Labour Economics 67 (2020) 101933

Contents lists available at ScienceDirect

Labour Economics

journal homepage: www.elsevier.com/locate/labeco

Are they all like Bill, Mark, and Steve? The education premium for entrepreneurs☆

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ARTICLE INFO

JEL classification:
J24
J31
M13

Keywords:
Skill premiums
Entrepreneurship

ABSTRACT

We calculate the average yearly income obtained by entrepreneurs during their venture using the Survey of Consumer Finances since the late 1980s. We find that the premium for postgraduate education has increased substantially more for entrepreneurs than for employees. Today an entrepreneur with a postgraduate degree earns on average $100,000 a year more than one with a college degree. The difference more than doubles at the higher quantiles of the income distribution. In the late 1980s, differences were close to zero. The rise in the postgraduate premium is mainly due to increased complementarity between higher education and past labor market experience.

1. Introduction

There is widespread evidence that the return to education for employees has increased over recent decades in most industrialized countries (see for example Card (1999) for a review), while we know very little—if anything—on the evolution of the return to education for entrepreneurs. The anecdotal evidence is somewhat mixed. On the one hand, some of the most successful new US companies, such as Microsoft, Facebook, and Apple, have been founded by college drop-outs: Bill Gates, Mark Zuckerberg and Steve Jobs. This could indicate that higher education has become less useful to entrepreneurship, possibly because of its high opportunity cost in terms of time. On the other hand, successful entrepreneurs with little or no formal education have been common throughout the history of capitalism.[1] And in more recent years, the US has also experienced a boom in the number of successful high-tech firms created by entrepreneurs with postgraduate education, which might rather suggest an increase in its return for entrepreneurs.[2]

In this paper we use the Survey of Consumer Finances (SCF) to supply evidence on the evolution of the return to education of US entrepreneurs over the period 1989–2013. The SCF is best suited for the purpose because it is fully representative of the wealth distribution of US households, including at the very top; it measures accurately the educational level of individuals; and it contains detailed information of the

☆ We thank Marco Cagetti, Mariacristina De Nardi, Isaac Hacamo, Bob Hall, Ed Lazear, Morten Sørensen and Annette Vissing-Jorgensen as well as participants at various seminars and conferences for useful comments. We are also grateful to Erminia Florio, Marco Forletta and Valentina Bianchi Vimercati for research assistance

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[1] Michael Dell, the founder of Dell Computers, and Ralph Lauren, CEO and Chairman of Ralph Lauren Corporation, are examples of well-known entrepreneurs who dropped out of college. George Eastman, the founder of Kodak, Henry Ford, John D. Rockefeller, the founder of Standard Oil, Ray Kroc, who founded McDonald's, and Walt Disney are all examples of entrepreneurs who never attended college at all and in some cases (Eastman, Kroc, Rockefeller, and Disney) did not even finish high school.

[2] Google began as a research project by Sergey Brin and Larry Page during their Ph.D in computer science at Stanford, where they eventually obtained their M.S. Both Michael Bloomberg, founder of the global financial data and media company Bloomberg L.P., and Scott McNealy, co-founder of Sun Microsystems, have an MBA—Bloomberg from HBS and McNealy from Stanford GSB. The three leading companies in the booming US biotechnology industry, Amgen, Gilead Sciences and Celgene, were founded by entrepreneurs with Ph.Ds: Amgen by George Blatz Rathmann, who holds a Ph.D in physical chemistry from Princeton; Gilead by Michael L. Riordan who holds both an M.D. from Johns Hopkins and an MBA from Harvard; and Celgene by Sol J. Barer together with David Stirling, who both hold Ph.Ds in biochemistry—Barer from Rutgers and Stirling from the University of Warwick. And even Peter Thiel, a serial entrepreneur and a leading figure in Silicon valley who has recently funded a fellowship program to encourage young people to skip or drop out of college to start businesses, holds a Juris Doctor degree from Stanford Law.

https://doi.org/10.1016/j.labeco.2020.101933
Received 15 May 2020; Received in revised form 11 October 2020; Accepted 12 October 2020
Available online 14 October 2020

businesses they run.[3] We identify entrepreneurs as individuals whose primary job consists of actively managing one or more privately-held businesses, which they own in part or in full. We also consider more restrictive definitions of entrepreneur based on the number of workers in the business and its legal form (incorporated versus unincorporated). In measuring the return to entrepreneurship, we consider that an important part of entrepreneurs' income comes from capital gains realized upon selling the business. An entrepreneur also immobilizes part of his wealth as well as his human capital in his business. Upon exit (due to failure or sale), the entrepreneur recovers some wealth that can be re-invested elsewhere or consumed, while the human capital can be re-employed in the labor market. Based on this insight, we construct a simple measure of *return to entrepreneurship* and implement it using the SCF, which consists of repeated cross-sectional surveys with information on the date of start-up, current income from the entrepreneurial venture (in the form of either labor income or dividend payments), its current market valuation and the investment made to acquire or start the business. We group entrepreneurs by education, distinguishing between: (i) post-graduate degree, (ii) college degree, (iii) high school degree, and (iv) less than high school degree. We find that the premium of having a college degree relative to a high school degree has increased, but only by about as much as the analogous premium for employees. Instead, the premium for postgraduate education has increased substantially more for entrepreneurs than for employees. On average, entrepreneurs with a post-graduate degree nowadays earn more than twice as much as in the early 1990s. The analogous percentage increase for entrepreneurs with a college degree is around 50%, while for entrepreneurs with less than a college degree the increase is small or negligible. Today an entrepreneur with a postgraduate degree earns on average $100,000 per year more (at 2010 prices) than one with only a college degree. This difference more than doubles at the higher quantiles of the entrepreneurs' income distribution. In the late 1980s, these differences were close to zero. The sharp increase in the skill premium for entrepreneurs with postgraduate education is partly due to the higher dividends paid by the firms they ran and partly due to the higher capital gains realized upon sale of the business. The premium for postgraduate education holds both for entrepreneurs with an M.A. or an MBA degree and for those with a Ph.D; it has remained high during the Great Recession (despite a drop in absolute returns); and it is robust to accounting for changes in how individuals self-select into higher education and/or entrepreneurship. All this suggests that the experience of "Bill, Mark and Steve" has been the exception rather than the rule and that higher education has become increasingly important for entrepreneurial success.

An increase in the return to skill for entrepreneurs can be the result of an increase in the return to education, in the return to labor market experience and in the complementarity between the two (EE-complementarity). We find that the complementarity between higher education and labor market experience has increased substantially. The increase is specific to entrepreneurship and accounts almost fully for the rise in the premium to postgraduate education. This holds true after controlling for several alternative explanations for the rise in the premium, including changes in (i) the sectoral specialization of businesses; (ii) their access to internal or external finance; (iii) the importance of vintage technology effects; (iv) the intergenerational transmission of wealth; (v) compensating differentials—due to greater business risk or lower possibilities of recycling entrepreneurial skills into new ventures; and (vi) the scale of business. The rising importance of EE-complementarity is consistent with a recent literature which, following Lazear (2004, 2005), has emphasized that entrepreneurs need a balanced mix of skills to succeed and with the findings by Azoulay et al. (2018) that highly successful start-ups tend to be founded by middle-aged entrepreneurs with some previous labor market experience.

There is cross-sectional evidence on the return to education for entrepreneurs and how it compares with the analogous return for employees, see Van der Sluis et al. (2008) for a review of the literature and Queiro (2016) for a more recent analysis which focuses on firm dynamics. Yet little is known about the time-series evolution of the skill premium for entrepreneurs. Some existing evidence is consistent with our findings that the return to education has increased. Kaplan and Rauh (2013) study the characteristics of the 400 wealthiest individuals in the US over the past three decades according to the Forbes 400 list and document that the share of college graduates has increased from 77 to 87%. Smith et al. (2019) provide evidence consistent with an increased return to skill for entrepreneurs, but they do not focus on education, which is a variable not available in the administrative data that they use.

There is debate on how to accurately identify entrepreneurship in the data, which according to Schumpeter (1947, 1949) is associated with job creation, innovation, and risk taking. Levine and Rubinstein (2017) use the National Longitudinal Survey of Youth 1979 (NLSY79) to argue that self-employed individuals who run incorporated businesses closer approximates the Schumpeterian definition of entrepreneur. Here we focus on the return to education in entrepreneurship, study its evolution over time and find that the return to postgraduate education has increased also when focusing on the preferred definition of entrepreneurs by Levine and Rubinstein (2017).

Hall and Woodward (2010) study the risk-adjusted return to entrepreneurship and conclude that it is only slightly above zero. Our measure of entrepreneurial return does not control for risk, but we think that risk aversion alone cannot explain the rising premium to higher education observed in the data, because the entire distribution of returns has generally become more favorable to highly educated entrepreneurs: failure rates have evolved similarly across educational groups, while the skill premium to entrepreneurship has increased in all the higher quantiles of the income distribution. Further, our results are robust to controlling for a measure of income uncertainty in the business.

Several other papers have used the SCF to study features of US entrepreneurs. De Nardi et al. (2007) investigate the role of liquidity constraints and personal wealth for business development. Moskowitz and Vissing-Jorgensen (2002) and Kartashova (2014) estimate the aggregate return to private equity, which accrues mainly to entrepreneurs, and compare it to the return from investing in public equity. None of these papers has analyzed differences in individual entrepreneurial returns and the evolution over time of the return to education for entrepreneurs.

The rest of the paper is organized as follows. Section 2 discusses how to measure the return to entrepreneurship in the SCF. Section 3 describes the data. Section 4 characterizes the evolution of average returns and deal with selection issues into both higher education and entrepreneurship. Section 5 focuses on different quantiles of the entrepreneurs' return distribution. Section 6 show the robustness of the results to possible biases in the measure of returns and the use of the March Current Population Survey (CPS) as an alterative source of information on entrepreneurial income. Section 7 provides evidence of increased complementarity between education and labor market experience and tests for alternative explanations of the rise in the premium for postgraduate education. Section 8 concludes.

2. Measuring the return from entrepreneurship

The *return to entrepreneurship* measures the yearly income that an entrepreneur expects over the course of the venture, summing labor income, dividend payments, and realized capital gains/losses upon sale or liquidation of the business. The entrepreneur is infinitely lived and risk-neutral and initially we posit that he can run at most one business in the course of a lifetime. Time is continuous. Let k denote the initial investment in the business, d the per period dividend payments

[3] The SCF sampling just excludes the Forbes list of the wealthiest 400 people in the US, so "Bill, Mark and Steve" are part of the population sampled by the SCF until they entered this list.

—which can be negative in case the entrepreneur injects capital into the business—and l the labor income from the business. The entrepreneur's total income in a period is then equal to $y \equiv d + l$. We assume that these quantities are constant over time.[4] The market interest rate is $r \geq 0$. The entrepreneur discounts cash flows at rate $\rho > r$. This recognizes that the entrepreneur's investment in the business is illiquid and undiversified. We assume that the difference between ρ and r is large enough so that the entrepreneur always sells the business at its market value $M = d/r$ when the opportunity arises, which occurs with instantaneous arrival rate λ. At any time the entrepreneur could work in the labor market, earning per period income w. So the value of his human capital is equal to

$$W = \frac{w}{\rho}. \tag{1}$$

The value of the venture to the entrepreneur, after the initial investment k, is equal to U which solves the following standard asset type equation:

$$\rho U = d + l + \lambda(M + W - U). \tag{2}$$

The left hand side is the business's yield to the entrepreneur; the right hand side the entrepreneur's expected income from the venture, equal to the sum of the instantaneous return (first two terms) and the expected capital gain from selling the business in the market, cashing in the full market value of the business M and re-employing human capital W in the labor market (third term). The net value of becoming an entrepreneur is denoted by S, equal to the difference between the value of the business to the entrepreneur, U, and the opportunity cost of the physical and human capital that the entrepreneur invests in the business, of value k and W, respectively. So we have:

$$S = U - k - W. \tag{3}$$

We convert this net value into a flow value for the sake of comparison with conventional wage regressions, see Mincer (1958). The *extra return* to entrepreneurship for an entrepreneur who has invested k units of wealth in the business is denoted by ϕ, which we define using the notion of Chisini mean (Chisini, 1929). Formally ϕ is obtained by equating the actual wealth gains that the entrepreneur expects, as measured by S in (3), with the hypothetical expected present value of wealth that the entrepreneur would get from a constant income flow ϕ in each period of the venture. Since the entrepreneur exits the venture at the Poisson arrival rate λ, ϕ should satisfy the following implicit functional Chisini equation condition:

$$\frac{\phi}{\lambda + \rho} = S. \tag{4}$$

From the definition of S in (3) and after using (2) and (1), we obtain

$$\phi = \theta - w, \tag{5}$$

where w measures the labor market opportunity flow cost from running the business while

$$\theta = d + l + \lambda(M - k) - \rho k \tag{6}$$

measures the *expected return* from becoming an entrepreneur gross of the opportunity cost of human capital. This return θ is the sum of three components. The first is the instantaneous income (in the form of dividend payments d and labor income l) that the business delivers to the entrepreneur in each period. The second is the *per period* expected capital gain, which corresponds to the third term in the right hand side of (6). To understand this expression, note that the entrepreneur invests k while the expected value of the business upon exit is M, so $M - k$ is the realized capital gain. Since the entrepreneur exits the business with Poisson arrival rate λ, the expected duration of the entrepreneurial venture is equal to $1/\lambda$. Thus the third term on the right hand side of (6) simply measures the per period capital gain generated over the (expected) life of the business. Finally, the last term in the right hand side of (6) measures the cost to the entrepreneur of immobilizing his wealth in the business. Notice that this cost is calculated using ρ rather than r, because the entrepreneur should be compensated for the lack of liquidity and the (idiosyncratic) risk of his investment in the business.

Our baseline measure for the expected return from entrepreneurship is based on θ in (6), after recognizing that the SCF data are cross-sectional and in discrete time. In particular, let $a = 1, 2, 3 \ldots$ denote the discretized age of the venture, t current time and h the size of the interval over which the time line is discretized. The SCF provides cross-sectional data on entrepreneurs with information about (i) the value of the businesses M; (ii) the total income flow obtained by the entrepreneur in a period in the form of either dividend payments dh or labor income lh; (iii) the discretized age of the venture a; (iv) the entrepreneur's investment in the business k; and (v) the current time t. To measure λ, we build on Nickell (1979) who observes that hazard rates out of a pool can generally be recovered by combining information on the cross-sectional distribution of age a and the inflow rate into the pool. For each entrepreneur-educational group we construct a measure of the mass of new ventures at time t, which we denote by m_t.[5] The mass of ventures of age a at time t is then equal to

$$f_{ta} = m_{t-a}\left(1 - \widetilde{\lambda}\right)^a \tag{7}$$

where

$$\widetilde{\lambda} = 1 - \exp(-\lambda h) \simeq \lambda h$$

is the exit rate out of the venture over an interval of size h and $\exp(-\lambda h)$ is the probability of not selling the business in an interval of size h. The approximation in the expression above works well when λh is small enough. To use cross-sectional data to infer λ and to account for changes in the entry rate over time, we normalize the entry flow into entrepreneurship to one. Let

$$n_{ta} = \frac{f_{ta}}{m_{t-a}} = \left(1 - \widetilde{\lambda}\right)^a \tag{8}$$

denote the fraction of ventures started at $t - a$ still in existence at t. At t, we weight each venture started at $t - a$ by the inverse of the size of the cohort of new ventures started at $t - a$ and then calculate the resulting cross-sectional average age of ventures, equal to

$$E_n(a) \equiv \frac{\sum_{a=1}^{\infty}(a n_{ta})}{\sum_{a=1}^{\infty} n_{ta}} = \frac{\widetilde{\lambda}}{1 - \widetilde{\lambda}} \cdot \sum_{a=1}^{\infty}\left[a\left(1 - \widetilde{\lambda}\right)^a\right] = \frac{1}{\widetilde{\lambda}} \simeq \frac{1}{\lambda h}, \tag{9}$$

where the second equality uses (8). This means that $1/E_n(a)$ measures the exit rate out of entrepreneurship.[6] Finally, we calculate the opportunity cost of capital as equal to

$$\rho = R(t - a, t)^{\frac{1}{a}} - 1$$

[4] Nothing changes if y evolves stochastically, provided these fluctuations do not lead to a liquidation of the business, an issue we discuss in the appendix.

[5] This index is constructed separately for each educational group: we first use information from the US Census Bureau's Longitudinal Business Database (LBD) to construct a measure of the total business creation rate in any year since 1976 and then multiply the year-specific value of the index by the share of ventures started in that year by entrepreneurs with the given educational level.

[6] We experimented with alternatives to (9) in order to calculate λh. These alternatives allow to test for whether the exit rate out of entrepreneurship varies as entrepreneurs age in the business (duration dependence). For each two age groups of ventures, say at age a and at age $a - i$ we can calculate

$$\widetilde{\lambda}_{ai} \equiv 1 - \left(\frac{n_{ta}}{n_{ta-i}}\right)^{\frac{1}{i}} \tag{10}$$

where n_{tj} is the mass at time t of entrepreneurial ventures of age j—again normalized by the size of the corresponding cohort of newly created entrepreneurial ventures, as defined in (8). In the absence of duration dependence we would have that $\widetilde{\lambda}_{ai} = \widetilde{\lambda} \simeq \lambda h$. By fixing i and comparing $\widetilde{\lambda}_{ai}$ with $\frac{1}{E_n(\tau)}$ for different values of a we can then evaluate the importance of duration dependence among entrepreneurs. In practice, in our data, we do not find strong evidence of duration dependence and we present results by measuring λ using (9).

where $t-a$ is the date of start of a venture of age a at time t and $R(t-a,t)$ is the total return from investing in the US stock market over the period $(t-a,t)$. Our baseline measure for the return from entrepreneurship θ is therefore given by

$$\widetilde{\theta} = dh + lh + \frac{M-k}{E_n(a)} - \left[R(t-a,t)^{\frac{1}{a}} - 1\right]k, \tag{11}$$

where $\widetilde{\theta}$ denotes the empirical counterpart of θ in (11).

3. The data

Our main source of information is the SCF, a triennial cross-sectional survey of US households conducted by the Federal Reserve Board of Governors over the period 1989–2013. Around 4000 households were sampled in each wave, save the last two where sample size increased to 6000. The SCF is unique in that it collects data on the household finances of a representative sample of Americans. Wealthy individuals are over-sampled in order to derive an accurate characterization of the right tail of the income and wealth distribution of US households, where entrepreneurs are more likely to be found. All the analysis, both descriptive and regression-based, uses the SCF sampling weights.[7] For the detailed definition of all the variables, see the Appendix.

We focus on household heads, defined as the male individual in a mixed-sex couple and the older person in a same-sex couple. We follow De Nardi et al. (2007) in defining as *entrepreneurs* all respondents who simultaneously satisfy three requirements intended to identify individuals who own the business they run. Since in the SCF an individual who runs and owns a business is explicitly coded as being self-employed in his main job (mnemonic X4106), we first require the respondent to be *self-employed*. Second, the respondent must *own or share ownership in at least one privately-held business* (mnemonic X3103).[8] Finally, the respondent must *actively manage* the business he owns (mnemonic X3104). According to this definition, around 7% of the household heads qualify as entrepreneurs (11.5% of those employed). The share is stable over time. We later experiment with some more restrictive definitions of entrepreneur.

We group individuals (either entrepreneurs or employees) into 4 educational groups: postgraduate degree, college degree, high school degree and high school dropout. Dropouts are defined as household heads who report less than 12 years of education; high school graduates, as those having completed high school and, possibly, up to 3 years of college but no college degree; college graduates, as those with a BA or equivalent but no more than 16 years of education and no postgraduate degree; postgraduates, as those with either a Master's or Ph.D.

Fig. 1 characterizes the evolution of the educational composition of the population of entrepreneurs (left panel) and employees (right panel). As in Hacamo and Kleiner (2016), we find that entrepreneurs are more highly educated than employees. The share of college graduates is around 30%, just slightly higher among entrepreneurs than among employees, while the share of entrepreneurs with postgraduate education, about a quarter, is twice as large as the analogous share for employees. This difference is offset by a higher share of high school graduates among employees than entrepreneurs (50% vs. 40%). The shares are fairly stable over time, with a slight increase in the proportion of college graduates and postgraduates, and a corresponding decrease in the share of high school dropouts, which falls below 10% for entrepreneurs and employees alike. Given their limited numbers and particular socio-economic conditions, we exclude high school dropouts from the rest of the analysis.

To calculate the total return to entrepreneurship, we construct each of its components in (11). *Labour income* l is measured using the following question in the SCF (mnemonic X4112): "About how much do you earn before taxes on your main job in salary and wages?". *Dividend payments* d are measured using mnemonic X4131: "In addition to salary and wages, how much do you personally receive from the business before taxes?". The measure for the *Value of the business* M is obtained from mnemonic X3129: "What is the net worth of (your share of) the business?; Probe: What could you sell it for?". The measure for the value of the entrepreneurs' (overall) *Investment in business* k is obtained from mnemonic X3130: "If you sold the business now, what would be the cost basis for tax purposes of your share of the business? Definition: The tax basis is the amount of the original investment (or the value when it was received) plus additional investments." $R(t-a,t)$ is calculated using the real value (nominal returns deflated with the CPI) of the S&P500 Total Return Index (from Bloomberg), which also includes income from dividend payments. All variables are calculated at constant 2010 prices. Finally, λ is the exit rate from entrepreneurship, which is calculated separately for each educational group as discussed in Section 2.[9]

Table 1 gives descriptive statistics for the population of employees and entrepreneurs. The latter average seven years older, are more likely to be married, white and male, and report one more year of schooling. The labor income of entrepreneurs and employees is about the same, but entrepreneurs' total income (which also includes dividends and expected capital gains) is twice the average labor income of employees. Entrepreneurs' total income also displays higher dispersion than employees' labor income: the median is comparable, but at the 90th percentile income is 2.3 times the median for employees and 6.4 times for entrepreneurs. More than 10% of entrepreneurs have negative returns, and the returns in the bottom quartile of the distribution of entrepreneurial income come to just $12,000, half of employees' income at that quartile. Considering the different components of total entrepreneurial income, we find that a large portion consists in labor income plus dividends. The average market value of a venture is about $900,000 and the investment in business averages $457,720. Sectoral composition is similar for the two groups, except for under-representation of entrepreneurs in manufacturing and their over-representation in construction, which reflects the fact that average firm size in terms of employment is larger in manufacturing than in construction.

Table 2 reports descriptive statistics for entrepreneurs with different educational levels. We include all the variables that are used in our subsequent regression analysis. On average, more educated entrepreneurs get a higher total return from entrepreneurship θ. The market value of the business M also increases with education. Entrepreneurs lacking a college degree are more likely to run unincorporated businesses and to operate in construction or trade, while those with a postgraduate degree are more likely to be in Transportation, Communication and Utilities (TCU).

4. The evolution of entrepreneurial returns

First we describe the evolution of the average return to education for entrepreneurs. Then we address whether the evolution is driven by changes in the general return to labor market skills or in how individuals self-select into schooling or entrepreneurship.

[7] To account for measurement error and missing observations, the SCF reports five separate imputation replicates (implicates) for each record: see Kennickell (1998) for details. All statistics are calculated following the procedure suggested by the SCF: for each implicate we calculate the desired statistic using the SCF sampling weights (mnemonic X42001) and then average across the five implicates.

[8] Of those who say they are self-employed, approximately 15% report that they do not share any ownership in privately held businesses. Presumably, these individuals are self-employed but work independently for somebody else. This interpretation is confirmed by the more recent waves (since 2004) of the SCF, which contain specific questions for this group of respondents.

[9] See the Appendix for details on how we aggregate information for all businesses actively managed by the entrepreneur. Results are robust to alternative aggregation choices, for example focussing solely on the first actively managed business.

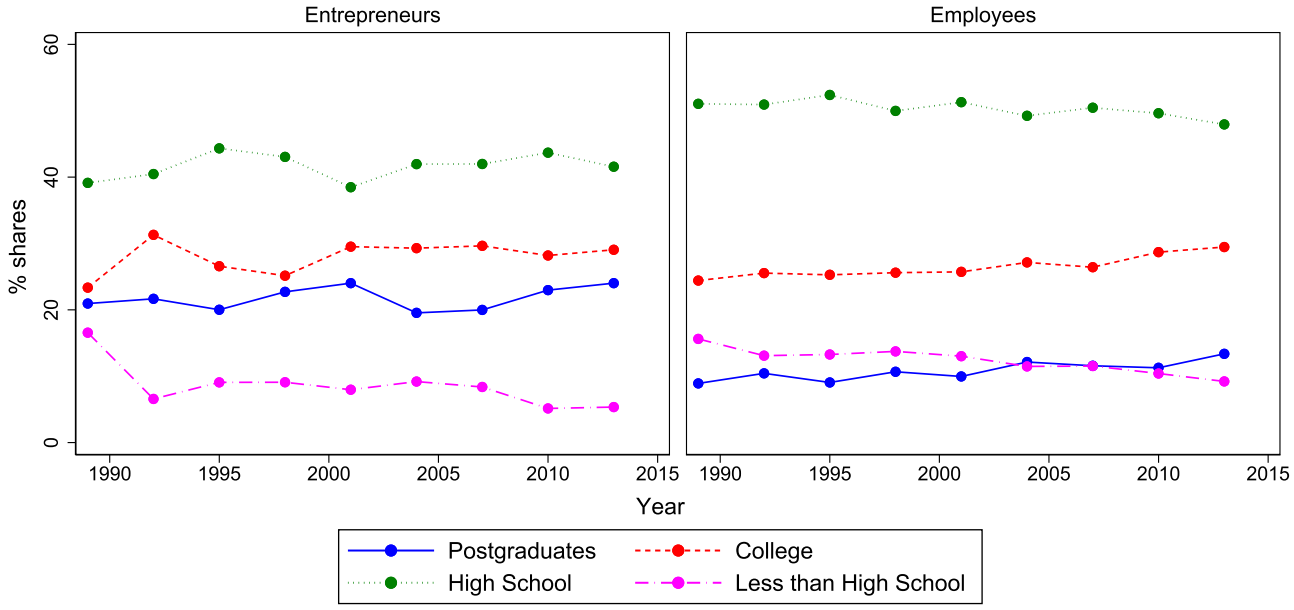


Fig. 1. Entrepreneurs and employees: Shares by education.
Source: Survey of Consumer Finances.

Table 1
Descriptive statistics: employees and entrepreneurs.

Variable	Mean	sd	p10	p25	p50	p75	p90
Employees							
Labor income, l	55.7	99.0	15.6	26.9	43.1	65.1	97.2
Age	41.7	12.5	26	32	41	50	59
Female	0.26	0.44	0	0	0	1	1
White	0.74	0.44	0	0	1	1	1
Married	0.60	0.49	0	0	1	1	1
Years of schooling	14.1	1.9	12	12	14	16	17
Agriculture	0.02	0.11	0	0	0	0	0
Mining and Construction	0.07	0.26	0	0	0	0	0
Manufacturing	0.18	0.38	0	0	0	0	1
Trade	0.16	0.36	0	0	0	0	1
Finance and Services	0.12	0.32	0	0	0	0	1
Transp., Communic. and Utilities	0.37	0.48	0	0	0	1	1
Public Administration	0.08	0.28	0	0	0	0	0
Entrepreneurs							
Total return, θ	125.6	811.7	−0.6	11.9	47.3	125.1	303.0
Labor income, l	46.3	141.0	0.0	0.0	0.0	51.9	130.0
Dividends, d	73.1	429.2	0.0	0.0	11.2	5.5	153.9
Value of business, M	898.9	5586.4	0.0	21.0	105.2	460.8	1535.4
Investment in business, k	457.7	5007.1	0.0	3.0	30.0	158.2	647.6
Gross capital gains, $\lambda(M-k)$	35.6	423.0	−4.3	−0.01	2.1	16.9	68.9
Net capital gains, $\lambda(M-k)-\rho k$	6.0	619.5	−27.6	−3.3	0.24	10.6	50.8
Age	49.0	12.6	33	40	49	58	66
Female	0.09	0.29	0	0	0	0	0
White	0.88	0.33	0	1	1	1	1
Married	0.78	0.42	0	1	1	1	1
Years of schooling	14.7	2.0	12	12	16	17	17
Agriculture	0.05	0.21	0	0	0	0	0
Mining and Construction	0.18	0.38	0	0	0	0	1
Manufacturing	0.08	0.27	0	0	0	0	0
Trade	0.15	0.36	0	0	0	0	1
Finance and Services	0.19	0.39	0	0	0	0	1
Transp., Communic. and Utilities	0.36	0.48	0	0	0	1	1

Note: Pooled SCF data over the period 1989–2013. All monetary values are in thousands of dollars at constant 2010 prices. Age is in years; Female, White and Married are dummies; Years of schooling is the number of completed years of schooling; Agriculture, Mining and Construction, Manufacturing, Trade, Finance and Services, Transp., Communic. and Utilities and Public Administration are dummies for the sector of occupation. See the Appendix for more details.

4.1. Baseline evidence

The left panel of Fig. 2 shows the time profile of the yearly average return to entrepreneurship, θ, for the three educational groups. For entrepreneurs with a high school degree, returns have remained stable at about $62,000. Until the mid 1990s the returns for college graduates and postgraduates were similar, just over $100,000. Since then the return for postgraduates has outpaced that for college graduates substantially: today an entrepreneur with a postgraduate degree averages $100,000 more than one with only a college degree.

In panel (a) of Fig. 3 we plot the returns separately for entrepreneurs with a master's degree (MA, MS or MBA) and for those with a more

Table 2
Entrepreneur characteristics by educational level.

	High school		College		Postgraduate	
Variable	mean	sd	mean	sd	mean	sd
Total return, θ	62.2	532.0	138.9	916.7	229.2	1059.9
Dividends, d	35.8	264.1	71.6	453.3	146.5	605.8
Labor income, l	26.2	59.1	50.3	146.4	79.8	217.4
Value of business, M	532.5	3601.2	1149.2	6325.1	1274.9	7359.3
Investment in business, k	301.9	3346.9	551.2	6017.7	634.3	6086.9
Gross capital gains, $\lambda(M-k)$	19.4	317.3	52.5	488.1	44.6	500.1
Net capital gains, $\lambda(M-k)-\rho k$	0.2	445.1	17.0	727.4	2.9	741.7
Age	48.00	13.00	48.14	12.19	52.09	11.87
Female	0.09	0.29	0.09	0.29	0.09	0.29
White	0.87	0.34	0.88	0.32	0.90	0.30
Married	0.78	0.42	0.76	0.43	0.81	0.39
Collateral	0.20	0.40	0.25	0.43	0.24	0.43
Value of collateral	294.3	2355.6	887.3	4108.5	653.3	3242.2
Previous experience	0.61	0.49	0.58	0.49	0.57	0.50
Inherited business	0.04	0.19	0.04	0.19	0.03	0.17
Number of workers	8.99	49.65	22.04	167.16	56.20	316.96
Number of businesses managed	1.21	0.64	1.35	0.89	1.39	1.09
Past earnings	26.2	92.1	52.6	586.8	51.0	134.3
Age of entrepreneurial venture	13.20	11.11	12.35	10.04	14.21	11.57
Uncertain Income	0.43	0.40	0.35	0.48	0.28	0.45
Incorporated	0.30	0.46	0.48	0.50	0.46	0.50
Agriculture	0.07	0.26	0.03	0.17	0.02	0.13
Mining and Construction	0.29	0.45	0.13	0.34	0.02	0.15
Manufacturing	0.09	0.29	0.09	0.29	0.04	0.20
Trade	0.16	0.37	0.19	0.39	0.07	0.25
Finance and Services	0.17	0.37	0.25	0.43	0.14	0.35
Transp., Communic. and Utilities	0.21	0.41	0.31	0.46	0.71	0.46

Notes: Pooled SCF data over the period 1989–2013. High school refers to household heads who have completed high school but have no college degree; college graduates have college but no postgraduate degree; postgraduates have either a Master's or a Ph.D. All monetary values are in thousands of dollars at constant 2010 prices. Age is in years; Female, White and Married are dummies; Collateral is a dummy for using one's personal assets as collateral or supplying guarantees to obtain credit, while Value of collateral is the value of such assets and guarantees; Previous experience is a dummy for labor market experience before starting or acquiring the current business; Inherited business is a dummy if the business was inherited; Number of workers is the number of persons working for the business, including the entrepreneur; Number of businesses is the number of businesses that the entrepreneur runs; Past earnings is earnings in the main job before starting or acquiring the business (conditional on having worked before); Age of entrepreneurial venture is the number of years since the individual started or acquired the business; Uncertain income is a dummy for entrepreneurs who do not have a good idea of next year's income; Incorporated is a dummy for incorporated businesses; Agriculture, Mining and Construction, Manufacturing, Trade, Finance and Services, Transportation, Communication and Utilities are dummies for the sector of occupation. See the Appendix for more details.

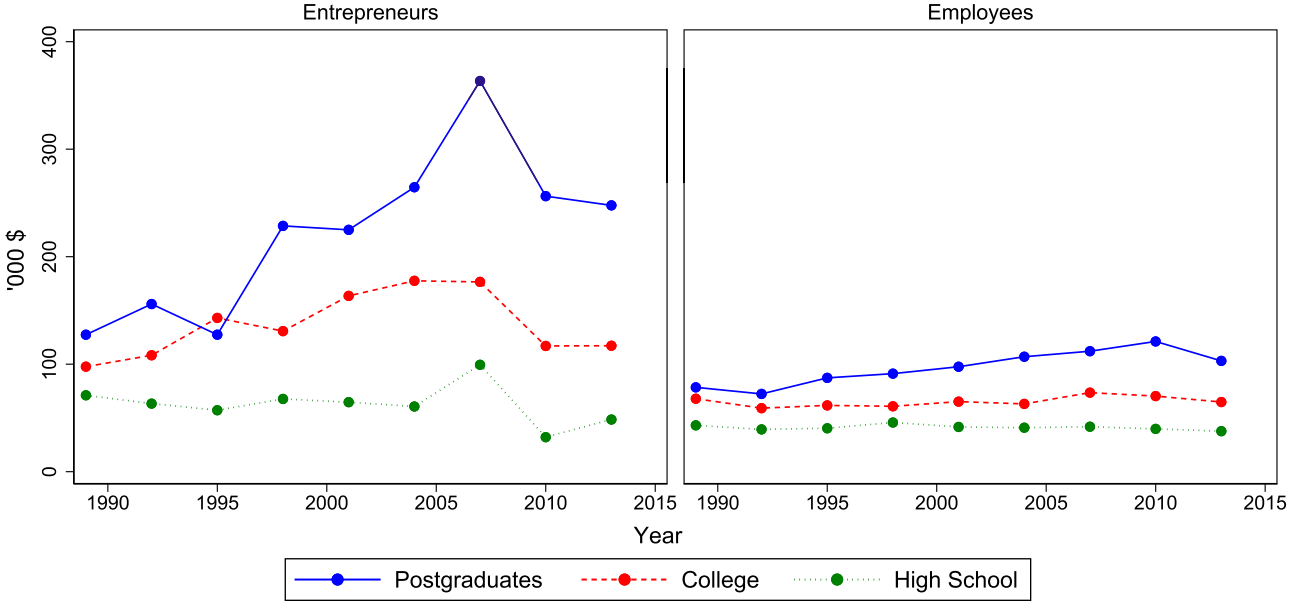
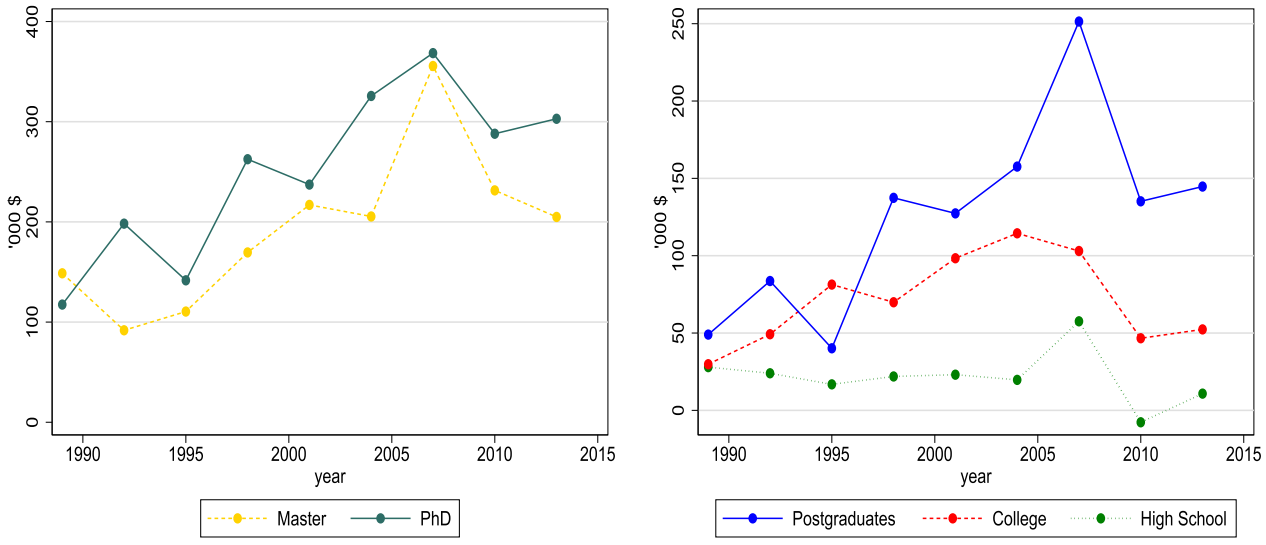


Fig. 2. Entrepreneurs' returns θ and employees' wage income w.
Source: Own calculations using the Survey of Consumer Finances, the Longitudinal Business Database and the S&P500 Total Return Index. Values are in thousands of dollars at constant 2010 prices.

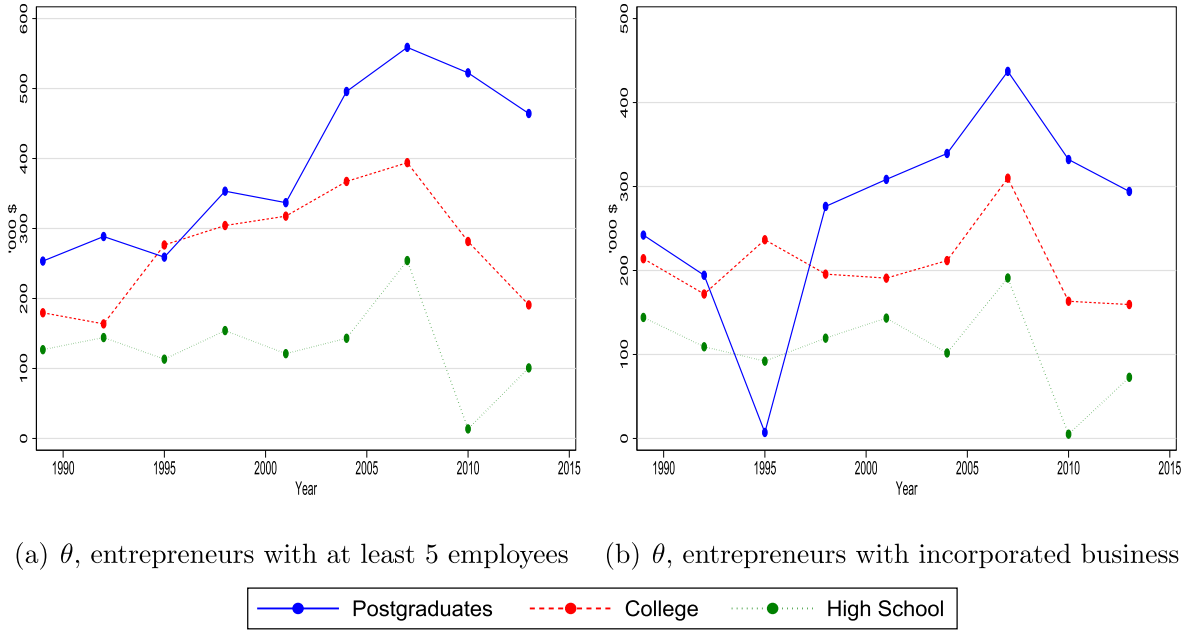


(a) θ, Master's vs. Ph.D (b) Extra Return, $\phi = \theta - w$

Fig. 3. Entrepreneurs' returns for postgraduates and extra returns.
Source: Own calculations using the Survey of Consumer Finances, the Longitudinal Business Database and the S&P500 Total Return Index. Values are in thousands of dollars at constant 2010 prices.

advanced degree (Ph.D, MD, or JD), which is the finest partition of postgraduate degrees in the public version of the SCF. On average, Ph.Ds earn more, but the time profile of returns is fairly similar for the two groups.

One might be especially interested in entrepreneurs with the potential to create jobs, possibly assuming risk, more associated with the notion of "Schumpeterian entrepreneur". Our definition of entrepreneurs also encompasses sole proprietorships, small traditional businesses as well as some firms organized as partnerships, such as law firms. To check if the pattern we have uncovered above holds in the population of entrepreneurs closer to the notion of Schumpeterian entrepreneur, we impose two additional restrictions: having employees, that indicate job creation, and incorporation, which signals risk taking. Panel (a) of Fig. 4 reports the evolution of returns θ for the population of *entrepreneurs* defined as in Fig. 3 but with the additional constraint of having at least 5 employees (in the Appendix we also consider the profile for entrepreneurs with at least 1 or 10 employees, finding the same pattern). In panel (b) of Fig. 4 we require them to run a limited liability company as in Levine and Rubinstein (2017). The time evolution of returns exhibit similar patterns as in



(a) θ, entrepreneurs with at least 5 employees (b) θ, entrepreneurs with incorporated business

Fig. 4. Entrepreneurs' returns with more restrictive definitions.
Source: Own calculations using the Survey of Consumer Finances, the Longitudinal Business Database and the S&P500 Total Return Index. Values are in thousands of dollars at constant 2010 prices. In panel (a) entrepreneurs are required to have at least 5 employees; in panel (b) they are required to run a limited liability company.

Fig. 3, although returns are on average higher by around $100,000 per year.

The second panel of Fig. 2 shows average wage income for employees. That of high school graduates has remained fairly stable through time, albeit decreasing slightly towards the end of the sample period. That of college graduates has increased slightly, from about $60,000 to $70,000, while that of postgraduates has risen more sharply, from $80,00 to over $100,000. In qualitative terms this pattern matches that for entrepreneurs, but there are some substantial quantitative differences that can be appreciated by plotting the extra return to entrepreneurship $\phi = \theta - w$, equal to the difference between the entrepreneurial return θ and the corresponding wage income of employees w for a given educational group (see Panel (b) of Fig. 3). The extra return to entrepreneurship ϕ has remained stable for high school graduates up to the mid 2000s, turning negative in 2010. Extra returns have increased for both college graduates and postgraduates, but the increase for the latter was much sharper: their extra returns quadrupled while those of college graduates only doubled. Extra returns diminished during the Great Recession, but the relative differences remained unchanged. In particular, extra returns for postgraduates continued to be nearly three times as high as at the beginning of the sample period.

Fig. 5 plots the time profile of the various components of θ separately for the three educational groups. Panel (a) focuses on the income flow, i.e., the sum of labor income and dividends $d + l$.

The profile of $d + l$ closely matches that of total returns for all educational groups. This confirms the evidence of Tables 1 and 2 that income flows represent the most significant part of total entrepreneurial income. Panel (b) of Fig. 5 characterizes the profile of Gross Capital Gains, defined as $\lambda(M - k)$, which have increased for both college graduates and postgraduates, but never exceeding $100,000. Moreover, subtracting our measure of the opportunity cost of the capital investment, ρk, we find that net capital gain $\lambda(M - k) - \rho k$ is close to zero (and sometimes actually negative), with no clear pattern over time. This is a manifestation of the private equity premium puzzle analyzed by Moskowitz and Vissing-Jorgensen (2002) and Kartashova (2014). Overall, this suggests that capital gains account for a modest share of the return to entrepreneurship. This does not mean that the wealth that entrepreneurs realize with an IPO or the sale of the business is small: for high school graduates the average market value of businesses is half a million dollars, stable over time, while for college graduates and postgraduates it rises from around that value at the beginning to more than $1.5 millions at the end of the sample period (panel d). The relatively small contribution of capital gains to total entrepreneurial income depends, rather, on the fact that they are converted into flows and that the typical duration of an entrepreneurial venture is around 10 years (panel f). Moreover, capital gains have increased just slightly for college graduates and postgraduates alike both because the investment in business k has increased (panel e) and because the exit rate from entrepreneurship λ has declined (panel f), with a similar pattern for college graduates and postgraduates.[10]

We apply regression analysis to quantify the differential changes in returns to different educational groups controlling for observable characteristics. The reference group is always high school graduates. We use three different specifications, two reported in the main text and the third in the Appendix. The first specification is based on the following regression model:

$$y_{it} = \beta_1 College_{it} + \beta_2 Postgrad_{it} + \beta_3 College_{it} \times Post_t + \beta_4 Postgrad_{it} \times Post_t + D_t + \beta_5' X_{it} + \epsilon_{it} \quad (12)$$

where y_{it} is a measure of entrepreneurial returns (extra, total, or one of its components), $College_{it}$ and $Postgrad_{it}$ are the education dummies discussed above, *Post* is a dummy for years after 2000, D_t are year dummies, and X_{it} are individual controls (including a quadratic polynomial in potential experience (age minus 6 minus years of education) plus dummies for female, married and white entrepreneur). Given that a substantial share of entrepreneurs record negative returns, we run the regressions in levels rather than logs. Our alternative second specification interacts the educational dummies with a linear trend rather than the post-2000 dummy, which allows for differential trends in returns across educational groups without having to specify a break date. Finally, the Appendix reports the results for a specification interacting educational dummies with a full set of time dummies, leaving the time profile of returns parametrically free. All the regressions are run with sampling weights and standard errors are bootstrapped using 500 replications.[11]

Table 3 gives the pre-post specification of Eq. (12). Column 1 shows that, before the turn of the century, college graduates and postgraduates earned on average $58,000 and $95,000 more per year than high school graduates.

Since 2000, postgraduates have earned an average additional premium compared with high school graduates of around $108,000, while the increase was substantially smaller for college graduates ($23,000) and not significantly different from zero. The last line in Table 3 indicates that we strongly reject the null hypothesis of an equal increase in the premium for college graduates and postgraduates in the post-2000 period. This confirms the hypothesis that the entrepreneurial return to postgraduate education has increased substantially over time. The other controls offer evidence of the typical concave experience profile of income and indicate that women entrepreneurs earn almost $50,000 less than men, that white entrepreneurs earns $33,000 more than non-white and that married entrepreneurs earn $29,000 more than single.

Column (2) reports the results when the dependent variable is the extra returns to entrepreneurship ϕ, defined as previously described. The increase in the extra return for postgraduates falls to $80,000, but remains positive and highly statistically significant; the null hypothesis that the extra return increased by the same amount for college graduates and postgraduates is still rejected at all conventional levels of significance.

In Columns 3 to 7 the dependent variable are the various components of total returns. The increase in the premium for postgraduates is explained mostly by current income $d + l$ (column 3). The market value of businesses rose substantially for both college graduates and postgraduates after 2000 (column 4), but so did the size of the investment in the business (column 5). As a result, the differential effect on capital gains between college graduates and postgraduates is positive and sizeable, but smaller than that due to current income.

Table 4 reports the results for the specification with a linear trend.

Here the coefficient of the interaction of the educational dummies with the year-trend characterizes the differential yearly growth of returns by comparison with the excluded category (high school graduates), whose trend is captured by the full set of time dummies. Column (1) indicates that the average yearly increase in returns for postgraduates was $7500, as against just $1000 for college graduates (not significantly different from zero). The last line in Table 4 also indicates that we strongly reject the null hypothesis that the growth in total returns was equal for the two groups. In this set of specifications too we see that the largest contribution to the differential trend in returns comes from current income $d + l$.

The year dummy specification in the Appendix confirms these results. The difference in the increase in returns to postgraduates first becomes statistically significantly different from zero in 1998, which suggests that, if anything, our pre-post specification, which uses 2000

[10] The reduction in the exit rate, and the corresponding increase in average firm age are in line with the evidence of a reduction in the dynamism of the US economy, as discussed, among others, by Decker et al. (2014).

[11] To deal with the repeated-imputation inference method of the SCF, which reports five implicates for each variable, we compute the standard error using the SCFcombo routine for STATA, described at https://www.federalreserve.gov/Standard_Error_Documentation.pdf.

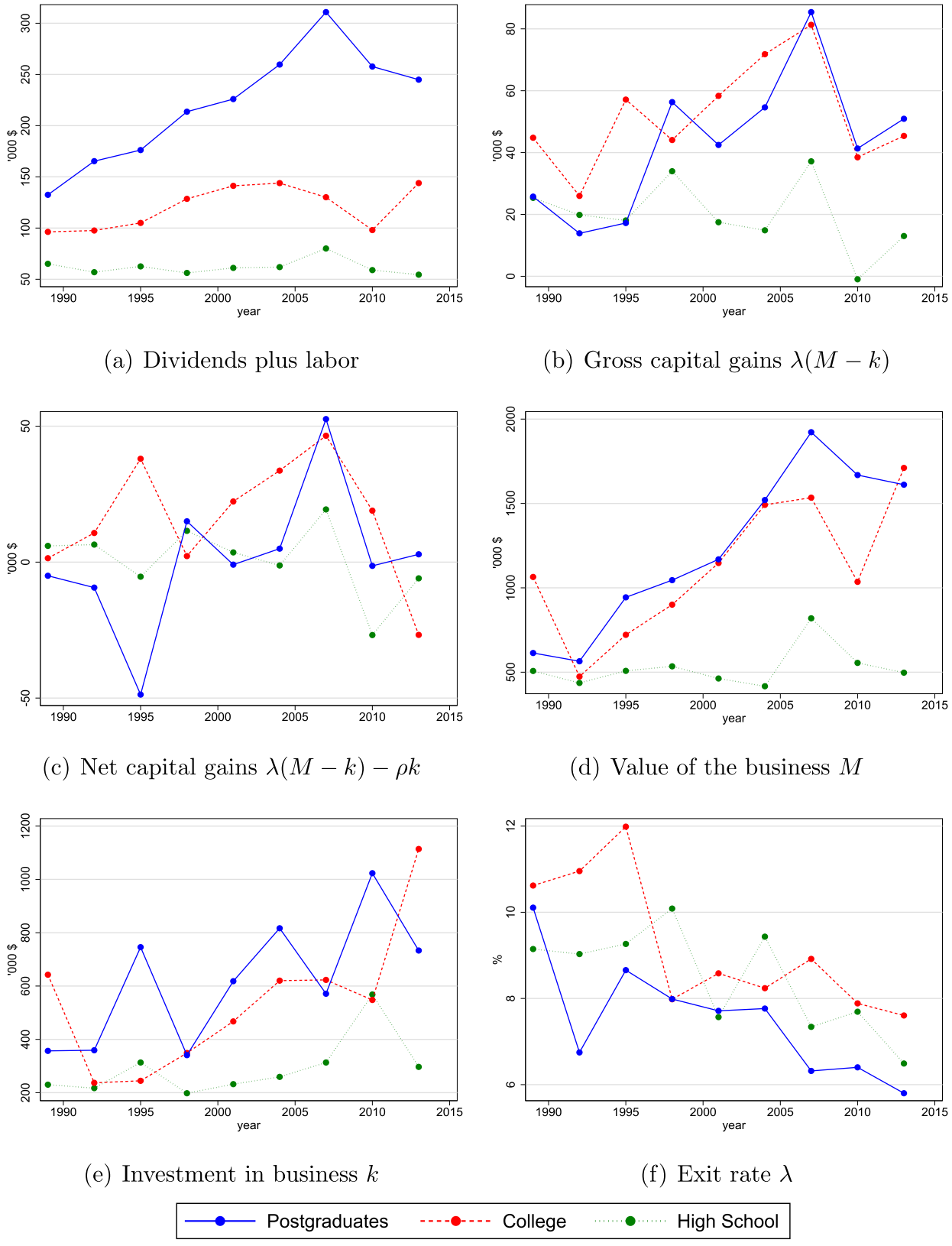


Fig. 5. Time profiles of the components of entrepreneurial returns θ.
Source: Own calculations using the Survey of Consumer Finances, the Longitudinal Business Database and the S&P500 Total Return Index. Values are in thousands of dollars at constant 2010 prices.

Table 3
Trend in the skill premium: pre-post specification.

	(1) θ	(2) ϕ	(3) $d+l$	(4) M	(5) k	(6) GCG	(7) NCG
College	57.7***	37.7***	53.3***	385.8***	202.7***	19.9***	4.5
	(12.9)	(12.9)	(8.4)	(83.2)	(62.8)	(7.0)	(9.3)
Postgraduate	95.0***	54.9***	110.6***	273.8***	191.0**	3.6	−15.6
	(16.8)	(16.6)	(10.7)	(98.2)	(88.7)	(9.0)	(14.8)
College × Post	23.1	15.8	9.7	476.1***	180.5*	22.0**	13.3
	(16.6)	(16.5)	(10.0)	(115.7)	(92.2)	(9.7)	(13.1)
Postgraduate × Post	107.5***	79.4***	79.7***	734.2***	230.6*	33.3***	27.8
	(24.0)	(23.9)	(16.7)	(135.1)	(119.4)	(11.6)	(18.0)
Experience	8.3***	8.2***	5.5***	32.8***	−1.6	2.6***	2.7**
	(1.4)	(1.4)	(0.6)	(7.3)	(9.6)	(0.8)	(1.2)
Experience^2	−0.2***	−0.2***	−0.1***	−0.2	0.4*	−0.0***	−0.1***
	(0.0)	(0.0)	(0.0)	(0.1)	(0.2)	(0.0)	(0.0)
Female	−47.9***	−47.4***	−43.4***	−434.0***	−202.5***	−17.8***	−4.5
	(10.5)	(10.5)	(8.2)	(67.4)	(52.3)	(4.5)	(6.3)
White	33.4***	33.2***	31.7***	166.6**	90.5*	6.2	1.7
	(9.5)	(9.5)	(6.3)	(72.2)	(46.6)	(4.9)	(6.6)
Married	28.9***	29.2***	35.1***	348.8***	242.2***	9.2*	−6.2
	(10.3)	(10.4)	(6.8)	(63.3)	(50.7)	(4.9)	(6.7)
H_0: College × Post = Postgrad × Post							
F-stat	12.30	7.027	14.32	3.169	0.187	0.916	0.648
P-value	0.000	0.008	0.000	0.075	0.666	0.338	0.421
N. of Obs.	7250	7250	7250	7250	7250	7250	7250

Notes: All monetary values are in thousands of dollars at constant 2010 prices. GCG denotes gross capital gains equal to $\lambda(M-k)$, NCG denotes net capital gains equal to $\lambda(M-k)-\rho k$. Post is a dummy equal to 1 for the years after 2000. All regressions include year dummies. See Table 2 for the definition of the other variables. Bootstrapped standard errors in parentheses, *** $p-value<0.01$, ** $p-value<0.05$, * $p-value<0.1$.

Table 4
Trend in the skill premium: time trend specification.

	(1) θ	(2) ϕ	(3) $d+l$	(4) M	(5) k	(6) GCG	(7) NCG
College	57.0***	38.7**	49.3***	287.4**	136.4	19.6*	7.8
	(18.8)	(18.8)	(11.5)	(120.5)	(99.0)	(10.5)	(14.5)
Postgraduate	56.3***	25.0	82.7***	45.0	162.7	−7.2	−26.5
	(20.3)	(20.1)	(13.5)	(118.9)	(124.7)	(10.8)	(19.0)
College × Year	1.0	0.6	0.7	28.0***	12.7*	1.0	0.4
	(1.2)	(1.2)	(0.7)	(7.9)	(7.2)	(0.7)	(1.0)
Postgraduate × Year	7.5***	5.6***	5.5***	48.6***	12.1	2.2***	2.0*
	(1.4)	(1.3)	(0.9)	(8.7)	(8.4)	(0.7)	(1.2)
Experience	8.3***	8.3***	5.6***	32.9***	−1.8	2.7***	2.8**
	(1.4)	(1.4)	(0.6)	(7.4)	(9.6)	(0.8)	(1.2)
Experience^2	−0.2***	−0.2***	−0.1***	−0.2	0.4*	−0.0***	−0.1***
	(0.0)	(0.0)	(0.0)	(0.1)	(0.2)	(0.0)	(0.0)
Female	−47.8***	−47.3***	−43.3***	−436.9***	−205.1***	−17.8***	−4.4
	(10.5)	(10.5)	(8.3)	(68.6)	(52.9)	(4.5)	(6.3)
White	33.6***	33.4***	31.8***	168.1**	90.5*	6.2	1.8
	(9.5)	(9.5)	(6.3)	(72.3)	(46.6)	(4.9)	(6.6)
Married	29.4***	29.7***	35.2***	354.0***	242.1***	9.6*	−5.8
	(10.4)	(10.4)	(6.9)	(63.8)	(51.1)	(5.0)	(6.8)
H_0 : College × Year = Postgraduate × Year							
F-stat	16.85	10.30	17.72	3.671	0.004	2.265	1.696
p-value	0.000	0.001	0.000	0.055	0.950	0.132	0.193
N. of Obs.	7250	7250	7250	7250	7250	7250	7250

Notes: All monetary values are in thousands of dollars at constant 2010 prices. GCG denotes gross capital gains equal to $\lambda(M-k)$, NCG denotes net capital gains equal to $\lambda(M-k)-\rho k$. Year is a variable equal to the calendar year. All regressions include year dummies. See Table 2 for the definition of all the other variables. Bootstrapped standard errors in parentheses, *** $p-value<0.01$, ** $p-value<0.05$, * $p-value<0.1$.

as the break point, might actually underestimate the differences in the increase in returns.

4.2. Labor market skills and selection

Since individuals endogenously self-select into both education and entrepreneurship, the previous evidence could be driven by self-selection rather than by a genuine increase in the return to education for entrepreneurs relative to employees. To address the issue we consider the following simple stripped-down model of educational and occupational choices. Assume the individual is born with ability a and sequentially chooses her education level s and whether to become entrepreneur or employee in order to maximise life-time earnings. Acquiring education entails a cost $C(s, a, \xi)$, where ξ is a random shock inducing some random variation in s for given a. It is natural to assume that acquiring education is costly and more so for less talented individuals, so that $C_s > 0$, $C_{ss} > 0$ and $C_{sa} < 0$. As in Queiro (2016), the return to entrepreneurship θ and the labor income as employee w of the individual depend on her education s and ability a as follows:

$$\theta = \beta_{\theta 0} + \beta_{\theta s} s + \beta_{\theta a} a + \epsilon \tag{13}$$

$$w = \beta_{w0} + \beta_{ws} s + \beta_{wa} a + u \tag{14}$$

where $\beta_{ji} > 0$ measures the return to education $i = s$ or innate ability $i = a$ for the individual if she chooses to start-up a business, $j = \theta$, or to work as employee, $j = w$, while ϵ and u are random shocks (possibly due to measurement error) orthogonal to s and a. Given s and a, the individual becomes an entrepreneur if the expected return from starting-up a business is greater than her permanent labor income as employee, i.e. if $\mathbb{E}(\theta) > \mathbb{E}(w)$, and chooses her educational level s by maximizing her expected life-time income, $\underset{s}{\text{Max}}\{\text{Max}[\mathbb{E}(\theta), \mathbb{E}(w)] - C(s, a, \xi)\}$. Since individuals endogenously self-select into both education and entrepreneurship, in equilibrium s and a are (positively) correlated in the overall population and this correlation generally differs among entrepreneurs and employees.

Our primary object of interest is how the return to schooling for entrepreneurs $\beta_{\theta s}$ in (13) has evolved over time and whether it has increased more than the analogous return for employees, as measured by β_{ws} in (14), leading to an increase in $\beta_{\theta s} - \beta_{ws}$. The problem is that, due to self-selection, failing to properly control for a when regressing θ on s in the population of entrepreneurs leads to an (upward) bias in the estimate for $\beta_{\theta s}$, whose magnitude can change over time if the selection process changes. Generally, self-selection can explain the increased return to education for entrepreneurs observed in the data if the increase is due to (i) an increased correlation between s and a in the overall population (highly talented individuals self-select more into higher education); (ii) an increased correlation between s and a in the population of entrepreneurs (at higher education talented individuals self-select more into entrepreneurship as opposed to paid employment); or (iii) an increase in the general return to skill for entrepreneurs (higher $\beta_{\theta a}$). The first possibility is unlikely to drive our results. Firstly, the share of people with higher education has increased over time, suggesting that, if anything, their innate ability has become less positively selected over time. Secondly, and more importantly, the evidence indicates that not only θ but also the extra return to entrepreneurship ϕ—which compares entrepreneurs and employees with the same educational level—has increased with education. In any case, to evaluate whether self-selection drives our results, we solve for a in (14) and then substitute the resulting expression into (13), which yields

$$\theta = \tilde{\beta}_{\theta 0} + \left(\beta_{\theta s} - \frac{\beta_{\theta a}}{\beta_{wa}}\beta_{ws}\right)s + \frac{\beta_{\theta a}}{\beta_{wa}}w - \frac{\beta_{\theta a}}{\beta_{wa}}u + \epsilon. \tag{15}$$

Eq. (15) suggests regressing entrepreneurial returns θ on the education of the entrepreneur s after controlling for her (past) wage as employee, which we take as a measure of w. An increased coefficient on education in this regression indicates that the return to education has increased more in entrepreneurship than in paid employment (higher $\beta_{\theta s} - \beta_{ws}$), if (i) the relative return to ability in entrepreneurship, as measured by $\frac{\beta_{\theta a}}{\beta_{wa}}$, is close to (or greater than) one and (ii) it has remained relatively stable over time. Both conditions can be tested by estimating (15), since the coefficient on w in (15) identifies $\frac{\beta_{\theta a}}{\beta_{wa}}$.

A remaining important issue in running the regression in (15) arises because the past wage of today entrepreneur w is generally correlated with the error term u, due to (14). To fix this endogeneity problem, we instrument w with the education of the entrepreneur's spouse. The idea is that, in the marriage market, individuals sort based on their permanent income $\mathbb{E}(\theta)$ and $\mathbb{E}(w)$ rather than on temporary income shocks or measurement errors in wages. So the education of the spouse is correlated with the ability of the individual but not with transitory shocks to wages u, which makes it a valid instrument when estimating (15). In the data w is measured using the earnings of the entrepreneur in the previous job as employee and we instrument it using the years of education of the entrepreneur's spouse.[12] To address the concern that a higher return to entrepreneurship θ might affect the marriage prospects of the entrepreneur (say the spouse education might be correlated with ϵ in (13)), we run the regression on the sample of entrepreneurs who married their current spouse before starting-up their business.

Table 5 reports the result from estimating (15). The first two columns are OLS estimates. Column (1) reiterates the regression in (12) on the sample of entrepreneurs with a stable marriage who worked as employees in their previous job. The results are similar to those in Table 3, although now the increase in the premium to postgraduate education is slightly larger (a result we come back to in Section 7). In Column (2) we add the *Past Wage* of the entrepreneur as a control, and we allow it to vary between the pre- and post-2000 period. The coefficient on *Past Wage*, measuring $\frac{\beta_{\theta a}}{\beta_{wa}}$, is close to one and roughly stable over time.

As expected from (15), the coefficient on the return to education falls in absolute terms, but the time profile of returns changes little: the increase in total returns for postgraduates, as measured by the *Postgrad* × *Post* interaction, diminishes just slightly, from $137,800 to $130,600, but it remains statistically significant. Column (3) reports the IV second stage-regression, columns (4) and (5) the first stage regressions. A standard F test indicates that the instruments are highly relevant. As expected, more educated spouses are married with entrepreneurs with higher wages, column (4), and we find no evidence that the relation has changed over time, column (5). In the second-stage regression, the coefficient on *Past Wage* increases relative to the OLS estimate in column (2) to a value well above one, suggesting that skill generally matters more for entrepreneurs than for employees. The increase relative to the OLS estimate is consistent with a positive correlation between w and u in (15). The *Postgrad* × *Post* interaction falls slightly relatively to the OLS estimates in column (2), from $130,600 to $120,000, but it remains statistically significant. Overall this evidence suggests that $\beta_{\theta s} - \beta_{ws}$ has gone up, meaning that the return to education has increased more in entrepreneurship than in paid employment, with self-selection playing a minor role in driving the results in Table 3.

5. Differences across the distribution of returns

We now study whether there are differences in the increase of the return to education at different quantiles of the distribution of returns. Fig. 6 reports the total returns θ to the three educational groups at the 25th, 50th, 75th and 90th percentiles. The returns at the lowest quartile (panel a) are meager, averaging $20,000, slightly higher for postgraduates than for the other two groups. The overall time profile of this quartile is flat for all three groups. Indeed, after a sharp increase in 2007, the returns for postgraduates dropped substantially and have remained aligned with those for the other two groups. The increase in the premium to higher education emerges very clearly at the median (panel b), and it increases (in absolute value) at the higher percentiles of the distribution (panel c and d). This suggests that the increase in the average depends on a shift in the right part of the distribution, while the returns of the low performing entrepreneurs have behaved similarly across educational groups.

This graphical evidence is confirmed by the regression analysis. Table 6 reports the results of quantile regressions at the 25th, 50th, 75th, 90th and 95th percentiles of the distribution of returns for the pre-post specification (the specifications with time trends and time dummies are reported in the Appendix). There is no evidence of an increase in the return to education at the bottom quartile: the coefficients for total returns for both college graduates and postgraduates tend to be negative when interacted with the post-2000 dummy, although the effects are not significantly different from zero, and there is no statistically significant evidence that any component of returns has behaved differently across educational groups in the post-2000 period.

For postgraduates, the increase in the premium relative to high school graduates in the post-2000 period is already appreciable at the median: the increase in total return is equal to around $31,000, almost

[12] A possible threat to the validity of the instrument arises if the spouse either works directly in the business or contributes to its success indirectly through some social informal activities. Unfortunately the SCF data do not allow us to control for the involvement of the spouse in the business activities.

Table 5
Trend in skill premium controlling for selection and the return to working skills.

	(1) OLS	(2)	(3) IV	(4) First stage	(5)
	θ	θ	θ	Past wage	Past wage × Post
College	53.4***	34.9*	−7.6	18.5***	0.7
	(20.1)	(19.1)	(43.9)	(6.6)	(1.5)
Postgrad	128.2***	103.0***	45.4	25.3***	2.0
	(28.2)	(27.2)	(65.8)	(6.9)	(1.8)
College × Post	42.8	47.3*	60.3	−8.0	9.8
	(26.9)	(27.0)	(44.5)	(16.1)	(14.4)
Postgrad × Post	137.8***	130.6***	119.9*	5.4	28.4
	(37.3)	(40.0)	(66.1)	(19.9)	(19.4)
Experience	15.9***	13.8***	9.3***	2.8***	2.0***
	(2.9)	(2.8)	(3.4)	(0.7)	(0.6)
Experience^2	−0.3***	−0.2***	−0.1**	−0.1***	−0.0***
	(0.1)	(0.0)	(0.1)	(0.0)	(0.0)
Female	−171.0	−127.9	−36.5	−66.7**	−67.3**
	(343.0)	(339.3)	(347.6)	(30.5)	(33.2)
White	55.1**	58.0**	63.2***	−8.4	−13.8
	(22.9)	(23.3)	(24.0)	(22.3)	(22.3)
Past wage		0.9***	3.1*		
		(0.3)	(1.9)		
Past wage × Post		−0.4	−1.3		
		(0.3)	(1.8)		
Spouse educ				11.8	−2.2
				(7.5)	(2.7)
Spouse educ^2				−0.4	0.1
				(0.3)	(0.1)
Spouse educ × Post				−5.4	9.8
				(19.3)	(17.4)
Spouse educ^2 × Post				0.5	0.0
				(0.6)	(0.5)
	H_0: College × Post = Postgrad × Post			H_0: Instruments jointly insignificant	
F-stat	5.040	4.298	1.594	19.07	11.19
P-value	0.025	0.038	0.207	0.001	0.025
N. of Obs.	2223	2223	2223	2223	2223

Notes: The sample comprises entrepreneurs with work experience as employees prior to their entrepreneurial venture and a stable marriage. Past wage is earnings in the longest previous job that lasted at least three years. *Spouse educ* is the spouse's years of education. All monetary values are in thousands of dollars at constant 2010 prices. See Table 2 for the definition of the other variables. Bootstrapped standard errors in parentheses, $^{***}\ p-value < 0.01$, $^{**}\ p-value < 0.05$, $^{*}\ p-value < 0.1$.

entirely accounted for by the sum of labor income and dividends. The increase in the premium to postgraduate education is greater at the higher percentiles—more than $300,000 per year at the 95th percentile. Interestingly, in this case capital gains account for almost a quarter of the overall increase, which reflects the fact that, at this percentile, the value of the business has increased by almost $2 million more for postgraduates than for high school graduates. For college graduates, the increase in returns is statistically significant only at the 90th and 95th percentiles, at $136,000 and $175,000 per year, respectively. At the 95th percentile the contribution of the net capital gain is even larger than for postgraduates. A similar picture emerges from the specifications with the time trend or the time dummies (see the Appendix).

Overall, there is evidence that the entire distribution of returns has become more favorable to more highly educated entrepreneurs. The increase in the return to education is more pronounced in the right tail of the distribution, while returns at the bottom have evolved similarly across educational groups. For postgraduates, the increase in the premium relative to high school graduates is perceptible at the median and increases as we move towards the right side of the distribution, while for college graduates it only emerges at the higher percentiles, where the contribution of the capital gain component is greater.

6. Further evidence

We discuss the robustness of the results to possible biases in the measure of returns and to differences in ability as measured by earnings in the previous job. The section concludes by discussing evidence from the Current Population Survey (CPS).

6.1. Some measurement biases

In constructing the measure for the entrepreneurial return θ in (11) we assumed that the entrepreneur exits the venture only by selling the business. But businesses can also fail before they can be sold. This introduces a first type of bias in the measure for the entrepreneurial return θ, which we call *valuation bias*. This arises because entrepreneurs in the SCF report the market value of their business and not the wealth that they expect to realize upon exit, which could be due to failure rather than a decision to sell. Moreover, the rates at which entrepreneurs exit may be heterogeneous. For example, worse businesses may be more likely to fail, or else entrepreneurs running better businesses may be able to sell more quickly. This heterogeneity introduces a second type of bias, which we call *composition bias*. Finally, as discussed in Gompers et al. (2010) and Hall and Woodward (2010), after exiting the current venture, an entrepreneur can recycle his entrepreneurial skills and start a new venture, which implies that the return to entrepreneurship should be cumulated over the expected future sequence of possible ventures. Failing to control for this might produce what we call *recycling bias*. In the appendix we formally characterize these biases and carefully discuss how we handled them in the SCF. Here we briefly discuss why the these biases are unlikely to explain the observed increased return to education.

The valuation bias is unlikely to explain the differential trend in returns because the average value of the businesses upon failure and the time profile of failure rates exhibit a common trend across educational groups. Composition bias arises because entrepreneurs who exit their venture more slowly are overrepresented in the cross-section of current

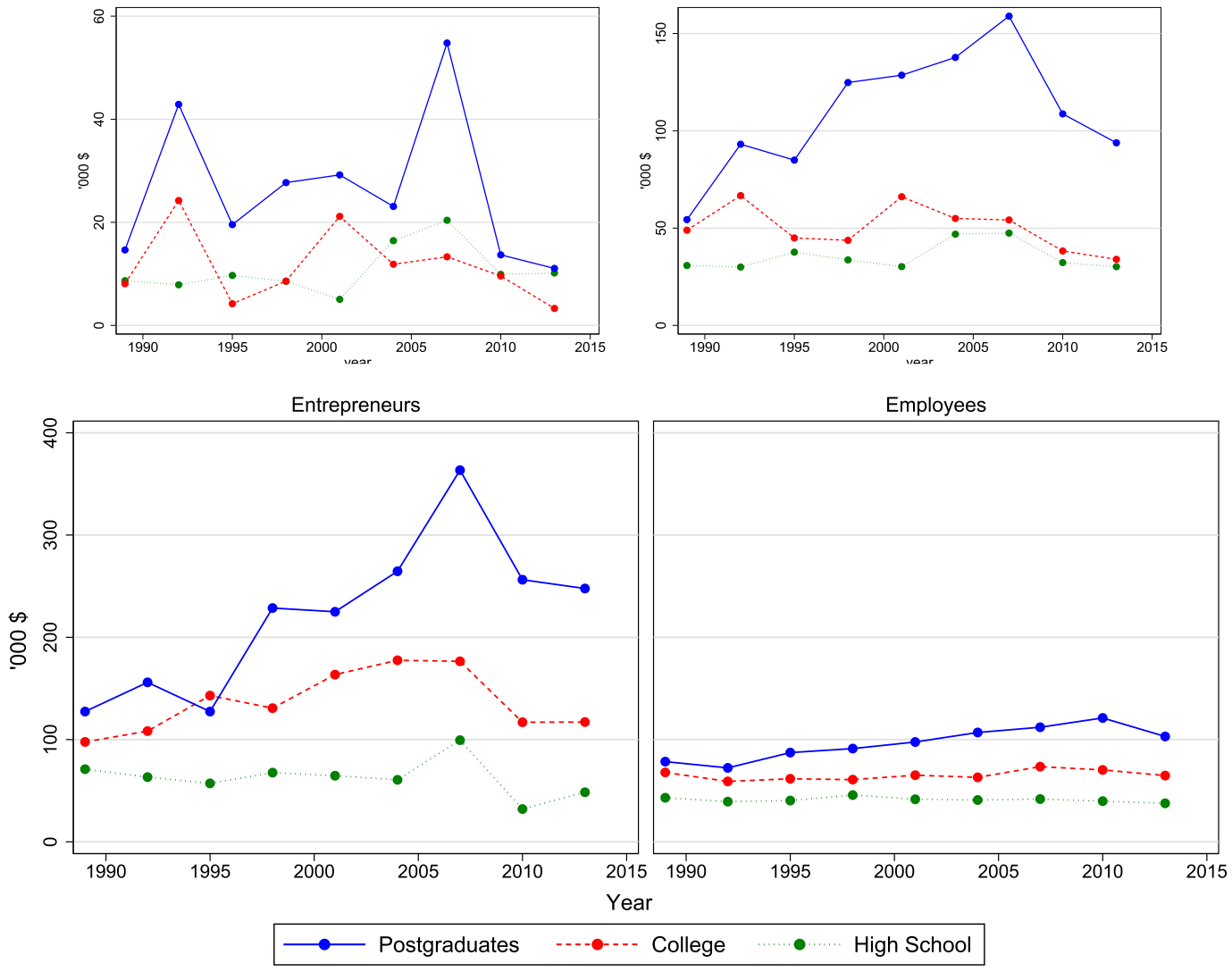


Fig. 6. Total returns θ at different percentiles of the return distribution.
Source: Own calculations using the Survey of Consumer Finances, the Longitudinal Business Database and the S&P500 Total Return Index. Values are in thousands of dollars at constant 2010 prices.

entrepreneurs. The sign of the bias generally depends on whether the composition effect is driven by heterogeneity in failures rate or in the selling opportunities arrival rate (see the Appendix for further details). This bias is small for recent entrepreneurial ventures while it gets potentially more and more important when focusing on older ones. So by comparing the value of current income $d + l$—which represents a major component of entrepreneurial returns— between recent ventures and relatively older ones, we can evaluate the sign and relevance of the composition bias. In Fig. 7 we report the time profile of $d + l$ for ventures up to 5 years of age and those older than 5 years. We exclude ventures in their first year of existence, which are unlikely to distribute dividends, but the results are similar when they are included. The time profile of total current income $d + l$ is similar for young and old ventures, and in both groups the returns for postgraduates increased substantially more than for college and high school graduates. This conclusion is confirmed by the more formal results reported in Table 9 below, which displays the evolution of the skill premium controlling for the age of the venture, whose effect is allowed to vary by educational group and over time. Overall, we take this evidence as indicating that the composition bias is unlikely to account for the increase in the premium to postgraduate education in entrepreneurship.

To analyze the effect of serial entrepreneurship on returns, we calculate the probability of the exited entrepreneur's starting up a new venture. This recycling probability is constructed by identifying within the SCF the set of individuals who were entrepreneurs in their past job. The evidence indicates that the recycling probability has remained constant for all educational groups. Once we construct a measure of entrepreneurial returns adjusted for the possibility that the entrepreneur can recycle her entrepreneurial skills in another venture, we see that the measure has evolved very similarly to the baseline measure plotted in Fig. 3, which suggests that changes in the patterns of serial entrepreneurship are unlikely to explain the increasing return to education.

6.2. Other data sources

We believe that SCF is best suited for the purpose of analyzing the time evolution of returns to education for US entrepreneurs because (i) it is fully representative of the US wealth distribution including at its very top, where entrepreneurs are more likely to be present, (ii) it measures accurately the educational level of individuals, and (iii) it contains detailed information on the businesses they run. Yet we explored whether we could obtain evidence of an increasing return to education in other

Table 6
Quantile regressions, pre-post specification.

	(1) θ	(2) ϕ	(3) $d+l$	(4) M	(5) k	(6) GCG	(7) NCG
Post interacted with:							
				25th percentile			
College	−4.4	−6.9	−2.8	6.0	2.1	−0.2	−1.2
	(4.4)	(4.4)	(5.2)	(5.2)	(1.8)	(0.2)	(0.9)
Postgrad	−8.4	−14.8*	−9.0	14.2	1.2	−0.1	3.7
	(7.7)	(7.7)	(8.1)	(11.1)	(1.4)	(0.3)	(4.6)
				50th percentile			
College	−5.6	−10.6	2.2	34.7	16.4**	−0.1	−0.6
	(6.4)	(6.7)	(5.3)	(25.1)	(6.5)	(0.9)	(0.4)
Postgrad	30.9***	15.8	32.1**	54.4	16.3	1.1	0.1
	(11.1)	(11.2)	(12.8)	(35.2)	(13.6)	(0.9)	(0.5)
				75th percentile			
College	4.1	−3.6	9.8	79.6	73.1**	0.6	0.2
	(15.9)	(16.3)	(13.1)	(91.0)	(34.2)	(7.9)	(5.2)
Postgrad	66.5***	35.4	46.5**	386.3***	142.7***	6.8	4.3
	(23.6)	(22.8)	(21.7)	(85.6)	(50.8)	(4.4)	(4.0)
				90th percentile			
College	136.0***	118.4**	44.9	1468.3***	366.7**	27.4	9.2
	(47.4)	(49.3)	(36.8)	(346.3)	(168.9)	(26.9)	(24.8)
Postgrad	179.9***	128.8***	150.4***	1739.2***	578.5***	45.4**	40.0**
	(49.6)	(48.3)	(49.4)	(373.5)	(141.5)	(21.7)	(16.4)
				95th percentile			
College	175.0*	153.5	110.1	3248.6***	929.8**	137.3***	100.1**
	(97.4)	(98.2)	(77.3)	(755.7)	(406.7)	(48.6)	(40.6)
Postgrad	302.6***	207.5**	250.5***	2062.2**	1127.4**	85.5	90.7**
	(88.8)	(97.6)	(69.1)	(879.7)	(496.0)	(52.2)	(35.6)

Notes: Results for separate quantile regression. All monetary values are in thousands of dollars at constant 2010 prices. GCG denotes gross capital gains equal to $\lambda(M-k)$, NCG denotes net capital gains equal to $\lambda(M-k)-\rho k$. To save on space, we only report the education dummies College and Postgrad interacted with the Post dummy. All regressions also include education dummies not interacted with the post dummy, year dummies, a quadratic in experience, dummies for female, white and married entrepreneurs. See Table 2 for the definition of the other variables. Bootstrapped standard errors in parentheses, *** $p-value<0.01$, ** $p-value<0.05$, * $p-value<0.1$.

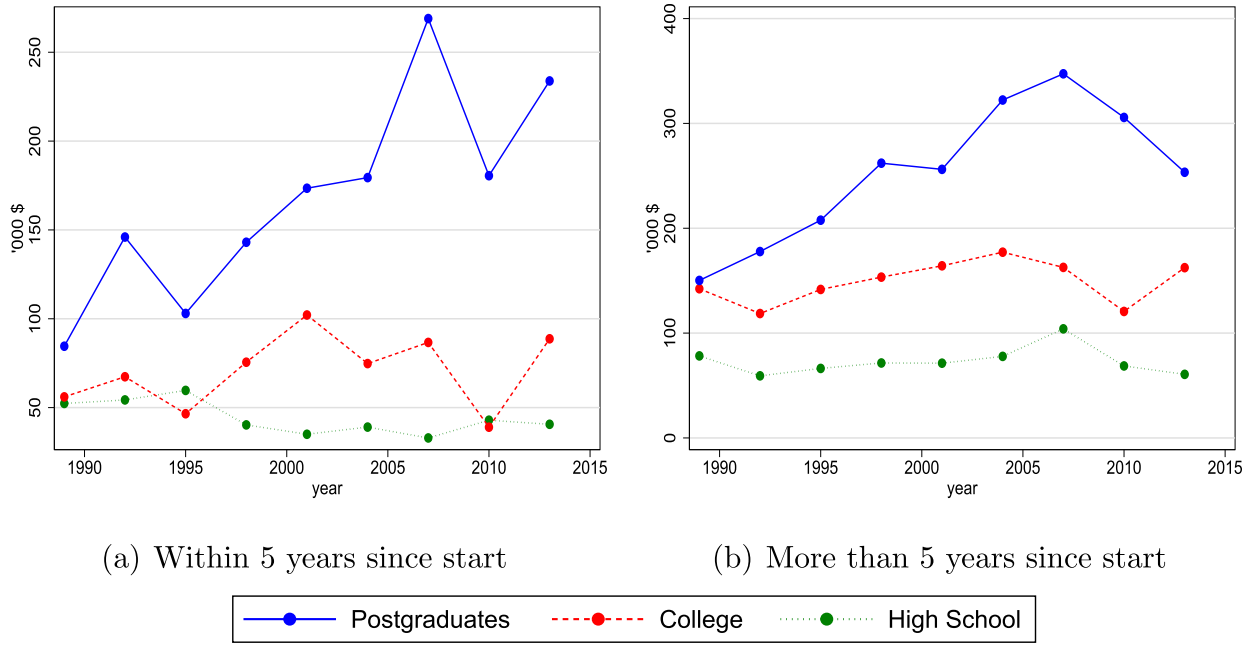


Fig. 7. Dividends plus labor income for different venture ages.
Source: Own calculations using the Survey of Consumer Finances, the Longitudinal Business Database and the S&P500 Total Return Index. Values are in thousands of dollars at constant 2010 prices.

data set such as the March Current Population Survey (CPS) or the National Longitudinal Survey of Youth (NLSY).

The CPS is the official source of information on the labor market in the US (see the appendix for a brief description, the precise definition of the variables and some descriptive statistics). Since CPS contains no information on business ownership, we defined as *Entrepreneur* any individual who declares to be self-employed as her main occupation, which includes, but not perfectly identifies, business owners actively managing their business. Earnings data are based on the question "What was your net earnings from this business after expenses during year ....?" and focus on full-time workers. Relative to the SCF, average entrepreneurial income in the CPS is forty percent lower, with a standard deviation

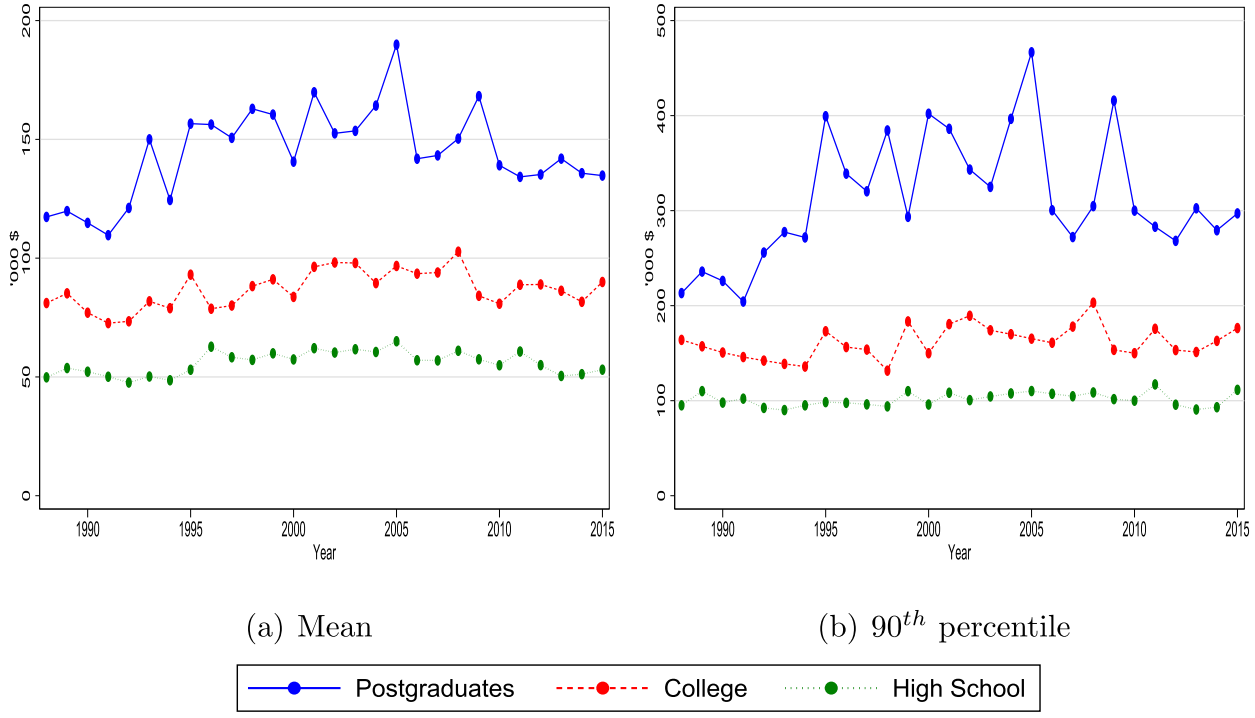


Fig. 8. Entrepreneurs' income in the CPS.
Source: Own calculations using the Current Population Survey. Values are in thousands of dollars at constant 2010 prices.

ten times lower. This clearly reflects the fact that in the CPS capital gains are not measured, the definition of entrepreneurs is less restrictive, and data are topcoded. Fig. 8 plots the mean and the 90th percentile of the resulting distribution of income for entrepreneurs according to their educational attainment. There is evidence of an increasing return to education for entrepreneurs, although, as expected, the trend appears less starkly than in the SCF (see Fig. 2 for a comparison). The average yearly income for postgraduates goes from around 110,000$ per year at the beginning of the sample period to around 170,000$ per year just before the Great Recession, declining to a value slightly lower than 150,000$ afterwards. There is also some sign of a mild upward trend in the income of entrepreneurs with a college or a high school degree before the Great Recession, but the trend completely disappears once considering the post-recession period. As a result, the premium to postgraduate education has increased. The increase in the premium appears more markedly when looking at the 90th percentile: the income of postgraduates has doubled since the beginning of the sample period until before the Great Recession and it has remained 50% higher in the post recession years, while the income profile of entrepreneurs with a college or a high school degree have both remained fairly flat.

We also considered using the NLSY, already analyzed in the entrepreneurship literature (e.g., Manso, 2016; Van Praag et al., 2013). Each wave of NLSY follows a cohort of youth over time and by comparing the return to education in different waves one could identify changes in the return to education. In practice we failed in implementing this alternative empirical strategy. The first wave (NLSY79) started in 1979 and included 12,686 individuals born in the years 1957–64. The second wave started in 1997 (NLSY97) and included 9000 individuals born in the years 1980–84. Once we defined as entrepreneur any individuals whose primary job consists of actively managing one or more privately-held businesses which they own in part or in full, in the NLSY97 we were left with just 51 entrepreneurs with a college degree and only 33 with a postgraduate degree, making inference unreliable.

7. What explains the increase in the skill premium?

We now show that the complementarity between higher education and labor market experience has strengthened; and that this accounts for a good portion of the increase in the premium to postgraduate education. This finding, as we shall see, is robust to several possible alternative explanations.

7.1. EE-Complementarity

The skills that are relevant for entrepreneurship are acquired partly through formal education and partly through labor market experience (Evans and Leighton, 1989). In fact, entrepreneurs might benefit from a balanced mix of theoretical competence and practical expertise.[13] We now investigate whether the complementarity between theoretical competence provided by formal education and practical expertise gained by labor market experience (EE-complementarity) has changed over time and whether this can help account for the differential time profiles of returns between educational groups. To fix ideas, let us posit that the total return of an entrepreneur $\theta(s, x)$ is a function of both formal education s and labor market experience x. An increase in the skill premium θ will then be the result of an increase in the return to education θ_s, in the return to experience θ_x, or in EE-complementarity θ_{sx}.

To analyze the evolution of EE-complementarity, we introduce one dummy if the entrepreneur had some labor market experience prior to the current venture, YX=1, and another if she did not, NX=1 (SCF mnemonic X4514). Fig. 9 plots the share of entrepreneurs with YX=1. This share has evolved very similarly across educational groups, slipping marginally from around 60% in the late 1980s to 55% in the last years of our sample period.

[13] The 'jack-of-all-trades' hypothesis that entrepreneurs benefit from a balanced mix of skills was introduced by Lazear (2004,2005); see Wagner (2006), Silva (2007), Astebro and Thompson (2011) and Iversen et al. (2016) for supporting empirical evidence.

Table 7
Trends in the skill premium by labor market experience.

	(1) θ	(2) ϕ	(3) $d+l$	(4) M	(5) k	(6) GCG	(7) NCG
High Sch. × *YX*	−24.0	−24.0	−22.9***	−338.1***	−163.3**	−14.8	−1.1
	(14.8)	(14.8)	(7.8)	(114.8)	(65.5)	(9.9)	(11.0)
College × *NX*	34.0	14.0	51.3***	373.0**	321.7**	5.7	−17.3
	(25.5)	(25.6)	(16.0)	(173.3)	(154.6)	(14.0)	(20.4)
College × *YX*	47.4**	27.4	30.6***	40.9	−41.7	13.3	16.8
	(18.6)	(18.6)	(10.5)	(131.3)	(69.1)	(12.0)	(13.4)
Postgrad × *NX*	106.1***	66.0***	99.1***	121.5	−19.0	7.6	7.1
	(24.2)	(24.1)	(15.4)	(171.7)	(113.2)	(13.8)	(16.6)
Postgrad × *YX*	62.5**	22.5	93.7***	8.8	149.4	−14.7	−31.2
	(26.1)	(26.0)	(15.0)	(132.7)	(138.2)	(13.9)	(23.9)
Post interacted with:							
× High Sch. × *YX*	19.7	19.5	4.3	102.0	−78.2	15.3	15.4
	(20.3)	(20.3)	(9.5)	(138.2)	(134.3)	(12.4)	(16.9)
× College × *NX*	21.2	13.9	−13.3	405.1*	−1.0	34.7*	34.5
	(31.7)	(31.7)	(18.2)	(227.0)	(214.5)	(18.5)	(27.2)
× College × *YX*	49.9*	42.5	33.5**	641.5***	222.2	30.4**	16.4
	(27.0)	(27.0)	(15.0)	(169.6)	(143.0)	(15.1)	(19.7)
× Postgrad × *NX*	54.9	26.4	44.6*	473.3**	149.1	21.9	10.4
	(34.0)	(34.1)	(24.0)	(227.1)	(175.8)	(17.3)	(22.5)
× Postgrad × *YX*	170.1***	142.1***	115.8***	1087.7***	254.7	58.1***	54.4*
	(36.8)	(36.9)	(23.5)	(171.1)	(204.4)	(17.2)	(29.7)
H_0: College×NX×Post =College×YX×Post							
F-stat	0.747	0.744	4.730	1.271	1.468	0.057	0.501
p-value	0.387	0.388	0.030	0.260	0.226	0.811	0.479
H_0: Postgrad×NX×Post =Postgrad×YX×Post							
F-stat	8.395	8.470	5.622	8.193	0.310	4.977	2.687
p-value	0.004	0.004	0.018	0.004	0.578	0.026	0.101
Obs	7250	7250	7250	7250	7250	7250	7250

Notes: All monetary values are in thousands of dollars at constant 2010 prices. *NX* is a dummy for no previous labor market experience before staring the business and *YX* is a dummy for some experience. GCG denotes gross capital gains equal to $\lambda(M-k)$, NCG denotes net capital gains equal to $\lambda(M-k)-\rho k$. All regressions include year dummies, a quadratic in experience, dummies for female, white and married entrepreneurs. See Table 2 for the definition of the other variables. Bootstrapped standard errors in parentheses, *** $p-value<0.01$, ** $p-value<0.05$, * $p-value<0.1$.

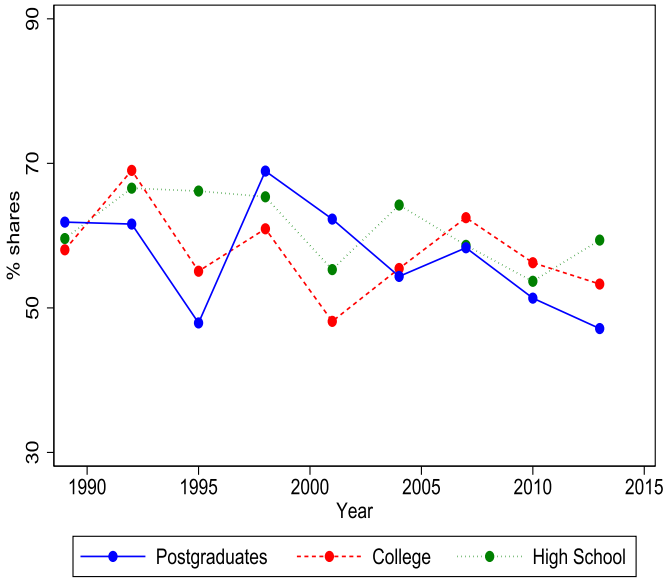


Fig. 9. Share of entrepreneurs with previous labor market experience.
Source: Survey of Consumer Finances.

We then run the same regressions as in Table 3, but now interacting the two experience dummies *YX* and *NX* with the three educational levels and allowing the interactions to vary between pre-2000 and post-2000. Entrepreneurs with a high school degree and no prior experience are the reference group.

The results in Table 7 indicate that the return to entrepreneurship has increased principally for entrepreneurs with some previous labor market experience, provided they are sufficiently well educated. High school graduates show no increase in the return to entrepreneurship regardless of experience. The difference in the increase in the return between entrepreneurs with and without previous work experience emerges for college graduates and becomes large and significant for postgraduates. The return for entrepreneurs with postgraduate education and some labor market experience was about $170,000 greater in the post-2000 period than the pre-2000 period, while for entrepreneurs with postgraduate education but no experience the gain came to only $55,000, not statistically significant different from zero.[14] This indicates that EE-complementarity θ_{sx} has strengthened, and especially for postgraduates. The last rows in the table show the significance level for the null hypothesis that the increase in the return to education has been the same for entrepreneurs with and without previous work experience. The null hypothesis of equality cannot be rejected for college graduates but is strongly rejected for postgraduates. The other columns consider the excess return ϕ and the components of θ. The sum of labor income and dividends accounts for two thirds of the increase in EE-complementarity, with net capital gains accounting for the remaining one third.

Overall, the evidence indicates that the combination of the advanced theoretical competence provided by postgraduate education and the applied practical expertise acquired through labor

[14] One concern is that entrepreneurs with labor market experience might consist mostly in holders of an MBA, which typically requires some job experience before enrollment. To check that the increase in the return to experience for postgraduates does not reflect just an increase in returns to an MBA, we run the same regression as in Table 7 excluding all entrepreneurs with master's degrees. This specification yields very similar results: entrepreneurs with a PhD and some experience record an increase in returns of $158,000 per year (significant at the 1% level) while those without experience show an increase of just $73,000, significant only at the 10% level.

market experience has become increasingly valuable to successful entrepreneurship.[15]

Decomposition We assess the contribution of increased EE-complementarity in explaining the different trends in entrepreneurial returns documented in Section 4. To do so, we perform a decomposition of the differential changes in returns between two educational groups into a component that measures changes in returns for given levels of experience (the "within" component), a component that accounts for changes in the composition of experience levels (the "between" component) and a cross term.[16] Let $\omega_s(x)$ denote the fraction of entrepreneurs with education s who have labour market experience x, where $x = y$ and $x = n$ identifies entrepreneurs with and without previous experience, respectively. The average return for entrepreneurs with education s can be written as

$$\mathbf{E_s}(\theta) = \sum_{x=y,n} \theta(s,x)\omega_s(x). \tag{16}$$

Consider two educational groups $\hat{s}$ and $\tilde{s}$, with $\hat{s}$ consisting of entrepreneurs with a postgraduate degree and $\tilde{s}$ of those with only a high school or a college degree. The contribution of the strengthened EE-complementarity to the overall change in differential returns is measured by $\Delta\theta(\hat{s},y)\omega_{\hat{s}}(y) - \Delta\theta(\tilde{s},y)\omega_{\tilde{s}}(y)$ where Δ denotes time changes. Given the estimates of the increase in the return to a postgraduate entrepreneurs with some experience, $\Delta\theta(\hat{s},y)$, (see Table 7) and the value of their shares $\omega_{\hat{s}}(y)$ in the pre-2000 sample period, this term is approximately equal to \$110,000 dollars, or 97% of the differential increase in entrepreneurial returns between postgraduates and high school graduates, which is equal to \$113,000 a year (Table 3).[17] The same decomposition for the differential change in returns between postgraduates and college graduates shows that the strengthened complementarity explains around 96% of the differential increase.

7.2. Robustness to alternative explanations

We now study the robustness of the conclusion that the strengthened complementarity between postgraduate education and previous labor market experience accounts for most of the increase in the return to postgraduate education. We show that it holds after controlling for several alternative explanations of the increase, such as changes in (i) sectoral specialization; (ii) access to internal or external finance; (iii) the entrepreneur's span of control; (iv) compensating differentials due to greater business risk; (v) the relevance of vintage technology effects; and (vi) the intergenerational transmission of wealth, see the Appendix for details on the construction of variables and Table 2 for descriptive statistics.

Sectoral specialization As Table 2 shows, entrepreneurs with different educational levels tend to operate in different sectors, and returns could vary by sector if entrepreneurial opportunities and entry barriers differ. The rising premium to postgraduate education could then be due to a pattern of sectoral specialization increasingly more favorable to postgraduate entrepreneurs either because they have specialized increasingly in high-return sectors or because sectoral returns have increased relatively more in the sectors that postgraduate entrepreneurs tend naturally to go into.[18] In practice, however, the sectoral composition of entrepreneurial ventures has remained stable over time: if anything, the sectoral specializations of college and postgraduate entrepreneurs have progressively become more similar. Fig. 10 plots the time profile of a simple index to measure differences in the sectoral specialization of two groups of entrepreneurs grouped by educational level e_1 and e_2. The index, which builds on Krugman (1993), is equal to $S(e_1,e_2) = \frac{1}{2}\sum_{n=1}^{N} |s_n^{e_1} - s_n^{e_2}|$, where s_n^j is the fraction of entrepreneurs of educational group $j = e_1, e_2$ active in sector $n = 1, 2, \ldots N$. The index has support on the [0,1]-interval: it is 0 when the two groups have the same sectoral shares and 1 when the shares are perfectly orthogonal. Comparing postgraduate and college entrepreneurs, we see that the index has fallen by 30 basis points since the late 1980s, which indicates that the two groups tend to specialize in more similar sectors.

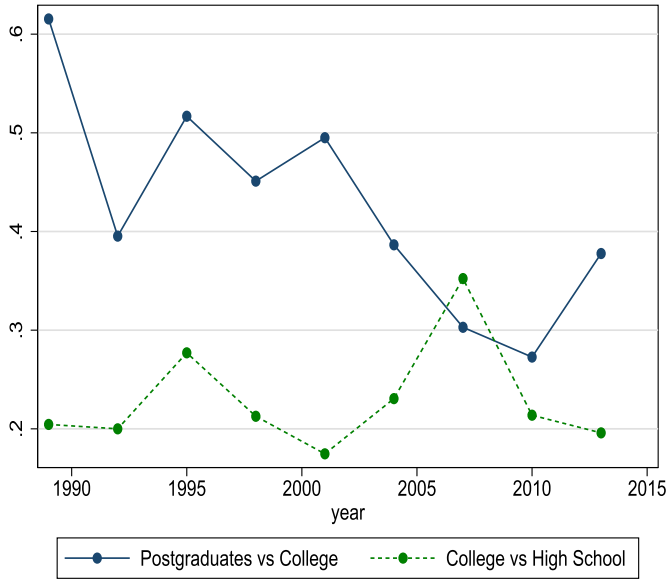


Fig. 10. Differences in patterns of sectoral specialization $S(e_1, e_2)$.
Source: Survey of Consumer Finances. The index is equal to $S(e_1,e_2) = \frac{1}{2}\sum_i |s_i^{e_1} - s_i^{e_1}|$, where s_i^j is the fraction of entrepreneurs of educational group $j = e_1, e_2$ working in sector i.

To formally evaluate the role of sectoral specialization in determining the rising premium to postgraduate education and the strengthened complementarity between education and experience, we augment the regressions of Table 7 with a full set of sectoral dummies both in levels and interacted with the post-2000 dummy. The excluded sector is Mining and Construction.

In the years up to 2000, the only significant sector dummy is Manufacturing, although ventures in Finance and TCU also show some evidence of yielding higher returns. In the post-2000 period, we observe significantly higher returns in Finance while those in TCU, where postgraduates tend to specialize, have if anything marginally decreased. The estimated coefficients for the changes in the return are reported in the first column of Table 8.[19] Controlling for sectoral composi-

[15] Interestingly, the strengthened complementarity is specific to entrepreneurship: when we run the same regression as in Table 7 but on a sample of employees rather than entrepreneurs, we find that the increases in wages for postgraduates with or without previous labor market experience are quantitatively similar (\$31,000 vs. \$27,000) and not statistically different from each other. The increase in wages for college graduates is also invariant to their previous labour market experience.

[16] To save on space, we formally derive the decomposition in the Appendix. Our approach follows the classical shift-share analysis used in the productivity growth literature (see, for example Foster et al., 2001) adapted to explain differential changes over time.

[17] The shares $\omega_s(x)$ have remained relatively stable over time and have evolved very similarly across educational groups (see Fig. 9). For example, the share of entrepreneurs with some previous work experience in the pre-2000 period is equal to 60% among both high school and college graduates and to 58% among postgraduates. In the post-2000 period, these shares are lower by 6, 5 and 1 percentage point for high school, college and postgraduates, respectively.

[18] When we ran the regression analogous to Table 3 after allowing the effect to vary by sector, we found that the return to education for entrepreneurs has increased more in Construction and Finance and Services (FIRE) than in Manufacturing, Trade activities, and Communication and Utilities (TCU), but differences were not statistically significant, maybe due to the limited sample size.

[19] To save on space, we only report the results for overall returns θ and for the education dummies interacted with the post-2000 dummy.

Table 8
EE-Complementarity for total returns θ: additional controls.

	(1) Sector	(2) Collateral	(3) Span	(4) Risk	(5) Vintage	(6) Inherited
Post interacted with:						
× High Sch. × *YX*	29.6	23.3	17.3	27.3	1.4	22.0
	(20.2)	(20.9)	(20.6)	(21.9)	(17.9)	(20.6)
× College × *NX*	18.9	19.7	23.3	−10.4	17.6	22.8
	(33.4)	(31.2)	(32.4)	(33.3)	(31.4)	(31.8)
× College × *YX*	56.0**	54.2*	46.8	56.7*	28.7	52.2*
	(27.3)	(28.3)	(28.7)	(31.1)	(24.2)	(27.1)
× Postgrad × *NX*	53.8	57.3*	51.4	47.7	49.5	56.5
	(34.0)	(33.8)	(36.1)	(38.4)	(34.3)	(34.4)
× Postgrad × *YX*	172.6***	172.2***	167.6***	154.9***	157.4***	170.6***
	(35.6)	(37.3)	(39.9)	(43.5)	(34.2)	(36.7)
Control 1		35.2*	0.7**	64.0***		20.7
		(21.2)	(0.4)	(16.4)		(31.8)
Control 1 × Post		−15.6	−0.3	24.7		39.0
		(38.0)	(0.4)	(20.5)		(45.5)
Control 2		−0.1	26.4**	−45.5***		
		(0.1)	(12.5)	(12.8)		
Control 2 × Post		0.0	−19.1	10.0		
		(0.1)	(23.5)	(15.2)		
H_0: College × *NX* × Post = College × *YX* × Post						
F-stat	1.257	1.086	0.527	3.983	0.113	0.791
p-value	0.262	0.297	0.468	0.046	0.737	0.374
H_0: Postgrad × *NX* × Post = Postgrad × *YX* × Post						
F-stat	8.937	8.087	9.074	6.598	7.281	8.156
p-value	0.003	0.004	0.003	0.010	0.007	0.004
N. of Obs.	7250	7250	7250	6772	7250	7250

Notes: The dependent variable is total entrepreneurial returns θ in thousands of dollars at constant 2010 prices. Education dummies (High School, College, and Postgraduate) interacted with experience dummies (*YX* and *NX*) are included but not reported. *NX* and *YX* are dummies for no and some previous labor experience, respectively. In column (2) Control 1 is *Collateral*, that is, a dummy for entrepreneurs who obtained credit with some collateral, and Control 2 is *Value of collateral*, that is, its value. In Column (3) Control 1 is *Nr. of workers*, that is, the number of workers in the business, including the entrepreneur, and Control 2 is *Nr. of businesses*, that is, the number of businesses run by the entrepreneur. In Column (4) Control 1 is *Incorporated*, that is, a dummy for incorporated businesses, and Control 2 is *Uncertain income*, that is, a dummy for uncertain next year income. In column (6) Control 1 is *Inherited*, that is, a dummy for inherited businesses. Column 4 excludes the 1989 survey because *Uncertain income* is unavailable. All regressions include a quadratic in experience, dummies for year and female, white and married entrepreneurs. Column 1 includes 6 industry dummies and their interaction with the post-2000 dummy; Column 5 includes 6 cohort dummies and their interaction with the post-2000 dummy. See Table 2 for the definition of other variables. Bootstrapped standard errors in parentheses, $^{***}\ p-value < 0.01$, $^{**}\ p-value < 0.05$, $^{*}\ p-value < 0.1$.

tion and allowing for time-varying sectoral returns has no significant effect on the estimated coefficients. For example, the Postgraduate × Post dummy for experienced entrepreneurs (YX = 1) increases just marginally—from $170,000 of the baseline specification in Table 7 to $173,100 in Table 8—, while the Postgraduate × Post dummy for postgraduate entrepreneurs without previous work experience (NX=1) falls slightly—from $54,900 to $53,800.

Access to finance Another potential explanation for the increased premium to education could be related to financial constraints and the possibility that better education may help in obtaining internal or external funds. For example, postgraduates may be able to obtain more credit because they can pledge more collateral, either because they earn more as employees, enabling them to accumulate more initial wealth, or simply because they get larger inheritances, which is consistent with the evidence that children's education is correlated with parents' wealth and that this correlation has strengthened over time (Belley and Lochner, 2007). The SCF inquires into the use of collateral or personal guarantees to obtain business loans. We construct a *Collateral* dummy equal to 1 if the entrepreneur has used personal wealth to guarantee a loan and create a variable that measures the *Value of collateral* posted. We also include interaction of these variables with the Post dummy (we do the same in all the regressions of the table). Column 2 of Table 8 shows that the provision of personal guarantees is correlated with higher entrepreneurial returns. However, the time profile of the return to postgraduate education with and without previous experience remains practically unchanged controlling for personal guarantees.

Entrepreneurs may obtain external funds even without offering personal guarantees, and education might provide greater financial literacy and other skills useful to interact with financiers. For example, Parker and Van Praag (2006) provide evidence for a sample of Dutch entrepreneurs that education helps to relax financial constraints. To test this hypothesis, we exploit a robust prediction of models of firm growth with financial constraints, namely that more severely constrained ventures have a steeper profile of dividends with respect to the age of the venture.[20] This is because financially constrained firms rely more on retained earnings to finance growth, which implies that dividend payments increase faster as the venture ages. To test whether ventures run by postgraduates, with or without previous work experience, have become progressively less financially constrained over time, we then check whether the age profile of dividends has become flatter for them than for college graduates. We regress dividends on the usual controls plus the current age of the entrepreneurial venture interacted with the educational dummies and allow this interaction to vary across sub-periods. If ventures run by postgraduates (with or without experience) have become less constrained, we should observe a more strongly negative coefficient for age × post × postgrad than for age × post × college. The results in Table 9 do not support this null hypothesis. If anything, the behavior of total income $d + l$ (Column 1), actually supports the opposite implication. Similar conclusions stems from considering business value (Column 2) or total returns (Column 3).

Overall, Table 9 suggests that the strengthened complementarity between postgraduate education and labour market experience is unlikely to be due to a relaxation of financial constraints.

[20] See for example Cooley and Quadrini (2001) and Clementi and Hopenhayn (2006). Michelacci and Quadrini (2009) extend the theory to the firm's overall compensation policy and Guiso et al. (2012) provide supportive evidence for it.

Table 9
Financial constraints and the age profile of entrepreneurial returns.

	(1) $d+l$	(2) M	(3) θ
Post interacted with:			
× High Sch. × *YX*	5.8	−13.6	9.5
	(9.3)	(130.7)	(16.3)
× College × *NX*	13.9	181.4	13.0
	(19.4)	(268.2)	(34.1)
× College × *YX*	51.0***	313.4	32.4
	(18.9)	(206.1)	(34.1)
× Postgrad × *NX*	17.4	−354.5	32.1
	(27.2)	(256.0)	(39.3)
× Postgrad × *YX*	97.7***	386.7*	142.9***
	(25.5)	(212.0)	(35.9)
Tenure × College	2.4**	24.5	0.0
	(1.0)	(18.4)	(2.9)
Tenure × Postgrad	−0.3	−31.9***	−1.7
	(0.9)	(11.2)	(1.6)
Tenure × College × Post	−2.0*	9.3	0.4
	(1.1)	(19.3)	(3.3)
Tenure × Postgrad × Post	1.8	53.5***	1.7
	(1.2)	(13.7)	(2.6)
Tenure × Post	0.7	−22.0**	−2.4
	(0.5)	(9.9)	(1.9)
Tenure	1.9***	40.1***	2.4**
	(0.4)	(9.1)	(1.2)
H_0: College × *NX* × Post =College × *YX* × Post			
F-stat	3.327	0.364	0.406
p-value	0.068	0.546	0.524
H_0: Postgrad × *NX* × Post =Postgrad × *YX* × Post			
F-stat	7.072	11.41	7.391
p-value	0.008	0.001	0.007
Obs	7250	7250	7250

Notes: All monetary values are in thousands of dollars at constant 2010 prices. Education dummies (High School, College, and Postgraduate) interacted with experience dummies (*YX* and *NX*) are included but not reported. *NX* and *YX* are dummies for no and some previous labor market experience, respectively. *Tenure* is the number of years since the entrepreneurs started running the business. All regressions include year dummies, a quadratic in experience, dummies for female, white and married entrepreneurs. See Table 2 for the definition of all the other variables. Bootstrapped standard errors in parentheses, *** $p-value < 0.01$, ** $p-value < 0.05$, * $p-value < 0.1$.

Span of control The ICT revolution might have encouraged organizational practices that favor larger businesses.[21] If higher education is complementary to the adoption of ICT-intensive organizational practices (Bresnahan et al., 2002; Caroli and Van Reenen, 2001), it could be that the span of control of highly educated entrepreneurs has (relatively) increased, allowing them to run larger ventures today than in the past. To test this hypothesis, we consider two variables measuring the entrepreneur's span of control: *Number of workers* employed in the entrepreneur's first actively managed businesses and *Number of actively managed businesses*. Panel (a) of Fig. 11 shows that the average number of workers employed by postgraduates increased from 25 in 1989 to 60 in the2000ıs. *Number of workers* also increased somewhat for college graduate entrepreneurs (but less than for postgraduates), and it has remained stable for high school graduates. The *Number of actively managed businesses* (panel b) increased modestly and very similarly for college graduates and postgraduates.

To quantify the effect of the size of entrepreneurial ventures (in terms of number workers or number of actively managed businesses) on the rising premium to postgraduate education, we augment our baseline regressions with these two measures of the span of control. The results are reported in column 3 of Table 8. On average, employing one additional worker is associated with an increase of $700 in total entrepreneurial returns θ. The effect of the number of businesses is also positive, and equal to $26,000 for each additional business. The interactions with the Post dummy are not significantly different from zero. The results are basically unchanged if a quadratic polynomial in our size measures is added, or if log size variables are used. Relative to Table 3, the increase in the premium in the post-2000 period is slightly reduced for both college graduates and postgraduates: for postgraduates with some labour market experience it goes down from $170,100 in Table 7 to $167,600 in Table 8. This suggests that the combination of postgraduate education and experience has become progressively more valuable in managing larger organizations. But size does not tell the whole story, because the difference in the increase in returns between postgraduate entrepreneurs with and without previous work experience remains statistically significant, of a similar order of magnitude as before, and significantly greater than that observed among college graduates.

Income uncertainty and legal form of businesses We previously discussed that the shifts in the distribution of returns and failure rates are inconsistent with the hypothesis that the increased premium to postgraduate education is simply a compensation for greater business risk. As a further check, we construct a direct measure of income uncertainty. Starting in 1992, the SCF has included this question: "At this time, do you have a good idea of what your income for next year will be?" We construct the dummy *Uncertain Income* equal to 1 for entrepreneurs who answer negatively. Table 2 shows that the share of entrepreneurs who are uncertain about their future business income decreases with education. We also control for the legal form of the business because limited liability companies are especially valuable to entrepreneurs seeking to undertake large, risky activities with high expected returns. Table 2 shows that 30% of high school-educated entrepreneurs run incorporated companies, compared with about 50% for both college graduates and postgraduates. Column 4 of Table 8 reports the results including our dummies for *Uncertain Income* and *Incorporated* businesses. Entrepreneurs with uncertain future income record lower returns, while those with incorporated businesses gain a substantial premium ($64,000 on average). However, the relevant coefficients are hardly affected. For example, entrepreneurs with postgraduate education and some previous experience now show an increase in returns of $154,900 a year in the post-2000 period, slightly larger than the increase of $163,000 estimated excluding the uncertain income dummy (results unreported for brevity).[22]

Vintage effects Another explanation for the increase in the premium to postgraduate education relates to vintage effects and the fact that new businesses might embody more advanced technologies and/or better organizational practices, possibly related to ICT (Bloom et al., 2012). As was first observed by Arrow (1962) and stressed by the managerial literature (Christensen and Rosenbloom, 1995), new entrants have an advantage in undertaking disruptive innovations. It could be that in a context of booming entrepreneurial opportunities like the US in the 1990s and the 2000s, postgraduates were particularly successful in embodying into their newly created ventures the latest technologies and business ideas. By this interpretation, the increase in the premium to postgraduate education should be at least partly attributable to the date of business creation. To evaluate this hypothesis, we augment the baseline regressions of Table 7 with a set of six cohort dummies for year of founding: pre-1960, 1960–1969, 1970–1979, 1980–1989, 1990–1999, and post-2000. We then interact these cohort dummies with our educational dummies and include them in the regression. The estimated coefficients for the changes in the return are reported in Column 5 of Table 8. Overall, cohort effects have little impact on the increase in the premium to postgraduate education or on the difference in the increase in returns between entrepreneurs with and without previous experience. This indicates that the strengthened complementarity between postgrad-

[21] See Garicano and Rossi-Hansberg (2015) for a review of the recent literature on how the acquisition, use, and communication of knowledge affects firms' organization.

[22] This is slightly less than the value of $170,100 reported in column 1 of Table 7 because of the exclusion of the 1989 survey, which lacked the question used to construct the *Uncertain Income* dummy.

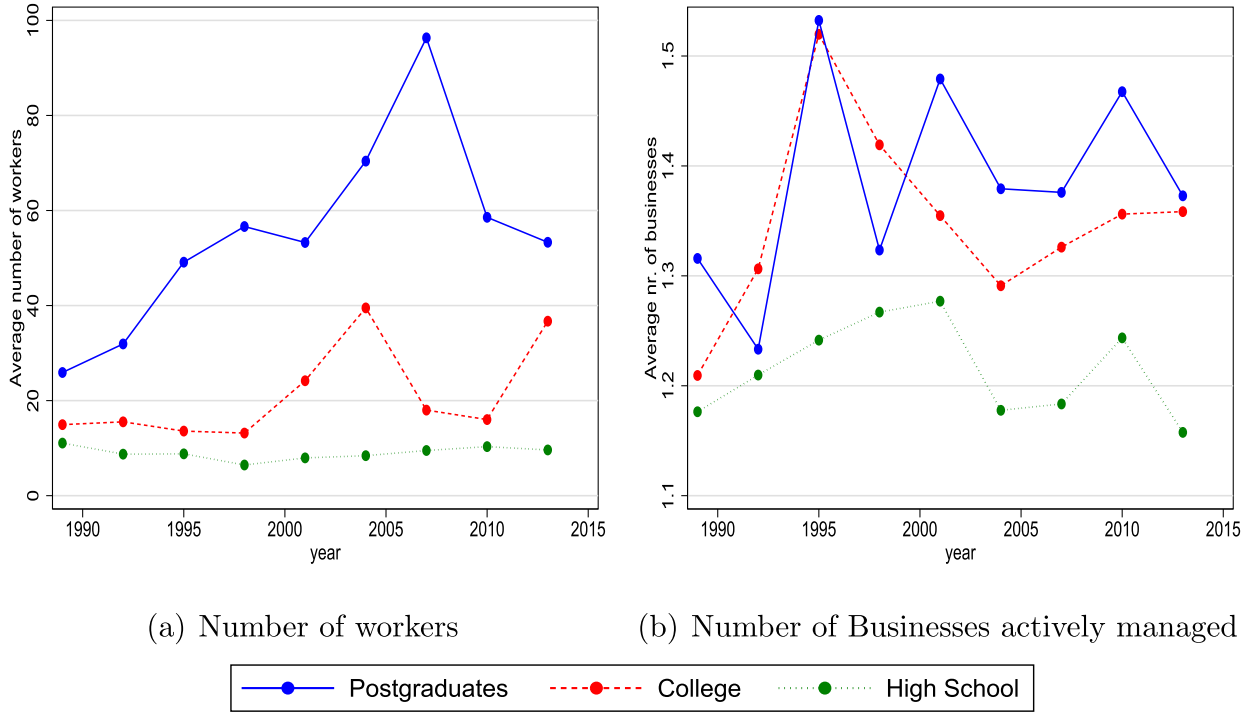


Fig. 11. Firm size and span of control.
Source: Own calculations using the Survey of Consumer Finances, the Longitudinal Business Database and the S&P500 Total Return Index. Values are in thousands of dollars at constant 2010 prices.

uate education and labor market experience is independent of the date when the venture was started.

Intergenerational transmission of wealth A last possible alternative we consider is the role of the intergenerational transmission of wealth. It could simply be that the better educated entrepreneurs inherit better businesses from their wealthier parents. To control for this we introduce a dummy specifying whether the entrepreneur's venture is *Inherited*. Column 6 of Table 8 shows that the return to *Inherited* businesses is $20,700, although the effect is not statistically different from zero. Again, the increase in the return to education for entrepreneurs with or without previous labor market experience in the post-2000 period remains unchanged after adding this additional control.

8. Conclusions

We have examined the evolution of the educational composition of US entrepreneurs and the entrepreneurial return to education since the late 1980s. The fraction with a college degree has increased, while that with postgraduate training has remained stable. The premium to entrepreneurs with a college relative to a high school degree has increased, but by about the same amount as the earnings premium for employees. The premium for postgraduate education relative to a college degree has increased substantially more for entrepreneurs than for employees: an entrepreneur with a postgraduate degree now earns fifty percent more than one with a BA or equivalent, whereas in the late 1980s their earnings were approximately equal. The analogous increase in the skill premium for employees is just 10–20%. The sharp increase in the skill premium for entrepreneurs with postgraduate education is due partly to the higher dividends paid by their businesses and partly to greater capital gains from selling. The premium for postgraduate education holds both for entrepreneurs with a MA or MBA degree and for those with a Ph.D or equivalent; it continued to be large during the Great Recession (although diminishing in absolute terms); it is little driven by self-selection issues into entrepreneurship or higher education; and it is substantially greater at the higher percentiles of the entrepreneurial income distribution. Finally, we find that the increase is largely accounted for by the strengthened complementarity between higher education and labor market experience, which indicates that higher education combined with labour market experience produces entrepreneurial capabilities that have become more valuable over time.

Our findings indicate that skills acquired through formal education and labor market experience have become progressively more valuable for entrepreneurship. This is consistent with the thesis that technological progress has been skill-biased, and more so for entrepreneurs than for employees. Our results seem also to indicate that the advanced entrepreneurial skills associated with higher education have grown scarcer: if the supply of entrepreneurial skills is large enough and individuals have a free occupational choice between salaried employment and entrepreneurship, any surge in the extra return to entrepreneurship would be competed away by increased entry. This would naturally raise the question of what can be done to increase the supply of entrepreneurial skills, which as emphasized by Lucas (1978) and shown by Gennaioli et al. (2013) is an important determinant of aggregate productivity.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.labeco.2020.101933.

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