Supplement to "Do elite colleges matter? The impact on entrepreneurship decisions and career dynamics"

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Appendix A: Literature review

This paper builds on the insights of many authors. Having discussed the literature on elite colleges in the Introduction, we now focus on the literature on self-employment.[1]

Several authors explore the individual characteristics, including income, wealth, and education that affect the probability of an individual's becoming self-employed (Blanchflower and Oswald (1998), Dunn and Holtz-Eakin (2000), Evans and Jovanovic (1989), Evans and Leighton (1989), Holtz-Eakin, Joulfaian, and Rosen (1994), Hurst and Lusardi (2004)). In particular, these studies produce mixed evidence of the relationship between education and self-employment. Some studies do not find a significant effect (Dunn and Holtz-Eakin (2000), Evans and Jovanovic (1989)), while others observe a significant impact (Parker and Van Praag (2006), Samaniego and Sun (2019)). Blanchflower (2000) examined OECD data and finds "evidence that self-employment is more prevalent among groups at the two ends of the education distribution and especially so for the least educated." Thus, several competing factors, such as human capital accumulation, opportunity cost, and financial constraints, affect the choice of education and self-employment.

The family may also affect the self-employment decision. Nicolaou and Shane (2010) used data on identical (MZ) and fraternal (DZ) twins in the U.S. to confirm the existence of a genetic component of the intergenerational transfer of self-employment. Using Swedish adoption data, Lindquist, Sol, and Van Praag (2015) compared individuals living with adopted parents with those living with their biological parents and find that post-birth factors are more critical than prebirth factors. Using Norwegian data, Hvide and Oyer (2018) found that most male self-employed individuals start a business in an industry the same as or closely related to that of their fathers.

Our paper is also related to the recent literature, highlighting the introduction of self-employed economic agents, hence the fact-matching in macro models (Bassetto,

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[1]Please refer to Astebro, Herz, Nanda, and Weber (2014), Hanushek and Woessmann (2015), Kerr et al. (2018), Oreopoulos and Salvanes (2011), Oreopoulos and Petronijevic (2013), and Van der Sluis, Van Praag, and Vijverberg (2008) for surveys of the literature on self-employment and education.

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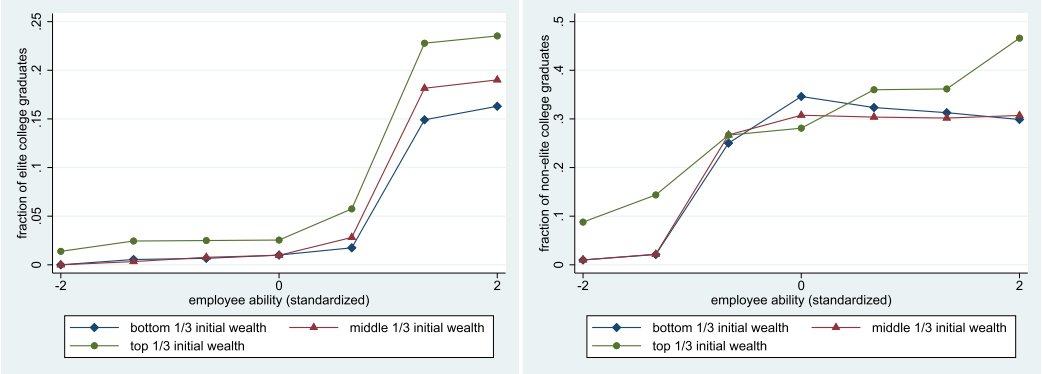
Cagetti, and De Nardi (2015), Cagetti and De Nardi (2006, 2009), De Nardi and Yang (2014), and Quadrini (2009)). Samaniego and Sun (2019) introduced endogenous education choices to the Cagetti and De Nardi framework and find that the higher labor earnings of college graduates allow them to mitigate credit constraints and become self-employed. They also find that subsidizing education's welfare benefits is greater than removing financing constraints on education because subsidies facilitate the accumulation of physical capital and loosen the credit constraints on would-be entrepreneurs.[2] Some dynamic equilibrium models of self-employment do not contain a life-cycle structure (Glover and Short (2011), Michelacci and Schivardi (2017)). Kwark and Ma (2018) incorporated entrepreneurial choice in a dynamic general equilibrium model with both aggregate and idiosyncratic shocks and show that their model can replicate the income transition matrices over occupational choices. Following Vereshchagina and Hopenhayn (2009), Choi (2017) developed a dynamic occupation choice model. It shows that self-employed individuals with better outside options as paid workers tend to take more business risks, and thus exhibit higher firm exit rates, more growth dispersion, and faster growth conditional on survival.

Our paper is also related to an emerging literature that differentiates between entrepreneurs and other self-employed individuals. Glover and Short (2011) documented that incorporated entrepreneurs operate larger businesses, accumulate more wealth, and are, on average, more productive than unincorporated entrepreneurs. Levine and Rubinstein (2017) showed that two types of self-employed have distinct cognitive and non-cognitive abilities, and Levine and Rubinstein (2018) analyzes how abilities and liquidity constraints have different effects on the likelihood of selecting entrepreneurship and other self-employment. Hincapié (2020) developed and estimated a dynamic Roy model of occupational choice, where individuals choose between white-collar, blue-collar, unincorporated business, incorporated business, and not working.[3]

We contribute to the literature in several ways. First, we build a life-cycle model in which different agents have different abilities and monetary endowments inherited from their families and make their education and career decisions accordingly. Hence, we can estimate the effect of education, particularly elite college education, on self-employment decisions controlling for the impact of wealth and ability. Our model mimics the observed intergenerational persistency in education, career, and income. Second, we show that the differences between incorporated and unincorporated business ownership are substantial. Specifically, these two types of self-employment have different technologies and risks and require different types of human capital and entry

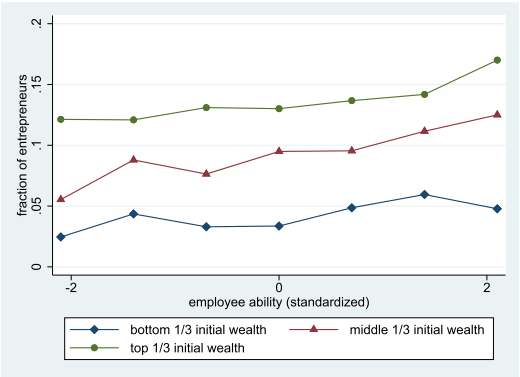
[2] Samaniego and Sun (2019) do not distinguish between elite and ordinary colleges and combine unincorporated and incorporated business owners as entrepreneurs. They calibrate their model and assume that entrepreneur human capital follows a simple Markov process with only two values. We estimate our model using individual panel data, and we allow for a more flexible human capital accumulation process.

[3] Hincapié (2020) quantified the relative importance of determinants of whether to become an entrepreneur and when to become an entrepreneur using a dynamic Roy model with experience accumulation, risk aversion, and imperfect information about ability. However, the model is silent on (1) the modeling of education decisions, (2) how human capital obtained from the school, and (3) wealth accumulation after school affects entrepreneurship decisions.

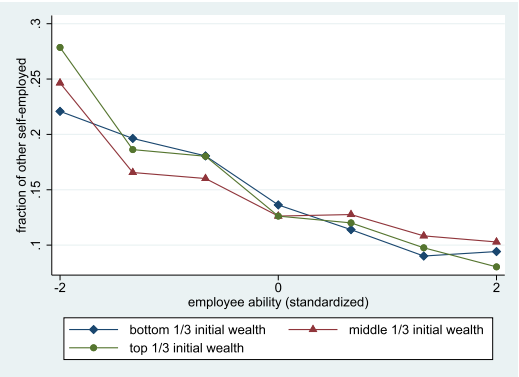


(a) Fraction of elite college graduates

(b) Fraction of ordinary college graduates



(c) Fraction of entrepreneurs



(d) Fraction of other self-employed

FIGURE B1. Education and career choices by general ability and initial wealth.

costs. Our structural model recognizes the differences between these two types of self-employment and explains life-cycle career decisions. Third, we conduct two counterfactual experiments, subsidies to elite and ordinary college students and subsidies to incorporated and unincorporated business startups. We evaluate their microeffects on entrepreneurs' decisions and performance and the aggregate impact on welfare, inequality, and intergenerational mobility.

APPENDIX B: ADDITIONAL RESULTS ON THE EFFECTS OF ABILITIES AND INITIAL WEALTH ON EDUCATION AND CAREER DECISIONS

This paper sheds light on how individuals with different abilities and initial wealth sort into different education and career types. In this section, we present some visualizations of the sorting. To illustrate how abilities and initial wealth jointly affect education and career decisions, we divide individuals' initial wealth into three groups: the bottom 1/3, the middle 1/3, and the top 1/3. Abilities are standardized and range from $+2$ to -2 standard deviations.

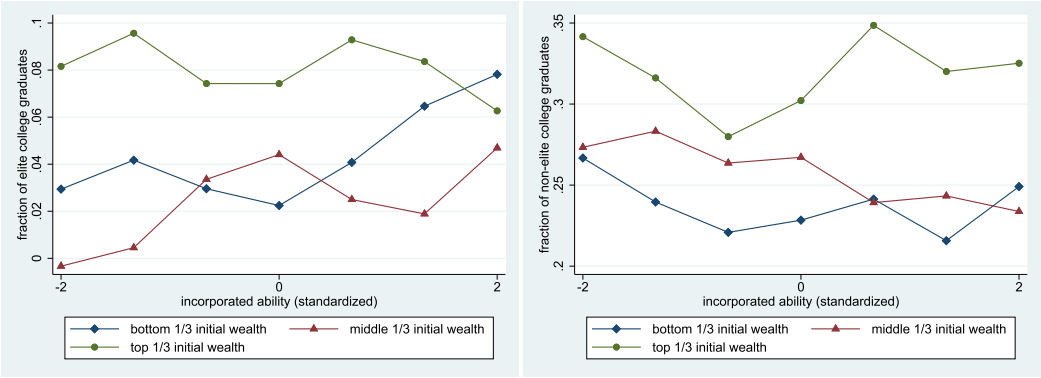
Figure B1 shows how general ability and initial wealth jointly affect decisions about college attendance and self-employment. The upper-left panel shows that the chance of

graduating from an elite college increases with a better general ability and initial wealth. Individuals with below-average ability are unlikely to enroll in an elite college because they do not want to apply for elite colleges. Elite colleges charge high tuition, and the return to an elite college is relatively low for low-ability individuals. Besides, the admission rates of elite colleges are low for individuals with low SAT scores. Based on our estimation, the general ability is mapped on to SAT scores according to $\text{SAT} = 2.050A_{em} + \varepsilon$ and the noise ε has a standard deviation of 0.627. For individuals with high general abilities, they are more likely to apply for elite colleges. Elite colleges reject around one-quarter of the applicants, and hence those applicants have to attend ordinary colleges or directly enter the labor market. The likelihood that an individual with high general ability (above one standard deviation) graduates from an elite college is 15% for the bottom initial wealth group, 18% for the middle group, and 23% for the top group. The pattern that low- and middle-income students "undermatch" to elite colleges is also found in Chetty, Friedman, Saez, Turner, and Yagan (2020), who show that at any given level of SAT/ACT scores, children from higher-income families attend more selective colleges. This is mainly because low-income students are deterred by the high tuition fees.

The upper-right panel of Figure B1 shows that the likelihood of graduating from an ordinary college increases with the general ability and is highest for the top initial wealth group. Individuals with ability below one standard deviation are unlikely to attend an ordinary college because the return to ordinary college is relatively small compared to the tuition. The lower-left panel shows that conditional on general ability, the chance of owning an incorporated business increases with initial wealth. In contrast, the lower-right panel shows that the opportunity to own an unincorporated business contingent on general ability does not vary by initial wealth. These relationships result from entrepreneurship being more capital intensive than other self-employment forms because entrepreneurship has an enormous entry cost. It is also possible that initial wealth does not play a direct role, but serves as a proxy of incorporated ability. Moreover, we find that conditional on initial wealth, the chance of becoming an entrepreneur increases with general ability, whereas the chance of becoming other self-employed declines with general ability.

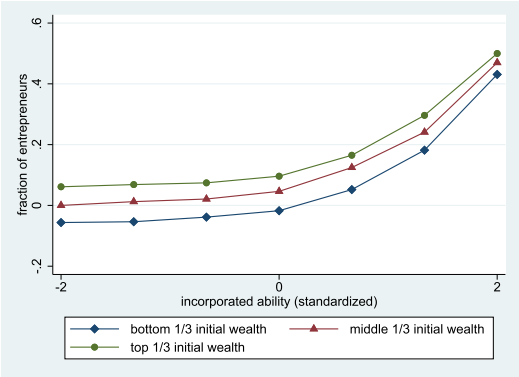
Figure B2 demonstrates the combined effects of incorporated ability and initial wealth on education and career choices. The upper-left and upper-right panels show that conditional on incorporated ability, individuals from high-income families are more likely to attend elite colleges and ordinary colleges, respectively. We find no apparent sorting behavior in terms of incorporated ability in either graph. The bottom two panels show that holding initial wealth fixed, incorporated ability increases the likelihood of being an entrepreneur but reduces the possibility of being other self-employed. Moreover, conditional on incorporated ability, the initial wealth is positively associated with the probability of being an entrepreneur but has no impact on the likelihood of being other self-employed.

Figure B3 presents the interaction between unincorporated ability and family wealth for education and career choices. The upper-left panel shows that conditional on unincorporated ability, the probability of having an elite college degree is much higher for

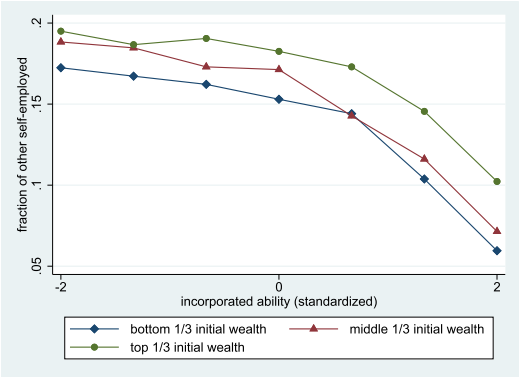


(a) Fraction of elite college graduates

(b) Fraction of ordinary college graduates



(c) Fraction of entrepreneurs

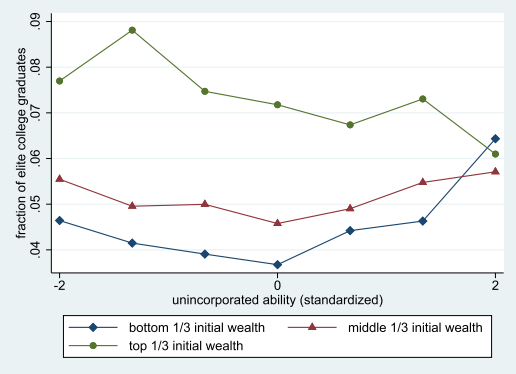


(d) Fraction of other self-employed individuals

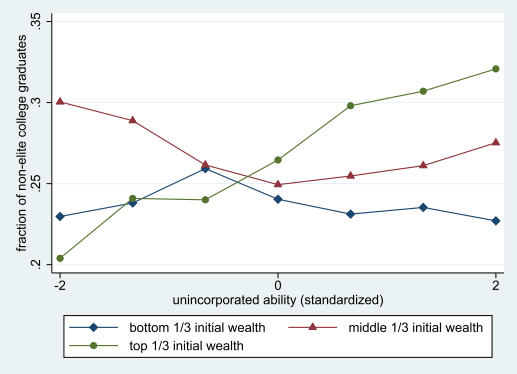
FIGURE B2. Education and career choices by incorporated ability and initial wealth.

individuals from the top initial wealth group. However, we do not find stable sorting behavior in the unincorporated ability for all three initial wealth groups. The upper-right panel shows the fraction of ordinary college graduates. Positive sorting in unincorporated ability is evident for the high initial wealth group but not for the other two groups. The lower-left panel shows that the likelihood of being an entrepreneur declines with unincorporated ability. In contrast, the lower-right panel shows that the probability of being other self-employed increases with unincorporated ability. Moreover, conditional on unincorporated ability, the initial wealth is positively associated with the likelihood of being an entrepreneur but has no impact on the possibility of being other self-employed.

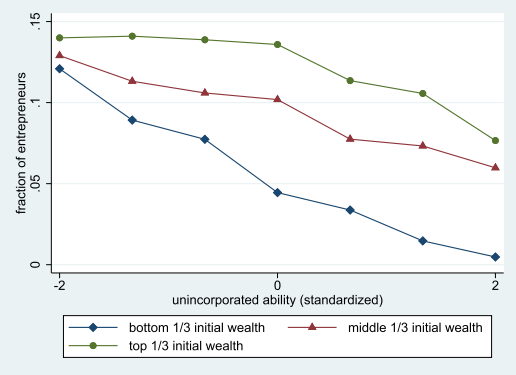
In sum, we find sorting behaviors in education and career choices — individuals with a better general ability and initial wealth sort into elite colleges. Individuals with a high general ability and incorporated ability are more likely to own an incorporated business. In contrast, individuals with low general ability and high unincorporated ability are more likely to own an unincorporated business. Initial wealth increases the chance of owning an incorporated business but does not affect the prospect of owning an unincorporated business.



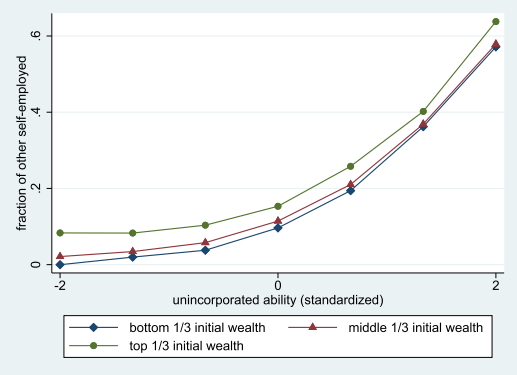
(a) Fraction of elite college graduates



(b) Fraction of ordinary college graduates



(c) Fraction of entrepreneurs



(d) Fraction of other self-employed individuals

FIGURE B3. Education and career choices by unincorporated ability and initial wealth.

APPENDIX C: SUPPLEMENTARY TABLES AND FIGURES

TABLE C1. College characteristics of elite and ordinary colleges.

	Share	Faculty-Student Ratio	Rejection Rate	Retention Rate	Faculty Salary	SAT Score	In-State Tuition	Out-of-State Tuition
Elite college	16.5%	0.13	0.66	0.94	92,859	1356	29,068	30,893
Ordinary college	83.5%	0.07	0.32	0.74	59,928	1035	14,115	17,104

Note: To define elite colleges, we follow Black and Smith (2006) in using factor analysis to construct a college quality index as a function of the faculty-student ratio, rejection rate, retention rate, faculty salary, and mean of reading and math SAT scores.

TABLE C2. List of elite colleges.

Ranking	Institution Name	Quality Index	Public
1	California Institute of Technology	6.31	0
2	Franklin W Olin College of Engineering	6.20	0

(*Continues*)

TABLE C2. *Continued.*

Ranking	Institution Name	Quality Index	Public
3	Harvard University	6.18	0
4	Yale University	6.16	0
5	Princeton University	6.14	0
6	Harvey Mudd College	6.14	0
7	Massachusetts Institute of Technology	6.11	0
8	Pomona College	6.01	0
9	Washington University in St Louis	6.00	0
10	Dartmouth College	5.99	0
11	Stanford University	5.99	0
12	Swarthmore College	5.98	0
13	Columbia University in the City of New York	5.94	0
14	Duke University	5.93	0
15	Brown University	5.91	0
16	University of Pennsylvania	5.91	0
17	Amherst College	5.90	0
18	University of Chicago	5.88	0
19	Williams College	5.86	0
20	Tufts University	5.83	0
21	Rice University	5.82	0
22	Northwestern University	5.81	0
23	University of Notre Dame	5.79	0
24	Claremont McKenna College	5.79	0
25	Carleton College	5.77	0
26	Cornell University	5.77	0
27	Georgetown University	5.76	0
28	Vanderbilt University	5.74	0
29	Haverford College	5.73	0
30	Carnegie Mellon University	5.73	0
31	Johns Hopkins University	5.73	0
32	Wellesley College	5.72	0
33	Bowdoin College	5.72	0
34	Emory University	5.72	0
35	Washington and Lee University	5.71	0
36	Reed College	5.71	0
37	Wesleyan University	5.71	0
38	Middlebury College	5.68	0
39	Vassar College	5.67	0
40	University of Southern California	5.64	0
41	Cooper Union for the Advancement of Science and Art	5.64	0
42	Colby College	5.60	0
43	Brandeis University	5.60	0
44	Scripps College	5.59	0
45	Davidson College	5.59	0
46	Oberlin College	5.58	0
47	Barnard College	5.57	0
48	Grinnell College	5.56	0
49	College of William and Mary	5.56	1
50	Colgate University	5.56	0

(*Continues*)

TABLE C2. *Continued.*

Ranking	Institution Name	Quality Index	Public
51	Jewish Theological Seminary of America	5.54	1
52	Macalester College	5.53	0
53	Boston College	5.52	0
54	New York University	5.50	0
55	University of California-Berkeley	5.49	1
56	Kenyon College	5.49	0
57	Whitman College	5.48	0
58	University of Rochester	5.48	0
59	Rensselaer Polytechnic Institute	5.48	0
60	Wake Forest University	5.46	0
61	Wheaton College	5.45	0
62	Connecticut College	5.45	0
63	Georgia Institute of Technology-Main Campus	5.44	1
64	University of Michigan-Ann Arbor	5.43	1
65	Bucknell University	5.43	0
66	Lehigh University	5.43	0
67	SUNY College at Geneseo	5.42	1
68	University of Virginia-Main Campus	5.42	1
69	Colorado College	5.41	0
70	New College of Florida	5.41	1
71	Bryn Mawr College	5.38	0
72	St Olaf College	5.37	0
73	University of North Carolina at Chapel Hill	5.36	1
74	University of California-Los Angeles	5.35	1
75	Kalamazoo College	5.35	0
76	Trinity College	5.34	0
77	Case Western Reserve University	5.33	0
78	Gettysburg College	5.31	0
79	University of Illinois at Urbana-Champaign	5.31	1
80	Trinity University	5.31	0
81	Lafayette College	5.31	0
82	Thomas Aquinas College	5.31	0
83	Occidental College	5.31	0
84	University of Richmond	5.30	0
85	Villanova University	5.30	0
86	George Washington University	5.30	0
87	Beloit College	5.29	0
88	Rose-Hulman Institute of Technology	5.27	0
89	University of Miami	5.27	0
90	Dickinson College	5.27	0
91	Worcester Polytechnic Institute	5.26	0
92	United States Air Force Academy	5.26	1
93	Tulane University of Louisiana	5.26	0
94	Knox College	5.26	0
95	University of Maryland-College Park	5.25	1
96	Furman University	5.25	0
97	United States Coast Guard Academy	5.23	1
98	United States Naval Academy	5.23	1
99	Boston University	5.23	0
100	Illinois Institute of Technology	5.21	0

TABLE C3. Regression on log total income.

	(1) Employee	(2) Entrepreneur	(3) Other Self-Employed
Elite college degree	0.3077***	0.4987***	0.2713***
	(0.0233)	(0.0796)	(0.0800)
Graduate school degree	0.0438***	0.1495***	0.1068***
	(0.0170)	(0.0575)	(0.0278)
Log father's average income at age 40–50	0.1091***	0.2824***	0.4003***
	(0.0160)	(0.0603)	(0.0712)
Father has high school degree	0.0065	−0.1901**	0.1687*
	(0.0257)	(0.0892)	(0.0959)
Father has ordinary college degree	0.0970***	−0.0405	0.1297
	(0.0283)	(0.1000)	(0.0997)
Father has elite college degree	0.0378	0.2044	−0.1283
	(0.0386)	(0.1286)	(0.1370)
Father ever runs unincorporated business	−0.1018***	−0.3711***	0.1558
	(0.0218)	(0.0715)	(0.1039)
Father ever runs incorporated business	−0.0495**	−0.3699***	−0.3087***
	(0.0203)	(0.0691)	(0.0806)
Age	0.1655***	0.1560***	0.2125***
	(0.0085)	(0.0290)	(0.0341)
Age square	−0.0017***	−0.0017***	−0.0025***
	(0.0001)	(0.0004)	(0.0004)
Constant	6.2167***	4.7090***	2.3512**
	(0.2351)	(0.8253)	(1.0541)
Observations	6468	959	692

Note: We use an OLS model. The dependent variable for all three columns is annual income. The sample includes all white males with college degree or above. The first column restricts the sample to employees, the second column entrepreneurs, and the third column other self-employed.
Standard errors in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

TABLE C4. Fixed parameters.

Parameter	Meaning	Calibration
β	discount rate	0.821
δ	capital depreciation rate	0.266
ζ_t	survival rate after age 65	See Table C5 (Health and Retirement Study)
σ	utility function parameter	1.5 (CDN2006)
ϕ	pension	40% of average earnings (CDN2006)
λ	budget constraint	1.22 (RR2014)
T_e	college tuition	33,046 for elite and 12,761 for ordinary (PSID)
$f_e(k^p, A_{em})$	college financial aid	See Section 4 (Fu2014)
p_e	admission rates of elite colleges	0.209 if SAT scores below 800 0.559 if SAT scores between 800 and 1200 0.756 if SAT scores above 1200 (Fu2014)

Note: CDN2006: Cagetti and De Nardi (2006); RR2014: Robb and Robinson (2014); Fu2014: Fu (2014).

TABLE C5. Survival rate by age.

Age	65	70	75	80	85	90	95	100
Survival rate	95%	93%	89%	83%	73%	57%	38%	21%

Note: Data source is Health and Retirement Study.

TABLE C6. Estimated parameters.

Parameter	Meaning	Target Moments
P_{em}, P_{ib}, P_{ub}	EM, IB, and UB technology	average income of EM, IB, and UB
μ_e^j, $e \in \{nc, ec\}$, $j \in \{em, ib, ub\}$	return to education	income by education and career type
γ_1, γ_2	return to experience	EM income by age
ν_{ib}, ν_{ub}	return to capital	IB and UB income by age
ρ_{ib}, ρ_{ub}	contribution of EM human capital to IB/UB	income correlation for switchers between EM, IB, and UB
ζ_j, $j \in \{em, ib, ub\}$	std of the productivity shock	income std of EM, IB, and UB
C_{ib}, C_{ub}	cost of IB and UB	transitions between IB and UB
η_{ib}, η_{ub}	std of consumption shocks to IB and UB	fraction of IB and UB
σ_j^a, $j \in \{em, ib, ub\}$	std of EM, IB, and UB abilities	income correlations of stayer in EM, IB, and UB
θ_j, $j \in \{em, ib, ub\}$	intergenerational ability transfer	intergenerational correlations in education and career
η_{nc}, η_{ec}	std of consumption shocks on NC and EC	fraction of NC and EC
ω	weight on offspring's welfare	parental monetary transfer as a fraction of parental wealth
α	output elasticity of capital	interest rate

Note: EM: employee, EN: entrepreneur, UB: incorporated business owner, UB: unincorporated business owner, HS: high school graduate, NC: ordinary college graduate, EC: elite college graduate.

TABLE C7. Average ability and wealth at age 20 by education and career.

	Employee	Entrepreneur	Other Self-Employed	Total
General ability				
High school	−0.275	−0.136	−0.563	−0.306
Ordinary college	0.494	0.631	0.426	0.492
Elite college	0.750	1.049	0.673	0.782
Total	0.001	0.162	−0.182	0.000
Incorporated ability				
High school	−0.067	1.535	−0.058	−0.012
Ordinary college	−0.084	1.360	−0.045	0.008
Elite college	−0.116	1.001	−0.097	0.022
Total	−0.076	1.451	−0.055	0.000

(*Continues*)

TABLE C7. *Continued.*

	Employee	Entrepreneur	Other Self-Employed	Total
Unincorporated ability				
High school	−0.134	−0.169	0.997	0.008
Ordinary college	−0.115	−0.210	0.931	−0.003
Elite college	−0.135	−0.052	0.755	−0.010
Total	−0.127	−0.173	0.966	0.000
Wealth at age 20				
High school	15,976	17,930	16,956	16,447
Ordinary college	22,343	26,212	24,167	23,488
Elite college	69,177	93,439	77,446	77,758
Total	20,315	28,767	23,621	21,758

Note: This table presents the average ability and initial wealth at age 20 by education and career types. Average ability is normalized to be zero. Initial wealth is in 2011 dollars.

TABLE C8. Distribution of initial conditions.

			Correlation With			
	Mean	Variance	$\log(A_{em})$	$\log(A_{ub})$	$\log(A_{ib})$	k_0
$\log(A_{em})$	0	0.41	1			
$\log(A_{ub})$	0	0.32	0	1		
$\log(A_{ib})$	0	0.38	0	0	1	
k_0	22,670	39,810	0.210	0.079	0.266	1
s	0.319	0.466	0.267	−0.003	0.079	0.202

Note: We normalize the means of log abilities to be zero and assume that the correlations between abilities are zero. Education is treated as a continuous variable here, where 0 equals high school graduates, 1 equals ordinary college graduates, and 2 equals elite college graduates.

TABLE C9. Counterfactual: average ability and wealth at age 20 of elite college graduates for different levels of elite college subsidies.

Subsidy	General Ability	Incorporated Ability	Unincorporated Ability	Wealth at Age 20
0	0.782	0.022	−0.010	77,758
0.1	0.771	0.051	−0.009	77,349
0.2	0.727	0.085	−0.008	76,952
0.3	0.683	0.119	−0.007	76,677
0.4	0.661	0.148	−0.006	76,175
0.5	0.654	0.172	−0.005	75,845
0.6	0.648	0.208	−0.005	75,596
0.7	0.632	0.241	−0.004	75,091
0.8	0.631	0.270	−0.004	74,787
0.9	0.629	0.311	−0.003	74,351
1	0.628	0.342	−0.003	73,976

Note: This table presents the average ability and initial wealth at age 20 for elite college graduates under different level of elite college subsidies with adjusted admission rates. Average ability is normalized to be zero. Initial wealth is in 2011 dollars.

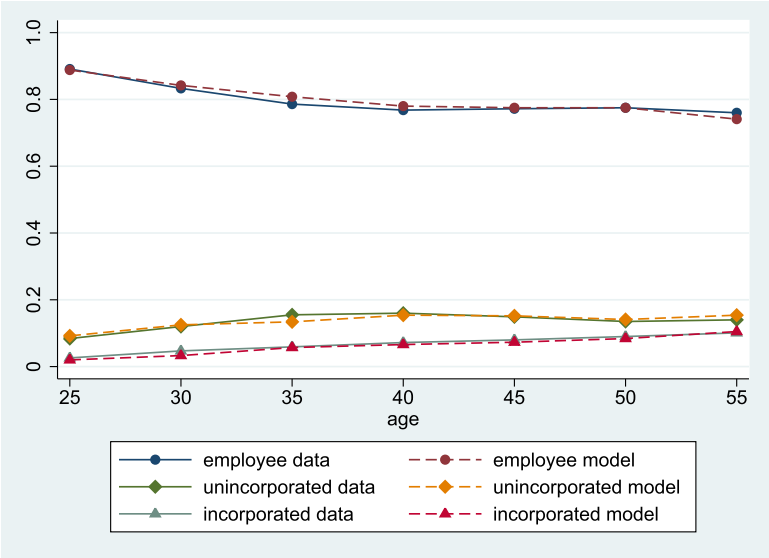


FIGURE C1. Career Choice by Age.

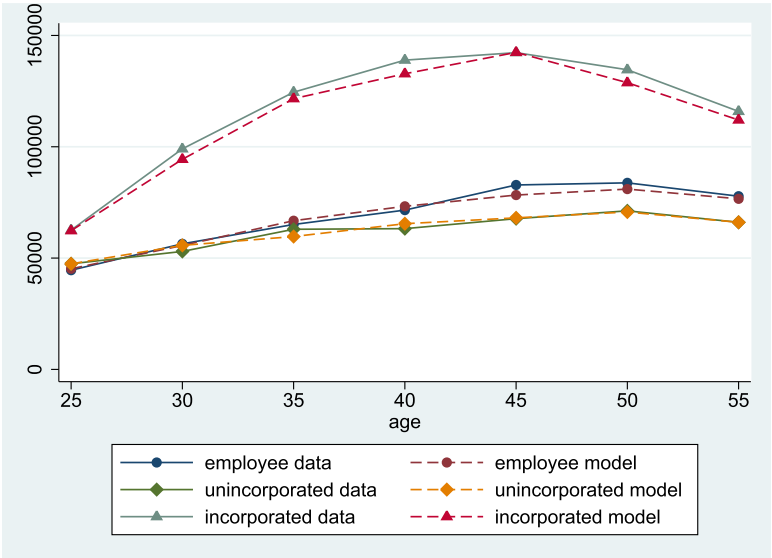


FIGURE C2. Average Income by Career and Age.

FIGURE C3. Counterfactual: Subsidy to Elite/ordinary College Students (Partial Equilibrium).

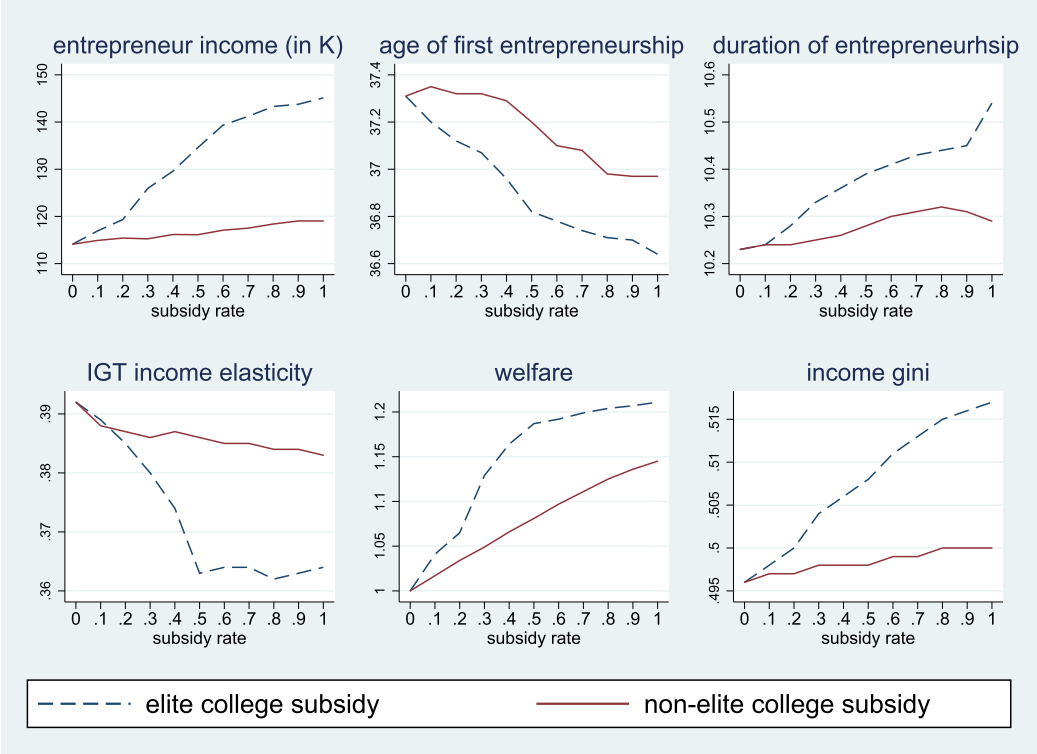


FIGURE C4. Counterfactual: Subsidy to Elite/ordinary College Students (Cont'd, Partial Equilibrium).

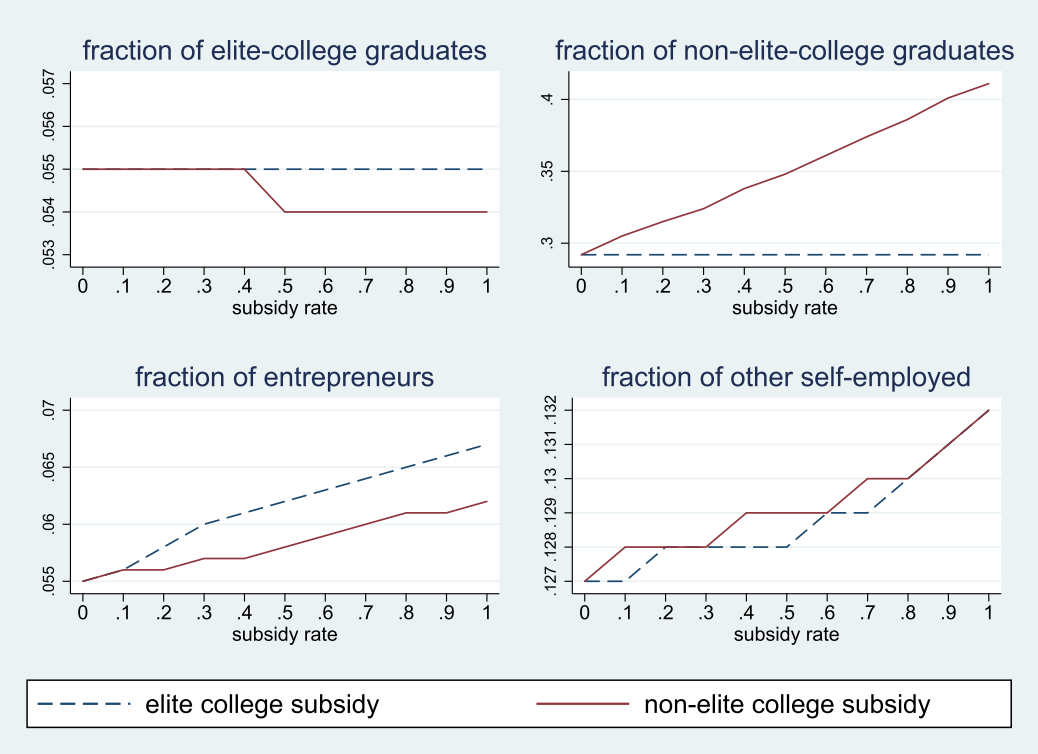


FIGURE C5. Counterfactual: Subsidy to Elite/ordinary College Students (Adjusted for Admission Rate, Partial Equilibrium).

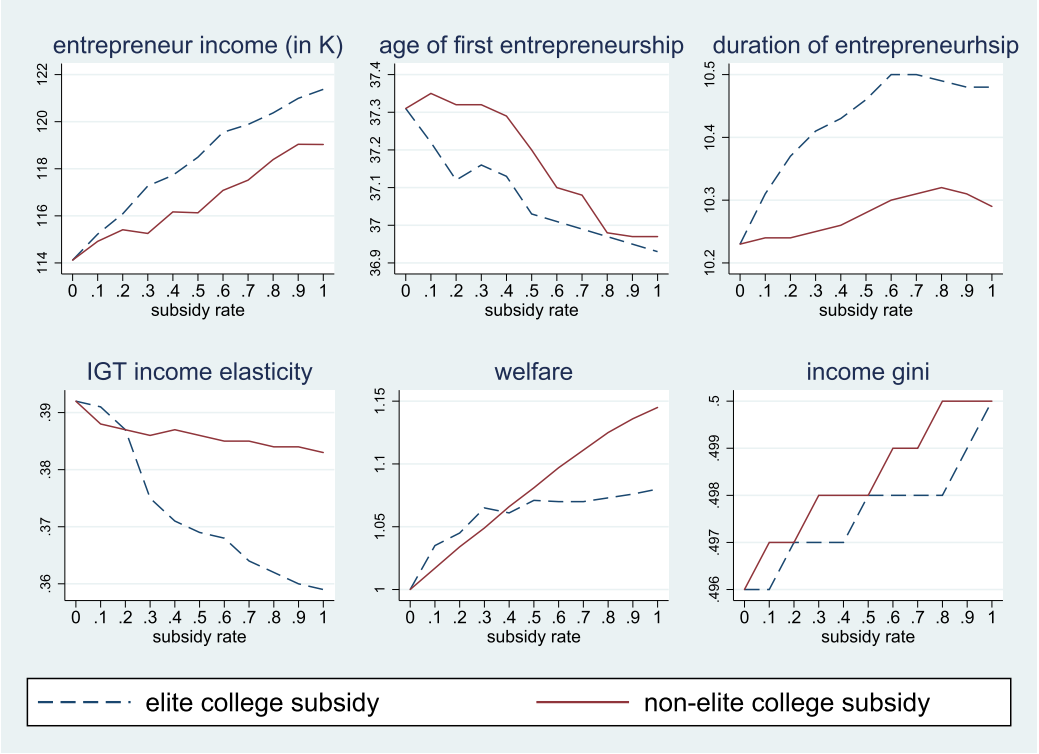


FIGURE C6. Counterfactual: Subsidy to Elite/ordinary College Students (Cont'd, Adjusted for Admission Rate, Partial Equilibrium).

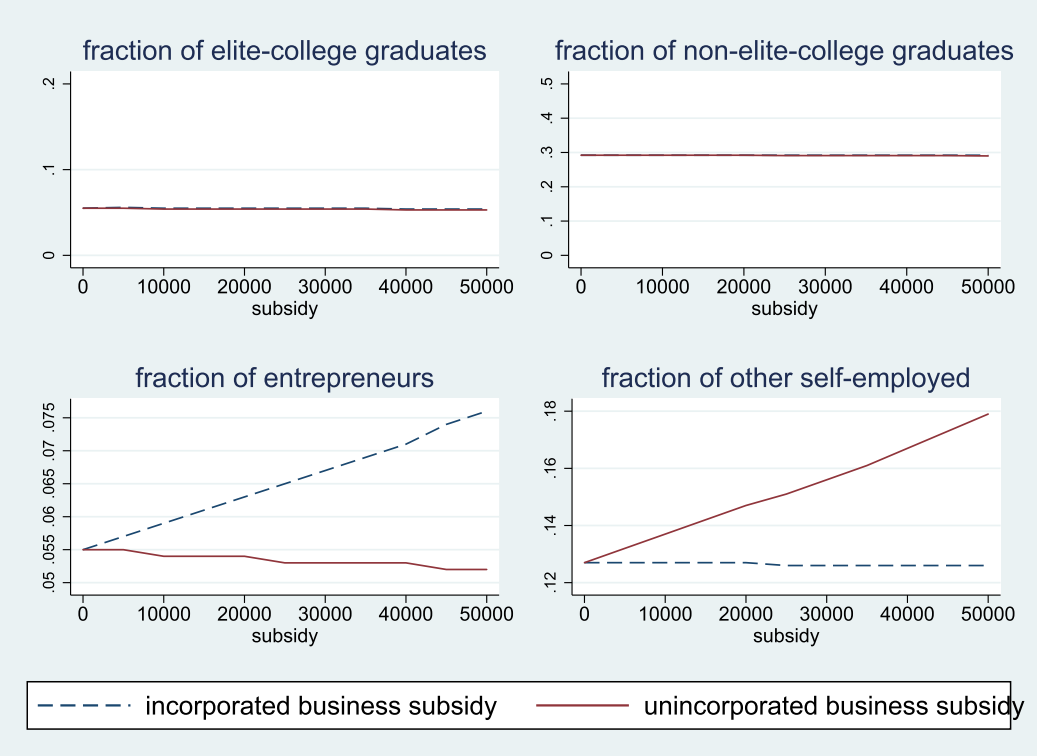


FIGURE C7. Counterfactual: Subsidy to Incorporated/unincorporated Business (Partial Equilibrium).

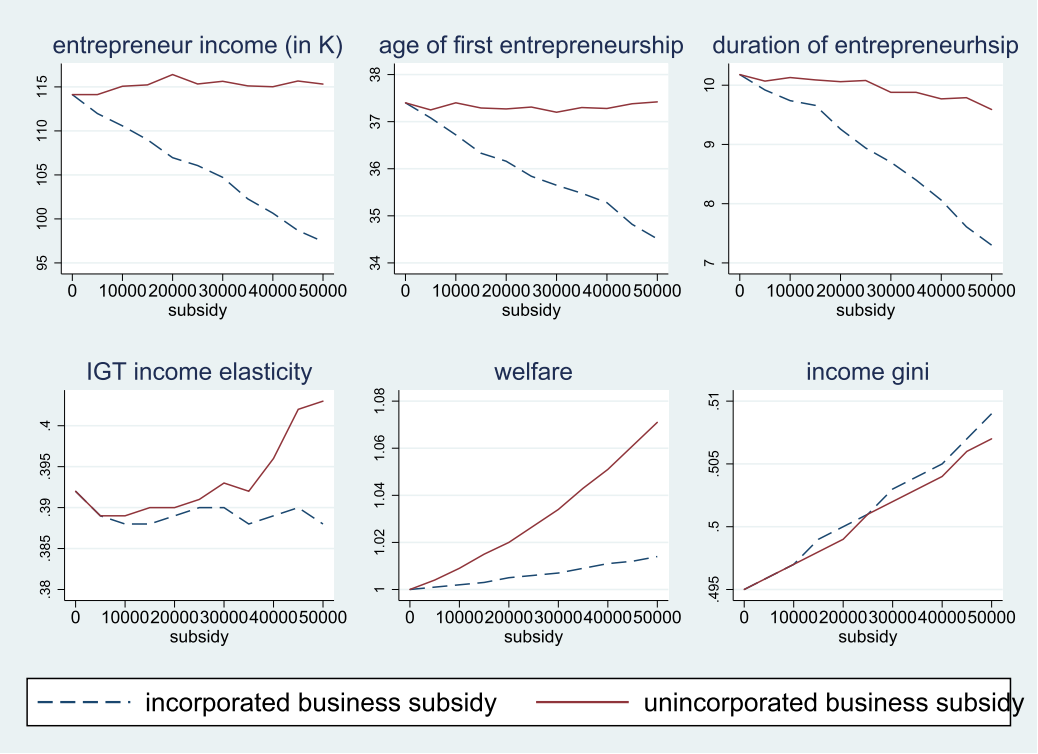


FIGURE C8. Counterfactual: Subsidy to Incorporated/unincorporated Business (Cont'd, Partial Equilibrium).

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