One Size Does Not Fit All: Multiple Dimensions of Ability, College Attendance and Earnings
WEB APPENDIX *

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Abstract

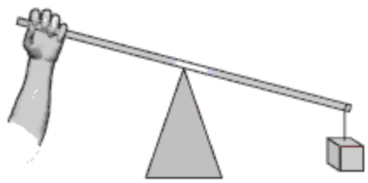
This paper investigates the role of mechanical ability as a determinant of schooling decisions and labor market outcomes. Using a Roy model with multiple unobserved abilities and longitudinal data from the NLSY79, we find that this ability has a positive effect on overall earnings. However, in contrast to cognitive and socio-emotional, mechanical ability reduces the likelihood of attending a four-year college. The rationale for this asymmetry comes from its large estimated impact on earnings conditional on not attending four-year college. Our findings highlight the importance of moving beyond the one-size-fits-all discourse to offer individuals alternative educational pathways for successful careers.

Contents

1 Sample Questions from Technical Composites of the ASVAB

The questions answered by the respondents of the NLSY79 are not available. However, in this section we present a set of questions for illustrative purposes. The set was extracted from: http://www.education.com/reference/article/mechanical-comprehension-quiz/

1.1 Mechanical Comprehension Section

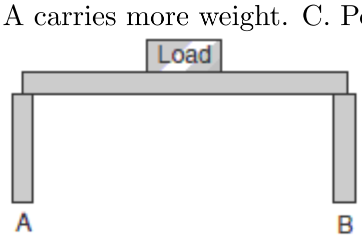
1. The diagram shows a class 1 lever. Which of the following is the same kind of lever? A. A pair  of tweezers B. A pair of scissors C. A wheelbarrow D. A pair of tongs

2. The diagram shows a class 2 lever. Which of the following is the same kind of lever? A. A seesaw B. A pair of scissors C. The human forearm D. A wheelbarrow

3. When a mass of air expands, which of the following is most likely to happen? A. The air warms up. B. The air cools down. C. The air stays at the same temperature. D. The air contracts.

4. The diagram shows a class 3 lever. Which of the following is the same kind of lever? A. A pair of tweezers B. A wheelbarrow C. A seesaw D. A wedge

5. Which of the following would feel hottest to the touch if one end were placed in a pot of boiling water? A. A wooden spoon B. A metal fork C. A plastic knife D. A plastic cup

6. In the diagram, what can you tell about the load on posts A and B? A. Post B carries more weight. B. Post A carries more weight. C. Post A carries no weight. D. The load is equal on posts A and B. 

7. Water is flowing through this pipe. Which statement is true? A. Water is moving faster at point A than at point B. Water pressure is equal at points A and B. C. Water pressure is

greater at point A than at point B. D. Water pressure is greater at point B than at point A.

8. What is the advantage of using triangle shapes in constructing a bridge? A. Triangles are sturdier than other shapes. B. Triangles are very flexible. C. Triangles are inexpensive to manufacture. D. Triangles are attractive to look at.

9. Shifting to a smaller gear on a mountain bike will have an effect on the speed of travel. The smaller sized gear will make pedaling easier but it will also a. increase the speed of travel. b. decrease the speed of travel. c. have no effect on the speed of travel. d. make the bicyclist work harder.

10. Which of the following examples does not make use of a wedge? a. Choosing a sand wedge to hit your golf ball b. Splitting firewood with a chisel and sledge hammer c. Chopping wood with an axe d. Using a lever to lift a load

11. A block and tackle refers to a device which is used to a. put under the wheel of a vehicle to prevent it from rolling backward. b. prevent fish from escaping the hook. c. leverage a stationary object. d. hoist an object into the air by means of rope and pulleys.

12. Downshifting an auto or a truck causes a. a decrease in speed and an increase in torque. b. an increase in speed and a decrease in torque. c. no change in speed and no change in torque. d. None of the above

13. Shifting to a higher gear in a car or truck causes a. a decrease in torque and an increase in speed. b. an increase in torque and a decrease in speed. c. an increase in both speed and torque. d. None of the above.

1.2 Automotive and Shop Information

1. A car uses too much oil when which of the following parts are worn? A. pistons B. piston rings C. main bearings D. connecting rods

2. What system of an automobile or truck determines the vehicle's cornering ability and ride stiffness? a. Steering system b. Braking system c. Electrical system d. Suspension system

3. The purpose of a transfer case is to a. make a vehicle ride more smoothly. b. make the steering more responsive to driver input. c. distribute power to front and rear wheels in a 4 x 4 vehicle. d. shorten the braking distance.

4. The reason a particular quarter inch nut may not fit a particular quarter inch bolt is because a. they may be of different thread classifications. b. a quarter inch bolt is incompatible with a quarter inch nut of the same size. c. the metal alloys from which the nut and bolt are made may cause the nut to seize.d. quarter-inch bolts require a nut of a slightly larger size to fit.

5. The kerf is a. a type of wood file. b. the angle of the blade on a circular saw. c. a slot or cut made by the blade of a saw as it cuts into the wood. d. a term of measurement used in vehicle wheel alignment.

6. It would be better to use thick viscosity motor oil in a. cold climates (makes vehicle startups easier). b. tropical climates (engine heat build-up). c. Eastern United States. d. four-wheel drive vehicles.

7. The part of the motor vehicle electric system which distributes the spark to the various combustion cylinders is the a. battery. b. rotor and distributor assembly. c. injection system. d. ignition coil.

8. A punch is used for a. hammering knots from wooden objects. b. marking metal or wooden objects to prepare for drilling or other activities and for driving small headed nails. c. filing the sharp edges of metal or wooden objects. d. drilling holes.

9. For a better grip on a stubborn fastener nut, it is better to use a. an adjustable wrench. b. an open-end wrench. c. a box-end wrench. d. a pipe wrench.

1.3 Electronics Information

1. Ohm's Law states that a. E = I x R. b. R = E x I. c. voltage is equal to the current multiplied by the resistance. d. Both a and c

2. The electrons revolve around the nucleus in a cumulative series of orbits which are called a. neutrons. b. subatomic particles. c. shells. d. circulating cores.

3. The part of the atom's shell that determines electrical properties is the ________ shell. a. insulator b. nucleic c. valence d. electronic

4. A semi-conductor is an element or substance which a. conducts electricity better than a conductor. b. is useful for certain conductive requirements necessary to some electrical technologies. c. completely inhibits the flow of electrons around the outer shell. d. insulates electrical current from contact with other materials.

5. When applied to electrical conductivity of household current, 60 hertz means that a. current flows in only one direction. b. current flows in two directions. c. current flows first in one direction and then another. d. 60 voltage cycles take place in one second.

6. The three necessary components of an electrical circuit are a. an electrical load, conductors, and a circuit for the electricity flow to follow. b. a switch, a resistor, and a path to follow. c. a 60 hertz receptacle, a switch, and a power source. d. a closed circuit, a battery, and radio waves.

7. Doping is a term used in the semiconductor process when a. impurities are added into the crystal structure of silicon. b. hydrogen atoms are added to the crystal structure of silicon. c. impurities are removed from the crystal structure of silicon. d. semiconductors are used for medical purposes.

8. The property of electricity that pushes and moves it along a circuit is called a. alternating current. b. amperage. c. resistance. d. voltage.

2 Statistical Inference

Let θ be the parameter of interest, in our case $\theta = (\alpha, \beta, \lambda)$, $f(\theta)$ the density of θ, called the prior distribution. $Y = \{y_{1,..,}y_N\}$ is the sample of N independent observations, where $f(y_n|\theta)$ is the probability of outcome y_n, and $f(Y)$ the marginal distribution of the data (marginal over θ). The posterior distribution is denoted by $f(\theta|Y)$ and the probability of observing the sample outcomes Y is the likelihood function of the observed choices, $L(Y|\theta) = \prod_{n=1}^{N} f(y_n|\theta)$.

In this context, $f(Y) = \int L(Y|\theta)f(\theta)d\theta$. Using the Bayes' rule we obtain:

$$f(\theta|Y)f(Y) = L(Y|\theta)f(\theta)$$

$$f(\theta|Y) \propto L(Y|\theta)f(\theta)$$

The mean of the posterior distribution is:

$$\bar{\theta} = \int \theta f(\theta|Y)d\theta \tag{1}$$

Since, we rely on Bayesian methods only to ease the computational burden of the estimation, we analyze $\bar{\theta}$ from a classical perspective, i.e., as an estimator that has the same asymptotic sampling distribution as the maximum likelihood estimator.[1] Therefore, we need to find the sampling distribution of the statistic $\bar{\theta}$. Following the Bernstein-von Mises Theorem, the variance of the posterior is the asymptotic variance of the estimates.[2] In consequence, estimation can be performed by using the moments of the posterior where the mean of the posterior provides a point estimate and the standard deviation of the posterior provides the standard errors.

In this paper we use MCMC as a method to obtain draws from the posterior distribution. We generate 1,000 draws from the posterior distribution of the parameters to compute the mean, which we denote by $\breve{\theta}$, and the standard errors reported in the text. To calculate the standard errors of functions of $\breve{\theta}$, we follow Gelman and Shirley (2011) and carry out simulation-based inference using a collection of 1,000 simulations of the parameter vector, summarized by a mean and standard deviation, and 95% interval using the empirical distribution of the simulations that have been saved.

3 Model Estimates

[1]From a bayesian perspective, the mean of the posterior distribution is the value that minimizes the posterior loss in the quadratic loss case. As stated in Train (2003) this is the value that minimizes the expected cost of the researcher being wrong about the parameter, if the cost is quadratic in the size of the error.

[2]The Bernstein-von Mises Theorem establishes the properties of the sampling distribution of $\bar{\theta}$ in three statements: 1. $\sqrt{N}(\theta - \bar{\theta}) \rightarrow^{d} N(0, (-H)^{-1})$; 2.$\sqrt{N}(\bar{\theta} - \theta^{MLE}) \rightarrow^{p} 0$ and 3.$\sqrt{N}(\bar{\theta} - \theta^{*}) \rightarrow^{d} N(0, (-H)^{-1})$. See Train (2003) for details.

Table A.1: Estimates of the Model: Measurement Equations

	cons	Sibl	Med	Fed	FamY	urban	south	coh3	coh4	hgtest	c	m	s
Auto	-2.39	-0.02	0.01	0.01	0.00	-0.18	-0.24	-0.30	-0.31	0.25	0.00	1.30	0.00
SE	0.53	0.02	0.01	0.01	0.00	0.07	0.07	0.10	0.12	0.04		0.09	0.00
Electronics	-2.73	-0.05	0.02	0.01	0.00	-0.11	-0.20	-0.11	-0.03	0.23	0.46	0.85	0.00
SE	0.52	0.02	0.01	0.01	0.00	0.07	0.07	0.10	0.12	0.04	0.00	0.06	0.00
Mech. C	-2.60	-0.01	0.03	0.01	0.00	-0.13	-0.21	-0.06	0.05	0.21	0.41	1.00	0.00
SE	0.54	0.02	0.01	0.01	0.00	0.07	0.07	0.11	0.12	0.04	0.00	0.00	0.00
Arithmetic K.	-3.69	-0.01	0.04	0.02	0.01	-0.01	-0.20	0.15	0.42	0.24	1.02	0.00	0.00
SE	0.50	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.12	0.04	0.03	0.00	0.00
Math	-3.37	-0.02	0.04	0.04	0.01	-0.03	-0.18	0.35	0.52	0.18	1.00	0.00	0.00
SE	0.48	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.11	0.04	0.00	0.00	0.00
Word K.	-3.86	-0.06	0.05	0.03	0.00	-0.04	-0.12	-0.14	0.16	0.28	0.93	0.00	0.00
SE	0.48	0.02	0.01	0.01	0.00	0.06	0.06	0.09	0.11	0.04	0.04	0.00	0.00
Paragraph C.	-3.69	-0.03	0.03	0.04	0.00	-0.05	-0.05	0.04	0.30	0.25	0.93	0.00	0.00
SE	0.50	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.12	0.04	0.04	0.00	0.00
Numerical S.	-3.61	-0.02	0.03	0.03	0.01	0.03	-0.17	0.20	0.38	0.23	0.77	0.00	0.00
SE	0.49	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.11	0.04	0.04	0.00	0.00
Coding S.	-3.14	-0.01	0.03	0.02	0.01	-0.02	-0.19	0.03	0.21	0.22	0.69	0.00	0.00
SE	0.51	0.02	0.01	0.01	0.00	0.07	0.07	0.10	0.12	0.04	0.04	0.00	0.00
Rotter	-1.52	-0.01	0.00	0.02	0.01	-0.02	0.01	-0.21	-0.17	0.13	0.23	0.00	0.22
SE	0.53	0.02	0.01	0.01	0.00	0.07	0.07	0.11	0.13	0.04	0.04	0.00	0.04
Rosen.	-0.66	-0.03	0.01	0.01	0.00	0.06	0.02	-0.03	-0.24	0.05	0.25	0.00	1.00
SE	0.50	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.12	0.04	0.04	0.00	0.00
Reckless	0.03	-0.02	0.00	0.00	0.01	-0.09	0.00	0.13	0.07	0.00	0.03	0.00	0.05
SE	0.54	0.02	0.01	0.01	0.00	0.07	0.07	0.11	0.13	0.05	0.05	0.00	0.04

Note: This table presents estimates of the model. Using data from the NLSY79, white males between 25-35 years old. Since the model is estimated using Bayesian methods, they represent the mean estimates over 1,000 iterations after discarding the first 30,000. cons is the constant, Sib is the number of siblings in 1979, Med is the mother's highest grade completed at age 17, Fed is the father's highest grade completed at age 17, FamY is the family income in 1979 in thousands, urban is a dummy variable for living in an urban area at age 14, south is a dummy variable for living in the south at age 14, Coh3 refers to the cohort of individuals that were born between 1961-1962, Coh4 refers to the cohort of individuals that were born between 1963-1964, hgtest is the highest grade attended by the time the test was presented and c, m, s refers to the cognitive, mechanical and socio-emotional factors respectively.

Table A.2: Estimates of the Model: College Decision Model

Pr(Attending college)	**Coefficient**	**SE**
Constant	-2.38	0.34
Number of siblings	-0.08	0.03
Mother's highest grade completed	0.07	0.02
Father's highest grade completed	0.09	0.02
Family Income 1979 (thousands)	0.02	0.00
Living in urban area at age 14	0.05	0.12
Living in the south at age 14	0.12	0.13
Cohort1 (Born 57-58)	-0.85	0.28
Cohort2 (Born 59-60)	-0.93	0.24
Cohort3 (Born 61-62)	-0.28	0.11
4y college tuition	-0.01	0.01
Cognitive	0.97	0.09
Mechanical	-0.73	0.13
Socio-emotional	0.16	0.07

Note: This table presents estimates of the model. Using data from the NLSY79, white males between 25-35 years old. Since the model is estimated using Bayesian methods, they represent the mean estimates over 1,000 iterations after discarding the first 30,000.

Table A.3: Estimates of the Model: Log Annual Earnings

	Conditional on $D = 0$	**SE**	**Conditional on $D = 1$**	**SE**
Constant	10.47	0.10	10.58	0.09
Northeast residence	0.11	0.09	0.36	0.10
Northcentral residence	-0.04	0.08	0.17	0.09
South residence	0.01	0.08	0.26	0.10
Cohort1 (Born 57-58)	-0.11	0.15	-0.40	0.22
Cohort2 (Born 59-60)	-0.35	0.12	-0.01	0.20
Cohort3 (Born 61-62)	-0.10	0.06	-0.09	0.07
Local unemployment	-0.07	1.32	-2.06	0.99
Cognitive	0.06	0.01	0.24	0.02
Mechanical	0.13	0.08	-0.03	0.08
Socio-emotional	0.10	0.04	0.09	0.04
Error	2.09	0.12	2.52	0.18

Note: This table presents estimates of the model. Using data from the NLSY79, white males between 25-35 years old. Since the model is estimated using Bayesian methods, they represent the mean estimates over 1,000 iterations after discarding the first 30,000.

Table A.4: Parameters of the Distribution of Unobserved Abilities

	Cognitive		**Mechanical Aux**		**Socio-emotional Aux**	
	Estimate	SE	Estimate	SE	Estimate	SE
μ_1	0.34	0.13	0.05	0.30	0.94	0.18
μ_2	-0.59	0.33	-0.10	0.31	-0.50	0.11
$1/\sigma_1^2$	4.11	1.24	5.97	2.26	5.47	2.07
$1/\sigma_2^2$	2.34	0.70	5.50	2.13	4.42	1.52
$1/\rho$	0.60	0.20	0.50	0.20	0.35	0.10

Note: This table presents estimates from the Model. Since the model is estimated using Bayesian methods, they represent the mean estimates over 1,000 iterations after discarding the first 30,000. Mechanical Aux. presents the results from the auxiliar component of the factor, θ_2 which is independent from cognitive ability. Where $\theta_m = \alpha_1\theta_c + \theta_2$ with $\alpha_1 = 0.38$. Socio-emotional Aux. presents the results from the auxiliary component of the factor, θ_3 which is independent from cognitive ability. Where $\theta_s = \beta_1\theta_c + \theta_3$ with $\beta_1 = 0.25$

4 Goodness of Fit and Comparison with a Two-Factor Model

This section summarizes the main empirical implications of dealing with the three-ability model versus the more conventional two-ability framework. We document differences in within-sample goodness of fit, but more importantly, we show how our approach contests the meaning of the term "low ability',' informs the discussion on the benefits of college, and corrects for potential biases. These results provide a sense of whether omitting the third ability dimension matters.

Our results support the theory of the existence of multiple dimensions of ability that are important in explaining schooling decisions and labor market outcomes. We find that our three ability framework marginally improves the goodness-of-fit of the model relative to a two-ability framework. Tables A.5 and A.6 compare the first and second moments of the estimated distribution of log earnings with the observed distribution. In addition, the three-ability model corrects for small biases in schooling choice models and earnings regressions (see Table A.7 and Figure A.7).

However its empirical relevance goes beyond these facts. As explained in the paper, by jointly analyzing mechanical, cognitive and socio-emotional abilities we explain and qualify phenomena, which are hard (if not impossible) to conceptualize using a two-factor framework. In this context, beyond contesting the validity of exogeneity assumptions in other papers, our study provides new insights into the complexities associated with schooling decisions and, more importantly, contests the meaning of the term "low ability" and its use in discussions on the benefits of college.

Table A.7 compares the results obtained in our model with those obtained from a model that only considers the two conventional dimensions of ability. At first glance, the set of results seem similar. However, differences emerge in the effect of cognitive ability on the decision to attend a four-year college and earnings associated with the scenario of not attending a four-year college. Specifically, a one unit increase in cognitive ability increases the probability of attending college by 31 and 24 percent points in a three-factor model and a two factor model respectively. Figures A.7 compares the sorting implied by each model. Meanwhile in earnings regressions that include mechanical ability, the effect of cognitive ability for those not attending four-year college is less than one half of the effect estimated in a two-ability model.

Table A.5: Goodness of fit: First Moment of the Distribution of (log) Annual Earnings

	Overall	$D = 0$	$D = 1$
Data	**10.526**	**10.363**	**10.749**
Simulated 3 factors	10.521	10.368	10.721
t-statistic	-0.2048	0.1623	-0.8266
p-value	(0.8377)	(0.8710)	(0.4085)
Simulated 2 factors	10.509	10.361	10.711
t-statistic	-0.6880	-0.037	-1.1286
p-value	(0.4914)	(0.9705)	(0.2591)

Note: Two-sample two-sided t-Test for equal means

Table A.6: Goodness of fit: Second Moment of the Distribution of (log) Annual Earnings

	Overall	$D = 0$	$D = 1$
Data	**0.7157**	**0.7080**	**0.6647**
Simulated 3 factors	0.7263	0.7245	0.67
F-statistic	1.0603	1.0963	1.0866
p-value	(0.2113)	(0.1321)	(0.2562)
Simulated 2 factors	0.7353	0.7231	0.6841
F-statistic	1.114	1.0882	1.1216
p-value	(0.0216)	(0.1105)	(0.1166)

Note: F-Test for Equal Variances

The analysis of the returns to education also illustrates the differences between our three-ability model and an alternative two-ability framework:

Table A.8 compares the ex-post effects of four-year college attendance on future annual earnings from three- versus two-ability models. Our results indicate that the return to college attendance among those who attended college (treatment on the treated) on (log) annual earnings is 0.265 in a model including mechanical ability, whereas in the conventional setup the estimated effect is 0.227. In contrast, conditioning on not attending college, the average effect (treatment on the treated) is 0.16 for the three-ability model versus the estimated 0.184 in the two-ability framework.

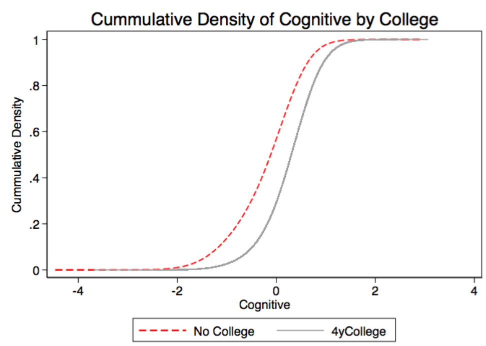
Overall, these results suggest that regardless of the setup, on average, attending four-year college is associated with higher average earnings even for individuals that, given their observable characteristics and latent abilities, ended up deciding not to attend it. This is consistent with the literature (Heckman, Humphries and Veramendi, 2016). However, this conclusion hides important

Table A.7: Estimated Effects on College Attendance and (log) Earnings: Three-ability vs Two-ability Model

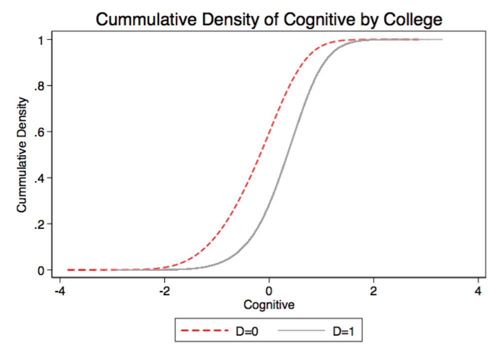
Outcomes	3 factors	2 factors
Pr(4year college Attended)		
Cognitive	0.31	0.23
Mechanical	-0.18	
Socio-emotional	0.04	0.05
Log annual Earnings by Schooling		
Cognitive conditional on D=0	0.06	0.15
Cognitive conditional on D=1	0.24	0.24
Mechanical conditional on D=0	0.13	
Mechanical conditional on D=1	-0.03	
Socio-emotional conditional on D=0	0.10	0.08
Socio-emotional conditional onD=1	0.09	0.08
Log annual Earnings overall		
Cognitive	0.25	0.25
Mechanical	0.05	
Socio-emotional	0.10	0.10

Note: The data are simulated from the estimates of the model and our NLSY79 sample. The table presents the effect of increasing each factor by one unit while leaving the other variables constant. D is a dummy variable indicating whether or not an individual attended four-year college. The college decision equation includes family background controls, cohort dummies and geographical controls for region and urban residence at the age of 14. In the (log) earnings equations we control for cohort dummies, geographical controls for region and urban residence as well as local unemployment rates for two-year and four-year college graduates at age 25.

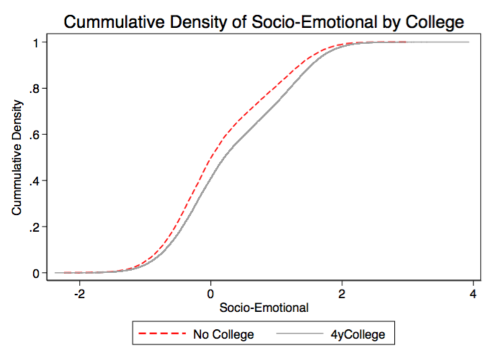
Figure A.1: Marginal Cumulative Distribution Function: Cognitive and Socio-emotional Ability



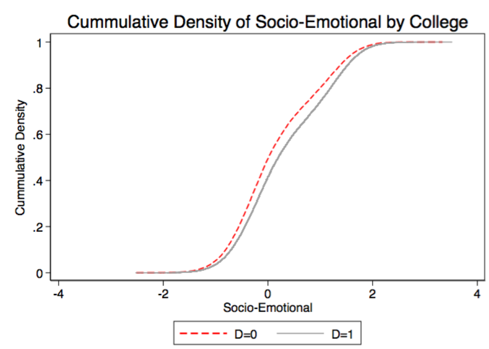
(a) Cognitive - Two-ability model



(b) Cognitive - Three-ability model



(c) Socio-emotional - Two-ability model



(d) Socio-emotional - Thee-ability model

Note: The data are simulated from the estimates of the model and our NLSY79 sample. The figure presents the marginal cumulative distribution functions of each latent factor by schooling level, attending four-year college or not. The red dashed line corresponds to individuals who chose not to attend four-year college while the grey solid line is the marginal cdf for individuals that decided to attend four-year college. Panel (a) corresponds to cognitive ability under the 2 factor model, (b) corresponds to cognitive ability under the 3 factor model and panel, (c) to socio-emotional ability under the 2 factor model and (d) to socio-emotional ability under the 3 factor model.

Table A.8: Three- versus Two-Ability Models: The Effect of Attending Four-year College on Annual Earnings

Parameter	Three-ability Model	Two-ability Model
$E[Y_1 - Y_0 \| D = 1]$	0.265***	0.227***
$E[Y_1 - Y_0 \| D = 0]$	0.160***	0.184***

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The table presents the calculated average effect of attending four-year college on annual earnings conditional on $D = 1$ (treatment on the treated) and $D = 0$ (treatment on the untreated). Each parameter is constructed using the estimates from our model.

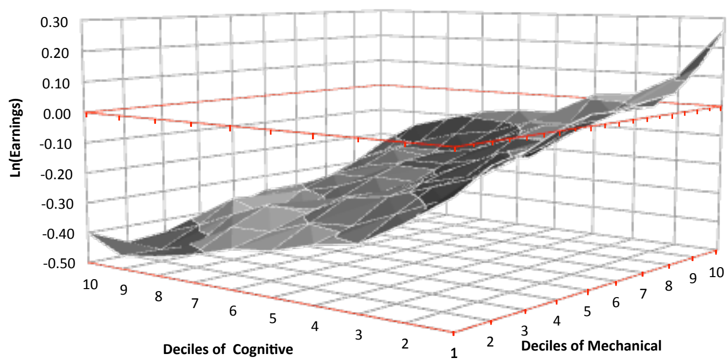
heterogeneity. As shown in Figure A.2 for individuals with high levels of mechanical ability and low levels of cognitive ability, choosing not to attend a four-year college is the alternative associated with the highest ex-post annual earnings. In a model that only incorporates cognitive and socio-emotional abilities, it is not possible to see this pattern (See panels a, b and c in Figure A.3). In fact, by restricting the analysis to the conventional two ability taxonomy, one would not only incorrectly level "low ability" individuals, but mis-compute their returns to college attendance.

An alternative way to illustrate the relevance of considering mechanical ability is to compare the average treatment effect on the untreated for different ability profiles as in Table A.9 The comparison of the results by quintiles of cognitive and socio-emotional ability from a three-ability model (column 3) versus two-ability model (column 4) would suggest little differences, particularly among those with high levels of cognitive ability. However, this comparison is misleading. On average, those individuals in the highest quintile of mechanical ability would face negative ex-post returns to college attendance.

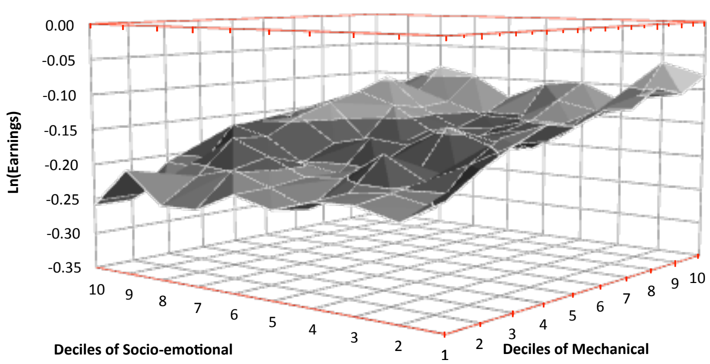
5 Comparison of Simulated Effects using Alternative Schooling Variables

This section presents a discussion about the empirical consequences of extending our model to other post-secondary alternatives: four year college completion, college attendance (including two and four year college) and a three schooling decision model comparing high school no college, attending

Figure A.2: $E[Y_0 - Y_1|D = 0]$ by Deciles of Ability in the Three-Ability Model



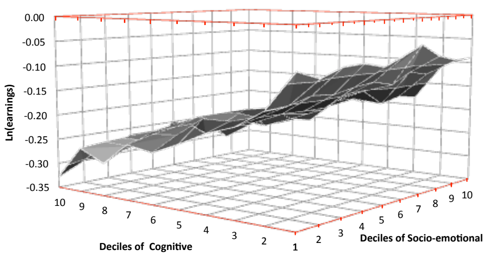
(a) Cognitive-Mechanical



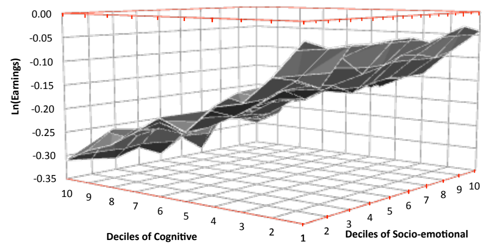
(b) Cognitive-Mechanical

Note: The data are simulated from the estimates of the model and our NLSY79 sample. The figure presents the average (log) annual earnings (ages 25-35) as a function of two abilities: Cognitive and mechanical (panel a), and socio-emotional and mechanical (panel b). Formally, if Y denotes average (log) annual earnings between ages 25 and 35 , Y_0 is the (log) annual earnings corresponding to the scenario of not attending four-year college, Y_1 is the analogous in the alternative scenario of attending four-year college. Given deciles d and p for abilities i and j, respectively, each panel depicts: $E(Y_0 - Y_1|D = 0, \theta_i \in d, \theta_j \in p) = \int E(Y_0 - Y_1|D = 0, \theta_i \in d, \theta_j \in p, \theta_k)dF(\theta_k|\theta_i \in d, \theta_j \in p)$ for different values of $d = 1, ..10$, and $p = 1, ..10$.

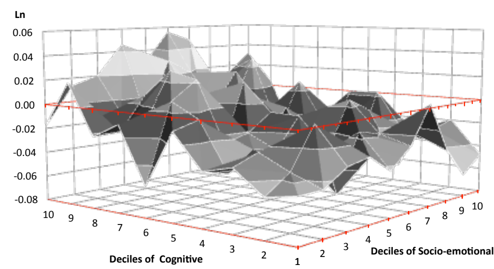
Figure A.3: Average Treatment Effect on the Untreated by Deciles of Cognitive and Socio-emotional: Two-Ability vs Three-Ability Models



(a) Two factors



(b) Three factors



(c) Difference: two vs three factors

Note: The data are simulated from the estimates of the model and our NLSY79 sample. The figure presents the average difference in (log) annual earnings (ages 25-35) as a function of two abilities: Cognitive and socio-emotional in a model of two factors (panel a), in a model of three factors (panel b) and the difference in the average difference of (log) earnings in a model of 2 and 3 factors. Formally, if Y denotes average (log) annual earnings between ages 25 and 35, Y_0 is the (log) annual earnings corresponding to the scenario of not attending four-year college, Y_1 is the analogous in the alternative scenario of attending four-year college. Given deciles d and p for abilities i and j, respectively, each panel depicts: $E(Y_0 - Y_1|D = 0, \theta_i \in d, \theta_j \in p) = \int E(Y_0 - Y_1|D = 0, \theta_i \in d, \theta_j \in p, \theta_k)dF(\theta_k|\theta_i \in d, \theta_j \in p)$ for different values of $d = 1, ..10$, and $p = 1, ..10$.

Table A.9: Average Treatment Effect on the Untreated, by Ability Levels (Quintiles)

	Three-ability Model						**Two-ability Model**	
	Bottom 20 Mech.		**Top 20 Mech.**		**Total**		**Total**	
	(1)		**(2)**		**(3)**		**(4)**	
Bottom20 C-Bottom20 SE	13%	***	-6.0%	***	7.0%	***	11%	***
Bottom20 C-Top20 SE	14%	***	-6.0%	***	7.0%	***	11%	***
Top20 C-Bottom20 SE	44%	***	21.0%	***	27.0%	***	28%	***
Top20 C-Top20 SE	47%	***	21.0%	***	27.0%	***	27%	***

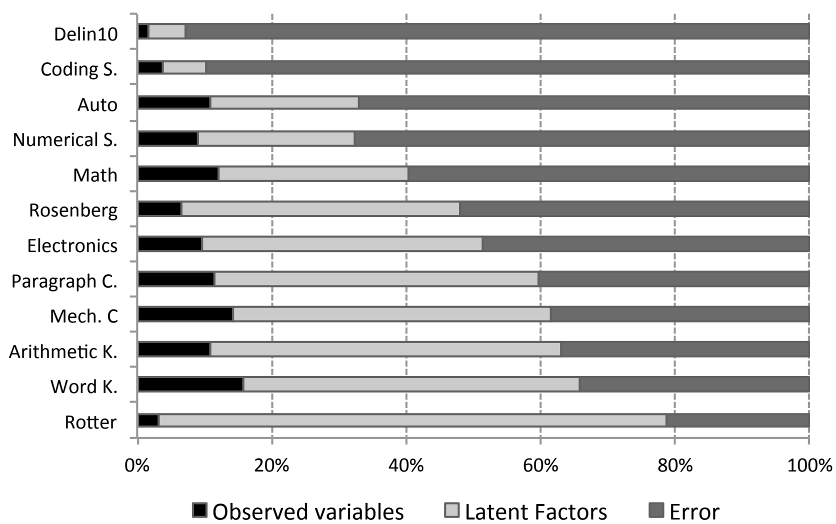
Note: The data are simulated from the estimates of the model and our NLSY79 sample. The table displays the average effects of four-year college Attendance on (log) annual earnings for those not attending college, i.e. $E[Y_1 - Y_0|D = 0]$, by different ability levels. Y_0 is the (log) annual earnings corresponding to the scenario of not attending four-year college, Y_1 is the analogous in the alternative scenario of attending four-year college.

Table A.10: Proportion of Individuals Who Benefit from Not Attending College

	3 factors	2 factors
Total	0.19	0.17
Conditional on schooling choice		
D=0	0.24	0.20
D=1	0.12	0.14

Note: The data are simulated from the estimates of the model and our NLSY79 sample. The table displays the percentage of people that benefits from not attending college in each category, i.e., $\Pr(Y_0 - Y_1 > 0)$ where Y_0 is the (log) annual earnings corresponding to the scenario of not attending four-year college, Y_1 is the analogous in the alternative scenario of attending four-year college.

Figure A.4: Variance Decomposition Two-Factor Model



Note: The figure presents the variance decomposition of the measurement system.

Table A.11: Completion Rates by Type of Institution

	Obs.	Completed	Completion rate
A. High School grads and GEDs	425		
B.College attended (2yr & 4yr)	**597**	**384**	**64%**
B.1. 2yr college attended	164	70	43%
B.2. 4yr college attended	430	284	66%
B.3 No info on type	3		
Total (A+B)	1022		

a two year college, and attending a four year college. Even though our small sample prevented us from estimating the full model (schooling and labor market outcomes) with three schooling decisions, we document the distinctive role of abilities on decision of attending four-year college versus the other options and document that our main results are robust to different specifications.

Table A.11 present completion rates by type of institution in the sample used in the paper. It is evident that completion is not the natural final stage following enrollment because of the large dropout rates. In fact, in our sample of white males only 66 percent of those who ever attended a four-year college graduate with a bachelor's degree by the age of 25.[3]

The argument to justify the selection of the schooling variable of interest is mainly theoretical. However, we estimate the model using two different schooling variables to confirm that the results are qualitatively similar. Table A.12 compares the results of three models. The first column presents the model of the paper (four-year college attended); the second column presents the model using four-year college completed to address the issue of attendance vs completion; the third column presents the model corresponding to college attended, where college includes both two-year and four-year college in order to address the possible differences arising from the inclusion of two-year college attendees in the base group.

The main results of the paper maintain disregarding the choice of schooling variable analyzed. Mechanical ability in all cases is negatively associated with higher levels of schooling, positively

[3]Completion rates for white males are higher than the national average.Bound, Lovenheim and Turner (2010), using data from the National Longitudinal Study of the High School Class of 1972 (NLS72) report an eight-year college completion rate of 50.5 percent for the class of 1972 high school cohort. The two completion rates are not strictly comparable because the individuals in our sample are slightly younger (1974 to 1983 high school cohorts), but it is close enough to serve as a reference point. Completion rates have improved over the years, still a large fraction those who attended a four-year college finishes. According to the National Center for Education Statistics-NCES about 59 percent of students who began seeking a bachelor's degree at a 4-year institution in fall 2007 completed that degree within 6 years. $http://nces.ed.gov/programs/coe/indicator_cva.asp$.

Table A.12: Comparison Marginal Effects: Different Outcome Variables

Schooling Choice	**Four-year college Attended (1)**	**Four-year college Completed (2)**	**College Attended (3)**
Observed percentage	**0.42**	**0.28**	**0.58**
College			
Cognitive	0.23	0.24	0.17
Mechanical	-0.11	-0.09	-0.09
Socio-emotional	0.04	0.02	0.03
Log annual Earnings by Schooling			
Cognitive conditional on D=0	0.05	0.04	0.07
Cognitive conditional on D=1	0.18	0.18	0.13
Mechanical conditional on D=0	0.08	0.07	0.06
Mechanical conditional on D=1	-0.02	-0.03	0.00
Socio-emotional conditional on D=0	0.08	0.09	0.09
Socio-emotional conditional on D=1	0.08	0.07	0.08
Log annual Earnings Overall			
Cognitive	0.18	0.19	0.16
Mechanical	0.02	0.02	0.01
Socio-emotional	0.09	0.09	0.09

Note: All results are significant at the 1 percent level. For that reason and for exposition purposes we have omitted standard errors. The table presents the effect on schooling choice and (log) annual earnings associated with a one standard deviation increase in each of the factors. The "Overall" effect of ability on wages includes the direct effect on log wages holding schooling constant, the effect of ability on the schooling decision and the implied effect of schooling choice on log wages. The effects by schooling comes from the (log) annual earnings equation we have calculated separately for the scenario with no college attendance, $D = 0$, and the scenario with college attendance, $D = 1$. In the (log) wage equations we control for cohort dummies as well as geographical controls for region and urban residence at age 25.

rewarded by the labor market and highly rewarded in the lower level of schooling.

The main difference between models (1) and (2) is that individuals who enroll a four-year college but did not finish it are included in the base category reducing the impact of mechanical on the variables of interest. On the other hand, the difference between models (1) and (3) is the inclusion of individuals who attended a two-year college in the high schooling category. This again attenuates the impact of mechanical ability on schooling and on earnings.

Table A.13: Comparison Effect of Ability with a Model of Two Probits: $Pr(college)$ and $Pr(4y - college|college)$

Attendance	**Probit**	**2 sequential Probit**	
	$Pr(4ycollege)$	$Pr(college)$	$Pr(4ycollege\|college)$
Observed percentage	**0.42**	**0.58**	**0.73**
Effect of abilities on attendace			
Cognitive	0.23	0.17	0.10
Mechanical	-0.11	-0.09	-0.08
Socio-emotional	0.04	0.03	0.02

6 Robustness Checks

6.1 Model Estimates Normalizing on Different Tests of Mechanical Ability

6.1.1 Normalizing on the Electronics Information Section Scores

Tables A.16 to A.17 present the results from the model when normalizing on the electronics information scores instead of the automotive and shop information section scores.

Table A.14: Estimates of the Model: Measurement Equations

	cons	Sib	Med	Fed	FamY	urban	south	coh3	coh4	hgtest	c	m	s	error
Auto	-2.46	-0.02	0.01	0.01	0.00	-0.18	-0.24	-0.31	-0.30	0.25	0.00	1.47	0.00	3.40
SE	0.53	0.02	0.01	0.01	0.00	0.07	0.07	0.10	0.12	0.04	0.01	0.10	0.00	0.37
Electronics	-2.77	-0.05	0.02	0.01	0.00	-0.11	-0.21	-0.12	-0.03	0.24	0.45	1.00	0.00	2.93
SE	0.53	0.02	0.01	0.01	0.00	0.07	0.07	0.10	0.12	0.04	0.04	0.00	0.00	0.17
Mech. C	-2.64	-0.01	0.03	0.01	0.00	-0.14	-0.21	-0.06	0.06	0.21	0.41	1.12	0.00	3.13
SE	0.55	0.02	0.01	0.01	0.00	0.07	0.07	0.11	0.13	0.04	0.02	0.07	0.00	0.21
Arithmetic K.	-3.68	-0.01	0.04	0.02	0.01	-0.01	-0.20	0.15	0.41	0.24	1.02	0.00	0.00	3.33
SE	0.48	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.11	0.04	0.04	0.00	0.00	0.20
Math	-3.32	-0.02	0.04	0.04	0.01	-0.03	-0.18	0.35	0.51	0.18	1.00	0.00	0.00	3.45
SE	0.49	0.02	0.01	0.01	0.00	0.07	0.06	0.10	0.11	0.04	0.00	0.00	0.00	0.22
Word K.	-3.83	-0.06	0.05	0.03	0.00	-0.05	-0.12	-0.14	0.15	0.28	0.92	0.00	0.00	3.09
SE	0.47	0.02	0.01	0.01	0.00	0.06	0.06	0.09	0.11	0.04	0.04	0.00	0.00	0.18
Paragraph C.	-3.68	-0.03	0.03	0.04	0.00	-0.05	-0.04	0.04	0.30	0.25	0.93	0.00	0.00	2.68
SE	0.49	0.02	0.01	0.01	0.00	0.06	0.06	0.10	0.12	0.04	0.04	0.00	0.00	0.15
Numerical S.	-3.59	-0.02	0.03	0.03	0.01	0.03	-0.17	0.20	0.38	0.23	0.77	0.00	0.00	1.88
SE	0.49	0.02	0.01	0.01	0.00	0.07	0.07	0.10	0.12	0.04	0.04	0.00	0.00	0.09
Coding S.	-3.14	-0.01	0.03	0.02	0.01	-0.02	-0.18	0.03	0.22	0.22	0.69	0.00	0.00	1.61
SE	0.51	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.12	0.04	0.04	0.00	0.00	0.08
Rotter	-1.49	-0.01	-0.01	0.02	0.01	-0.02	0.02	-0.22	-0.18	0.13	0.18	0.00	0.22	1.10
SE	0.53	0.02	0.01	0.01	0.00	0.07	0.07	0.11	0.13	0.04	0.05	0.03	0.04	0.05
Rosenberg	-0.62	-0.02	0.01	0.01	0.00	0.05	0.02	-0.04	-0.24	0.05	0.25	0.00	1.00	5.38
SE	0.52	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.12	0.04	0.04	0.00	0.00	1.41
Reckless	0.03	-0.02	0.00	0.00	0.01	-0.10	0.00	0.13	0.07	0.00	0.03	0.02	0.04	1.01
SE	0.55	0.02	0.01	0.01	0.00	0.07	0.07	0.11	0.13	0.05	0.05	0.03	0.04	0.05

Note: This table presents estimates of the model. Using data from the NLSY79, white males between 25-35 years old. Since the model is estimated using Bayesian methods, they represent the mean estimates over 1,000 iterations after discarding the first 30,000. cons is the constant, Sib is the number of siblings in 1979, Med is the mother's highest grade completed at age 17, Fed is the father's highest grade completed at age 17, FamY is the family income in 1979 in thousands, urban is a dummy variable for living in an urban area at age 14, south is a dummy variable for living in the south at age 14, Coh3 refers to the cohort of individuals that were born between 1961-1962, Coh4 refers to the cohort of individuals that were born between 1963-1964, hgtest is the highest grade attended by the time the test was presented and c, m, s refers to the cognitive, mechanical and socio-emotional factors respectively.

Table A.15: Estimates of the Model: College Decision Model

Pr(college)	**Coefficient**	**SE**
Constant	-2.19	0.30
Number of siblings	-0.08	0.03
Mother's highest grade completed	0.07	0.02
Father's highest grade completed	0.09	0.02
Family Income 1979 (thousands)	0.02	0.00
Living in urban area at age 14	0.03	0.13
Living in the south at age 14	0.07	0.12
Cohort1 (Born 57-58)	-0.78	0.28
Cohort2 (Born 59-60)	-0.91	0.24
Cohort3 (Born 61-62)	-0.27	0.11
4y college tuition	-0.01	0.01
Cognitive	0.96	0.09
Mechanical	-0.85	0.13
Socio-emotional	0.16	0.07

Table A.16: Estimates of the Model: Log Annual Earnings

	Conditional on $D = 0$	**SE**	**Conditional on** $D = 1$	**SE**
Constant	10.47	0.10	10.57	0.09
Northeast residence	0.11	0.09	0.36	0.11
Northcentral residence	-0.04	0.08	0.18	0.09
South residence	0.01	0.08	0.26	0.09
Cohort1 (Born 57-58)	-0.11	0.16	-0.39	0.22
Cohort2 (Born 59-60)	-0.35	0.12	0.00	0.20
Cohort3 (Born 61-62)	-0.11	0.07	-0.10	0.07
Local unemployment	-0.17	1.28	-1.98	0.98
Cognitive	0.06	0.06	0.24	0.07
Mechanical	0.15	0.09	-0.04	0.09
Socio-emotional	0.10	0.05	0.09	0.04
error	2.08	0.13	2.52	0.18

Table A.17: Parameters of the Distribution of Unobserved Abilities

	Cognitive		**Mechanical Aux**		**Socio-emotional Aux**	
	Estimate	SE	Estimate	SE	Estimate	SE
μ_1	-0.54	0.31	-0.03	0.22	-0.49	0.11
μ_2	0.36	0.13	-0.04	0.24	0.96	0.19
$1/\sigma_1^2$	2.29	0.66	5.98	1.98	4.30	1.52
$1/\sigma_2^2$	4.28	1.26	5.85	2.19	5.74	2.22
p	0.44	0.21	0.53	0.25	0.66	0.10

Note: This table presents estimates from the Model. Since the model is estimated using Bayesian methods, they represent the mean estimates over 1,000 iterations after discarding the first 30,000. Mechanical Aux. presents the results from the auxiliar component of the factor, θ_2 which is independent from cognitive ability. Where $\theta_m = \alpha_1\theta_c + \theta_2$ with $\alpha_1 = 0.38$. Socio-emotional Aux. presents the results from the auxiliary component of the factor, θ_3 which is independent from cognitive ability. Where $\theta_s = \beta_1\theta_c + \theta_3$ with $\beta_1 = 0.25$

6.1.2 Normalizing on the Automotive and Shop Information Section Scores

Tables A.18 to A.20 present the results from the model when normalizing on the test auto shop information.

Table A.18: Estimates of the Model: College Decision Model

Pr(college)	**Coefficient**	**SE**
Constant	-2.19	0.30
Number of siblings	-0.08	0.03
Mother's highest grade completed	0.07	0.02
Father's highest grade completed	0.09	0.01
Family Income 1979 (thousands)	0.02	0.00
Living in urban area at age 14	0.02	0.12
Living in the south at age 14	0.05	0.12
Cohort1 (Born 57-58)	-0.77	0.27
Cohort2 (Born 59-60)	-0.89	0.24
Cohort3 (Born 61-62)	-0.26	0.11
4y college tuition	-0.01	0,01
Cognitive	0.97	0.10
Mechanical	-0.55	0.09
Socio-emotional	0.16	0.07

Table A.19: Estimates of the Model: Log Annual Earnings

	Conditional on $D = 0$	**SE**	**Conditional on** $D = 1$	**SE**
Constant	10.47	0.10	10.57	0.09
Northeast residence	0.11	0.09	0.37	0.11
Northcentral residence	-0.05	0.08	0.18	0.09
South residence	0.01	0.09	0.26	0.09
Cohort1 (Born 57-58)	-0.10	0.16	-0.39	0.22
Cohort2 (Born 59-60)	-0.34	0.12	0.00	0.20
Cohort3 (Born 61-62)	-0.10	0.07	-0.09	0.07
Local unemployment	-0.18	1.35	-2.01	0.99
Cognitive	0.05	0.06	0.23	0.04
Mechanical	0.11	0.06	-0.02	0.06
Socio-emotional	0.10	0.04	0.09	0.04
Error	2.09	0.13	2.52	0.18

Table A.20: Estimates of the Model: Measurement Equations

	cons	Sib	Med	Fed	FamY	urban	south	coh3	coh4	hgtest	c	m	s	error
Auto	-2.28	-0.02	0.01	0.01	0.00	-0.17	-0.22	-0.29	-0.31	0.24	0.14	1.00	0.00	3.79
SE	0.52	0.02	0.01	0.01	0.00	0.07	0.07	0.11	0.12	0.04	0.04	0.00	0.00	0.51
Electronics	-2.66	-0.05	0.02	0.01	0.00	-0.10	-0.19	-0.11	-0.03	0.23	0.56	0.63	0.00	2.85
SE	0.51	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.12	0.04	0.03	0.05	0.00	0.17
Mech. C	-2.53	-0.01	0.03	0.01	0.00	-0.13	-0.19	-0.05	0.05	0.20	0.54	0.73	0.00	3.06
SE	0.52	0.02	0.01	0.01	0.00	0.06	0.07	0.11	0.12	0.04	0.02	0.06	0.00	0.22
Arithmetic K.	-3.67	-0.01	0.04	0.02	0.01	-0.01	-0.20	0.15	0.41	0.24	1.02	0.00	0.00	3.32
SE	0.50	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.11	0.04	0.04	0.00	0.00	0.21
Math	-3.31	-0.02	0.04	0.04	0.01	-0.04	-0.18	0.35	0.51	0.18	1.00	0.00	0.00	3.43
SE	0.51	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.12	0.04	0.00	0.00	0.00	0.21
Word K.	-3.85	-0.06	0.05	0.03	0.00	-0.05	-0.12	-0.14	0.15	0.28	0.92	0.00	0.00	3.11
SE	0.47	0.02	0.01	0.01	0.00	0.06	0.06	0.10	0.11	0.04	0.04	0.00	0.00	0.18
Paragraph C.	-3.67	-0.03	0.03	0.04	0.00	-0.05	-0.05	0.04	0.29	0.25	0.93	0.00	0.00	2.68
SE	0.50	0.02	0.01	0.01	0.00	0.07	0.06	0.10	0.12	0.04	0.04	0.00	0.00	0.15
Numerical S.	-3.60	-0.02	0.03	0.03	0.01	0.03	-0.17	0.20	0.38	0.23	0.77	0.00	0.00	1.88
SE	0.51	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.12	0.04	0.04	0.00	0.00	0.09
Coding S.	-3.15	-0.01	0.03	0.02	0.01	-0.02	-0.19	0.03	0.21	0.22	0.69	0.00	0.00	1.61
SE	0.52	0.02	0.01	0.01	0.00	0.07	0.07	0.10	0.12	0.04	0.04	0.00	0.00	0.08
Rotter	-1.53	-0.01	0.00	0.02	0.01	-0.02	0.02	-0.21	-0.17	0.13	0.18	0.00	0.22	1.10
SE	0.54	0.02	0.01	0.01	0.00	0.07	0.07	0.11	0.13	0.04	0.04	0.00	0.05	0.05
Rosenberg	-0.65	-0.03	0.01	0.01	0.00	0.06	0.02	-0.03	-0.24	0.05	0.00	0.00	1.00	5.45
SE	0.51	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.11	0.04	0.04	0.00	0.00	1.52
Delin	0.06	-0.02	0.00	0.00	0.01	-0.10	0.00	0.13	0.07	-0.01	0.03	0.00	0.04	1.01
SE	0.56	0.02	0.01	0.01	0.00	0.07	0.07	0.11	0.13	0.05	0.04	0.00	0.04	0.04

Note: This table presents estimates of the model. Using data from the NLSY79, white males between 25-35 years old. Since the model is estimated using Bayesian methods, they represent the mean estimates over 1,000 iterations after discarding the first 30,000. cons is the constant, Sib is the number of siblings in 1979, Med is the mother's highest grade completed at age 17, Fed is the father's highest grade completed at age 17, FamY is the family income in 1979 in thousands, urban is a dummy variable for living in an urban area at age 14, south is a dummy variable for living in the south at age 14, Coh3 refers to the cohort of individuals that were born between 1961-1962, Coh4 refers to the cohort of individuals that were born between 1963-1964, hgtest is the highest grade attended by the time the test was presented and c, m, s refers to the cognitive, mechanical and socio-emotional factors respectively.

6.2 Model Estimates using Hourly Wages as Outcome Variable

Table A.21: Estimates of the Model: College Decision Model

Pr(college)	**Coefficient**	**SE**
Constant	-2.13	0.30
Number of siblings	-0.08	0.03
Mother's highest grade completed	0.07	0.02
Father's highest grade completed	0.09	0.01
Family Income 1979 (thousands)	0.02	0.00
Living in urban area at age 14	0.02	0.12
Living in the south at age 14	0.08	0.13
Cohort1 (Born 57-58)	-0.78	0.26
Cohort2 (Born 59-60)	-0.91	0.24
Cohort3 (Born 61-62)	-0.27	0.11
4y college tuition	0.96	0.01
Cognitive	0.96	0.09
Mechanical	-0.74	0.14
Socio-emotional	0.15	0.07

Table A.22: Estimates of the Model: Log Annual Earnings

	Conditional on $D = 0$	**SE**	**Conditional on $D = 1$**	**SE**
Constant	2.91	0.07	2.96	0.07
Northeast residence	-0.06	0.06	0.45	0.08
Northcentral residence	-0.12	0.05	0.11	0.07
South residence	-0.06	0.06	0.25	0.08
Cohort1 (Born 57-58)	0.13	0.10	-0.19	0.22
Cohort2 (Born 59-60)	-0.08	0.09	-0.01	0.15
Cohort3 (Born 61-62)	-0.03	0.04	-0.03	0.06
Local unemployment	-0.39	0.89	-1.00	0.82
Cognitive	0.08	0.04	0.21	0.086
Mechanical	0.08	0.05	0.01	0.07
Socio-emotional	0.05	0.03	0.06	0.03
Error	4.58	0.28	3.84	0.28

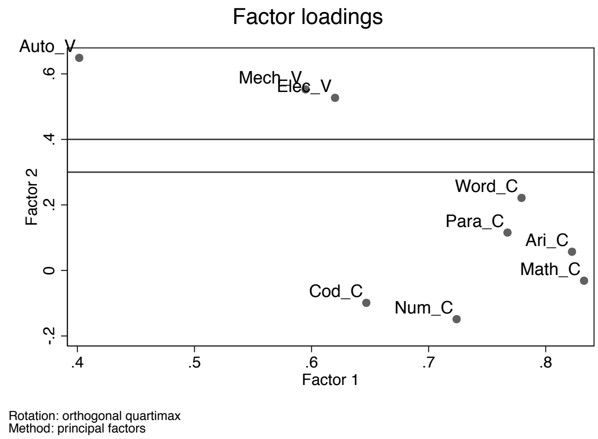
Table A.23: Estimates of the Model: Measurement Equations

	cons	Sib	Med	Fed	FamY	urban	south	coh3	coh4	hgtest	c	m	s	error
Auto	-2.48	-0.02	0.01	0.01	0.00	-0.19	-0.22	-0.30	-0.29	0.26	0.00	1.29	0.00	3.43
SE	0.52	0.02	0.01	0.01	0.00	0.07	0.07	0.10	0.12	0.04	0.01	0.09	0.00	0.37
Electronics	-2.79	-0.05	0.02	0.01	0.00	-0.12	-0.18	-0.11	-0.02	0.24	0.46	0.85	0.00	2.89
SE	0.50	0.02	0.01	0.01	0.00	0.07	0.07	0.10	0.12	0.04	0.02	0.06	0.00	0.17
Mech. C	-2.68	-0.01	0.02	0.01	0.00	-0.14	-0.18	-0.05	0.07	0.22	0.41	1.00	0.00	3.17
SE	0.53	0.02	0.01	0.01	0.00	0.07	0.07	0.10	0.12	0.04	0.04	0.00	0.00	0.21
Arithmetic K.	-3.68	-0.01	0.04	0.02	0.01	-0.02	-0.18	0.15	0.42	0.25	1.02	0.00	0.00	3.33
SE	0.50	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.11	0.04	0.04	0.00	0.00	0.21
Math	-3.34	-0.02	0.04	0.03	0.01	-0.04	-0.16	0.36	0.52	0.19	1.00	0.00	0.00	3.43
SE	0.49	0.02	0.01	0.01	0.00	0.06	0.06	0.09	0.11	0.04	0.00	0.00	0.00	0.22
Word K.	-3.85	-0.06	0.05	0.03	0.00	-0.05	-0.10	-0.13	0.16	0.28	0.92	0.00	0.00	3.09
SE	0.47	0.02	0.01	0.01	0.00	0.06	0.06	0.09	0.11	0.04	0.04	0.00	0.00	0.18
Paragraph C.	-3.68	-0.03	0.03	0.04	0.00	-0.06	-0.03	0.05	0.31	0.26	0.93	0.00	0.00	2.69
SE	0.50	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.11	0.04	0.04	0.00	0.00	0.15
Numerical S.	-3.61	-0.02	0.03	0.03	0.01	0.02	-0.16	0.21	0.39	0.24	0.77	0.00	0.00	1.88
SE	0.50	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.11	0.04	0.04	0.00	0.00	0.09
Coding S.	-3.16	-0.01	0.03	0.01	0.01	-0.03	-0.18	0.03	0.22	0.22	0.68	0.00	0.00	1.61
SE	0.51	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.12	0.04	0.04	0.00	0.00	0.07
Rotter	-1.52	-0.01	-0.01	0.01	0.01	-0.02	0.02	-0.21	-0.17	0.13	0.18	0.00	0.23	1.10
SE	0.53	0.02	0.01	0.01	0.00	0.07	0.07	0.11	0.13	0.04	0.03	0.00	0.04	0.05
Rosenberg	-0.79	-0.03	0.01	0.00	0.00	0.05	0.04	-0.03	-0.21	0.06	0.00	0.00	1.00	5.37
SE	0.52	0.02	0.01	0.01	0.00	0.06	0.07	0.10	0.12	0.04	0.04	0.00	0.00	1.48
Delin	0.04	-0.02	0.00	0.00	0.01	-0.09	0.00	0.13	0.07	-0.01	0.03	0.00	0.04	1.01
SE	0.55	0.02	0.01	0.01	0.00	0.07	0.07	0.11	0.13	0.05	0.04	0.00	0.04	004

Note: This table presents estimates of the model. Using data from the NLSY79, white males between 25-35 years old. Since the model is estimated using Bayesian methods, they represent the mean estimates over 1,000 iterations after discarding the first 30,000. cons is the constant, Sib is the number of siblings in 1979, Med is the mother's highest grade completed at age 17, Fed is the father's highest grade completed at age 17, FamY is the family income in 1979 in thousands, urban is a dummy variable for living in an urban area at age 14, south is a dummy variable for living in the south at age 14, Coh3 refers to the cohort of individuals that were born between 1961-1962, Coh4 refers to the cohort of individuals that were born between 1963-1964, hgtest is the highest grade attended by the time the test was presented and c, m, s refers to the cognitive, mechanical and socio-emotional factors respectively.

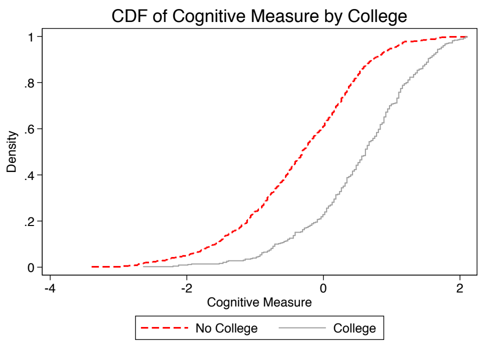
7 Additional Tables and Figures

Figure A.5: Loadings from Factor Analysis-Orthogonal Factors: rotated

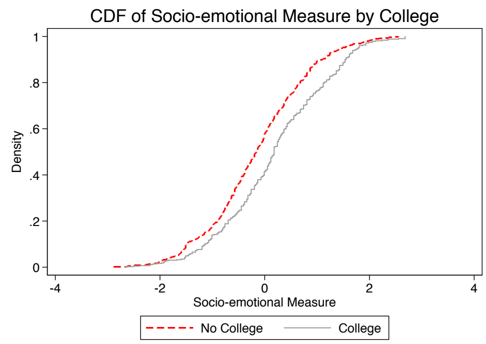


Note: "mechanical" is computed by using Auto_V (automotive and shop information), Mech_V (mechanical comprehension) and Elec_V (electronics information). The others are used to measure the cognitive component: Ari_C (arithmetic reasoning), Math_C (mathematics knowledge), Word_C (word knowledge) and Para_C (paragraph comprehension) Num_C (numerical operations) and Cod_C (coding speed). The magnitude of the loading is critical because any factor loading with an absolute value of 0.30 or greater is considered significant in the sense described by (Diekhoff, 1992; Sheskin, 2004, among others).

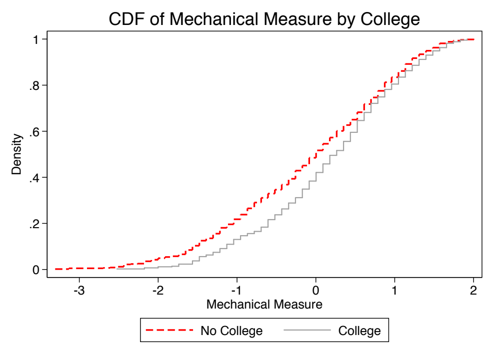
Figure A.6: Cumulative Distribution of Cognitive, Socio-emotional and Mechanical Measures by Schooling Choice



(a) Cognitive



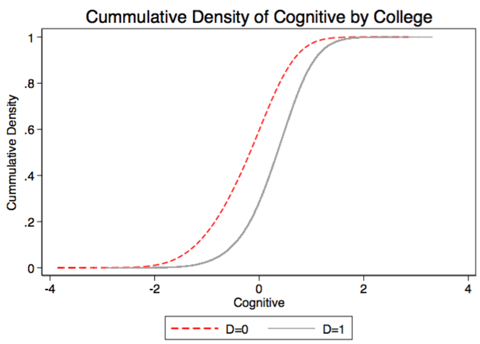
(b) Socio-emotional



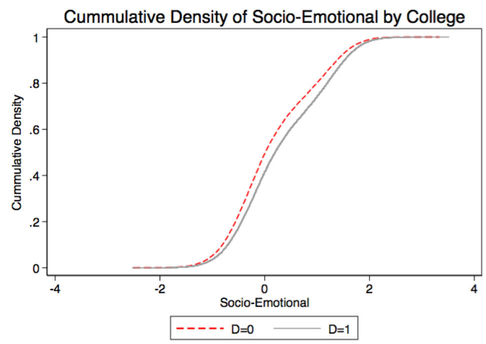
(c) Mechanical

Note: The figure shows the cumulative distribution function of each measure of ability by schooling choice, attending four-year college ($D = 1$) or not ($D = 0$). The red dashed line corresponds to individuals who chose not to attend four-year college while the grey solid line corresponds to individuals who decided to attend four-year college. Panel (a) corresponds to the cognitive measure, panel (b) depicts the case for the socio-emotional measure and panel (c) for mechanical. The sample of individuals under "College" includes those with at least one year of enrollment in a four-year college institution before age 25. "No college" includes all those individuals in our sample who have not attended four-year college but excludes high school dropouts.

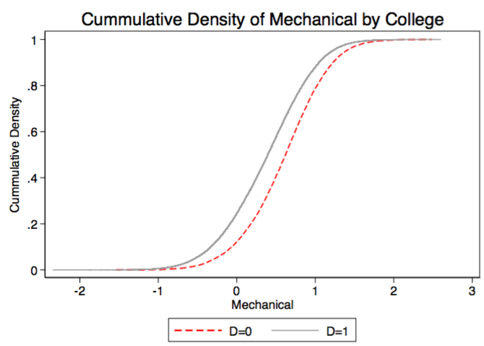
Figure A.7: Cumulative Distribution Function of Cognitive, Socio-emotional and Mechanical Ability by Schooling Choice



(a) Cognitive



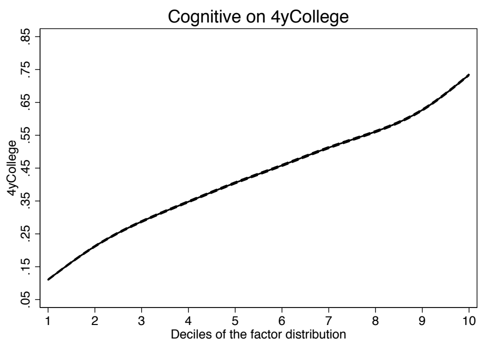
(b) Socio-emotional



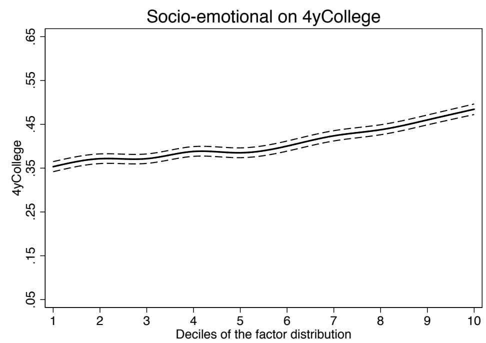
(c) Mechanical

Note: The data are simulated from the estimates of the model and our NLSY79 sample. The figure presents the cumulative distribution function of each measure of ability by schooling choice: attending four-year college ($D = 1$) or not ($D = 0$). The red dashed line corresponds to individuals who chose not to attend four-year college while the grey solid line corresponds to individuals who decided to attend four-year college. Panel (a) corresponds to the cognitive ability, panel (b) to socio-emotional ability and panel (c) to mechanical ability.

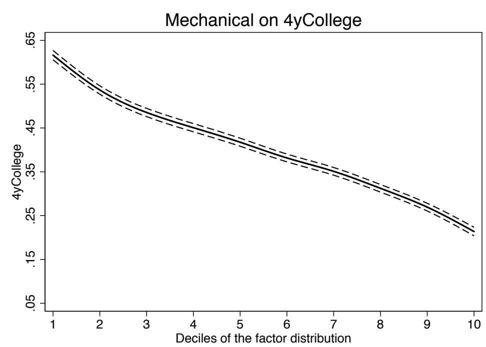
Figure A.8: The Effect of Ability on the Probability of Attending Four-year College



(a) Cognitive



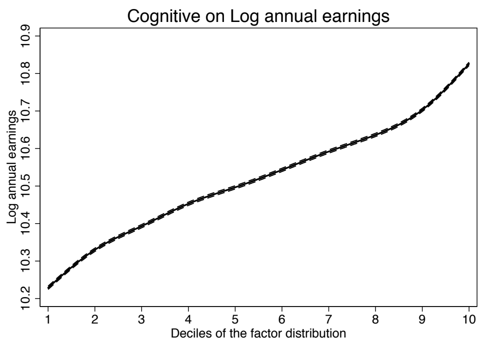
(b) Socio-emotional



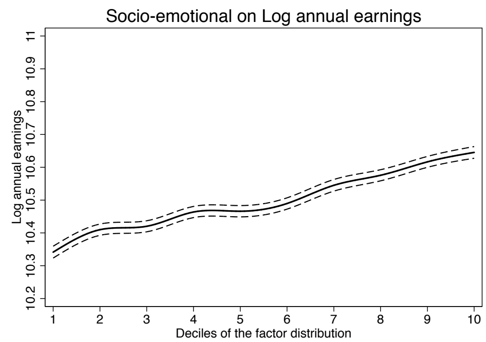
(c) Mechanical

Note: The data are simulated from the estimates of the model and our NLSY79 sample. Panel (a) of the figure presents the marginal effect of cognitive ability integrating out the effect of socio-emotional and mechanical ability, while panels (b) and (c) present analogous results for socio-emotional and mechanical ability, respectively. Dashed lines demarcate the 95% confidence interval.

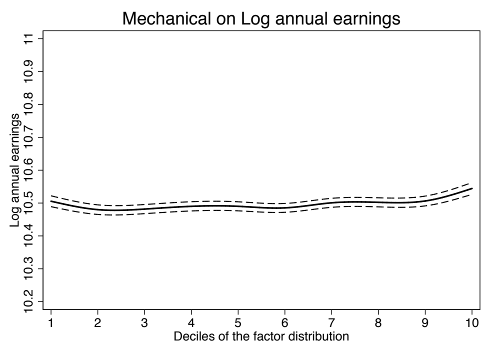
Figure A.9: The Impact of Ability on Average (log) Annual Earnings (ages 25-35)



(a) Cognitive



(b) Socio-emotional



(c) Mechanical

Note: The data are simulated from the estimates of the model and our NLSY79 sample. The data are simulated from the estimates of the model and our NLSY79 sample. Each panel presents the effect of ability taking into account: the direct effect on earnings holding schooling constant as well as the effect of ability on earnings through education (i.e., the effect of attending four-year college on earnings). Panel (a) presents the effect of cognitive ability integrating out the effect of the other two dimensions of ability, while panels (b) and (c) present analogous results for socio-emotional and mechanical ability, respectively. Dashed lines demarcate the 95% confidence interval.

References

Bound, John, Michael F. Lovenheim, and Sarah Turner. 2010. "Why Have College Completion Rates Declined? An Analysis of Changing Student Preparation and Collegiate Resources." *American Economic Journal: Applied Economics*, 2(3).

Diekhoff, George. 1992. *Statistics for the social and behavioral sciences: Univariate, bivariate, multivariate.* Wm. C. Brown Publishers (Dubuque, IA).

Gelman, Andrew, and Kenneth Shirley. 2011. "Inference from Simulations and Monitoring Convergence." In *Handbook of Markov Chain Monte Carlo.* , ed. G. Jones S. Brooks, A. Gelman and X. L. Meng. CRC Press.

Heckman, James J., John E. Humphries, and Gregory Veramendi. 2016. "Returns to Education: The Causal Effects of Education on Earnings, Health and Smoking." Forthcoming in *Journal of Political Economy.*

Sheskin, David J. 2004. *Handbook of Parametric and Nonparametric Statistical Procedures.* . Third Edition ed., Chapman and Hall/CRC Press.

Train, Kenneth E. 2003. *Discrete Choice Methods with Simulation.* National Economic Research Associates, Inc:Cambridge University Press.