Determinants of Self-employment by New PhDs*

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ABSTRACT

Using 16 years of NSF data, we explore determinants of self-employment by new PhDs in the US, considering the role of field of study, demographics, and a factor that has gotten much attention in recent years (though in different contexts) – the role of student debt. While a small share of the population, one would think that young doctoral recipients are an especially innovative group, and perhaps likely candidates for entrepreneurial activities. After controlling for field and demographics, we find some evidence consistent with an impact of student debt in limiting the choice of self-employment as an immediate career path post-graduate school.

Keywords: Self-employment; entrepreneurship; doctoral students

JEL codes: J24; L26

I. Introduction

Much has been written about the declining rate of new firm entry (or entrepreneurship generally) in the US economy in recent years. The US Bureau of Labor Statistics reports that about ten percent of US workers are self-employed (both incorporated and not), and this has trended down somewhat in recent years. While clearly only a small part of that category, little has been written on the propensity for doctoral recipients to choose self-employment as a career path (Muscio and Ramaciotti (2019) do examine this for Italy). That is the focus of this note. Using 16 years of NSF data, we explore determinants of self-employment by new PhDs in the US, considering the role of field of study, demographics, and a factor that has gotten much attention in recent years (though in different contexts) – the role of student debt. While a small share of the population, one would think that young doctoral recipients are an especially innovative group, and perhaps likely candidates for entrepreneurial activities.

II. Previous literature on financial constraints and entrepreneurship

While not the first to study determinants of small-firm entry, Acs and Audretsch (1989) provide both a good review of prior empirical literature on entry generally and (the more limited) work on small-firm entry, and a cross-section study explaining entry of firms smaller than 500 employees[1] across 247 US industries (based on Small Business Administration data). They find that "traditional" industry-specific variables (growth, market concentration, entry barriers) play a role, but that also contributing to more small-firm entry is the rate of innovative activity by small

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[1] Their results are robust to alternative definitions of "small firm" including those under 50 employees.

firms in the industry. Of course, self-employment and small-firm entry are not the same thing; nevertheless, one would think that similar determinants would hold.

There is some literature on the role of financial constraints in affecting entrepreneurship. Holtz-Eakin et al. (1994) – focusing on inheritances, Lindh and Ohlsson (1996) – Swedish lottery winners, and Johansson (2000) – personal wealth – all find support for an infusion of financial resources leading to more entrepreneurial activity. Recent work by Schmalz et al. (2017) supports the view that credit constraints can limit entrepreneurial entry.[2] Lofstrom et al. (2014) find wealth holdings to promote small firm entry, but only in "high-barrier" industries. Feinberg and Kuehn (2019), examining impacts of the Alaska Permanent Fund Dividend program, finds some modest support for a "safety net" of this type (similar to a Guaranteed – or Universal – Basic Income) promoting both small-firm entry and the decision to become self-employed.

Given all this it would not be surprising to find that large amounts of student debt would have an impact on the early-career decision to be self-employed. Related work (Feinberg 2019) has found that this debt seems to have an impact more generally on career choice by PhDs; here we focus on self-employment.

III. Data and Econometric Specifications

Data from the National Science Foundation's annual Surveys of Earned Doctorates form the basis of this study; students are surveyed soon after completing their doctorate (and the response rate is quite high – in the range of 90 to 93 percent for the 16-year period studied here).

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[2] Hurst and Lusardi (2004) have questioned this result.

While data are available from much earlier periods, the 2001-2016 data are examined here, as earlier surveys did not include all the variables of interest. Only PhD recipients are included. The dependent variable explained is the definite decision to immediately choose self-employment (unfortunately no more detailed information than this is available); however, two alternate samples are analyzed – the first is the largest sample of more than 575,000 individuals, including those indicating other employment, further schooling, no employment plus unknown plans, while the second includes only those with firm employment plans for the following year.

The key explanatory variables in the econometric work below are variables representing student debt loads (both undergraduate and graduate), in addition to parental education (graduate degrees), gender, minority, and citizenship status, as well as other control variables (including broad field of doctoral work and the quality of doctoral institution—Carnegie 1 vs. others).

The surveys provide information on both graduate and undergraduate student debt, however these are reported (separately) within ranges – somewhat problematic is that these ranges have changed over time. The solution adopted here is to impute actual debt at the midpoint of the ranges; as for the top – open-ended – ranges, these were "over $35,000" from 2001-2003, "over $50,000" from 2004- 2006, "over $70,000" from 2007-2009, and "over $90,000" from 2010 -2016, and the imputed values used for these are $42,500, $60,000, $80,000, and $100,000, respectively. While obviously this truncates high-end debt, only about five percent of survey participants have debt above those thresholds. The debt figures are adjusted by the Consumer Price Index to express them in real terms, in 2001 dollars.

It must be acknowledged that student debt cannot be regarded as exogeneous and is to a large extent a choice variable. Essentially, the main econometric model estimated is a reduced-form of a recursive system. Debt taken on during one's education is determined by parental resources (proxied by their level of education), citizenship (which makes some sources of education loans available), and minority status (also likely correlated with family wealth), as well as the quality of the doctoral institution (with two possibly competing effects – one might avoid debt by attending a lower-ranked institution offering a "full-ride" vs. a higher-ranked one with no support or simply a tuition waiver, but may top-ranked institutions only admit students with full fellowships). We do not expect, however, that debt is determined by the decision to pursue self-employment, so simultaneity concerns should not arise.

Both probit and linear probability regression models are employed, with fixed year effects. Results were virtually identical qualitatively, so the OLS regression results are presented below for ease of interpretation. Initially, the self-employment choice is explained by demographics, broad field, quality of doctoral program and citizenship. Parental education is included to see if that variable -- which brings in aspects of encouragement, family norms and possible financial resources -- affects the role of minority and female status in determining self-employment. Finally, debt is brought in.

Consider first some descriptive statistics. As noted above, from the 2001-2016 surveys we start with a sample of 575,841 new PhDs responding to their plans for the following year. Table 1 reports on means and standard deviations of variables of interest. One percent of this sample chooses self-employment. We see that mean total real debt, in 2001 dollars is $15,444

(this would be about $22,000 in current – 2019 – dollars); however, of those with non-zero debt (48% of the sample), mean total real debt is $32,406 (again, in 2019 dollars, this would be over $46,000). The maximum amount of debt in the sample (keeping in mind the truncation of the variable discussed above) is $162,404 (in 2001 dollars -- this would be almost $232,000 in 2019 dollars). About one-third of this debt is from undergraduate studies.

Females represent 45.1% of the sample, blacks 5.7%, Hispanics 7.0%, Asians 27.9%, American Indians and Native Alaskans 1.2%, Native Hawaiians and Pacific Islanders 0.3%, and US citizens 64.3%. A significant number of new doctoral recipients seem to be following in a family tradition, with 34.2% having a father with a graduate degree and 23.4% having a mother with a graduate degree. The highest-ranked (Carnegie-1) universities produced 78.7% of these PhDs. In terms of doctoral fields about one-third are in Biological Sciences and Engineering, with another one-third in Physical and Social Sciences and Humanities.

Of that full sample, however, only 68.7 percent report definite employment plans for the next year, and we focus in our analysis on this subsample.[3] For this subsample of 395,854 persons, we report mean values in Table 2. Of this group, 1.5% report plans for self-employment the following year, and the demographics are quite similar to the full sample. The field distribution of those with definite plans is also very similar to that of the full sample. Table 3 presents descriptive statistics by broad academic field on demographics and the likelihood of self-employment. There is quite a bit of demographic variation across fields: females are about 70 percent of all PhDs in Psychology and Education, while as low as 20 percent in Engineering

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[3] The effects of student debt in the full sample – both by itself and interacted with demographic categories – are similar to what are presented here for the subsample of those with definite employment plans.

and CIS; blacks are most heavily represented among Education PhDs (13 percent), less so in Engineering, CIS, Mathematics, and Physical Science. Not surprisingly, some fields are more aimed towards self-employment than others – of those with definite post-doctoral employment plans, four percent of Psychology PhDs are expecting that status, while less than 0.6 percent of Math and Physical Sciences PhDs are pursuing self-employment.

Before analyzing the data, we present some additional descriptive statistics in Table 4, breaking out mean values of debt and academia by selected demographic groups. While the mean levels of student debt carried (at the time of receipt of the PhD) by females and Hispanics are noticeably higher than of the full sample (12 and 21 percent higher, respectively), what is striking is that black student debt is about twice the sample mean, on average. The mean levels of the self-employment variables are virtually the same for blacks and Hispanics than for the full sample, but considerably higher for females. It must be acknowledged that we are only capturing the first-year employment decision of new PhDs, and cannot claim to be capturing long-term entrepreneurial determinants.

IV. Regression Results

First, before bringing in debt issues, we consider the demographic and field determinants of the self-employment decision. The focus here is on the subsample of those with definite post-doctoral employment plans. The results in Table 5 present OLS results explaining self-employment, with year and academic field fixed effects (not reported there) and robust standard errors. In column (1) we find female PhDs are more likely to pursue self-employment, while blacks and Asians are less likely to do so. Graduates of the highest-ranked institutions are also

less likely to choose self-employment, while US citizens are more likely to. The role of parental education – a proxy either for more familiarity with career options for those with graduate degrees, or for greater family resources allowing for a riskier career choice – has no significant impact. The academic field effects (not reported in Table 5) are generally as expected from the means of Table 3, with psychology students particularly likely to choose self-employment, and those in the "hard" sciences less likely to.

When we bring in debt (column (2)), expressed in thousands of dollars, we see a small (but statistically significant) impact – with a $50,000 increase in debt (2001 dollars) reducing the probability of choosing self-employment by 0.11 percentage points. While small, considering the mean value of self-employment of 1.49% (of those with definite employment plans), this is not an effect to be easily dismissed (a 7.4% reduction). None of the other coefficients are affected in a noticeable way. [4] In results not presented here, we interact debt with dummy variables denoting female, black, and Hispanic PhDs, finding no statistically significant effects -- suggesting these groups are not differentially impacted by debt in their self-employment decision.

As noted above, debt is not strictly exogenous – though likely predetermined relative to the self-employment choice. In Feinberg (2019) total debt of new PhDs is shown to have increased over time (increasing by about $5,000 on average between 2001 and 2016), with demographic differences: controlling for year and academic field, blacks on average have about

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[4] Probit marginal effects results are qualitatively identical to these linear probability model findings. However, in the probit analysis total debt no longer has a statistically significant impact (though still a negative sign) – in that version we do see, however, a strong (and highly significant) negative effect only of undergraduate student debt.

$12,000 more in debt than whites, American Indians about $6,500 more, females have $1,000 more debt on average than males, while US citizens have over $12,000 more in debt than non-citizens. The effect of parental education seems consistent with its interpretation as a proxy for family resources – PhD graduates with two parents having graduate degrees took on about $6,500 less in debt than those with no similarly-educated parents. Given these results, clearly sorting out debt effects on the self-employment decision from those of the other control variables is difficult, though one would think the estimated coefficients of these controls in Table 5 there should be interpreted as impacts *over and above* those which are due to debt effects.

V. Conclusion

Entrepreneurship is determined by many factors, but financial resources surely play a role. The increasing attention (both in the media and by academic researchers) to student debt has focused on impacts on a broad range of activities by younger individuals – from delaying home-buying, to marriage and child-rearing decisions, to career choice. However, how this may be impacting entrepreneurship – and more generally risk-taking in the economy – has not received notice.

This paper, in a sample of new PhDs, finds some evidence consistent with an impact of student debt in limiting the choice of self-employment as an immediate career path post-graduate school. Whether this generalizes to the broader population is a topic worthy of further study.

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Table 1 – Mean Values, Full Sample (n=575,841)

Self-employment (%)	1.03
Undergraduate Student Debt ($2001)	5,112
Graduate Student Debt ($2001)	10,333
Total Student Debt ($2001)	15,444
Female	0.451
Black	0.057
Hispanic	0.070
Asian	0.279
American Indian/Native Alaskan	0.012
Hawaiian/Pacific Islander	0.003
US citizen	0.643
Graduate degree – father	0.342
Graduate degree – mother	0.234
Carnegie-1	0.787
Agriculture & Natural Resources	0.026
Biology & Biomedical Sciences	0.162
Health Sciences	0.042
Engineering	0.169
Computer & Information Sciences	0.035
Mathematics	0.032
Physical Sciences	0.110
Psychology	0.071
Social Science	0.097
Humanities	0.112
Education	0.086
Business	0.027
Communication	0.012
Other	0.018

Table 2 – Mean Values – Subsample with Definite Employment Plans (n= 395,854)

Self-employment (%)	1.49
Undergraduate Student Debt ($2001)	4,971
Graduate Student Debt ($2001)	9,955
Total Student Debt ($2001)	14,926
Female	0.441
Black	0.051
Hispanic	0.068
Asian	0.261
American Indian/Native Alaskan	0.011
Hawaiian/Pacific Islander	0.003
US citizen	0.658
Graduate degree – father	0.345
Graduate degree – mother	0.236
Carnegie-1	0.793
Agriculture & Natural Resources	0.026
Biology & Biomedical Sciences	0.149
Health Sciences	0.043
Engineering	0.160
Computer & Information Sciences	0.037
Mathematics	0.035
Physical Sciences	0.111
Psychology	0.078
Social Science	0.103
Humanities	0.105
Education	0.090
Business	0.033
Communication	0.013
Other	0.018

Table 3 – Selected Demographics and Self-Employment Choice by Academic Field (Means)

	N	Female	Black	Hispanic	Self-employ %	Self-employ (given job) %
Agriculture & Natural Resources	15,248	0.43	0.06	0.12	1.05	1.57
Biology & Biomedical Sciences	93,062	0.52	0.04	0.07	0.41	0.65
Health Sciences	24,041	0.69	0.09	0.06	1.14	1.63
Engineering	97,181	0.21	0.03	0.06	0.60	0.92
Computer & Information Sciences	20,128	0.20	0.03	0.04	0.77	1.07
Mathematics	18,939	0.29	0.03	0.06	0.42	0.57
Physical Sciences	63,081	0.31	0.03	0.06	0.45	0.64
Psychology	41,061	0.70	0.07	0.08	3.03	4.03
Social Science	55,927	0.47	0.07	0.09	1.09	1.50
Humanities	64,257	0.51	0.05	0.09	1.42	2.19
Education	49,735	0.68	0.13	0.07	1.40	1.94
Business	15,807	0.39	0.07	0.06	1.06	1.30
Communication	7,176	0.60	0.08	0.06	1.10	1.56
Other*	10,198	0.58	0.11	0.07	2.75	3.95

*The "other" category contains a mix of PhDs in architecture, environmental design, family and consumer science, law, library science, recreation and fitness, public administration, and social work.

Table 4 – Mean Debt and Self-Employment Choice by Selected Demographic Groups

	Real Total Debt ($2001)	Self-employ %	Self-employ (given definite plans) %
All	$15,444	1.03	1.49
Female	$17,309	1.31	1.95
Black	$30,735	.94	1.51
Hispanic	$18,652	1.00	1.49

Table 5 – Regression Results Explaining Self-employment (%), of those with definite plans (n= 395,854)

	(1)	(2)
Real Total Debt	--	-0.0022*
		(0.00097)
Female	0.45**	0.45**
	(0.04)	(0.04)
Black	-0.49**	-0.47**
	(0.09)	(0.09)
Hispanic	-0.095	-0.089
	(0.079)	(0.079)
Asian	-0.42**	-0.43**
	(0.047)	(0.05)
American Indian	0.11	0.13
	(0.21)	(0.21)
Hawaiian	0.36	0.37
	(0.39)	(0.39)
US citizen	0.71**	0.73**
	(0.046)	(0.05)
Carnegie-1	-0.83**	-0.83**
	(0.056)	(0.06)
Grad degree –father	0.027	0.018
	(0.046)	(0.046)
Grad degree—mother	-0.087	-0.091
	(0.051)	(0.051)
R^2	0.018	0.018

Academic Field and Year Fixed Effects (2001-2016), Robust standard errors below estimated coefficients
** = Significance at 1%; * = Significance at 5%