a technical education. Beyond motivated, teachers described their students as highly entrepreneurial, creative, and imaginative. One student in school B said he chose to concentrate in programming to "foster the ability, creativity, logical reasoning, and ingenuity to solve problems." Teachers from school B said around 90% of their students matriculated to a university, largely thanks to positive peer effects of motivation - as one teacher described it, "If you go, I go." Teachers from school B said *politécnico* students were much more motivated to push through in their studies, reminded that "there are so many students who wanted to be here." Indeed, students from school B emphasized how lucky they felt to be in the technical modality, learning "necessary skills to have a stable job." The academic coordinator at school E said 98% of their students go to university, a rate that vastly exceeds that of the surrounding *liceos*: "Because they are better trained, they don't have the disadvantage of not being able to pay for college. They can work and pay for their university, while a student of the general modality isn't inserted into the labor force as easily, because he doesn't have an approved technical course. It's a huge disadvantage." The subdirector of school C and vice chancellor of school D reiterated this ability of their graduates to work part time to support their university studies, explaining their schools' exceptionally high rate of college enrollment. In regards to student retention, none of the *politécnicos* surveyed said they had more freedom to expel students than *liceos*, especially since the Educational Revolution took hold. Instead, as described by the academic coordinator of school E, "we implement action plans with the psychology team. If the child is still no longer able to achieve the objectives here, we may recommend another institution."

In conclusion, I identify a number of pedagogical and operational differences that contribute to *politécnicos'* success: managerial autonomy, curriculum and classroom design, hiring practices and teacher quality, school climate, and student body composition. As emphasized by policymakers, *politécnicos* that resulted from the conversion of *liceos* during the Educational Revolution lacked these inputs. When one policymaker was asked if there had been conversations around emulating and incorporating these successful elements in *liceos*, such as project-based learning and group work, rather than converting them entirely, he said, "We should be having that discussion. We don't have it." Converting schools that have cut corners in incorporating the elements that are critical to *politécnicos'* success have not

demonstrated superior performance. My fieldwork findings have indicated that there are some valuable reforms schools can undertake that do not require significant infrastructural changes.

4 Public Finance and Returns to Investment

4.1 Background

Before the Educational Revolution, low levels of public investment in pre-university education, hovering between 35% to 55% of that established by law, forced families to take direct responsibility for basic supplies in the basket of educational goods and services, increasing the inequality gap in access and quality of education by socioeconomic status (Caraballo et al., 2016). In 2013, the proportion of capital expenditure as a percentage of total budget doubled, primarily due to the National Plan for School Buildings, which oversaw a great expansion in school coverage. Since 2013, the expansion of the extended school day, which assumes a higher cost per student than the regular day, as well as expanding spending on teacher compensation has led to capital expenditures absorbing over 80% of the Ministry's budget (Caraballo et al., 2016). Salaries and pensions for teaching and non-teaching staff is equivalent to almost 60% of the Ministry's budget; investment in infrastructure 15%, capital expenditures 8%, school breakfast 8%, and administrative and management another 8% (Caraballo et al., 2016).

Funding amounts received from the Ministry by public schools are not supplemented by any other governmental funds or resources on the local or district level. However, local communities and families fundraise to complement these expenditures, and community participation in educational expenses has been growing since the early 90s (Gajardo, 2007). Although it is prohibited by law, some schools ask parents for contributions to school maintenance (Scheker, 2007). Some schools are additionally aided by nonprofit or corporate business sponsorship; these entities provide basic educational inputs, such as some materials and equipment, funding for school maintenance, and professional development for teachers, yet the central government finances the majority of public schools' operations.

On a school level, the expenditures received from the Ministry fall into two categories: teacher salaries and transfers. Law 66/97 classifies teachers as either educators, who teach in the regular educational system and have a qualifying degree, or as teaching-technicians, who teach in *politécnicos* and

have qualified prior professional experience and a qualifying degree (Ministerio de Educación, 1997). As per Article 77 of Decree 63903, teacher renumeration consists of a base salary and variable incentives, which account for around 25% of the total salary (Ministerio de Educación, 2003). The base salary is fixed according to the responsibilities of the position and category of teacher and indices of the cost of living and inflation at the national level, and incentives are provided according to a teacher's performance evaluation, years of service, and academic degree higher than that required by the position. At the turn of the 21st century, teachers' average salary in the Dominican Republic was so low that it made the teaching career one of the lowest paid professions in the country. It was not until 2008 when the average salary of a teacher exceeded the average salary of the economy (Caraballo et al., 2016). Since the start of the Educational Revolution in 2012, teacher salaries have increased by almost 100% on average (El Caribe, 2019), and the total number of public school teachers has grown from 65,000 to over 90,000 in order to aid in the implementation of the extended school day program and staff newly constructed schools (Caraballo et al., 2016). The teaching profession has grown in in popularity as a result of this boost in wages. As previously described, the Ministry holds biannual competitions in June and July to fill vacant positions in the public school system; in the year following the first increase in teacher wages in 2013, 137% more prospective teachers applied for entrance into the educational system (Caraballo et al., 2016). While more individual teacher performance evaluations have been conducted nationwide in an effort to provide incentive pay, Caraballo et al. (2016) note these evaluations are not robust or unbiased enough to accurately reward and retain effective teachers.

For the 2018-2019 school year, the total public expenditure on teacher salaries for *liceos* was RD$16.41 billion and for *politécnicos* was RD$5.53 billion, according to data from the Ministry's Financial Management Information System. While the salaries of primary teachers and secondary teachers have been equalized, there are still differences in base pay between *politécnico* teachers and *liceo* teachers. In my interviews with a budget analyst within the Ministry of Education, they confirmed that *politécnico* teachers have historically had higher wages on average than *liceo* teachers, thanks to their specialized functions and professional experience. In the data of all 2019-2020 teacher salaries sent to me by the Ministry of Education, including the entries I was unable to match to my panel, the average annual base salary per *liceo* teacher was RD$410,070, the average annual bonus per *liceo* teacher was RD$110,535, and the average total salary per *liceo* teacher was RD$521,005. For converting *politécnicos*, these

amounts were RD$527,164; RD$171,679; and RD$698,843. For *politécnicos*, these amounts were the highest at RD$561,107; RD$180,969; and RD$742,076.

The other component of school expenditures is referred to as "transfers" by the Ministry of Education, which makes up about 10% of annual expenditures for *politécnicos* and 5% of annual expenditures for *liceos*. Transfers consist of a school's operating expenditures, which include all of their yearly expenses except those related to the hiring of personnel and their salaries and benefits. Total transfers for the 2018-2019 year were RD$403.22 million for *liceos* and RD$437.51 million for *politécnicos*, according to the Ministry's Financial Management Information System. The Ministry of Education sends these transfer expenditures to decentralized committees, known as *juntas,* at the regional, district, and local level. These committees were created in 2008 as the Dominican Republic began to move towards a process of decentralization in the allocation of educational resources (Ministerio de Educación, 2008). Resolution 0668-2011 established an official process for these committees to administer and distribute the funds that come from Ministry; for these committees to even receive the funding, they need to have up to date information of the schools in their jurisdiction, including enrollment, the number of teachers, and physical infrastructure (Ministerio de Educación, 2011).

Public *liceos* receive a fixed quarterly transfer amount as a function of their enrollment. These transfers are to be spent in 3 categories: 40% in services, such as internet, telephone services, and transportation; 40% in materials and supplies, such as food, classroom supplies, medications, and sports and recreation equipment; and 20% in non-financial assets, such as IT equipment and office furniture (Ministerio de Educación, 2011). According to a budgetary official within the Ministry of Education, this formulated budget does not take into account any specificities in the *liceos'* operations; transfers are sent to the schools, which must design their budget accordingly. However, with time, this funding formula will evolve to include how many schools fall under the committees' jurisdiction and the location and accessibility of the schools. While some *liceos* receive support from partnership with private companies, a budgetary official within the Ministry of Education said this sponsorship has declined in recent years.

Politécnico transfers, on the other hand, are not subject to similar regulations or a per capita formula; instead, they are allocated in a discretionary manner. Each *politécnico* submits its own transfer budget, which is reviewed and granted by the relevant authorities within the budgetary office of the Ministry of Education and then distributed by the committees. As the vice chancellor of school D said,

"We have a lot of autonomy. We create our budget and ask for specific support as we need it. They may tell us no, but we have established credibility in how we allocate our funds." Indeed, from interviews with policymakers, it seems *politécnicos* with a track record of sustained academic performance and of many years of operation are able to more successfully petition and obtain higher transfer expenditures from the Ministry. There is high variance amongst *politécnico* transfer expenditures, with an average of RD$6,154 per student per year and a standard deviation of RD$5,796. These transfers are of a much larger magnitude than those of *liceos*, as *politécnicos* face higher operating costs to maintain their infrastructure, which includes costly laboratories and machinery. One policymaker said maintaining these laboratories consumes up to a third of a *politécnico's* total operating expenditures. A budgetary official within the Ministry of Education has said the Ministry is in a process of creating a more equitable process to distribute transfers to *politécnicos* and create a per capita funding formula in accordance with the concentrations that each *politécnico* offers. While these transfer amounts are not supplemented by any other public funds, more so than *liceos*, some *politécnicos* receive financial support and resources, such as donated machinery and qualified technical personnel, from partnerships with private companies.

4.2 Literature Review

Beyond differences in organizational practices, *politécnicos* receive greater funding per student in comparison to *liceos*. This heterogeneity in expenditure, both between *politécnicos* and *liceos* and within *politécnicos*, necessitates closer examination of its impact on variation in school performance and student achievement. There has been debate in the academic literature over the impact of increasing spending on public schools on student educational outcomes, particularly for low-income students and particularly among differing country contexts. In Jackson's (2018) review of this literature, he notes most studies estimate a correlational relationship between school spending and student outcomes after controlling for family background and geography, as it is difficult to estimate a causal relationship. This difficulty is due to the unobserved student characteristics that predict academic achievement and are correlated with school spending, as well as the confounding principle that school spending is a function of family background and neighborhood wealth. For example, wealthier families or families who place a higher premium on quality education might select into schools with higher levels of spending, which

would upwardly bias the estimate, as children of those families would most likely be more academically prepared and more intrinsically motivated. Further, wealthier and more connected families may lobby or otherwise exert influence for an increase in educational resources. Disparities in spending may therefore be related to patterns of social stratification and concentration, and local political resource-allocation decisions will work in favor of more advantaged constituencies (Condron and Roscigno, 2003). As Jackson (2018) posits, in order to overcome these limitations, one must rely on an exogenous shock to school spending that is unrelated to other determinants of student outcomes and that is not influenced by the decisions of the students' families, so as not to bias the estimated relationship.

In Jackson's (2018) review of studies from the United States, he finds strong support in the observational literature for a positive association between increased school spending and improved student outcomes. In the more recent quasi-experimental literature that relates school spending to student outcomes, Jackson (2018) finds overwhelming support for a causal relationship between school spending and student outcomes in 12 out of 13 multi-state studies, even across different time periods, data sets, and different statistical techniques and sources of variation, suggesting that money matters. Notably, Jackson et al. (2016) finds a 10% increase in per pupil spending each year for all 12 years of public school leads to 0.31 more completed years of education and increases the probability of high school graduation by 10 percentage points for low-income children and 2.5 percentage points for nonpoor children. Lafortune et al. (2018) finds a one-time $1,000 increase in per-pupil annual spending sustained for 10 years increases student test scores by up to 0.24 standard deviations.

While on average, aggregate measures of per-pupil spending are positively associated with improved or higher student outcomes (Baker, 2016), the size of this effect can depend on *how* the money is spent. Specific types of expenditures can have a range of impacts: increased spending towards instructional funds can attract more highly qualified and trained teachers, increased spending on the maintenance of school buildings can lead to physical conditions that are more conducive to learning and influence students' attendance and engagement (Cuesta et al., 2016), and increased spending can further serve to shape the climate of classrooms and curriculum, creating a greater degree of order amongst the student body (Condron and Roscigno, 2003). Relevant to the Dominican Republic's efforts in reforming and boosting teacher compensation, Baker (2016) finds in his review of studies from the United States that teacher salaries affect the quality of the teaching workforce, which in turn affects student outcomes.

He cites Murnane and Olsen's (1989) finding that salaries affect the decision to enter teaching and the duration of the teaching career, Figlio (1997, 2002) and Ferguson's (1991) conclusions that higher salaries are associated with more qualified teachers, as well as Loeb and Page's (2000) finding that raising teacher wages by 10% reduces high school dropout rates by 3-4%. However, because increases in wages have been awarded widely in the Dominican Republic, without robustly taking into account the level of achievement and impact demonstrated by individual teachers, these wage incentives may not necessarily lead to a more skilled teacher workforce, even given the aforementioned evidence of low approval rates from the teacher competitions. Hanushek and Rivkin (2007) indicate that salary increases only have an effect on the performance of the education system when they are tied to improvements in student performance.

Nevertheless, the findings from the United States of a positive association between per-pupil spending and student outcomes may lead us to expect increased spending to have even larger positive impacts on student outcomes in a developing country context like the Dominican Republic, where the marginal value of an additional peso is higher for students with limited resources (Evans, 2019). The Education Commission (2016) finds a dollar invested in an additional year of schooling generates earnings and health benefits of $2 for an upper middle-income country like the Dominican Republic. However, if the additional resources from increased expenditure on public education are less likely to reach individual schools or be utilized effectively, there could be a smaller impact. The World Bank Group (2018b), finds a positive, yet weak, correlation between countries' spending and learning outcomes as measured by Programme for International Student Assessment (PISA) scores, with the link between spending and learning varying widely even for countries at similar levels of economic development. Roser and Ortiz-Ospina (2016) find that on a cross-sectional level, expenditure on education correlates positively with mean years of schooling and mean PISA score, yet expenditure on education does not explain cross-country differences in learning outcomes. When the OECD looked into whether money can buy stronger PISA test performance, they concluded countries that prioritized the quality of teachers over class sizes performed much better, indicating that the most important factor is how resources are used (Roser et al., 2020). Yet using a different empirical specification, Vegas and Coffin (2015) find educational spending is associated with increased student performance on the PISA only for systems that spend below $8,000 US per student annually.

Thus, while how money is spent is more important than how much is spent for the returns to schooling in systems that already provide sufficient inputs for a quality education, in a developing country context like the Dominican Republic's, higher spending – irrespective of how efficiently the funds are spent – may increase quality to a minimum standard by providing the basic learning inputs to students. The mixed literature on the returns to increased educational spending due to the variance in environments in which educational systems function lends itself to further analysis for the Dominican Republic's context.

4.3 Data

I obtained public expenditure data directly from the Ministry of Education, including the transfers for operating expenditures for *politécnicos* from 2010-2019, the transfers for operating expenditures for *liceos* for the 2018-2019 school year, the transfers for teacher salaries for *politécnicos* and *liceos* for the 2019-2020 school year, the total number of enrolled students for *politécnicos* from 2010-2020, and the total number of enrolled students for *liceos* from 2017-2020.

4.3.1. Variables and Data Preparation

All values are in Dominican pesos; approximately 55 pesos are equivalent to 1 US dollar. I divided the total transfer expenditures and teacher salaries by the total matriculation each year for each school in order to obtain total per capita transfer expenditures and total per capita salary expenditures per school per year. While the per capita transfer expenditures vary per *politécnico*, transfers for *liceos* in the 2018-2019 year are fixed at RD$5,800 per student per year if *liceos* have less than 30 students, RD$3,864 per student per year if *liceos* have less than 60 students, and RD$1,932 per student per year if *liceos* have greater than 60 students. The transfer data I received from the Ministry of Education was identified by each school's identification number; I was able to match it to 146, or 80% of, *politécnicos* and 1,102, or 45% of, *liceos* in my panel.

The teacher salary data I received from the Ministry of Education was identified by school names rather than their identification number; as a result, I was able to match it to 97, or 54% of, *politécnicos* and 218, or 9% of, *liceos* in my panel. The relationship between 2018-2019 per capita transfers and 2019-

2020 per capita teacher salaries is a positive one, and teacher salaries did not fluctuate within schools from the 2018-2019 and 2019-2020 school year (Ministerio de Educación, 2019). Therefore, I assume that I can take the 2019-2020 per capita teacher salaries as roughly equivalent to a school's 2018-2019 per capita salary expenditures, and I construct an assumed total expenditure for the 2018-2019 school year by adding the per capita teacher expenditures from 2019-2020 to the per capita transfer expenditures from 2018-2019. 90 *politécnicos* and 213 *liceos* had both teacher expenditure and transfer expenditure data and thus have associated total per capita expenditure values.

To calculate the per capita transfer spending received by the five cohorts of *politécnico* students graduating in 2014, 2015, 2016, 2017, and 2018, I averaged the annual per capita amounts these five cohorts received for the four years they were enrolled in high school. I use this average annual value of per capita transfers received by each cohort when estimating within-school effects of increased transfer expenditures. I took the average of annual per capita transfer expenditures received by *politécnicos* from 2010-2018 and divided these values into transfer spending quintiles, with 1 indicating the lowest per capita transfer spending and 5 corresponding to the highest per capita transfer spending. I denote *politécnicos* in quintiles 1 and 2 as low transfer spending *politécnicos*, and *politécnicos* in quintiles 4 and 5 as high transfer spending *politécnicos*. Because *liceos* receive fixed transfer per capita expenditures as a function of their enrollment, I do not include them in these transfer spending quintiles. I created teacher salary spending quintiles for all schools, with 1 indicating the lowest per capita teacher salary quintile and 5 the highest. I denote schools in quintiles 1 and 2 as low per capita teacher salary schools, and quintiles 4 and 5 as high per capita teacher salary schools. While I don't directly observe teacher salaries for the years of my panel, I assume high schools do not fluctuate heavily in their relative per capita teacher spending, and thus a school's quintile of teacher spending in 2019-2020 can apply to the school in the years I observe graduating cohorts from 2014-2018. Lastly, with my proxy value of total school expenditures adding per capita teacher expenditures from 2019-2020 to per capita transfer expenditures from 2018-2019, I create total expenditure quintiles, with 1 indicating the lowest per capita expenditure and 5 the highest per capita expenditure. I denote schools in quintiles 1 and 2 as low spending schools, and schools in quintiles 4 and 5 as high spending schools. Again, I assume these relative quintiles of total spending are equivalent to that of the 2018-2019 proxy and remain constant from 2014-2018.

4.3.2. Summary Statistics

Table 16 presents the average annual per capita spending by *politécnicos* and *liceos*. The average 2019-2020 school year per capita spending on teacher salaries for the 97 *politécnicos* with data was RD$63,062, in comparison to RD$43,544 for the 218 *liceos*. The average teacher salary was also higher amongst *politécnicos*: RD$771,272 in comparison to RD$552,178 for *liceos*. The table also shows changes in per capita transfer spending amongst *politécnicos* from the 2010-2011 school year to the 2018-2019 school year. For the 146 *politécnicos* with at least one year of data on per capita transfer spending, the average annual per capita transfer expenditures was RD$6,154. In line with the promise of the Educational Revolution, these per capita transfers doubled from RD$3,561 for the 2011-2012 school year to RD$6,512 for the 2012-2013 school year. Per capita transfer expenditures hovered within RD$1,000 of RD$6,000 until the 2018-2019 school year, when they fell to RD$4,660. The average annual per capita transfer expenditures for *liceos* for the 2018-2019 school year is RD$1,945. Of the 90 *politécnicos* that have both transfer expenditure data for the 2018-2019 school year and per capita teacher expenditure data for the 2019-2020 school year, the proxy average per capita total spending is RD$68,125. Of the 213 *liceos*, the proxy average per capita total spending is RD$47,062. There is little difference in average 8^{th} grade or 12^{th} grade PN scores across *politécnico* spending quintiles, with PN scores fluctuating by a maximum of 0.5 points between quintiles for a given subject.

4.4 Methodology

Between Sector Impacts

In order to examine the heterogenous impact of attending *politécnicos* in a given quintile of spending versus *liceos* on standardized 12^{th} grade PN Spanish scores, I conduct the same two-stage least squares regression analysis as described above in equations (4) and (5). My controls remain the same, and I limit my analysis to students who remained at the same high school all four years. Because *liceos* do not have the variation in per capita transfer spending *politécnicos* do, I compare the impact of attending a low transfer spending *politécnico* or a high transfer spending *politécnico* to all *liceos*. I further this 2SLS analysis to evaluate the impact of attending a low teacher salary spending *politécnico* in comparison to a low teacher salary spending *liceo*, a high teacher salary spending *politécnico* in

comparison to a high teacher salary spending *liceo*, a low total spending *politécnico* in comparison to a low total spending *liceo*, and a high total spending *politécnico* in comparison to a high total spending *liceo*.

Within Sector Impacts

To examine the association between spending differences amongst *politécnicos* and spending differences amongst *liceos* with standardized 12th grade PN scores, my empirical specification follows equation (6). I limit my analysis to students who remined at the same high school all four years and my controls of student characteristics stay the same, yet I do not control for high school characteristics. Instead, I control for quintiles of per capita spending. I repeat this analysis for quintiles of transfer spending, quintiles of teacher spending, and quintiles of total spending for *politécnicos*, as well as quintiles of total spending for *liceos*. It should be specified here that these spending quintiles, calculated separately for just *politécnicos* and just *liceos*, are thus slightly different from the overall spending quintiles used in the 2SLS model for all high schools.

Within School Impacts

I use a mixed estimation approach as described in Guarino et. al (2014) in order to estimate the effects of within-school, between-cohort variation in transfer expenditures on cohorts' 12th grade PN scores. I limit my sample to students who have stayed at the same school all four years. My multilevel mixed effects model is:

$$Y_{ij} = X_{ij}\delta + \ u_j \tag{7}$$

where Y_{ij} is the outcome of standardized 12th grade PN scores for student i in school j, and X_{ij} is the vector of controls of student characteristics for student i in school j, including the student's 8th grade PN scores, their gender, as well as the wealth level of the municipality of their middle school and whether it was public or private. I estimate this model for each of the five cohorts of graduating students and each of the four subjects of the PN: Spanish, Math, Social Science, and Natural Science. From this, I am able to estimate the random high school effect per subject, u_j, for each cohort of students graduating in 2014, 2015, 2016, 2017, and 2018.

Using the random effects as a latent variable for school performance per subject, I then estimate the impact of within-school change in average annual per capita transfer expenditures on those random effects:

$$Y_{jt} = S_{jt}\delta + \ u_{jt} \tag{8}$$

where Y_{jt} is the latent variable created by the random effects of the multilevel model in (7) of school j's effect at time t on its graduating students' standardized 12th grade Spanish, Math, Social Science, and Natural Science PN scores, S_{jt} is the average annual per capita transfer expenditures received by school j's cohort of graduating students at time t, and u_{jt} is the error component. I use robust standard errors.

4.5 Results

4.5.1. Spending Treatment Effects

Between Sector Impacts

The IV results presented in Table 17 show *politécnicos* in the lowest two quintiles of per capita transfer spending boost students' 12th grade Spanish scores by 0.356 standard deviations over all *liceos*. This impact is of a larger magnitude for *politécnicos* in the highest two quintiles of per capita transfer spending: 0.690 standard deviations. Table 17 also illustrates the intensity of the impact of *politécnicos* over *liceos* by per capita teacher spending quintiles. *Politécnicos* in the lowest two quintiles of teacher spending have a positive but statistically insignificant impact over *liceos* in the lowest two quintiles of teacher spending; this sample size was much smaller than the others, with only 37,643 observed students who attended the same high school for all four years in that category. *Politécnicos* in the highest two quintiles of per capita teacher spending boost students' Spanish scores by 0.527 standard deviations over *liceos* in the highest two quintiles of teacher spending. *Politécnicos* in the lowest two quintiles of per capita total spending have a positive but statistically insignificant impact over *liceos* in the lowest two quintiles of per capita total spending; again, this sample size was much smaller than the others, with 35,107 observations. *Politécnicos* in the highest two quintiles of per capita total spending boost students' Spanish scores by 0.519 standard deviations over *liceos* in the highest two quintiles. Figure 17 provides

a visualization of the heterogenous impacts of *politécnicos* in these three categories of spending – transfer, teacher, and total – over *liceos*.

Within Sector Impacts

Table 18 reports the relationship between quintiles of per capita transfer spending and standardized 12th grade PN scores for *politécnicos*. *Politécnicos* of higher transfer spending quintiles outperform *politécnicos* in the lowest quintile of transfer spending, by up to 0.479 standard deviations in Math and 0.428 standard deviations in Natural Science for the fifth quintile. The relationship between transfer spending quintile and 12th grade scores is somewhat linear by quintile, with larger quintiles associated with larger magnitudes in scores, as illustrated in Figure 18. However, for all four subjects, there is a more marked increase in magnitude between the fourth and fifth quintile than between the third and fourth. In Spanish and Social Science, the third quintile is associated with a larger increase in scores over the lowest quintile than the fourth.

Table 19 reports the relationship between quintiles of per capita teacher spending and standardized 12th grade PN scores for *politécnicos*. In Math, the highest quintile of teacher spending is associated with an increase of 0.528 standard deviations over a *politécnico* in the lowest quintile of teacher spending. The second, third, and fourth quintile are all associated with a decrease in Social Science and Natural Science scores over the lowest quintile, the second and third are associated with a decrease in Math scores over the lowest quintile, and the second quintile is associated with a decrease in Spanish scores over the lowest quintile.

Table 20 reports the relationship between quintiles of per capita total spending and standardized 12th grade PN scores for *politécnicos*. While no quintiles show a significant increase over the lowest quintile in Spanish scores, in Math, the highest quintile of total spending is associated with an increase of 0.717 standard deviations in scores over a *politécnico* in the lowest quintile of total spending, the fourth with an increase of 0.107 standard deviations, and the third with a decrease of 0.090 standard deviations. The fifth quintile is also associated with an increase in Social Science and Natural Science scores over the lowest quintile of 0.169 and 0.197 standard deviations, respectively.

Table 21 reports the relationship between quintiles of per capita total spending and standardized 12th grade PN scores for *liceos*. Unlike *politécnicos*, no quintiles are associated with a significant effect over the lowest quintile for Math. However, the second highest quintile of total spending is associated

with an increase over the lowest quintile of 0.238 standard deviations in Spanish, 0.390 in Social Science, and 0.143 in Natural Science. Additionally, the highest quintile of total spending is associated with an increase of 0.158 standard deviations in Social Science over the lowest quintile.

Within School Impacts

While Table 18 suggests *politécnicos* in higher quintiles of per capita transfer spending outperform *politécnicos* in the lowest quintile, the question still remains if increases in annual transfer expenditures within a *politécnico* have an impact on the school's performance. Table 22 shows no statistically significant relationship between an additional RD$ of per capita annual transfer spending within a school on the school's impact on students' Spanish, Math, Social Science, or Natural Science scores. This perhaps reflects the bottom-up nature of *politécnico* school financing, where high-performing *politécnicos* with a credible history of fiscal responsibility and academic performance ask for and are granted more transfer funds. Thus, transfer expenditures may serve as more of a lagging indicator rather than a driver of future academic performance, so the incremental RD$ has little impact.

4.5.2. Estimated Returns to Investment

In this section, I conduct a back-of-the-envelope calculation to estimate the returns to public investment in *politécnicos* via raising students' test scores. Policymakers have not conducted a cost-benefit analysis of investing in vocational education in the Dominican Republic, so while this analysis relies on assumptions and approximations, it can nevertheless be useful in light of policymakers' limited information. On average, *politécnicos* spend three times that of *liceos* on their per capita operating expenditures, and 1.5 times more than *liceos* on their per capita teacher salaries: in total, approximately 1.5 times the annual total per capita spend of *liceos*. I find *politécnicos* increase the likelihood of on-time graduation, boost students' 12^{th} grade standardized scores, increase their likelihood of college application, and boost their college admissions test scores. Because I have the most robust data on students' 12^{th} grade standardized scores, I use that singular outcome to quantify *politécnicos'* impact on student outcomes. Blau and Kahn (2001) find in the United States, controlling for education, a one standard deviation in cognitive test scores is estimated to raise annual wages in the United States by 16.4% for men and 11.9% for women. Neal and Johnson (1996) find that a one standard deviation increase in the Armed

Forces Qualification Test is associated with a 20% increase in annual wages for men and women, and Lazear (2003) finds for every one tenth of a standard deviation increase between 8th and 12th grade in the sum of a student's standardized scores on Reading, Math, History, and Science tests, there is an increase in student earnings of 1.2% per year; therefore, a one standard deviation increase would translate to a 12% increase in annual earnings. The impact of school quality on wages in the United States can generalize to a country context like the Dominican Republic, as evidence suggests the returns to educational quality may be larger in developing countries than in developed countries, consistent with the range of estimates for returns to quantity of schooling that indicate diminished marginal returns (Hanushek and Woesmann, 2007). Thus, the available estimates of the impact of cognitive skills, as demonstrated by standardized test scores, on outcomes, as demonstrated by wages, suggest powerful economic returns to developing countries.

Politécnicos overall boost Spanish, Social Science, and Natural Science scores by 0.224-0.357 standard deviations, respectively. I use a conservative estimate of a 0.25 standard deviation boost for *politécnicos'* impact. Using a back-of-the envelope calculation of the benefits of the boost in standardized scores from *politécnicos*, I equate a one standard deviation increase in *Prueba Nacional* scores with a 12% increase in annual future earnings, the lowest estimate from the aforementioned literature in line with Lazear (2003) and Blau and Kahn's (2001) findings. Therefore, the 0.25 standard deviation boost in scores from a *politécnico* would translate to an approximate 3% increase in annual earnings. According to the 2016 census, the average annual salary was RD$224,669 for males and RD$175,908 for females (Oficina Nacional de Estadistica, 2020). Even though males are more represented in the labor force, I take a conservative estimate of yearly income Y averaging the two values to be RD$200,289, and assume our representative high schooler enters the labor force at age 18 and retires at age 60 with a constant yearly income of $200,289 and a 3% increase in income, p. I use a discount rate r equal to the interest rate on the Dominican Republic's 10-year bond, 4.5% (Dominican Today, 2020). Therefore, the present discounted value of the increase in future income equals:

$$p|Y\sum_{t=1}^{t=42}\frac{1}{(1+r)^t} = (0.03)|RD\$200{,}289\sum_{t=1}^{t=42}\frac{1}{(1.045)^t} \approx RD\$112{,}504$$

The average annual difference in per capita expenditures between *politécnicos* and *liceos* is RD$68,125 – RD$47,062 = RD$21,063, or RD$21,063 * 4 = RD$84,252 over the four years of a students'

education. Therefore, the per-student net present value of *politécnicos'* boost on their 12th grade standardized test scores is RD$28,252.

It should be noted that I use estimates that would bias the results towards an underestimation of *politécnicos'* benefits. I use conservative estimates of *politécnicos'* impact on 12th grade standardized test scores – an estimate that includes converting *politécnicos*, which I have shown have no impact over *liceos* on students' outcomes. I assume the subsequent effect on annual earnings is accruing from the increase in human capital reflected by students' standardized test scores alone. Because my sample size is smaller for college outcomes, I do not include these additional impacts of *politécnicos* on the increased likelihood of college application and admission and boost in college admission test scores, which would increase the benefits accruing to students if included in the equation. I use a conservative estimate of average income that stays constant over an individual's entire life time, and an average income that is most likely less than what a professional technician or university graduate would make. Even though my calculations make assumptions about the linearity and stability of benefits accruing to *politécnico* gradates, they suggest that the benefits of a *politécnico* education outweigh the costs.

4.6 Discussion

The Educational Revolution doubled the Dominican Republic's investment in pre-university education, channeling these funds towards rehabilitation and expansion of educational infrastructure, doubling the cost per student with an expanded school day, and doubling teacher salaries, which make up the majority of a school's yearly budget. There is great heterogeneity between *politécnicos* and *liceos* and amongst *politécnicos* in the funding they receive; while *liceos* are subject to greater standardization under the Ministry of Education, particularly in their transfer expenditures, *politécnicos* have greater authority in designing their budget and requesting what they require for their operating expenditures. Because of the costs of maintaining their laboratories and other machinery, *politécnicos'* per capita transfer expenditures are over 3 times those of *liceos*, and because of the tendency of *politécnico* teachers to have greater professional experience, *politécnicos'* per capita teacher salary expenditures are 1.5 times those of *liceos*.

When examining the heterogeneity of *politécnicos'* impact by spending, *politécnicos* in higher quintiles of spending significantly outperform *liceos* in higher quintiles of spending, while *politécnicos* in lower quintiles of spending have no significant impact over *liceos* in lower quintiles of spending. This corroborates my previous findings that converting *politécnicos* have no significant impact over *liceos*: without the costly inputs that drive a *politécnicos'* impact, such as higher teacher caliber, longer school days, and sufficient laboratory space to conduct project-based learning, these schools do not reproduce the impacts authorized *politécnicos* do.

When comparing *politécnicos* to each other by quintiles of per capita transfer spending, I find the relationship between transfer spending quintiles and standardized 12th grade PN scores is somewhat linear by quintile, with larger quintiles associated with larger magnitudes in scores, yet for all four subjects, there is a more marked increase in magnitude between the fourth and fifth quintile than between the third and fourth. In two subjects, the third quintile is associated with a larger increase in scores over the lowest quintile than the fourth. While transfer expenditures make up only about 10% of a school's annual operating expenditures, since they exhibit a high level of heterogeneity and are often dictated on the *politécnico* level, this finding can have a number of implications for how the Ministry of Education thinks of allocating transfer expenditures to *politécnicos* going forward, if not on a per capita basis like *liceos*. While there are other unobserved variables that impact a school's performance and their ability to petition funding from the Ministry that could confound the relationship between a school's per capita transfer spending quintile and their academic performance, the evidence suggests that if faced with a fixed pool of funds, the marginal utility of a dollar moving a *politécnico* from the fourth to the fifth quintile of transfer spending could be higher than moving from the third to the fourth. The relationship between quintiles of per capita teacher spending and per capita total spending amongst *politécnicos* with student outcomes are not as consistently significant, and sometimes show a negative relationship, yet the highest quintile is consistently associated with an increase in scores over a *politécnico* in the lowest quintile of spending.

When analyzing the impact of increased annual per-capita transfer expenditure within schools, however, I find no significant relationship. This is not uncommon in literature evaluating spending and learning outcomes; in global learning assessments, while per-student spending initially appears to lead to more learning at the poorer end of the global income scale, the correlation largely disappears when

controlling for countries' per capita income (The World Bank Group, 2018b). These findings indicate schools within the same educational system vary in their ability to translate increased investment into better learning outcomes (The World Bank Group, 2018b). As I learned in my fieldwork, the *politécnicos* that can successfully petition for increased transfer expenditures are ones that have demonstrated past high performance, and thus the marginal RD$ in transfers has little influence on their future operations that drive their impact on students' academic outcomes.

Even though *politécnicos* necessitate greater investment in comparison to *liceos*, there is greater reward. While the Dominican Republic is faced with a number of tradeoffs in how it chooses to allocate scarce resources to public education by weighing the short and long term benefits of different spending choices, by a conservative estimate, I find the per-student net present value of *politécnicos* on student's academic outcomes is RD$28,252. This finding does not imply *politécnicos* are the Dominican Republic's only and best solution, as the country is limited by its inability to make such a sustained annual investment at a 1.5 times greater cost per student. From my fieldwork, I identify a number of pedagogical and operational differences that contribute to *politécnicos'* success but do not necessitate a large increase in expenditures, such as greater managerial autonomy, more emphasis on group work and practical, hands-on learning, more emphasis on teacher feedback and development, and a school climate of greater discipline and personal autonomy. Perhaps these strategies are more cost effective ways for the Ministry to improve *liceos'* performance and boost students' performance overall.

5 Conclusion

Vocational education has been promoted as a mechanism to smooth the transition from schooling to work, particularly for disadvantaged youth. Throughout Latin America, expanding the coverage of vocational education has become a central axis of national policies to promote a more skilled labor force and boost economic development. Causal evidence of the impact of vocational education on students' academic outcomes is limited, however, as overcoming students' self-selection into vocational education presents a methodological challenge. My thesis addresses this challenge by building off of Card's (1993) methodology, exploiting variation in students' proximity to the nearest vocational high school in the

Dominican Republic as an instrumental variable to estimate the impact of vocational education. For the past eight years of its Educational Revolution, the Dominican Republic has invested heavily in improving the quality of its educational system, placing special emphasis on vocational education through expanding coverage of its vocational high schools, *politécnicos*. My findings are line with policymakers' increased emphasis on vocational education, as not only are higher scoring students more likely to enroll in *politécnicos*, but *politécnicos* positively impact students' educational outcomes, boosting students' 12th grade standardized test scores, increasing the probability of on-time high school graduation and likelihood of college application, and further boosting students' college admission test scores by 0.3 standard deviations. While secondary vocational programs are heterogenous within and between countries across a range of occupational and educational focuses, I interpret my findings as applicable to a developing Latin American country context like the Dominican Republic, which offers a two-track system of vocational and academic high school. *Politécnicos'* impact on students' scores are on par with analysis of the most successful charter schools' returns. These impacts are significant across gender, academic ability, and socioeconomic status of students.

I observe significant heterogeneity in the magnitude of impacts of *politécnicos* for certain student and school profiles. I find more magnified impacts for authorized *politécnicos*, religious *politécnicos*, and authorized religious *politécnicos* than for *politécnicos* overall. These *politécnico* profiles further demonstrate reductions in inequality, boosting males' 12th grade standardized Spanish scores from the lowest wealth quintiles more than males from the highest wealth quintiles, and additionally having more magnified impacts on lowest scoring males than highest scoring males, suggesting these schools more effectively serve students at the bottom of the ability and income distribution. While these groups of male students see the biggest benefit from a *politécnico* education, however, they are less likely to enroll in and be served by *politécnicos*.

Greater effort can be made to prioritize females' education, particularly within *politécnicos*, where the gender disparity is more magnified than within *liceos*. *Politécnicos* are more likely to enroll females; some of the most popular *politécnico* degrees, such as Nursing and Marketing, are associated with feminized professions and enroll high fractions of women, which may explain the significance of being female in increasing a student's likelihood to enroll in a *politécnico* over a *liceo*. While females' academic outcomes are universally significantly and positively impacted by *politécnicos* over *liceos*, these

impacts are of a lesser magnitude than the impacts for males, with the largest gender penalty in Math scores. Further, unlike males, females from lower wealth quintiles receive lesser impacts than females from wealthier quintiles, and, unlike high scoring females, low scoring females receive no significant boost from *politécnicos* over low scoring females in *liceos*. This suggests an opportunity for policymakers to invest in these profiles in order to place females on an equal footing with male graduates and retain the relative parity in 8th grade scores they have with males upon enrolling in high school. Beyond having a significant impact on *politécnico* enrollment, the wealth level of the municipality of a student's middle school has a large and significant impact on their academic outcomes, and having attended a public middle school has a significantly negative impact, indicating the importance of environmental factors for a student's achievement and reflecting the unsurprisingly substandard performance of primary public school in comparison to private public school.

Converting *liceos* to *politécnicos* was one of the main policies surrounding expanding secondary vocational education during the Educational Revolution. I find little to no significant impacts for converting *politécnicos* over *liceos* for any of the aforementioned academic outcomes, which may not come to a surprise to policymakers. As one said, "I think we raised the number of *politécnicos* without necessary conditions to get really good technicians … If you don't have different teachers and different institutions, it's just not good." Others said that expanding the coverage of *politécnicos* was planned poorly, characterized as responding to "inertia" and "not a coordinated policy," and the conversion of *liceos* to *politécnicos* was haphazard at best. My findings suggest that these expenditures could have been more efficiently channeled towards other educational policies or towards emulating certain pedagogical inputs that drive successful *politécnicos'* performance.

In my fieldwork where I travelled to the Dominican Republic, I identified five main organizational and operational factors that contributed to *politécnicos'* success: managerial autonomy, curriculum and classroom design, hiring practices and teacher quality, school climate, and student body composition. These educational inputs are closely aligned with the OECD's (2012) recommendations to support low performing disadvantaged schools and improving equity in education, which included developing and supporting specialized school leadership; ensuring effective learning strategies; training, recruiting and retaining competent teachers; fostering a positive and supportive school environment; and linking parents and communities with these schools for sustainable improvement. While some of these

inputs would require a significant and sustained boost in investment, such as creating the infrastructure for a laboratory to fulfill the technical skills required by a certain concentration, some pedagogical practices could be incorporated by *liceos* without necessitating a conversion to a *politécnico* or markedly increased expenditures. As the Minister of Economy, Planning, and Development said, "I don't think we need an increase in the number of *politécnicos*. If what we're trying to achieve is an increase in human capital, I think that we should learn from the experience of *politécnicos* to improve the quality of education. We should be doing more co-management with other schools to improve their students' performance, not just investing in technical inputs."

According to Ministry officials, the country has not completed a cost-benefit study comparing the *politécnico* system to the *liceo* system. I find that while *politécnicos'* per capita transfer expenditures are over 3 times those of *liceos* and per capita teacher salary expenditures are 1.5 times those of *liceos*, the academic benefits of *politécnicos'* boost in students' 12th grade standardized tests alone, as estimated by an increase in students' annual salaries, translates to a net present value of RD$28,252 per student. Because there is great heterogeneity in spending amongst *politécnicos*, as well, especially amongst transfer expenditures, I examine the relationship between increased annual per capita transfer expenditures and standardized test scores. I find no significant relationship between increased per capita transfer expenditures and student test scores on an individual school level, perhaps reflecting the bottom-up method of allocating *politécnico* transfers; transfer expenditures thus serve as more of a lagging indicator of the *politécnico's* credible history of fiscal responsibility and sustained academic achievement than a driver of their future performance. I also find, when comparing *politécnicos* to each other by quintiles of transfer spending, *politécnicos* in the third quintile are associated with slightly less or larger increases in scores over the lowest quintile than *politécnicos* in the fourth, while *politécnicos* in the fifth quintile are universally associated with the largest increase in scores. As policymakers look to standardize transfer expenditures for *politécnicos*, the evidence suggests that, if faced with a fixed pool of transfer funds, they should look more closely at these schools in the third and fifth transfer spending quintiles; the marginal utility of an RD$ moving a *politécnico* from the second to the third or from the fourth to the fifth quintile of transfer spending could be higher than moving from the third to the fourth.

Further avenues of research are promising. Because my data is restricted to schools constructed before 2014, there are more opportunities to evaluate how newly constructed or converted schools post

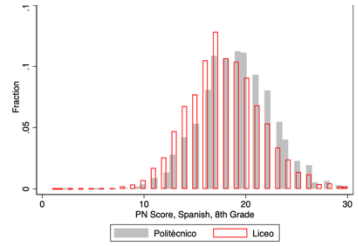
2014 performed, as well as if this increase in *politécnico* coverage has induced students to enroll in secondary school rather than substituted for *liceo* enrollment. Greater data on variation in per capita teacher salary expenditures before and during the Educational Revolution could also be informative, as teacher salaries make up the majority of a school's budget and increases in teacher wages could perhaps lead to greater teacher quality and explain school performance in some cases. In addition, because the socioeconomic status of a student's middle school municipality seems to be highly significant in their enrollment decision and educational outcomes, more refined measures of a student's home environment, from the socioeconomic status of their household to the education level of their parents, could also be impactful. Further, the instrumental variables I utilize in my empirical analysis can be refined with greater specificity of the distance between a student's household, rather than their middle school, and the *liceos* and *politécnicos* surrounding them.

Research surrounding high school vocational education has typically focused on labor market outcomes, examining the tensions between the tradeoffs of vocational high school in potentially substituting for the educational and career flexibility provided by general academic high school yet also teaching disadvantaged students valuable skills for the job market they would not have obtained otherwise (Bertrand et al., 2019). Some papers illustrate a positive relationship between vocational secondary education and earnings (Mane, 1999; Bishop and Mane, 2005; Meer, 2007), while some find only a positive association between vocational education and employment probabilities, but not earnings (Ryan, 2001; Hampf and Woessmann, 2017). Most recently, Bertrand et al. (2019) extend this research by studying the effects of Reform 94 in Norway that sought to improve the quality of vocational education and offer vocational students a pathway to college, finding the reform increased enrollment in the vocational track, particularly improved social mobility among men, and reduced the gap in adult earnings between disadvantaged and less disadvantaged children by about 20%. Therefore, beyond academic outcomes, there remain opportunities to look at other impacts of *politécnicos* on certain variables as described in the aforementioned literature, such as college graduation, students' employment, students' wages, students' crime levels, and even rates of teen pregnancy, for example.

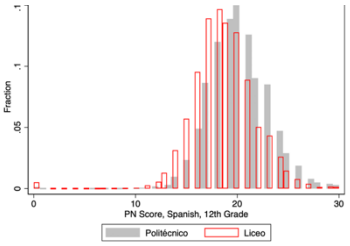
Tangible gains in education in the Dominican Republic have been slim, even in light of the considerable support under Medina's presidency, with policy hindered by minimum supervision and coherence, as well as high levels of heterogeneity. The World Bank has argued that one of the five

principal explanations for inequality and poverty in the Dominican Republic is low labor productivity due to the failure of the educational system to provide students with skills necessary in the labor market (USAID, 2013). My analysis has shown that *politécnicos* achieve significant net benefits in students' academic outcomes, a finding that is especially notable considering *politécnicos* are geared to equip students with vocational skills that span a range of sectors, from agriculture to radio production. Continuing to invest in vocational education, as well as adopting and implementing successful practices of *politécnicos* throughout the country's educational system, has the potential to significantly raise the Dominican Republic's level of human capital, yielding economic and social growth.

6 Figures

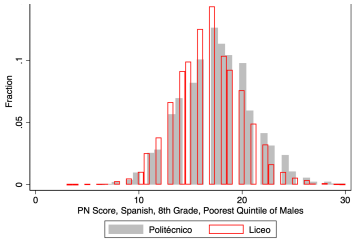


(a) 8th grade

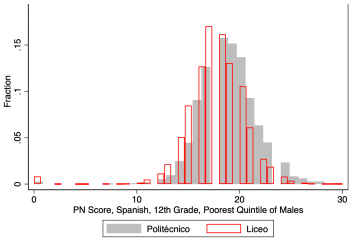


(b) 12th grade

Figure 1: Distribution of Students by Spanish PN Scores

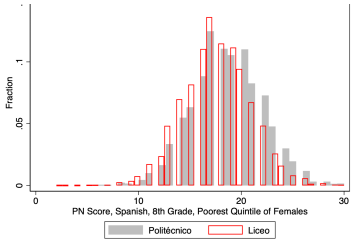


(a) 8th grade

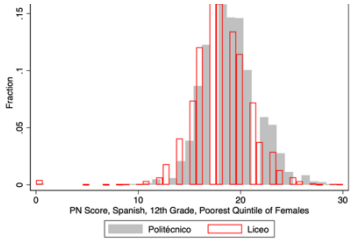


(b) 12th grade

Figure 2: Distribution of Poorest Male Spanish PN Scores

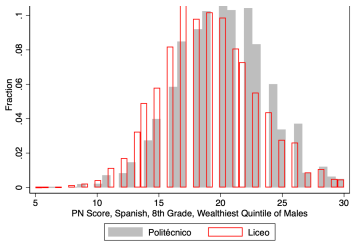


(a) 8th grade

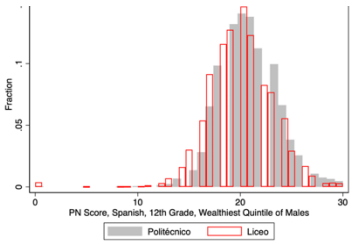


(b) 12th grade

Figure 3: Distribution of Poorest Female Spanish PN Scores

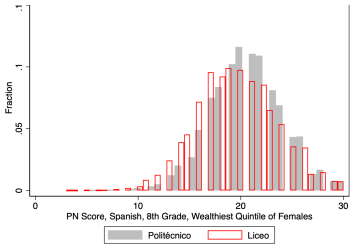


(a) 8th grade

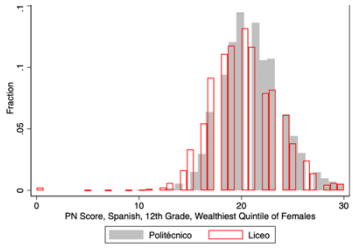


(b) 12th grade

Figure 4: Distribution of Wealthiest Male Spanish PN Scores



(a) 8th grade



(b) 12th grade

Figure 5: Distribution of Wealthiest Female Spanish PN Scores

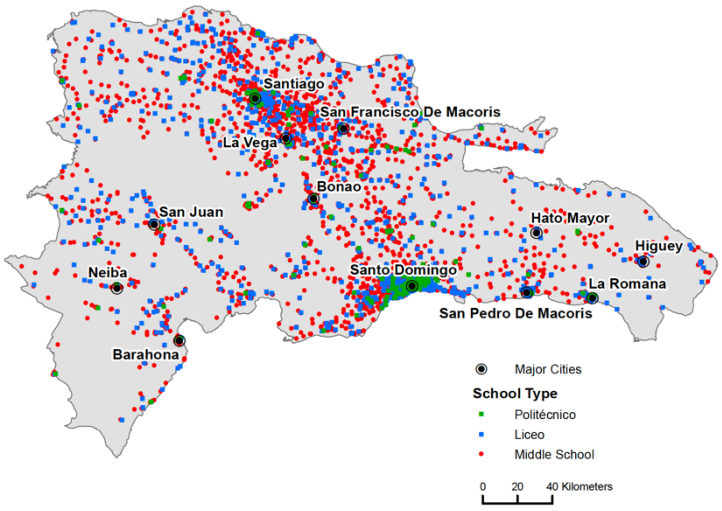


Figure 6: Geospatial Mapping of All Schools

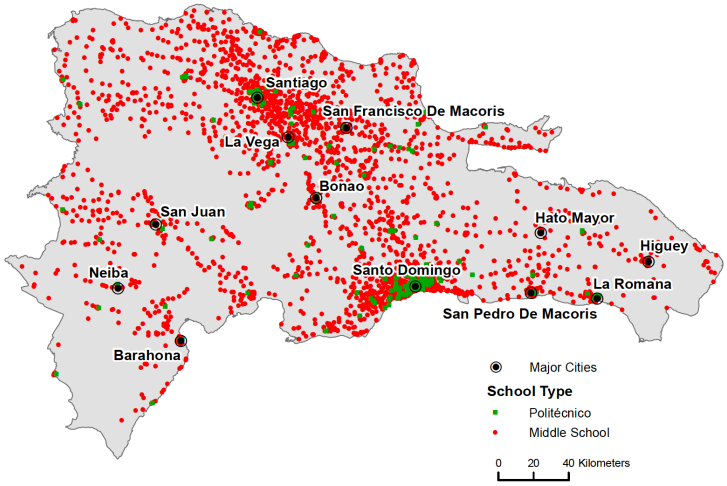
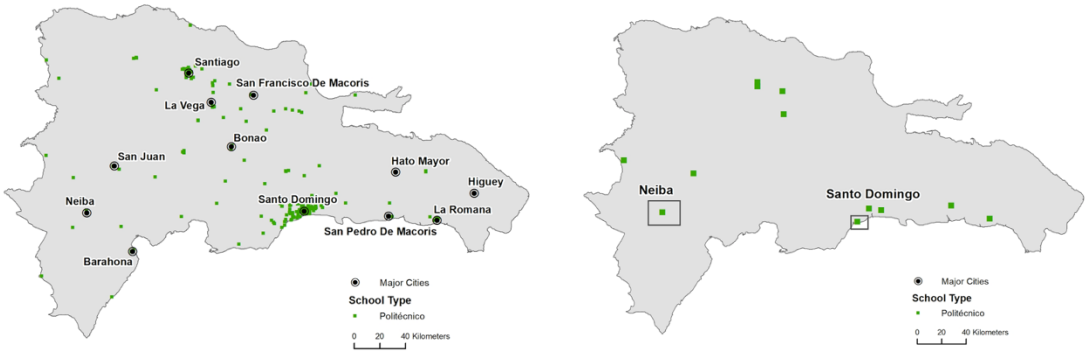


Figure 7: Geospatial Mapping of Middle Schools and *Politécnicos*



(a) All *Politécnicos* (b) Opened 2012-2014

Figure 8: Geospatial Mapping of *Politécnicos*

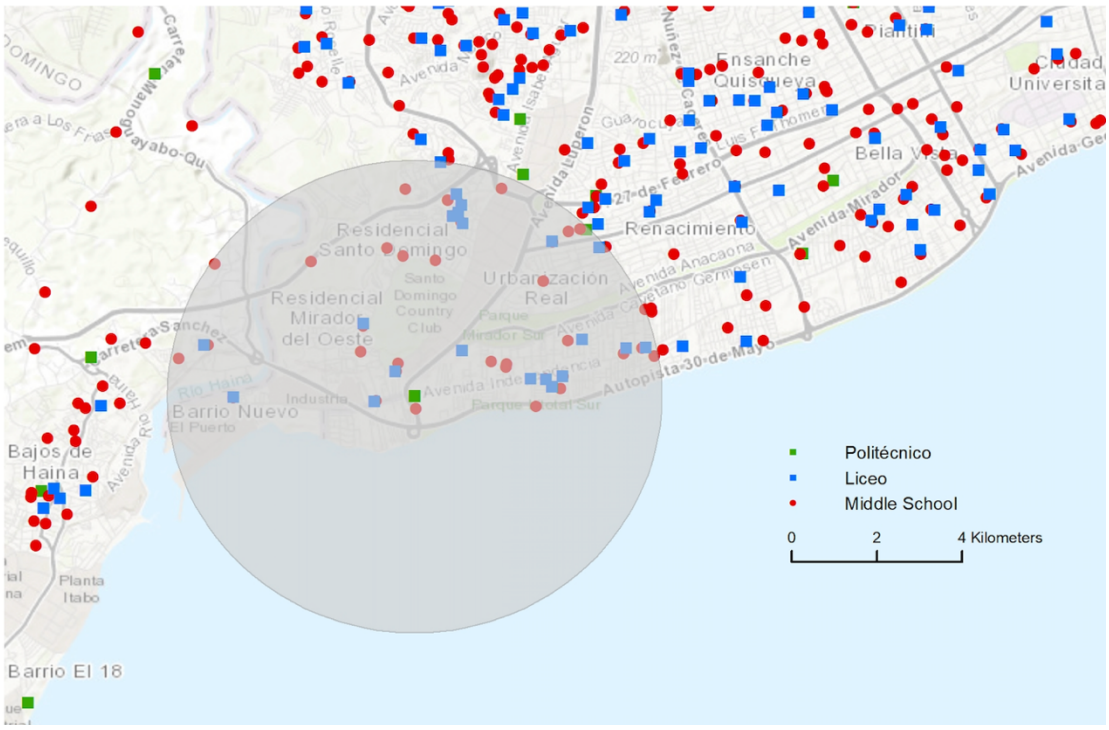


Figure 9: Schools Within 3 KM of New *Politécnico* in Santo Domingo

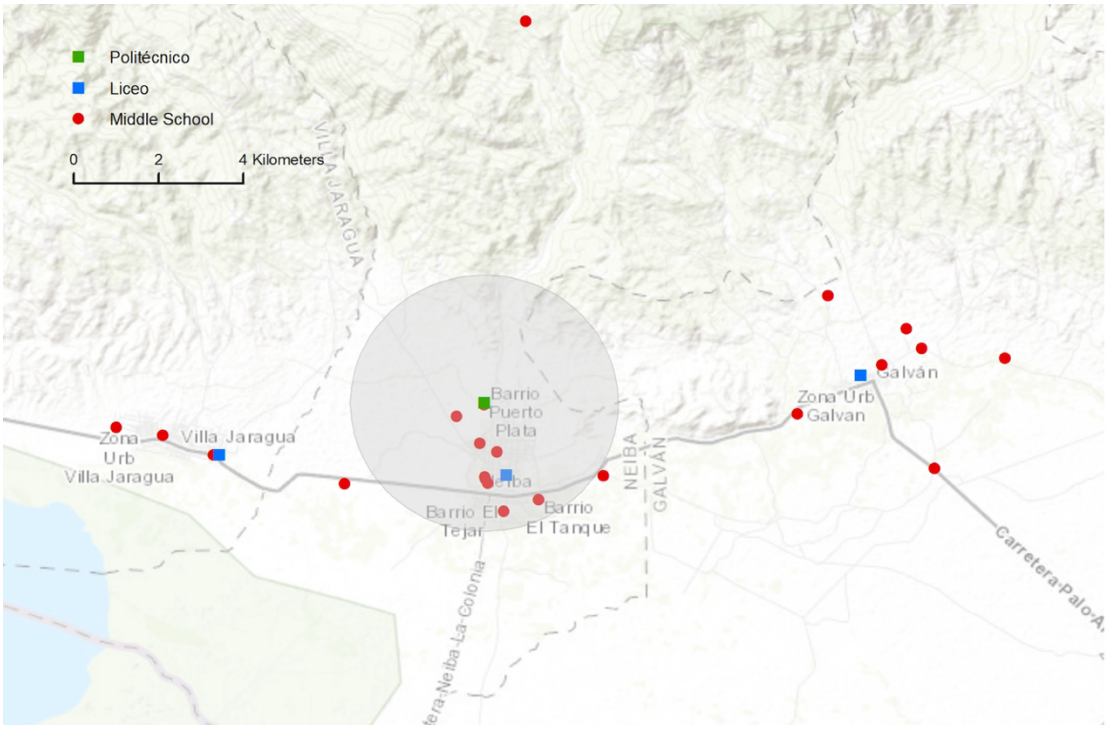


Figure 10: Schools Within 3 KM of New *Politécnico* in Neiba

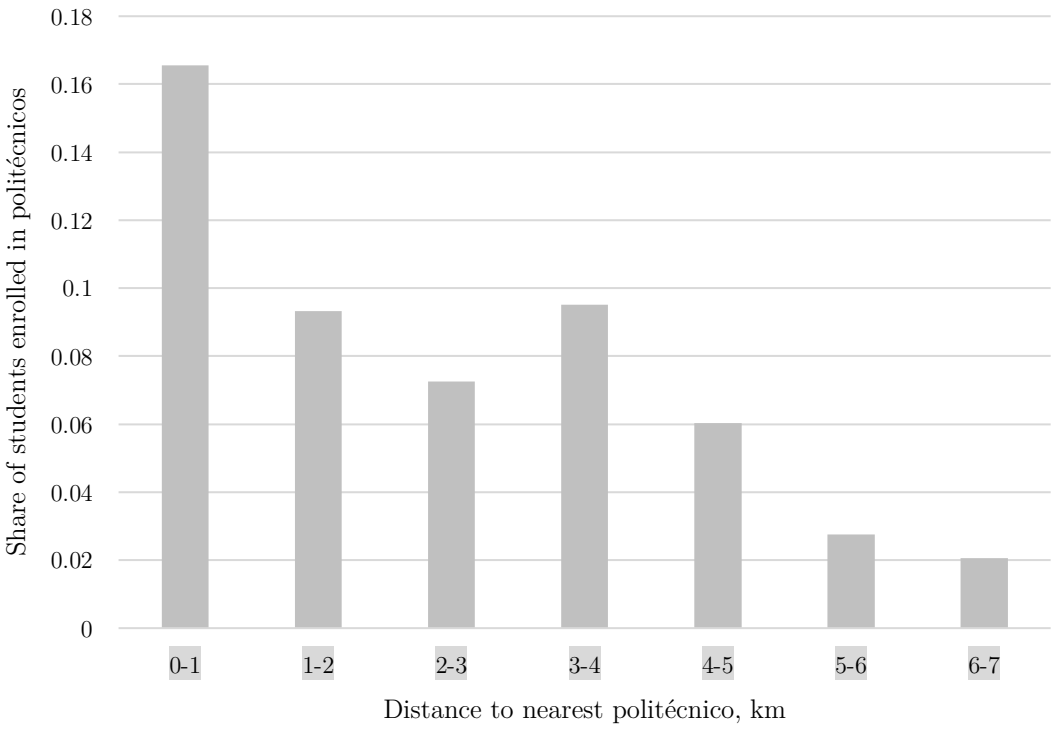


Figure 11: *Politécnico* Enrollment Based on Distance

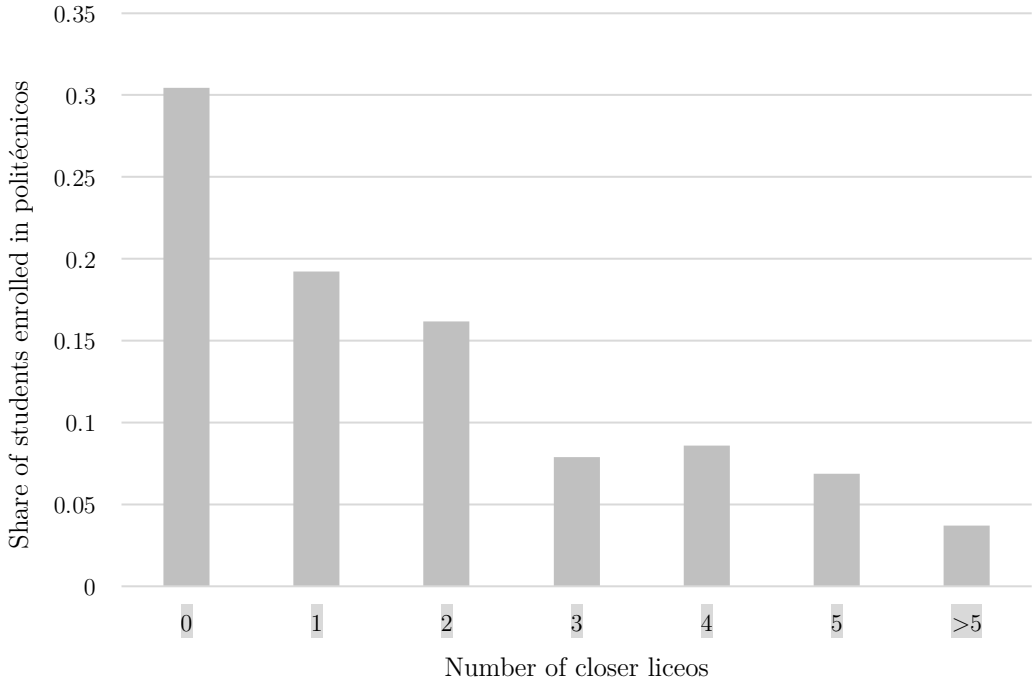


Figure 12: *Politécnico* Enrollment Based on Number of Closer *Liceos*

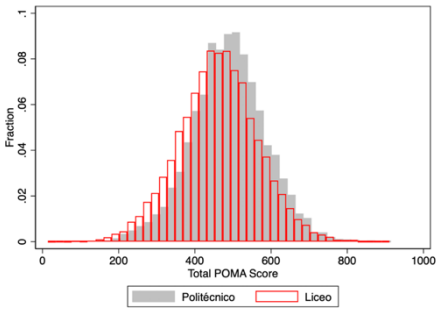
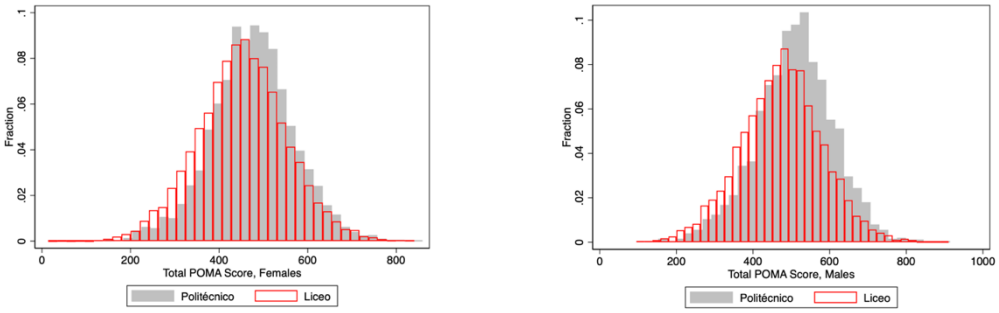
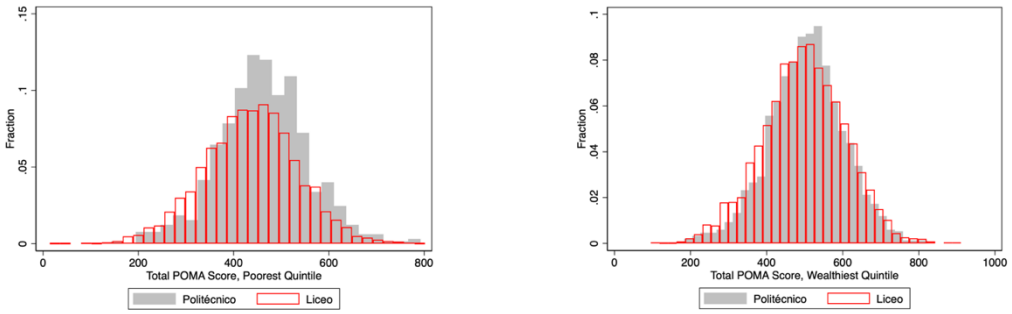


Figure 13: Distribution of Total POMA Score



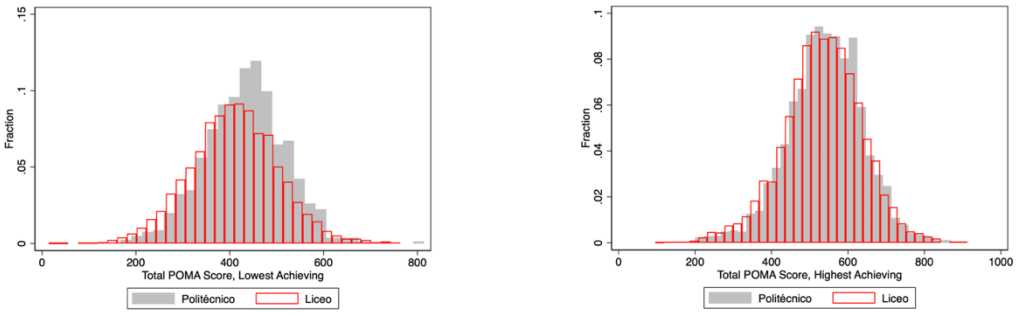
(a) Female (b) Male

Figure 14: Distribution of Total POMA Score by Gender



(a) Poorest (b) Wealthiest

Figure 15: Distribution of Total POMA Score by Wealth



(a) Lowest (b) Highest

Figure 16: Distribution of Total POMA Score by 8th Grade Achievement

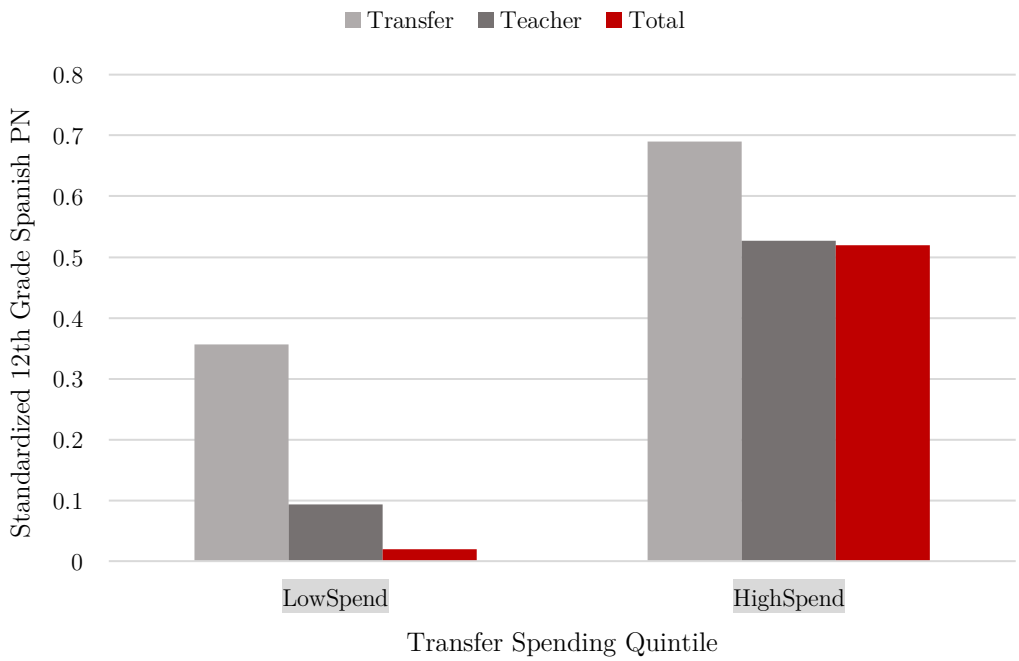


Figure 17: Intensity of *Politécnico* Impact on Standardized 12th Grade Spanish PN by Spending Quintile

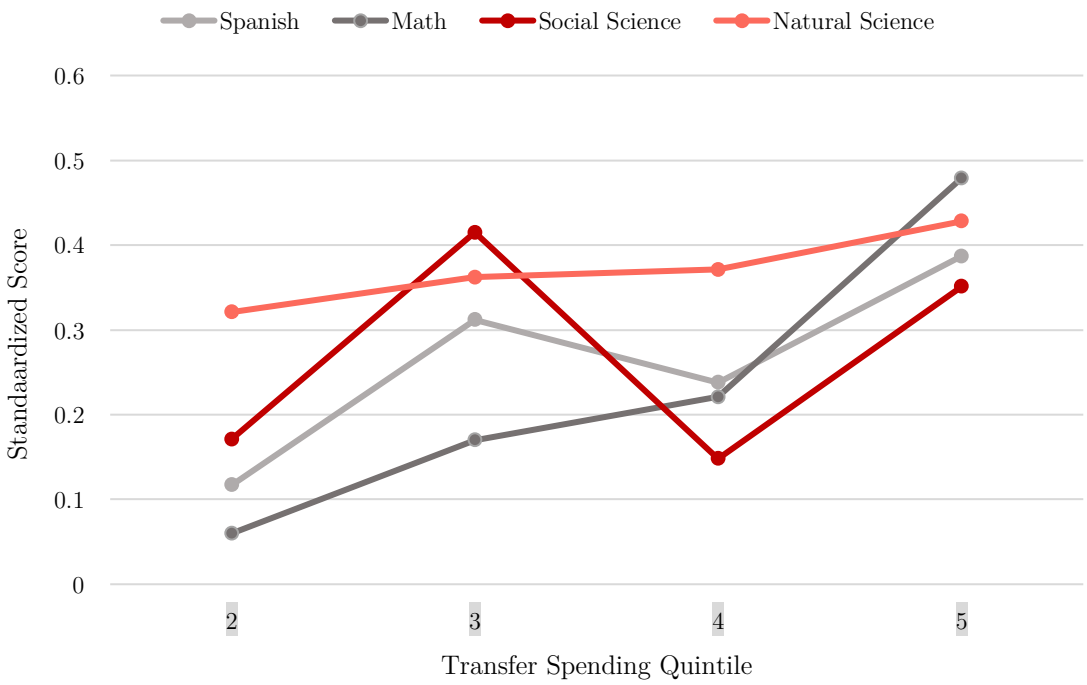


Figure 18: Estimated Relationship Between *Politécnico* Transfer Spending Quintile and PN

7 Tables

Table 1: Characteristics of *Politécnicos* and *Liceos*

	Politécnicos		***Liceos***	
	Number	Percentage	Number	Percentage
Schools	181	6.94	2,426	93.05
Public	129	71.27	1,571	64.76
Private	52	28.73	855	35.24
Authorized	76	41.99		
Converting	75	41.44		
Religious Order	69	38.12	118	4.86
Religious & Authorized	36	19.89		
Extended Day	130	71.82	432	17.81
Urban	167	92.27	1,876	77.33
Rural	14	7.73	550	22.67
Degrees Offered	5.52		2.18	
12^{th} Grade Size	144.29		63.74	
Wealth Quintile				
Quintile 1	3	1.88	98	6.75
Quintile 2	16	10.00	223	15.36
Quintile 3	39	24.38	293	20.18
Quintile 4	48	30.00	360	24.79
Quintile 5	54	33.75	478	32.92
Enrolling Classes				
Cohort				
2010	13,875	18.45	125,395	20.83
2011	14,418	19.17	114,800	19.07
2012	14,535	19.33	119,897	19.92
2013	15,652	20.82	118,747	19.68
2014	16,713	22.23	123,416	20.50
Students	75,193	11.10	601,982	88.90
Male	31,773	42.26	288,201	47.88
Female	43,420	57.74	313,781	52.12
Public 8^{th}	60,891	80.98	461,889	76.73
Private 8^{th}	14,302	19.02	140,093	23.27
Wealth Quintile of Students				
Quintile 1	7,907	10.77	128,931	21.67
Quintile 2	15,156	20.64	121,270	20.38
Quintile 3	20,225	27.54	121,723	20.46
Quintile 4	17,716	24.12	111,690	18.77
Quintile 5	12,439	16.94	111,339	18.71
Average 8^{th} PN Quintile				
Quintile 1	11,127	14.80	134,778	22.39
Quintile 2	13,068	17.38	120,240	19.97
Quintile 3	14,885	19.80	117,404	19.50
Quintile 4	17,347	23.07	117,890	19.58
Quintile 5	18,766	24.96	111,670	18.55

Table 1: Characteristics of *Politécnicos* and *Liceos* (continued)

	Politécnicos		***Liceos***	
	Number	Percentage	Number	Percentage
12th Grade Size Quintile				
Quintile 1	612	0.81	137,699	22.87
Quintile 2	6,297	8.37	126,785	21.06
Quintile 3	20,975	27.89	114,896	19.09
Quintile 4	28,265	37.59	106,305	17.66
Quintile 5	19,044	25.33	116,297	19.32
Dropout	21,262	20.81	220,345	36.60
Male	10,270	48.30	119,468	54.22
Female	10,992	51.70	100,877	45.78
Graduating Classes				
Repetition/Disruption	1,733	2.26	42,449	12.85
Male	950	54.82	21,665	51.04
Female	783	45.18	20,784	48.96
Pass 12th Grade	76,555	94.63	330,458	90.47
Male	28,863	37.70	145,910	44.15
Female	47,682	62.30	184,548	55.85
Apply College	25,079	31.00	83,734	22.92
Male	8,924	35.58	32,530	38.85
Female	16.155	64.42	51,204	61.15
Pass POMA	5,152	83.27	16,146	73.09
Male	2,171	42.14	7,310	45.27
Female	2,981	57.86	8,836	54.73
Enroll College	22,451	27.75	74,029	20.27
Male	7,864	35.03	28,125	37.99
Female	14,587	64.97	45,904	62.01

Table 2: Distance from *Politécnicos* and *Liceos*

	Middle Schools						**Students**					
	2012		2013		2014		2012		2013		2014	
	#	%	#	%	#	%	#	%	#	%	#	%
Politécnico												
0-1 km	1170	30	1193	30	1201	30	266175	36	272234	37	275421	37
1-2 km	591	15	600	15	600	15	122071	17	123947	17	123251	17
2-3 km	252	6	251	6	253	6	47188	6	47414	6	47559	6
3-4 km	168	4	164	4	166	4	29636	4	28322	4	28778	4
4-5 km	136	3	131	3	130	3	22896	3	21708	3	21469	3
$>$ 5 km	1554	39	1532	39	1521	38	236956	32	231297	31	228444	31
No data	86	2	86	2	86	2	11244	2	11244	2	11244	2
Liceo												
0-1 km	2557	65	2557	65	2557	65	554989	75	554989	75	554989	75
1-2 km	390	10	390	10	390	10	60956	8	60956	8	60956	8
2-3 km	311	8	311	8	311	8	36491	5	36491	5	36491	5
3-4 km	211	5	211	5	211	5	22001	3	22001	3	22001	3
4-5 km	146	4	146	4	146	4	14497	2	14497	2	14497	2
$>$ 5 km	256	7	256	7	256	7	35988	5	35988	5	35988	5
No data	86	2	86	2	86	2	11244	2	11244	2	11244	2

Table 3: Estimating Probability of *Politécnico* Enrollment

	Dependent variable: Politécnico enrollment	
	(Model 1)	(Model 2)
	OLS	Logistic
*Politécnico*Distance	-0.009***	-0.021***
	(0.001)	(2.37e-04)
*Politécnico*Distance^2	3.63e-04***	0.001***
	(5.63e-05)	(1.27e-05)
ClosestSchoolIs*Politécnico*	0.192***	0.088***
	(0.008)	(0.001)
Sex	-1.44e-05	0.005***
	(0.001)	(0.001)
Public8	0.026***	0.054***
	(0.005)	(0.001)
GPA8Spanish	0.003***	0.002***
	(1.26e-04)	(1.19e-04)
GPA8Math	0.001***	1.31e-04
	(1.15e-04)	(1.17e-04)
GPA8Social	0.001***	0.001***
	(1.26e-04)	(1.18e-04)
GPA8Natural	0.002***	0.001***
	(1.29e-04)	(1.21e-04)
PN8Spanish	0.003***	0.005***
	(1.13e-04)	(1.10e-04)
PN8Math	0.001***	0.001***
	(1.18e-04)	(1.13e-04)
PN8Social	0.001***	3.25e-04**
	(1.27e-04)	(1.22e-04)
PN8Natural	0.001***	0.001***
	(1.31e-04)	(1.26e-04)
Wealth Quintile		
Quint2	0.021**	0.013***
	(0.008)	(0.001)
Quint3	0.033***	0.013***
	(0.009)	(0.001)
Quint4	0.016	0.003*
	(0.009)	(0.001)
Quint5	-0.012	-0.027***
	(0.009)	(0.001)
Cohort		
2011	0.008***	0.009***
	(0.001)	(0.001)
2012	0.009***	0.005***
	(0.001)	(0.001)
2013	0.014***	0.011***
	(0.001)	(0.001)
2014	0.015***	0.010***
	(0.001)	(0.001)
cons	-0.441***	
	(0.009)	
N	661,416	661,416
R^2	0.090	

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table 4: Estimating Probability of *Politécnico* Enrollment with Distance Dummy Variables

	Dependent variable: Politécnico Enrollment		*Dependent variable: Politécnico Enrollment; Liceo within 2 KM*	
	(Model 1) OLS	(Model 2) Logistic	(Model 3) OLS	(Model 4) Logistic
Distance Dummy Variables				
Between 0-1 km	0.061***	0.167***	0.056***	0.162***
	(0.005)	(0.001)	(0.005)	(0.001)
Between 1-2 km	0.066***	0.098***	0.063***	0.097***
	(0.005)	(0.001)	(0.005)	(0.002)
Between 2-3 km	0.018**	0.073***	0.017**	0.070***
	(0.006)	(0.002)	(0.006)	(0.003)
Between 3-4 km	0.009	0.090***	0.008	0.087***
	(0.007)	(0.002)	(0.007)	(0.002)
Between 4-5 km	0.003	0.046***	0.005	0.048***
	(0.007)	(0.002)	(0.007)	(0.002)
Between 5-6 km	-0.006	-0.015***	-0.006	-0.016***
	(0.009)	(0.003)	(0.010)	(0.003)
Controls	Yes	Yes	Yes	Yes
cons	-0.474		-0.475	
	(0.009)		(0.010)	
N	628,458	628,458	668,396	668,396
R^2	0.042		0.040	

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table 5: 2SLS Model of *Politécnico* Impact on High School Outcomes

	Dependent variable: High school outcomes			
	(1) Dropout	(2) Years	(3) On Time Grad	(4) Graduation
Politécnico	-0.013	0.051	0.045***	0.058
	(0.044)	(0.129)	(0.018)	(0.047)
Sex	-0.047***	0.065***	0.019***	0.048***
	(0.002)	(0.004)	(0.001)	(0.002)
Public8	0.055***	-0.060***	-0.025***	-0.066***
	(0.005)	(0.013)	(0.004)	(0.006)
GPA8Spanish	-0.007***	0.013***	0.002***	0.009***
	(4.07e-04)	(0.001)	(2.51e-04)	(4.44e-04)
GPA8Math	-0.001**	0.001	0.001**	0.002***
	(3.29e-04)	(0.001)	(2.07e-04)	(3.54e-04)
GPA8Social	-0.006***	0.008***	0.002***	0.007***
	(3.71e-04)	(0.001)	(2.751-04)	(3.93e-04)
GPA8Natural	-0.004***	0.007***	0.001***	0.005***
	(3.76e-04)	(0.001)	(2.60e-04)	(3.94e-04)
PN8Spanish	-0.011***	0.018***	0.002***	0.016***
	(4.58e-04)	(0.001)	(2.71e-04)	(4.90e-04)
PN8Math	-0.002***	0.003***	2.76e-04	0.003***
	(3.21e-04)	(0.001)	(1.94e-04)	(3.37e-04)
PN8Social	-0.004***	0.001	0.002***	0.006***
	(3.33e-04)	(0.001)	(2.36e-04)	(3.54e-04)
PN8Natural	-0.003***	0.003***	0.001***	0.004***
	(3.54e-04)	(0.001)	(2.27e-04)	(3.59e-04)

Table 5: 2SLS Model of *Politécnico* Impact on High School Outcomes (Continued)

	Dependent variable: High school outcomes			
	(1)	(2)	(3)	(4)
	Dropout	Years	On-Time Grad	Graduation
Wealth Quintile				
Quint2	0.002	0.006	1.39e-04	-0.003
	(0.006)	(0.017)	(0.004)	(0.006)
Quint3	0.021**	0.035	0.002	-0.025***
	(0.007)	(0.030)	(0.004)	(0.007)
Quint4	0.006	0.085***	-0.001	-0.012
	(0.008)	(0.018)	(0.004)	(0.008)
Quint5	-0.015*	0.120***	0.003	0.013
	(0.007)	(0.017)	(0.005)	(0.008)
Cohort				
2011	-0.002	-0.014*	0.002	0.009**
	(0.003)	(0.006)	(0.002)	(0.003)
2012	0.002	-0.050***	0.014***	0.013***
	(0.003)	(0.008)	(0.002)	(0.003)
2013	0.065***	-0.130***	0.027***	-0.049***
	(0.004)	(0.009)	(0.002)	(0.004)
2014	0.151***	-0.247***		-0.131***
	(0.004)	(0.010)		(0.004)
cons	1.735***	1.506***	-0.461***	-1.151***
	(0.030)	(0.077)	(0.004)	(0.032)
N	661,416	661,416	199,126	661,416
R^2	0.087	0.044	0.034	0.118

Standard errors in parentheses. Two-tailed test.

* p < 0.05, ** p < 0.01, *** p < 0.001

Table 6: 2SLS Model of *Politécnico* Impact on On-Time Graduation for Differing *Politécnico* Profiles

	(1)	(2)	(3)	(4)
	On-Time Grad	On-Time Grad	On-Time Grad	On-Time Grad
PoliAuthorized	0.060*			
	(0.026)			
PoliConverting		0.061		
		(0.039)		
PoliReligious			0.057*	
			(0.030)	
PoliAuthReligious				0.079
				(0.042)
Controls	Yes	Yes	Yes	Yes
cons	-0.456***	-0.492***	-0.471***	-0.464***
	(0.022)	(0.017)	(0.020)	(0.023)
N	188,890	180,518	183,081	179,929
R^2	0.033	0.033	0.033	0.032

Standard errors in parentheses. Two-tailed test.

* p < 0.05, ** p < 0.01, *** p < 0.001

Table 7: 2SLS Model of *Politécnico* Impact on Standardized 12th Grade PN Scores

	Dependent variable: 12th grade standardized PN scores			
	(1)	(2)	(3)	(4)
	Spanish	Math	Social	Natural
Politécnico	0.367***	0.218	0.224*	0.244*
	(0.105)	(0.133)	(0.116)	(0.123)
Sex	-0.011***	-0.158***	-0.166***	-0.118***
	(0.005)	(0.007)	(0.006)	(0.006)
Public8	-0.212***	-0.226***	-0.250***	-0.252***
	(0.023)	(0.029)	(0.027)	(0.030)
GPA8Spanish	0.015***	0.001	0.004***	0.004*
	(0.001)	(0.002)	(0.002)	(0.002)
GPA8Math	0.003***	0.011***	0.001	0.003*
	(0.001)	(0.002)	(0.001)	(0.001)
GPA8Social	0.007***	-0.001	0.008***	0.001
	(0.001)	(0.002)	(0.002)	(0.002)
GPA8Natural	0.004***	-0.001	4.83e-04	-0.002
	(0.001)	(0.002)	(0.001)	(0.002)
PN8Spanish	0.095***	0.060***	0.058***	0.057***
	(0.001)	(0.002)	(0.002)	(0.002)
PN8Math	0.014***	0.042***	0.018***	0.024***
	(0.001)	(0.002)	(0.002)	(0.002)
PN8Social	0.026***	0.015***	0.036***	0.018***
	(0.001)	(0.002)	(0.002)	(0.002)
PN8Natural	0.015***	0.019***	0.020***	0.021***
	(0.001)	(0.002)	(0.002)	(0.002)
Wealth Quintile				
Quint2	0.128***	0.020	-0.007	0.029
	(0.011)	(0.026)	(0.026)	(0.025)
Quint3	0.189***	0.083*	0.038	0.116**
	(0.012)	(0.037)	(0.035)	(0.039)
Quint4	0.048***	0.164***	0.121***	0.173***
	(0.012)	(0.034)	(0.033)	(0.033)
Quint5	0.260***	0.383***	0.298***	0.331***
	(0.013)	(0.033)	(0.033)	(0.034)
Cohort				
2011	0.128***	0.079***	0.093***	0.101***
	(0.011)	(0.014)	(0.014)	(0.015)
2012	0.189***	0.205***	0.299***	0.334***
	(0.012)	(0.017)	(0.017)	(0.016)
2013	0.048***	0.300***	0.312***	0.372***
	(0.012)	(0.016)	(0.017)	(0.017)
2014	0.260***	0.167***	0.335***	0.331***
	(0.013)	(0.016)	(0.018)	(0.018)
cons	-4.449***	-2.972***	-3.094***	-2.550***
	(0.101)	(0.132)	(0.123)	(0.127)
N	244,393	244,393	244,393	244,393
R^2	0.376	0.278	0.269	0.247

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table 8: 2SLS Model of *Politécnico* Impact on 12th Grade Standardized PN Scores for Differing *Politécnico* Profiles

	Dependent variable: 12th grade standardized PN score			
	(1)	(2)	(3)	(4)
	Spanish	Math	Social	Natural
PoliAuthorized	0.505***	0.401*	0.369*	0.432*
	(0.156)	(0.196)	(0.186)	(0.198)
PoliConverting	0.422	0.228	0.166	0.234
	(0.227)	(0.280)	(0.261)	(0.288)
PoliReligious	0.541***	0.469*	0.382*	0.469*
	(0.170)	(0.216)	(0.203)	(0.216)
PoliAuthReligious	0.676**	0.623*	0.504	0.625*
	(0.244)	(0.306)	(0.277)	(0.310)

Each cell is a different regression, with the same controls as the standard 2SLS model. Each cell displays the impact of the *politécnico* profile on the standardized 12th grade PN score of the given subject.
Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table 9: 2SLS Model of *Politécnico* Impact on 12th Grade Standardized Spanish PN Scores for Differing Student and *Politécnico* Profiles

	Dependent variable: 12th grade standardized Spanish PN scores				
	(1)	(2)	(3)	(4)	(5)
	Poli	PoliAuth	PoliConv	PoliReligious	PoliAuthRel
Male	0.507***	0.724***	0.663*	0.757***	0.998***
	(0.120)	(0.184)	(0.269)	(0.200)	(0.299)
Female	0.280**	0.374**	0.268	0.411**	0.485*
	(0.100)	(0.146)	(0.214)	(0.159)	(0.223)
Wealth Quintiles 1-3	0.477***	0.660***	0.623***	0.760***	0.936***
	(0.096)	(0.158)	(0.200)	(0.181)	(0.274)
Male	0.694***	1.002***	0.986***	1.136***	1.467***
	(0.116)	(0.202)	(0.260)	(0.243)	(0.376)
Female	0.341***	0.451***	0.391*	0.529***	0.612**
	(0.089)	(0.139)	(0.178)	(0.158)	(0.230)
Wealth Quintiles 4-5	0.720***	0.771***	2.645	0.708***	1.128***
	(0.198)	(0.205)	(1.903)	(0.197)	(0.347)
Male	0.820**	0.890***	3.396	0.753***	1.335**
	(0.259)	(0.269)	(2.694)	(0.241)	(0.452)
Female	0.661***	0.702***	2.253	0.674***	1.010**
	(0.177)	(0.183)	(1.562)	(0.186)	(0.314)
Lowest Scoring	0.371**	0.567**	0.454	0.695**	0.917*
	(0.121)	(0.213)	(0.235)	(0.274)	(0.421)
Male	0.593***	0.948***	0.829*	1.181**	1.645**
	(0.157)	(0.283)	(0.324)	(0.396)	(0.600)
Female	0.195	0.271	0.160	0.348	0.374
	(0.110)	(0.188)	(0.205)	(0.227)	(0.354)
Highest Scoring	0.381**	0.485**	0.445	0.477**	0.593**
	(0.122)	(0.164)	(0.290)	(0.165)	(0.226)
Male	0.465***	0.605***	0.552	0.576***	0.727**
	(0.136)	(0.183)	(0.333)	(0.178)	(0.247)
Female	0.337**	0.421**	0.386	0.422**	0.520*
	(0.118)	(0.160)	(0.278)	(0.163)	(0.222)
Public	0.343***	0.473**	0.327	0.525**	0.617*
	(0.105)	(0.159)	(0.211)	(0.178)	(0.245)
Male	0.481***	0.696***	0.558*	0.764***	0.953**
	(0.120)	(0.187)	(0.247)	(0.212)	(0.303)
Female	0.256*	0.338*	0.177	0.381*	0.418*
	(0.101)	(0.149)	(0.203)	(0.167)	(0.225)
Private	0.305	0.359	0.638	0.275	0.493
	(0.269)	(0.330)	(1.008)	(0.271)	(0.517)
Male	0.442	0.520	0.896	0.356	0.644
	(0.337)	(0.417)	(1.252)	(0.321)	(0.595)
Female	0.224	0.265	0.479	0.224	0.392
	(0.251)	(0.307)	(0.938)	(0.263)	(0.509)

Each cell is a different regression, with the same controls as the standard 2SLS model. Each cell displays the impact of the specific *politécnico* profile on the standardized 12th grade Spanish PN scores of the specific student profile.
Standard errors in parentheses. Two-tailed test.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: 2SLS Model of *Politécnico* Impact on 12th Grade Standardized Spanish PN Scores for Differing School Profiles

	Dependent variable: 12th grade standardized Spanish PN scores				
	(1)	(2)	(3)	(4)	(5)
	Poli	PoliAuth	PoliConv	PoliReligious	PoliAuthRel
Wealth Quintiles 1-3	0.313**	0.477*	0.294	0.526*	0.585
	(0.131)	(0.246)	(0.205)	(0.223)	(0.339)
Male	0.388**	0.647*	0.389	0.661**	0.825*
	(0.136)	(0.271)	(0.213)	(0.246)	(0.394)
Female	0.259*	0.361	0.224	0.437*	0.429
	(0.132)	(0.241)	(0.208)	(0.219)	(0.321)
Wealth Quintiles 4-5	0.405**	0.477**	0.585	0.466*	0.670*
	(0.157)	(0.183)	(0.572)	(0.204)	(0.304)
Male	0.639**	0.745**	1.073	0.717**	1.056**
	(0.212)	(0.240)	(0.927)	(0.256)	(0.400)
Female	0.275*	0.325*	0.278	0.314	0.447
	(0.136)	(0.160)	(0.451)	(0.183)	(0.266)
Grade Size Quintiles 1-3	0.259*	0.322	0.252	0.319	0.383
	(0.127)	(0.199)	(0.246)	(0.174)	(0.298)
Male	0.350**	0.467*	0.434	0.438*	0.570
	(0.144)	(0.233)	(0.292)	(0.199)	(0.350)
Female	0.201	0.231	0.140	0.247	0.266
	(0.123)	(0.190)	(0.231)	(0.169)	(0.283)
Grade Size Quintiles 4-5	0.574**	0.756**	0.825	0.950**	1.048**
	(0.197)	(0.266)	(0.519)	(0.366)	(0.408)
Male	0.780***	1.045***	1.109	1.312**	1.503**
	(0.224)	(0.308)	(0.594)	(0.451)	(0.505)
Female	0.451*	0.587*	0.633	0.741*	0.793*
	(0.187)	(0.246)	(0.488)	(0.331)	(0.364)
Public	0.326**	0.450**	0.287	0.510**	0.586*
	(0.103)	(0.154)	(0.204)	(0.181)	(0.241)
Male	0.454***	0.659***	0.490*	0.737***	0.900**
	(0.116)	(0.180)	(0.232)	(0.215)	(0.295)
Female	0.247**	0.325*	0.157	0.376*	0.405
	(0.099)	(0.146)	(0.198)	(0.170)	(0.223)
Private	0.520	0.577	0.930	0.268	0.714
	(0.587)	(0.720)	(2.009)	(0.357)	(1.105)
Male	0.596	0.581	1.609	0.361	0.833
	(0.642)	(0.763)	(2.665)	(0.393)	(1.079)
Female	0.453	0.563	0.557	0.209	0.629
	(0.586)	(0.730)	(1.767)	(0.359)	(1.107)
Religious Order				0.524***	0.655**
				(0.165)	(0.238)
Male				0.731***	0.966***
				(0.194)	(0.290)
Female				0.398**	0.471*
				(0.155)	(0.218)
Extended Day	0.290***	0.416***	0.279	0.437***	0.554***
	(0.086)	(0.116)	(0.147)	(0.124)	(0.168)
Male	0.362***	0.518***	0.368*	0.532***	0.699***
	(0.093)	(0.128)	(0.163)	(0.138)	(0.192)
Female	0.246**	0.354**	0.223	0.380***	0.469**
	(0.084)	(0.112)	(0.142)	(0.120)	(0.159)

Each cell is a different regression, with the same controls as the standard 2SLS model. Each cell displays the impact of the specific *politécnico* profile on a student's standardized 12th grade Spanish PN scores.
Standard errors in parentheses. Two-tailed test.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: Effect of *Politécnico* Profiles on 12th Grade Standardized PN Scores

	Dependent variable: 12th grade standardized PN scores			
	(1)	(2)	(3)	(4)
	Spanish	Math	Social	Natural
Authorized	0.040	-0.018	0.037	0.079**
	(0.030)	(0.035)	(0.029)	(0.029)
Private	0.055*	-2.46e-04	0.037	0.051
	(0.023)	(0.030)	(0.031)	(0.028)
ReligiousOrder	0.140***	0.292***	0.189***	0.176***
	(0.020)	(0.029)	(0.031)	(0.028)
ExtendedDay	0.182***	0.160***	0.115***	0.088***
	(0.023)	(0.027)	(0.027)	(0.025)
Degrees Offered				
Quint2	0.079	-0.141	0.060	-0.079
	(0.113)	(0.152)	(0.191)	(0.142)
Quint3	0.067	-0.207	0.068	-0.081
	(0.115)	(0.151)	(0.192)	(0.146)
Quint4	0.119	-0.145	0.165	-0.018
	(0.115)	(0.151)	(0.194)	(0.146)
Quint5	0.311**	0.015	0.231	0.119
	(0.115)	(0.153)	(0.191)	(0.146)
Wealth Quintile				
Quint2	-0.043	-0.235***	-0.180***	-0.064
	(0.032)	(0.050)	(0.047)	(0.041)
Quint3	0.028	-0.208***	-0.110*	0.052
	(0.036)	(0.048)	(0.052)	(0.045)
Quint4	0.021	-0.179***	-0.059	0.063
	(0.029)	(0.046)	(0.043)	(0.039)
Quint5	-0.022	-0.168***	-0.008	0.033
	(0.037)	(0.049)	(0.046)	(0.041)
Grade Size Quintile				
Quint2	0.079	0.056	0.003	0.052
	(0.113)	(0.034)	(0.028)	(0.027)
Quint3	0.066	0.200***	0.103**	0.124**
	(0.115)	(0.039)	(0.033)	(0.032)
Quint4	0.119	0.114***	0.099**	0.126***
	(0.115)	(0.036)	(0.034)	(0.032)
Quint5	0.311**	0.125***	0.175***	0.105**
	(0.115)	(0.038)	(0.033)	(0.033)
Sex	-0.087***	-0.205***	-0.203***	-0.167***
	(0.009)	(0.011)	(0.010)	(0.010)
Controls	Yes	Yes	Yes	Yes
cons	-4.522***	-3.411***	-3.508***	-2.899***
	(0.145)	(0.201)	(0.219)	(0.172)
N	39,457	39,457	39,457	39,457
R^2	0.355	0.216	0.223	0.199

Standard errors in parentheses. Two-tailed test.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: Effect of *Liceo* Profiles on 12th Grade Standardized PN Scores

	Dependent variable: 12th grade standardized PN scores			
	(1)	(2)	(3)	(4)
	Spanish	Math	Social	Natural
Private	0.086***	0.071*	0.137***	-0.021
	(0.023)	(0.031)	(0.027)	(0.033)
ReligiousOrder	0.110***	0.106***	0.095***	0.230***
	(0.017)	(0.022)	(0.021)	(0.025)
ExtendedDay	0.192***	0.199***	0.173***	0.142***
	(0.011)	(0.012)	(0.012)	(0.012)
Wealth Quintile				
Quint2	0.004	0.018	-0.024	0.060***
	(0.014)	(0.017)	(0.017)	(0.017)
Quint3	-0.002	3.78e-05	-0.032	0.024
	(0.016)	(0.017)	(0.018)	(0.017)
Quint4	0.021	0.022	0.020	0.068***
	(0.016)	(0.020)	(0.020)	(0.019)
Quint5	0.035**	0.217***	0.208***	0.299***
	(0.013)	(0.021)	(0.020)	(0.020)
Grade Size Quintile				
Quint2	0.013	0.049***	0.032*	0.035**
	(0.012)	(0.014)	(0.014)	(0.014)
Quint3	0.037**	0.070***	0.044***	0.056***
	(0.012)	(0.013)	(0.014)	(0.014)
Quint4	0.046***	0.091***	0.047***	0.052***
	(0.012)	(0.014)	(0.014)	(0.014)
Quint5	0.035***	0.051***	0.014	0.028*
	(0.013)	(0.015)	(0.014)	(0.014)
Sex	-0.064***	-0.154***	-0.168***	-0.123***
	(0.005)	(0.005)	(0.005)	(0.005)
Controls	Yes	Yes	Yes	Yes
cons	-4.213***	-2.583***	-2.808***	-2.323***
	(0.041)	(0.060)	(0.053)	(0.056)
N	153,450	153,450	153,450	153,450
R^2	0.220	0.077	0.101	0.079

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table 13: 2SLS Model of *Politécnico* Impact on College Outcomes

	Dependent variable: College outcomes			
	(1)	(2)	(3)	(4)
	Apply College	Fail POMA	Total POMA	Enroll College
Politécnico	0.054*	-0.101*	0.294***	0.032
	(0.024)	(0.044)	(0.111)	(0.024)
Sex	0.043***	0.068***	-0.270***	0.045***
	(0.002)	(0.006)	(0.015)	(0.002)
Public8	-0.037***	0.037***	-0.145***	-0.037***
	(0.005)	(0.011)	(0.028)	(0.006)
GPA8Spanish	0.003***	-0.004**	0.012***	0.003***
	(4.56e-04)	(0.001)	(0.003)	(4.38e-04)
GPA8Math	0.001**	-0.004***	0.015***	0.001**
	(3.74e-04)	(0.001)	(0.003)	(3.80e-04)
GPA8Social	0.003***	-4.28e-04	-4.19e-04	0.003***
	(4.17e-04)	(0.001)	(0.003)	(4.24e-04)
GPA8Natural	0.001**	-0.001	0.001	0.001**
	(4.38e-04)	(0.001)	(0.003)	(4.34e-04)
PN8Spanish	0.006***	-0.024***	0.083***	0.006***
	(4.62e-04)	(0.001)	(0.003)	(4.58e-04)
PN8Math	-0.001*	0.001	0.015***	-0.001*
	(4.36e-04)	(0.001)	(0.002)	(4.37e-04)
PN8Social	0.004***	-0.005***	0.013***	0.004***
	(4.19e-04)	(0.001)	(0.002)	(4.23e-04)
PN8Natural	2.99e-05	-0.002	0.009***	0.001
	(4.61e-04)	(0.001)	(0.003)	(4.59e-04)
Wealth Quintile				
Quint2	0.007	-0.030*	0.057	0.009
	(0.005)	(0.013)	(0.029)	(0.006)
Quint3	0.016*	-0.035*	0.082*	0.018**
	(0.007)	(0.015)	(0.034)	(0.007)
Quint4	0.019**	-0.077***	0.188***	0.023***
	(0.007)	(0.014)	(0.033)	(0.007)
Quint5	0.011	-0.071***	0.234***	0.015*
	(0.007)	(0.014)	(0.033)	(0.007)
Cohort				
2011	-0.063***	0.027***	-0.023	-0.073***
	(0.004)	(0.007)	(0.016)	(0.004)
2012	-0.397***	0.114***	-0.095***	-0.375***
	(0.005)	(0.010)	(0.024)	(0.005)
2013	-0.586***	0.214***	-0.391***	-0.540***
	(0.006)	(0.051)	(0.098)	(0.006)
2014	-0.594***	0.031	0.292	-0.546***
	(0.006)	(0.243)	(0.565)	(0.006)
cons	-0.060*	1.305***	-3.656***	-0.137***
	(0.030)	(0.058)	(0.135)	(0.029)
N	244,393	16,783	16,783	244,393
R^2	0.339	0.118	0.257	0.308

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table 14: 2SLS Model of *Politécnico* Impact on POMA Subscores

	Dependent variable: POMA subscores					
	(1)	(2)	(3)	(4)	(5)	(6)
	Verbal	Math	Perceptive	Natural	Social	Human
Politécnico	0.278**	0.377***	0.160	0.118	0.208*	0.062
	(0.108)	(0.110)	(0.097)	(0.097)	(0.105)	(0.112)
Sex	-0.048**	-0.276***	-0.234***	-0.211***	-0.183***	-0.078***
	(0.015)	(0.016)	(0.015)	(0.016)	(0.015)	(0.016)
Public8	-0.176***	-0.096***	-0.058*	-0.091***	-0.129***	-0.103***
	(0.028)	(0.027)	(0.026)	(0.025)	(0.027)	(0.027)
GPA8Spanish	0.013***	0.008*	0.006*	0.005	0.005	0.006
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
GPA8Math	0.008**	0.022***	0.013***	0.007*	0.008**	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
GPA8Social	-0.002	-0.005	-0.007*	0.005	0.007*	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
GPA8Natural	0.003	-0.002	0.003	0.001	-0.003	0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
PN8Spanish	0.061***	0.052***	0.061***	0.058***	0.047***	0.042***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
PN8Math	0.006**	0.029***	0.008**	0.003	0.012***	0.002
	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
PN8Social	0.012***	0.007***	0.008***	0.010***	0.010***	0.008**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
PN8Natural	0.009***	0.009***	0.003	0.013***	0.002	0.006*
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
Wealth Quint						
Quint2	0.037	0.020	0.086**	-0.014	0.054	0.020
	(0.030)	(0.029)	(0.028)	(0.028)	(0.029)	(0.030)
Quint3	0.077*	0.016	0.112***	-0.005	0.049	0.023
	(0.034)	(0.023)	(0.032)	(0.031)	(0.033)	(0.034)
Quint4	0.167***	0.064	0.208***	0.090**	0.140***	0.042
	(0.035)	(0.035)	(0.032)	(0.031)	(0.034)	(0.035)
Quint5	0.196***	0.122***	0.202***	0.116***	0.167***	0.094**
	(0.034)	(0.035)	(0.033)	(0.030)	(0.035)	(0.035)
Cohort						
2011	-0.035*	-0.009	0.009	-0.006	-0.042*	-0.051**
	(0.017)	(0.018)	(0.015)	(0.017)	(0.017)	(0.017)
2012	-0.212***	0.002	-0.023	-0.078***	-0.223***	-0.190***
	(0.024)	(0.023)	(0.025)	(0.022)	(0.024)	(0.025)
2013	-0.243*	-0.115	-0.171	-0.160	-0.568***	-0.512***
	(0.117)	(0.096)	(0.110)	(0.085)	(0.090)	(0.119)
2014	-0.117	0.134	0.731	-0.138	0.051	0.075
	(0.276)	(0.179)	(0.525)	(0.599)	(1.039)	(0.302)
cons	-2.861***	-2.966***	-2.309***	-2.429***	-2.097***	-1.673***
	(0.131)	(0.133)	(0.138)	(0.134)	(0.130)	(0.133)
N	16,783	16,783	16,783	16,783	16,783	16,783
R^2	0.160	0.149	0.127	0.122	0.110	0.068

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table 15: 2SLS Model of *Politécnico* Impact on College Outcomes for Differing *Politécnico* Profiles

	Dependent variable: 12th grade standardized PN scores					
	(1)	(2)	(3)	(4)	(5)	(6)
	Apply	Fail	Total	Verbal	Math	Social
PoliAuthorized	0.057	-0.116*	0.386*	0.321*	0.539***	0.291*
	(0.035)	(0.062)	(0.157)	(0.151)	(0.162)	(0.147)
PoliConverting	0.077	-0.166	0.449	0.431	0.675*	0.472
	(0.052)	(0.111)	(0.279))	(0.270)	(0.303)	(0.277)
PoliReligious	0.075*	-0.122*	0.367*	0.324**	0.473**	0.318*
	(0.038)	(0.062)	(0.156)	(0.149)	(0.161)	(0.148)
PoliAuthReli-	0.087	-0.149	0.477*	0.393	0.679**	0.416
gious	(0.055)	(0.091)	(0.237)	(0.223)	(0.254)	(0.227)

Each cell is a different regression, with the same controls as the standard 2SLS model. Each cell displays the impact of the specific *politécnico* profile on the given college outcome.
Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table 16: Summary Statistics of Spending

	Politécnicos			***Liceos***		
	Mean	Std. Dev	#Schools	Mean	St. Dev.	#Schools
Per Cap 2020 Teacher Spend	63,062	27,134	97	43,544	29,685	218
Average 2020 Teacher Salary	771,272	76,868	97	552,178	149,343	218
Per Cap Transfer Spend	6,154	5,796	146	1,945	168	1,102
2011	3,482	5,786	74			
2012	3,561	5,419	88			
2013	6,512	12,000	111			
2014	5,678	5,099	112			
2015	5,684	4,475	115			
2016	5,967	5,223	122			
2017	6,199	5,958	123			
2018	6,820	5,612	124			
2019	4,660	2,699	125	1,945	168	1,102
Per Cap Total Spend	68,125	26,141	90	47,062	43,159	213

Table 17: 2SLS Spending Treatment on *Politécnico* Impact on 12th Grade Standardized Spanish PN Scores

	Dependent variable: 12th grade standardized Spanish PN score					
	(1)	(2)	(3)	(4)	(5)	(6)
PoliLowTransferSpend	0.356**					
	(0.143)					
PoliHighTransferSpend		0.690**				
		(0.262)				
PoliLowTeacherSpend			0.093			
			(0.155)			
PoliHighTeacherSpend				0.527***		
				(0.162)		
PoliLowTotalSpend					0.020	
					(0.171)	
PoliHighTotalSpend						0.519***
						(0.144)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
cons	-4.411***	-4.388***	-4.517***	-4.402***	-4.430***	-4.430***
	(0.103)	(0.119)	(0.224)	(0.113)	(0.230)	(0.109)
N	230,767	221,776	37,643	206,750	35,107	209,286
R^2	0.368	0.368	0.341	0.377	0.314	0.381

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table 18: Effect of *Politécnico* Transfer Spending on 12th Grade Standardized PN Scores

	Dependent variable: 12th grade standardized PN scores			
	(1)	(2)	(3)	(4)
	Spanish	Math	Social	Natural
Transfer Spending				
Quint2	0.117***	0.060	0.171***	0.321***
	(0.017)	(0.033)	(0.040)	(0.037)
Quint3	0.312***	0.170***	0.415***	0.362***
	(0.019)	(0.047)	(0.042)	(0.046)
Quint4	0.238***	0.221***	0.148**	0.371***
	(0.019)	(0.052)	(0.050)	(0.052)
Quint5	0.387***	0.479***	0.351***	0.428***
	(0.020)	(0.049)	(0.046)	(0.044)
Controls	Yes	Yes	Yes	Yes
cons	-5.017***	-3.877***	-3.879***	-3.533***
	(0.107)	(0.124)	(0.124)	(0.120)
N	37,605	37,605	37,605	37,605
R^2	0.380	0.285	0.262	0.263

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table 19: Effect of *Politécnico* Teacher Spending on 12th Grade Standardized PN Scores

	Dependent variable: 12th grade standardized PN scores			
	(1)	(2)	(3)	(4)
	Spanish	Math	Social	Natural
Teacher Spending				
Quint2	-0.113**	-0.161***	-0.147***	-0.143***
	(0.037)	(0.040)	(0.044)	(0.044)
Quint3	-0.071	-0.228***	-0.146***	-0.112*
	(0.042)	(0.043)	(0.044)	(0.046)
Quint4	0.011	-0.040	-0.215***	-0.112*
	(0.047)	(0.048)	(0.050)	(0.048)
Quint5	-0.057	0.528***	0.049	-0.014
	(0.046)	(0.071)	(0.058)	(0.058)
Controls	Yes	Yes	Yes	Yes
cons	-4.701***	-3.635***	-3.520***	-3.110***
	(0.093)	(0.162)	(0.162)	(0.148)
N	29,103	29,103	29,103	29,103
R^2	0.369	0.226	0.243	0.248

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table 20: Effect of *Politécnico* Total Spending on 12th Grade Standardized PN Scores

	Dependent variable: 12th grade standardized PN scores			
	(1)	(2)	(3)	(4)
	Spanish	Math	Social	Natural
Total Spending				
Quint2	-0.063	-0.010	-0.051	0.023
	(0.042)	(0.042)	(0.053)	(0.046)
Quint3	-0.025	-0.090*	-0.059	0.054
	(0.050)	(0.404)	(0.054)	(0.051)
Quint4	0.085	0.107*	-0.106	0.026
	(0.051)	(0.051)	(0.056)	(0.048)
Quint5	0.012	0.717***	0.169**	0.197***
	(0.050)	(0.069)	(0.062)	(0.055)
Controls	Yes	Yes	Yes	Yes
cons	-4.768***	-3.788***	-3.574***	-3.212***
	(0.133)	(0.154)	(0.168)	(0.150)
N	26,605	26,605	26,605	26,605
R^2	0.366	0.222	0.236	0.232

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table 21: Effect of *Liceo* Total Spending on 12th Grade Standardized PN Scores

	Dependent variable: 12th grade standardized PN scores			
	(1)	(2)	(3)	(4)
	Spanish	Math	Social	Natural
Total Spending				
Quint2	-0.055	-0.041	0.047	-0.027
	(0.055)	(0.063)	(0.055)	(0.057)
Quint3	-0.112	-0.097	0.042	-0.002
	(0.060)	(0.060)	(0.055)	(0.058)
Quint4	0.238***	0.120	0.390***	0.143*
	(0.071)	(0.091)	(0.077)	(0.071)
Quint5	-0.037	0.077	0.158*	0.108
	(0.059)	(0.085)	(0.064)	(0.067)
Controls	Yes	Yes	Yes	Yes
cons	-4.990***	-2.822 ***	-3.507***	-2.506***
	(0.146)	(0.241)	(0.264)	(0.303)
N	29,125	29,125	29,125	29,125
R^2	0.180	0.081	0.097	0.082

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table 22: Estimating Within School Impact of *Politécnico* Annual Transfer Spending on 12th Grade Standardized PN Scores

	Dependent variable: 12th grade standardized PN scores			
	(1)	(2)	(3)	(4)
	Spanish	Math	Social	Natural
AvgAnnualSpending	-2.61e-05	-2.21e-05	8.64e-06	-2.03e-05
	(1.61e-05)	(2.07e-05)	(2.88e-05)	(1.93e-05)
Controls	Yes	Yes	Yes	Yes
cons	0.807***	0.350*	0.195	0.308*
	(0.106)	(0.137)	(0.190)	(0.127)
N	401	401	401	401
R^2	0.696	0.766	0.597	0.693

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

8 References

Acento (2019, December 26). MINERD afirma pagó más de RD$ 3,700 millones a docentes por incentivos en 2019. Retrieved from https://acento.com.do/2019/actualidad/8764001-minerd-afirma-pago-mas-de-rd-3700-millones-a-docentes-por-incentivos-en-2019/.

Acevedo, P., Cruces, G., Gertler, P., Martinez, S. (2017). Living Up to Expectations: How Job Training Made Women Better Off and Men Worse Off. National Bureau of Economic Research Working Pa per No. 23264.

Ahn, J., & McEachin, A. (2017). Student Enrollment Patterns and Achievement in Ohio's Online Charter Schools. *Educational Researcher*, 46(1): 44–57.

Aizenman, A., Y. Jinjarak, N. Ngo, and I. Noy (2017). Vocational Education, Manufacturing, and Income Distribution: International Evidence and Case Studies. National Bureau of Economic Research Working Paper No. 23950.

Almeida, R. K.; Anazawa, L.; Menezes Filho, N. and Vasconcellos, L. M. De. (2015). Investing in technical & vocational education and training: does it yield large economic returns in Brazil? Policy Research working paper; no. WPS 7246. Washington, D.C.: World Bank Group.

Amargós, O. (2016). The Dominican Republic's agenda for development to 2030: coordination of public pol icies for technical and vocational education and training. In A. Isgut and J. Weller (335-351), *Protection and training: Institutions for improving workforce integration in Latin America and Asia.* Santiago: United Nations.

Araneda, P., Leyton, C., Bobdailla, C. (2018). Estudio sobre el mejoramiento de la educación secundaria en la República Dominicana. Retrieved from https://www.cepal.org/es/publicaciones/43559-estudio-mejoramiento-la-educacion-secundaria-la-republica-dominicana.

Attansio, O., A. Guarín, C. Medina, C. Meghir (2015). Long Term Impacts of Vouchers for Vocational Training: Experimental Evidence for Colombia. National Bureau of Economic Research Working Paper No. 21390.

Baker, B. (2016). Does Money Matter in Education? Albert Shanker Institute. Retrieved from https://www.shankerinstitute.org/resource/does-money-matter-second-edition.

Bertrand, M., M. Mogstad, J. Mountjoy. (2019). Improving Educational Pathways to Social Mobility: Evi dence from Norway's Reform 94. National Bureau of Economic Research Working Paper No. 25679.

Bishop, J., and F. Mane (2005). Raising Academic Standards and Vocational Concentrators: Are They Bet ter or Worse? *Education Economics*, 13: 171-187.

Blau, F., and Kahn, L. (2001). Do Cognitive Test Scores Explain Higher US Wage Inequality? National Bureau of Economic Research Working Paper No. 8210.

Bloom, N., Lemos, R., Sadun, R., Van Reenen, J. (2014). Does Management Matter in Schools. National Bureau of Economic Research Working Paper No. 20667.

Borko, H. (2004). Professional development and teacher learning: mapping the terrain. *Educ. Res.* 33: 3-15.

Bourne, J. (2014, March 6). Why Educating Girls Makes Economic Sense. Retrieved from https://www.globalpartnership.org/blog/why-educating-girls-makes-economic-sense.

Brunner, E., Dougherty, S., and Ross, S. (2019). The Effects of Career and Technical Educa tion: Evidence from the Connecticut Technical High School System. Working Papers 2019-047, Human Capital and Economic Opportunity Working Group. Retrieved from https://ideas.repec.org/p/hka/wpaper/2019-047.html.

Camargo, J., Riva, F., Souza, A (2018). Technical education, noncognitive skills and labor market out comes: experimental evidence from Brazil. Textos para discussão 480, FGV/EESP - Escola de Economia de São Paulo, Getulio Vargas Foundation.

Caraballo, E., García, J., Javier, K., Lara, D., Compres, R., Cartagena, M., Sena, S. (2016). Calidad del

Gasto Eductivo en La República Domincana. EDUCA. Retrieved from http://www.educa.org.do/wp-content/uploads/2016/09/Calidad_Del_Gasto.pdf

Carbonaro, W. (2005). Tracking, Students' Effort, and Academic Achievement. *Sociology of Education*, 78(1): 27-49.

Card, D. (1993). Using Geographic Variation in College Proximity to Estimate the Return to Schooling. National Bureau of Economic Research Working Paper No. 4483.

Card, D. (1994). Earnings, Schooling, and Ability Revisited. National Bureau of Economic Research Work ing Paper No. 4832.

Card, D., P. Ibarran, F. Regalia, D. Rosas, Y. Soares (2007). The Labor Market Impacts of Youth Training in the Dominican Republic: Evidence from a Randomized Evaluation. National Bureau of Economic Research Working Paper No. 12883.

Chaia, A., Child, F., Dorn, E., Frank, M., Krawitz, M., Mourshed, M. (2017). Drivers of Student Perfor mance: Latin America Insights. *McKinsey & Company.* Retrieved from https://www.mckinsey.com/~/media/mckinsey/industries/social%20sector/our%20insights/what%20drives%20student%20performance%20in%20latin%20america/drivers-of-student-performance.ashx.

Chetty, R., Friedman, J., and Rockoff, J. (2014). Measuring the Impacts of Teachers II: Teacher Value-Added and Student Outcomes in Adulthood. *American Economic Review*, 104(9): 2633–2679.

Cohodes, S. (2018). Charter Schools and the Achievement Gap. Retrieved from https://futureofchil dren.princeton.edu/sites/futureofchildren/files/resource-links/charter_schools_compiled.pdf.

Condron, D., & Roscigno, V. (2003). Disparities within: Unequal spending and achievement in an urban school district. *Sociology of Education,* 76(1): 18–36.

Cuesta, A., Glewwe, P., & Krause, B. (2016). School Infrastructure and Educational Outcomes: A Litera ture Review, with Special Reference to Latin America. *Economía,* 17(1): 95-130.

Dominican Today (2020, January 24). Dominican Republic US$2.5B bond sets a milestone. Retrieved from https://dominicantoday.com/dr/economy/2020/01/24/dominican-republic-us2-5b-bond-sets-a-milestone/.

Dougherty, S.M. (2018). The Effect of Career and Technical Education on Human Capital Accumulation: Causal Evidence from Massachusetts. *Education Finance and Policy*, 13(2): 119-148.

Dumay, X., Boonen, T., and Van Damme, J. (2013). Principal leadership long-term indirect effects on learning growth in mathematics. *Elem. School J.* 114, 225–251.

The Education Commission (2016). The Learning Generation: Investing in Education for a Changing World. Retrieved from http://report.educationcommission.org/wp-content/uploads/2016/08/Learning_Generation_Exec_Summary.pdf.

Educational Policy Data Center (2018). Dominican Republic National Educational File. Retrieved from https://www.epdc.org/sites/default/files/documents/EPDC%20NEP_Dominican%20Republic.pdf.

El Caribe (2019, December 26). Educación pagó más de 3,700 millones a docentes por incentivo en 2019. Retrieved from https://www.elcaribe.com.do/2019/12/26/educacion-pago-mas-de-3700-millones-a-docentes-por-incentivo-en-2019/.

Eskeland, G. S. and Filmer, D. (2007). Autonomy, Participation and Learning: Findings from Argentine Schools, and Implications for Decentralization. *Education Economics*, 15(1): 103–127.

Elacqua, G., Navarro-Palau, P., Fernanda Prada, M., Soarese, S. (2019). Does technical education improve academic outcomes? Evidence from Brazil. Inter-American Development Bank Working Paper No. IDB-WP-01057.

Evans, D. (2019, January 17). Education spending and student learning outcomes. *World Bank Blogs.* Re trieved from https://blogs.worldbank.org/impactevaluations/education-spending-and-student-learning-outcomes.

Ferguson, R. (1991). Paying for Public Education: New Evidence on How and Why Money Matters. *Har vard Journal on Legislation*, 28(2): 465-498.

Field, E., Linden, L., Malamud, O., Rubenson, D., Wang, S. (2019). Does Vocational education Work? Evi dence from a Randomized Experiment in Mongolia. National Bureau of Economic Research Working Paper No. 26092.

Figlio, D. N. (1997). Teacher Salaries and Teacher Quality. *Economics Letters* 55: 267-271.
Figlio, D.N. (2002). Can Public Schools Buy Better-Qualified Teachers? *Industrial and Labor Relations Re view* 55: 686-699.
Fonagy, P., Twemlow, S. W., Vernberg, E. M., Sacco, F. C., Little, T. D. (2005). Creating a peaceful school learning environment: The impact of an antibullying program on educational attainment in elementary schools. *Medical Science Monitor,* 11: 317–325.
Freeman, S., Eddy, S.L., McDonough, M., Smith, M.K., Okoroafor, N., Jordt, H., Wenderoth, M.P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences of the United States of America,* 111(23): 8510-5.
Fuchs, T., Woessman, L. (2007). What accounts for international differences in student performance? A re-examination using PISA data, *Empirical Economics*, 32(2): 433-464.
Gajardo, M., (2007). Dominican Republic Country Case Study. *Education for All Global Monitoring Report 2008*. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000155539.
Goddard, Y. L., Miller, R., Larsen, R., Goddard, G., Jacob, R., Madsen, J. (2010). "Connecting principal leadership, teacher collaboration, and student achievement," in *Paper presented at the American Educational Research Association Annual Meeting*.
Gómez, D. (2020). UNESCO conoce avances en ejes fundamentales de la educación dominicana. *Diario Dig ital*. Retrieved from https://diariodigital.com.do/2020/02/19/unesco-conoce-avances-en-ejes-fundamentales-de-la-educacion-dominicana.html.
Graham, P. (2007). Improving teacher effectiveness through structured collaboration: a case study of a pro fessional learning community. *Res. Middle Level Educ.* 31: 1–17.
Gregory, A., Cornell, D. (2009). "Tolerating" adolescent needs: Moving beyond zero tolerance policies in high school. *Theory Into Practice*, 48: 106–113.
Gregory, A., Cornell, D., Fan, X. (2011). The relationship of school structure and support to suspension rates for Black and White high school students. *American Educational Research Journal*, 48: 904–934.
Gregory, A., Cornell, D., Fan, X., Sheras, P., Shih, T., Huang, F. (2010). Authoritative school discipline: High school practices associated with lower student bullying and victimization. *Journal of Educational Psychology*, 102: 483–496.
Gropello, E., Vargas, M., Yanez-Pagans, M. (2019). What are the main lessons from the latest results from PISA 2018 for Latin America? *World Bank Blogs*. Retrieved from https://blogs.worldbank.org/latinamerica/what-are-the-main-results-pisa-2018-latin-america.
Guarino, C., Maxfield, M., Reckase, M., Thompson, P., Wooldridge, J. (2014). An Evaluation of Empirical Bayes' Estimation of Value Added Teacher Performance Measures. *The Education Policy Center or Michigan State University*. Retrieved from http://education.msu.edu/epc/publications/documents/WP31-Guarino-et-al-2014-Empirical-Bayes-Estimation-of-Value-Added_000.pdf.
Hampf, F., and L. Woessmann. (2017). Vocational vs. General Education and Employment over the Life-Cycle: New Evidence from PIAAC. Working Paper.
Hanushek, E. (2008). Education production functions. In S. N. Durlauf,& L. E. Blume (Eds.), *The New Palgrave dictionary of economics*. Basingstoke: Palgrave Macmillan.
Hanushek, E., and Rivkin, S. (2007). Pay, Working Conditions, and Teacher Quality. *The Future of Chil dren,* 17(1): 69-86.
Hanushek, E., and Woessmann, L. (2007). Education Quality and Economic Growth. The World Bank, Washington, D.C. Retrieved from http://siteresources.worldbank.org/EDUCATION/Resources/278200-1099079877269/547664-1099079934475/Edu_Quality_Economic_Growth.pdf.
Hanushek, E., Woessmann, L., & Zhang, L. (2011). General education, vocational education and labor mar ket outcomes over the life-cycle. IZA Discussion Paper No. 6083. Bonn, Germany.
Hochweber, J., Steinert, B., and Klieme, E. (2012) The impact of teacher cooperation and instructional quality on learning in English as a foreign language. *Unterrichtswissenschaft* 40: 351–370.
Hoxby, C. (2000). Peer Effects in the Classroom: Learning from Gender and Race Variation. National Bu

reau of Economic Research Working Paper No. 7867.
Jackson, K. (2018). Does School Spending Matter? The New Literature on an Old Question. National Bu reau of Economic Research Working Paper No. 25368.
Jackson, K., and Bruegmann, E. (2009). Teaching students and teaching each other: the importance of peer learning for teachers. *American Economic Journal,* 1: 85–108.
Jackson, K., Johnson, R., & Persico, C. (2016). The Effects of School Spending on Educational and Eco nomic Outcomes: Evidence from School Finance Reforms. *The Quarterly Journal of Economics*, 131(1): 157–218.
Johnson, D, Johnson, R., & Smith, K. (2014). Cooperative learning: Improving university instruction by basing practice on validated theory. *Journal on Excellence in University Teaching*, 25(4), 1-26.
Kemple, J., and Snipes, JC. (2000). Career Academies: Impacts on Students' Engagement and Performance in High School. New York, New York: MDRC.
Kemple, J., and Willner, C. (2008). Career Academies: Long-Term Impacts on Labor Market Outcomes, Educational Attainment, and Transitions to Adulthood. New York, New York: MDRC.
Kugler, A., M. Kugler, J. Saavedra, L. Omar Herrera Prada (2015). Long-term Direct and Spillover Effects of Job Training: Experimental Evidence from Colombia. National Bureau of Economic Research Working Paper No. 21607
Lafortune, J., Rothstein, J., & Schanzenbach. D. (2018). School Finance Reform and the Distribution of Student Achievement. *American Economic Journal: Applied Economics*, 10(2): 1-26.
Lavy, V., Schlosser, A. (2007). Mechanisms and Impacts of Gender Peer Effects at School. National Bureau of Economic Research Working Paper No. 13292.
Lazear, E. P. (2003). Teacher Incentives. *Swedish Economic Policy Review*, 10(3): 179–214.
Lee, V. E., and Smith, J. B. (1996). Collective responsibility for learning and its effects on gains in achieve ment for early secondary school students. *American Economic Journal.* 104: 103–147.
Loeb, S. and Page, M. (2000). Examining the Link Between Teacher Wages and Student Outcomes: The Importance of Alternative Labor Market Opportunities and Non-Pecuniary Variation. *Review of Economics and Statistics*, 82(3): 393-408.
Louis, K. S., Dretzke, B., and Wahlstrom, K. (2010). How does leadership affect student achievement? Re sults from a national US survey. *School Effect. School Improv.* 21: 315–336.
Loyalka, P., X. Huang, L. Zhang, J. Wei, H. Yi, Y. Song, Y. Shi, J. Chu (2015). The Impact of Vocational School on Human Capital Development in Developing Countries: Evidence from China. Retrieved from http://documents.worldbank.org/curated/en/943091468178758979/pdf/WPS7396.pdf
Mane, F. (1999). Trends in the Payoff to Academic and Occupation-Specific Skills: the Short and Medium Run Returns to Academic and Vocational High School Courses for Non-College-Bound Students. *Economics of Education Review*, 18: 417-437.
Manning, K. (2014, December 05). Dominican Republic revamps failing education system. Retrieved from https://www.dw.com/en/dominican-republic-revamps-failing-education-system/a-17625149
Maxwell, S., Reynolds, K. J., Lee, E., Subasic, E., & Bromhead, D. (2017). The Impact of School Climate and School Identification on Academic Achievement: Multilevel Modeling with Student and Teacher Data. *Frontiers in Psychology*, 8: 2069.
Meer, J. (2007). Evidence on the Returns to Secondary Vocational Education. *Economics of Education Re view*, 26: 559-573
Ministerio de Educación (1997). Ley 66-97: Ley General de Educación. Retrieved from https://www.oas.org/juridico/spanish/mesicic2_repdom_sc_anexo_7_sp.pdf
Ministerio de Educación (2003). Dec. No. 639-03 que establece el Estatuto del Docente. Retrieved from https://semma.gob.do/media/1741/decreto-no639-03-que-establece-el-reglamento-del-estatuto-do-cente.pdf.
Ministerio de Educación (2008). Ordenanza No. 02-2008. Retrieved from http://idec.edu.do/Archivos/Or denanza%2002-2008%20Reglamento%20Juntas%20Descentralizadas.pdf
Ministerio de Educación (2011). Instructivo transferencias Resolución 0668-2011. Retrieved from http://idec.edu.do/Archivos/Instructivo%20transferencias%20Resolucion%200668-2011.pdf.

Ministerio de Educación (2018a, June 05). Andrés Navarro busca vincular los *politécnicos* a la demanda del mercado laboral. Retrieved from http://www.ministeriodeeducacion.gob.do/comunicaciones/noticias/andres-navarro-busca-vincular-los-politecnicos-a-la-demanda-del-mercado-laboral.

Ministerio de Educación (2018b, January 01). Andrés Navarro firma acuerdo con el ITLA para nuevos *politécnicos*. Retrieved from http://www.ministeriodeeducacion.gob.do/comunicaciones/noticias/andres-navarro-firma-acuerdo-con-el-itla-para-nuevos-politecnicos.

Ministerio de Educación (2018c, July 22). Andrés Navarro firma alianza con zonas francas para mejorar *politécnicos*. Retrieved from http://www.ministeriodeeducacion.gob.do/comunicaciones/noticias/andres-navarro-firma-alianza-con-zonas-francas-para-mejorar-politecnicos.

Ministerio de Educación (2019). Memorias Institucionales 2019. Retrieved from http://www.ministeriodeeducacion.gob.do/transparencia/media/plan-estrategico-de-la-institucion/memorias-institucionales/8qv-memoria-2019pdf.pdf.

Murnane, R. J., and Olsen, R. (1989) The Effects of Salaries and Opportunity Costs on Length of Stay in Teaching: Evidence from Michigan. *Review of Economics and Statistics,* 71(2): 347-352.

Naper, L. (2010). Teacher hiring practices and educational efficiency. *Economics of Education Review*, 29(4): 658-668.

National School Climate Council. (2007). The School Climate Challenge: Narrowing the gap between school climate research and school climate policy, practice guidelines and teacher education policy. Retrieved from http://www.schoolclimate.org/climate/advocacy.php.

Neal, D., Johnson, W. (1996). The role of premarket factors in black-white wage differences. *Journal of Political Economy,* 104(5): 869-895.

Nilsson, A. (2010). Vocational education and training – an engine for economic growth and a vehicle for social inclusion?. *International Journal of Training and Development*, 14: 251-272.

OECD (2008). *Reviews of National Policies for Education: Dominican Republic 2008*, OECD Publishing.

OECD (2012). *Reviews of National Policies for Education: Higher Education in the Dominican Republic 2012*, OECD Publishing.

Oficina Nacional de Estadistica (2020). Salarios y costos laborales. Retrieved from https://www.one.gob.do/sociales/empleo-y-seguridad-social/salarios-y-costos-laborales.

Opper, I. (2019). Teachers Matter: Understanding Teachers' Impact on Student Achievement. Santa Monica, CA: RAND Corporation. Retrieved from https://www.rand.org/pubs/research_reports/RR4312.html.

Presidencia de la República Dominicana (2018, March 14). Gobierno lanza programa educación técnico profesional con apoyo Unión Europea y Cooperación Española. Retrieved from https://presidencia.gob.do/noticias/gobierno-lanza-programa-educacion-tecnico-profesional-con-apoyo-union-europea-y.

Presidencia de la República Dominicana (2019, August 20). Presidente Danilo Medina envía proyecto Ley de Cualificaciones al Congreso. Retrieved from https://presidencia.gob.do/noticias/presidente-danilo-medina-envia-proyecto-ley-de-cualificaciones-al-congreso.

Preszler, R.W. (2009). Replacing lecture with peer-led workshops improves student learning. *CBE Life Sciences Education* 8(3): 182-92.

Robin, S. and Sprietsma, M. (2003). Characteristics of teaching institutions and students' performance: new empirical evidence from OECD data. Discussion Papers 2003028, Institut de Recherches Economiques et Sociales. Retrieved from https://ideas.repec.org/p/ctl/louvir/2003028.html.

Roser, M., and Ortiz-Ospina, E. (2016). "Global Education." *Our World in Data.* Retrieved from https://ourworldindata.org/global-education#the-link-between-expenditure-and-outcomes.

Roser, M., Nagdy, M., and Ortiz-Ospina, E. (2020). Quality of Education. *Our World in Data.* Retrieved from https://ourworldindata.org/quality-of-education.

Ryan, P. (2001). The School-to-Work Transition: A Cross-National Perspective. *Journal of Economic Literature*, 39: 34-92.

Saavedra, J., Baron, J. (2018, August 8). The Teaching Profession: What is the Dominican Republic Doing

Right? Retrieved from https://blogs.worldbank.org/education/teaching-profession-what-dominican-republic-doing-right.
Scheker, A. (2007). Comparing School-Level to Private Higher Education: Using the Dominican Republic as a Pioneer Study. PROPHE Working Paper 8.
Secretaria de Estado de Edución Superior (2012). Ley Nº 139-01 de Educación Superior, Ciencia y Tecnología. Retrieved from https://www.siteal.iiep.unesco.org/sites/default/files/sit_action_files/do_3063_0.pdf.
Slavin, R. (1991). Synthesis of research on cooperative learning. *Educational Leadership* 48(5): 71-82.
Thapa, A., Cohen, J., Guffey, S., Higgins-D'Alessandro, A. (2013). A review of school climate research. *Review of Educational Research.* 83(3): 357-385.
USAID. (2013). Dominican Republic: Country Development Cooperation Strategy. Retrieved from https://www.usaid.gov/sites/default/files/documents/1862/Dominican-Republic-CDCS_publicversion_FY14_FY18.pdf.
Vegas, E. & Coffin, C. (2015). When Education Expenditure Matters: An Empirical Analysis of Recent International Data. *Comparative Education Review*, 59: 289-304.
Wang, M. T., Selman, R. L., Dishion, T. J., Stormshak, E. A. (2010). A Tobit regression analysis of the covariation between middle school students' perceived school climate and behavioral problems. *Journal of Research on Adolescence*, 20: 274:286.
Woessmann, L., Luedemann, E., Schuetz, G., and West, M. (2009), School Accountability, Autonomy and Choice Around the World. Edward Elgar Publishing.
The World Bank (2006). Dominican Republic Poverty Assessment: Achieving More Pro-Poor Growth. Report 32422-DO. Washington, DC: Work Bank.
The World Bank. (2015, September 30). Dominican Republic's Efforts to Improve Quality of Education Receive a New Boost. Retrieved from https://www.worldbank.org/en/news/press-release/2015/09/30/dominican-republic-improve-quality-education.
The World Bank (2018, December 14). Dominican Republic to Scale Up Efforts in Improving Learning. Retrieved from https://www.worldbank.org/en/news/press-release/2018/12/14/dominican-republic-to-scale-up-efforts-in-improving-learning.
The World Bank Group (2016). Building a Better Future Together: Dominican Republic Policy Notes. Retrieved from http://documents.worldbank.org/c rated/en/949151486105331993/pdf/112502-WP-P156995-PUBLIC-DRPolicyNotesenglishfinal.pdf.
The World Bank Group (2018a). FY 2019 Dominican Republic Country Opinion Survey Report. Retrieved from http://documents.worldbank.org/curated/en/942251573126339807/pdf/FY2019-Dominican-Republic-Country-Opinion-Survey-Report.pdf.
The World Bank Group (2018b). Learning to Realize Education's Promise. The World Bank, Washington, D.C. Retrieved from https://www.worldbank.org/en/publication/wdr2018.
World Economic Forum (2019). Dominican Republic Global Competitiveness Index 2019. Retrieved from http://www3.weforum.org/docs/WEF_GCI4_2019_Profile_Dominican_Republic.pdf.

9 Appendix

9.1 Additional Tables

Table A1: Student Characteristics of *Politécnicos* and *Liceos*

	Politécnicos		***Liceos***	
	Mean	Std. Dev	Mean	St. Dev.
GPA 8th Grade Spanish	58.80	4.84	57.79	4.83
Male	57.65	4.78	56.61	4.70
Female	59.65	4.70	58.88	4.70
GPA 8th Grade Math	58.23	4.99	57.34	4.89
Male	57.58	4.93	56.61	4.81
Female	58.70	4.99	58.00	4.88
GPA 8th Grade Social Science	59.12	4.87	58.12	4.82
Male	58.21	4.83	57.10	4.72
Female	59.79	4.79	59.06	4.71
GPA 8th Grade Natural Science	58.96	4.83	57.98	4.79
Male	58.07	4.79	57.01	4.70
Female	59.62	4.75	58.87	4.70
PN 8th Grade Spanish	19.00	3.52	17.86	3.56
Male	18.59	3.51	17.48	3.51
Female	19.30	3.50	18.21	3.58
PN 8th Grade Math	16.62	3.41	16.21	3.56
Male	16.70	3.41	16.28	3.52
Female	16.57	3.41	16.16	3.59
PN 8th Grade Social Science	16.89	3.31	16.41	3.30
Male	16.92	3.29	16.42	3.28
Female	16.88	3.32	16.40	3.32
PN 8th Grade Natural Science	16.67	3.23	16.26	3.26
Male	16.68	3.24	16.26	3.25
Female	16.67	3.22	16.26	3.26
Total PN 8th	17.30	2.67	16.68	2.69
Male	17.22	2.67	16.61	2.67
Female	17.36	2.66	16.75	2.71
GPA 12th Grade Spanish	58.31	4.13	57.78	4.20
Male	57.07	3.92	56.60	3.88
Female	59.06	4.08	58.75	4.20
GPA 12th Grade Math	57.36	4.35	56.97	4.24
Male	56.75	4.21	56.32	4.00
Female	57.73	4.39	57.50	4.36
GPA 12th Grade Social Science	58.75	4.01	58.11	4.20
Male	57.83	3.89	57.14	3.94
Female	59.31	3.98	58.91	4.23
GPA 12th Grade Natural Science	58.04	4.01	57.67	4.12
Male	57.15	3.87	56.77	3.88
Female	58.58	4.00	58.40	4.17
PN 12th Grade Spanish	20.09	2.95	18.63	3.15
Male	20.04	2.93	18.48	3.18
Female	20.12	2.97	18.76	3.11
PN 12th Grade Math	18.29	2.97	17.67	3.00
Male	18.68	3.04	17.86	3.05
Female	18.05	2.90	17.52	2.95
PN 12th Grade Social Science	18.82	2.74	18.05	2.78
Male	19.15	2.74	18.23	2.84
Female	18.62	2.72	17.90	2.73
PN 12th Grade Natural Science	18.20	2.53	17.63	2.74
Male	18.47	2.54	17.76	2.80
Female	18.03	2.51	17.53	2.69
Total PN 12th	18.85	2.22	18.00	2.32
Male	19.09	2.24	18.08	2.34
Female	18.71	2.20	17.93	2.29
Years to Graduate	4.02	0.22	4.17	0.61
Male	4.03	0.26	4.18	0.64

Table A1: Student Characteristics of *Politécnicos* and *Liceos* (Continued)

	Politécnicos		***Liceos***	
	Mean	Std. Dev	Mean	St. Dev.
Female	4.02	0.19	4.15	0.58
POMA Verbal	7.76	2.36	7.17	2.44
Male	7.89	2.41	7.16	2.44
Female	7.67	2.32	7.17	2.44
POMA Math	6.50	2.43	6.02	2.40
Male	6.99	2.48	6.33	2.42
Female	6.17	2.34	5.78	2.35
POMA Graphs and Figures	8.10	2.57	7.54	2.60
Male	8.61	2.64	7.83	2.66
Female	6.29	2.12	5.98	2.14
POMA Social Science	6.34	2.07	6.14	2.09
Male	6.60	2.12	6.31	2.13
Female	6.17	2.02	6.01	2.06
POMA Ethics	7.92	2.24	7.63	2.25
Male	8.04	2.30	7.67	2.32
Female	7.83	2.20	7.59	2.19
Total POMA	59.12	6.44	57.29	6.60
Male	60.45	6.72	58.03	6.76
Female	58.22	6.08	56.72	6.41

Table A2: Reduced Form of *Politécnico* Impact on High School Outcomes

	Dependent variable: High school outcomes			
	(1)	(2)	(3)	(4)
	Dropout	On Time Grad	Graduation	Years
Politécnico	-0.060***	0.015***	0.058***	0.218***
	(0.002)	(0.001)	(0.002)	(0.005)
Sex	-0.050***	0.013***	0.053***	0.056***
	(0.001)	(0.001)	(0.001)	(0.002)
Public8	0.067***	-0.020***	-0.078***	-0.047***
	(0.002)	(0.001)	(0.002)	(0.010)
GPA8Spanish	-0.008***	0.001***	0.010***	0.013***
	(2.37e-04)	(1.20e-04)	(2.50e-04)	(0.001)
GPA8Math	-0.001***	0.001***	0.003***	0.002***
	(2.17e-04)	(1.10e-04)	(2.28e-04)	(4.61e-04)
GPA8Social	-0.007***	0.002***	0.008***	0.009***
	(2.36e-04)	(1.18e-04)	(2.48e-04)	(0.001)
GPA8Natural	-0.004***	0.001***	0.006***	0.008***
	(2.41e-04)	(1.22e-04)	(2.54e-04)	(0.001)
PN8Spanish	-0.012***	0.002***	0.018***	0.012***
	(2.21e-04)	(1.11e-04)	(2.33e-04)	(4.52e-04)
PN8Math	-0.003***	0.001***	0.004***	0.001
	(2.31e-04)	(1.14e-04)	(2.42e-04)	(4.72e-04)
PN8Social	-0.006***	0.001***	0.008***	-4.91e-04
	(2.49e-04)	(1.20e-04)	(2.61e-04)	(0.001)
PN8Natural	-0.004***	0.001***	0.005***	0.001*
	(2.54e-04)	(1.21e-04)	(2.66e-04)	(0.001)
Wealth Quintile				
Quint2	0.004*	0.001	-4.32e-04	0.007
	(0.002)	(0.001)	(0.002)	(0.012)
Quint3	0.025***	0.002*	0.024***	0.031*
	(0.002)	(0.001)	(0.002)	(0.013)
Quint4	0.009***	0.001	-0.011***	0.075***
	(0.002)	(0.001)	(0.002)	(0.013)
Quint5	-0.017***	0.004***	0.020***	0.120***
	(0.002)	(0.001)	(0.002)	(0.014)
Cohort				
2011	-0.002	0.002*	0.011***	-0.021***
	(0.002)	(0.001)	(0.002)	(0.004)
2012	0.001	0.011***	0.015***	-0.061***
	(0.002)	(0.001)	(0.002)	(0.004)
2013	0.067***	0.020***	-0.051***	-0.133***
	(0.002)	(0.001)	(0.002)	(0.004)
2014	0.159***		-0.144***	-0.254***
	(0.002)		(0.002)	(0.004)
cons				1.448***
				(0.023)
N	668,396	187,685	668,396	668,396
				0.043

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table A3: Reduced Form of *Politécnico* Impact on 12th Grade Standardized PN Scores

	Dependent variable: 12th grade standardized PN scores			
	(1) Spanish	(2) Math	(3) Social	(4) Natural
Politécnico	0.250***	0.204***	0.206***	0.149***
	(0.006)	(0.007)	(0.007)	(0.007)
Sex	-0.028***	-0.177***	-0.181***	-0.134***
	(0.003)	(0.003)	(0.003)	(0.004)
Public8	-0.149***	-0.144***	-0.183***	-0.186***
	(0.011)	(0.014)	(0.013)	(0.013)
GPA8Spanish	0.020***	0.004***	0.007***	0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
GPA8Math	0.005***	0.021***	0.005***	0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
GPA8Social	0.009***	-0.002*	0.011***	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
GPA8Natural	0.007***	0.003***	0.004***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
PN8Spanish	0.079***	0.040***	0.043***	0.041***
	(0.001)	(0.001)	(0.001)	(0.001)
PN8Math	0.015***	0.034***	0.013***	0.018***
	(0.001)	(0.001)	(0.001)	(0.001)
PN8Social	0.027***	0.010***	0.030***	0.014***
	(0.001)	(0.001)	(0.001)	(0.001)
PN8Natural	0.017***	0.015***	0.016***	0.015***
	(0.001)	(0.001)	(0.001)	(0.001)
Wealth Quintile				
Quint2	0.111***	0.034*	0.004	0.028
	(0.013)	(0.017)	(0.016)	(0.016)
Quint3	0.153***	0.087***	0.050**	0.117***
	(0.014)	(0.018)	(0.017)	(0.018)
Quint4	0.188***	0.163***	0.119***	0.168***
	(0.015)	(0.019)	(0.018)	(0.018)
Quint5	0.328***	0.412***	0.341***	0.409***
	(0.015)	(0.020)	(0.018)	(0.019)
Cohort				
2011	0.122***	0.074***	0.087***	0.093***
	(0.005)	(0.005)	(0.005)	(0.005)
2012	0.201***	0.173***	0.269***	0.300***
	(0.005)	(0.006)	(0.006)	(0.006)
2013	0.065***	0.279***	0.292***	0.347***
	(0.005)	(0.006)	(0.006)	(0.006)
2014	0.269***	0.142***	0.310***	0.304***
	(0.005)	(0.006)	(0.006)	(0.006)
cons	-5.026***	-3.310***	-3.439***	-2.888***
	(0.028)	(0.032)	(0.031)	(0.031)
N	247,023	247,023	247,023	247,023
R^2	0.374	0.266	0.262	0.242

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

Table A4: 2SLS Model of Public *Politécnico* Impact over Private *Liceo* on 12th Grade Standardized PN Scores

	Dependent variable: 12th grade standardized PN scores			
	(1) Spanish	(2) Math	(3) Social	(4) Natural
Poli	0.295*			
	(0.145)			
Poli		0.234		
		(0.186)		
Poli			0.371	
			(0.207)	
Poli				0.298
				(0.194)
Controls	Yes	Yes	Yes	Yes
cons	-4.700***	-3.587***	-3.331***	-2.47***
	(0.101)	(0.148)	(0.150)	(0.147)
N	97,391	97,391	97,391	97,391
R^2	0.416	0.349	0.291	0.281

Standard errors in parentheses. Two-tailed test.
* p < 0.05, ** p < 0.01, *** p < 0.001

9.2 Questionnaires

Principals

Enrollment profiles:

1. How many students are enrolled in each grade? What percentage are women? What is the approximate breakdown by socioeconomic status?
2. What is the dropout rate?
3. How many concentrations do you offer and which are the most popular?
4. Why do students come to a *politécnico* over a *liceo*?
5. What are the profiles of students who enroll in a *politécnico* over a *liceo* (academically, socioeconomically)?
6. What are your processes for student admission and expulsion?

School organization:

7. Why did you choose to become a principal?
8. How much influence do you have in deciding how your school budget will be spent?
9. On average, how much do you spend annually on the school's operations?
10. What are your expenditures per student?
11. How much influence do teachers have in designing the curriculum?
12. What is the school's process for hiring and evaluating teachers?
13. How much influence do you have in evaluating teachers at this school and firing poor performing teachers?
14. How much influence do you have in setting performance standards for students? Are student test score outcomes included as a criterion in your evaluation?
15. What are your most crucial goals for the school as a principal?

Educational content:

16. How many hours is the school day?
17. What is the general schedule for a student? How many hours a week do they spend on various subjects?
18. What skills do students learn at a *politécnico* that they would not at a *liceo*?
19. How is the day to day of a *politécnico* education different from a *liceo*?
20. What words do you associate with a *politécnico* education?

Post-graduation plans:

21. What percent of students graduate?
22. What percent of graduating students go onto college?
23. What are students likely to do post-graduation? Is that different from *liceo* students?
24. Why do you think students in *politécnicos* perform better on their 12th grade *Pruebas Nacionales* than students in *liceos*? Does that finding surprise you?

Teachers

Student profiles:

1. How many students do you teach?
2. How do the students at *politécnicos* differ from the students at *liceos*?
3. How motivated are your students?
4. Are students prepared to learn?
5. Why would a student choose to enroll in a *politécnico* over *liceo*?

Day to day teaching:

6. What subject(s) do you teach?

7. What are the differences in teaching at a *politécnico* over a *liceo*?
8. How do you allocate your time in the classroom?
9. What are your goals for your students?
10. Is student absenteeism or tardiness a problem in your classroom?
11. How would you rate the autonomy you have to design your own curriculum?
12. Do you believe you have adequate support in preparing students for the *Pruebas Nacionales*?
13. Do you feel the *Pruebas Nacionales* influence the curriculum you teach?
14. What is the biggest influence on your teaching (such as compensation, performance evaluation, student achievement metrics, etc.)?

Professional development and support:

15. Do you receive adequate training and professional development?
16. How would you rate the support received from administrators for development and promotion?
17. What is the formal evaluation process for your teaching?
18. How would you rate the recognition received from superiors?
19. How would you rate the availability of resources and equipment for doing your job?

Self-evaluation:

20. Why did you choose to become a teacher?
21. How long do you plan to remain as a teacher?
22. How effective do you think you are as a teacher?
23. If you could go back and start all over again, would you become a teacher or not?
24. How would you rate your sense of personal accomplishment?
25. How would you rate the opportunity to make a difference in the lives of your students?

18+ year old students

Enrollment:

1. What was your perception of a *politécnico* when you were growing up?
2. Did your family or friends go to *politécnicos*?
3. Why did you enroll in a *politécnico*?

Educational content:

4. What is your concentration?
5. What classes do you take?
6. What is your schedule like at a *politécnico*?
7. How is your day to day different at a *politécnico* than in middle school?
8. How would you describe yourself as a student?
9. What words do you associate with a *politécnico* education?
10. What are the main differences between a *politécnico* and a *liceo* education?
11. What skills do you learn here that you would not at a *liceo*?

Post-graduation plans:

12. What are your plans post-graduation?
13. Did these plans change from when you were in middle school?
14. What type of school is better if you want to go to college - a *politécnico* or a *liceo*?
15. What type of school is better if you want to work right after graduation - a *politécnico* or a *liceo*?
16. How supportive are your teachers in helping you achieve your goals?

PLEDGE:

This paper represents my own work in accordance with University regulations.