College Quality and Attendance Patterns: A Long-Run View*

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Abstract

We construct a time series of college attendance patterns for the United States and document a reversal: family characteristics were better predictors of college attendance before World War II, but academic ability was afterwards. We construct a model of college choice that explains this reversal. The model's central mechanism is that an exogenous surge of college attendance leads better colleges to be oversubscribed, institute selective admissions, and raise their quality relative to their peers, as in Hoxby (2009). Rising quality at better colleges attracts high-ability students, while falling quality at the remaining colleges dissuades low-ability students, generating the reversal.

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1 Introduction

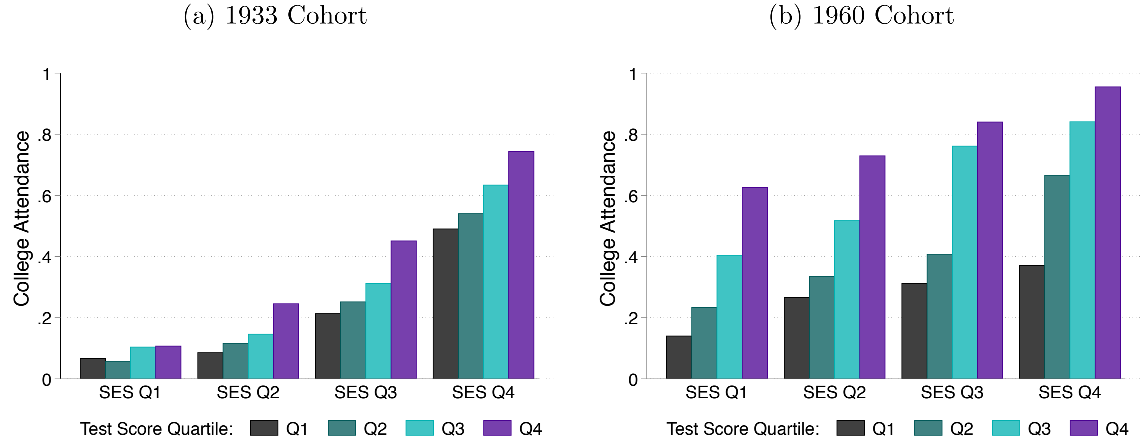
This paper studies how U.S. college entry patterns have evolved over the course of the 20th century. Our empirical contribution is to document a reversal. In the early 20th century, college entry was mainly determined by family background, with student abilities playing a lesser role. However, the roles reversed by 1960. Our theoretical contribution is to offer an explanation for the reversal. We argue that it is caused by the stratification of college qualities documented previously by Hoxby (2009). This stratification is, in turn, driven by a surge in college enrollment following World War II that allowed high quality colleges to institute selective admissions.

Our empirical work extends an existing literature that documents the increasing role of student abilities for college entry over the course of the 20th century (Taubman and Wales, 1975; Hendricks and Schoellman, 2014). This literature finds that college students have become more selected on measures of academic ability, consistent with the broader sense that college has become more meritocratic. We add to this literature by collecting and harmonizing new studies that investigate the role of family background for college attendance. Importantly, ten of our newly harmonized studies tabulate college entry rates as a joint function of academic ability and family background, similar to Belley and Lochner (2007) but for high school graduating classes as early as 1933. We use these studies to estimate the effect of family characteristics for college-going conditional on academic ability. Consistent with previous anecdotal evidence from select colleges, we find that the role for family declines at the same time the role for academic ability rises (Herrnstein and Murray, 1994; Karabel, 2006).

Taken together, our data reveal a striking reversal in entry patterns that is illustrated in Figure 1. It compares the college attendance rates for two high school graduation cohorts, 1933 and 1960. Students are divided into quartiles according to their academic abilities (measured by test scores) and family background (measured by socioeconomic status). For the 1933 cohort, family background was the main determinant of college attendance; test scores mattered little, particularly for students with below-median family background. The relative importance of these two factors reversed by the 1960 cohort.

In total, we collect and harmonize 42 historical studies that document college entry rates by student abilities and/or family background. We show that the patterns observed in Figure 1 are representative of a broader trend. The reversal appears to be complete by 1960. Thereafter, we do not observe significant changes in entry patterns.

Figure 1: Changing Patterns of College Attendance: Select Cohorts



We propose a theory for the reversal that draws on three major structural transformations in the market for higher education that have been documented extensively in the literature. The first is the massive increase in college enrollment after World War II (Goldin and Katz, 2008). The second is the emergence of selective college admissions based on standardized testing (Duffy and Goldberg, 1998). The third is the increasing quality differentiation of colleges (Hoxby, 2009). We discuss these empirical developments in Section 3.

The main driving force is the expansion of college enrollment following World War II. We model this as an exogenous, common increase in the value of college for all students. This rise in demand causes high-quality colleges to hit their capacity constraint and institute selective admissions. A feedback mechanism through peer effects endogenously changes the value of college differentially for different students. Top colleges with selective admissions attract high-ability students and make themselves yet more attractive to high-ability students, whose incentives to attend college increase. On the other hand, low-ability students are constrained to non-selective colleges whose quality declines, reducing the students' incentives to attend college. This explanation for the reversal ties it to the facts on increasing college stratification documented by Hoxby (2009). The introduction of college admissions tests interacts with this mechanism. It changes students' perceptions of their own ability and how much they will learn in college, but it also changes how their peers are selected into the various colleges.

We formalize this argument in a quantitative model of college choice. The model allows us to accomplish three objectives. First, we show that a model that incorporates the well-known elements of rising college enrollment and stratification of college quality can also generate a reversal of attendance patterns. Second, we verify that the mechanism generates a quantitatively significant reversal in attendance patterns. Finally, the model allows us to distinguish between ability, which is a latent variable, and observed proxies such as test scores. We use the model to distinguish between the level and trends of sorting along both dimensions.

The key model elements are as follows. There are a large number of locations, each with a single college and a continuum of students. Students are heterogeneous with respect to their academic ability, which affects how much they learn in college, and their family background, which determines the resources they can consume if they attend college. Students decide whether to work after high school, attend their local college, or attend a college outside their local area at an extra cost. Colleges are heterogeneous with respect to their quality, which is determined by their endowment and the average ability of students they attract. Colleges accept students until they hit an enrollment cap; at that point, they adopt selective admissions and accept only the students with the highest ability.

The baseline model features only two time-varying exogenous forces that drive the reversal in college entry patterns. First, the value of college rises over time. This generates the rise in college attendance, which is one important ingredient in our story.[1] Second, standardized college entrance examinations become more common, providing additional information about student abilities. Although we explore other potential driving forces in our empirical work or in robustness checks, we find that they are neither necessary nor sufficient to generate the reversal.[2] We show that these driving forces are sufficient by calibrating the model to match data moments for the 1933 and 1960 high school graduation cohorts, including the attendance patterns shown in Figure 1. We choose 1933 as the earliest year for which high quality data on college entry rates by student abilities and family background are available. We choose 1960 because, by then, the reversal is complete.

In the model, the reversal occurs in response to the increasing quality differentiation among colleges. In 1933, college entry rates are low. Since most colleges cannot attract enough students to fill all available seats, their admissions are not selective. This is consistent with

[1] An existing literature has proposed several possible explanations for the rise in college attendance (Goldin and Katz, 2008; Restuccia and Vandenbroucke, 2014; Donovan and Herrington, 2019; Castro and Coen-Pirani, 2016; Alon, 2018). The nature of the underlying driving force is not important for our results.

[2] Concretely, declining costs to applying to non-local colleges or changes in the characteristics of high school graduates do not affect our findings; see Section 6. We abstract from student loans because loans were rare throughout this period; we show in Section 3 that students and their parents financed 85–90 percent of college until the mid-1960s, with loans accounting for only a small share of the remainder.

pre-World War II admissions policies (see Section 3). Most students, regardless of ability, can attend their local college, and most do so. As a result, most colleges are of fairly similar qualities. This reinforces students' incentives to attend the local college rather than incur the expense of attending a better, non-local one.

By 1960, college enrollment has increased substantially. High quality colleges become oversubscribed and respond by implementing selective admissions. This raises the average ability of their student body, which makes them more attractive to students. As a result, more students, especially those of higher abilities, attend non-local colleges. High-ability students match up with the the best colleges, raising their quality. Low-ability students are only admitted by less selective colleges, which are therefore of poor quality. Thus, the model endogenously produces the integration of the market for college education. The economy transitions from an equilibrium where all students can choose from a common set of homogeneous colleges to an equilibrium where high-ability students can choose better colleges than low-ability students. This change in the choice set generates the reversal.

We use counterfactual experiments to quantify the exogenous forces driving the reversal. Our model implies that the rising value of college and the spread of standardized testing are equally important for generating the rising importance of test scores for college attendance, whereas the spread of standardized testing generates almost all of the declining importance of family background. Additionally, we show that the stratification of college quality is critical to generating a quantitatively significant reversal.

We also use the model to distinguish between sorting that occurs based on test scores, which are observed, and actual ability, which is not observed in the data. We show that sorting on actual ability is stronger than sorting on test scores in both periods, but by any measure student ability becomes relatively more important for college attendance between 1933 and 1960.

The key to understanding these results is that test scores are noisy proxies of student abilities that have become more common over time. The observed sorting by test scores in 1933 is weak in part because of the noise in test scores but also because few students and colleges observed test scores or used them for college admissions. College entrance examinations became nearly universal after the War, providing most students and colleges with a test score signal that they use to help forecast student ability. The result is that students become more sorted on test scores. This change reflects in part more sorting on ability, but also sorting on the noise in test scores. The model makes an important and novel contribution by allowing us to differentiate between the two.

The rest of the paper proceeds as follows. Section 2 introduces our historical data and describes the trends in college attendance patterns. Section 3 describes the historical context that motivates our model. Section 4 describes the model, Section 5 provides a quantitative assessment, and Section 6 considers extensions. Finally, Section 7 concludes.

2 Historical Data

Our empirical work extends a literature that documents the increased role of academic ability for college attendance over the course of the 20th century (Taubman and Wales, 1975; Hendricks and Schoellman, 2014). We collect additional historical studies that are consistent with this trend. However, our main empirical contribution is to document that the role of family background has declined over time.

To do so, we collect historical studies that characterize college attendance as a function of academic ability (measured by test scores) and/or family background (measured by family income or socioeconomic status) dating back to the high school graduating class of 1919. Our preferred studies tabulate college entry rates as a function of both academic ability and family background. This allows us to estimate the effect of academic ability on college entry *conditional* on family background, and vice versa, as Belley and Lochner (2007) do with modern data for recent cohorts. We show below that this step is important because the conditional correlations show clearer patterns than the unconditional correlations. Before describing the trends, we briefly overview the underlying studies and the data that we use.

Our evidence draws on studies from two different types of sources. For the modern era (high school graduating classes of 1960 onward), we have access to microdata or published results from large nationally representative surveys with multiple measures of family background and academic ability as well as students' post-graduation outcomes. These sources are largely familiar to economists and include most prominently Project Talent and the NLSY79. For students graduating before 1960, our evidence comes from studies conducted by researchers in a variety of fields, including psychology, economics, and education. We have collected and harmonized the results from three dozen such studies, building on the research of Taubman and Wales (1975) and Hendricks and Schoellman (2014) by adding more than a dozen new studies, including many that document patterns of college attendance by family background.

The original microdata from studies before 1957 no longer exist. Instead we rely on their published results, which we have collected from journal articles, dissertations, books, technical volumes, and government reports. The design, sample, and presentation of results are different for each study. Nonetheless, it may be helpful to consider a hypothetical typical study that utilizes the most common elements in order to understand our approach. Appendix D gives references for the studies used and summarizes some of the most pertinent metadata for each, particularly in Table D1.

In a typical study, a researcher worked with a state's department of education to administer a questionnaire and an aptitude or ability examination to a sample or possibly the universe of the state's high school seniors in the spring, shortly before graduation. Students' academic ability was measured by their performance on the examination or, in some cases, by their rank in their graduating class. The questionnaire inquired about students' family background, with typical questions covering parental education and occupation or estimates of the family's income. These data were used to rank students based on family income or an index of socioeconomic status that would combine several different elements of the data. Finally, the researchers would inquire about students' plans for college or, alternatively, follow up at a later date with the students, their parents, or school administrators to learn about the actual college attendance. Our main data source for this era is published tabulations of these results giving the fraction of students of different academic ability or family background levels (or, ideally, both) that attended college. Most sources cover only whether the students attended college, with little comparable detail about which college they attended; Chetty et al. (2017) have information about this for recent cohorts.

Our goal is to summarize the results of these studies in a simple way that is easy to compare over time. We start with the subset of studies for which we have the ideal information, which is the full cross-tabulation of college-going as a function of family background and academic ability. We convert family background and academic ability categories into percentile ranges. We then treat the reported tabulations as data on $C(s, p)$, where C is the percentage of students in a group who attend college and s and p are the midpoints of the percentile intervals of ability (score) and family background (parents), respectively. We regress $C(s, p)$ on s and p and report the estimated conditional correlations β_s and β_p, which capture the importance of academic ability or family background for college while controlling for the other factor.[3] This control is useful because family background and academic ability are positively correlated in every study for which we can cross-tabulate the two.

[3]Similar results obtain if we instead standard normalize s and p instead of using percentiles; see Figure B1 in the Appendix.

Figure 2: Changing Patterns of College Attendance

(a) Academic Ability

(b) Family Background

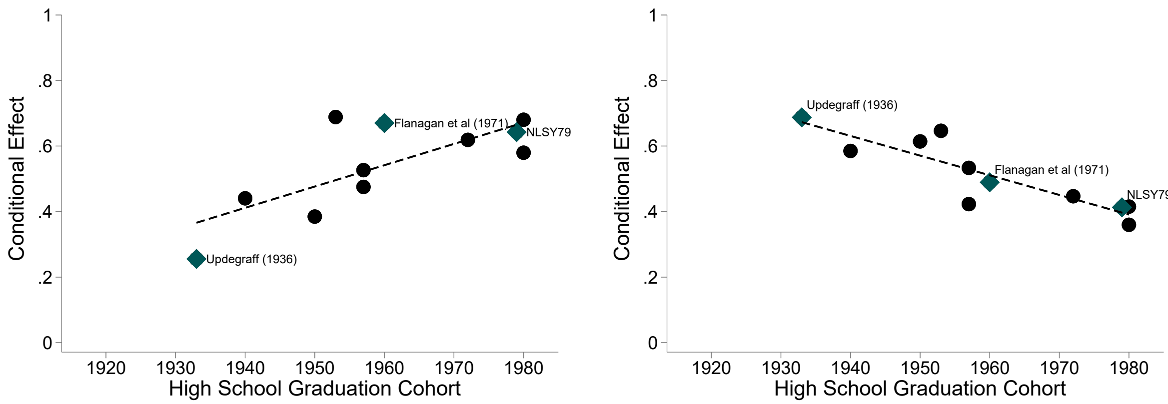


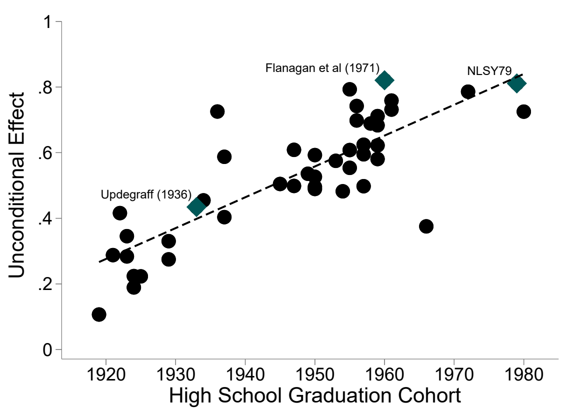
Figure 2 plots the estimated coefficients β_s and β_p against high school graduation cohort. The role of academic ability (test scores or grades) has risen sharply over time, in line with the previous work of Taubman and Wales (1975) and Hendricks and Schoellman (2014). Our main new finding is that the role of family background (parental income or socioeconomic status) has fallen. Studies conducted before World War II tend to find that family background is more important than academic ability, while studies after World War II tend to find the opposite.

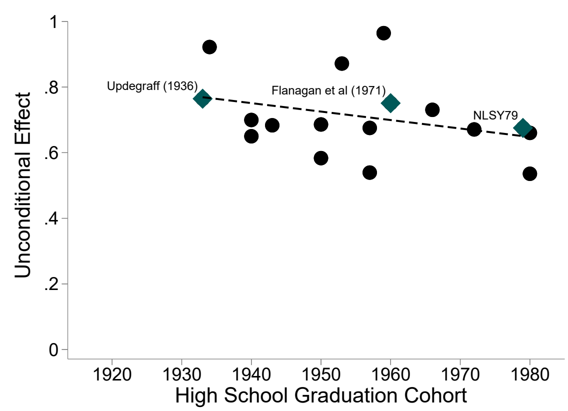
We have highlighted three data points of particular importance. Updegraff (1936) is the first study to cross-tabulate college attendance by family background and academic ability. It shows that prior to World War II, family background rather than academic ability was a more important determinant of who attended college. Flanagan et al. (1971) provide results from Project Talent, the first nationally representative study with existing microdata. It shows that sorting patterns had already reversed by 1960. The NLSY79 is the starting point for most of the existing literature. Our data suggest that the level of sorting did not change appreciably between Project Talent and the NLSY79. Thus, in our quantitative exercises we attempt to explain what changed sorting between 1933 and 1960.

In addition, we have many more studies that tabulate college-going as a function of family background or academic ability alone. We construct a similar time series with these tabulations, which we can use to estimate the unconditional correlation between test scores or family background and college attendance (by regressing $C(p)$ on midpoint percentiles of p, for example). The main advantage of doing so is that we can incorporate many more studies covering a longer period. Figure 3 shows the results.

Figure 3a shows that a large number of studies investigate the role of academic ability for college attendance. These studies consistently find that the role of ability increased over time, consistent with previous work. Figure 3b shows that we have fewer studies that investigate family background. They show only a weak decline in β_p over time. A standard omitted variable argument suggests that not controlling for academic ability (which is positively correlated with family background) leads to a positive, growing bias over time as selection on academic ability strengthens. The implication again is that selection on family background must be weakening.

Figure 3: Changing Patterns of College Attendance





2.1 Patterns by Gender

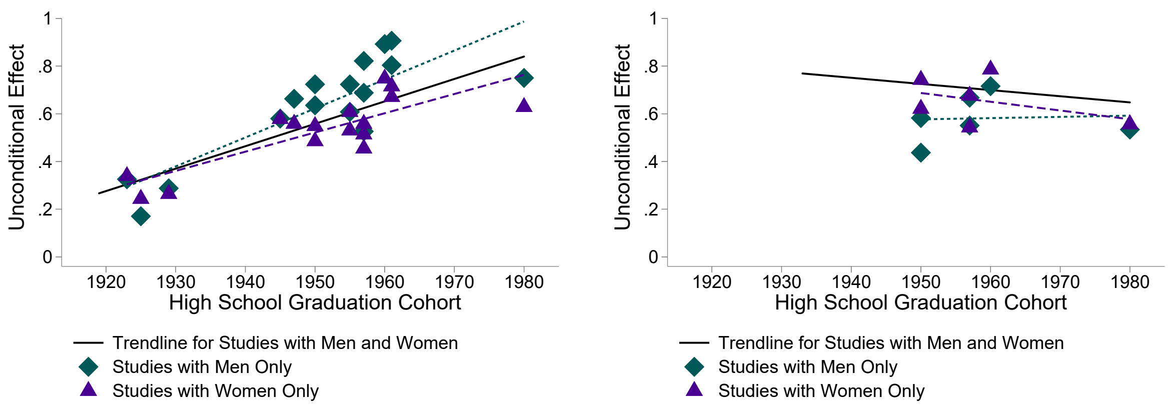
Our results so far have covered aggregate trends. A large literature has documented important changes in the access of women and minorities to educational and labor market opportunities over this time.[4] Hsieh et al. (2018) argue that these changes may have contributed to aggregate economic growth. About one-third of our historical studies tabulate results separately for men and women, allowing us to study whether the trends differ. We focus on tabulations of college-going as a function of academic ability or family background separately; we have the full cross-tabulation of gender, family background, and academic

[4]See Altonji and Blank (1999) for an overview of labor market differences between men and women, including historical trends.

ability only for three sources, starting around 1960. We repeat our measurement exercises separately for each gender and then study the time series for men and women separately, with comparison to the trend for the two genders combined from the previous subsection.

Figure 4: Changing Patterns of College Attendance by Gender

(a) Academic Ability (b) Family Background



The results are shown in Figure 4. We have a large number of studies investigating the role of academic ability by gender, including three studies from the 1920s. Those studies show that academic ability was equally unimportant for both genders in the 1920s and that it became more important for both in the 1940s and 1950s. Academic ability seems to have risen in importance more for men than for women, as indicated by the fact that the data points for men exceed those for women for almost all studies in the 1950s. We have fewer studies investigating the role of family background by gender, and the first such study dates only to 1950. Family background is equally important for men and women in 1980, and it appears from the few available studies to have been more important for women than for men in the 1950s. This is consistent with the conventional wisdom that the college attendance choices of women were more sensitive to family income in the past because it was harder for them to work their way through college, both because they had fewer job opportunities and because they earned lower wages (Greenleaf, 1929; Hollis, 1957).

Unfortunately, we have little to say about the importance of race. None of our sources from before the 1950s provide separate tabulations by race. In large part, this is because most of these studies were conducted in northern states where black students would have been much less common. Of the few studies of southern states, several explicitly mention that they restrict attention to schools for white students, and we suspect the others may have done so implicitly. Hence, our early data sources and our overall trends should really be read as applying to white students. We have computed in the NLSY79 that black and Hispanic students are relatively more sorted by academic ability and less sorted by family background than are white students. Given the absence of earlier race-specific data, we can only speculate about the long-term trends implied by this fact.

2.2 Controlling for Variation in Historical Study Design

Our baseline results combine the findings of studies that differ in numerous ways, such as which proxies they use for family background or academic ability, when they measured college attendance, the size of the bins they used for tabulations, and so on. In this section we explore whether variation in study design systematically affects the estimated trends in β_p and β_s that we document.

Our approach is based on fixing a data set for which we have the microdata – the NLSY79 – and exploring the implications of varying four dimensions of study design. First, studies vary in whether they measure academic ability using test scores or class rank. Within the NLSY, we experiment with using the Armed Forces Qualifying Test (AFQT) score or class rank at high school graduation. Second, studies vary in whether they measure family background using parental income or socioeconomic status. Within the NLSY, we experiment with using family income at the time of the student's high school graduation or creating an index of socioeconomic status. Third, studies vary in whether they measure college attendance plans or actual college attendance. Within the NLSY, we experiment with using whether high school seniors planned for one or more years of college (versus zero) and using the longitudinal aspect of the NLSY to track whether they actually attended college. Finally, historical studies grouped academic ability and family background into bins of various sizes. We do the same within the NLSY. Details on sample selection and measurement are available in Appendix A.

We vary these four dimensions systematically within the NLSY and study how they affect the resulting estimates β_s and β_p. By far the most important dimension is family background. Estimates of β_p are systematically larger when family background is measured as socioeconomic status than when it is measured as parental income.[5] We conjecture that

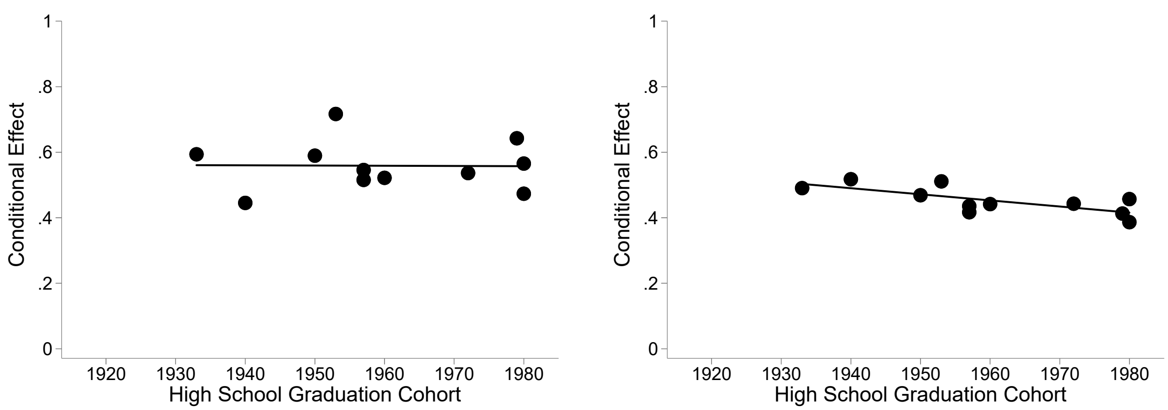
[5]Specifically, we regress β_s and β_p on cohort while including dummy variables to control for study design parameters (e.g., a dummy for using test scores instead of grades). There is a consistent, statistically significant effect of using socioeconomic status rather than income, which raises the conditional estimate of β_p by 0.22 and the unconditional estimate by 0.30. We find similar effects when we focus solely on the

this result may arise because socioeconomic status is a better measure of permanent income than is parental income in one year. Fortunately, our three main studies of interest (Updegraff (1936), Project Talent, and NLSY79) all use socioeconomic status as the measure of family background. We find lesser roles for the other dimensions.

To formalize these findings, we conduct a falsification test. We mimic each of our historical studies by taking the NLSY data and setting the four dimensions of interest to match those of the original study. For example, Goetsch (1940) reports college-going as a function of family income for students who score in the top 15 percent of a standardized test. She provides tabulations for eight family income categories, containing 24, 8, 16, 22, 20, 7, and 3 percent of the relevant population. We take students who score in the top 15 percent of the AFQT in the NLSY and form them into eight family income categories, containing the same percentage of the population. We then estimate the counterfactual β_p that Goetsch would have found if she had conducted her study on the NLSY sample.

Figure 5: Counterfactual Changes in Patterns of College Attendance

(a) Academic Ability (b) Family Background



In Figure 5, we re-create Figure 2 with our counterfactual estimates of β_s and β_p plotted against high school graduation cohort (for the original study).[6] It is clear from this figure that variation in study design induces noise in our estimates of β_s and β_p. Given the same NLSY79 data, we can find a range of possible results depending on what proxies we use and how we format the data. However, the main message is that this variation seems to

NLSY79. Our time series figures above are all adjusted for this gap (by increasing implied coefficients from studies that use income).

[6]Similar results apply for the unconditional correlations; see Figure B2 in the Appendix.

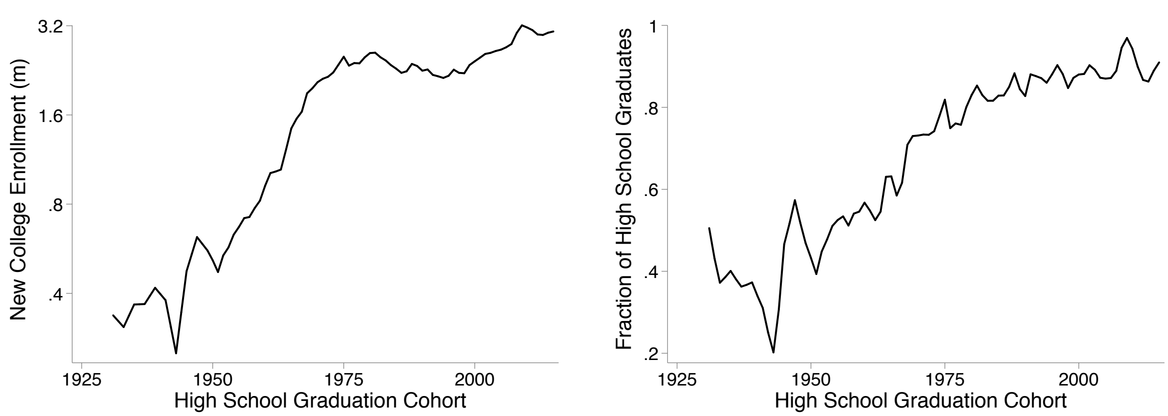
be uncorrelated with time and hence likely does not bias our estimates of the underlying trends.[7]

3 The Growth and Integration of the Market for College Education

Our empirical results show that college attendance patterns changed sharply in the 1940s and 1950s. In the next section, we formulate a model that is grounded in two important changes that affected colleges after the war: the growth and integration of the market for college education (Hoxby, 2009). The model takes the expansion of college as an exogenous driving force and endogenously produces the integration of the market for college education. The latter differentially affects the quality of colleges available to high-ability and high-income students, which affects their attendance decisions and generates the reversal. Here we document some of the relevant facts that motivate our model setup.

Figure 6: Increase in College Attendance

(a) First-Time College Enrollment (b) College Attendance Rate



We start with attendance. Figure 6 shows the dramatic increase in college enrollment using statistics on high school graduates and new college enrollment by year from the Biennial

[7]An alternative worry is that older tests may have been worse, which would explain our time trend in academic ability measures. In Hendricks and Schoellman (2014), we document that the predictive validity of tests seems reasonably stable over time. Further, a similar pattern emerges if one compares across cohorts taking the same test.

Survey of Education and the Digest of Education Statistics. We show complementary statistics derived from census data in Appendix C. Figure 6a shows total new college enrollment by year. Enrollment hovered around 400,000 students per year during the Great Depression and fell during World War II. There was a large spike after the war associated in large part with the GI Bill. There was also a long upward trend until around 1970. Our historical data and our model focus on the college attendance decisions of high school graduates. Figure 6b shows college enrollment relative to high school graduation rates. These figures were low during the Great Depression and fell during World War II. They spiked after the war but also show a sustained long-term increase to around 80–85 percent.

Our model takes the rise in the demand for college itself as an exogenous driving force. Nonetheless, it is useful to note that there are several plausible candidates for this trend in the literature. One is the declining cost of college (Donovan and Herrington, 2019). We document in Appendix C that the cost of a year of college relative to income fell by three-fourths between the Great Depression and the post-War period, reaching an all-time low in 1947. Alternatively, Alon (2018) argues that changes in high school and college curricula around this time made college more valuable. Several papers in the literature suggest that the success of the GI Bill may have triggered widespread changes in beliefs about the benefits of college (Bound and Turner, 2002; Goldin and Katz, 2008).[8] The exact source of the rise in demand for college is not important for our results.

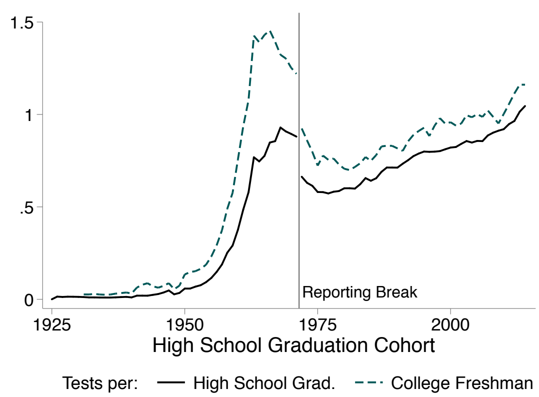
We now turn to the integration of the market for college education. An important driving force for this change is that college applications and admissions procedures became standardized and streamlined after World War II. Prior to World War II, college admissions decisions were based on whether students had demonstrated mastery of certain knowledge. The subjects to be mastered, level of knowledge required, and mechanism for demonstrating mastery varied widely by college and year, with many colleges offering multiple paths to achieve admissions (Kurani, 1931). Given the idiosyncratic nature of college requirements and admissions processes, college guides from the 1930s recommended that students choose a college as early as possible and then work with its admissions department to demonstrate compliance with the relevant standards (Halle, 1934). In many states, high schools would form a relationship with a local college. The high school tailored its curriculum to the college's requirements, while the college agreed to certify and accept the high school's

[8] The rising college wage premium is often considered an important driver of the long-run expansion of college attendance (Goldin and Katz, 2008; Restuccia and Vandenbroucke, 2014). However, it is challenging to attribute the post-War surge of attendance to wages because the college wage premium was at its lowest around 1950 before subsequently rising. High school graduates would have to predict the future increase in the wage premium and have a very low discount rate for the timing to work.

graduates for admissions.

This system was replaced by a homogeneous system based on standardized college admissions exams (the SAT and later its competitor, the ACT) after the war. The real cost of these tests fell by two-thirds after the introduction of machine scoring in 1937 and became an attractive option for assessing the rapidly growing number of applicants after the War; see Appendix C for details. Figure 7 shows the main takeaway: an explosion of test-taking took place from 1950 to 1965. At the peak, there were more tests taken than college freshmen, and roughly three-quarters of high school seniors took a test.[9]

Figure 7: Rise of College Entrance Examinations



The standardization of admissions and the surge of demand for college had two important implications that will act as mechanisms for our model. First, they led students to apply to more colleges over a larger geographic area. Hoxby (2009) documents some geographic facts and cites the fall in transportation and communication costs. Before the war, students applied to multiple colleges only rarely because of the difficulty of complying with multiple admissions requirements.[10] College guides from after the war already recommend applying to "three or four" colleges (Dunsmoor and Davis, 1951). Just under three-fourths of applicants applied to a single college in 1947; only one-half did so by 1959; and less than one-third did so by 1979 (Roper, 1949; Flanagan et al., 1964; Pryor et al., 2007). This "plague" or "specter" of multiple applications was a recurring topic of discussion among

[9]Figures include ACT test-taking from its introduction in 1959 onward. The discontinuity reflects a break in how the SAT reports test-taking; until 1971 it reports tests taken, while from 1972 it reports unique test-takers.

[10]Partridge (1925) provides figures from a large urban high school with a large majority of students attending college, which was rare at the time. Even at this evidently advantaged high school, only 11 percent of students applied to more than one college.

admissions officers in the 1950s.[11]

Second, the growth in applications allowed better colleges to switch from recruitment to selective admissions. Before the war, the typical college accepted all students who met the posted requirements.[12] The surge of attendance after the war was sufficiently large and rapid that more desirable colleges found it infeasible to expand enrollment in proportion to their applications. College entrance exam scores emerged as a key metric of college quality and selectivity. The result was the "fanning out" of colleges documented in Hoxby (2009): average student test scores have risen at top colleges but fallen for median and below-median colleges since at least 1962.

These changes lead us to formulate a model that takes as exogenous the general increased demand for college and produces changes in sorting patterns consistent with the national integration of college. By contrast, we abstract from changes in college financing, which would seem to be a plausible alternative explanation. The reason we do so is that the changes in sorting patterns we document take place before 1960, whereas significant federal government involvement in college financing via grants and loans starts only in 1959 with the National Defense Education Act and does not become quantitatively important until the 1960s. The main form of earlier financing was the GI Bill, which was enormous (accounting for one-quarter of all college income at its peak) but also short-lived and applied only to men, and so is unlikely to drive our lasting changes. Appendix C has further details.

To document this point, we draw on three surveys that collected information on how students financed college throughout the 1950s (Hollis, 1957; Iffert and Clarke, 1965; Lansing et al., 1960). These surveys all agree on the broad picture of college financing. The main source of financing was students and their families, with the reported share ranging between 80 and 87 percent in the three studies. The next leading categories were scholarships (4.8–8.4 percent) and "other" (2.6–7.1 percent). Only 1.9–3.3 percent of students and 14 percent of families report borrowing from any source, with the total borrowed accounting for a tiny fraction of total expenditures. Similarly, Harris (1962) reports that loans only accounted for about 1 percent of all undergraduate student charges in 1956. Where loans did exist, they were generally financed by endowed funds, managed by individual colleges, and typically had to be repaid in several (no more than 10) years. To be clear, these figures

[11] See Duffy and Goldberg (1998) pp. 37–39 and Bowles (1967) p. 117.

[12] From Duffy and Goldberg (1998), p. 35: "[S]tudents tended to apply only to their first-choice college, and they were usually accepted" and "Admissions officers visited selected high schools, interviewed candidates for admissions, and then usually offered admission to students on the spot." Less politely, this was the "warm body, good check" stage of admissions (p. 34). Admission was certainly implied under the widely used certificate system (Wechsler, 1977).

were quite different by 1969–1970; the share paid for by families had fallen below three-quarters, with loans taking up much of the shortfall (Haven and Horch, 1972). Given that the goal of our quantitative exercise is to explain the switch in attendance patterns between 1933 and 1960, we focus on a model where students cannot borrow throughout.

4 Model

We develop a model of college choice and admissions that captures the forces described in Section 3. The economy contains a discrete number of locations (islands) indexed by $i \leq I$. Each location is home to a single college and a measure 1 of new high school graduates per year. Locations are heterogeneous with respect to the quality of the local college but are otherwise identical. Each college sets an admissions policy that specifies the expected ability needed for admission. Students with heterogeneous family backgrounds and expected abilities decide whether to attend the local college, attend college elsewhere, or work straight out of high school.

The model is static: it covers the college attendance decisions of a single high school graduation cohort in isolation. Our goal in the next section is to show that the model can generate a quantitatively significant reversal of who attends college, consistent with the data. When we do so, we simulate two equilibria of the model, corresponding to the equilibrium of the 1933 and 1960 cohorts. Most parameters will be held fixed, but we will allow two to vary over time; we denote these parameters with a t subscript to highlight their particular role in the analysis.

4.1 Colleges

Colleges have endowments $\bar{q}_i$ spaced uniformly on the interval $[\underline{q}, \overline{q}]$. This represents the literal endowment of the college: the land, buildings, and financial accounts that a college possesses. The college's quality q_i depends on both its endowment and the mean ability of its students $\bar{a}_i$, $q_i = \bar{q}_i + \bar{a}_i$.

Colleges set an admission criterion, which is specified as a minimum expected student ability for acceptance, $\underline{a}_i$. Their objective is lexicographic. Their first priority is to maximize enrollment e_i, until it hits capacity E. Keeping enrollment high is important for colleges because they need to finance large fixed costs associated with building maintenance. For colleges that are at capacity, their goal is to maximize quality, which leads them to set the highest value of $\underline{a}_i$ that maintains full enrollment. We hold capacity fixed in the baseline model, motivated by the fact that enrollment rose quickly after the war, leaving colleges little time to build classrooms or dormitories. For example, first-year enrollment in 1947 was 150 percent larger than in 1943 and 50 percent larger than the pre-war peak. However, we will also explore extensions where capacity expands in Section 5.

4.2 Students

High school graduates have heterogeneous endowments (a, p, z, s, l). Ability a affects how much they learn in and benefit from college. Family (parental) background p determines the resources students can access to finance consumption if they attend college. It can be thought of as including transfers from parents plus income from work while in college, minus payments for tuition. Children from richer families can access more funding and enjoy higher consumption while in college, making it more enjoyable. Students are endowed with two noisy signals of their ability, z and s. Finally, l is their endowed location, which determines the quality of their local college. Endowments are drawn from a distribution $F(a, p, z, s)$ that is constant across locations and (in the baseline analysis) over time.

Ability is unobservable to students and to colleges when application and admissions decisions are made. Instead, students and colleges form expectations about the student's ability. Below we assume that p, z, and s are all correlated with a and hence are potentially useful for forming expectations. Our first time-varying driving force is the subset of this information $\mathbb{I}_t$ that is observed by cohort. We assume that pre-war cohorts had information sets $\mathbb{I}_t = (p, z)$, while post-war cohorts had more information, $\mathbb{I}_t = (p, z, s)$. The variable z represents the set of information that is available in the absence of test scores. Empirically, it can be thought of as a student's transcript (courses taken, grades, rank in class) and letters of recommendation. The variable s represents the information provided by scores on standardized college admissions tests, which are available only to post-War cohorts. We denote by $\mathbb{E}(a \mid \mathbb{I}_t)$ the expected ability given available information.

Given this time-varying information set, graduates make an irrevocable decision whether to work as a high school graduate or attend college. High school graduates who enter the labor force directly possess a single unit of human capital that they supply to the labor market inelastically at the prevailing wage for high school graduates when they are of age

$j \in \{0, 1, ..J\}$, w_j^{HS}. They solve a simple life-cycle consumption problem:

$$\max_{c_j} \sum_{j=0}^{J} \beta^j \log(c_j)$$
$$s.t. \sum_{j=0}^{J} c_j R^{-j} = \sum_{j=0}^{J} w_j^{HS} R^{-j},$$

where β is the discount rate and R is the gross interest rate. We assume $\beta R \equiv 1$, which gives that consumption is constant over the life cycle and allows us to solve for the flow value of being a high school graduate V_t^{HS}.[13] This value can vary over time to capture growing wages or (indirectly) changes in the non-pecuniary aspects of working as a high school graduate.

Alternatively, graduates can choose to attend a college. We start by defining the value of attending the local college, which is feasible as long as the student's expected ability exceeds the college's cutoff, $\mathbb{E}(a \mid \mathbb{I}_t) \geq \underline{a}_l$. The student finances consumption while in college using family resources p, which gives them flow utility $\log(p)$. Students are restricted from borrowing against their future income although they would wish to do so, consistent with the financial environment through the mid-1960s. Upon graduation they acquire human capital given by a CES production function that takes the student's ability and college quality as inputs, $h(a, q) = [\phi q^\gamma + (1 - \phi)a^\gamma]^{\alpha/\gamma}$. The virtue of a CES production function is that it allows flexibility in γ, which governs how substitutable college quality is for student ability. The parameter α governs the overall curvature of human capital formation.

College graduates enter the labor market and supply $h(a, q)$ units of labor inelastically each year at the prevailing wage for college graduates when they are of age j, w_j^C. They solve a similar life-cycle consumption problem as high school graduates. Extending the logic above, the expected post-graduation utility of working as a college graduate taken before ability is known can be represented as $\sum_{j=1}^{J} \beta^j \mathbb{E}_a[\log(h(a, q)) \mid \mathbb{I}_t] + V_t^C$.[14] The total value of attending the local college is then given by

$$V(p, \mathbb{I}_t, l) = \log(p) + \hat{\alpha}\mathbb{E}_a \left[\log\left([\phi q_l^\gamma + (1 - \phi)a^\gamma]^{1/\gamma}\right) \mid \mathbb{I}_t\right] + V_t^C, \tag{1}$$

where $\hat{\alpha} \equiv \alpha \sum_{j=1}^{J} \beta^j$.

[13] $V_t^{HS} \equiv \log\left(\frac{\sum_{j=0}^{J} w_{t+j}^{HS} \beta^j}{\sum_{j=0}^{J} \beta^j}\right) \sum_{j=0}^{J} \beta^j$.

[14] If we assume that college takes one period, then $V_t^C \equiv \log\left(\frac{\sum_{j=1}^{J} w_{t+j}^{C} R^{-j}}{\sum_{j=1}^{J} R^{-j}}\right) \sum_{j=1}^{J} \beta^j$.

Finally, students can pay cost κ to apply to and attend non-local colleges. This cost represents transportation costs, search frictions, out-of-state tuition fees, and so on. Once this cost is paid, students can attend any college where their expected ability meets the admissions criteria. On the other hand, it reduces their consumption while in college to $p - \kappa$. These trade-offs are embedded in the value function for non-local applicants:

$$W(p, \mathbb{I}_t, l) = \mathbb{E}_{a,\zeta_i} \left\{ \max_{i \neq l : \mathbb{E}(a|\mathbb{I}_t) \geq \underline{a}_i} V(p - \kappa, \mathbb{I}_t, i) + \bar{\zeta}\zeta_i \right\}, \tag{2}$$

where ζ_i is an i.i.d. type-I extreme value taste shock for college i. It is revealed to students only after they choose to apply outside their local area. Its primary purpose is to make the model more tractable computationally by smoothing students' application behavior across the parameter space. The parameter $\bar{\zeta}$ controls the dispersion of the shocks, which in turn controls the relative importance of taste versus human capital formation for college choices.

Students choose among these three options (work as high school graduate, attend local college, search among all colleges) to maximize lifetime utility:

$$\max \left\{ V_t^{HS} + \bar{\eta}\eta_{HS}, V(p, \mathbb{I}_t, l) + \bar{\eta}\eta_V, W(p, \mathbb{I}_t, l) + \bar{\eta}\eta_W \right\}, \tag{3}$$

where the ηs are again i.i.d. type-I extreme value taste shocks scaled by $\bar{\eta}$ and introduced mainly for computational tractability. As is standard in these problems, the level of utility is not identified, so without loss of generality we normalize $V_t^{HS} \equiv 0$ for each cohort and interpret V_t^C as affecting the level of lifetime utility of college relative to high school. The difference in lifetime utility also depends on utility from consumption in college and the human capital that would be formed in college as in equation (1).

We then have two driving forces that we will vary as we simulate the choices of different cohorts: V_t^C, which we use to fit the fraction of each cohort that attends college, and $\mathbb{I}_t$, which captures the improved signals of students' abilities after the introduction of standardized testing.

4.3 Equilibrium and Equilibrium Selection

An equilibrium in this model consists of college choices for students (whether to attend and, if so, which college), admissions cutoffs for colleges, and college qualities. The choices need to maximize the lifetime utility of each student (equation (3)) and the lexicographic objective of the colleges. The equilibrium quality of each college also has to be consistent with the set of students who actually attend the college.

As in most models with peer effects, we face the possibility of multiple equilibria. For example, if we take an equilibrium and rank colleges from highest to lowest quality, it may be the case that we can switch the student bodies of the highest- and lowest-quality colleges and obtain a new equilibrium. The extent of multiplicity depends on the relative importance of peer effects as compared to differences in college endowments in the overall production of college quality. We follow the approach of Epple et al. (2017) and focus on what they call a "hierarchical adherence" equilibrium, which requires the college quality hierarchy to follow the endowment hierarchy.[15] This produces what we (and they) view as the most natural equilibrium. We verify computationally that such an equilibrium exists. Extensive experimentation with different (weakly increasing) initial guesses of college quality as a function of college endowment $q_i(\bar{q}_i)$ suggest that there is a unique equilibrium in the parameter region of interest.

5 Quantitative Assessment

In this section, we calibrate the model and study its implications for the time series patterns of sorting. We simulate two equilibria of the model, corresponding to the 1933 (Updegraff (1936)) and 1960 (Project Talent) cohorts. These cohorts span the reversal in sorting, and the corresponding studies offer the full bivariate tabulation of college-going as a function of academic ability and family background that we prefer. Stopping with the 1960 cohort also allows us to abstract from federal government involvement in college financing, which comes later.

We calibrate the model to fit the fraction of students of different types who attend college in the two cohorts, as well as the application behavior of students by cohort. As emphasized in the last section, most of our parameters are time-invariant. Our calibration exercise is thus judged on whether we can generate a quantitatively large reversal in college attendance patterns using two time-varying driving forces: a change in the relative value of college for all students and an increase in information about students' abilities. We show that the model is capable of doing so. We explore the mechanism, which is that the endogenously generated change in application and admissions behavior differentially affects the quality of college available to students of different types. We disentangle the role of the two exogenous driving

[15]They distinguish between private and public colleges when taking their model to the data; our historical data do not allow us to do so.

forces as well as showing the importance of increasing quality differentiation of colleges as an endogenously generated mechanism in the model.

5.1 Calibration

The model has a number of parameters that need to be calibrated for a quantitative assessment. We start with the parameters relevant to colleges. We assume that colleges have endowments spaced uniformly on the interval $[\underline{q}, \bar{q}]$. We also need to choose the capacity of each college, E.

The second set of parameters govern students' endowments. We assume that $(a, \log(p))$ are drawn from a bivariate normal distribution with mean (μ_a, μ_p), standard deviations $(1, \sigma_p)$, and correlation ρ.[16] We assume that the signals z and s are unbiased draws from a normal distribution with standard deviations σ_z and σ_s.[17] Since all variables are jointly normal, we can solve analytically for $\mathbb{E}(a \mid \mathbb{I}_t)$.

The third set of parameters govern human capital formation and its labor market returns. The human capital production function has three parameters, ϕ, γ, and $\hat{\alpha}$, which govern the relative weight on quality versus ability in the production of human capital; the elasticity of substitution between the two; and the overall curvature of human capital production. The parameter κ is the extra cost to apply to non-local colleges. V_t^C is the relative value of college (as compared to high school) for cohort t.

Finally, we have two preference parameters, $\bar{\eta}$ and $\bar{\zeta}$, which provide a scale to the type-I i.i.d. extreme value shocks for the three broad choices (work as a high school graduate, attend local college, attend national college) and for specific non-local colleges, respectively. All told, this gives us 17 parameters, which are summarized in Table 1.

We choose these parameters to fit a weighted quadratic loss function with 32 moments from each cohort, or 64 in total. Our main targets are the share of students in each (s, p) quartile and the share of each (s, p) quartile that attends college for each cohort. We map the test scores and indices of socioeconomic status in the data into the model objects s and p. Note that for the 1933 cohort, we match the model and the data on the basis of test scores, even though we have assumed that agents in the model do not know test scores. The idea is that although we have access to test scores from Updegraff (1936), and students covered

[16] Our human capital production function requires a to be positive. We truncate the distribution and replace all non-positive values with a small positive value.

[17] We also explored allowing for a more general structure of correlations between (a, p, z, s) but found that doing so does not substantially improve the model fit or change its predictions.

Table 1: Calibrated Parameters

Parameter	Description	Value
Colleges		
$\underline{q}$	Lower bound on college endowments	0.61
$\overline{q}$	Upper bound on college endowments	2.26
E	College capacity	0.55
Endowments		
μ_p	Mean log parental transfer	-0.08
μ_a	Mean ability	0.90
σ_p	Standard deviation of log transfer	0.10
ρ	Correlation of parental transfers and ability	0.43
σ_z	Noise in information signal	0.74
σ_s	Noise in test score signal	1.50
Human capital production		
γ	Substitution between ability and quality	-0.26
ϕ	Weight on quality	0.74
$\hat{\alpha}$	Curvature of human capital production	0.71
κ	Application cost	0.41
V_t^C	Relative value of college	(-0.37, 0.66)
Preferences		
$\bar{\eta}$	Scale of taste shocks among broad education choices	0.08
$\bar{\zeta}$	Scale of taste shocks among colleges	0.08

Note: Table gives model parameters, a brief description of their role, and the calibrated value.

by this study likely did as well, test scores – particularly standardized college admissions test scores – were generally rare at the time.

Finally, we fit a measure of how nationally integrated the market for higher education is. Before World War II, most students applied to only a single college, typically one with a close relationship with their high school. Our best estimate for the 1933 cohort is that 85 percent apply to just one college, which is a midpoint between the estimate of 89 percent from the 1920s and 75 percent from 1947 (see Section 3 for sources). By contrast, about one-half of students in the 1960 cohort applied to multiple colleges (Flanagan et al., 1964). We calibrate the share of students attending non-local colleges in the model to fit the share of students who apply to multiple colleges in the data. Our underlying idea is that students who apply to only a single college are probably choosing a college with a close relationship with their high school and a high probability of acceptance, which is how we think of the local college in our model. Submitting multiple applications indicates a broader search.

5.2 Model Fit

Table 1 describes the calibrated parameters. We highlight two areas of special interest. First is the human capital production function. This function puts a large weight on college quality ($\phi = 0.74$). It also finds that college quality and student ability are complementary inputs to the formation of human capital ($\gamma < 0$). This calibrated production function implies that students, particularly high-ability students, have incentives to seek out high-quality colleges.

Second, we are interested in the evolution of the parameters that vary by cohort. The relative value of attending college V_t^C rises substantially. The level of V_t^C governs whether a worker who will acquire $h = 1$ units of human capital prefers high school (negative) or college (positive). The rise in V_t^C generates a large increase in college attendance, which turns out to drive most of our results. We allow for additional information about students' abilities in later cohorts in the form of s (test scores). The large variance of s relative to z suggests that these test scores do not improve the precision of expected ability forecasts by much as compared to the entire information available on a student's transcript or in their letters of recommendation. Nonetheless, we show below that this change does help the model fit the reversal in sorting patterns.

The model delivers a good fit to the data. Table 2 briefly summarizes the four main moments we target for the 1933 and 1960 cohorts: the fraction of high school graduates

Table 2: Summary of Model Fit, 1933 and 1960

	1933 Cohort		1960 Cohort	
	Data	Model	Data	Model
College attendance	0.29	0.29	0.53	0.52
Local college attendance	0.85	0.85	0.51	0.51
β_s	0.23	0.29	0.71	0.78
β_p	0.69	0.67	0.48	0.60

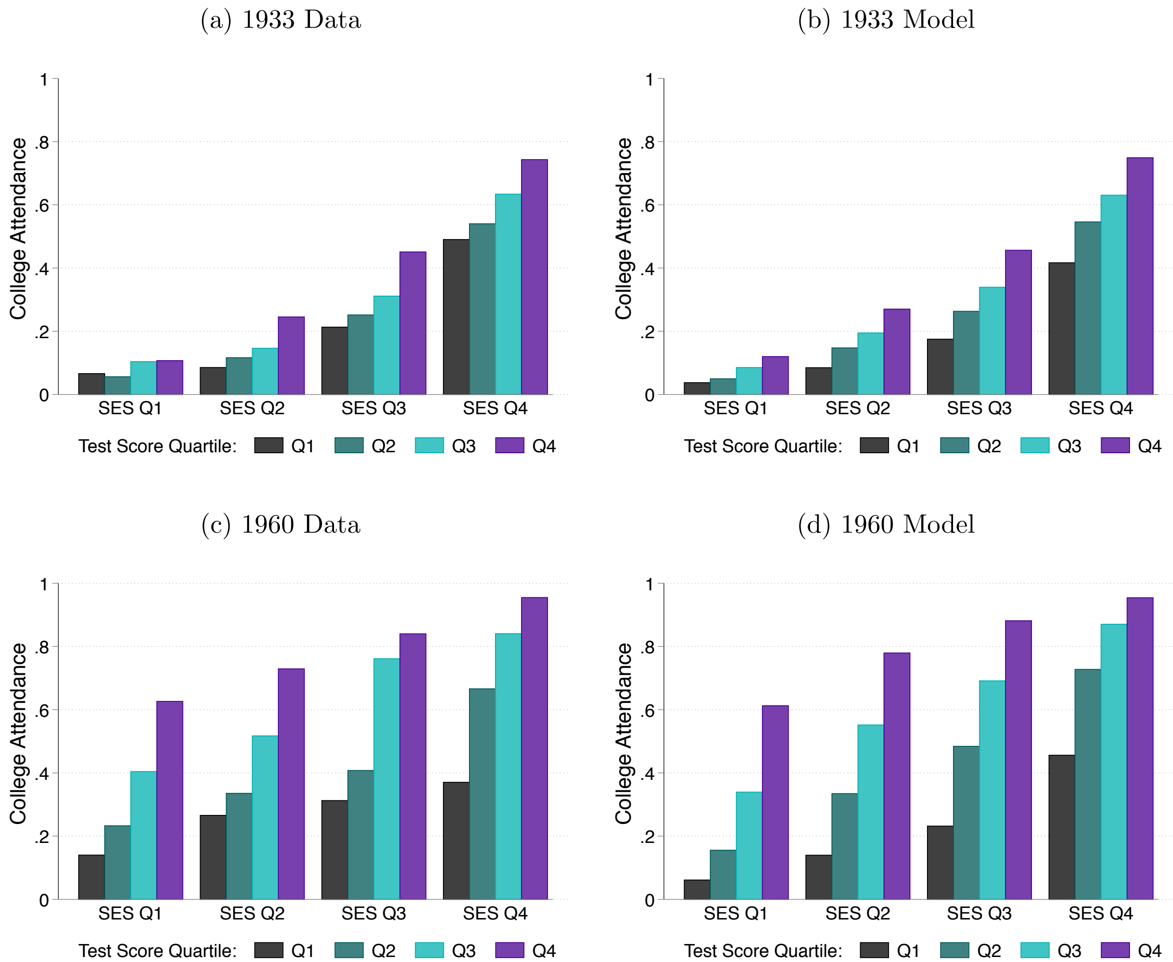
Note: Columns compare the model to the data for the 1933 and 1960 high school graduation cohorts. The rows provide four moments: the share of graduates who attend college; the share of college students who attend a local college; and the importance of test scores and family background for determining who attends college.

who attend college; the fraction of college enrollees who choose the local college; and sorting by test score and family background. For the table, we reduce the sorting to the estimated coefficients β_s and β_p from a bivariate regression of college attendance on test scores and family background, in line with Section 2. The model fits the targets well, with the main challenge being that it captures only about one-third of the decline in the importance of family background for college attendance. Figure 8 shows the full pattern of college entry by (s, p) quartiles from the data and the model for the 1933 and 1960 cohorts. Family background dominates attendance patterns for the 1933 cohort, but academic ability does for the 1960 cohort, consistent with the data. The main area where the model struggles is with the increase in attainment of students with low test scores, particularly those with low test scores and below-median family background. The model predicts that these students have low human capital formation in college and has a hard time accounting for their rising tendency to go to college.

We focus on the model's implied changes in sorting by test scores (s) and family background (p) because this is what we observe in the data. However, the model also allows us to construct sorting when ability is measured directly (a) or proxied for by expected ability $(\mathbb{E}(a \mid \mathbb{I}_t)$, constructed using the information available to students and colleges). Table 3 compares the sorting in 1933 and 1960 when ability is proxied for by test scores, actual ability, or expected ability. In each case, we measure sorting using the coefficients of a regression of college attendance on the respective ability proxy and family background, as in Section 2.

Table 3 offers two main lessons. First, there are large differences in the implied patterns of sorting depending on which ability proxy is used. "Ability" sorting is weakest when

Figure 8: College Attendance Patterns



measured by test scores because our calibration implies that test scores are a noisy proxy for ability. It is much stronger when measured using actual ability. Finally, it is stronger still when measured using expected ability because that is the information available to agents for college attendance and admissions decisions. In some cases, students are sorting into college based on noise in their expectations.[18]

These findings are consistent with the results from Cooper and Liu (2016), who find that much of the apparent mismatch between students and colleges on the basis of test scores is

[18]The measured sorting on family background follows an inverse pattern. This finding can be understood primarily as a result of using noisy, correlated regressors. For example, when ability is proxied using test scores in the regression, then the coefficient on family background is inflated because family background is correlated with expected ability, which is only imperfectly controlled for by test scores.

Table 3: Sorting by Cohort for Alternative Proxies for Ability

	1933 cohort		1960 cohort	
	Ability Proxy	Family	Ability Proxy	Family
Test scores (s)	0.29	0.67	0.78	0.60
Ability (a)	0.61	0.51	1.08	0.39
Expected ability ($\mathbb{E}(a \mid \mathbb{I}_t)$)	0.84	0.37	1.46	0.17

Note: Columns give estimated coefficients from a joint regression of college attendance on an ability proxy and family background in the calibrated 1933 and 1960 equilibria of our model. Rows give different ability proxies: test scores (as in the baseline); ability; and expected ability given available information.

due to noise in test scores. The findings suggest a more nuanced view of the historical trends. The model implies that ability has always been more important for college attendance than family background. Focusing on sorting by test scores can obscure this fact.

The second main lesson of this table is that students become more sorted on ability and less sorted on family background over time regardless of which proxy we use to measure ability. In fact, the increase in sorting on ability is about as large as the increase in sorting on test scores. Thus, our findings do still support that college has become more "meritocratic" over time. In the next section, we explain how the model is able to generate this change.

5.3 Model Mechanisms

The model generates a large reversal in college attendance patterns. The calibrated 1933 equilibrium features a local market for college: few students attend college, and most who do attend their local college. The exogenously higher V_t^C in the 1960 equilibrium increases the share of students who wish to attend college. For colleges, this implies that many of the best colleges are oversubscribed, and so selective admissions is more common. For students, it implies that many more students apply to and attend colleges outside their local area. In equilibrium, this integration of the market for college education leads to a different menu of colleges and college qualities available to students of different types, which in turn generates different college attendance patterns. Although there are important feedback effects between college and student behavior, we consider each in turn.

For colleges, the main effect of the expansion of enrollment is that many more colleges are capacity constrained and practice selective admissions. Whereas in the 1933 equilibrium only 8 percent of colleges have selective admissions, in the 1960 equilibrium 86 percent do.

Recall that our definition of selective admissions is minimal: it means only that a college is at capacity and imposes any floor on expected ability for admission.

The widespread adoption of selective admissions leads colleges to be much more differentiated by student ability. This change can be understood as the result of three differences between the 1933 and 1960 equilibria. First, colleges that practice selective admissions in the 1933 equilibrium are even more selective in the 1960 equilibrium. Second, many more colleges are selective in the 1960 equilibrium. Finally, the fact that most students in the 1933 equilibrium attend their local college implies that even low-quality colleges have some high-ability students. Many fewer students attend local colleges in the 1960 equilibrium, which further reduces the average student ability in these low-quality colleges.

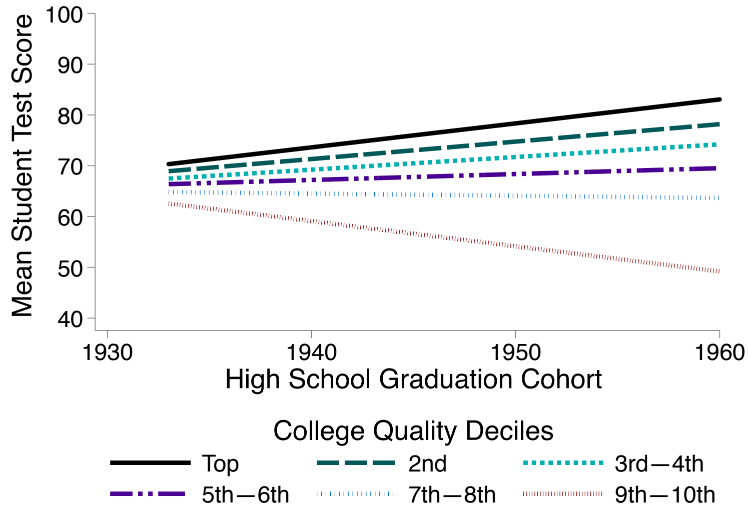
Hoxby (2009) identifies growing quality heterogeneity as one of the central features of the integration of the market for college education. She constructs a figure that ranks colleges by median test score (e.g., SAT test score) of their student bodies, with test score again acting as the empirical proxy for expected ability. She shows that test scores have risen at the top colleges but fallen for below-median colleges. While we cannot adopt her data as a formal calibration target, we can construct the same figure using our model and compare the two.[19] Figure 9 shows the same figure implied by our model. Here, we rank colleges by test score, then compute the average test score of the top decile of colleges, the second decile, and the bottom four quintiles, where each decile has an equal share of enrollment. We plot the points against time to mimic the same figure in Hoxby, although of course we have only two equilibria.

In the 1933 equilibrium, only the very top decile of colleges is selective, so the gap in test scores between top and bottom colleges is small, less than 10 percent. In the 1960 equilibrium, college quality is much more dispersed. Mean test scores are higher for above-median colleges but lower for below-median colleges. The gap between top and bottom colleges in the 1960 equilibrium is around 30 percent. This figure matches the earliest figures in Hoxby (2009) quite well. She finds that the gap in 1962 was 40 percent and suggests based on spotty earlier evidence that the gap in the 1950s was probably around 20 percent. Hence, both the level and the trend in college quality heterogeneity are consistent with existing evidence.

For students, the main changes are higher college attendance (which is delivered by the exogenous rise in V_t^C) and lower rates of local college attendance. The model is calibrated

[19]Unfortunately, Hoxby's data stretch back only to the 1950s, not the 1930s, and she provides only a figure (Figure 1, p. 98), not the data plotted in the figure.

Figure 9: Fanning out of Colleges



to fit each change. The higher dispersion of colleges by quality and the lower rates of local college attendance have important implications for the menu of colleges available to each student. One metric that speaks to this changing menu is the fraction of students who have access to their first-choice college, meaning the college they would attend if students were individually exempted from admissions standards. In the 1933 equilibrium, 99 percent of students can do so. This finding is explained by the fact that few colleges are selective, but also by the fact that quality gaps are generally small enough that most students prefer to attend their local, unselective college.

In the 1960 equilibrium, only 55 percent of students can attend their first-choice college. The share of students who can attend their first-choice college varies strongly in characteristics such as test score. For example, Figure 10 plots the fraction of students who can attend their first-choice college by (s, p) quartile. While most top-quartile test score students can attend their most preferred college, few bottom-quartile test score students can.

A second metric to gauge the changing menu of college qualities is to examine the changing distribution of human capital and college quality. Table 4 provides several statistics that summarize these changes. Focusing on the first row, we see that the average human capital of college graduates declines over time. The distribution also becomes more dispersed because of increased stratification. Students in the top 27 percent of the 1960 human capital distribution have more human capital than the top 27 percent of the distribution in 1933, while students in the bottom 73 percent have less. Quality drops at 64 percent of

Figure 10: Access to First-Choice College

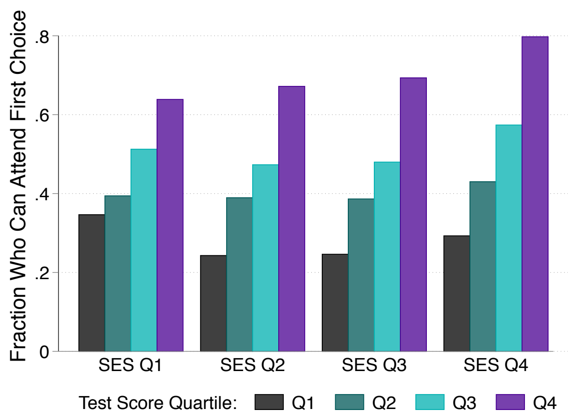


Table 4: Human Capital Formation

	Δ mean $\log(h)$	Share higher h	Share higher q
Baseline	-0.12	0.27	0.36
No change in sorting	-0.11	0.00	0.00
No change in attainment	-0.01	0.63	0.48

Note: Columns give the change in mean human capital of college graduates between 1933 and 1960, the share of college graduates with higher human capital in 1960, and the share of colleges with higher quality in 1960. Rows give the baseline model and counterfactual models that hold either sorting patterns or college attendance rates fixed.

colleges, again suggesting growing dispersion.

The next two rows in Table 4 give the results from counterfactual experiments that explain these findings. The second row shows the same statistics for the case in which, for each agent, we take the decision of whether or not to attend college from the 1960 equilibrium, but the decision of which college to attend from the 1933 equilibrium. This row shows that the expansion of college lowers the mean human capital of college graduates, primarily because the students who enter college in the 1960 equilibrium but not the 1933 one have lower expected ability. By itself, this change implies that all students should have lower human capital and all colleges should have lower quality. The third row shows results from the reverse case: for each agent, we take the decision of whether or not to attend college from the 1933 equilibrium, but the decision of which college to attend from the 1960 equilibrium. This row shows that sorting improves outcomes for about two-thirds of students and about one-half of colleges. For the most part, these are high expected ability students who sort into selective colleges with their peers. Overall, the results in the first row combine the effects of an expansion of education, which lowers average human capital and quality, and a change in sorting, which raises human capital and college quality for selective colleges and the high-ability students who attend them.

Thus, the model endogenously produces changes in application and admissions behavior consistent with the integration of the market for college education and the facts documented in Section 3. These changes combine to imply very different college qualities available to students of different academic abilities and family backgrounds, because colleges are more selective and more differentiated by quality, and students are more willing to apply to non-local colleges. The change in college qualities available to students drives the change in sorting patterns. In the next section, we consider which of the driving forces is most responsible for our results.

5.4 Decomposing Results

Next we decompose the results to highlight the role of three essential ingredients: the rising value of college; changing information; and the growing quality differentiation of colleges. We start by taking our calibrated model with the parameters from Table 1. These parameters fit the 1933 and 1960 data as well as possible. We then construct two alternative 1960 equilibria, which hold $\mathbb{I}_t$ or V_t^C fixed at the 1933 level. We show the results in Table 5. The rows are the same fit statistics as in Table 2, as well as the degree of sorting that we would estimate if we regressed college attendance on actual ability rather than proxies, which we denote by β_a, as well as two summary statistics for the model mechanism: the share of college students who can attend their first-choice college and the share of colleges that are selective. The columns show results for the 1933 and 1960 baseline calibrations and the two counterfactual 1960 equilibria.

We start with the third column of results, which shuts off the test scores and focuses on the rising value of college. These results show that the rising value of college accounts for nearly all of the rise in college attendance and decline in local college attendance. It also produces essentially all of the national integration of the market for college, and the same switch to selective admissions. However, the results for sorting patterns are more subtle. The rising value of college accounts for about one-third of the rise in sorting on test scores and none of the decline in sorting on family background.

The last column of results shuts off the rising value of college and focuses on the new information provided by test scores. The introduction of standardized college admissions

Table 5: Decomposing Model Results

	1933 cohort	1960 cohort		
		Baseline	No Test Scores	Constant V^c
College attendance	0.29	0.52	0.52	0.29
Local college attendance	0.85	0.51	0.51	0.81
β_s	0.29	0.78	0.46	0.47
β_p	0.67	0.60	0.68	0.61
β_a	0.61	1.08	1.02	0.65
Access to first choice	0.99	0.56	0.55	0.98
Fraction selective	0.08	0.86	0.86	0.12

Note: Columns compare results from the model for the baseline 1933 calibration, the baseline 1960 calibration, and alternative 1960 equilibria where the information set $\mathbb{I}_t$ or V_t^C is held fixed. Rows display the share of graduates who attend college; the share of college students who attend a local college; and the importance of test scores, family background, and ability for determining who attends college. The last two rows contain moments related to how the model works: the share of students who can attend their first-choice college and the share of colleges that are selective.

tests accounts for little of the rise in college or the national integration of college. It accounts for a substantial portion of the change in sorting patterns: about one-third of the rise in sorting on test scores and the entirety of the decline in sorting on family background. The mechanism is a straightforward information story: when test scores become available, students and colleges' forecasts of student ability put more weight on test scores and less weight on family background.

The model also includes an interaction effect between the two forces in explaining the rise in the importance of test scores for college admissions. The two driving forces interact through selective admissions. For example, consider a high s, low p student. In the 1933 equilibrium, this student is highly unlikely to go to college (only about 10 percent of such students do in the data and in the calibrated equilibrium). Rising V_t^C makes this student more likely to attend college. Allowing the student to observe s makes them more likely to attend college because it raises their expected ability and hence their expected gains from college. The interaction between the two comes through the college choice set: as other high-ability students become more likely to go to college, college quality at top colleges rises, which makes college yet more attractive to this student.

We can use the model to infer the sources of the rise in sorting on academic ability documented in Table 3. The surprising conclusion is that although sorting by test scores and ability both increased, they did so for very different reasons. While sorting by test scores is explained roughly equally by the rising value of college, new information, and the interac-

Table 6: Model Results with Constant College Quality

	Data	Model	
		Baseline	Constant Quality
College attendance	0.24	0.22	0.23
Local college attendance	-0.34	-0.34	-0.29
β_s	0.48	0.49	0.38
β_p	-0.21	-0.07	0.05
Access to first choice	-	-0.44	-0.51
Fraction selective	-	0.78	0.48

Note: Columns compare results from the data (where available), the baseline model, and an alternative, recalibrated model where education quality is held fixed at the 1933 level. The rows give the difference in each moment $m_{1960} - m_{1930}$, where the moments m are: the share of graduates who attend college; the share of college students who attend a local college; the importance of test scores and family background for determining who attends college; the share of students who can attend their first-choice college; and the share of colleges that are selective.

tion between the two, sorting by ability is explained entirely by the rising value of college. The intuition for this finding relies on the fact that we find test scores to be quite noisy signals. The introduction of this noisy signal leads students to become more sorted on test scores, including the noise in test scores, but has little impact on the sorting by ability.

Finally, we show that the growing quality differentiation documented by Hoxby (2009) plays an important role for our results. To do so, we consider a version of the model where college quality is held fixed over time, meaning that it is both exogenous and independent of mean student ability. We recalibrate the model parameters to fit the targets as well as possible. We particularly want to make sure the model fits the college attendance rate before we discuss the college attendance patterns.

We study the results in Table 6, which shows the model-implied changes in our four moments of interest (college attendance, share of college attendance that is local, and sorting by test score and family background) as well as two moments that speak to the model's mechanism: the share of students that can attend their first-choice college and the share of colleges that are selective. Columns give results for the data (where available), the baseline model, and the recalibrated model with fixed college quality. The model where quality is fixed can generate a rise in college attendance through V_t^C, but it falls somewhat short on the decline in local college attendance. Most importantly, it can fit only three-fourths of the increase in the importance of test scores and it generates an increase rather than a decrease in the importance of family background. It struggles on both dimensions because it shuts down the mechanism of worsening college quality available to low-ability students that generates this reversal.[20] We conclude that there is a strong link between our empirical findings and those previously documented by Hoxby (2009).

6 Extensions

In this section, we consider two extensions to the baseline model. We focus on two plausible alternative driving forces that might generate the reversal in sorting patterns: changes in the pool of high school graduates and changes in the college application cost.

6.1 Time-Varying High School Graduation Patterns

For our baseline analysis we assume that the distribution of students $F(a,p)$ is the same for both cohorts and calibrate the correlation parameter ρ between a and p to fit the observed distribution $F(s,p)$ as well as possible in the two cohorts. We do so because most of our empirical studies from Section 2, including notably Project Talent, concern the college-going behavior of high school graduates – the most common study design involves surveying students shortly before high school graduation. However, the expansion of high school over this period raises the concern that changes in the set of students who graduate high school may contribute to or confound the reversal in sorting patterns we document.

To make progress on this question, we need information on the selection of high school graduates over time. Fortunately, Updegraff (1936) is a rare example of a historical study with extra information. It records outcomes for all students with at least a sixth-grade education, which we take to cover all students. As noted above, similar data do not exist for Project Talent. Instead, we explore using data from the NLSY79. Since this is a later cohort with a higher high school graduation rate than Project Talent, we hypothesize that substituting NSLY79 data overstates the importance of rising high school graduation rates and changing high school graduate composition.

We recalibrate the model. We now choose ρ to fit the observed distribution over (s,p) quartiles for all students (not just high school graduates) in these two cohorts and explicitly feed in the high school graduation rate by (s,p) quartiles for each cohort, measured from

[20] Experiments that allow college capacity to expand by a large amount (a factor of three or more) also struggle to generate the right trends in sorting patterns for similar reasons.

Table 7: Model Results with Time-Varying Graduation

	Data	Model	
		Baseline	Time-Varying Graduation
College attendance	0.24	0.22	0.22
Local college attendance	-0.34	-0.34	-0.33
β_s	0.48	0.49	0.48
β_p	-0.21	-0.07	-0.04
Access to first choice	-	-0.44	-0.44
Fraction selective	-	0.78	0.78

Note: Columns compare results from the data (where available), the baseline model, and an alternative model that allows for time variation in the composition of students who graduate high school. The rows give the difference in each moment $m_{1960} - m_{1930}$, where the moments m are: the share of graduates who attend college; the share of college students who attend a local college; the importance of test scores and family background for determining who attends college; the share of students who can attend their first-choice college; and the share of colleges that are selective.

Updegraff (1936) and the NLSY79. The rest of the calibration procedure remains the same. We study the results in Table 7, which has the same format as Table 6. The main message of the table is that allowing the set of high school graduates to vary over time has little effect on our results. The model captures slightly less of the change in sorting patterns, but overall we conclude that variation in who graduates high school does not have a first-order effect on our results. The underlying intuition is that the model already fits college attendance conditional on (s, p); changing somewhat the distribution of students across cells $F(s, p)$ has second-order effects on our results.

6.2 Falling Application Cost

The main exogenous driving force in our baseline model is a rise in the value of college V_t^C, which captures, for example, the rising college wage premium. Hoxby (2009) emphasizes a second change around this time: declining costs of applying to and attending distant colleges, driven by declines in communication and transportation costs. Her work motivates us to allow for κ_t to vary over time in the model to see whether declining application costs are a plausible alternative driving force to V_t^C. To do so, we recalibrate the model and allow κ_t to vary by cohort.

When we do so, we find that the calibrated search cost remains essentially constant at $\kappa_t = 0.41$, as in the baseline calibration. Not surprisingly, the model results do not change (table omitted). We have also considered experiments where κ_t replaces V_t^C as the main driving force, but we found that calibrated versions of that model could not generate much of the rise in college attendance, which is a crucial part of the mechanism of interest. We conclude that while application and travel costs fell during this period, they do not appear to be responsible for the reversal in sorting patterns we have documented.

7 Conclusion

This paper documents large changes in the patterns of college attendance in the United States during the 20th century. We collect and harmonize the results of a number of studies and data sets describing college attendance patterns for high school graduates from 1919 to 1980. Our main finding is that prior to World War II, family income or socioeconomic status was a more important predictor of who attended college, whereas academic ability was more important afterward.

We provide a theory that attributes this primarily to the expansion of college enrollment following World War II. Rising demand for high quality colleges causes them to institute selective admissions. This sets off a feedback loop where their quality rises, making them yet more attractive for high ability students. At the same time, college becomes less attractive for low-ability students who can only access less selective colleges whose qualities decline over time. This explanation for the reversal ties it to increasing college stratification documented by Hoxby (2009). The introduction of college admissions tests interacts with this mechanism. It changes students' perceptions of their own ability and how much they will learn in college, but it also changes how their peers are selected into the various colleges. We perform a quantitative assessment of this theory to make this link formally and to show that the model can generate a quantitatively significant reversal in attendance patterns.

Our analysis stops in 1960 for two reasons. First, the federal government introduced and expanded college grant and loan programs after this time, rendering our assumption of self-financing of college unpalatable. The subsequent period is better thought of in a framework such as Lochner and Monge-Naranjo (2011), where access is affected by a race between expanding generosity of federal loan programs and rising college tuition. Second, the reversal in sorting patterns appears to be complete by this time, with Belley and Lochner (2007) showing that the trend even reversed for later cohorts. Increased demand for college and college stratification appear to have affected other margins for this later era, including the college preparatory behavior of high school students and the amount of time parents spend with their children (Bound et al., 2009; Ramey and Ramey, 2010; Blandin and Herrington, 2019).

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