From laboratory to market: on the propensity of young inventors to form a new business

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Abstract:

Many researchers have studied correlates of business formation. Through the case-based and statistical literature, several broad categories of influence on the entrepreneurial decision to start a new business have been identified. We contribute to this literature through statistical analysis of a unique database of young inventive scientists and engineers and their propensity toward new business formation. Our particular focus is on young inventors starting a business based on their creative achievements. Among this group, we do not find empirical support for the influence of traditional variables such as age, education, and gender on the propensity to start a new business. Rather, we find that their entrepreneurial experience as a new business proprietor is driven by dimensions of their university laboratory research experience.

Keywords: entrepreneurship | business formation | patents | entrepreneurship | economics

Article:

1 Introduction

Hébert and Link (1988, 1989, 2009) chronicled the intellectual history of the prominence of the entrepreneur and his or her role in both economic theory and market activity. Among the many features of the entrepreneur, being the owner of an enterprise has long been recognized.1 This feature of the entrepreneur has been exploited within academic research over the decades to shift emphasis from the specific to the general, that is, from the entrepreneur as an individual economic agent to associated entrepreneurial activity within the boundaries of a firm or business, and this shift was a harbinger of the empirical research that followed.

Many researchers have studied correlates of business formation.2 Through the case-based and statistical literature, three broad categories of influence on the entrepreneurial decision to start a new business have been identified. Here, we contribute to this multifarious literature though statistical analysis of a unique database of young inventive scientists and engineers and their propensity toward new business formation. Our particular focus is on young inventors starting a business based on their creative achievements.

The remainder of the paper is outlined as follows. In Sect. 2, we discuss this unique and previously unexamined database. It is drawn from Technology Review's (TR's) list of TR100 and TR35 winners from 1999 through 2009. In Sect. 3, we motivate, based on the extant literature, an empirical model of the probability of a TR winner starting a new business based on the invention(s) that led to his or her award. In Sect. 4, we present our empirical findings, and we offer concluding observations in Sect. 5.

2 Technology Review database

To commemorate the 100th year of continuous publication of MIT's innovation magazine, Technology Review, 100 young international inventors (under age 35 at time of nomination) from universities, large and small businesses, and government laboratories, who have the potential to make major contributions in fields related to technology in the decades ahead, were identified and highlighted in the November/December 1999 issue of the Review (Benditt 1999). A second class of TR100 inventors was nominated to receive this distinction in 2002, and similarly for 2003 and 2004. Beginning in 2005, and in every year thereafter, the TR100 became the TR35.3

All TR winners, arguably among the most promising and inventive young individuals in the world from 1999 through 2009, became the population for our survey-based study.4 Of the 575 winners, email addresses were collected from public-domain sources for 373, and each so-identified winner was sent an electronic mail survey (variables on the e-survey are discussed below). Thirty-two surveys were returned due to an incorrect email address. Of the 341 nonreturned surveys, 63 individuals, or 18.5% of the contacted winners, were willing to participate in this study.5 Table 1 presents this data reduction process.6

Table 1

Data reduction process

(1)	(2)	(3)	(4)	(5)	(6)	(7)

Year	*TR*winners	Identified email addresses	Returned surveys with an incorrect email address	Number of surveys	Responses	Response rate (6)/(5)
1999	100	73	9	64	8	12.5%
2002	100	54	1	53	9	17.0%
2003	100	60	5	55	8	14.5%
2004	100	63	5	58	9	15.5%
2005	35	26	4	22	6	27.3%
2006	35	26	4	22	4	18.2%
2007	35	20	1	19	5	26.3%
2008	35	24	0	24	5	20.8%
2009	35	27	3	24	9	37.5%
Total	575	373	32	341	63	18.5% (mean)

3 A model of the probability of new business formation

Storey (1994) identified three broad categories of factors that influence new business formations, generally measured in terms of self-employment. These categories included personality, human capital, and ethnic origin. Such factors are present in one form or another throughout the entrepreneurship and small-business empirical literature, which relies on data on such activity from a number of different cohorts of entrepreneurs across developed nations.

Personality is typically quantified in terms of family background. Many studies have shown that self-employed entrepreneurs have fathers who were self-employed regardless of field of occupation (e.g., Lentz and Laband 1990; Butler and Herring 1991; Roberts 1991; Blanchflower and Oswald 1998).

Human capital variables considered in studies of new business formation and self-employment include the gender, age, and education of the venturesome entrepreneur. Previous research has concluded that males are more likely than females to start a new business or to be self-employed (e.g., Blanchflower and Meyer 1994; Reynolds 1997; Blanchflower and Oswald 1998; Uusitalo 2001).7 Age generally has a nonlinear effect on the decision to pursue self-employment. The

propensity toward self-employment increases with age to a point, and then decreases, with the age turning point varying across studies (e.g., Blanchflower and Meyer 1994; Sanders and Nee 1996; Fairlie 1999). Finally, with regard to education, those with more education are more likely to exploit new opportunities through self-employment (e.g., Borjas and Bronars 1989; Robinson and Sexton 1994).8

Finally, several scholars have shown that the probability of self-employment varies across country by the nationality of the entrepreneur and/or his or her parents (e.g., Borjas 1986; Butler and Herring 1991).

Table 2 defines the variables considered herein. The data used in our study differ from those used in other studies in at least two dimensions. First, our dependent variable measures whether an inventive entrepreneur started a new business, not a new business per se but one based on the technology associated with his or her TR recognition.9 Second, our sample is highly skewed in terms of the entrepreneur's age, education, and especially inventive accomplishments. By constraint, those within the TR100 and TR35 are under 35 at the time of nomination; they are highly educated, and this also bounds the age variable from below. Also, the TR winners are among the world's elite in terms of their inventive accomplishments to date.10

Table 2
Definition of variables relevant to the *TR* entrepreneur

Variable	**Definition**
Dependent	
Formation	=1 if started a business based on the technology associated with the *TR* award, 0 otherwise
Independent	
FathBus	=1 if father ever started a technology-based business, 0 otherwise[a]
Gender	=1 if male, 0 if female
Age	=age at the time the *TR* award was announced
HighDegree	=1 if holds a degree higher than his or her father, 0 otherwise[b]
AppPat	=1 if applied for a patent based on the technology associated with the *TR* award

Variable	Definition
Univ	=percentage of the research that led to the patent application conducted in a university laboratory
UnivPat	=1 if applied for a patent that was researched in a university laboratory, 0 otherwise
CompSci	=1 if field of study is computer science, 0 otherwise
Science	=1 if field of study is among the basic sciences, 0 otherwise
Other	=1 if field of study is not computer science, basic science or engineering[c]

[a]The survey also asked whether the mother had ever started a technology-based business, but none had

[b]This variable was constructed on the basis of terminal degrees; for example, Ph.D. M.D., and J.D. were considered equivalent terminal degrees. If the *TR* entrepreneur held the Ph.D. and the father held a B.S. degree then *HighDegree* = 1

[c]Each of the following fields is represented by a *TR* winner: art, business, history, medicine, and philosophy

Descriptive statistics on all variables are presented in Table 3. Selectively, nearly 40% of the *TR* winners started a business based on the technology underlying their award, and nearly 81% had applied for at least one related patent (a measure of creativeness). Only 11% of the *TR* winners had fathers who had started a technology-based business, and nearly 62% had more education than their father.

Table 3
Descriptive statistics (*n* = 63)

Variable	Mean	Std. dev.	Range
Formation	0.3968	0.4932	0/1
FathBus	0.1111	0.3168	0/1
Gender	0.5873	0.4963	0/1
Age	31.35	2.48	26–35[a]

Variable	Mean	Std. dev.	Range
HighDegree	0.6190	0.4895	0/1
AppPat	0.8095	0.3958	0/1
Univ	48.27	48.46	0–100
UnivPat	0.5397	0.5024	0/1
CompSci	0.2063	0.4079	0/1
Engineer	0.3333	0.4752	0/1
Science	0.3810	0.4895	0/1
Other	0.0794	0.2725	0/1

[a]Several *TR* winners were under 35 when nominated but turned 35 by the time the award was announced.

Our empirical model is written simply as

Probability (formation)= f(**X**),

where the vector **X** contains personality and human capital variables. There was insufficient information available from the published *Technology Review* sketch of each *TR* winner to accurately determine their race or ethnicity, or that of their parents.

An econometric issue related to the estimation of Eq. 1 is sample selection. Given the data reduction process in Table 1 and the relatively low response rate, we cannot assume that the errors in the model of response are uncorrelated with the errors in the model of business formation in Eq. 1. We therefore estimated Eq. 1, by maximum likelihood, as a bivariate probit model simultaneously with a model of the probability of response to the survey

Probability (response)= g(*Award*),

where *Award* measures the number of years since the entrepreneur received the *TR* award. *Award* is defined as the survey year (2010) minus the year of the award. In the absence of a theory on response, our intuition is that, the more recent the award, the more meaningful it is and thus the greater the likelihood of response.[11] This is confirmed by our econometric estimates.[12]

The bivariate probit results provided no indication of selection bias. Specifically, the estimates failed to reject the null hypothesis that the models of response and formation were independent of each other (i.e., the correlation of the errors in the two models was not significantly different

from zero), and the parametric estimates in the formation model were always very close to those obtained without accounting for selection.[13] For this reason, the results reported in Table 4 are for single equation variations of the formation model in Eq. 1.[14]

Table 4
Probit estimates from Eq. 1 (n = 63, std. errors in parentheses)

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
FathBus	0.606 (0.519)	0.556 (0.508)	−0.014 (0.575)	−0.256 (0.579)	−0.030 (0.596)
Gender	0.368 (0.349)	0.389 (0.346)	−0.001 (0.393)	0.029 (0.421)	0.236 (0.449)
Age	0.939 (1.841)	0.055 (0.072)	0.120 (0.081)****	0.107 (0.088)	0.106 (0.092)
Age^2	−0.014 (0.030)	–	–	–	–
HighDegree	0.125 (0.355)	0.108 (0.353)	0.103 (0.378)	−0.104 (0.411)	−0.149 (0.432)
AppPat	–	–	0.717 (0.545)*****	–	–
Univ	–	–	–	0.015 (0.005)*	–
UnivPat	–	–	–	–	1.925 (0.635)*
CompSci	–	–	0.580 (0.505)	1.212 (0.620)***	1.414 (0.679)**
Science	–	–	0.759 (0.447)***	0.705 (0.475)****	0.524 (0.497)

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Other	–	–	2.181 (0.932)**	2.778 (0.992)*	2.954 (1.049)*
Intercept	−15.780 (28.027)	−2.361 (2.193)	−5.302 (2.647)**	−5.112 (2.787)***	−5.604 (2.984)***
Pseudo R^2	0.043	0.043	0.134	0.230	0.283
Log-likelihood	−40.50	−40.61	−36.63	−32.59	−30.36

* Significant at 0.01 level or better

** Significant at 0.05 level

*** Significant at 0.10 level

**** Significant at 0.15 level

***** Significant at 0.20 level

4 Empirical findings

The probit results for five specifications of Eq. 1 are presented in Table 4, based on the variables defined and described in Tables 2 and 3, respectively. The specifications in columns (1) and (2) allow for comparison with the extant literature, subject to data limitations. Following Storey, these two specifications include personality and human capital variables.15

However, none of the variables in either specification was statistically significant, i.e., whether the winner's father had started a technology-based business,16 gender, age, and education relative to father.17 Based on these results, we suggest that the Storey taxonomy of relevant variables, and for that matter the variables considered by other scholars who have studied empirically correlates with the propensity of individuals toward new business formation, do not apply to young inventors as represented by our sample of TR winners.

The variables considered in the specifications of Eq. 1 in columns (3), (4), and (5) of Table 4 extend the literature on new business formation as applied to young inventors.18 These variables measure the creativity of the TR winners, the venue in which that creativity was nurtured, and their field of specialization.

Consider the results presented in column (3). The relevant correlates with the probability that a TR winner formed a new business are whether the winner had applied for a patent(s) based on the technology associated with the TR award, and his or her field of specialization, ceteris paribus. The estimated coefficient on AppPat is positive and statistically significant at the 0.20 level. Regarding field of specialization, in this specification those with a basic science degree or a degree other than computer science or engineering were more likely to start a new business than engineers (subsumed in the intercept term), ceteris paribus. Interestingly, the field of specialization of those young inventors in the other category ranged from art to philosophy.19

The specification in column (4) does not include the variable AppPat, but it does include the variable Univ (Table 2). Those young inventors who applied for a patent(s) and who did a greater percentage of the foundation research underlying the patent application(s) in a university laboratory were more likely to start a new business than other young inventors, ceteris paribus. More specifically, all else held constant, the more time spent in the university laboratory, the greater the probability of forming a new business. The estimated coefficient on Univ is positive and statistically significant at the 0.01 level or better. This result suggests that at least part of the tacit knowledge gained as a graduate student through the nurturing process that occurs in a university laboratory engenders an entrepreneurial spirit that is manifested through starting a new business. In this specification, those with a computer science, science or other field of specialization were more likely to form a new business than were engineers, ceteris paribus.

Finally, the specification in column (5) replicates the model underlying the results in column (4) except that the university laboratory experience is represented dichotomously rather than by a percentage of time. The same conclusion can be drawn about a university laboratory engendering an entrepreneurial spirit.

5 Conclusions

The lack of empirical support for the so-called traditional variables explaining the probability that young inventors will form a new business is as important as the empirical support that we offer related to patenting activity and association with a university laboratory. Clearly, young inventors, a group that have not previously been studied in any literature on new business formations, are unique in the sense that their entrepreneurial experience as a new business proprietor is driven by dimensions of their university laboratory research experience.

This conclusion should be interpreted cautiously for several reasons. One reason is that our sample of inventive entrepreneurs is unique and not comparable to other studies in the literature. A second reason is that our sample size, while unbiased in terms of selection, only includes the best and the brightest inventors as defined by the TR award. Finally, data limitations prohibited us from exploring other dimensions of the university research laboratory experience that could affect entrepreneurial activity including and going beyond forming a new business.

Perhaps others will explore additional dimensions of the university-based research experience as related to entrepreneurial behavior, thereby expanding the scope of inquiry that falls broadly under the rubric of academic entrepreneurship.

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Footnotes

1 Hébert and Link's (1988, 1989, 2009) disquisition identifies three writers on the early history of the entrepreneur who proffered this view: Quesnay (1888), von Wieser (1927), and Pigou (1929).

2 Much of this literature is summarized by Storey (1994) and Shane (2003). See also, Wadhwa et al. (2009).

3 We speculate that the change from TR100 to TR35 in 2005 was due, at least in part, to a change in the editorial leadership at Technology Review in that year.

4 Our data collection process took place during 2010.

5 This response rate is on par with that realized by other researchers examining the innovative behavior of both individuals and technology-based entrepreneurial firms. See, for example, the

academic researcher survey studies referenced in Hall and Rosenberg (2010). In 2005, the National Research Council (NRC) within the National Academy of Sciences surveyed, under the auspices of a Congressional mandated study, Small Business Innovation Research award recipient firms funded by the National Aeronautics and Space Administration (National Research Council 2009). The NRC's response rate was 23%. More recently, the National Science Foundation's survey of scientists and engineers in the USA, conducted by the US Bureau of Census, has fallen from 80% in 1993 to near 50% in 2010; http://www.nsf.gov/statistics/srs11200/content.cfm?pub_id=3952&id=1#fn1.

6 The 61 responses were returned electronically within 3 days of being sent, and 2 more surveys were returned within 10 days of being sent. Approximately 3 weeks after the 63rd survey was returned, a follow-up email was sent to nonrespondents, but it did not generate any additional participants.

7 Fairlie (1999), for example, showed that White males are more likely than Black males to be self-employed.

8 To the extent that education is correlated with earnings, these finding may measure the ability of the entrepreneur to self-finance his or her self-employment venture.

9 Conceptually, starting a new business is synonymous with being self-employed, but self-employment per se, as studied in the literature, does not imply that one started the business.

10 Starting a new business may be only a peripatetic activity of these highly talented TR winners.

11 This is observed, at a general level, in column (7) of Table 1.

12 These probit results are available on request from the authors.

13 These results are available on request from the authors.

14 Because of the size of our sample, selection was also tested for by including the predicted probability of response for each winner as a regressor in Eq. 1. In no case was the estimated coefficient on the probability of response variable significant at a conventional level.

15 Information on the race and ethnicity of the TR winners was not available.

16 In this regard, the apple does fall far from the tree.

17 An education variable was not warranted because nearly all of the winners held a terminal degree (e.g., Ph.D.).

18 There is no statistical indication that the age of the TR winner had a nonlinear (logarithmic or quadratic) effect on his or her propensity to form a new business. Thus, only the linear term is

included in the specifications in columns (3), (4), and (5). The results with nonlinear age terms are available on request from the authors.

19 See note c in Table 2.