

MEMORANDUM

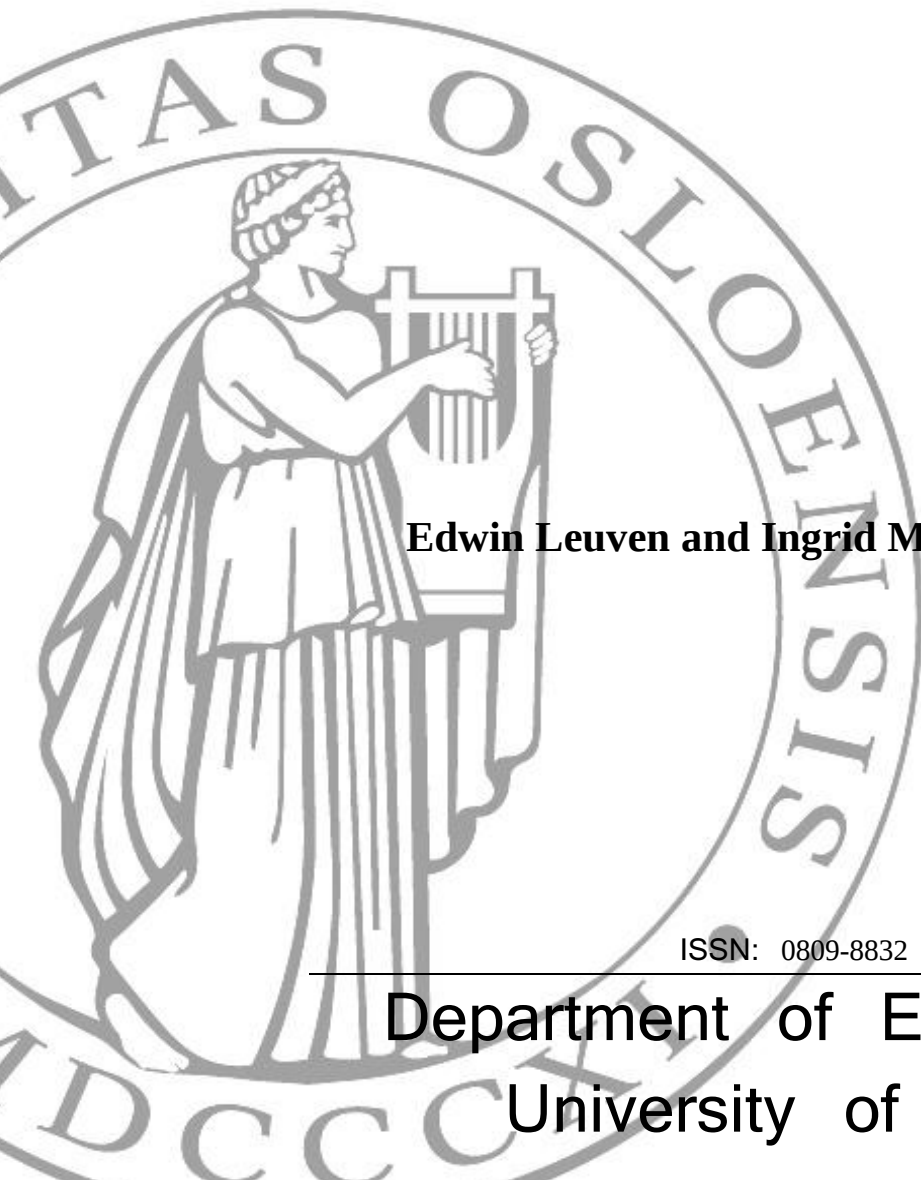
No 03/2025
November 2025

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ISSN: 0809-8832

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University of Oslo



This series is published by the
University of Oslo
Department of Economics

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Last 10 Memoranda

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Entrepreneurial returns to college*

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Abstract

How does college education shape entrepreneurship? We first document striking differences between college fields in the share of students becoming entrepreneurs. We then leverage quasi-random variation in college admissions near GPA-based thresholds to study the causal impact of the college environment on subsequent entrepreneurship. Exposure to more entrepreneurially intensive college programs, measured as a higher share of entrepreneurs among alumni, substantially increases the probability that a student starts their own business.

*The Norwegian Research Council supported this research under project no. 275906.

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1 Introduction

Entrepreneurship has long been viewed by economists as a vital driver of innovation and economic growth (e.g., Schumpeter 1947; Baumol 1968). Understanding how economies can facilitate and stimulate entrepreneurship is therefore a key policy concern.

A potential policy tool to stimulate entrepreneurship is education. While most research to date has focused on specific forms of entrepreneurship education (see, e.g., reviews in Bae et al. 2014; Nabi et al. 2017; Pittaway and Cope 2007), the question of how traditional education affects entrepreneurship remains relatively underexplored. Beyond offering dedicated entrepreneurship courses, colleges provide a variety of other inputs that might be conducive to entrepreneurship, such as formal training and skill development, networking opportunities, and exposure to entrepreneurial role models among peers or alumni. To leverage the full potential of the education system in creating entrepreneurship and economic growth, it is important to understand how traditional college education affects entrepreneurial aspirations and capabilities.

In this paper, we investigate the entrepreneurship returns to college education. Specifically, we ask whether college has a causal impact on business creation.

We study these questions in the context of the Norwegian higher education system. The combination of institutional setting and highly detailed registry data allows us to overcome obstacles in measuring entrepreneurship and estimating causal effects unconfounded by selection. Importantly, we are able to follow individuals from their college applications stage, through their college experience, and into their post-college careers.

We transparently define entrepreneurship by combining administrative records of firm ownership, board members, and employment, rather than relying on self-reported measures of entrepreneurship. In line with most of the recent literature on entrepreneurship, we focus only on new incorporated businesses because these tend to be more entrepreneurial than sole proprietor firms (Levine and Rubinstein 2018). We measure entrepreneurs as individuals who during the startup period own at least one-third of the firm and serve as board chairman, CEO, or are formally employed in the firm.

We start by providing descriptive evidence on how entrepreneurship varies with the college environment. We find little evidence that entrepreneurship varies by education level. In contrast, we find substantial heterogeneity within the population of college-educated individuals. Whereas entrepreneurship is relatively common among former students of business or STEM education, entrepreneurship rates among former humanities or teaching students are lower than in the population without any college education.¹

¹Buenstorf et al. (2017) provide descriptive evidence of how entrepreneurship varies with college education in Denmark. Our analysis differs from theirs in two important ways. Firstly, they allow entrepreneurs to be either self-employed or incorporated, whereas we focus only on the incorporated, as these are more likely to be opportunity rather than necessity entrepreneurs. Secondly, they are only

We then proceed to estimate the causal effects of the college environment. To overcome the classic endogeneity problem between education and the decision to become an entrepreneur, we utilize variation in offers generated by the centralized college admission system in Norway. College applicants in Norway are ranked solely based on their application scores, which largely consist of their high school grades. Program slots are then allocated to applicants using a version of the Gale-Shapley Deferred Acceptance mechanism, leading to admission thresholds that represent the application score of the lowest-ranking applicant among those admitted. By nature, these admission thresholds cannot be exactly predicted ex-ante. This allows us to account for preferences for specific types of college education by comparing individuals who apply to the same college programs, but receive different offers due to marginal differences in application scores (Dale and Krueger 2002; Kirkeboen et al. 2016).

We create a measure of the entrepreneurial activity level within each college program in Norway, defined as the share of former students who pursued entrepreneurship. Subsequently, we utilize the admission design to study the effect of marginally crossing the threshold to a program with a higher entrepreneurial activity level.²

We link the application data to post-application college and entrepreneurship trajectories of applicants. Importantly, the setting allows us to observe all students of a given program, not just those who eventually complete the degree. This is important both because entrepreneurship rates among college dropouts exceed those of college graduates, and because the decision to drop out might be correlated with the decision to create a business, thereby potentially biasing samples of college graduates.

We provide two alternative regression discontinuity approaches. In the first, we study the effect of enrolling in a program with a higher entrepreneurial intensity as a binary treatment. In the second, we study the effect of higher entrepreneurial intensity as a continuous treatment. Across both approaches, we find that the college environment has a sizeable causal effect on the probability of becoming an entrepreneur.

Our main contribution is to provide the first causal estimates of how college shapes entrepreneurship. Previous studies of the relationship between college and entrepreneurship have relied on comparisons between individuals who differ in their educational

interested in entrepreneurship within the first three years following college because they want to abstract from labor market experience. By contrast, we think of the potential effect of college on labor market pathways as an important channel through which college could shape entrepreneurship.

²It is not obvious that enrolling in a program with a higher entrepreneurial activity level would increase entrepreneurship. Oosterbeek et al. (2010) find that an entrepreneurship program commonly used in the US and Europe had a significantly negative impact on entrepreneurial intentions, which they attribute to students becoming more realistic about what it takes to become an entrepreneur as well as their own entrepreneurial ability. Lerner and Malmendier (2013) find that a higher share of peers with entrepreneurial experience in business school reduces the probability of entrepreneurship, with evidence consistent with peers helping screen ideas or providing access to networks. While our measure of entrepreneurial intensity is not predominantly concerned with concurrent peers, the same channels might apply for the lecturers, technology transfer offices, alumni networks or other components of the college environment that we capture with our broader measure.

choices (Buenstorf et al. 2017; Daghbashyan and Hårsman 2014; Breznitz and Zhang 2020).³ While a small number of studies utilize variation from randomization or quasi-randomization of educational treatments, they are predominantly concerned with the effects of specific types of entrepreneurship education (Alaref et al. 2020; Oosterbeek et al. 2010) or the effect of MBA peers (Lerner and Malmendier 2013). By contrast, we study the impact of a broader set of college education programs.

We further contribute to the literature studying returns to higher education along earnings or other dimensions (Card 1999; Dale and Krueger 2002; Moretti 2004; Hastings et al. 2013; Joseph G. Altonji et al. 2012; J. G. Altonji et al. 2016; Sekhri 2020; Bleemer and Mehta 2022; Hvidberg 2023) by shedding light on how entrepreneurship is shaped by the college environment.

Finally, the paper complements existing research focused on entrepreneurship among college students and faculty (e.g., Åstebro et al. 2012; Hvide and Jones 2018), while also adding to a broader set of papers that employ quasi-experimental variation to study the malleability of entrepreneurship (e.g., Lindquist et al. 2015; Guiso et al. 2021; Wallskog 2024).

The paper proceeds as follows: Section 2 describes the college admission process in Norway and the data we use for educational and entrepreneurship measurement. Section 3 presents descriptive evidence on the link between entrepreneurship and higher education, and lays out our empirical approach for obtaining causal estimates of the effect of the college environment on the decision to become an entrepreneur. Section 4 presents our results, and Section 5 concludes.

2 Institutions and data

We leverage detailed population-wide administrative data from a variety of sources. A unique individual identifier allows us to follow the same individuals across education, firm, and demographic registers. These data sources, as well as the institutional settings of college and entrepreneurship in Norway, are further described below.

2.1 Business creation and entrepreneurship

The literature on entrepreneurship employs a wide spectrum of entrepreneurship definitions (see, e.g., Lazear 2005). Firstly, definitions differ in what businesses they capture, in particular whether they include self-employment, incorporation, or both. Secondly,

³Buenstorf et al. (2017) and Ahn and Winters (2023) also use instrumental variable approaches to understand how education shapes entrepreneurship. Their instrumental variables, however, may not satisfy exclusion restrictions. Ahn and Winters (2023) instrument for (college) education using mean schooling in the birth cohort of the mother, while Buenstorf et al. (2017) instrument for college completion as opposed to dropping out of college using high school GPA and sibling dropout status.

definitions differ in which individuals associated with the business they classify as entrepreneurs.

We focus on incorporated limited liability firms. Recent studies suggest that individuals with high entrepreneurial capabilities tend to favor establishing incorporated firms, whereas sole proprietorship to a larger extent attracts negatively selected individuals and ventures with limited potential for growth (Levine and Rubinstein 2017; Levine and Rubinstein 2018).

To create an incorporated business in Norway, an individual needs to be above the legal age of 18. Registration costs about 600 USD and can be carried out online. There is an equity requirement of 30,000 NOK, which corresponds to about 3,000 USD as of 2024.⁴ As is common in many countries, incorporation provides protection against personal liability. If the business is not successful, owners risk losing the equity they invested in the firm, but are not personally responsible for debt incurred by the business.

The next question is who to count as entrepreneurs. We follow the definition used by Statistics Norway (Fjærli et al. 2013), whereby an individual is classified as an entrepreneur if, at the time of initial business registration, they meet the following two criteria: Firstly, they hold a significant ownership stake in the business, defined as more than one-third. Secondly, they actively engage in the operations of the business, defined as being employed within the business and/or holding the position of either registered CEO or board chairman. This definition aligns with the common understanding in the literature that an entrepreneur must have a vested interest in the enterprise by assuming financial risk while also playing a role broader than that of a passive investor (see, e.g., Berglann et al. 2011; Lindquist et al. 2015).

To implement this definition, we combine a variety of administrative data sources.

Our starting point is the universe of incorporated firms in the Norwegian Enterprise Register between 2004 and 2017. To capture new businesses, we restrict our sample to firms that were registered for the first time during this period. We filter out holding companies by excluding businesses that, at the time of startup, own more than 0.9 of another firm, in accordance with Fjærli et al. (2013). This allows us to abstract from the role of certain types of education in learning about wealth management.

Each firm in the Enterprise Register is recorded with an unique (anonymous) identifier. This allows us to identify the entrepreneurs behind the firms by coupling the Enterprise Register with three other registers: the Ownership Register, the Role Register, and the Employer-Employee register, all recording formal relations between firms and individuals. Similar to firms, individuals are identified by unique, anonymous identifiers that can be linked across registers.

The Ownership Register records all ownership of firms. Firms can be owned by

⁴The capital requirement was lowered from 100,000 NOK to 30,000 NOK in 2012. See Bacher et al. (2024) for details.

personal or firm owners, which complicates the exercise of quantifying the share owned by a specific individual. Following the approach outlined in Fjærli et al. (2013), we trace indirect ownership through up to two intermediate firms. For an individual to be classified as an entrepreneur of a new business, their combined direct and indirect ownership at the time of startup must constitute at least one-third.

As outlined above, this measure of financial risk-taking is a necessary, but not sufficient, requirement to be classified as an entrepreneur. To measure active involvement in the operation of the business, we turn to the Role and the Employer-Employee Registers. The Role Register records the individuals formally holding a role in the firm, such as being CEO, chairman, or member of the board. The Employer-Employee Register records all employees of the firm. For an individual to be counted as an entrepreneur, he must be observed as either the CEO, chairman of the board, or an employee of the firm during the startup period.

Individuals who satisfy both the ownership requirement and the involvement requirement for a given new incorporated firm are counted as entrepreneurs.

2.2 Education

2.2.1 College admissions and educational setting

Our educational setting is the public higher education system in Norway, encompassing nearly all higher education institutions. Most college trajectories follow the Bologna structure, typically beginning with a three-year bachelor program, which may be followed by a two-year master's program.⁵ Specialization takes place at a relatively early stage, with students being admitted to specific programs that represent a combination of major and institution, such as Computer Science at the University of Oslo. Programs vary in the extent to which they, either explicitly or implicitly, teach skills that might be particularly useful to starting a business, a feature we discuss in Section 3. Students are not charged tuition, except from a semester registration fee of approximately 90 USD.

Since 1997, admission to all higher education has been centrally administered by the Norwegian Universities and Colleges Admission Service (NUCAS) through an online platform.⁶ Applicants submit a rank-ordered list of up to 10 preferences over programs.⁷ Applications are free of charge, and NUCAS automatically retrieves grades and eligibility information from official databases. Applicants are ranked solely based on their application score, which is calculated using a transparent, predetermined formula. Application scores are primarily based on high school GPA and performance in centralized

⁵Some specialized degrees, such as law and medicine, are structured as integrated five- or six-year programs.

⁶Prior to 1997, admissions were administered locally at each college.

⁷Cohorts applying through NUCAS prior to 2004 were allowed to rank up to 15 programs in their application.

exams, with extra points awarded in certain cases such as completion of advanced math courses.⁸⁹ Applicants are allocated to programs using a Deferred Acceptance algorithm, in which a program’s fixed number of slots are assigned to the applicants with the highest application scores among those not already admitted to a more preferred program. Consequently, the algorithm gives rise to admission cutoffs that cannot be perfectly predicted in advance. For candidates with application scores close to the cutoff, being assigned to either the preferred or less-preferred program can be considered quasi-random. This setting is explained in detail in Kirkeboen et al. (2016).

2.2.2 Education data

Our analyses draw on two main building blocks of education data: The NUCAS database, which records college applications starting from 1998, and the Norwegian Education Database (NED), which contains the educational history of the entire population dating back to the 1970s. Both databases are at the individual-level.

Our NUCAS data covers the universe of college applications between 1998 and 2016. For every applicant, we observe the rank-ordered list of preferences over programs (ROL), application scores, admission outcomes, and enrollment status. Additionally, we utilize publicly available information on admission cutoffs for each program annually. From this data, we calculate each applicant’s distance from the admission cutoff and predict their admission outcome based on whether their application score exceeds or falls short of the cutoff.

Our NED data records ongoing and completed education at a highly granular level for each individual in Norway every year. Education is classified using a six-digit code describing level and detailed field, which is further documented in SSB (2024). The record for highest completed education begins in 1970, and the record for ongoing education in 1974.¹⁰

All individuals in the NUCAS and NED datasets can be linked to comprehensive background data, which includes information about their gender, age, and family characteristics.

⁸Some programs receive permission to boost the application scores of applicants of one gender. An individual’s application score may therefore vary slightly across programs.

⁹A few programs, typically within performing arts or sports, use additional criteria such as performance in physical tests or auditions. These programs are excluded from our analysis.

¹⁰Education completed before the beginning of the database is recorded based on imputations from historical censuses, sometimes with less granular information. We avoid these measurement challenges by restricting our analysis to birth cohorts with complete observable trajectories, as explained in more detail below.

2.3 Samples

The richness of the data allows us to construct two samples for complementary analyses. In our analysis of the causal effect of college on entrepreneurship, we rely on individuals who apply to college after the beginning of the NUCAS database in 1998, allowing us to observe both college applications and actual ongoing education. For descriptive purposes, however, it is useful to include individuals who entered college before 1998, even if their college applications cannot be observed. Entrepreneurship may take time to materialize, and for individuals entering college after 1998, it may thus not have reached its ultimate level by 2017, our last observation year. We therefore create a second sample of older cohorts, allowing us to study entrepreneurship over a larger share of the life cycle. Both samples are described in more detail below.

2.3.1 College applicants (“CA sample”)

The starting point for the CA sample is the universe of college applicants in Norway between 1998 and 2016. Our goal is to compare the effects of different types of college education on entrepreneurship. To facilitate this analysis, we impose several key restrictions on the sample. Firstly, we study only first-time applicants, as other applicants might have outside options we do not capture (Kirkeboen et al. 2016). Secondly, we restrict ourselves to applicants who are on the margin between different college programs, rather than those on the margin between college and non-college options. Thirdly, we exclude applicants who prefer a program which admitted all applicants that year. Fourthly, we restrict ourselves to applicants who are between 18 and 25 years old when they apply to college. Lastly, we only use applicants applying to programs that existed before 2004, ensuring that the treatment can be defined.

Table 1 illustrates how these restrictions affect our sample. Column (1) presents descriptive statistics for our CA sample, while Column (2) provides the same statistics for the entire population of first-time college applicants during the same period. Application scores are standardized to have a mean of zero and a standard deviation of one in the universe of first-time applicants. Women are over-represented among Norwegian college students, and our sample has a slightly higher share of women than the universe of applicants, with 63 percent of our applicants being women. About 6 percent are born outside of Norway, compared to 10 percent of college applicants overall. The applicants in the CA sample are, on average, 19.9 years old upon applying to college, which is slightly younger than among first-time applicants overall due to our exclusion of applicants older than 25 years of age. In terms of application scores, our sample is somewhat positively selected relative to first-time applicants overall, resulting from our focus on applicants to over-subscribed programs. Post-application entrepreneurship is somewhat lower in our sample than in the population overall, consistent with the age restrictions leaving us

Table 1: Descriptive statistics for CA sample and universe of college applicants

	Our CA sample		All first-time applicants	
	(1)		(2)	
Age in application year	19.9	(1.4)	23.6	(7.3)
Female	0.63		0.60	
Born outside of Norway	0.06		0.10	
Standardized application score	0.16	(0.94)	0.00	(1.00)
Post-application entrepreneurship	0.028		0.034	
Observations	196,915		886,306	

Notes: Columns display key variable means (standard deviations in parenthesis) for (1) our estimation sample and (2) all first-time college applicants in Norway 1998-2016. The application score is standardized using the universe of first-time college applicants. Post-application entrepreneurship refers to whether the applicant creates a business at any point after the application year.

with a younger sample.¹¹

2.3.2 Birth cohorts 1959-1988 (“BC sample”)

This sample consists of all individuals born in Norway between 1959 and 1988. Older cohorts, and individuals born outside of Norway, are excluded because their education is not observed with similar granularity in NED. By ending our sample with the 1988 cohort, we aim to capture individuals at the highest level of education they will ever complete. Individuals born in 1988 are 29 years old when we last observe them.

Depending on the analyses, we further restrict the sample to e.g., only individuals who enrolled in college. These additional restrictions are explained in the relevant analyses. Table A.1 presents descriptive statistics for the BC sample.

3 College and entrepreneurship

3.1 Descriptive evidence

We start out by providing descriptive evidence on entrepreneurship and its educational origins.

First, we demonstrate that the relationship between college and entrepreneurship is not uniform. Figure 1 displays the probability of entrepreneurship among individuals in our BC sample, categorized by their level of education and field of study. The left panel strikingly documents that the average individual with college education (either completed

¹¹Entrepreneurship rates are lower than in Figure 1 because the population for which college applications are observable is younger on average than the NED population.

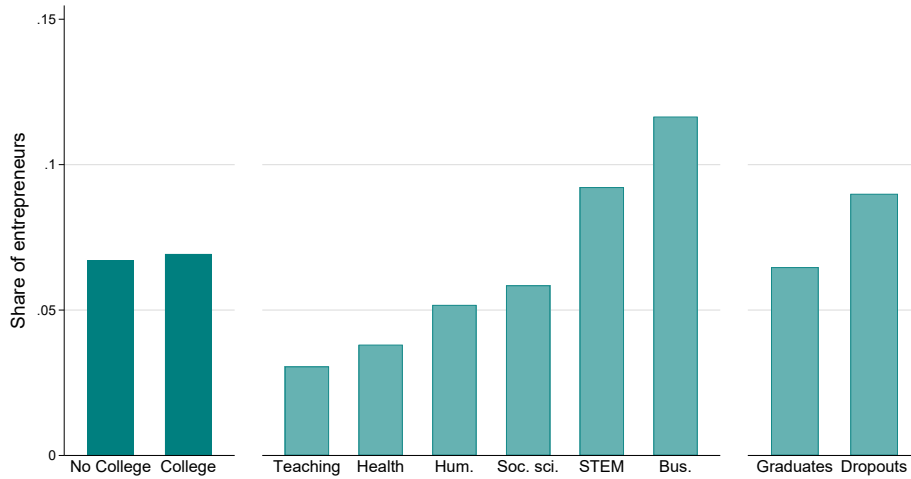


Figure 1: Entrepreneurship by type of education

Notes: The figure displays the probability of being observed as an entrepreneur at any point between 2004 and 2017 by (left panel) highest attempted level of schooling, (middle panel) field of study for individuals who enrolled in college, and (right panel) college completion status for individuals who enrolled in college, as recorded in the Norwegian Educational Database (NED). All individuals born in Norway between 1959 and 1988 are included.

or not completed) is no more likely to become an entrepreneur than an individual without any college education. In both groups, about 7 percent create a business between 2004 and 2017.

Within the college-educated, by contrast, there is substantial heterogeneity. The middle panel of Figure 1 splits the group with any college education by field of study. While 12 percent of former business students become entrepreneurs, only 3 percent of individuals formerly enrolled in a teaching program do the same.

The right panel of Figure 1 shows that college completion status matters. We split the population of college educated individuals by whether they completed any college degree. College dropouts are much more likely to create a business, at a rate of about 9 percent compared to the college graduate average of just above 6 percent. This highlights the importance of including all former college students, rather than just graduates, when studying the link between college and entrepreneurship, both to capture the full effect of college, and to prevent the sample from being biased by the potentially endogenous decision to drop out.¹²

Lastly, we document that the probability of entrepreneurship increases substantially during the first decades of an individual's career. Figure 2 shows the share of a given birth cohort that engages in entrepreneurship between 2004 and 2017. The figure displays an inverted U-shaped relationship between birth cohort and entrepreneurship, with the highest proportions observed among cohorts who are approximately 45-50 years old in 2017.

¹²As evident in Table A.1, the college dropout rate is approximately 19 percent in this setting.

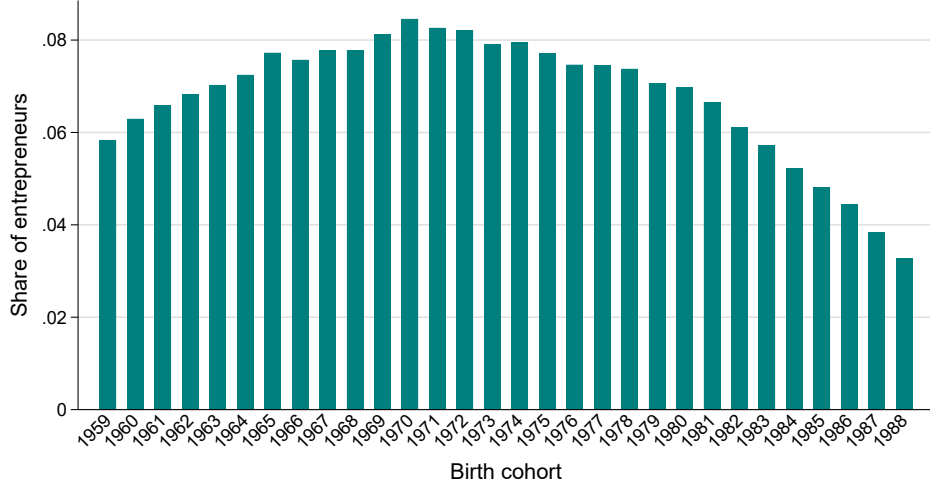


Figure 2: Entrepreneurship over the life-cycle

Notes: The figure displays the probability of being observed as an entrepreneur at any point between 2004 and 2017 by birth cohort. All individuals born in Norway between 1959 and 1988 are included.

These first findings motivate our further analysis of how college shapes entrepreneurship. Next, we ask whether the type of college education causally affects the probability of becoming an entrepreneur.

3.2 Estimating entrepreneurship returns to college

Our primary question of interest is whether exposure to a more entrepreneurial program increases the probability that an individual starts a business. Of course, we might expect the choice of what program to enroll in to be endogenous with respect to whether an individual considers starting a business. To overcome this obstacle, we utilize that the admission mechanism gives rise to unpredictable admission cutoffs, so that candidates with the same preferences over the program and grades close to the cutoff are quasi-randomly assigned to either their preferred or their next-best program. This allows us to employ a regression discontinuity design, using the margins between the program where a candidate is predicted to receive an offer and adjacent programs in the candidate's rank-ordered list of preferences.

The discontinuity in program assignment at the cutoff is fuzzy by nature since some individuals remain on waiting lists long enough to be admitted despite failing to exceed the admission cutoff, and since some individuals who receive offers choose not to enroll. We therefore estimate the following specification:

$$y_i = \alpha + \beta d_i + x_i' \phi + \epsilon_i \quad (1)$$

$$d_i = \gamma + \theta z_i + x_i' \pi + u_i \quad (2)$$

Here, y_i is a binary indicator for whether the individual creates a business at any point after applying to college; d_i is one of two treatments further defined below; z_i is an indicator variable equal to one if the individual is predicted to receive an offer from the more entrepreneurial of the two programs she is on the margin between, and zero otherwise; and x_i is a vector of observable characteristics including distance to the more entrepreneurial program and a categorical variable for the most preferred program. We cluster standard errors at the individual level because the same individual might be observed with up to two margins. Below, we discuss the variables in more detail.

3.2.1 Shifting between more and less entrepreneurial programs

Our instrument z shifts individuals between more and less entrepreneurial programs. Regression discontinuity designs have been frequently used in similar settings to study the returns to college (Zimmerman 2014) or to specific majors (Hastings et al. 2013; Zimmerman 2019; Kirkeboen et al. 2016). Such studies are frequently focused on the effect of the most-preferred option. By contrast, we are interested in the effect of enrolling in a more entrepreneurial program, which may or may not be the most preferred one.¹³

Consider the following stylized example, which is illustrated in Table 2. Two applicants A and B both prefer the more entrepreneurial program H1 to the less entrepreneurial program L1. A and B have marginally different grades, so that the application score of A just exceeds the admission cutoff to H1, whereas B receives an offer from the less entrepreneurial L1. Consider then two other applicants C and D. By contrast, they both prefer a less entrepreneurial program L2 to a more entrepreneurial program H2. Applicant C has slightly better grades and receives an offer from the most-preferred program, which means he does *not* receive an offer from the most entrepreneurial program. In this example, it is the marginally weaker applicant D who receives an offer from the more entrepreneurial program H2.

Whereas these two types of margins can be studied separately, our baseline estimates pool them in order to increase precision. Instead of letting the running variable be the distance to the most preferred program, that is, the difference between the application score and the admission cutoff for the most-preferred program, we define it as the distance to the more entrepreneurial program. For applicants preferring a more entrepreneurial program to a less entrepreneurial one, like A and B in the example above, this is the same as the distance to the most preferred program. For applicants preferring a less entrepreneurial one, the distance to the more entrepreneurial program is the difference between the admission cutoff to the most-preferred program and the application score. This is illustrated in the column “Distance to more entrepreneurial program” in Table 2.

¹³Hvidberg (2023) studies the effect of enrolling in economics as the less-preferred option.

Table 2: Creating the running variable

	First best program	Second best program	Distance to first best program	Distance to more entrepreneurial program	Offer first best program	Offer more entrepreneurial program
A	H1	L1	0.5	0.5	Yes	Yes
B	H1	L1	-0.5	-0.5	No	No
C	L2	H2	1	-1	Yes	No
D	L2	H2	-1	1	No	Yes

Notes: This table illustrates how our regression discontinuity estimation approach pools margins where an individual prefers a more entrepreneurial program over a less entrepreneurial program, and margins where an individual prefers a less entrepreneurial program over a more entrepreneurial program.

3.2.2 Measuring the entrepreneurial intensity of the program

Much of the literature on the link between education and entrepreneurship has focused on specific entrepreneurship courses or entrepreneurship education (e.g., Oosterbeek et al. 2010; Alaref et al. 2020). It is, however, not obvious what courses or majors are the most important for someone who wants to prepare for starting a business. For instance, general business studies or courses that provide advanced training in certain technologies might be valuable even if such studies are not usually branded as entrepreneurial.

We therefore start out by allowing for all types of programs to affect business creation. In order to distinguish between programs that are more and less likely to be conducive to entrepreneurship, we measure the historical share of students who started their own business. Since few people start businesses early in life, we consider only the oldest cohorts in our sample, those admitted between 1998 and 2004, who we can follow until they are approximately 40 years old. Throughout the paper, we refer to this measure as the entrepreneurial intensity of a program.

Figure 3 displays how the measure varies within and across fields.¹⁴ Entrepreneurial activity is typically higher in STEM and business than in other fields, but even within these fields, there is substantial variation.

The more entrepreneurial program out of the two programs an individual is on the margin between is therefore defined as the program with the highest entrepreneurial intensity. Figure 4 characterizes the margins in our sample in terms of the entrepreneurial intensity of the more and less entrepreneurial program. All points will mechanically be weakly above the 45 degree line. The figure displays a strong positive correlation between the intensity of the more and less entrepreneurially intensive program. Applicants who prefer programs with high entrepreneurial intensity are also likely to apply to other programs with relatively high rates of entrepreneurial activity, and vice versa. Nonetheless, the more entrepreneurial program typically exhibits significantly higher entrepreneurial

¹⁴The rates are lower than in Figure 1 because of the difference in age between the samples.

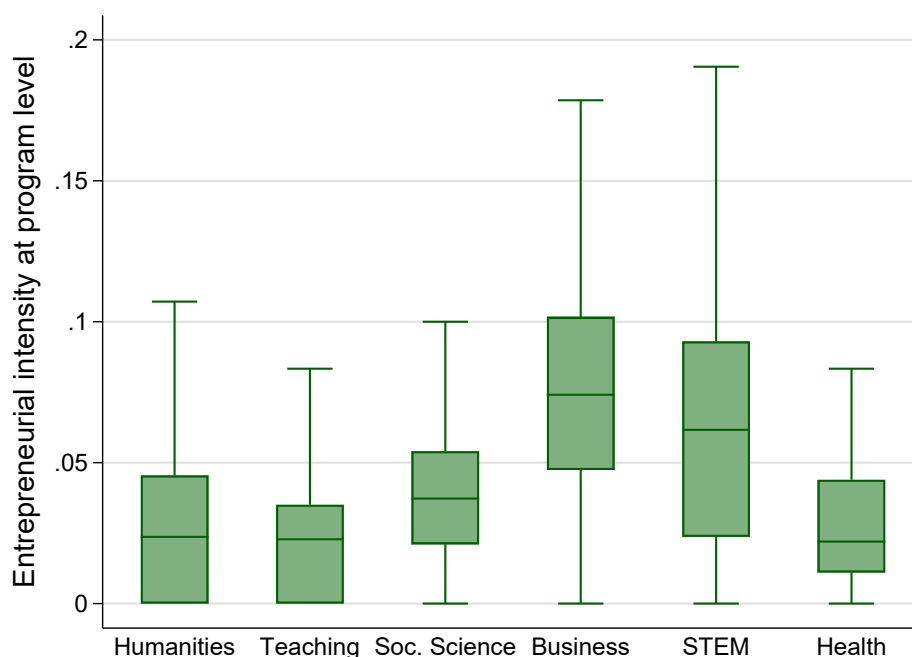


Figure 3: Variation in entrepreneurial intensity

Notes: This boxplot illustrates how the entrepreneurial intensity at the program level varies within and across fields. Entrepreneurial intensity is defined as the fraction who became entrepreneurs out of everyone enrolled in the program between 1998 and 2004. Outliers are excluded from the visual representation.

intensity compared to the less entrepreneurial program.

3.2.3 Outcome and treatments

Our outcome of interest is whether an individual meets the criteria for being classified as an entrepreneur, as defined in Section 2.1. To avoid conditioning on college completion, we allow for entrepreneurship to be measured at any time after admission.

Our analyses employ two definitions of treatment. The first treatment definition is the leave-one-out entrepreneurial intensity of the program an individual enrolls in.¹⁵ This allows us to utilize the information about the change in treatment intensity associated with crossing the threshold. As crossing the threshold might also be associated with changes to location, institution, or other characteristics that may affect subsequent business creation, we combine this measure with a second treatment definition, which is an indicator for whether the applicant enrolls in the more entrepreneurial of his first- and next-best program. The latter measure comes with a more straightforward exclusion restriction, at the cost of hiding some of the information from the continuous measure. We therefore use both measures throughout.

¹⁵For applicants who do not enroll in any program, the entrepreneurial intensity is set to 0.

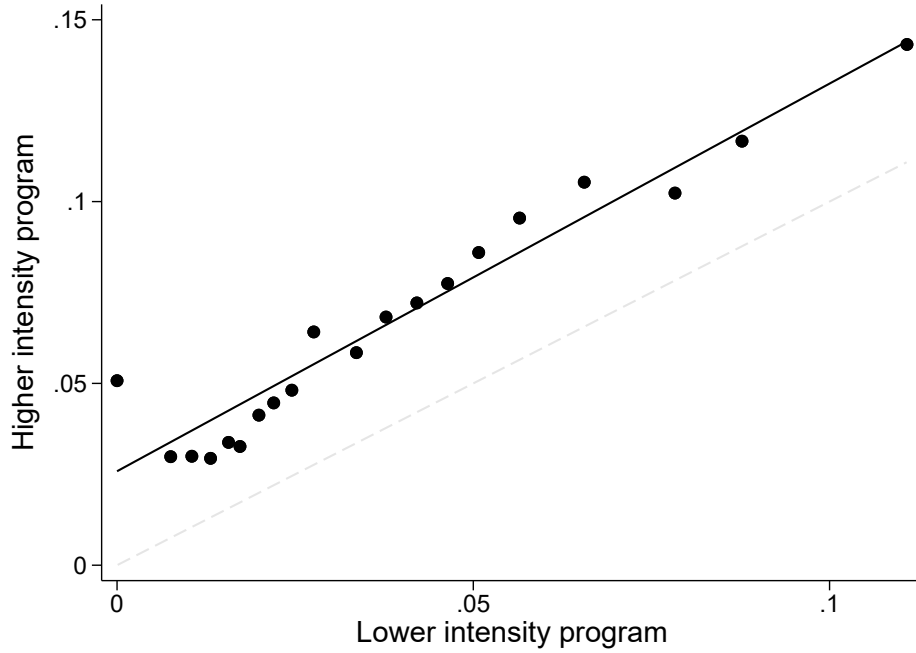


Figure 4: Margins in our estimation sample

Notes: This figure displays the margins in our CA sample. Intensity refers to the leave-one-out share of entrepreneurs among students ever enrolled in the program. Among the two programs a student in our sample is on the margin between, the Y-axis represents the intensity of the program with the highest intensity, and the X-axis represents the intensity of the program with the lowest intensity. The solid line displays the actual correlation. The dashed line indicates the 45 degree reference line. All data points will mechanically be weakly above the 45 degree line due to the definition of the axes.

3.2.4 Assumptions

Our regression discontinuity approach relies on some key assumptions. Firstly, the random assignment assumption requires that conditional on application scores, individuals who are predicted to receive offers from the more entrepreneurial program have the same potential treatment and outcomes as those not predicted to receive offers. Although this assumption is not directly testable, Figure A.2 shows that there is no sign that individuals can perfectly sort around the admission cutoff. Figure A.3 furthermore shows that background characteristics are balanced across the threshold.

Secondly, the exclusion restriction requires that any change in entrepreneurial outcomes associated with crossing the threshold operates solely through the change in treatment. Crossing the admission threshold might be associated with changes in many characteristics, including location and college quality, some of which could potentially affect entrepreneurial outcomes. For this reason, in addition to the entrepreneurial intensity of the program the individual enrolls in, we also use the binary treatment definition of whether the individual enrolls in the more entrepreneurial program throughout. The binary measure can be thought of as capturing the bundle of changes in characteristics,

thereby adhering to the exclusion restriction, at the cost of potentially hiding some of the information from the treatment intensity measure.

The design also relies on the presence of a first stage as well as a monotonicity assumption. By nature, the first stage relationship between crossing the threshold and the program enrollment is strong since the threshold determines whether an offer is made. We also test this below. Monotonicity requires that receiving an offer from the more entrepreneurial program does not make an individual less likely to enroll in that program than if the individual received an offer from another program. This is arguably mechanically satisfied due to the admission process.

4 Entrepreneurial returns to college

We begin by establishing that the measure of the entrepreneurial activity level of the college environment is positively correlated with the probability that a given individual becomes an entrepreneur. Figure 5 shows a strong positive relationship between the entrepreneurial intensity of the program a student enrolled in and the subsequent entrepreneurship.¹⁶ The coefficient is reported in Column (1) of Table 3. On average, enrolling in a program where 1 pp. more students become entrepreneurs is associated with an increase of 0.34 pp. in the probability that one oneself becomes an entrepreneur.

Table 3 displays how the OLS coefficient changes when we gradually include more control variables. Columns (2) and (3) show that the coefficient on the entrepreneurial intensity shrinks to 0.131 when we include fixed effects for the preferred program, and to 0.064 when we additionally include fixed effects for the second best program, consistent with preferences explaining a sizeable portion of the relationship in Figure 5. Further inclusion of application year fixed effects in Column (4) or background control variables for gender, age, or being born outside of Norway in Column (5), however, do not substantially alter the estimated relationship between the entrepreneurial intensity of the program an individual enrolls in and subsequent entrepreneurship. Even when extensively controlling for educational preferences and background characteristics, the OLS coefficient suggests that the college environment plays a role in determining entrepreneurship.

To understand how much of this relationship is causal, we next turn to analysing effects of crossing the threshold to the more entrepreneurial program in the regression

¹⁶Mathematically, the group average of the leave-self-out mean equals the group mean. The relationship in Figure 5 is, however, not mechanical, as both sample and definitions differ between the axes. The Y-axis measures entrepreneurship that takes place after applying to college among first-time applicants to college 1998-2016. The X-axis measures entrepreneurship that takes place at any point relative to college application for cohorts who enrolled in college 1998-2004, irrespective of whether they had applied before.

Figure A.1 presents the same figure excluding application cohorts before 2005, eliminating the possibility of any mechanical relationship between the two measures. The estimated relationship is almost identical.

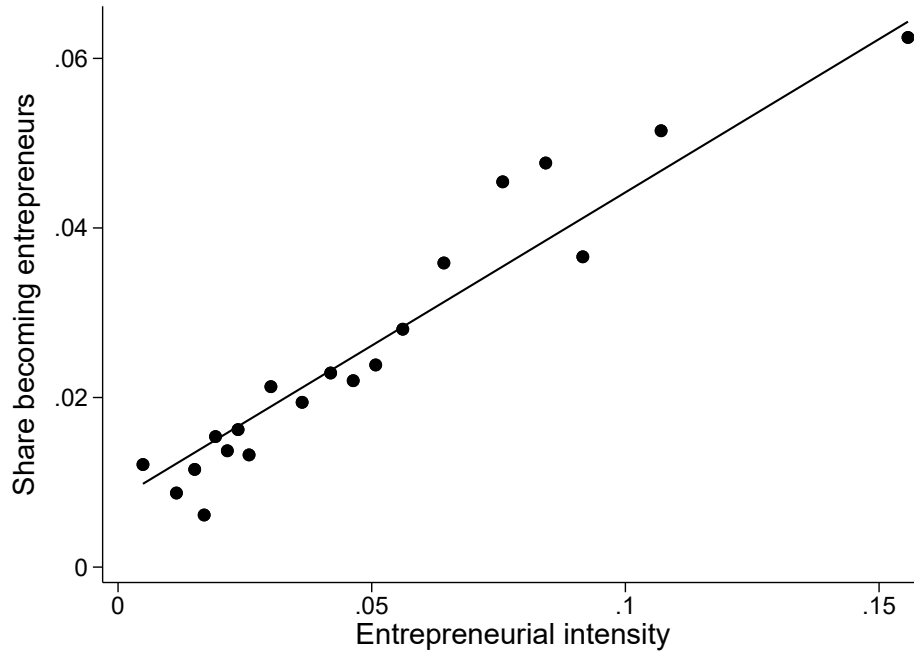


Figure 5: Entrepreneurial intensity in college and subsequent entrepreneurship

Notes: The Y-axis measures the share of first-time applicants in the period 1998-2016 becoming entrepreneurs after enrolling in a given program. The X-axis measures entrepreneurial intensity in the program they enrolled in. Entrepreneurial intensity is the leave-self-out share of entrepreneurs among all students enrolled in the program 1998-2004, not restricting to first-time applicants, and not restricting to post-enrollment entrepreneurship.

Table 3: The OLS effect of a more entrepreneurial college environment

	Becomes entrepreneur				
	(1)	(2)	(3)	(4)	(5)
Entrepreneurial intensity	0.336*** (0.0151)	0.131*** (0.0225)	0.0635* (0.0251)	0.0631* (0.0249)	0.0672** (0.0248)
Preferred program fixed effects	No	Yes	Yes	Yes	Yes
Second best program fixed effects	No	No	Yes	Yes	Yes
Application year fixed effects	No	No	No	Yes	Yes
Individual characteristics	No	No	No	No	Yes
Observations	137,087	137,057	136,984	136,984	136,984

Notes: The table presents estimated coefficients (standard errors in parentheses) from OLS regressions in the CA sample where the outcome is whether an individual becomes an entrepreneur after the application year, and the treatment is the entrepreneurial intensity of the program the individual enrolls in. Only individuals who enroll in college are included. Individual characteristics are the applicant's gender, age in the application year, and a categorical variable for whether the individual is born abroad. Standard errors are clustered at the individual level.

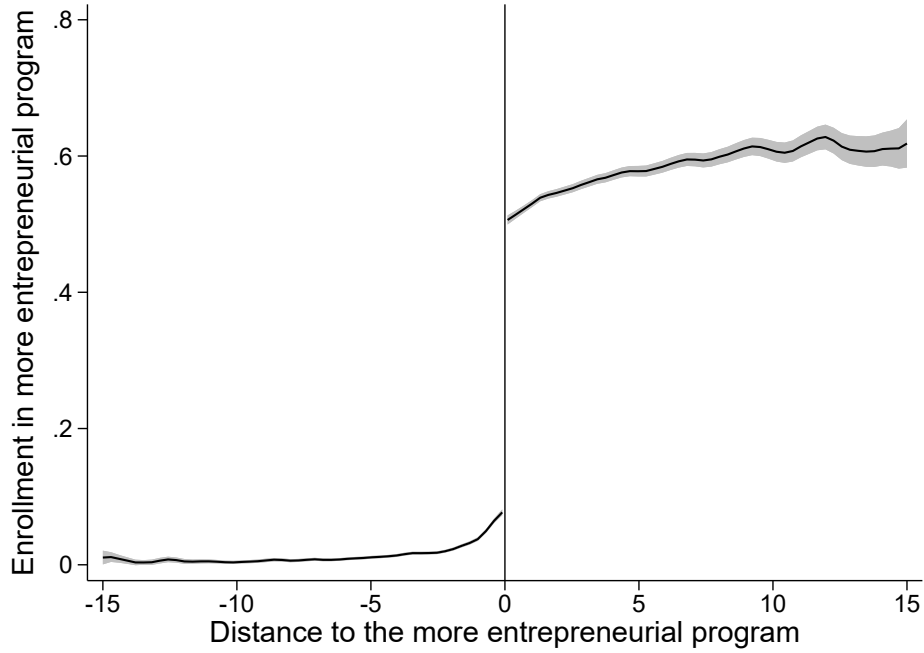


Figure 6: First stage. Enrollment in the more entrepreneurial program

Notes: The figure illustrates the first stage effect of crossing the admission threshold to the more entrepreneurial program, out of the two the applicant is on the margin between, on enrollment in that program.

discontinuity framework laid out above. We start out by documenting that there is a strong first stage relationship between our instrumental variable and our two treatments.

First, we illustrate the link between our instrument and the binary treatment: whether the individual enrolls in the more entrepreneurial program. Figure 6 shows that crossing the admission threshold to the more entrepreneurial of two programs increases the probability that the applicant enrolls in this program by approximately 45 pp.¹⁷ Columns (1) and (2) of Table A.2 presents the estimated first stage coefficient and the associated F-statistic, with and without the inclusion of program fixed effects. Across both specifications, the F-statistic confirms that the instrument is very strong.

Next, we illustrate the relationship between our instrument and the second treatment: the entrepreneurial intensity of the program in which an applicant enrolls. Applicants crossing the threshold experience a pronounced change in entrepreneurial environment. Figure 7 show that applicants just above the threshold enter programs where the entrepreneurial intensity averages approximately 3.7 percent, an increase of almost 60 percent compared to applicants immediately below the cutoff.¹⁸ Again, the associated

¹⁷The relatively low take up of offers in this setting is well-known (Kirkeboen et al. 2016) and driven in part by restricting the sample to first-time applicants only, as many high school graduates take a gap year before applying to college again.

¹⁸The slopes to the right of the threshold vary between the two treatments because program composition changes along the X-axis of both figures.

Although applicants far above the cutoff are more likely to take up the offer from the more entrepreneurial

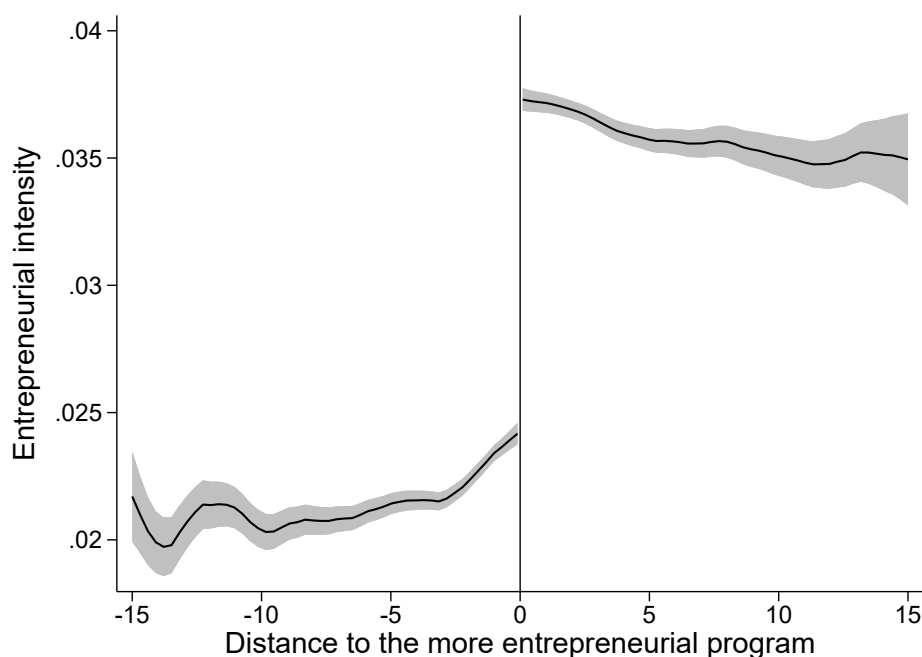


Figure 7: First stage. Entrepreneurial intensity of the college environment

Notes: The figure illustrates the first stage effect of crossing the admission threshold to the more entrepreneurial program, out of the two the applicant is on the margin between, on the entrepreneurial intensity of the program the applicant enrolls in. For applicants who do not enroll in any program, the entrepreneurial intensity is set to 0.

F-statistic, displayed in the middle panel of Table A.2, shows that the instrument is very strong.

Having established that crossing the threshold to the more entrepreneurial program leads to a significant change in the college environment in terms of entrepreneurial intensity, we next ask whether this increased exposure to entrepreneurship translates into a higher probability of creating a business.

Figure 8 displays the share of college applicants who later become entrepreneurs by their distance to the more entrepreneurial program. When interpreting the figure, it is important to keep in mind that the program composition, and thereby also other determinants of entrepreneurship, varies along the X-axis. The figure shows that crossing the admission threshold of the more entrepreneurial program leads to a reduced form increase of approximately 0.5 pp. in the probability of creating a business. Compared to applicants immediately to the left of the cutoff, this represents an increase of more than 10 percent.

Given that the reduced form relationship measures the intention to treat effect among all applicants admitted to a program, rather than among those who actually enroll,

program than applicants closer to the cutoff, they do not necessarily enroll in the same programs as applicants just above the cutoff. The average intensity need therefore not increase even though take up increases along the axis.

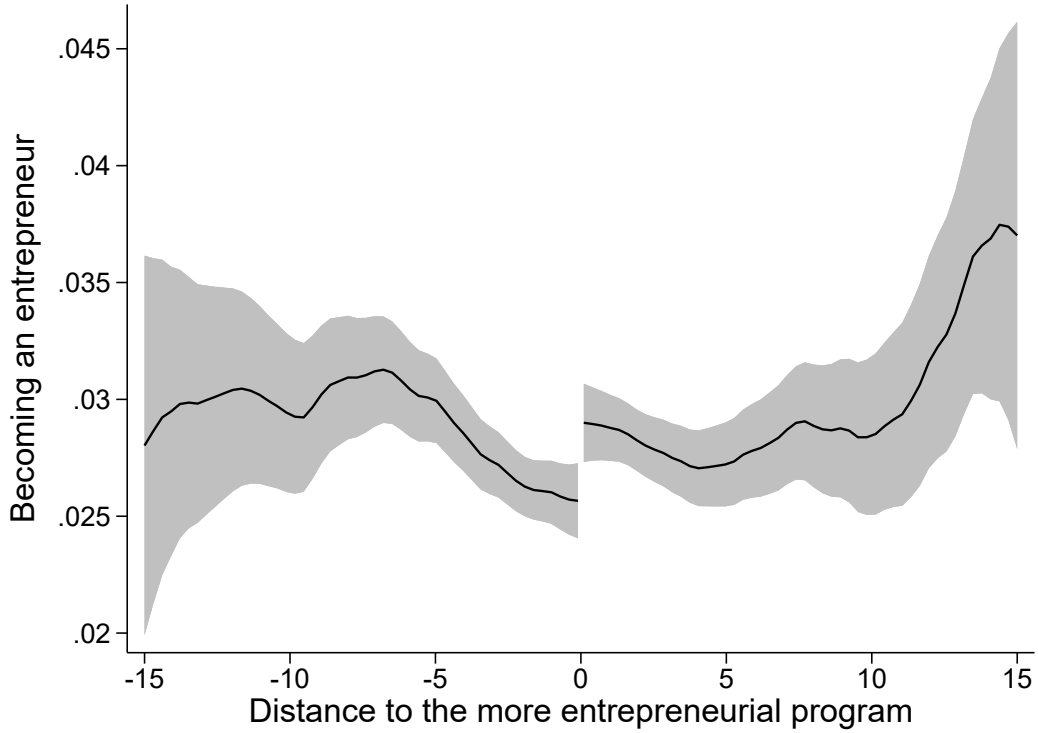


Figure 8: Reduced form

Notes: The figure illustrates the reduced form effect of crossing the admission threshold to the more entrepreneurial program, out of the two the applicant is on the margin between, on the probability that the applicant becomes an entrepreneur later in life.

the visual increase in entrepreneurship at the cutoff significantly understates the local average treatment effect (LATE) of a higher entrepreneurial activity level in college. Next, we study the effect of the two treatments, instrumented by whether the applicant exceeds the cutoff to the more entrepreneurial program.

Table 4 shows the estimated 2SLS coefficients. Column (1) and (2) represent regressions where we instrument for enrollment in the more entrepreneurial program among the two an individual is on the margin between. As discussed in Section 3.2.3, this approach does not distinguish between individuals who experience a sizeable change in the college environment when they cross the threshold to the more entrepreneurial program, and individual who experience only a small change. Column (3) and (4) therefore represent regressions where we instrument for the entrepreneurial intensity of the program the individual enrolls in. Across both instrumental variable approaches, we find that the college environment has a sizeable effect on the probability of becoming an entrepreneur.

The first two columns show that enrolling in the more entrepreneurial program on average increases the probability of entrepreneurship by more than 1 pp. This estimate is very similar across the specification without program fixed effects (Column 1) or with program fixed effects (Column 2). The estimated effect represents a sizable increase

Table 4: The effect of a more entrepreneurial college environment

		Becomes entrepreneur			
		(1)	(2)	(3)	(4)
Treatment:	Enrollment in the more entrepreneurial program	0.0111*** (3.43)	0.0116*** (3.56)		
Treatment:	Entrepreneurial intensity of the program			0.369*** (3.42)	0.387*** (3.56)
Program fixed effects		No	Yes	No	Yes
Observations		235,694	235,713	235,694	235,713

Notes: The table presents estimated coefficients (*t*-statistics in parentheses) from 2SLS regressions. The outcome is a binary indicator for whether the individual becomes an entrepreneur after the application year. The instrument is a binary indicator for whether the application score of an individual exceeds the admission cutoff of the more entrepreneurial program out of the two programs the individual is on the margin between. The first row presents estimated coefficients when instrumenting for enrollment in the more entrepreneurial program. The second row presents estimated coefficients when instrumenting for the entrepreneurial intensity of the program the individual enrolls in. All specifications include a quadratic spline for the distance to the more entrepreneurial program. Standard errors are clustered at the individual level.

from the baseline probability of approximately 2.5 percent at the cutoff.

Turning to the specifications where we instead instrument for the entrepreneurial intensity of the program an individual enrolls in, Column (3) shows that a 1 pp. increase in the entrepreneurial intensity of the college environment increases the probability of business creation by almost 0.4 pp. The estimate is comparable when we include program fixed effects in Column (4).

Taken together, these estimates suggest that the college environment plays a significant role in shaping entrepreneurship.

5 Conclusion

The significance of entrepreneurship as an important driver of innovation and economic growth has long been recognized by economists. While education is a potential tool to enhance entrepreneurship, we know little about how college education affects entrepreneurship.

In this paper, we provide novel empirical evidence on how entrepreneurship rates vary with the college environment, and shed light on the causal effect of college on entrepreneurship.

We document that there is little average difference in the probability of becoming an entrepreneur between individuals with and without college education. Among individuals with college education, however, the probability of becoming an entrepreneur varies

substantially with college field. Whereas entrepreneurship is relatively common among former students of business or STEM education, entrepreneurship rates among former humanities or teaching students are lower than in the population without any college education.

We proceed to estimating the causal effect of the college environment on entrepreneurship by leveraging unpredictable admission cutoffs in the Norwegian college admission system. Our evidence suggests that marginally enrolling in a program with more entrepreneurial activity, measured as the share of former students engaged in entrepreneurship, significantly increases the probability that an individual goes on to create a business.

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A Appendix Tables and Figures

A.1 Tables

Table A.1: Descriptive Statistics for BC Sample

	(1) BC sample overall	(2) Individuals with some college
Share with some college education	0.483	
Share with completed college	0.397	
<i>College fields (%)</i>		
Humanities		16.47
Teaching		13.13
Social science		11.03
Business		21.23
STEM		20.33
Health		17.82
Observations	1,711,160	826,462

Notes: Column (1) presents key variable means for the full population of individuals born in Norway 1959-1988 ("BC sample"). Column (2) presents relative frequencies of college fields for individuals in the BC sample who are recorded as having enrolled in higher education in the Norwegian Education Database (NED).

Table A.2: First Stage and Reduced Form Coefficients

	Treatment: Enrolls in the more entrepreneurial program		Treatment: Entrepreneurial intensity of the program		Outcome: Becomes entrepreneur	
	(1)	(2)	(3)	(4)	(5)	(6)
Exceeds cutoff	0.451*** (129.69)	0.451*** (128.67)	0.0136*** (42.53)	0.0135*** (37.62)	0.005*** (3.43)	0.005*** (3.56)
Program fixed effects	No	Yes	No	Yes	No	Yes
Mean at LHS of cutoff	0.0561	0.0573	0.0229	0.0241	0.0245	0.0244
F-statistic	21485.1	23120.5	1812.4	1604.2	5.390	4.982
Observations	235,694	235,713	235,694	235,713	235,694	235,713

Notes: The table presents estimated coefficients (*t*-statistics in parentheses) for the effect of crossing the admission cutoff to the more entrepreneurial program among the two programs an individual is on the margin between, on (Columns 1 and 2) the probability of enrolling in that program, (Columns 3 and 4) the entrepreneurial intensity of the program the individual enrolls in, and (Columns 5 and 6) the probability of becoming an entrepreneur after the application year. Effects are estimated using a quadratic spline for the distance to the more entrepreneurial program. Standard errors are clustered at the individual level.

A.2 Figures

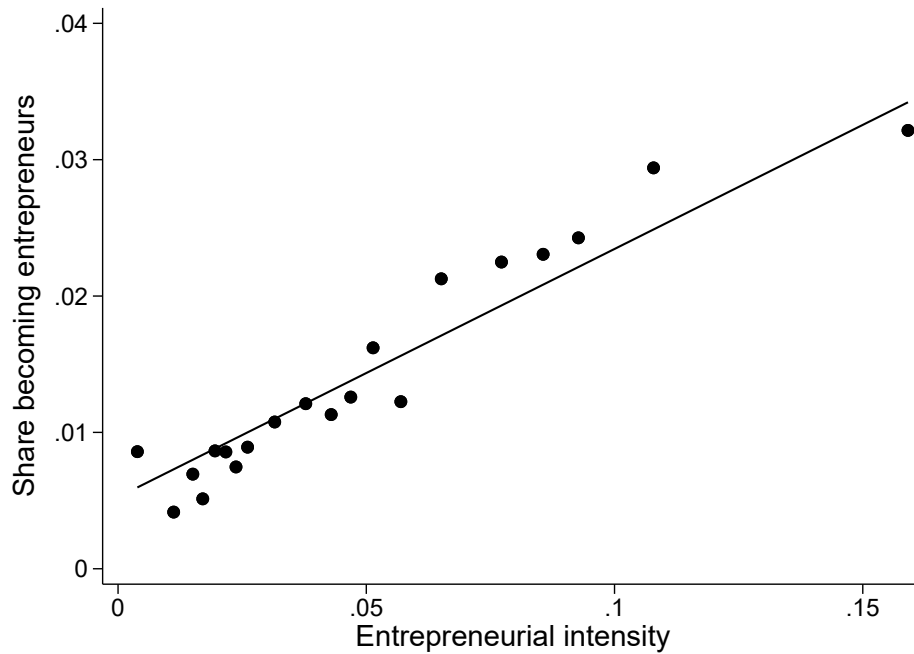


Figure A.1: Entrepreneurial intensity in college and subsequent entrepreneurship for application cohorts 2005 and later

Notes: The Y axis measures the share of first-time applicants in the period 2005-2016 becoming entrepreneurs after enrolling in a given program. The X axis measures entrepreneurial intensity in the program they enrolled in. Entrepreneurial intensity is the leave-self-out share of entrepreneurs among all students enrolled in the program 1998-2004, not restricting to first-time applicants, and not restricting to post-enrollment entrepreneurship.

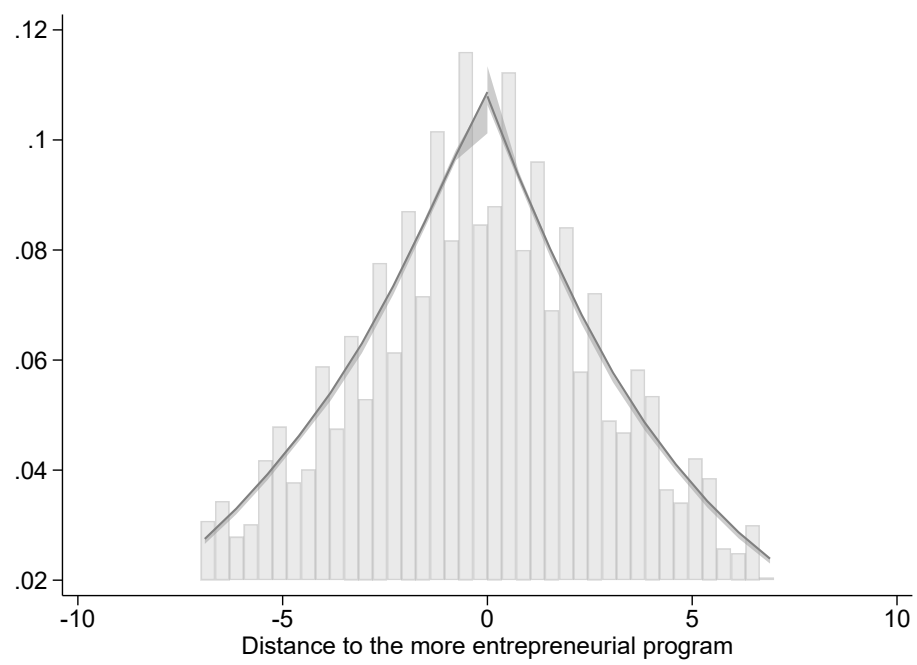
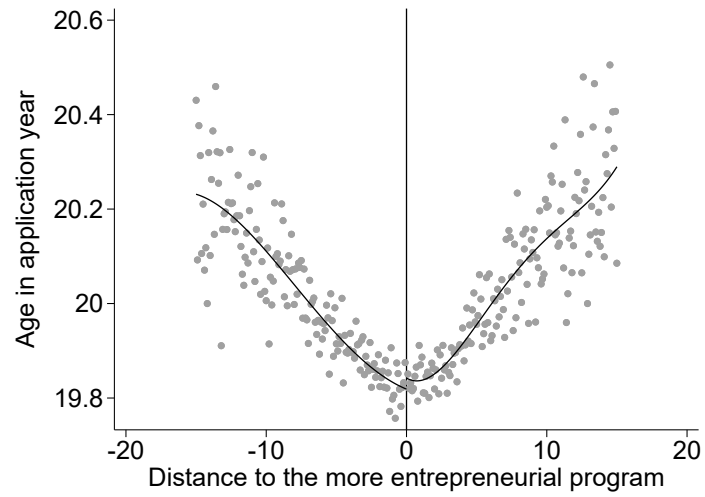
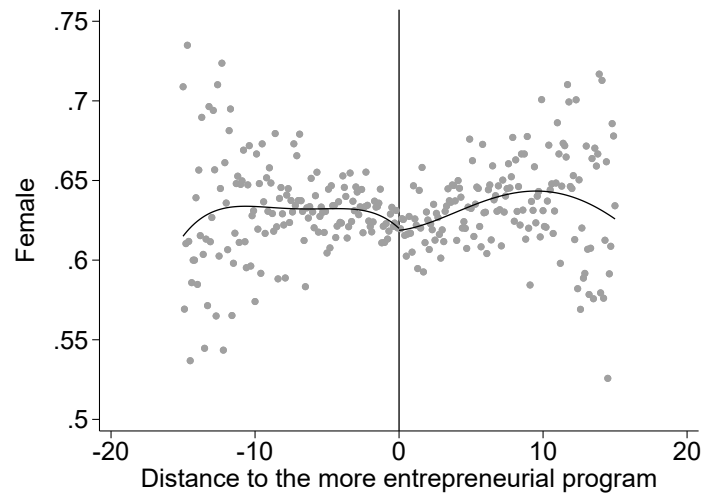


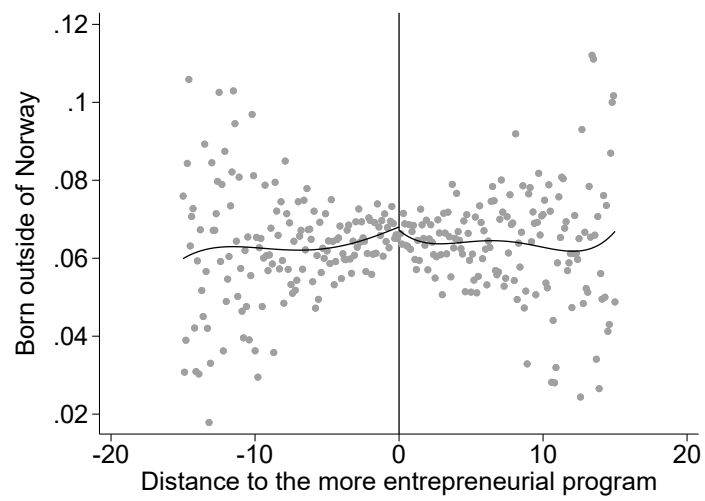
Figure A.2: Density check



(a) Age of applicant



(b) Probability that applicant is female



(c) Probability that applicant is foreign-born

Figure A.3: Balancing checks