Making Top Managers: The Role of Elite Universities and Elite Peers

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Abstract

This paper estimates the causal effect of elite college admission on students' chances of reaching top management positions, and decomposes the total effect into a component attributable to ties formed between college peers and a component attributable to other institutional inputs. I construct a novel dataset linking archival records of applications to elite colleges in Chile to the census of corporate directors and executive managers at publicly traded Chilean firms. I combine these data with a regression discontinuity design to estimate the causal effect of admission on leadership outcomes. Overall, elite admission raises the number of leadership positions students hold by 50 percent, but gains are larger for students who attended elite private high schools and near zero for students who did not. Admitted students from elite high schools are much more likely to work in top management roles with other elite high school students from their college degree program and cohort, but are no more likely to work with elite high school students from the same degree program in other cohorts or other degree programs in the same cohort. I interpret this difference-in-differences analysis of co-management outcomes using a simple model of referral-based hiring. The model suggests that peer ties account for 80 to 100 percent of admissions gains for elite high school students.

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1 Introduction

Can talented people from humble backgrounds make it to the top of the business world? This question forms a common starting point for discussions of economic opportunity in the US and abroad (Miller 1949, 1950), and is central to a political economy literature emphasizing the importance of innovation and turnover amongst the elite for long run growth (e.g., Acemoglu and Robinson 2006, 2008, 2012; North et al. 2009). On the one hand, 'rags to riches' stories of business success provide salient evidence of economic opportunity. On the other hand, a series of descriptive studies spanning many countries and more than one hundred years of data on business leaders have shown that top managers are disproportionately likely to have come from prominent families and attended a small number of elite high schools and universities.[1] For instance, Useem and Karabel (1986) find that 12 percent of managers from a sample of large US firms attended one of sixteen private high schools, while Cohen et al. (2008) report that 10 percent of all publicly traded firms in the US have at least one senior manager who graduated from Harvard.[2] Understanding the role of higher education in facilitating advancement to top management positions is of particular interest because policies aimed at expanding access to college form a key part of public efforts to promote economic opportunity.

The goals of this paper are a) to disentangle the causal role of elite universities in the production of top corporate managers from selection effects; b) to understand what kinds of students– those from elite family backgrounds versus those from non-elite backgrounds– benefit from attendance; and c) to decompose the overall effect of admission into a component attributable to ties formed between college peers and a component attributable to other inputs. Answering these questions poses a number of challenges. For one, the observed correlation between elite university attendance and top management outcomes may reflect the selection of talented students from successful families into both top universities and fast-track careers. Further, even if elite university attendance does enter directly into the management production function, the correlation between peer quality and the quality of other institutional inputs makes understanding

[1]See, e.g., Sorokin 1924; Taussig and Joslyn 1932; Miller 1949, 1950; Mills 1956; Warner and Abegglen 1979; Useem and Karabel 1986; Temin 1997, 1999; Capelli and Hamori 2004; Gallego and Larrain 2012; Nguyen 2012.

[2]Harvard was the most commonly represented institution, followed by Stanford University, the University of Pennsylvania, and Columbia University.

the mechanism underlying the overall effect difficult.

I address these questions using data from Chile, a middle-income OECD country, where college admissions policies and data collection procedures provide leverage not available in the US. To estimate the effect of elite admission on leadership outcomes, I use a regression discontinuity design based on discontinuous, score-based admissions policies. I explore the value of peer ties using a difference-in-differences approach that compares the rates at which pairs of college peers who attend the same degree program at the same time serve on management teams at the same firm to rates for pairs of students who attend the same degree program at different times or different degree programs at the same time. I link the regression discontinuity and difference-in-differences estimates using a simple model of management hiring in which students provide information to firms on the productivity of their college peers. I conduct this analysis using a novel dataset linking applications to elite business, law, and engineering programs between 1968 and 1995 with administrative records of leadership outcomes at all publicly traded Chilean companies.

I find that admission to an elite degree program raises the average number of leadership positions students hold by 50 percent, from 0.044 to 0.067. Effects are consistent across executive leadership and directorship outcomes, and across both (generally large) firms that are listed on the Santiago Stock Exchange and (often smaller) firms that are not. The leadership gains from admission accrue only to the 18 percent of applicants who attend one of nine elite private high schools. For these students, threshold-crossing raises the average number of leadership positions 65 percent, from 0.117 to 0.193. Effects for the 82 percent of applicants who did not attend one of these schools are close to zero and statistically insignificant. Notably, this is true even for students who attend elite public exam schools.

Peer ties are a key driver of leadership gains for students from elite high schools. When admitted to an elite college degree program, students from elite high schools become much more likely to serve on the same leadership teams as other elite high school students from nearby cohorts in that degree program. They do not become more likely to lead the same firms as elite high school students from the same degree program in other cohorts or other degree programs in the same field. Overall, two students from elite high schools who are college peers are 1.9 times more likely to have leadership roles in the same firm as two students from elite high schools who attend the same program but at different times, and 2.3 times as likely to have leadership roles in the same firm as students studying the same subject in a different elite college at the same time. To help interpret these results, I consider a model of referral-based hiring in which students transmit information about peer quality to potential employers. In combination with this model, my findings indicate that peer ties account for 80 to 100 percent of the leadership gains associated with admission for elite high school students. Elite college students who are not from elite high schools are not significantly more likely to work with college peers from elite high schools than with students from other cohorts or other degree programs.

My results indicate that the role of elite universities in the production of top managers is to sort within a relatively small group of students from elite social backgrounds, rather than to expand access to the group of students from less privileged backgrounds with equal academic ability. This finding has a number of important implications. Most straightforwardly, it suggests limits on the type of upward mobility attainable through attending an elite college. Business leaders are some of the best paid members of the labor force,[3] but attending an elite college does not help students without elite high school backgrounds get these jobs. My findings suggest that students' initial endowments, broadly construed as skills, family connections, and family culture, not only have important level effects on leadership attainment, but also affect the efficacy of educational investments.[4]

Beyond this, my paper contributes to five distinct strands of literature. First, I build on descriptive studies of business leaders. Papers such as Sorokin (1924), Taussig and Joslyn (1932) , Miller (1949, 1950), Mills (1956), Warner and Abegglen (1979), Useem and Karabel (1986), Temin (1997, 1999), and Capelli and Hamori (2004) describe the population of business leaders in qualitative and quantitative terms and discuss various pathways to business success. Though these authors often note that many business leaders have elite educational backgrounds, they do not provide causal evidence on the

[3]In the U.S., incomes for CEOs of large firms roughly track the top 0.1 percent of the income distribution, and have risen as fast or faster than incomes for others in this group over the past 25 years (Kaplan 2012; Bivens and Mishel 2013). Frydman and Jenter (2010), Frydman and Saks (2010), and Frydman and Molloy (2012) describe trends in executive pay over the longer run.

[4]See Solon (1999, 2002) or Black and Devereux (2011) for a review of the empirical literature on on intergenerational income mobility. Nunez and Miranda (2010) consider the case of Chile specifically.

role of elite universities in making business leaders. This paper fills that gap in the literature. My findings on the importance of the peer interactions at elite colleges are consistent with qualitative explanations advanced in these papers.[5]

Second, my work extends a line of research studying the ways that students form peer ties in college and how these ties affect labor market outcomes. Marmaros and Sacerdote (2002, 2006) and Mayer and Puller (2008) provide evidence that peer connections are strongest between students of the same race and that these connections can help students obtain their first jobs after college. Arcidiacono and Nicholson (2005), de Giorgi et al. (2010), and Sacerdote (2001) also explore the role of peers in career choices. For a review of this literature and the extensive literature on school peer effects in skill production, see Sacerdote (2011). While existing work focuses on early-career outcomes, this paper provides empirical evidence that the ties formed at college continue to influence hiring outcomes over the long run and at the highest levels of occupational attainment.

Third, I link the labor economics literature on the importance of early career connections to a set of empirical corporate finance findings on the role of school peers in firm performance, executive hiring, and corporate strategy. Shue (2013) shows that salaries for pairs of executives who were randomly assigned to the same section at Harvard Business School are more closely correlated than salaries for executives assigned to different sections. These effects are strongest following reunions and extend to acquisitions propensities. Similarly, Fracassi and Tate (2012) and Fracassi (2012) find, respectively, that powerful CEOs are likely to appoint school peers (defined as people who graduated from the same degree program within one year of one another) to corporate boards, and that companies where directors were school peers have more similar investment policies than firms without such connections. Cohen et al. (2008) find that mutual fund portfolio managers perform better on holdings in firms where corporate board members attended

[5] For instance, Mills (1956) describes how

> Harvard or Yale or Princeton is not enough. It is the really exclusive prep school that counts, for that determines which of the 'two Harvards' one attends. The clubs and cliques of college are usually composed of carry-overs of association and name made in the lower levels at the proper schools; one's friends at Harvard are friends made at prep school.

More recently, Kantor (2013) describes a student at Harvard Business School who 'was told by her classmates that she needed to spend more money to fully participate, and that 'the difference between a good experience and a great experience is only $20,000."

the same colleges or graduate programs. These papers illustrate the value that school ties have for top managers and the hiring advantages that may accompany this excess value. This paper addresses the question of how much school ties raise the ex ante probability that students at elite programs will rise to top levels of management.

Fourth, I build on a growing body of research using discontinuous admissions policies to estimate the effects of college admissions on labor market outcomes. Hastings, Neilson and Zimmerman (2013; henceforth HNZ) use college admissions data from Chile for the population of degree programs (i.e., not only elite programs in certain fields) for more recent applicants to study the earnings effects of admission to different degree programs. Consistent with my findings here, students admitted to the most selective institutions realize large earnings gains. Other papers using admissions discontinuities to study earnings outcomes include Zimmerman (forthcoming), Hoekstra (2009), Saavedra (2009), Ozier (2011), and Öckert (2010); these papers also tend to find evidence that admission to more selective degree programs is associated with earnings gains. In addition, Oyer and Schaefer (2009) and Arcidiacono et al. (2008) use non-RD methods to study applicants to law and business graduate programs, respectively, in the US. These papers find relatively large earnings returns to attending top programs. I contribute by focusing on top-end labor market outcomes that are not observable in standard datasets. As discussed above, these top-end outcomes may be of particular social importance. Further, given that the average private high school student just above the admissions threshold holds about 0.2 leadership positions, the pecuniary and non-pecuniary returns associated with achieving this level of success may represent a substantial portion of the overall benefit of admission. I also extend this line of work by exploring the mechanisms underlying the benefits students realize when they cross an admissions threshold.

Fifth, and finally, I contribute to a theoretical and empirical literature on the role of peer referrals in hiring. Peer effects in my model operate through students with ex-ante connections to firms, who provide information to firms about the quality of their school peers. Recent papers that study this mechanism include Dustmann et al. (2011) and Galenianos (2012); other papers, such as Calvo-Armengol and Jackson (2004, 2007) and Topa (2001) focus on an alternate mechanism in which employees pass information about job openings to their peers.[6] My contribution is to use a very simple model of

[6] A foundational paper here is Montgomery (1991). For reviews of the literature on networks in hiring, see Ioannides and Loury (2004) and Topa (2011).

referral-based hiring to derive an expression relating the hiring gains attributable to peer networks to the rate at which students from the same networks work in the same firms. The empirical analysis of co-hiring is similar in spirit to Oyer and Schaefer (2012), who study the agglomeration of law graduates in law firms. In contrast to Oyer and Schaefer, I use variation in peer groups across cohorts within firms to isolate the role of peer ties in top management hiring. My empirical approach is most similar to Bayer et al. (2008), who examine co-hiring probabilities for neighbors.

The paper proceeds as follows. In section two, I describe corporate and educational institutions in Chile, and discuss the college admissions institutions that provide the basis for regression discontinuity estimation. In section three, I present descriptive results on the educational backgrounds and academic skills of top managers relative to the broader applicant population. Section four presents the regression discontinuity analysis. Section five presents theoretical and empirical results leading to a decomposition of the overall admissions effect into a component attributable to peer ties and a residual 'other institutional inputs' component. Section six concludes.

2 Institutional background and data collection

This section describes corporate and educational institutions in Chile. The goal is to provide the background information necessary for a discussion of external validity and to outline the institutional features that allow for data collection and generate identifying variation.

2.1 Corporate institutions and international context

Chile is a middle-income OECD member country, and executives and board members who work there operate in a modern business environment. Appendix Table A1 compares economic and business indicators in Chile to those for several other countries. Per-capita GDP in Chile is about $9,400 (all values reported here are in constant 2005 USD). This is the highest in Latin America and roughly comparable to Eastern European EU member states such as Poland. As is true elsewhere in Latin America, inequality in Chile is high. Earners in the top ten percent of the income distribution account for 42.9

percent of all income, compared to 29.9 percent in the US and approximately 25 percent in Poland and Slovenia. Compared to other states at similar or higher income levels, Chile is a good place to do business. Its World Bank Ease of Doing Business Ranking, which captures the regulatory hurdles associated with starting and operating a firm, is 37 (out of 185, with 1 being the best ranking). Only 0.7 percent of businesses report 'informal payments' to government officials, compared to 18.1 percent in Argentina or 11.7 percent in Mexico. Still, Chile is similar to other Latin American countries in that many firms are controlled by a small number of large shareholders (see Gallego and Larrain 2012 and Lefort and Walker 2000 for further discussion). 38 percent of adults between 25 and 34 years old in 2010 had obtained a tertiary degree, compared to 42 percent in the US, 22 percent in Mexico, and 12 percent in Brazil.

Students in this study applied to college between 1968 and 1995. Many of these students grew up and made schooling choices during a time of substantially lower economic and political development than prevails in Chile today.[7] Per capita GDP in Chile in 1980, near the midpoint of the applicant cohorts I consider, was about $3,300, compared to $25,500 in the US. 19 percent of Chilean adults between 55 and 64 years old in 2010 (25 to 34 years old in 1980) had obtained a tertiary degree, compared to 41 percent in the US.

2.2 Higher education institutions and applications

Until the mid-2000s, almost all college students in Chile attended one of 25 'traditional' universities (Rolando et al. 2010). These are known as CRUCH universities,[8] and include a mix of public and private institutions. The two most selective are the Universidad de Chile (UC) and Pontificia Universidad Católica de Chile (PUC). Both are world class institutions, ranking fourth and second, respectively, in the the 2012 U.S. News Latin American university rankings.[9] Within these institutions, some fields are more selective and/or more business-oriented than others. I focus much of my analysis on

[7]The earliest applicants applied during the terms of democratically elected presidents Eduardo Frei and Salvador Allende. In 1973, during a period of high inflation and unemployment, a military coup led by Augusto Pinochet overthrew the Allende government. The Pinochet regime retained power until 1990, when democratic leadership was peacefully restored through a plebiscite.

[8]CRUCH is an acronym for 'Council of Rectors of Universities of Chile.'

[9]See `http://www.usnews.com/education/worlds-best-universities-rankings/best-universities-in-latin-america`. Accessed 9/23/2013.

three highly selective, business-oriented fields of study: law, engineering, and business. A 2003 study conducted by an executive search firm using a sample of business owners and business executives found that 58.1 percent had degrees from one of these six institution-field combinations, outpacing other universities or fields by a wide margin (Seminarium Penrhyn International, 2003; henceforth SPI).

CRUCH applicants commit to specific fields of study prior to undergraduate matriculation. The application process works as follows.[10] Following their final year of high school, students take a standardized admissions exam.[11] After receiving the results from this test, students apply to up to eight degree programs by sending a ranked list to a centralized application authority (the Departamento de Evaluación, Medición, y Registro Educacional, or DEMRE). These degree programs consist of institution-degree pairs; e.g., law at UC or engineering at PUC. Degree programs then rank students using an index of admissions test outcomes and grades, and students are allocated to degrees based on a deferred acceptance algorithm. Students are admitted to only the most preferred degree program for which they have qualifying rank. For instance, a student who is rejected from his first choice but admitted to his second choice will not be considered for admission at his third choice if he lists one. Students near the cutoff for admission to an institution-degree are placed on a waitlist, and both admissions and waitlist outcomes are published in the newspaper.[12] This process is similar to the medical residency match in the US (see Roth and Peranson 1999), but with public disclosure of evaluation criteria and outcomes. My regression discontinuity analysis amounts to a comparison of the students near the bottom of the published lists of admitted students to students near the top of the published waitlists.

Three features of this process are worth highlighting. First, students do not have access to ex post choice between multiple accepted outcomes. If they wish to change institution-degree enrollment, they must wait a year, retake the admissions test, and reapply. Second, the scores required for admission vary from year to year depending on aggregate demand for institutions and careers and the number of spots universities allocate to each career. Though students can likely construct reasonably accurate guesses of cutoff scores based on cutoff scores in past years, these guesses will not be precise.

[10] See HNZ (2013) for more details.

[11] Prior to 2003, this test was known as the Prueba de Aptitud Académica, or PAA. The test was updated in 2003 and renamed the Prueba de Selección Universitaria.

[12] Specifically, results are published in *El Mercurio* in March of the application year.

Uncertainty about the precise location of cutoffs from year to year is consistent with the imprecise control condition required for unbiased regression discontinuity estimation (Lee and Lemieux 2010). I present standard tests for regression discontinuity balance in section four. Third, each degree program maintains its own standalone curriculum. Students enrolled in different degree programs at the same institution generally do not take courses together. Each of the degree programs studied here maintains its own physical plant, separated by at least several city blocks from the location of other degree programs, and sometimes by as much as several miles. For this reason, I think of peer effects as operating within degree programs (i.e., institution-degree pairs) rather than at level of the institution.

2.3 Secondary education institutions

Gains in both skills and peer ties associated with elite college admission may vary depending on students' high school backgrounds. I focus on three types of high schools: elite private schools, elite public exam schools, and non-elite schools. The elite private category includes nine schools: St. George's College, Colegio del Verbo Divino, the Grange School, Colegio Sagrados Corazones Manquehue, Colegio Tabancura, Colegio San Ignacio, Allianza Francesa, Craighouse School, and Scuola Italiana. This list can be divided into two groups: elite Catholic schools, and 'language schools' characterized by bilingual instruction. Each of these schools is a private school located in or near Santiago with very high tuition,[13] and several are male only (my analysis will focus only on male students). Admissions can be exclusive. For instance, applications for admission to the pre-kindergarten program at the Grange School require a letter of reference from a member of the school community.[14] These schools appear frequently in press accounts and studies of the business elite,[15] and represent what many Chileans would regard as a consensus set of prestigious private schools. In Appendix B, I discuss school categorization in more detail and present results that subset on an approximate 'prestige' ranking within the group.

The elite public category includes only the Instituto Nacional General José Miguel Car-

[13]As fraction of per capita GDP, tuition at these schools is similar to tuition at elite U.S. high schools like Deerfield or Phillips-Andover; see Neilson (2013).

[14]See `http://www.grange.cl/admissions`. Accessed 11/6/2013.

[15]See, e.g., Engel (2013), SPI.

rera (henceforth the Instituto Nacional), an exam school located in Santiago. There is no tuition fee at the Instituto Nacional. However, as is the case with exam schools in the US, such as Stuyvesant or Bronx Science, admission depends on students' scores on an entrance exam. Alumni of the Instituto Nacional include 17 Chilean presidents, and it is typically the only public school mentioned in studies of the Chilean business elite (SPI). In 2012, students at the Instituto Nacional had a higher average score on the standardized college admissions exam than students at any other public high school; their scores were similar to those for students at elite private high schools (PUC 2012). The non-elite category includes all schools not listed here. In 2010, students in elite private schools considered here accounted for about half of one percent of Chilean 12th graders; students in the Instituto Nacional accounted for about one third of one percent.

2.4 Data collection

I construct a dataset linking admissions outcomes for applicants to all CRUCH degree programs for the years 1982 through 1988 and to elite law, engineering, and business programs between 1968 and 1995 to corporate leadership outcomes for all publicly traded companies in Chile in the 2000s.[16] To obtain application records, I digitized hard copy newspaper application and waitlist announcements stored in the Biblioteca Nacional de Chile. Figure A1 presents an example of newspaper admissions and waitlist records. Appendix B discusses data collection and data availability in more detail.

Publicly traded companies in Chile are required to disclose the identities of top executives and board members to the Superintendicia de Valores y Seguros (SVS), the Chilean analogue to the Securities and Exchange Commission in the US. I obtain leadership data using a web scrape of the SVS website.[17] I conducted this scrape in March of 2013. The SVS website allows users to search historical filing records by date for each firm. I searched for all executive managers and directors who served between January 1st, 1975 and January 1st 2013. Most firms do not provide leadership records for the earlier part of this period. 10 percent of all corporate leaders in my sample began their leadership roles in 2012 or 2013, and the median leader was hired in 2009. 90 percent of leaders

[16] Records of applications to non-elite degree programs are also used in HNZ (2013).

[17] `http://www.svs.cl/sitio/mercados/consulta.php?mercado=V&entidad=RVEMI`. Accessed 9/23/2013.

were hired in 1998 or later. See Figure A2 for an example of these records.

The link between application records and SVS data on top managers relies primarily on government-issued personal identifiers (known as Rol Único Nacional or Rol Único Tributario; abbreviated as RUTs). The SVS data on top managers include RUTs for all Chilean citizens. Beginning in 1974, I match 95 percent of applications to RUTs. Much of the missing data is due to decay or illegibility of hard copy records. For the years 1968 through 1973, I match application records by name to SVS records. Because Chileans typically have four distinct names– a first name, middle name, a patronymic, and matronymic– this match works reasonably well in the sense that there are zero instances in which a single name matched to multiple RUTs. Appendix Table B2 presents basic descriptive statistics on the sample of matched applications to elite degree programs.

Administrative application records for the years 1974 through 1988 include high school identifiers. These data are not available in other years, so I subset on the 1974-1988 period in the portion of my analysis that uses data on high school type. High school identifiers are available for 92 percent of students in those years.

2.5 What kinds of firms?

Students in the applicant sample hold 3,759 top management roles. Of these, 2,107 are directorship positions and 1652 are executive positions. They hold these positions at a total of 713 firms; there are many firms in which more than one applicant holds a top position. Students in this data lead a broad variety of companies, including multinationals that are among the largest companies in Latin America, and Latin American subsidiaries of US companies. 34 percent of the leadership roles are at firms listed on the Santiago Stock Exchange (SSE), the third largest exchange in Latin America by market capitalization.[18] For leaders of SSE firms, the 25th percentile of the asset distribution is about $300 million, the 75th percentile is $2.4 billion, and the 95th percentile is $9.75 billion. The largest firms in the dataset, such as Quiñenco, Antarchile, and Falabella, routinely appear in the Forbes Global 2000 list of the world's largest companies. Quiñenco, the

[18] In January 2013, SSE market capitalization was $334 billion USD. Source: World Federation of Exchanges. `http://www.world-exchanges.org/statistics/monthly-reports`.

largest of these as measured by assets, had assets of more the $40 billion in December 2011. Quiñenco holds controlling stakes in a) Banco de Chile, which merged with the Chilean subsidiary of Citibank in 2008; b) CCU, a joint beverage venture with Heineken, and c) Madeco, an international manufacturer of flexible packaging. See Table A2 for additional firm descriptions.

To help make the comparison more concrete, companies with assets of about $40 billion in the 2013 Forbes Global 2000 include Aetna and Lockheed Martin; companies with assets of between two and four billion in 2012 include Moody's (the credit rating firm) and Foot Locker.[19] Table A3 presents examples of Chilean firms at different points in the asset distribution. These firms span a wide variety of sectors and corporate parents. In addition to the firms listed above, students in the data go on to lead large Latin American retailers like La Polar, Chilean subsidiaries of US retailers such as WalMart, financial consulting firms, and agricultural production and export firms.

3 Who are top managers?

The data collected here allow for a fairly rich description of the educational backgrounds of the pool of potential top managers, as well as of top managers themselves. This section describes the population of students accepted to college in Chile in terms of college characteristics, high school backgrounds, and subject test scores, and contrasts the full population of accepted students to the subset of students who go on to become top managers. The goal is to establish a set of stylized facts about the educational backgrounds of top managers that helps motivate subsequent analyses. These results may also be of independent interest: to the best of my knowledge, this is the first paper to report standardized subject test scores for top corporate leaders.

Table 1 presents presents test score and leadership outcomes for male students admitted to college, broken down by college and high school type. I focus on the years 1982 through 1988 because it is for those years that I have data on both the population of admitted students and on students' high school backgrounds. As shown in Panel A, students from non-elite high schools account for 91 percent of admitted students, while students from elite public and elite private high schools account for four and five percent

[19]Source: `http://www.forbes.com/global2000/list/`. Accessed October 2013.

of admissions, respectively. Admitted students as a group score substantially above the population mean on reading and math tests, which are normalized to 500 each year, with a standard deviation of 100. Students from elite public and private high schools score 30 to 60 points higher on these tests than other admitted students.

Students from elite private high schools account for a disproportionate share of top managers, while students from elite public high schools do not. On average, students from elite private high schools hold 0.09 top management positions (nine positions for every one hundred students), compared to 0.01 for students at elite public high schools or other high schools (one per one hundred students). The five percent of students from elite private school backgrounds make up 39 percent of top managers in this sample, while the four percent of students from elite public high schools make up five percent of top managers. Top managers score about 2.5 standard deviations above the population mean on standardized math tests, and 1.5 standard deviations above the mean on standardized verbal tests.

Table 1: Student characteristics by high school and college type

	All College Programs			Elite college programs		
HS type:	Non-elite	Exam	Elite private	Non-Elite	Exam	Elite private
A. All accepted students						
% of sample	0.91	0.04	0.05	0.72	0.10	0.19
Math	673	712	733	761	767	769
Reading	604	647	660	669	671	682
N Lead	0.01	0.01	0.09	0.04	0.05	0.21
N	118223	4979	6359	5764	764	1497
B. Students with leadership positions						
% of sample	0.56	0.05	0.39	0.40	0.07	0.53
Math	733	764	760	777	776	778
Reading	637	657	679	675	680	697
N	599	40	321	165	20	160

Sample consists of male students accepted to CRUCH degree programs between 1982 and 1988. Data are at student-year level. Elite college programs are law, engineering, or business programs at PUC or UC. Non-elite students are accepted at other CRUCH degree programs. 'Math' and 'Reading' rows show means of scores on standardized college admissions subject tests. Sections are normed to have means of 500 and SD of 100 in the population. 'Exam' high schools are elite public high schools. 'N Lead' is the mean of the count of the number of leadership positions students hold.

The right three columns of Table 1 subset on students admitted to elite business, law, and engineering programs. Students admitted to these programs have much higher math scores than other admitted students, are more than twice as likely to have attended an elite public school, and are nearly four times as likely to have attended an elite private school. They are substantially more likely to hold leadership roles than other admitted students, with the number of average leadership positions rising to 0.05 for students from elite public schools and to 0.21 for students from elite private schools. These findings are consistent with studies showing disproportionate representation of elite private high schools and colleges amongst top managers. However, they do not provide insight into the causal impact of elite college attendance, since they also reflect differences in the composition of students' skills and preferences. I consider the causal effect of admission to elite degree programs in the next section.

4 Regression discontinuity analysis

4.1 Econometric strategy

I obtain estimates of the effects of elite college admission on top management outcomes using a regression discontinuity design generated by admissions cutoffs. I pool over all applications and estimate 'stacked' specifications (Urquiola and Pop-Eleches 2013; HNZ 2013) of the form

$$Y_{ipt} = f(d_{ipt}) + \Delta A_{ipt} + e_{ipt} \quad (1)$$

where Y_{ipt} is a leadership outcome for student i applying to program p in year t, d_{ipt} is the difference between the admissions score for application ipt and the cutoff score for program p in year t, and $f()$ is some smooth function. $A_{ipt} = 1[d_{ipt} \geq 0]$ is a dummy equal to one if i is admitted to p in year t. The parameter of interest, Δ, captures the effect of admission to an elite program for marginal applicants to that program, averaged across programs and application years.

Rejected applicants are admitted to a mix of alternate degree programs. Some may be rejected from one elite program and admitted to another elite program, or to the same elite program in a later year. To address the possibility of elite admission for below-threshold students, I will also present estimates from 'fuzzy RD' specifications in which I use the threshold-crossing variable as an instrument for a dummy equal to one if students are admitted to any elite program.

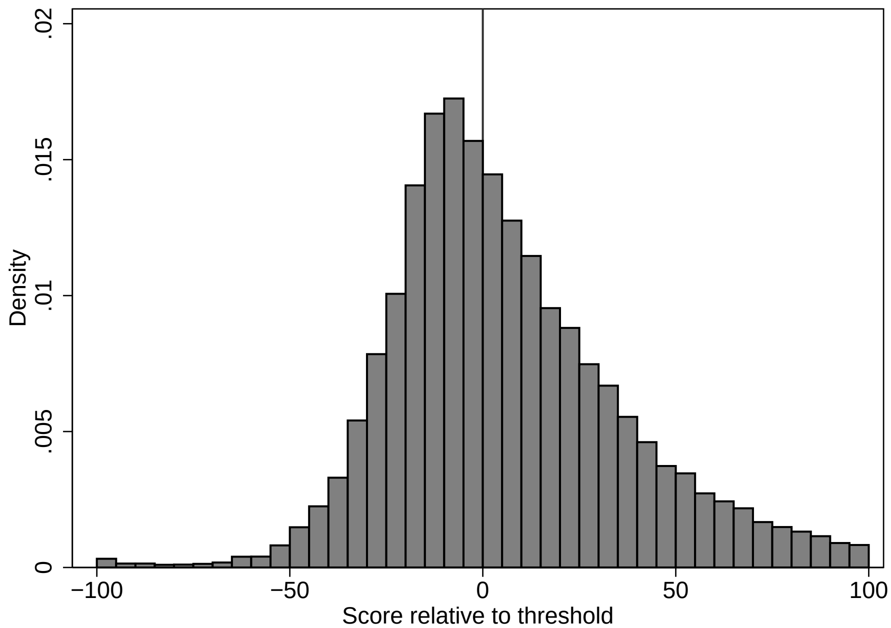
I estimate equation 1 using local linear and local polynomial specifications (Imbens and Lemiuex 2008; Lee and Lemieux 2010). I explore a variety of bandwidths and polynomial forms, and allow polynomial terms to vary above and below the threshold value. I accompany these specifications with the standard graphical analysis and balance tests.

4.2 Results

4.2.1 RD validity

Regression discontinuity estimates will return unbiased estimates of admission effects only if other determinants of leadership outcomes are balanced across the threshold. I consider two tests of cross-threshold balance. The first is to look for a discontinuity in the density of scores at the cutoff point (McCrary 2008). If, for example, more ambitious students were able to manipulate their test scores so as to fall just above the cutoff, one would expect a discontinuously higher density of scores at that point. Figure 1 shows a histogram of scores relative to admissions cutoff value. There is no evidence of clumping above the threshold. The distribution is densest close to the threshold value; 55 percent of all applicants have scores within 20 points on either side of the threshold value and 82 percent have scores within 40 points of that value. Figure A3 shows separate density plots for students who attended elite private high schools and those who did not. Score densities are smooth across the cutoff in both samples.

Figure 1: Density of score distribution



Density of score distribution around cutoff score. Bins have width of five points.

The second test of RD validity is to check the balance of observable covariates across the threshold. Panels A and B of Figure 2 display binned means of observable leadership determinants by score relative to the cutoff. Elite high school status, gender, and a linear index of cohort and program effects all change smoothly across the threshold. Additional graphical analysis shown in Figure A4 confirms that selection into the full sample and into the high school sample are smooth through the cutoff as well.

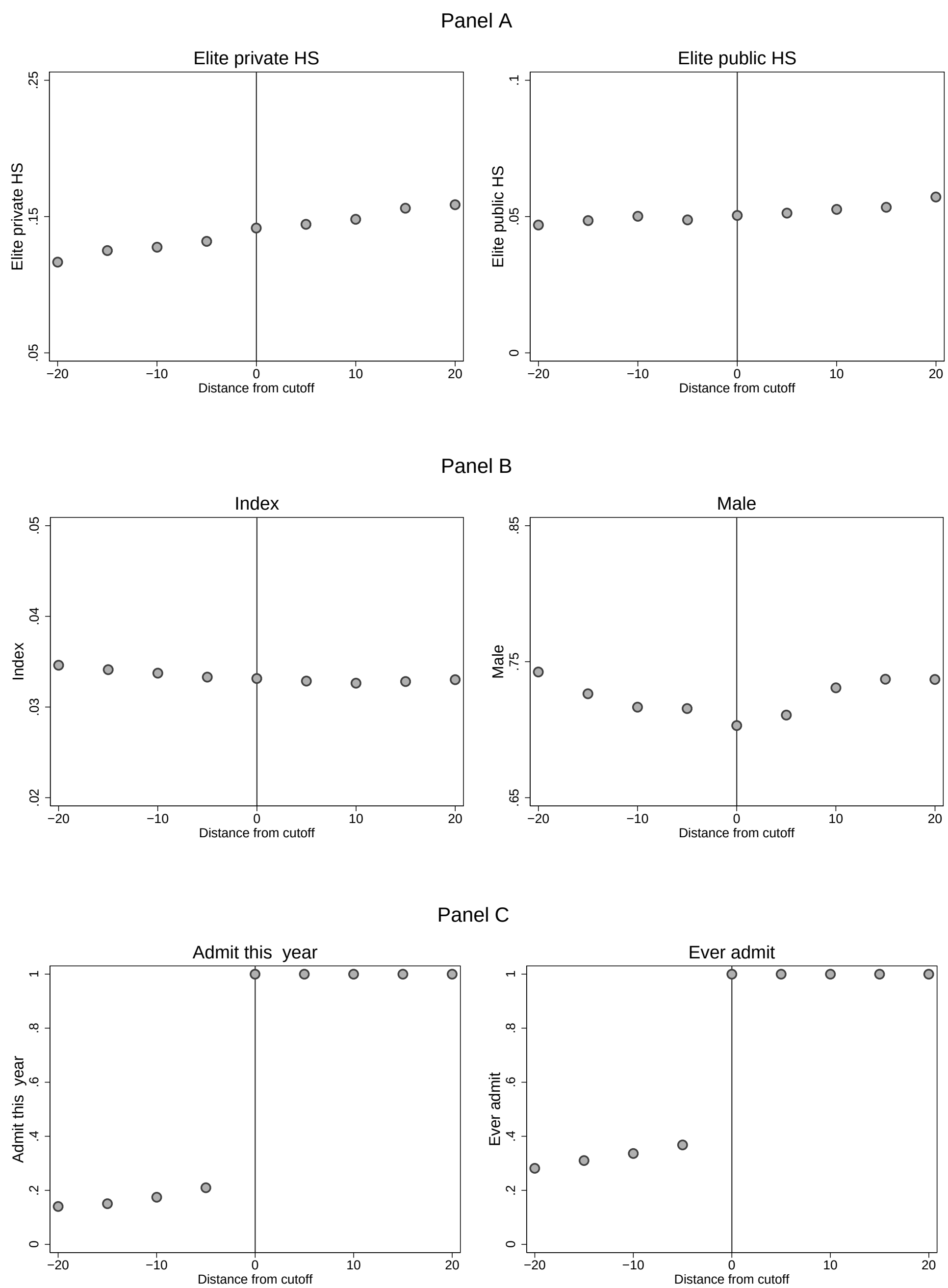
Regression estimates confirm the visual analysis. I present these estimates in Panels A and B of Table 2. Here and in what follows, I present estimates from four versions of equation 1. The first version, labeled ‘BW=10,’ is a simple mean comparison of covariates for students within a 10 point score window on either side of the admissions threshold. This specification does not include slope terms. The second version, labeled ‘BW=20,’ includes students within 20 point window on either side of the admissions threshold and includes separate linear terms in scores above and below the cutoff. The third version, labeled ‘BW=40,’ includes all applications within a 40 point window on either side of the threshold and includes controls for second-degree polynomials in score that may differ above and below the cutoff. The fourth version, labeled 'Controls,' is identical to the BW=20 specification but includes controls for program and application year fixed effects. Point estimates are very similar across the four specifications. The narrow bandwidth specification increases statistical power in some specifications because of the restriction on slope terms; in the text, I will generally refer to point estimates from this specification.[20] I find no evidence of discontinuities in covariates or sample selection across the threshold. Out of the 23 hypothesis tests in Panels A and B of Table 2, three reject the null at the ten percent level.

Threshold-crossing at a given program p in year t has a large impact on admissions outcomes even after accounting for admission at other programs and reapplication in other years. Panel C of Figure 2 and Panel C of Table 2 present estimates of the effect of threshold crossing at a given program-year combination on admissions outcomes at any elite program in the same year and at any elite program in any year. Threshold-crossing raises the probability students will be admitted to any elite program in the same year by 79 percent, and in any year by 63 percent. That is, 21 percent of marginal rejected students at elite programs are admitted to other elite programs in the same year, and 37 percent are eventually admitted to an elite program. While threshold-crossing induces substantial variation in admissions outcomes, estimated threshold-crossing effects will be smaller than effects of admission to any elite program in the same year by about one quarter and in any year by about 60 percent.[21] In what follows, I supplement my analysis of threshold-crossing effects with an IV analysis of 'any admission' effects.

[20]Appendix C discusses the selection of optimal bandwidths and polynomial degrees in more detail. Standard model selection criteria suggest that the preferred polynomial degree is zero, even at relatively wide bandwidths. This is consistent with my choice of 'preferred' specification and with the observation that leadership outcomes remain flat as students' scores rise (see Figures 3 and 4). Optimal bandwidths computed using the methods of Calonico et al. (2013) and Imbens and Kalyanaraman (2012) in a local linear setting range from 13.5 to 69.8 depending on the subsample.

[21]Most students who are rejected from one elite program but admitted to another have been rejected from one of the three PUC programs, which tend to be slightly more selective, and admitted to the UC degree program in the same field. 51 percent of marginally rejected PUC applicants are admitted to another elite degree program in the same year, compared to 5.5 percent of marginally rejected UC applicants. These results should be interpreted with caution because there is some asymmetry in this outcome across cohorts. While it is likely that the data include all applications in any year for students in the middle of the sample period, students applying near the beginning or end of the sample period may also have submitted applications in out-of-sample years. See Appendix B for details on data availability.

Figure 2: Admissions outcomes by distance from cutoff



Rolling averages of values within 5 points on either side of horizontal axis value. Estimates are reported at five point intervals and include only data with the same value of the threshold-crossing dummy. 'Index' is a linear index of program and year dummies constructed using a regression of leadership counts on these variables.

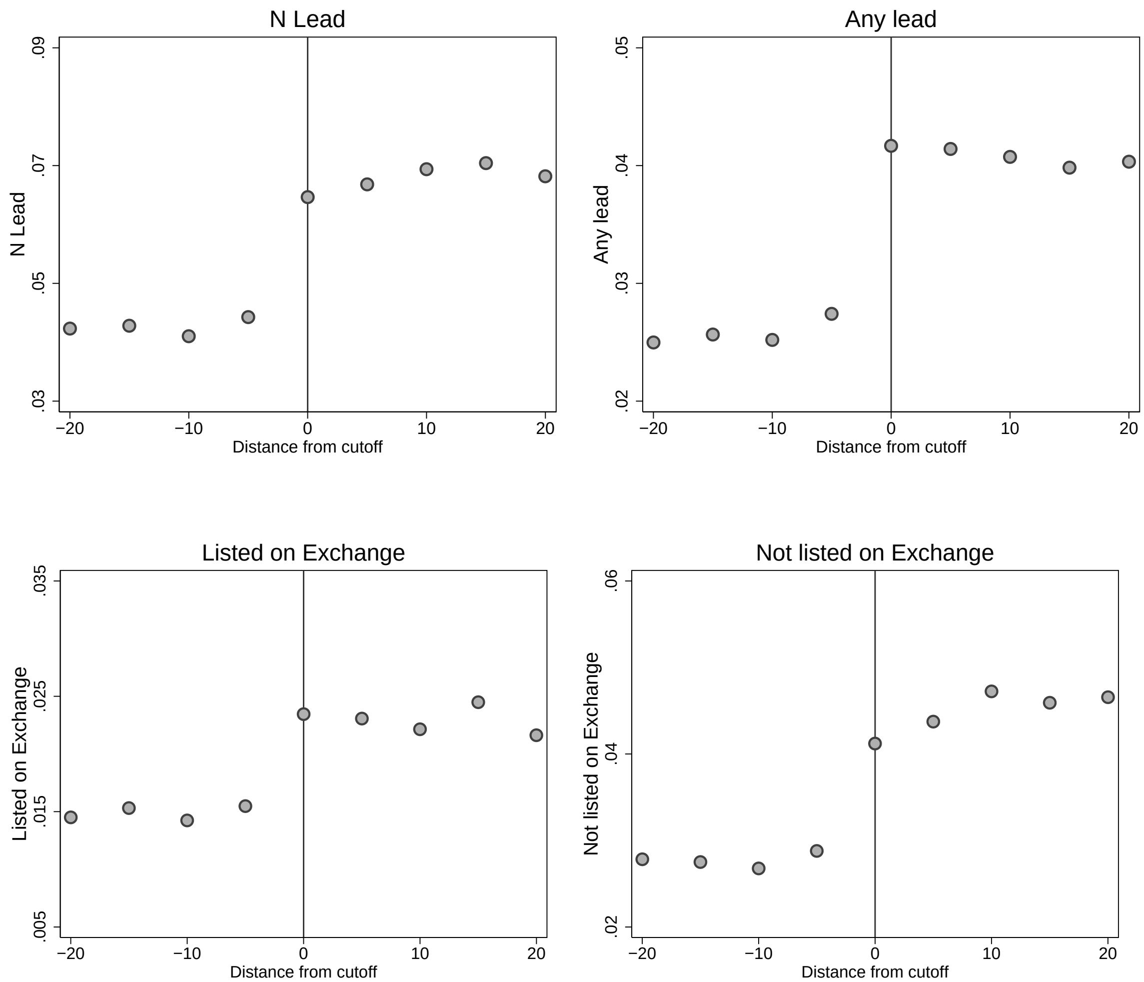
Table 2: Effect of threshold-crossing on admissions outcomes and covariate means

	Bandwidth			
	BW=10	BW=20	BW=40	Controls
A. Student characteristics				
Male	-0.0048	-0.0052	-0.0073	-0.0108
	(0.0067)	(0.0096)	(0.0106)	(0.0093)
Elite private HS	0.0124**	0.0017	0.002	0.0026
	(0.0061)	(0.0088)	(0.0096)	(0.0087)
Elite Public HS	0.0023	-0.0008	0.0001	-0.0019
	(0.0041)	(0.0059)	(0.0066)	(0.0059)
Index	-0.0004	0.0002	0.0012***	
	(0.0002)	(0.0003)	(0.0004)	
B. Selection into sample				
Matched to ID	-0.0069	-0.0116*	-0.004	-0.0035
	(0.0044)	(0.0063)	(0.0071)	(0.0055)
In HS data	0.001	-0.0045	0.0011	-0.0007
	(0.0046)	(0.0066)	(0.0075)	(0.0066)
C. Admissions outcomes				
Admit this year	0.7905***	0.7628***	0.7597***	0.7566***
	(0.0051)	(0.0072)	(0.0079)	(0.0066)
Admit ever	0.6325***	0.6060***	0.6045***	0.6011***
	(0.0065)	(0.0089)	(0.0098)	(0.0084)
N	13043	24419	35950	24419

Significance: ***: 1% **: 5% *: 10%. Standard errors clustered at person level. Effect of threshold crossing on covariate means. 'Index' is a linear index of program and year dummies. Admissions score window listed in column heading. 'Matched to ID' is a dummy equal to one if an application record is matched to a unique person identifier. 'In HS data' specification includes data from 1974-1988 only. Standard errors for row 5 are clustered at the application identifier-year level.'Admit this year' is a dummy equal to one if a student is admitted to any elite program in the same year as the target application. 'Admit ever' is equal to one if a student is ever admitted to an elite program in the available data.

4.2.2 Leadership outcomes

Figure 3: Leadership outcomes by distance from cutoff and firm type



Rolling averages of values within 5 points on either side of horizontal axis value. Estimates are reported at five point intervals and include only data with the same value of the threshold-crossing dummy. 'N lead' counts total leadership positions. 'Any lead' is dummy equal to one if an individual is either a director or an executive officer. 'Listed on exchange' and 'Not listed' count leadership positions at firms listed and not listed on the Santiago Stock Exchange, respectively.

Figure 3 and Table 3 present estimates of the effect of admission on leadership outcomes for all male applicants. The number of top management positions students hold rises by 50 percent across the admissions threshold, from 0.044 to 0.067. The probability that students will hold any leadership position also rises by 50 percent, from 0.027 to 0.041.

Leadership effects are proportionally similar for firms that are and are not listed on the SSE. The expected count of leadership positions at SSE firms rises by 48 percent across the threshold, from 0.015 to 0.023, and the expected count of leadership positions at unlisted firms rises 52 percent, from 0.029 to 0.043. Aside from the jump at the point of admission, the relationship between admissions scores and leadership outcomes is weak. As shown in the lower rows of Table 3 and Figure A5, gains are large for the executive management and directorship positions. Table A4 presents instrumental variables estimates of the effect of admission to any elite program on leadership outcomes.

Table 3: Leadership outcomes by admissions score

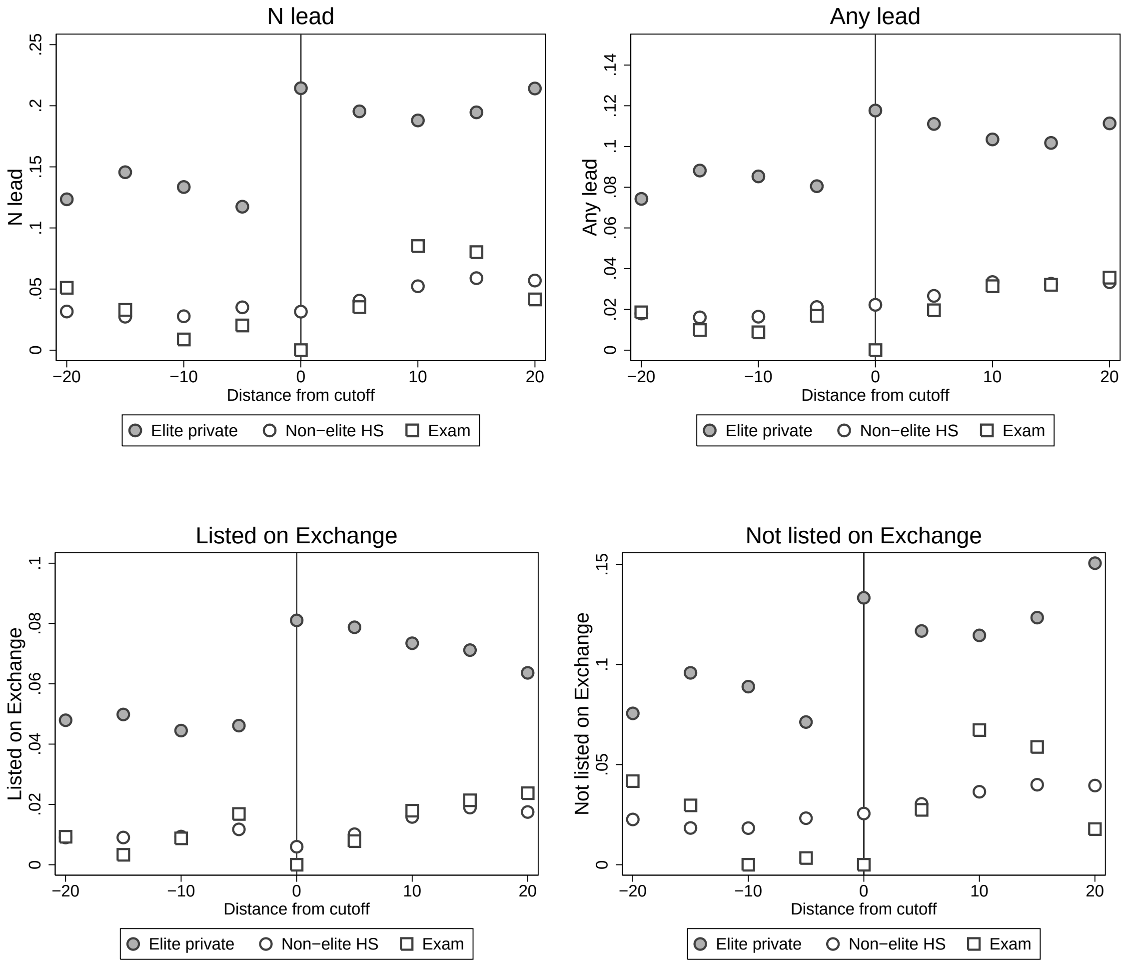
	Bandwidth			
	BW=10	BW=20	BW=40	Controls
A. Pooled leadership outcomes				
N lead	0.0223***	0.0256**	0.0244**	0.0260**
	(0.0077)	(0.0105)	(0.0111)	(0.0104)
Any lead	0.0138***	0.0148***	0.0118**	0.0151***
	(0.0032)	(0.0047)	(0.0051)	(0.0046)
B. By firm type				
N SSE	0.0074**	0.0076*	0.0094*	0.0074*
	(0.0031)	(0.0045)	(0.0050)	(0.0045)
N non-SSE	0.0149**	0.0180**	0.0151*	0.0186**
	(0.0063)	(0.0082)	(0.0084)	(0.0082)
C. By position type				
N BOD	0.0123*	0.0141	0.0137	0.0150*
	(0.0064)	(0.0089)	(0.0095)	(0.0088)
Any BOD	0.0081***	0.0106***	0.0076*	0.0114***
	(0.0026)	(0.0039)	(0.0042)	(0.0038)
N CEO	0.0100***	0.0114***	0.0107**	0.0110**
	(0.0031)	(0.0042)	(0.0044)	(0.0043)
Any CEO	0.0079***	0.0070**	0.0065*	0.0065**
	(0.0023)	(0.0032)	(0.0034)	(0.0032)
N	13043	24419	35950	24419

Significance: ***: 1% **: 5% *: 10%. Standard errors clustered at person level. 'N lead' and 'any lead' are counts and dummies of total leadership positions. 'N SSE' and 'N non-SSE' count positions at SSE-listed and non-SSE listed companies. 'BOD' and 'CEO' variables are counts and dummies for directorship and executive management positions.

The effects of college admission on leadership outcomes depend on high school background. Figure 4 presents binned means of leadership outcomes for three groups of students: those who attended elite private high schools, those who did not, and the subset of the second group who attended elite public exam schools. Below threshold students who attended elite private high schools hold an average of 0.117 executive management and directorship positions, 335 percent more than the 0.035 average for students who did not attend elite high schools. For elite private high school students, the mean number of positions held jumps by 0.076 (65 percent) to 0.193 across the threshold, while the number of positions held by students from other high schools does not appear to jump at all. The result is a widening of the below-threshold gap in leadership outcomes. Above-threshold students hold 474 percent more top management positions than below-threshold students. Again, aside from the jump at the point of admission, there is a weak relationship between scores and leadership outcomes. Interestingly, results for students who attended elite public exam schools are very similar to those for the broader group of students who did not attend elite private high schools, if somewhat noisier. As shown in the lower row of Figure 4, similar patterns hold for SSE and non-SSE firms. Figure A6 presents results for directorship and executive management positions.

Table 4 reports regression results that bear out the visual analysis. The first column presents results for students who attended elite private high schools, the second column presents results for students who did not, and the third presents results for the subset of those students who attended elite public exam schools. The fourth column presents p-values from tests of equality of the elite private high school estimates and the estimates for all other students. The estimates shown here are from the BW=10 specification. Subsetting on the years for which high school data is available (1974-1988) and splitting the sample by high school type substantially reduces precision relative to the pooled model. However, the effects of threshold-crossing on pooled and executive management outcomes for students with private high school backgrounds remain significant at at least the ten percent level. Estimates for students who did not attend elite private high schools are close to zero and statistically insignificant. Tests of equality between the estimates for elite private high school students and other students reject at the ten percent level for the most comprehensive leadership measure (total number of leadership positions held), as well as for total SSE-listed positions and executive management positions.

Figure 4: Leadership outcomes by HS background and admissions score



Rolling averages of values within 5 points on either side of horizontal axis value. Estimates are reported at five point intervals and include only data with the same value of the threshold-crossing dummy. 'Non-elite HS' pools data for all schools that are not elite private high schools. The 'exam' category is the subset of applications from the non-elite HS group from public exam schools. 'Listed on exchange' and 'Not llisted' count leadership positions at firms listed and not listed on the Santiago Stock Exchange, respectively.

Table A5 presents instrumental variables estimates of the effects of ever being admitted to an elite degree program on leadership outcomes. For students from elite private high schools, the gain in leadership positions associated with any admission is 0.141, while for other students it is 0.009. I highlight these results here because I will use them in the decomposition exercise in Section 6. Table A6 presents equivalent results for the BW=20 and BW=40 specifications. Point estimates from these specifications are similar to those presented in Table 4. However, the inclusion of above- and below-threshold polynomial terms reduces precision. For instance, the estimated effect of threshold-crossing on the count of leadership outcomes for elite high school students is 0.0881 with a standard error of 0.0576, compared to a point estimate of 0.0760 with a standard error 0.0365 in the BW=10 specification.

Table 4: Effects of admission on leadership outcomes by high school type

	I. Elite private	II. Not elite private	III. Public exam	Test: I v. II
A. Pooled leadership outcomes				
N lead	0.0760**	0.0058	0.0147	0.0611*
	(0.0365)	(0.0088)	(0.0208)	
Any lead	0.0295**	0.0055	0.0026	0.1139
	(0.0146)	(0.0038)	(0.0114)	
B. By firm type				
N SSE	0.0318*	-0.0012	-0.0091	0.0615*
	(0.0177)	(0.0030)	(0.0104)	
N non-SSE	0.0442*	0.0074	0.0238	0.1586
	(0.0250)	(0.0074)	(0.0181)	
C. By position type				
N BOD	0.0495	0.0019	0.001	0.1545
	(0.0326)	(0.0076)	(0.0073)	
Any BOD	0.0149	0.0023	0.001	0.3122
	(0.0121)	(0.0030)	(0.0073)	
N CEO	0.0266**	0.0039	0.0137	0.0577*
	(0.0114)	(0.0036)	(0.0190)	
Any CEO	0.0238**	0.0041	-0.0018	0.0789*
	(0.0109)	(0.0027)	(0.0095)	
N	1513	6965	562	

Significance: ***: 1% **: 5% *: 10%. Standard errors clustered at person level. Estimates of admissions effects from BW=10 specification. 'Non-elite HS' pools data for all schools that are not elite private high schools. The 'public exam' category is the subset of applications from the column II for students from public exam schools. p-value column reports tests of equality of coefficients for students from elite private high schools and other students.

5 Peer ties in management hiring

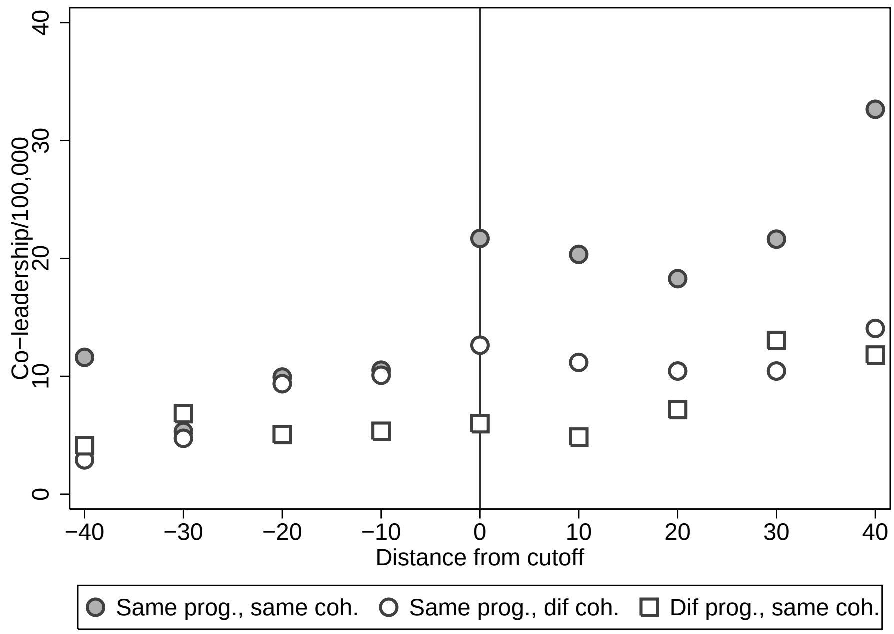
The results above show that elite university admission plays a causal role in the production of top managers, but only for students who attended elite private high schools. Broadly speaking, there are two ways to explain this finding. The first is complementarity between an elite private high school background and institutional inputs such as coursework, faculty interaction, or 'sheepskin' signaling effects. For example, reaching a top management position could require both the skills learned at elite colleges and fluency in English. Students attending elite private high schools are often taught English at a young age, while other students are not and may be unable to catch up. It could also be the case that admission to an elite college provides a stronger signal about the management productivity of elite high school students than about students who attended other high schools. What these types of effects have in common is that they do not depend upon interactions between college students. The second explanation is that it is precisely these interactions that are important. For example, students who attended elite private high schools might have ties to businesses through which they can refer college peers. Alternatively, school peers may be more productive if they work together, and working with peers may incentivize good management behavior. Students from elite high school backgrounds could benefit disproportionately if they are better able to form these kinds of ties with other students from elite backgrounds. This section asks how much of the observed effect of admission to elite degree programs can be attributed to peer ties.

I study peer ties by looking at co-leadership rates, which I define as the expected number of firms where both members of a pair of students have leadership positions. I compare co-leadership rates for students who were college peers (i.e., who attended the same degree program at the same time) to co-leadership rates for pairs who attended the same degree program at different times, or who attended a different degree program at the same time. The intuition is that within a degree program, same-year pairs are similar to pairs of students a few years apart in terms of pre-college backgrounds and institutional inputs, but that students in same-year pairs are more likely to know each other and to have mutual contacts. If students obtain jobs through contacts, or if peers are more productive when working together, college peers may be more likely to serve on leadership teams at the same firms than other pairs of similar students. If management hiring depends only on non-peer institutional inputs, there would be little reason to expect such a result.

To motivate this analysis, I present evidence on the changes in co-leadership rates that accompany college admission for students from elite private high schools. Figure 5 displays co-leadership rates for pairs of students from elite high schools by the position of the applicant relative to the admissions cutoff. I focus on the way admission changes applicants' co-leadership outcomes with three types of students: admitted students at the target degree program (e.g., the law program at PUC) separated by at most one application year (i.e., students who will be applicants' college peers), admitted students at the target degree program separated by more than one year, and students from different degree programs in same field separated by at most one year. Co-leadership rates are expressed on per-100,000 pairs basis. One way to think about the group means is as the number of co-leaders who would emerge from a group of about 317 ($\approx \sqrt{100000}$) students. This is roughly the size of the admitted cohort in the engineering program at PUC and the business program at UC during the period studied here. Note that, in contrast to the regression discontinuity graphs presented above, Figure 5 displays binned means within a 40 point window on each side of the admissions threshold, and uses a wider bin width. Rates of co-leadership are relatively low relative to overall leadership rates,[22] reducing statistical power. I therefore focus this discussion on a simple comparison of means for students within broad score ranges above and below the admissions threshold rather than a formal regression discontinuity analysis.

[22] Admitted students from elite high schools hold a total of 731 leadership positions. 100, or 14 percent, are at firms where a student from the same degree program admitted one cohort apart also holds a position.

Figure 5: Co-leadership outcomes by position relative to cutoff



Rolling averages of values co-leadership rates per 100,000 pairs within 10 points on either side of horizontal axis value. Estimates are reported at 10 point intervals and include only data with the same value of the threshold-crossing dummy.

Figure 5 shows that students who are not admitted to their target program are similarly likely to co-lead firms with students accepted to nearby cohorts in their target program, with students accepted to other cohorts in that program, and with students from nearby cohorts in other same-field degree programs. Students admitted to their target program become roughly twice as likely to co-lead firms with same-program students from nearby cohorts (i.e., their college peers), but are no more likely to co-lead firms with other types of admitted students. For example, a student admitted to PUC Law class of 1983 is much more likely than a student rejected from that degree program to serve on the same corporate board as another PUC Law student from the class of 1983. However, he is no more likely than the rejected student serve on the same corporate board as a student from the PUC Law class of 1980, or from the UC Law class of 1983. Statistical tests reported in Table A7 reject the hypothesis that the observed gain in co-leadership for same-degree, nearby cohort pairs is equal to zero, but fail to reject the hypothesis that co-leadership gains for other pair types are zero. This is consistent with a story in which ties to college peers account for an important component of the overall gains from admission, but difficult to reconcile with a story based on peer-independent skills. In the next subsection, I formalize this intuition using a model of top management hiring.

5.1 Model of top management hiring

I present a simple model of top management hiring in which hiring depends on student skills and referrals from school peers. This exercise has two goals. The first is to show how an analysis of changes in co-leadership rates across the admissions threshold such as that presented above can provide insight into the relative importance of the peer effects channel. The second is to develop a formula relating differences in co-leadership rates for pairs of students who are and are not college peers to the overall gain in leadership positions associated with admission. This will provide the basis for a decomposition of the total effect of admission into a 'skill' component and a 'peers' component.

In the model, peer ties help students by providing firms with information about student productivity. As mentioned above, peer ties could also operate through other channels. I return to this point in section 6. I design the model to capture three intuitive features of top management hiring decisions. First, admission to an elite degree program may help students develop skills applicable at many firms, and may also connect students to peers who make top management hiring decisions at specific firms. Second, because a very small number of students advance in a firm to the point where they are able to decide which top managers to hire, students from different degree programs may have connections to different firms even if each degree program is quite large. Third, even within degree programs, access to connections may depend on students' friend groups, which in turn may depend on social class.

To ensure the model is tractable, I consider a very simple framework for hiring decisions and the formation of peer connections.[23] Model setup is as follows. Students may attend

[23]Strong restrictions on the hiring process and the form of peer connections (or complementarities) are often necessary to obtain tractable solutions in agglomeration models. The closest parallel in the existing literature is Oyer and Schaefer (2012), who adopt the model of Ellison and Glaeser (1997). This analysis differs from Oyer and Schaefer in that my goal is to relate extensive-margin changes in hiring outcomes

either elite or non-elite high schools, indexed by $d \in \{l, h\}$. They may attend either elite or non-elite college degree programs; there are P elite degree programs, each with a measure of students. There are F total firms hiring top managers. Hiring is independent across firms, and students may hold positions at multiple firms. The latter point is consistent with the observed data.

Hiring depends on students' skills and on referrals from college peers. Students take one of two skill types: productive or unproductive. I use the term 'productivity' loosely; it may reflect firm profitability, but could also reflect the incentives of those making the hiring decision. The probability a student is the productive type depends on what kind of high school and college he attended. A student who attended a type d high school and a non-elite college is productive with probability γ_d. If that student attends an elite college, the probability he is productive rises to $\gamma_d + b_d$. The model captures skill complementarities by permitting b_h to be larger than b_l; i.e., skill gains can be larger for students from elite high schools. Skill endowments are independent across students.

Firm incentives are such that a firm hires a worker if and only if the firm knows the worker is productive. Fraction π of firms observe students' skill types and do not face an informational constraint. Fraction $(1 - \pi)$ do not observe skill types. These firms receive information on skills from referrals. Referrals, which reveal student productivity without error, are available only from same-type college peers with ex-ante connections to particular firms. For simplicity, I assume that there is precisely one student per firm who can provide referrals, and that referral-providing students always attend elite degree programs. The former assumption can be relaxed; the key feature is that referrals cannot be so common that they are available at all elite degree programs. I discuss the empirical basis for the latter restriction below. One could think of the students providing referrals as having family connections to firms, or as advisers to hiring committees chosen prior to management hiring. The probability that the referral-providing student for firm f is of high school type d and attends elite degree program p is r_d. Such students provide referrals to all of their same-type college peers.

The network setup described here captures in a simple way the idea that connections to firms are more common in elite degree programs and vary across both elite degree programs and social groups. I now consider the effects of elite college admission on

to gains from peer ties, whereas Oyer and Schaefer conduct their analysis within a sample of individuals already employed at law firms.

hiring outcomes. Let Y_{idpf} be a dummy variable equal to one if student i from high school d attending elite college degree program p is hired for a top management role at f, and let Y_{id0f} be a dummy variable equal to one if i from high school d attending a non-elite college degree program is hired at f. Then we may write the effect of elite admission on expected total leadership positions for students from high school type d as

$$E\left[\sum_f (Y_{idpf} - Y_{id0f})|d\right] = F \times (b_d\pi + r_d(\gamma_d + b_d)(1-\pi))$$

or

$$\Delta_d = S_d + C_d \tag{2}$$

where $\Delta_d = E\left[\sum_f (Y_{idpf} - Y_{id0f})|d\right]$, $S_d = F \times (b_d\pi)$, and $C_d = F \times (r_d(\gamma_d + b_d)(1-\pi))$. The total gain in leadership positions is equal to the sum of skill component S_d, which is equal to zero if skill gain b_d is zero, and connections component C_d, which is equal to zero if connections gain r_d is zero. The evidence in section 4 suggests that either $S_h > S_l$, $C_h > C_l$, or both.

Co-leadership outcomes can provide insight into the relative importance of S_d and C_d in Δ_d. I focus on two model implications. The first model implication is that, for students gaining admission to elite degree program p who would otherwise have attended a non-elite college, a) any increase in the rate of co-leadership with students at some other elite degree program q is due to skill gains, and b) any additional increase in the rate of co-leadership with college peers at p is attributable to network effects. More formally, let κ_d^{dif} be the change in rates of co-leadership with non-peers associated with elite admission, and let κ_d^{same} be the change in rates of co-leadership with peers. For example, consider an experiment in which a student is randomly assigned admission to PUC Law rather than admission to some non-elite degree program. κ_d^{dif} reflects the expected gain in co-leaders from some other elite degree program (e.g., UC Law), while κ_d^{same} reflects the expected gain in co-leaders also from PUC Law.

Then, for a pair of students $i \neq j$, and two elite degree programs $p \neq q$, we may write

$$\kappa_d^{dif} = E\left[\sum_f \left(Y_{idpf}Y_{jdqf} - Y_{id0f}Y_{jdqf}\right)|d\right]$$
$$= F(\gamma_d + b_d)b_d\pi \quad (3)$$

and

$$\kappa_d^{same} = E\left[\sum_f \left(Y_{idpf}Y_{jdpf} - Y_{id0f}Y_{jdpf}\right)|d\right]$$
$$= \kappa_d^{dif} + r_d F(\gamma_d + b_d)^2(1-\pi) \quad (4)$$

The admissions gain in co-leadership rates with non-peers, κ_d^{dif}, is equal to zero if skill gains b_d are equal to zero, or if $\pi = 0$ and there are no firms that observe skill gains without referrals. The admissions gain in co-leadership with peers, κ_d^{same}, is equal to κ_d^{dif} plus a term that is greater than zero only if network gains r_d are greater than zero and if some firms do not observe skill perfectly.

The second model implication is that the connection effect term C_d can be expressed as the difference in co-leadership rates for pairs of college peers relative to non-peers multiplied by a scaling term. Specifically,

$$C_d = \tau_d \times \frac{E[\sum_f Y_{idpf}|d]}{E[\sum_f Y_{idpf}Y_{jdpf}|d]} \quad (5)$$

where $\tau_d = E\left[\sum_f \left(Y_{idpf}Y_{jdpf} - Y_{idpf}Y_{jdqf}\right)|d\right]$. The scaling term, which is equal to $(\gamma_d + b_d)^{-1}$, accounts for the fact that students can only form co-leadership pairs if both members are the productive type.

This model abstracts from potentially important forms of heterogeneity by assuming that degree programs and firms are homogeneous. It is possible that students admitted to different degree programs or fields of study have skill sets that match particularly well to certain firms. It could also be the case that students from particular cohorts are more valuable to some firms if career paths for students of a certain age coincide with a firm's management hiring schedule. I address these concerns in my empirical work using first difference and difference-in-differences approaches that compare pairs of students in the same degree programs but different cohorts and different degree programs in the same field and the same cohort. Appendix D extends the model to the case in which productivity at specific firms varies across degree programs and cohorts, and describes conditions under which difference-in-difference approaches account for this heterogeneity. As is standard in difference-in-difference analyses, the key assumption is that firm-program-type effects and firm-cohort-type effects are additively separable; i.e., that there are not differential changes in the skill match between degree programs and firms over time.

5.2 Estimating gains from peer connections

The first model implication maps fairly straightforwardly to results presented above in Figure 5. The model indicates that, if elite admission increases rates of co-leadership with students who are not peers at the targeted elite degree program, this can be interpreted as evidence of skill gains. If co-leadership gains with peers at the elite degree program targeted for admission exceed co-leadership gains with non-peers, this is evidence of gains from peer connections. Figure 5 shows that admission to an elite degree program only increases co-leadership rates with college peers at that degree program, not with students who attend that program in different years or who attend different programs in the same field. This suggests a limited role for skill effects in driving overall gains from admission, and a potentially large role for peer effects.[24]

The second model implication is that the connection effect component of total admissions gains, C_d, can be expressed as the difference in co-leadership rates for pairs of college peers relative to non-peers, τ_d, multiplied by a scaling term. I estimate differences in co-leadership rates for elite college peers and non-peers using single-difference and difference-in-difference specifications of the form

[24]One complication in mapping the model to the regression discontinuity analysis is that threshold-crossing into admission at one degree program is associated with a reduced probability of attending the same-field program in the other institution (see Table 2 and the associated discussion). If peer effects matter, this could drive up the gains in co-leadership outcomes with college peers relative to other students. I discuss the value of peer ties for rejected students in more detail below.

$$Y_{idpt}^{jd'pt'} = \beta_0 + \beta_1 C(t,t') + e_{idpt}^{jd'pt'} \tag{6}$$

and

$$Y_{idpt}^{jd'p't'} = \pi_0 + \pi_1 C(t,t') + \pi_2 S(p,p') + \pi_3 C(t,t') S(p,p') + e_{idpt}^{jd'p't'}. \tag{7}$$

Here, $Y_{idpt}^{jd'pt'}$ counts the total number firms where applicants ipt and $jp't'$ both hold positions. $C(t,t')$ is an indicator variable equal to one if $|t-t'| \leq 1$; i.e., if two students in question attended school within one cohort of one another. $S(p,p')$ is an indicator variable equal to one if $p = p'$, i.e., if both students in the pair are at the same degree program. I label students college peers if $C(t,t')$ and $S(p,p')$ both equal one. I estimate equation 6 using only pairs of admitted applications to the same degree program (e.g., PUC law-PUC law pairs). I estimate equation 7 using pairs of admitted applications to the same field (e.g., PUC law-PUC law pairs and PUC law-UC law pairs). I estimate both equations separately for pairs of students from elite high schools, pairs of students from non-elite high schools, and mixed pairs. My model stipulates that referrals should act only through pairs of students from the same type of high school; the inclusion of mixed pairs can be viewed as test of this restriction.

Panel A of Table 5 presents estimates of equation 6. The three left columns display estimates where the sample is restricted to pairs from application cohorts five or fewer years apart, while the right three columns display estimates for pairs at any cohort distance. Columns display estimates of equation 6 for elite-elite, elite-non-elite and non-elite-non-elite pairs, respectively. I compute standard errors that allow for clustering of the error term separately by i and j; i.e., clustering at the student by student level (Cameron et al. 2011). Appendix E discusses approaches to clustering in pairwise datasets and presents results obtained using alternate clustering strategies.

Within all same-degree pairs where students are at most five cohorts apart, pairs of elite high school students who attended the same college but not at the same time become co-leaders of firms at a rate of 13.9 per 100,000. For students who are college peers, this rate rises by 13.0, or 93 percent, to 26.9 per 100,000. This change is statistically significant at the one percent level. For pairs in which one student attended an elite high school and one did not, the baseline co-leadership rate is 2.5, and this rate rises by a statistically insignificant 0.6 (24 percent) for college peers. For pairs of non-elite students, the baseline co-leadership rate is 0.7 per 100,000, and this rises by 0.3, or 44 percent, for college peers. This change is statistically significant at the ten percent level. These results are stable when the sample is expanded to include all same-degree pairs, not just those within five years of one another, with the exception that the effect for pairs of non-elite students becomes statistically insignificant.That results are insensitive to this change in sample indicates that patterns of management recruitment are relatively stable within institutions over time.[25]

[25]This suggests that my results are not driven by life-cycle patterns in top management attainment. It also argues against a corporate recruitment story. If certain firms only recruit at certain degree programs in a subset of years, this could potentially lead to results like those observed here. Concerns about the effects of differential corporate recruitment across degree programs and cohorts are surely lower here, where the outcomes in question are realized roughly 30 years after graduation, than they would be for entry level positions. They are also mitigated by the fact that all of the programs here are located in Santiago, reducing costs associated with separate recruitment visits. In any case, if corporate recruiting did differ within programs across years, one might expect higher rates of co-leadership for students in closer cohorts who face more similar recruiting environments. Comparing panels A and B suggests that this is not the case.

Table 5: Mean co-leadership rates for student pairs, by type of pair

	I. Within 5 years			II. All pairs		
A. Within same degree	Elite-elite	Elite-not elite	Not elite-not elite	Elite-elite	Elite-not elite	Not elite-not elite
Close cohort	13.0***	0.6	0.3*	12.9***	1	0.4
	(4.4)	(0.6)	(0.2)	(5.0)	(0.6)	(0.2)
Constant	13.9***	2.5***	0.7***	13.9***	2.2***	0.6***
	(3.4)	(0.5)	(0.1)	(2.9)	(0.5)	(0.1)
N	740928	7086379	21539977	1115903	11123695	34730816
B. Within same field						
Same degree × close cohort	16.5***	0.7	0.4	16.6***	1.3*	0.5
	(5.3)	(0.7)	(0.3)	(5.2)	(0.8)	(0.3)
Same degree	2.8	-0.2	-0.1	2.7	-0.8*	-0.2
	(2.4)	(0.4)	(0.1)	(2.8)	(0.4)	(0.1)
Close cohort	3.5	-0.1	-0.1	3.7	-0.4	-0.1
	(2.9)	(0.4)	(0.2)	(2.8)	(0.3)	(0.2)
Constant	11.0***	2.76***	0.7***	11.2***	2.9***	0.8***
	(2.4)	(0.5)	(0.1)	(2.3)	(0.4)	(0.1)
N	1478180	13719925	32949927	2215586	21304466	52514174

Significance: ***: 1% **: 5% *: 10%. Units are co-leadership rates per 100,000 pairs. Standard errors use two-way clustering at student by student level. 'Elite-elite' columns subset on pairs of admitted students in which both students attended an elite private high school. 'Elite-not elite' subsets on pairs where one student attended an elite private high school and one did not. 'Not elite-not elite' pairs are those for which neither student attended an elite private high school.

Panel B of Table 6 presents estimates of equation 7. These estimates follow a similar pattern to estimates from Panel A, but point estimates on peer effect terms are generally larger. Pairs of elite high school students from the same field and non-close cohorts become co-leaders at rate of 11.0 per 100,000. This rises by 3.5 per 100,000 for students from nearby cohorts, and by 2.8 per 100,000 for students in the same institution. Neither of these effects is statistically significant. For students in the same institution and nearby cohorts, co-leadership rates rise by 16.5 per 100,000. This effect is significant at the one percent level, and is stable when the sample is expanded to include all cohort distances. As was the case for equation 6, estimates of peer effects for pairs of elite and non-elite students and pairs of non-elite students are substantially smaller in both levels and percentage terms, and are generally not statistically significant.

These estimates of τ_d are consistent with a large role for peer ties in the overall admissions effect. Table 6 presents a decomposition of total admissions effects for students from elite private high schools and students from other high schools. The first column repeats differences and difference-in-differences estimates of τ_d from Table 5. The second column is the scaling factor from equation 5, divided by 100,000 to account for the units in the τ_d term. The scaling factor is just the ratio of leadership rates to co-leadership rates amongst college peers of a given type. Column three presents the estimated peer tie term C_d obtained by multiplying columns one and two. The single differences estimates suggest that peer ties increase the number of leadership positions held by students from elite private high schools by 0.11, compared to 0.02 for other students. Difference-in-differences estimates suggest peer-related gains of 0.14 for private high school students, and 0.02 for other students. Peer ties account for 80 to 100 percent of the overall admissions effect for elite private high school students.

Table 6: Referral gains as a fraction of top management hiring

	Computing total peer effects: Peer gains (τ_d)	Scaling factor	C_d	Δ_d	C_d/Δ_d
A. Differences					
Elite HS	13	0.0087	0.11	0.14	0.8
Non-Elite HS	0.3	0.0601	0.02	0.01	N/A
B. Diff. in Diff.					
Elite HS	16.5	0.0087	0.14	0.14	1.02
Non-Elite HS	0.4	0.0601	0.02	0.01	N/A

'Peer gains' column reproduces estimates of τ_d from Table 5. 'Scaling factor' calculated using expression in equation 5, divided by 100,000 to reflect units of τ_d. C_d is total gain from peer connections associated with admission, and Δ_d are RD estimates of total admissions effects reproduced from Table A6.

There are several possible questions that might be raised about this decomposition. One concern is that the difference-in-differences estimates of co-leadership effects may reflect friendships formed with high school peers who happen to attend the same college, rather than the effects of college peers per se. Table A8 presents estimates of equations 6 and 7 that subset on pairs of students who attended different elite high schools, and the accompanying estimates of the connections effect C_d. Rates of co-leadership are somewhat lower for these pairs, but the implied values of C_d are similar to those reported in Table 6. Another concern is that overall co-leadership effects may overstate effects for students with scores near the threshold, for whom the admissions gain is calculated. Table A8 re-estimates equations six and seven for pairs of elite students, subsetting on matches between students with scores within 20 points of the cutoff value and other accepted students. Results are again similar to those from Table 6. A final concern is that students who are admitted may lose valuable peer ties at non-elite degree programs they otherwise would have attended. A challenge in addressing this question is that full data on acceptance outcomes for below-threshold students is only available between 1982 and 1988. However, the data that is available suggests that students who are rejected from elite programs do not benefit much from peer connections in the programs they end up attending. Out of 63 rejected applicants from elite high schools who go on to hold leadership positions, I observe zero instances in which they form co-leadership pairs with students from nearby cohorts in the degree program to which they were admitted.

6 Discussion

This paper considers the role of elite colleges in providing a pathway for talented students from non-elite backgrounds into top management roles at major corporations. To address this question, I combine rich and novel data on applicants to elite business, law, and engineering programs in Chile between 1968 and 1995 with a regression discontinuity design that exploits score-based admissions cutoffs. I find that admission to an elite degree program raises the number of leadership positions students hold by 50 percent, but that these gains accrue only to students who attended elite private high schools. Students who attend other types of high schools, including elite public schools, do not realize any gains in leadership outcomes from elite college admission.

The composition of leadership teams at particular firms suggests that ties formed between college peers from elite private high schools are an important driver of top management hiring. Pairs of private school students who attend the same degree programs at similar times are 93 percent more likely to serve on leadership teams at the same firm than pairs of private school students who attend the same degree program in more distant years, and 133 percent more likely than pairs of private high school students who attend different programs in the same field at similar times. Students who are not from private high schools are not significantly more likely to co-lead firms with college peers who attended private high schools than they are with students from different degree programs or different cohorts. A simple model of referral based hiring relates these findings to overall admissions effects, and allows for a decomposition of total admissions effects into a 'peers' component and an 'other inputs' component. The model indicates that peer ties are the key driver of overall admissions effects. Specifically, peer ties account for 80 to 100 percent of the hiring gain for students from elite private high schools.

One surprising aspect of these findings is that, even in the presence of a transparent admissions system (based only on test scores and grades, and notably without the legacy preferences common in the US), elite colleges appear to widen the leadership gap between students from elite private high schools and students from other high schools, including elite public exam schools. This is an important observation, because higher education is perhaps the main avenue open to policymakers hoping to connect talented students from non-elite backgrounds with high-end skill inputs and connections to elite-background peers. In Chile, as in the United States, elite private high schools cost far more than available subsidies and frequently have opaque admissions criteria (Nielson 2013). In contrast, loans and scholarships are more readily available to cover college costs, and the admissions process is relatively transparent.[26] Elite colleges in both Chile and the US appear to be aware of the unique role they play in identifying and developing talented students from non-elite backgrounds.[27] However, my findings suggest that these efforts have not been fully successful, perhaps because students from elite and non-elite backgrounds tend to self-segregate. Understanding the effects of efforts aimed at increasing within-school integration on leadership outcomes should be a high research priority.

My findings are consistent with two stories in which the dominance of a small group of elites reduces social welfare. The failure of elite universities to facilitate innovation amongst the economic elite could be a driver or a symptom (or both) of the type of growth-reducing elite entrenchment described, e.g., in Acemoglu and Robinson (2006, 2008, 2012). Even abstracting from possible growth effects, the absence of an elite education pathway to top management positions for students from non-elite backgrounds may have deleterious welfare effects. Authors dating back to Marx (1865) and de Tocqueville (1830-35) have argued that low social position is more tolerable when advancement seems plausible (see Ferrie 2005 for a discussion). The magnitude of welfare losses through these two channels is of course very difficult to quantify.

My results have more ambiguous implications for the efficiency of corporate management. A growing literature suggests that managers' skills and backgrounds can affect firm performance (Bertrand and Schoar 2003; Malmendier and Tate 2005, 2010; Guner et al. 2008; Lazear et al. 2012). This means that welfare losses could accrue if talented but unconnected individuals cannot reach the executive suite. The model of informational frictions in hiring that I develop in this paper is consistent with this story. Welfare implications are less clear, however, if peer ties can affect managerial productivity directly. Recent papers suggest that peer connections among managers could either reduce effi-

[26]Though Hoxby and Turner (2013) and Dynarski and Scott-Clayton (2008) do raise questions about the transparency of the college admissions and financial applications in the U.S., particularly for low-income applicants.

[27]For instance, the business program at the University of Chile lists as part of its mission statement 'preserv[ing] a diverse student body' and 'recruit[ing] and retain[ing] high potential undergraduate students' (Agosin 2012). Part of Harvard's stated mission is to 'identify and remove constraints on students' full participation, so that individuals may... develop their full intellectual and human potential' (Lewis 1997).

ciency by encouraging lax oversight or inefficient compensation decisions (Fracassi and Tate 2012; Shue 2013), or increase efficiency by facilitating the flow of information within and across firms or by taking advantage of peer complementarities in production (Cohen et al. 2008; Oyer and Schaefer 2012). Network inputs into manager performance could mitigate or eliminate welfare losses due to informational frictions in hiring; alternatively, they could exacerbate these losses. This is a topic for future research.

Another important question is whether results from Chile can be meaningfully extrapolated to other countries. It seems likely that access to elite educational institutions and family networks play a smaller role in Chile than in other Latin American countries, which are characterized by slower growth, similar levels of inequality, and less business transparency. Comparisons with the US and European countries are more challenging. Lower levels of GDP and higher inequality suggest that access to elite educational and family networks may play a larger role in Chile in the population as a whole. The present analysis, however, focuses on applicants to elite colleges, a privileged group. Cross-country comparisons of inequality are not as straightforward after conditioning on college application. The fraction of students attending college in Chile during the period in question was far smaller than the fraction in the US, which suggests that cross-country differences in inequality could be reduced or even reversed within the subpopulation of applicants.

Further complicating the comparison are differences in the size and geographic dispersion of the business elite. Chile has a relatively small corporate sector concentrated in one city, Santiago. The US has a much larger set of business leaders distributed across several major population centers. On the one hand, this suggests that, at the national level, peer ties between corporate leaders may be stronger in Chile. On the other hand, elite university attendance in the US could be even more valuable if opportunities to network with a nationally-recruited group of elite students are rarer. The direction of 'bias' in Chilean estimates of overall admissions effects and heterogeneous admissions effects by family background relative to population parameters in the US is unclear.

I conclude with an important caveat: My results do not indicate that students from non-elite high schools get no benefits from elite admission. HNZ (2013) show that students from lower tier high schools do realize earnings gains from admission to selective degree programs. Further, it is possible that some students from non-elite high schools become leaders in other fields, such as politics. Questions about when students from non-elite high schools leave the corporate leadership track and whether they attain leadership roles in other fields are important, and represent a pathway for future work using early-career data and data on leadership outcomes outside of the private sector. A finding that students from non-elite high schools become leaders in areas other than business would arguably make the finding that they do not reach top management positions in the corporate world more surprising.

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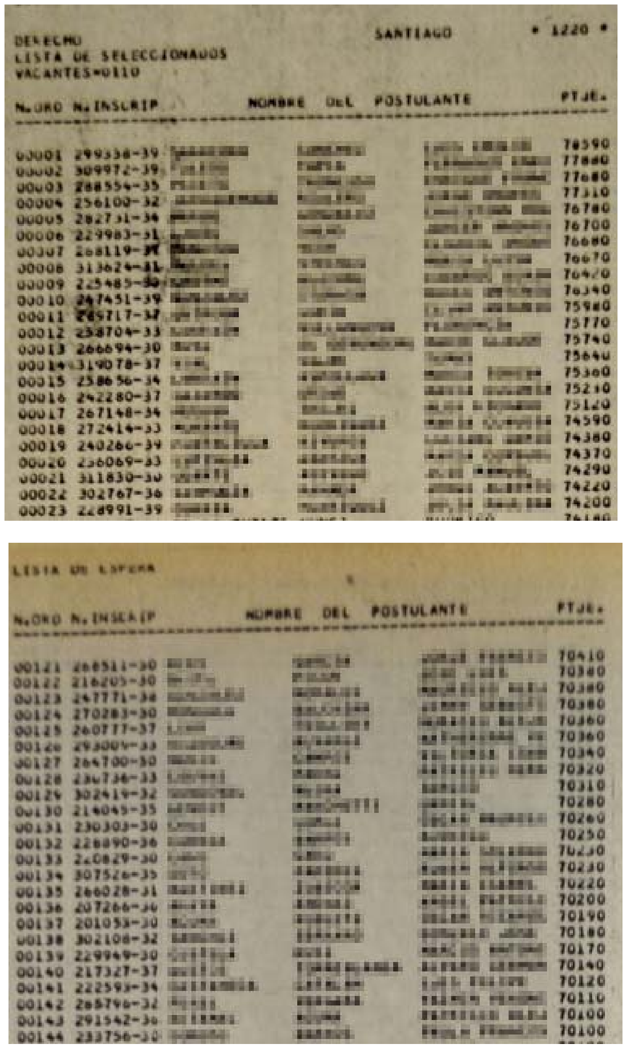
Appendix

A Additional tables and figures

Figure A-1: PUC Law admissions and waitlist announcements, 1984



DERECHO	SANTIAGO	* 1220 *
LISTA DE SELECCIONADOS
VACANTES=0110

N.ORD	N.INSCRIP	NOMBRE DEL POSTULANTE	PTJE.
00001	299538-39	[illegible]	78590
00002	309972-39	[illegible]	77880
00003	288554-35	[illegible]	77680
00004	256100-32	[illegible]	77310
00005	282731-34	[illegible]	76780
00006	229983-31	[illegible]	76700
00007	268119-[illegible]	[illegible]	76680
00008	313624-[illegible]	[illegible]	76670
00009	225485-[illegible]	[illegible]	76420
00010	247451-39	[illegible]	76340
00011	265717-32	[illegible]	75980
00012	258704-33	[illegible]	75770
00013	266694-30	[illegible]	75740
00014	319078-37	[illegible]	75640
00015	258656-34	[illegible]	75300
00016	242280-37	[illegible]	75210
00017	267148-34	[illegible]	75120
00018	272414-33	[illegible]	74590
00019	240266-34	[illegible]	74380
00020	256069-33	[illegible]	74370
00021	311830-30	[illegible]	74290
00022	302767-36	[illegible]	74220
00023	228991-39	[illegible]	74200

LISTA DE ESPERA

N.ORD	N.INSCRIP	NOMBRE DEL POSTULANTE	PTJE.
00121	268511-30	[illegible]	70410
00122	216205-30	[illegible]	70380
00123	247771-34	[illegible]	70380
00124	270283-30	[illegible]	70380
00125	260777-37	[illegible]	70360
00126	293004-33	[illegible]	70360
00127	264700-30	[illegible]	70340
00128	236736-33	[illegible]	70320
00129	302419-32	[illegible]	70310
00130	214045-35	[illegible]	70280
00131	230303-30	[illegible]	70260
00132	228890-36	[illegible]	70250
00133	220829-30	[illegible]	70230
00134	307526-35	[illegible]	70230
00135	266028-31	[illegible]	70220
00136	207266-36	[illegible]	70200
00137	201053-30	[illegible]	70190
00138	302108-32	[illegible]	70180
00139	229949-30	[illegible]	70170
00140	217327-37	[illegible]	70140
00141	222593-34	[illegible]	70120
00142	288796-32	[illegible]	70110
00143	291542-36	[illegible]	70100
00144	233756-30	[illegible]	70100

Upper panel is the beginning of the list of admitted students, ordered by score. Following this list the newspaper prints the list of waitlisted students, also ordered by score. Though these data are publicly available, names are blurred to preserve confidentiality. Source: *El Mercurio*, March 1984.

Figure A-2: Example of data from web scrape

GERENTES, EJECUTIVOS PRINCIPALES

(Fecha Informe: 29/09/2013)

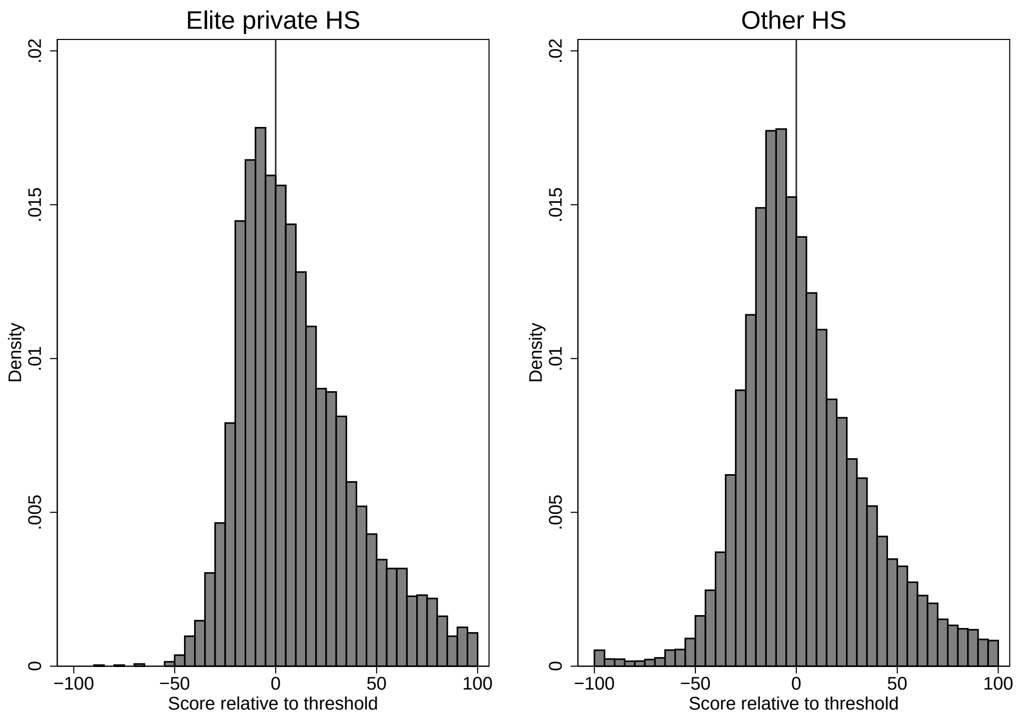
RazÃ³n Social: AES GENER S.A.
RUT: 94272000

Listado histÃ³rico Gerentes, Ejecutivos Principales de la Sociedad entre el 01/01/1975 y el 01/01/2013

Rut	Nombre	Cargo	Cargo Ejecutivo Principal	Fecha Nombramiento	Fecha termino
6.921.313-8	DANIEL STADELMANN ROJAS	Gerente General Subrogante		07/04/2011	
0-E (Extranjero)	MICHAEL WHITTLE -	Ejecutivo Principal	GERENTE DESAROLLO	26/01/2011	
12.458.775-1	IVAN JARA CARRASCO	Ejecutivo Principal	GERENTE DE INGENIERIA Y CONSTRUCCION	24/09/2010	
12.240.551-6	MARIANA PAZ SOTO ESPINOSA	Ejecutivo Principal	GERENTE ASUNTOS CORPORATIVOS	01/09/2010	
7.054.225-0	ALBERTO ZAVALA CAVADA	Ejecutivo Principal	FISCAL Y MANDATARIO JUDICIAL	24/05/2010	
23.202.311-2	VICENTE JAVIER GIORGIO	Ejecutivo Principal	GERENTE DE EXPLOTACION Y GERENTE GENERAL SUBROGANTE	26/05/2009	
6.921.313-8	DANIEL STADELMANN ROJAS	Ejecutivo Principal	GERENTE DE FINANZAS Y GERENTE GENERAL SUBROGANTE	25/02/2009	
6.375.799-3	LUIS FELIPE CERON CERON	Gerente General		29/08/2001	

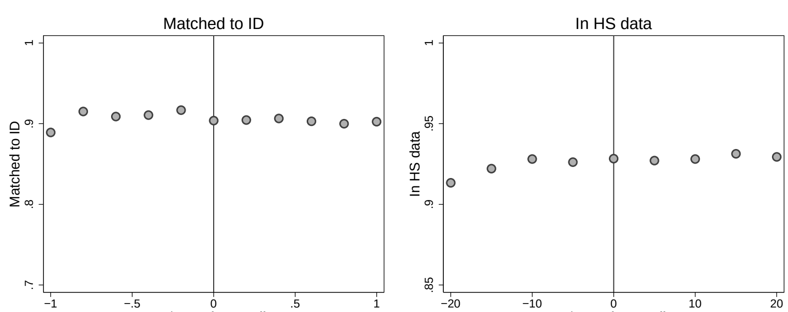
Source: SVS filings. `http://www.svs.cl/sitio/mercados/consulta.php?mercado=V&entidad=RVEMI`. Accessed 9/29/2013.

Figure A-3: Density of scores for Elite HS and other students



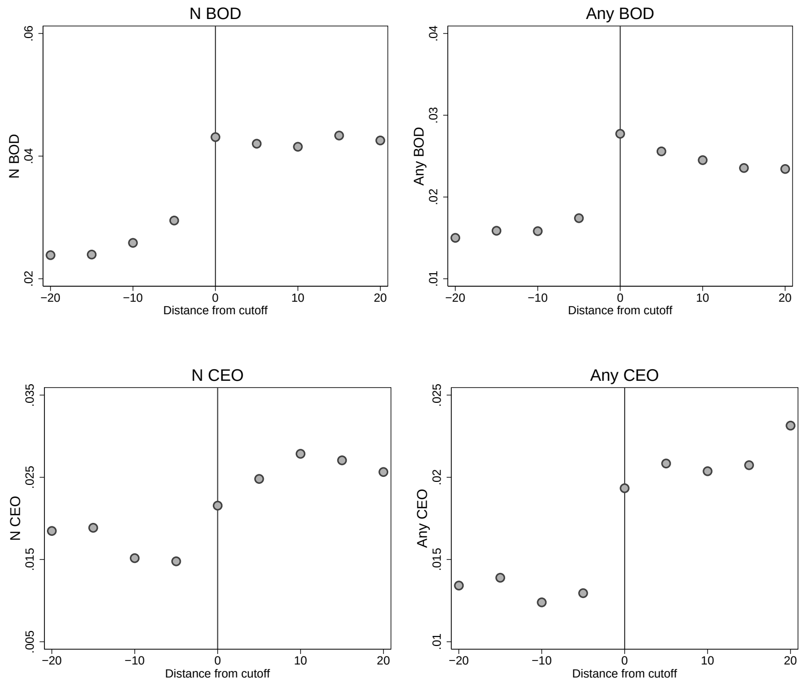
Density of admissions score distribution for students from elite private high schools and other students. Bin width is five score points.

Figure A-4: Selection into full sample and high school sample



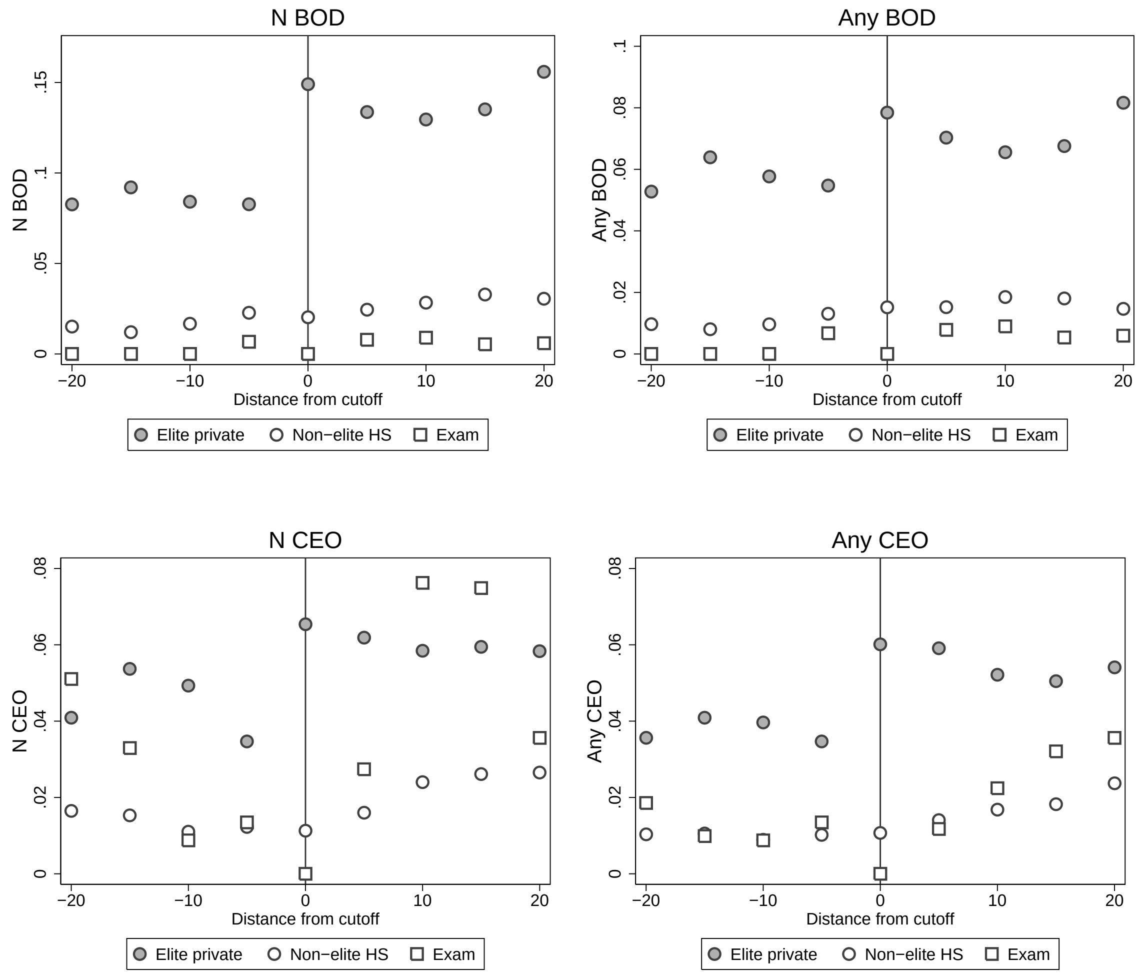
Rolling averages of values within 5 points on either side of horizontal axis value. Estimates are reported at five point intervals and include only data with the same value of the threshold-crossing dummy.

Figure A-5: Leadership outcomes by distance from cutoff leadership position



Rolling averages of values within 5 points on either side of horizontal axis value. Estimates are reported at five point intervals and include only data with the same value of the threshold-crossing dummy. 'Any BOD' is equal to one if an individual holds at least one directorship position. 'N BOD' counts total directorship positions. 'Any CEO' and 'N CEO' are defined analogously for executive management positions.

Figure A-6: Executive outcomes by HS background



Rolling averages of values within 5 points on either side of horizontal axis value. Estimates are reported at five point intervals and include only data with the same value of the threshold-crossing dummy. 'Any BOD' is equal to one if an individual holds at least one directorship position. 'N BOD' counts total directorship positions. 'Any CEO' and 'N CEO' are defined analogously for executive management positions. 'Non-elite HS' pools data for all schools that are not elite private high schools. The 'exam' category is the subset of applications from the non-elite HS group from public exam schools.

Table A-1: Chile in international context

Country	GDP	Top share	Bus. Rank	Informal payments	Tertiary completion	OECD
Panel A: 2012						
Chile	9.4	42.8	37	0.7	38	Yes
United States	43	29.9	4		42	Yes
Mexico	8.3	37.5	48	11.6	22	Yes
Argentina		32.3	124	18.1		No
Brazil	5.7	42.9	130	11.9	12	No
Italy	28.3	26.8	73		21	Yes
Poland	10.6	25.9	55	14.7	37	Yes
Panel B: 1980						
Chile	3.3				19	
United States	25.5				41	
Mexico	6.5				12	
Argentina	4.4					
Brazil	4.2				9	
Italy	20.3				11	
Poland					13	

All data from World Bank (2013) except tertiary completion, which is from OECD (2012; Table A1.3a). Statistics are reported for most recent available year. GDP is per capita in 1000s of 2005 US dollars. 'Top share' is the percentage of income earned by the top 10 percent of the income distribution. ' 'Bus. Rank' is the World Bank Ease of Doing Business Index; countries are ordered from 1 to 185 with a top rank of 1. 'Informal payments' reports the percentage of businesses reporting informal payments to government officials. Tertiary completion for 2012 panel is given by completion rates for 25-34 y.o. in 2010. Tertiary completion for 1980 panel is given by completion rates for 55-64 y.o. in 2010.

Table A-2: Leadership roles held by applicants

A. Titles of corporate directors	
Director	0.62
Substitute director	0.19
President	0.09
General manager	0.05
Vice President	0.04
N	2107
B. Titles of executive managers	
Principal Executive	0.75
General Manager	0.24
Other	0.01
N	1652
C. Assets of SSE companies	
Fraction listed on SSE	0.34
25th percentile	0.3
50th percentile	0.7
75th percentile	2.4
95th percentile	9.7
Largest	47.5
D. Assets of non-SSE companies	
Fraction not listed on SSE	0.66
25th percentile	0.06
50th percentile	0.4
75th percentile	1.2
95th percentile	5.9
Largest	44.4

Sample: applicants to elite college programs who rise to top management positions. Data at position level. Panels A and B show the fraction of directors and executives, respectively, by title listed on SVS filings. Panels C and D show the assets (in billions of 2012 USD) for companies that are listed and not listed on the Santiago Stock Exchange (SSE). I use asset data from December 2012; asset data are available for 95 percent of the SSE sample and 32 percent of the non-SSE sample.

Table A-3: Companies at by position in asset distribution

	Example 1	Example 2
Biggest	Quiñenco	Antarchile
p75	Gasco	Walmart Chile Inmobiliaria
p50	Empresas la Polar	Farmacias Ahumada
p25	Hortifrut	Detroit Chile
p5	First Factors	Somela

Examples of companies at different points in the asset distribution. Observations at the application-leadership position level. 2011 asset data from SVS filings.

Table A-4: Effects of any admission on leadership outcomes

	BW=10	BW=20	BW=40	Controls
A. Pooled leadership outcomes				
N lead	0.0282***	0.0335**	0.0322**	0.0343**
	(0.0098)	(0.0137)	(0.0146)	(0.0138)
Any lead	0.0175***	0.0194***	0.0156**	0.0200***
	(0.0041)	(0.0061)	(0.0067)	(0.0061)
B. By firm type				
N BSE	0.0094**	0.0099*	0.0123*	0.0098*
	(0.0039)	(0.0058)	(0.0066)	(0.0059)
N non-BSE	0.0189**	0.0236**	0.0198*	0.0246**
	(0.0079)	(0.0107)	(0.0111)	(0.0108)
C. By position type				
N BOD	0.0156*	0.0185	0.0181	0.0199*
	(0.0081)	(0.0116)	(0.0124)	(0.0116)
Any BOD	0.0103***	0.0139***	0.0100*	0.0150***
	(0.0033)	(0.0050)	(0.0056)	(0.0050)
N CEO	0.0126***	0.0150***	0.0141**	0.0145**
	(0.0040)	(0.0056)	(0.0058)	(0.0057)
Any CEO	0.0079***	0.0092**	0.0085*	0.0086**
	(0.0023)	(0.0042)	(0.0045)	(0.0042)
N	13043	24419	35950	24419

Significance: ***: 1% **: 5% *: 10%. Standard errors clustered at person level. Instrumental variables estimates of effects of any admission on leadership outcomes. Instrument is threshold-crossing for admission at target program. See note to Table 3 for variable definitions.

Table A-5: Effects of any admission on leadership outcomes by high school type

	I. Elite Private	II. Not Elite Private	III. Public Exam	Test: I vs. II
A. Pooled leadership outcomes				
N lead	0.1413**	0.0089	0.0231	0.0553*
	(0.0678)	(0.0135)	(0.0326)	
Any lead	0.0547**	0.0085	0.004	0.0965*
	(0.0272)	(0.0059)	(0.0179)	
B. By firm type				
N BSE	0.0591*	-0.0026	-0.0142	0.0629*
	(0.0329)	(0.0046)	(0.0163)	
N non-BSE	0.0822*	0.0115	0.0373	0.1388
	(0.0464)	(0.0113)	(0.0283)	
C. By position type				
N BOD	0.0919	0.0029	0.0016	0.1481
	(0.0605)	(0.0116)	(0.0114)	
Any BOD	0.0276	0.0035	0.0016	0.292
	(0.0224)	(0.0045)	(0.0114)	
N CEO	0.0493**	0.006	0.0215	0.0477**
	(0.0212)	(0.0055)	(0.0297)	
Any CEO	0.0442**	0.0062	-0.0028	0.0666*
	(0.0203)	(0.0042)	(0.0148)	
N	1513	6965	562	

Significance: ***: 1% **: 5% *: 10%. Standard errors clustered at person level. Instrumental variables estimates of effects of any admission from BW=10 specification. ‘Not elite private’ pools data for all schools that are not elite private high schools. The ‘public exam’ category is the subset of applications from the column II for students from public exam schools. p-value column reports tests of equality of coefficients for students from elite private high schools and other students.

Table A-6: Effects of any admission on leadership outcomes by high school type

	BW=20			BW=40		
	Elite Private	Non-elite	p-value	Elite private	Non-elite	p-value
N lead	0.0881	0.0029	0.146	0.0893	-0.0007	0.1714
	(0.0576)	(0.0106)		(0.0650)	(0.0108)	
Any lead	0.0294	0.0043	0.2748	0.0243	-0.0011	0.3184
	(0.0224)	(0.0052)		(0.0249)	(0.0058)	
N SSE	0.0372	-0.0048	0.128	0.0371	-0.0054	0.1956
	(0.0273)	(0.0041)		(0.0326)	(0.0045)	
N non-SSE	0.0509	0.0077	0.2806	0.0522	0.0047	0.2794
	(0.0391)	(0.0089)		(0.0430)	(0.0089)	
N BOD	0.06	-0.0025	0.2414	0.0561	-0.0025	0.3299
	(0.0526)	(0.0089)		(0.0595)	(0.0090)	
Any BOD	0.0211	0.0028	0.3493	0.0115	0.0002	0.6037
	(0.0191)	(0.0042)		(0.0213)	(0.0047)	
N CEO	0.0282	0.0054	0.2124	0.0332*	0.0018	0.1279
	(0.0176)	(0.0049)		(0.0200)	(0.0050)	
Any CEO	0.0212	0.0025	0.2529	0.0254	-0.0004	0.1469
	(0.0160)	(0.0036)		(0.0174)	(0.0040)	
N	2855	13156		4015	19107	

Significance: ***: 1% **: 5% *: 10%. Standard errors clustered at person level. Estimates of admissions effects from BW=20 and BW=40 specifications. 'Non-elite' column includes data from students who did not attend elite private high schools. p-value column reports tests of equality of coefficients for students from elite and non-elite high schools.

Table A-7: Co-leadership rates for admitted and non-admitted students

	College peers	Same deg., dif. coh.	Dif. deg., same coh.
A. Within 40 points of cutoff			
Admitted	12.54**	2.6	1.43
	(5.60)	(2.56)	(2.67)
N	455459	1703535	440509
Test		0.0591	0.0426
B. Within 10 points of cutoff			
Admitted	12.96	4.15	1.18
	(8.77)	(4.95)	(4.52)
N	165304	611947	157109
Test		0.2578	0.2272

Significance: ***: 1% **: 5% *: 10%. Standard errors computed using two-way clustering at the person by person level. Coefficients are estimated effects of admission on co-leadership rates per 100,000 pairs. 'College peers' are students admitted to applicants' target degree program within one application year. 'Same degree, different cohort' are students admitted to applicants' target degree program in more distant application years. 'Different degree, same cohort' are students admitted to different degree programs in the same field within one application year. 'Test' row provides p-values for tests of equality between the 'college peers' coefficient and the coefficient listed in the column label.

Table A-8: Mean co-leadership rates for student pairs, by type of pair

	I. Different HS		II. Only marginal	
A. Within same degree	E-E	C_d	E-E	C_d
Close cohort	8.7**	0.10	12.7**	0.09
	(4.4)		(5.7)	
Constant	11.5***		13.6***	
	(3.0)		(3.5)	
N	631626		413724	
B. Within same field				
Same degree × close cohort	12.4***	0.14	14.6**	0.14
	(4.7)		(5.7)	
Same degree	1.7		1.6	
	(2.3)		(5.3)	
Close cohort	-3.7		-8.2*	
	(2.6)		(4.8)	
Constant	9.8***		11.9***	
	(2.1)		(4.3)	
N	1265996		520481	

Significance: ***: 1% **: 5% *: 10%. Standard errors use two-way clustering at student by student level. 'E-E' columns report co-leadership rates for pairs of admitted students from elite private high schools per 100,000 pairs. C_d column reports total connections effects for elite private high school students implied by estimates of co-leadershp rates. Columns under heading I report results for student pairs where students attended different high schools. Columns under heading II report results for student pairs where at least one student had a score within 20 points of the admissions threshold.

B Data appendix

B.1 Data construction and description of the applicant sample

This subsection provides more detail on data availability by year and describes the sample of students applying to elite degree programs.

Table B1 describes data availability for each of the six elite degree programs by year. Data is missing in some years because newspaper records could not be located. Out of 168 total program-year cells between 1968 and 1995, I have data on 131. Most of the missing cells are due to the fact that PUC applications do not become available until

1976. The rightmost columns shows the total number of programs for which I have application data for the years 1982 through 1988. I use this data to describe characteristics of applicants and business leaders in Table 1.

Table B-1: Data availability by year

	PUC law	PUC Eng.	PUC Bus.	UC Law	UC Eng.	UC Bus.	N total
1968	0	0	0	1	0	1	
1969	0	0	0	1	0	0	
1970	0	0	0	1	1	1	
1971	0	0	0	1	1	1	
1972	0	0	0	1	1	1	
1973	0	0	0	1	1	0	
1974	0	0	0	1	1	1	
1975	0	0	0	0	0	1	
1976	1	1	1	1	1	1	
1977	1	1	1	1	1	1	
1978	1	1	1	1	1	1	
1979	1	1	1	1	1	1	
1980	1	1	1	1	1	1	
1981	1	1	1	1	1	1	
1982	1	1	1	1	1	1	450
1983	1	1	1	1	1	1	460
1984	1	1	1	1	1	1	475
1985	1	1	1	1	1	1	435
1986	1	1	1	1	1	1	431
1987	0	0	0	1	1	1	428
1988	1	1	1	1	1	1	
1989	1	1	1	1	1	1	
1990	1	1	1	1	1	1	
1991	1	1	1	1	1	1	
1992	1	1	1	1	1	1	
1993	1	1	1	1	1	1	
1994	0	0	1	1	1	1	
1995	1	1	1	0	0	1	

Data availability by degree program and application year. 1 indicates data is available for a program-year cell. 0 indicates it is not. 'N total' column counts number of total degree programs observed between 1982 and 1988.

Table B2 describes the sample of applicants to elite degree programs between 1974 and 1995. I match 68,793 applications (unique at the person-degree program-year level) to unique person identifiers. Beginning in 1989, these identifiers were printed in the newspaper alongside application results. For the years 1974 through 1988, I obtain these ruts by matching printed results to administrative application records based on a unique application identifier. Acceptances account for 53.1 percent of the application sample. The balance between accepted and rejected applicants reflects the fact that schools typically publish a waitlist of equal length to the list of accepted students. 75.5 percent of applicants are male, and applicants have an average weighted application score of 682 points. About 1.6 percent of applicants obtain directorship positions, and 1.4 percent obtain executive leadership positions. Compared to the overall pool of applicants, male applicants have similar scores and acceptance rates, and are more likely to obtain leadership roles. Marginal applicants, defined here as those within 20 points on either side of the admissions cutoff, are less likely to be admitted than the full pool of applicants. Students in the marginal sample for whom high school data is available resemble other marginal students in terms of admissions, test score, and leadership outcomes. 17.8 percent of marginal students attended one of the nine elite high schools.

Table B-2: Applicants to elite degree programs 1974-1995

	Matched	Male	Marginal	Marginal HS
Admit	0.531	0.537	0.415	0.41
Score	682	682	679	677
Male	0.755	1	1	1
Elite HS				0.178
Any BOD	0.016	0.02	0.02	0.022
Any CEO	0.014	0.018	0.017	0.018
N BOD	0.028	0.036	0.033	0.037
N CEO	0.017	0.021	0.02	0.023
N	68793	49778	23373	16011

Means of covariates by sample. 'Matched' sample is all data matched to unique identifiers. 'Male' sample includes only male students. 'Marginal' sample includes male students within 20 points of the cutoff. 'Marginal HS' sample includes all marginal observations matched to high school records. Elite HS is dummy equal to one if individual attended an elite private HS. 'Any BOD' and 'Any CEO' are dummies equal to one for students holding at least one such position. N BOD and and N CEO count positions.

B.2 Categorizing high schools

I identify elite private and public high schools as follows. First, I constructed a list of candidate 'prestigious' high schools based on media reports (e.g., Engel 2013), research reports (SPI 2003) and discussions with individuals who attended private high schools in Chile. This candidate list included three types of schools:

1. Private Catholic high schools: Colegio Verbo Divino, Colegio San Ignacio, Colegio Sagrados Corazones Manquehue, and Colegio Tabancura.
2. Private 'language' schools offering bilingual instruction: Saint George's College,

the Grange School, Scuola Italiana, Allianza Francesa, Colegio Aleman, Colegio Suizo, and Craighouse School.

3. Public exam schools: Instituto Nacional General José Miguel Carrera.

Each of these schools is located in Santiago, and some are all male. The private high schools on this list place highly in rankings based on test scores (see PUC 2012). More importantly, however, attendance at schools within what Contardo (2008) describes as 'the Ivy League of Santiago' connotes social pedigree. As discussed in Neilson (2013), tuition at these high schools is similar to tuition at elite private high schools in the U.S. as a fraction of per capita GDP. Within the list of elite private schools, it is possible to construct a loose prestige ranking: Verbo Divino, San Ignacio, Saint George's, the Grange School, Tabancura, and Manquehue generally place at the top of high schools ranked by business success of graduates (SPI 2003; Engel 2013). The Instituto Nacional is clearly the top public school in Chile. Instituto Nacional students score higher than students from any other public school on college entrance examinations (PUC 2012), and the school counts 17 Chilean presidents (out of 35) amongst its alumni.

I obtain high school data from administrative DEMRE records for the years 1974 through 1988. These records include high school codes for 92 percent of applicants in the years I study, but high school names are not provided and identification codes change from year to year. I identify high schools by constructing a biographical dataset on prominent Chileans who applied to college during the period in question. I link this dataset to college applications, and identify high schools based on the biographical dataset.[28] I count a high school as having been successfully identified if I match at least two biographical records from different coding regimes to that high school. I link high school codes across years using data on students who re-apply. This procedure allows me to identify each of the schools listed above except for Colegio Aleman and Colegio Suizo. To extent that this process fails to identify or falsely identifies elite private high schools, this should tend to lessen differences between elite high school students and other students.

My core finding of heterogeneous effects for students from elite private high schools is robust to subsetting on different groups of elite private high schools. Table B3 shows estimates of equation 1 in the BW=10 specification for three definitions of elite private

[28] I delete the biographical dataset following the merge so that I do not observe academic records for included individuals.

high school. ‘Group 1’ includes the four older schools in the loose ‘highest prestige’ category defined above: Verbo Divino, St. George’s, the Grange, and San Ignacio. These account for roughly two thirds of the elite private high school applicants in my sample. ‘Group 2’ adds Tabancura and Manquehue. ‘Group 3’ includes all elite private schools, reproducing results from Table 4 in the text.

Table B-3: Effects of admission on leadership outcomes by high school group

	Group 1	Group 2	All
Prep	0.0709*	0.0754*	0.0760**
	(0.0420)	(0.0408)	(0.0365)
	1032	1311	1513
Non-Prep	0.0126	0.0082	0.0058
	(0.0096)	(0.0088)	(0.0088)
	7446	7167	6965

Significance: ***: 1% **: 5% *: 10%. Estimates of equation 1 for different subsets of elite private high schools. Group 1 consists of Verbo Divino, St. George’s, Grange, and San Ignacio. Group 2 adds Tabancura and Manquehue. ‘All’ column uses all available elite private high schools and reproduces estimates from Table 4.

C Optimal bandwidth and polynomial selection

This appendix considers the selection of optimal polynomial controls and bandwidths for regression discontinuity analysis. I first consider the selection of optimal polynomial controls. Panel A of Table C1 presents AIC values for estimates of equation 1 using number of leadership positions as the dependent variable, broken down by student population, bandwidth choice, and polynomial degree. In each case, coefficients on polynomial terms are allowed to vary above and below the admissions threshold. At bandwidths of ten and twenty points, the AIC is minimized in all samples with a zero-degree polynomial; i.e., a simple mean comparison. At at 40 point bandwidth, a simple mean comparison minimizes the AIC in both of the high school subsamples, while a first degree polynomial minimizes the AIC in the pooled sample.

That the optimal polynomial degree is often zero is unsurprising given how flat leadership outcomes are in scores; see, e.g., Figures 3 and 4. This is somewhat atypical in regression discontinuity designs. Therefore, while I choose a simple mean comparison as my preferred specification, I also present results using first- and second-degree polynomial controls, as is standard in the literature.

Table C-1: Optimal polynomial and bandwidth calculation

A. AIC by bandwidth and polynomial degree

	Polynomial degree			
	0	1	2	3
I. All students				
BW=10	13711	13714	13716	13719
BW=20	24721	24724	24727	24729
BW=40	34109	34105	34108	34112
II. Elite HS				
BW=10	3187	3189	3191	3194
BW=20	6039	6042	6044	6047
BW=40	8549	8552	8554	8557
III. Non-elite HS				
BW=10	5179	5179	5180	5182
BW=20	10127	10128	10127	10127
BW=40	12717	12718	12718	12721

B. Optimal bandwidth in local linear models

	All students		Elite HS		Non-elite HS	
	CCT	IK	CCT	IK	CCT	IK
BW	20.9	69.8	13.5	27.6	12.7	31.1
Admit	0.0240	0.0125	0.0890	0.0639	-0.0161	0.0089
SE	(0.0101)	(0.0068)	(0.0734)	(0.0464)	(0.0114)	(0.0094)

Panel B of Table C1 presents optimal bandwidths in different samples computed using the methods outlined in Imbens and Kalyanaraman (2012; henceforth IK) and Calonico et al. (2013; henceforth CCT), along with estimates of admissions effects computed at each bandwdith. These are computed using local linear versions of equation 1. Optimal bandwidths vary by method and subsample. In the pooled sample, the CCT bandwidth is 20.9, while the IK bandwidth is 69.8. In the elite high school subsample, the CCT bandwidth is 13.5, compared to 27.6 for the IK bandwidth. Estimates obtained using optimal bandwidths in local linear specifications are generally very similar to those reported in the local linear BW=20 specifications; see Tables 3 and A6. The exception is the pooled-sample IK estimate, for which the optimal bandwidth is extremely wide relative to that computed using the CCT method or using the IK method in other samples.

D Model extension to match heterogeneity

This section extends the model described in section 5.1 to allow for heterogeneous skill match between firms and degree programs and between firms and cohorts. The presence of separable degree-firm and cohort-firm match effects motivates the difference-in-differences empirical approach presented in section 5.2 as well as the restriction to within-field comparisons of admissions effects at the beginning of section 5.

Model setup is as described in section 5.1, with three changes. First, students attend elite or non-elite degree programs in T different cohorts, denoted by t. Second, skills are firm-specific, and may depend on which elite degree program a student attends and when. The probability a student from high school type d in cohort t who does not attend an elite degree degree program is productive at firm f is γ_{dtf}. If that student attends an elite college, the probability he is productive at f rises to $\gamma_{dtf} + b_{dpf}$. The skill gains from admission to a particular elite degree program for each high school type are constant within firms over time. Third, referrals occur only within degree-program-cohort groups; i.e., within students who attend the same degree program at the same time. The probability that there is a type d referral-provider for firm f in elite degree program p and cohort t is again r_d.

Let Y_{idptf} be a dummy variable equal to one if student i from high school type d attending elite degree program p in cohort t is hired at f, and let Y_{id0tf} be a dummy equal to one if i from high school type d in cohort t attending a non-elite degree program is hired at f. Define Δ_d^{pt} as the gain from admission to elite degree program p rather than a non-elite degree program for a cohort-t student. Then we may write

$$
\begin{aligned}
\Delta_d^{pt} &= E[\sum_f (Y_{idptf} - Y_{id0tf})|d] \\
&= F \times \left(\overline{b}_{dpf}\pi + r_d(\overline{\gamma}_{dtf} + \overline{b}_{dpf})(1-\pi)\right) \\
&= S_d^{pt} + C_d^{pt}
\end{aligned} \tag{D.1}
$$

where $\overline{b}_{dpf} = F^{-1}\sum_f b_{dpf}$, $\overline{\gamma}_{dtf} = F^{-1}\sum_f \gamma_{dtf}$, $S_d^{pt} = F\overline{b}_{dpf}\pi$, and $C_d^{pt} = Fr_d(\overline{\gamma}_{dtf} + \overline{b}_{dpf})(1-\pi)$. As above, we can think of S_d^{pt} and C_d^{pt} as reflecting the skill and connections contributions, respectively, to the total effect.

Now consider the first model implication, which held that the admissions gains in co-leadership rates with non-peers were equal to zero if skill gains were zero, and that admissions gains in co-leadership rates with peers were equal to gains with non-peers plus a term that depended on network gains r_d. Let $\mu_{dpt}^{dp't'} = E\left[\sum_f Y_{idptf}Y_{jdp't'f}|d, i \neq j\right]$ be the expected co-leadership rate for a pair of high school d students at elite degree programs p and p' in cohorts t and t'. Further, let $\mu_{d0t}^{dp't'}$ be expected co-leadership rate for a high school type d student in cohort t who is not admitted to an elite program and some student with high school-program-cohort category $dp't'$. Then for some program $p' \neq p$, we may write

$$
\begin{aligned}
\kappa_{dpt}^{dp't} &= \mu_{dpt}^{dp't} - \mu_{d0t}^{dp't} \\
&= F\pi\overline{b_{dpf}(\gamma_{dtf} + b_{dp'f})}
\end{aligned} \tag{D.2}
$$

where $\overline{b_{dpf}(\gamma_{dtf} + b_{dp'f})} = F^{-1}\sum_f b_{dpf}(\gamma_{dtf} + b_{dp'f})$. This is the gain in co-leadership rates with students from other degree programs in the same cohort associated with elite admission. Similarly,

$$
\begin{aligned}
\kappa_{dpt}^{dpt'} &= \mu_{dpt}^{dpt'} - \mu_{d0t}^{dpt'} \\
&= F\pi\overline{b_{dpf}(\gamma_{dt'f} + b_{dpf})}
\end{aligned} \tag{D.3}
$$

while

$$\kappa^{dpt}_{dpt} = \mu^{dpt}_{dpt} - \mu^{dpt}_{d0t}$$
$$= F(1-\pi) r_d \overline{(\gamma_{dtf} + b_{dpf})^2} + F\pi \overline{b_{dpf}(\gamma_{dtf} + b_{dpf})}. \tag{D.4}$$

Equations D2 and D3 show the gains in co-leadership rates with students who are not college peers associated with elite college admission. As in the model without match effects, these gains would be zero if elite colleges do not make students more likely to be productive; i.e., if the $b_{dpf} = 0$ for each dpf triplet. Equation D4 shows the gains in co-leadership rates with college peers associated with elite admission. As in the model without match effects, these gains include a peer connections term that is positive only if $r_d > 0$, as well as a skill effect term. However, in contrast to the simpler model, the skill effect term in κ^{dpt}_{dpt} is not the same as the skill effect terms in $\kappa^{dp't}_{dpt}$ and $\kappa^{dpt'}_{dpt}$. In the former case, the skill effect terms will differ if $b_{dpf} \neq b_{dp'f}$; i.e., if different degree programs teach students different skills. In the latter case, the skill effect terms will differ if $\gamma_{dtf} \neq \gamma_{dt'f}$. In my empirical work, I take steps to reduce the impact of these types of heterogeneity by considering only pairs of students within the same fields of study, and by considering pairs of students from nearby cohorts.

I now turn to the second model implication, which provided a formula for the connections effect term C_d. A similar result goes through here based on a difference-in-differences approach. Specifically, we may define

$$\tau^{pt}_d = \left(\left(\mu^{dpt}_{dpt} - \mu^{dpt'}_{dpt} \right) - \left(\mu^{dp't}_{dpt} - \mu^{dp't'}_{dpt} \right) \right)$$
$$= F(1-\pi) r_d \overline{(\gamma_{dtf} + b_{dpf})^2} \tag{D.5}$$

This difference-in-differences approach isolates a term that is proportional to total peer effect contribution C^{pt}_d. The single-difference approach outlined in the model without match effects fails because of cohort match effects (for differences within degree programs across cohorts) and skill match effects (for differences across degree programs within cohorts).

As in the model presented in the main text, it is possible to rescale the difference-in-differences estimates using observable quantities to recover overall gains from peer effects. Let $C_d = E_{pt}[C_d^{pt}|d]$ and $\tau_d = E_{pt}[\tau_d^{pt}|d]$ be the average total peer effect and the difference-in-differences estimate of peer co-leadership effects, respectively, across all degree programs and cohorts. Then

$$C_d = \tau_d \times \frac{E_{ipt}[\sum_f Y_{idptf}|d]}{E_{ijpt}[\sum_f Y_{idptf} Y_{jdptf}|d, i \neq j]} \tag{D.6}$$

as before.

E Standard errors in peer effects analysis

I estimate equations six and seven using paired data that is unique at the application by application level. A priori it is not clear how best to compute standard errors. Leadership error terms are most likely correlated within all observations for the same individual. It is also reasonable to think that errors might be correlated across observations within the same program cohort, since students within program-cohort cells have access to the same or similar peer contacts. Prior studies using similar data have taken a variety of approaches. Bayer et al. (2008) compute standard errors using a pairwise bootstrap. Shue (2013) presents results using both two-way clustering at the person-person level (as in Cameron et al. 2011 or Peterson 2009) and a non-parametric placebo test. The two procedures yield similar results. Fracassi (2012) uses data on pairs of firms, and computes standard errors using two-way clustering at the firm-firm level.

In the main text, I present standard errors that allow for two-way clustering at the person-person level. To check that inference is not compromised by error correlations within peer groups, I present alternate estimates that allow for two-way clustering at the program-year by program-year and field-year by field-year level in Table E1 below. Standard errors computed using do not materially change inferences drawn in the main text.

Table E-1: Mean co-directorships for student pairs, by type of pair

	I. Program-Year Clustering			II. Field-year clustering		
A. Within same degree	E-E	E-NE	NE-NE	E-E	E-NE	NE-NE
Close cohort	13.0***	0.6	0.3	13.0**	0.6	0.3
	(4.7)	(0.6)	(0.2)	(4.5)	(0.6)	(0.2)
Constant	13.9***	2.5***	0.7***	13.9***	2.5***	0.7***
	(2.5)	(0.5)	(0.1)	(3.2)	(0.5)	(0.1)
N	740928	7086379	21539977	740928	7086379	21539977
B. Within same field						
Same degree × close cohort	16.5***	0.7	0.4	16.5***	0.7	0.4
	(5.4)	(0.8)	(0.2)	(5.1)	(0.5)	(0.3)
Same degree	2.8	-0.2	-0.1	2.8	-0.2	-0.1
	(2.7)	(0.4)	(0.1)	(1.6)	(0.3)	(0.2)
Close cohort	3.5	-0.1	-0.1	3.5	-0.1	-0.1
	(3.1)	(0.5)	(0.2)	(2.3)	(0.2)	(0.2)
Constant	11.0***	2.8***	0.7***	11.0***	2.8***	0.7***
	(2.3)	(0.5)	(0.1)	(2.5)	(0.5)	(0.1)
N	1478180	13719925	32949927	1478180	13719925	32949927

Significance: ***: 1% **: 5% *: 10%. Standard errors use two-way clustering at degree-year level (panel A) and field-year level (panel B). Units are co-leadership rates per 100,000 pairs. 'E-E' columns subset on pairs of admitted students in which both students attended an elite private high school. 'E-NE subsets on pairs where one student attended an elite private high school and one did not. 'NE-NE' pairs are those for which neither student attended an elite private high school.