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The Returns to Field of Study in College: A Comparison Between Entrepreneurs and Wage-Workers

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Abstract. The different returns to formal education for entrepreneurs and wage-workers is a widely studied topic, yet little is known about the effects of specific educational training (i.e., field of study) on entrepreneurial earnings. In this study, we use panel data from the National Longitudinal Survey of Youth 1997 to compare the returns to field of study between entrepreneurs and wage-workers among individuals who attended college in the United States. We distinguish between individuals with a major in Business/Economics, Natural Sciences, Technology/Engineering, and Other fields. The empirical results show that entrepreneurs earn on average less than wage-workers, but the returns to field of study are not different between entrepreneurs and wage-workers. For both occupational groups, individuals with a major in Business/Economics or Technology/Engineering earn more than those with a major in Natural Sciences, and Other fields. We also analyze the relationship between returns and field of study separately for males and females and find a bigger income gap between entrepreneurs and wage-workers for women compared to men. We also find evidence that the income gap between men and women increases fast after leaving college.

Keywords: earnings, entrepreneurship, field of study, gender gap, income, performance, returns to education.

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1. Introduction

Individuals attend college and choose fields of study to acquire skills and qualifications that prepare them for their future life and career. Having a college degree positively influences the intention to start a business (Arenius and Minniti, 2005; Blanchflower, 2004), the confidence in having the required skills to start a

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business (Koellinger, Minniti, and Schade, 2007) and the chance of business survival (Van der Sluis et al., 2008). However, college degrees also provide individuals with attractive wage-work opportunities (Kher et al., 2012). In fact, considering business and employment survival, Asoni and Sanandaji (2016) find that wage workers benefit more from college education than self-employed workers. On the other hand, considering earnings, Van Praag et al. (2013) find the returns to formal education to be higher for entrepreneurs than for wage-workers. What is not yet known, is whether field of study impacts these differential returns for college-educated entrepreneurs and wage-workers.[2] This is the topic of the present paper.

Graduates from different college majors possess different qualities (i.e., skills) and different employment intentions. For example, 4% of the Harvard Business School 2014 graduates became entrepreneurs (HBS, 2016), as compared to 14% of M.I.T. graduates (Roberts, Murray, and Kim, 2015). Robst (2007) finds that graduates from majors that emphasize general skills have a higher likelihood of job mismatch, which lowers their returns to education. By comparing the change in sales, Douglass (1976) shows that entrepreneurs who studied Life Sciences are more successful in their business three years after graduation than entrepreneurs who studied other disciplines in college. However, entrepreneurs who studied Engineering are more successful five years after graduation than entrepreneurs with other fields of study. It is unclear whether these differences are statistically significant though. Moreover, these relationships may have changed during the last 40 years.

There is no lack of research that compares the returns to education between wage-workers and entrepreneurs (e.g., Robinson and Sexton, 1994; Burke et al., 2000; Van der Sluis et al., 2008; Parker, 2009; Block et al., 2012; Van Praag et al., 2013; Iglesias et al., 2016). Research on the returns to field of study, within the subgroup of higher educated labor force participants is more scarce, though (e.g., Robst, 2007; Kelly et al., 2010; Kucel et al., 2016). As Iglesias et al. (2016) indicate, studying the returns to field of study among higher educated *entrepreneurs* has hardly been attempted in previous studies. Although several papers specifically focus on the effects of entrepreneurship education programs on various entrepreneurial outcomes (e.g., Kolvereid and Moen, 1997; Dickson et al., 2008; Oosterbeek et al., 2010), to our knowledge the earlier mentioned study from 1976 is the only one that explores the relation between the field of study (i.e., major field of study for college graduates) and entrepreneurial success (Douglass, 1976).

By analyzing longitudinal data (2002-2011) from the National Longitudinal Survey of Youth 1997 (NLSY97), we estimate the returns to field of study in entrepreneurship and wage-work by comparing post-graduation earnings of college graduates. Our findings contribute to the understanding of the returns to

2. In the remainder of this paper, the term ‘returns’ refers to returns in terms of income/earnings.

education, but also to the debate about the purpose of higher education. Some economists argue that higher education is purely about signaling, where education is used to demonstrate one's underlying level of talents to future employers (Van der Sluis et al., 2004), while others (Verhaest et al., 2015) argue that higher education is about skill building (i.e., learning). If the returns to education differ per field of study (not only in wage-employment but also in entrepreneurship), it shows the importance of skill building in higher education. If not, then the type of skills learned (i.e., field of study) is apparently less important for future earnings than the ability of obtaining a college degree as such (in accordance with the signaling hypothesis).

This paper is structured as follows: In section 2, we draw on the existing literature on the returns to education and the role of field of study among wage-workers and entrepreneurs to develop our hypotheses. Section 3 presents data and methodology, Section 4 presents our empirical results and Section 5 concludes.

2. Literature Review

In this section, we first discuss the returns to higher education among wage-workers and entrepreneurs. Next, we investigate the impact of higher education by elaborating on the role of field of study. This section concludes with the formulated hypotheses.

2.1. Returns to Higher Education: Wage-Workers versus Entrepreneurs

Human capital theory states that skills and knowledge relevant to performing labor can be gained through education and experience to produce economic value (cf., Van Praag et al., 2013). Education is often used as a proxy for human capital (e.g., Koellinger, Minniti, and Schade, 2007). Thus, achieving higher education can be seen as an investment in human capital. Even though higher education systems differ between countries, it provides skills and trainings to prepare students for the job market. Studies find strong evidence supporting the positive relationship between levels of education and income, for both wage-workers and entrepreneurs (Dickson et al., 2008; Robinson and Sexton, 1994), but the relative effect seems to vary with Burke et al. (2000) finding the effects stronger for wage-workers in the UK while Van Praag et al. (2013) finding the opposite for the USA.

College students gain specific knowledge, critical thinking skills, problem solving skills and other professional skills during the process of completing their degree. In wage-work, this makes that productivity levels of college graduates are on average higher than those of people without a college degree (Haltiwanger, Lane and Spletzer, 1999). Among entrepreneurs, educational attainment has also been positively linked to start-ups' survival rate (Bates, 1990), job creation

(Burke et al., 2000), firm growth (Kangasharju and Pekkala, 2002), earnings (Van Praag et al., 2013), rate of innovation (cf. Dickson et al., 2008) and access to capital (Coleman, 2007). Having more access to capital explains one of Reynolds et al.'s (1994) findings: Founders with university education make higher investments in their business than non-academic entrepreneurs, which may subsequently influence business performance.

2.2. The Role of Field of Study: Wage-Workers versus Entrepreneurs

Robst (2007) argues that the choice of major implies an investment in specific knowledge and skills necessary to enter a profession related to the chosen degree. He examines the returns to education among wage-workers from different fields of study. For high returns, a good match between field of study and later occupation is important, but 47% of workers report that their job is only partially related or not related to their field of study. Individuals with majors such as English and Foreign Languages, Liberal Arts, and Humanities studies are more likely to have job mismatches, which means that their returns to education are comparatively lower than for individuals with other majors. This is in line with Kucel et al.'s (2016) findings: Humanities' graduates are more likely to have a mismatched job than Social Sciences graduates, because Humanities graduates possess oratory skills that are less applicable for today's technological-driven economy. Robst (2007) also finds that individuals with masters, professional, or doctoral degrees are less likely to be mismatched than bachelor's degree recipients.

Pascarella and Terenzini (2005) also analyze the returns to field of study amongst wage-workers and stress the importance of specific knowledge and skills obtained in the college major for earnings: females who studied Business or Health-related subjects earn more than those who studied Humanities or Education. Males who studied Engineering, Public Service, or vocational-technical areas earn more than those who studied Humanities or Education. The largest earnings accrue to majors characterized by a relatively specific and well-defined body of content knowledge and skills, such as Engineering, Business-accounting, Physical Sciences, etc. A recent report by Looksharp (2015) finds that Computer Science graduates have on average the highest starting salary, followed by graduates in Engineering, Mathematics, Economics and Finance. However, it is yet to be determined if Pascarella and Terenzini's (2005) findings also apply to entrepreneurs, as existing literature offers only few insights among entrepreneurs with different majors. For example, while most start-ups have negative returns at the beginning, Gort and Lee (2007) find that some graduates who studied Sciences and Engineering have positive returns. Moreover, looking at the change in sales over five years, Douglass (1976) finds that entrepreneurs who studied Engineering outperform entrepreneurs with all other majors.

Business and Economics graduates are more likely to be exposed to entrepreneurial trainings than graduates from other fields. Matlay (2008) defines entrepreneurial skills in the following eight categories: Creating and executing business strategy, understanding and accessing business risk, marketing, market research, financing, human resources, business planning and business idea development. Around 1950 only a few higher education institutes offered entrepreneurship courses. Fifty years later, the number of institutes with entrepreneurship education rose to more than 1,500 colleges and universities worldwide (Solomon et al., 2002). Solomon et al. (2002) argue what differentiates entrepreneurship education from business education is the focus of skill-building that is related to leadership, new product development and technological innovation. Dickson et al. (2008) state that entrepreneurship skill trainings increase students' ability to recognize venture opportunities as well as entrepreneurial self-efficacy. It has been shown that Business school graduates who took entrepreneurship courses have a higher propensity to become entrepreneurs (Matlay, 2008). Entrepreneurship education can also reduce start-up failure from inconsistent management accounting, funding gaps, law-related problems and indecisive leadership to insufficient market adjustment (Oehler, Hofer and Schalkowski, 2015).

However, an aggregated list of famous (i.e., successful) inventors and entrepreneurs through history by Baumol et al. (2009) shows that the vast majority of 'pure' entrepreneurs majored in Business/Economics or Engineering, while the list of 'inventor-entrepreneurs' (who are inventor and entrepreneur at the same time) is dominated by the Engineering field. Even though Engineering graduates may lack business-relevant skills, they possess an advantage in today's economy with their technical skills (Kucel et al., 2016). The strong labor market position of Engineering graduates is also confirmed by GUCEW (2015), who report that 16 different Engineering majors are in the top-25 of majors with the highest wages.

Kucel et al. (2016) investigate entrepreneurial skills and job matching among graduates, and find that some young graduates often receive purely academic training in universities, which creates a significant gap in business-relevant skills. Another finding worth noting from Kucel et al. (2016) is that entrepreneurial skills are important for a good (wage job) match even when fields of study are controlled for. Thus, entrepreneurship training is not only beneficial for entrepreneurs, but also for wage-workers. For this reason, Business and Economics graduates may have an advantage in both wage-work and entrepreneurship. Nevertheless, as Engineering and Business and Economics majors are overrepresented in Baumol et al.'s (2009) list of fields of study of a selection of 'superstar' (inventor-) entrepreneurs, it seems plausible to assume that entrepreneurial or engineering skills are best exploited in a job as entrepreneur.

Taking all above arguments into consideration, we formulate the following two hypotheses:

1. Individuals who studied Business/Economics or Technology/Engineering earn more than those who studied Natural Sciences, or all other majors.

2. This earnings differential is larger in entrepreneurship than in wage-work.

3. Methodology

3.1. Data

The National Longitudinal Survey of Youth 1997 is an ongoing nationally representative panel survey of youth that began in 1997, and data are collected from 8,984 individuals in the United States through interviews and surveys every year.[3] NLSY97 is advantageous for our hypothesis testing as it contains detailed data on individuals' former education (field of study and level of educational attainment), employment status, and income. To obtain larger amounts of information and to observe the changes in income, we use panel data instead of cross-sectional data. We choose to include the most recent 10 years of data (from 2002 to 2011) as most individuals do not have a college education and/or income before 2002. That is, the age of the surveyed individuals ranges between 18 and 22 in 2002, and between 27 and 31 in 2011. The use of a sample with a relatively small time gap between education and labor force participation has the advantage that the estimated relationship is more likely to reflect skills gained from former education.

We use self-employment as a proxy for entrepreneurship as it is the most commonly used indicator for entrepreneurship (Parker, 2009). This also facilitates the comparison of our results with future studies on this topic, because data on self-employment are more readily available in most countries than other entrepreneurship measures.

We use the last reported highest degree achieved to determine the education level of the participants, and find that 34% of the total sample obtained a post-secondary or higher degree. About 26% of the total sample reported to have a declared major, but no post-secondary degree was ever achieved. As most universities require their students to declare a major at the end of their first year, we assume those individuals who reported to have a major in college have at least a year of college experience, and are included in the analysis as drop-outs. In total, there are 60% of individuals who have at least some college. Since we are only

3. See https://www.nlsinfo.org/content/cohorts/nlsy97

interested in the effect of college major on wage-workers' and entrepreneurs' income, individuals who do not have at least some college education, or have no reported income or employment status are excluded from the analysis.

3.2. Dependent Variable

To measure entrepreneurial success, we use income as the outcome of interest in this analysis. Total annual income includes an individual's wages before tax deduction and income received from an individual's business after expenses for the past 12 months. Missing values in income data may be caused by various reasons: some individuals may not wish to disclose their income, some may be unemployed, not yet graduated (no full time income), or may not know the exact amount of their income. To ensure the validity of the dependent variable *Income*, we exclude income that is reported before graduation (or drop-out), i.e., we focus on post-college earnings. Given the skewness in the distribution of our dependent variable *Income*, this variable is log-transformed.

3.3. Main Independent Variables

Our main independent variables are *Self-employed* and the various fields of study (college majors). If an individual is self-employed in a given year, it is coded as 1 in *Self-employed,* and 0 otherwise. Around 11% of the sample is self-employed. Forty-nine majors are recorded in NLSY97, which are divided into four categories in this paper: Business/Economics (*BUS)*, Natural Sciences (*SCIENCES*), Technology/Engineering (*TEC)*, and the remaining majors (*OTHERS*). Other than the general subjects, related majors are also included in Business/Economics, Technology/Engineering, and Natural Sciences. For example Management and Marketing are included in *BUS*, and Medical Sciences and Health professions programs are included in *SCIENCES. OTHERS,* which is the largest category among the four, includes for example Law, Journalism, Psychology, and Humanities studies. A detailed classification is available from the authors upon request.

3.4. Control Variables

In addition to the four categories of majors, we also include some other variables to control for their effects: *Female, Drop-outs, Year*, *Time after graduation or dropout* and *Student loans*. Women typically earn less than men (Marini and Fan, 1997), hence we expect a negative sign for variable *Female*. Regarding drop-outs, individuals who reported to have a college major but without ever achieving a

college degree in the sample are considered drop-outs, and we find around half of the sample attended college without reporting having a completed college degree (see Table 1). A report by Shapiro et al. (2014) suggests that the high drop-out rate in the United States is not unusual due to student's financial ability and motivation. In spite of various famous examples of hugely successful entrepreneurs who dropped out of college to pursue a profit opportunity (e.g., Bill Gates, Mark Zuckerberg and Steve Jobs), in general *Drop-outs* may be expected to earn less than graduates finishing their college education, hence the expected sign for this variable is negative. A set of *year* dummies is included to control for business cycle effects. *Time after graduation or dropout* measures the number of years since leaving college and captures experience. Each additional year of time after leaving their education may have a positive effect on income for both wage-workers and entrepreneurs. *Student loans* may influence income as graduates with high debts will be forced into jobs that pay high in the short term (so that they can pay off their debt more quickly), even if they would prefer lower paid jobs with better long-term career prospects (Choi, 2014). Table 1 presents the definitions and descriptive statistics for all model variables.

Table 1: Descriptive statistics of the analysis sample. The *p*-value results from a test for differences in the mean of the variables between wage-workers and entrepreneurs.

		Wage-workers (N = 22,321)		Entrepreneurs (N = 2,366)		*p*-value
	Description	**Mean**	**SD**	**Mean**	**SD**	
Dependent variable						
Income	The logarithm of yearly income in dollars	9.83	1.04	9.78	1.24	0.03
Independent variables						
Business/Economics (BUS)	1 if field of study is Business or Economics, 0 otherwise	0.22	0.41	0.22	0.41	0.36
Technology/ Engineering (TEC)	1 if field of study is Technology/ Engineering, 0 otherwise	0.12	0.32	0.12	0.32	0.74
Natural Sciences (SCIENCES)	1 if field of study is Natural Sciences, 0 otherwise	0.16	0.37	0.11	0.32	<0.01
Other fields (OTHERS)	1 if field of study is not Business/ Economics, Technology/ Engineering, or Natural Sciences, 0 otherwise	0.50	0.50	0.55	0.50	<0.01
Control variables						
Female	1 if female, 0 if male	0.52	0.50	0.45	0.50	<0.01
Drop-out	1 if uncompleted college education, 0 otherwise	0.55	0.50	0.52	0.50	<0.01
Time after graduation or dropout	Number of years after leaving college	4.67	2.76	5.10	2.74	<0.01
Student loan	Total sum of student loans in dollars	3,787	7,313	3,478	7,279	<0.01

3.5. Statistical Method

We analyze the possibly different relations between college majors and income for entrepreneurs and wage-workers by using a set of dummies for the four majors in combination with a set of interaction terms of the four majors with self-employment.[4] While the coefficients of the majors will show the main effect of these majors on income (holding for both entrepreneurs and wage-workers), the coefficients of the interaction terms will show if the relationship between income and field of study is different for entrepreneurs, i.e., they show the additional effect on income of a certain major for self-employed (relative to wage-workers). We perform pooled OLS with standard errors clustered on the individual level to investigate the association between field of study and earnings among college-educated individuals. We also perform a random effects regression. A Breusch-Pagan test is used to conclude which model is preferred. Because our main independent variables are time-invariant, the fixed effect estimator is not considered.

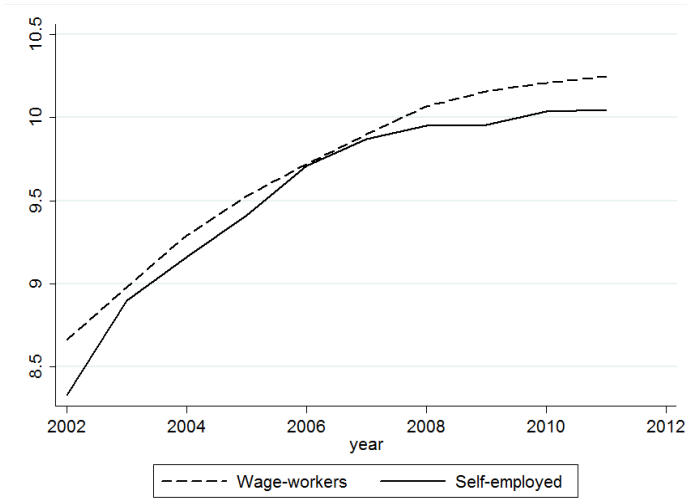
4. Results

4.1. Descriptive Statistics

After excluding individuals without any college experience, 4,623 individuals are included in total, which make up 24,687 observations for hypothesis testing. Table 1 provides descriptive statistics for the variables used in the analysis, along with *p*-values resulting from tests comparing the means of the variables between wage-workers and entrepreneurs. For income, the results show that on average wage-workers earn significantly more than entrepreneurs (the self-employed). This pattern is confirmed by Figure 1 showing the income trend for college-educated entrepreneurs and college-educated wage-workers. The figure shows that before the crisis, the income gap was closing, but that since 2008 the gap is increasing again.

4. Both for the main set and the interaction set we leave one Major category out to avoid full multicollinearity. To facilitate interpretation of the results in light of our hypotheses, we use Business/Economics as the reference category.

Figure 1: Mean income (in logarithms) for college-educated entrepreneurs and wage workers, 2002-2011



4.2. Estimation Results

Table 2 shows the results of our Pooled OLS models with standard errors clustered on the individual level (models 1 and 2) and Random Effects models (models 3 and 4). Models 1 and 3 in Table 2 show the coefficients of the regression models excluding the interaction terms of self-employed and field of study. These specifications enable testing of Hypothesis 1. Models 2 and 4 include those interaction terms, where *BUS* and *Self-employed x BUS* form the reference categories for the main effects and interaction effects, respectively. These specifications enable testing of Hypothesis 2.

Table 2: Regression results for college-educated entrepreneurs and wage-workers

	Pooled OLS		Random effects	
	(1)	(2)	(3)	(4)
Variables	**Ln(income)**	**Ln(income)**	**Ln(income)**	**Ln(income)**
SCIENCES[a]	-0.191***	-0.179***	-0.182***	-0.183***
	(0.035)	(0.035)	(0.037)	(0.038)
TEC	-0.017	-0.008	0.004	-0.0008
	(0.039)	(0.039)	(0.042)	(0.043)
OTHERS	-0.167***	-0.158***	-0.168***	-0.169***
	(0.028)	(0.027)	(0.029)	(0.030)
Self-employed	-0.166***	-0.097	-0.122***	-0.137***
	(0.038)	(0.069)	(0.020)	(0.043)
Self-employed x SCIENCES[b]		-0.142		0.015
		(0.128)		(0.071)
Self-employed x TEC		-0.082		0.053
		(0.130)		(0.071)
Self-employed x OTHERS		-0.082		0.012
		(0.087)		(0.050)
Student loan	-0.001**	-0.001**	-0.001***	-0.001***
	(0.001)	(0.001)	(0.001)	(0.001)
Female	-0.258***	-0.258***	-0.222***	-0.222***
	(0.022)	(0.022)	(0.023)	(0.023)
Time after graduation or dropout	0.061***	0.061***	0.058***	0.058***
	(0.006)	(0.006)	(0.006)	(0.006)
Drop-out	-0.526***	-0.527***	-0.577***	-0.577***
	(0.034)	(0.034)	(0.037)	(0.037)
Constant	9.356***	9.349***	9.278***	9.280***
	(0.044)	(0.044)	(0.042)	(0.042)
Observations	24,687	24,687	24,687	24,687
Individuals	4,623	4,623	4,623	4,623
R^2	0.241	0.241	0.286	0.286

a. Reference group: Business/Economics
b. Reference group: Self-employed x Business/Economics

Robust standard errors in parentheses.
Year dummies are included in the regression, but not reported.
*** $p<0.01$, ** $p<0.05$, * $p<0.10$

Although the two estimators produce similar results, a Breusch and Pagan Lagrangian multiplier test for random effects shows that the Random Effects estimator is preferred over Pooled OLS. Therefore, we use the results from the Random Effects estimator in models 3 and 4 to draw conclusions.

In model 3, the regression coefficients for *SCIENCES* and *OTHERS* are significantly negative, which means that individuals who studied Business or Economics (the reference category) perform better than those who studied Natural Sciences and all "other" majors. *Ceteris paribus*, they earn 18% more a year than those who studied Natural Sciences majors and 17% more than those who studied other majors. These outcomes are in line with Hypothesis 1. *TEC* is found to be insignificant, thus there is no difference between the incomes of individuals who studied Business or Economics and of those who studied Technology and Engineering. This outcome is also in line with Hypothesis 1, so we conclude that the first hypothesis is supported. The variable *Self-employed* shows that individuals who are self-employed in a given year earn 12% less than individuals who are not self-employed, while holding other variables constant. The lower income for the self-employed is a well-known finding in the entrepreneurship literature (Hamilton, 2000). We also note that the results for our control variables are according to expectations.

In model 4, all three interaction terms for field of study with self-employment are insignificant, which means that there is no additional income effect of choosing a certain field of study for entrepreneurs. In other words, the returns to field of study are not significantly different for entrepreneurs and wage-workers. Hence, hypothesis 2 is not supported.

As a robustness check, we estimated our model separately for men and women. Table 3 presents the results. We note that our main results are the same for men and women: For both gender groups, individuals with a major in Natural Sciences or Other fields earn less than those with a major in Business/Economics or Technology/Engineering. Furthermore, with the exception of "other" majors for males, we again find no differential impact of field of study between self-employed individuals and wage-workers. Nevertheless, Table 3 shows two remarkable gender differences. The first gender difference involves the income gap between self-employed and wage-workers. This gap seems to be much bigger for women: Female self-employed earn 22% less than female wage-workers whereas male self-employed earn only 4.6% less than their wage-employed counterparts (see models 1 and 3). The second gender difference involves the variable *Time after graduation or dropout*. We see that men accumulate income much faster than women after leaving college: For each additional year after leaving college, men increase their income with 5%, versus only 2.6% for women (ceteris paribus).

Table 3: Gender-stratified regression results (random effects) for college-educated entrepreneurs and wage-workers

	Female		Male	
	(1)	(2)	(3)	(4)
Variables	**Ln(income)**	**Ln(income)**	**Ln(income)**	**Ln(income)**
SCIENCES[a]	-0.206***	-0.200***	-0.166***	-0.180***
	(0.048)	(0.048)	(0.057)	(0.058)
TEC	0.050	0.058	0.018	0.010
	(0.085)	(0.086)	(0.049)	(0.050)
OTHERS	-0.195***	-0.188***	-0.136***	-0.150***
	(0.039)	(0.040)	(0.041)	(0.042)
Self employed	-0.220***	-0.162**	-0.046*	-0.131**
	(0.030)	(0.069)	(0.026)	(0.053)
Self-employed x SCIENCES[b]		-0.065		0.123
		(0.105)		(0.099)
Self-employed x TEC		-0.099		0.069
		(0.188)		(0.077)
Self-employed x OTHERS		-0.073		0.124*
		(0.079)		(0.065)
Student loan	-0.001	-0.001	-0.001***	-0.001***
	(0.001)	(0.001)	(0.001)	(0.001)
Time after graduation or dropout	0.026***	0.026***	0.050***	0.049***
	(0.008)	(0.008)	(0.010)	(0.010)
Drop-out	-0.634***	-0.634***	-0.530***	-0.529***
	(0.047)	(0.047)	(0.057)	(0.056)
Constant	7.249***	7.243***	6.203***	6.213***
	(0.239)	(0.239)	(0.258)	(0.257)
Observations	12,656	12,656	12,031	12,031
Individuals	2,482	2,482	2,141	2,141
R^2	0.233	0.233	0.349	0.349

a. Reference group: Business/Economics
b. Reference group: Self-employed x Business/Economics

Robust standard errors in parentheses.
Year dummies are included in the regression, but not reported.
*** $p<0.01$, ** $p<0.05$, * $p<0.10$

5. Conclusions

Although several studies investigate the differential returns to formal education for entrepreneurs and wage-workers, the specific field of study is seldomly taken into account. In this paper, we estimated the returns to education for college-educated wage-workers and entrepreneurs in the United States, while taking

account of the major field of study. We found that entrepreneurs earn on average less than wage-workers, but the returns to field of study are not different between entrepreneurs and wage-workers: For both occupational groups, individuals with a major in Business/Economics or Technology/Engineering earn more than those with a major in Natural Sciences, and Other fields. Moreover, these earnings differentials between different fields of study are not significantly different between entrepreneurs and wage-workers.

With respect to the value of higher education in terms of signaling (e.g., Van der Sluis et al., 2004) versus skill building (e.g., Verhaest et al., 2015), these results are clearly in favour of skill building: We find that the returns to education differ by field of study, not only for wage-workers but also for entrepreneurs. Hence, the type of skills learned (i.e., field of study) clearly seems to matter for future earnings, in accordance with the skill building hypothesis.

Our variable *OTHERS* includes majors such as Journalism and Humanities studies while our variable *Natural Sciences* includes disciplines that lead to high paying careers such as medical doctors or chemists. Nevertheless, graduates with a Business or Economics background are more desirable in the current job market. These graduates may be more likely to find a job that matches their formal education than graduates with a Natural Sciences or "other" background. Natural Sciences graduates might have more difficulty in securing a high paying career in the related profession. The earnings for CEOs, bankers and management level jobs have been rapidly rising (Looksharp, 2015), while such a rapid increase in earnings for professions such as medical doctors or scientists has not been observed.

We found that individuals with a technological background do not perform better or worse than individuals with a Business or Economics background. Hence, it is unclear whether technical skills are more important for earnings compared to business relevant skills. It may be argued that technical skills are more important in high-tech industry while business skills are more important in other industries. Future research may test for this by estimating the model for separate industries.

Another direction for future research may be to delve deeper into the gender-specific results. In particular, our finding that the income gap between self-employed and wage-workers is much bigger for women than for men is worth investigating further. This holds as well for our finding that college-educated males accumulate income after leaving college twice as fast as college-educated women.

Although our paper provides new evidence on the returns to field of study, there are also a few limitations, such as the inaccessibility of the detailed curriculums of individuals' educational backgrounds. We assume that skills are largely obtained from their reported major in college, but we cannot control for additional courses (such as electives) or trainings that one may receive in and outside college. For example, individuals who did not study Business or

Economics in college may also have received training for entrepreneurial skills. Askun and Yildirim (2011) find that entrepreneurial education in Engineering schools become increasingly popular so that students can learn business, social, and interpersonal skills in addition to their technical skills. Engineers who are trained in entrepreneurial skills may outperform other engineers without the same training as well as Business graduates without technical skills. Thus, another suggestion for future research is to compare the effect of having followed entrepreneurial education within samples of students who study the same discipline (i.e., follow the same major) and, vice versa, to compare the effect on entrepreneurial performance of different fields of study within samples of students having followed entrepreneurial education.

Moreover, we cannot control for the effect of switching majors or having double majors. Del Rossi and Hersch (2008) find that college-graduated wage-workers with double majors can earn 7% to 50% more than those with single majors, depending on the combination of the majors. Individuals who participate in multiple intellectual domains are more likely to introduce creative breakthroughs than well-established experts in a single domain (Baumol et al., 2009; Douglass, 1976). These effects of having double majors for entrepreneurship are yet to be examined.

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