Preferences, Personality Psychology, and Economics: Some New Results

James J. Heckman
University of Chicago

Econ 350, Winter 2021
This draft, February 12, 2021 5:20pm

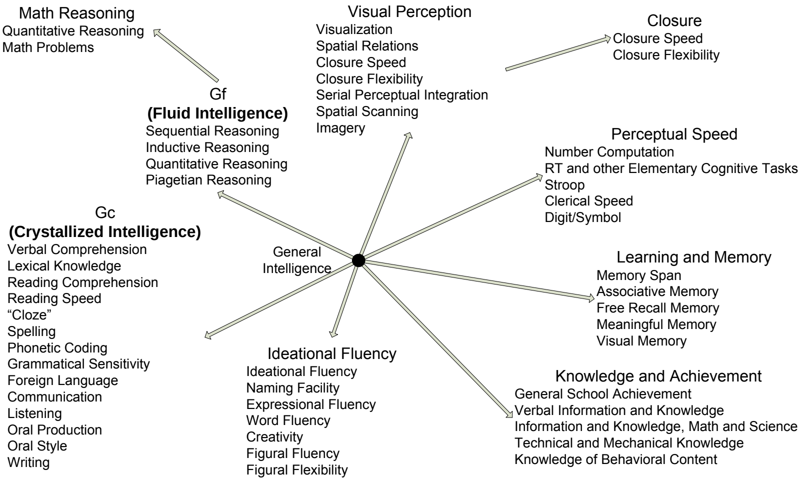
What Are The Market (Life) Relevant Skills?

a. **Traits versus skills**
b. **Traits as strategies**
c. **Relating psychological "traits" to "economic preferences"**

Cognition: "g"

- "g": a product of early Twentieth Century psychology.
- Concept of "g" has been broadened even beyond subcomponents of "fluid" and "crystallized" intelligence.
- But still is at the center of a hierarchy of correlated traits.
- **Circularity: Validation in psychology is often done using grades and other test scores**.
- Rarely look at workplace or real behavioral productivity of these traits.
- Exceptions
  a. Personnel psychology
  b. AFQT and studies of achievement tests in economics

Figure 1: An Hierarchical Scheme of General Intelligence and Its Components



Source: Recreated from Ackerman and Heggestad [1997], based on Carroll [1993].

Table 1: The Big Five Domains and Their Facets

Big Five Personality Factor	American Psychology Association Dictionary description	Facets (and correlated trait adjective)	Related Traits	Childhood Temperament Traits
Openness to Experience	"the tendency to be open to new aesthetic, cultural, or intellectual experiences"	Fantasy (imaginative) Aesthetic (artistic) Feelings (excitable) Actions (wide interests) Ideas (curious) Values (unconventional)	—	Sensory sensitivity Pleasure in low-intensity activities Curiosity
Conscientiousness	"the tendency to be organized, responsible, and hardworking"	Competence (efficient) Order (organized) Dutifulness (not careless) Achievement striving (ambitious) Self-discipline (not lazy) Deliberation (not impulsive)	Grit Perseverance Delay of gratification Impulse control Achievement striving Ambition Work ethic	Attention/(lack of) distractibility Effortful control Impulse control/delay of gratification Persistence Activity*

Table 1: The Big Five Domains and Their Facets

Big Five Personality Factor	American Psychology Association Dictionary description	Facets (and correlated trait adjective)	Related Traits	Childhood Temperament Traits
Extraversion	"an orientation of one's interests and energies toward the outer world of people and things rather than the inner world of subjective experience; characterized by positive affect and sociability"	Warmth (friendly) Gregariousness (sociable) Assertiveness (self-confident) Activity (energetic) Excitement seeking (adventurous) Positive emotions (enthusiastic)	—	Surgency Social dominance Social vitality Sensation seeking Shyness* Activity* Positive emotionality Sociability/affiliation
Agreeableness	"the tendency to act in a cooperative, unselfish manner"	Trust (forgiving) Straight-forwardness (not demanding) Altruism (warm) Compliance (not stubborn) Modesty (not show-off) Tender-mindedness (sympathetic)	Empathy Perspective taking Cooperation Competitiveness	Irritability* Aggressiveness Willfulness

Table 1: The Big Five Domains and Their Facets

Big Five Personality Factor	American Psychology Association Dictionary description	Facets (and correlated trait adjective)	Related Traits	Childhood Temperament Traits
Neuroticism/ Emotional Stability	Emotional stability is "predictability and consistency in emotional reactions, with absence of rapid mood changes." Neuroticism is "a chronic level of emotional instability and proneness to psychological distress."	Anxiety (worrying) Hostility (irritable) Depression (not contented) Self-consciousness (shy) Impulsiveness (moody) Vulnerability to stress (not self-confident)	**Internal vs. External Locus of control** **Core self-evaluation** Self-esteem Self-efficacy Optimism Axis I psychopathologies (mental disorders) including depression and anxiety disorders	Fearfulness/behavioral inhibition Shyness* Irritability* Frustration (Lack of) soothability Sadness

Notes: Facets specified by the NEO-PI-R personality inventory (Costa and McCrae [1992b]). Trait adjectives in parentheses from the Adjective Check List (Gough and Heilbrun [1983]). * These temperament traits may be related to two Big Five factors. *Source*: Table adapted from John and Srivastava [1999].

THE UNIVERSITY OF CHICAGO

The Person-Situation Debate

- Is variation across people in behavior a consequence of personal traits or of situations?

Mischel [*Personality and Assessment*, 1968, p. 146]

"...with the possible exception of intelligence, highly generalized behavioral consistencies have not been demonstrated, and the concept of personality traits as broad dispositions is thus untenable."

THE UNIVERSITY OF CHICAGO

Evidence on The Predictive Power of Personality Traits

Main Findings from Predictive Analyses

- **Conscientiousness is the most predictive Big Five trait across many outcomes.**
  a. Educational attainment, grades
  b. Job performance across a range of occupational categories (predictive power of "g" decreases with job complexity)
  c. Longevity
  d. Criminality
- Neuroticism (and related *locus of control*)
  a. Predicts schooling outcomes
  b. Labor market search
- Other traits play roles at finer levels.
- The GED is an informative "natural experiment"

What Do Grades and Achievement Tests Measure?
Lex Borghans, Bart H. H. Golsteyn, James J. Heckman and John Eric Humphries, *PNAS* (2016)

Figure 2: Decomposing Achievement Tests and Grades into IQ and Personality

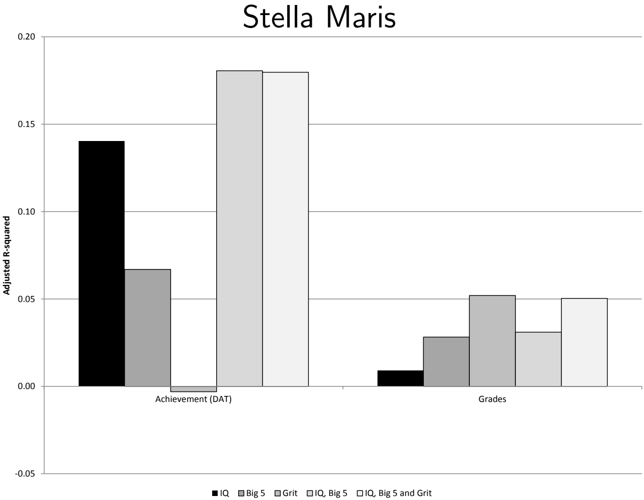


Figure 3: Decomposing Achievement Tests and Grades into IQ and Personality

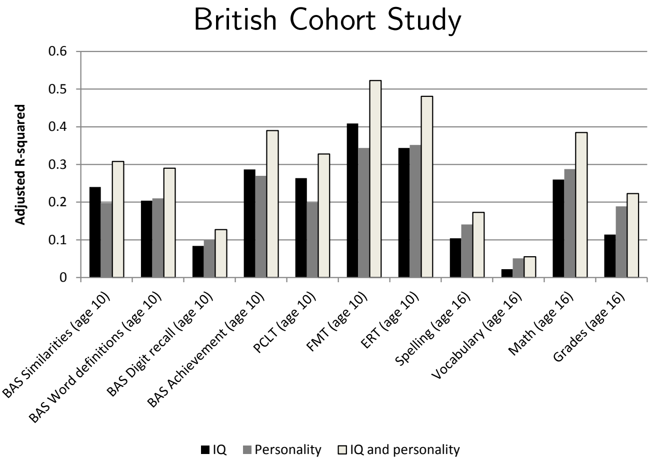


Figure 4: Decomposing Achievement Tests and Grades into IQ and Personality

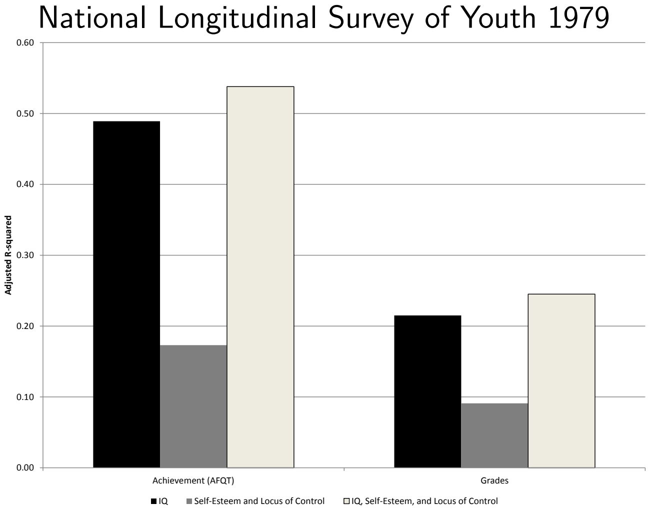


Figure 5: Decomposing Life Outcomes into IQ and Personality

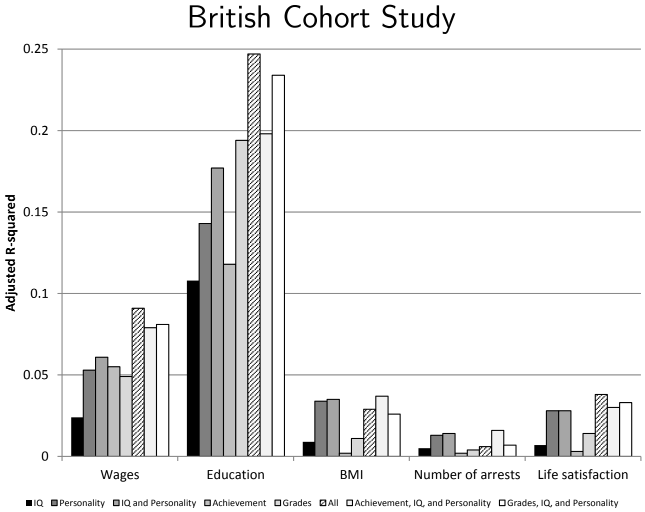


Figure 6: Decomposing Life Outcomes into IQ and Personality

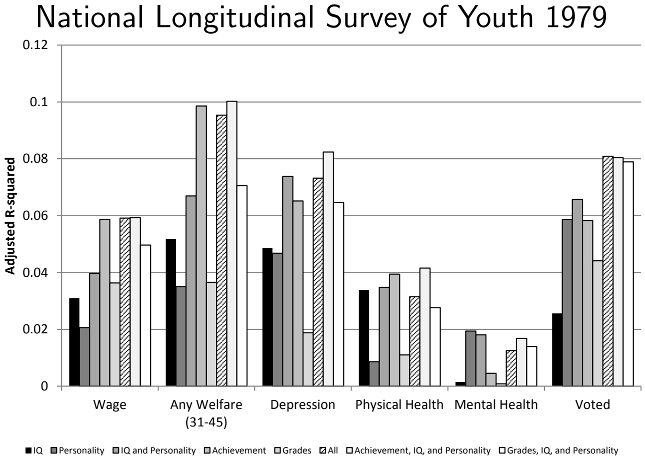


Figure 7: Decomposing Life Outcomes into Cognition and Personality

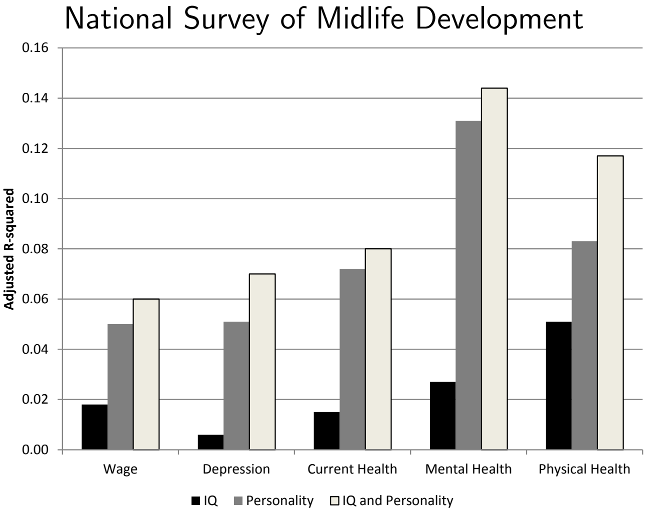


Table 2: Data Analyzed

Datasets	IQ	Achievement Tests	Grades	Personality Measures	Adult Outcomes
Stella Maris (Dutch H.S. students)	✓	✓	✓	✓(Big Five; Grit)	NA
BCS (Children born in one week in 1970 followed until 38)	✓	✓	✓	✓[1]	✓
NLSY79 (Prospective survey youth 14–21 in 1979, currently followed)	✓	✓	✓	✓(Self Esteem; Locus of Control)	✓
MIDUS (Survey in adult life, baseline 24–34 in 1995; follow-up 2004–2006)	✓	NA	NA	✓(Big Five)	✓

Note: "NA" denotes "not available." Details on each data set and their measures are provided in Web Appendices 2–5. [1] Self esteem, locus of control, disorderly activity, antisocial behavior, introversion, and neuroticism.

THE UNIVERSITY OF CHICAGO

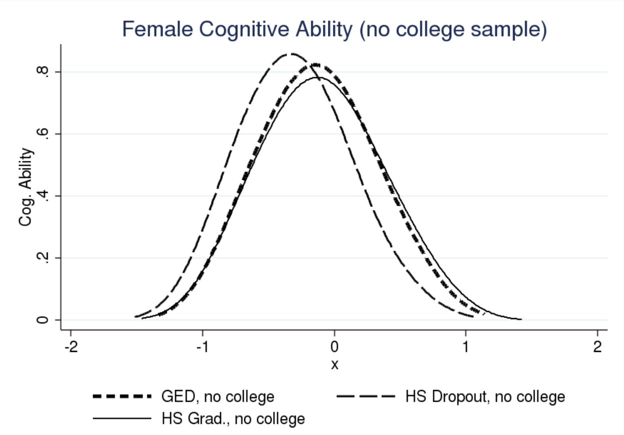
Table 3: Correlations (Pearson Correlations)

Correlations	Stella Maris	BCS	NLSY	MIDUS
ρ (IQ, Achievement)	0.378	0.509	0.698	-
ρ (IQ, Grades)	0.112	0.338	0.464	-
ρ (Achievement, Grades)	0.316	0.379	0.610	-
ρ (IQ, Personality)	0.195	0.451	0.291	0.189
ρ (Achievement, Personality)	0.294	0.446	0.410	-
ρ (Grades, Personality)	0.257	0.433	0.305	-

p-values are presented in Web Appendix 6.

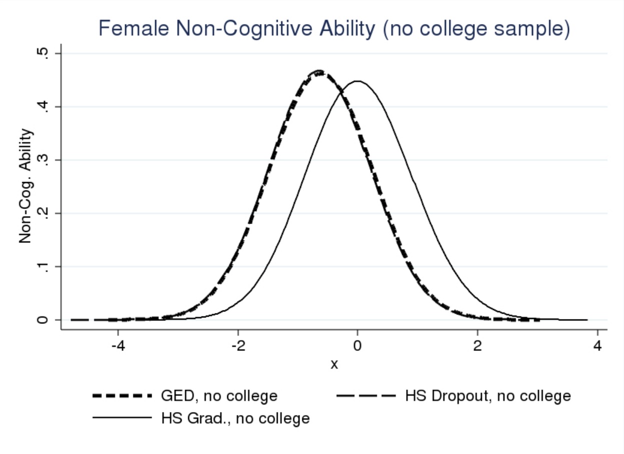
GEDs

Figure 8: Distribution of Cognitive and Non-Cognitive Skills by Education Group



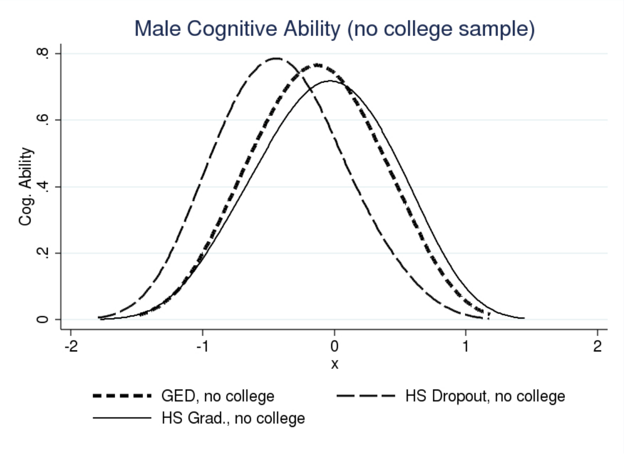
Source: Heckman, Humphries, and Veramendi (2010).

Figure 8: Distribution of Cognitive and Non-Cognitive Skills by Education Group, cont'd



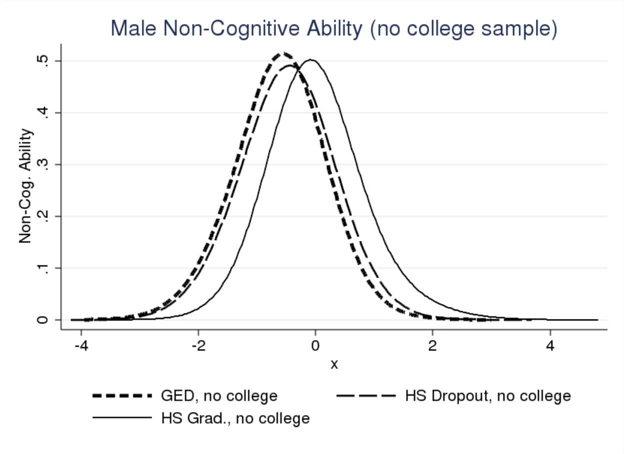
Source: Heckman, Humphries, and Veramendi (2010).

Figure 8: Distribution of Cognitive and Non-Cognitive Skills by Education Group, cont'd



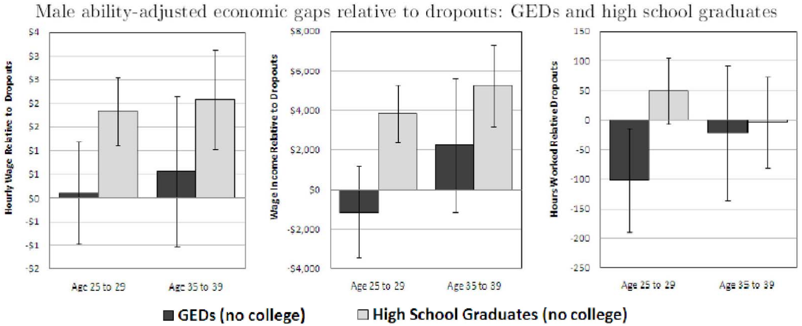
Source: Heckman, Humphries, and Veramendi (2010).

Figure 8: Distribution of Cognitive and Non-Cognitive Skills by Education Group, cont'd



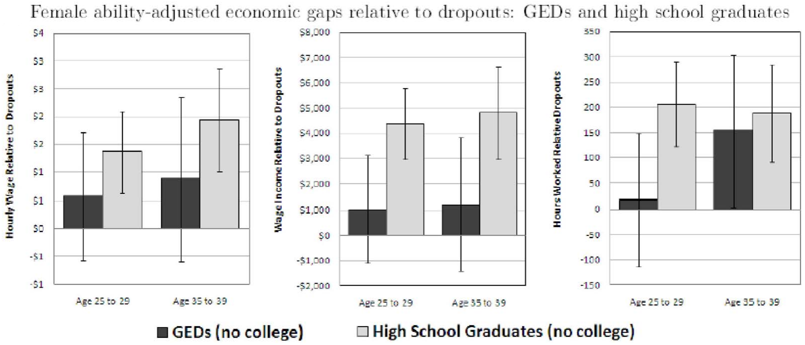
Source: Heckman, Humphries, and Veramendi (2010).

Figure 9: Ability-Adjusted Economic Gaps Relative to Dropouts: GEDs and High School Graduates for Males



Source: Heckman, Humphries, and Mader (2010).

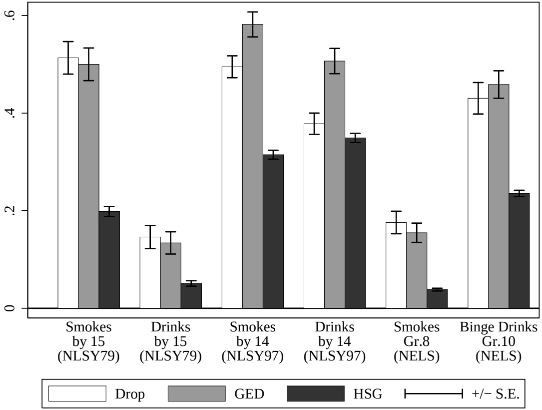
Figure 9: Ability-Adjusted Economic Gaps Relative to Dropouts: GEDs and High School Graduates for Females



Source: Heckman, Humphries, and Mader (2010).

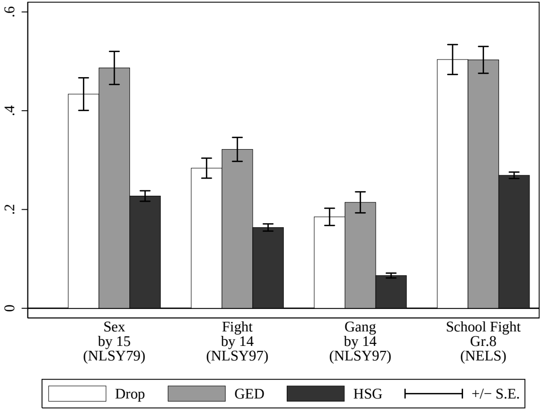
Link to Appendix

Figure 10: Measures of Adolescent Behaviors for Male Dropouts, GED Recipients, and High School Graduates: Smoking and Drinking



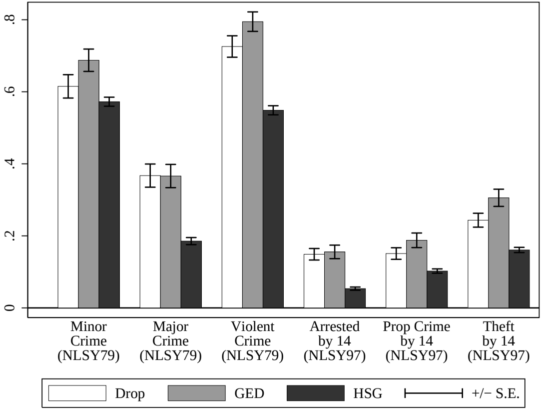
Sources: **?**, Chapter 3. National Longitudinal Survey of Youth 1979, National Longitudinal Survey of Youth 1997, National Educational Longitudinal Survey. school. *Notes:* Minor crime includes vandalism, shoplifting, petty theft, fraud, holding or selling stolen goods. Major crime includes auto theft, breaking/entering private property, grand theft. Violent crime includes fighting, assault, aggravated assault.

Figure 10: Measures of Adolescent Behaviors for Male Dropouts, GED Recipients, and High School Graduates: Sex and Violent Behavior



Sources: **?**, Chapter 3. National Longitudinal Survey of Youth 1979, National Longitudinal Survey of Youth 1997, National Educational Longitudinal Survey. school. *Notes*: Minor crime includes vandalism, shoplifting, petty theft, fraud, holding or selling stolen goods. Major crime includes auto theft, breaking/entering private property, grand theft. Violent crime includes fighting, assault, aggravated assault.

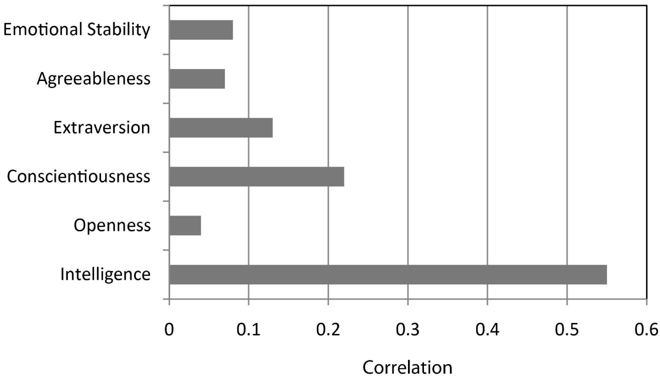
Figure 10: Measures of Adolescent Behaviors for Male Dropouts, GED Recipients, and High School Graduates: Criminal Behavior



Sources: **?**, Chapter 3. National Longitudinal Survey of Youth 1979, National Longitudinal Survey of Youth 1997, National Educational Longitudinal Survey. school. *Notes*: Minor crime includes vandalism, shoplifting, petty theft, fraud, holding or selling stolen goods. Major crime includes auto theft, breaking/entering private property, grand theft. Violent crime includes fighting, assault, aggravated assault.

Labor Market Outcomes

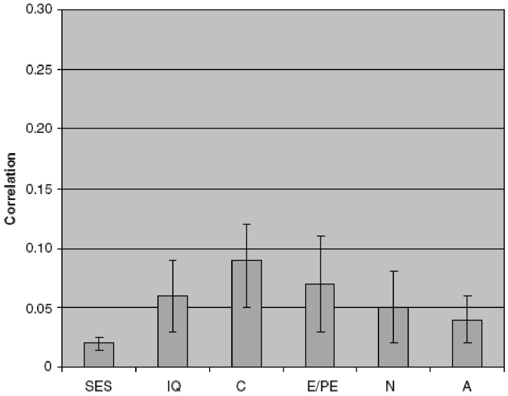
Figure 11: Associations with Job Performance



Notes: The values for personality are correlations that were corrected for sampling error, censoring, and measurement error. Job performance was based on performance ratings, productivity data and training proficiency. The authors do report the timing of the measurements of personality relative to job performance. Of the Big Five, the coefficient on Conscientiousness is the only one that is statistically significant with a lower bound on the 90 credibility value of 0.10. The value for IQ is a raw correlation.
Sources: The correlations reported for personality traits come from a meta-analysis conducted by Barrick and Mount [1991]. The correlation reported for IQ and job performance come from Schmidt and Hunter [2004].

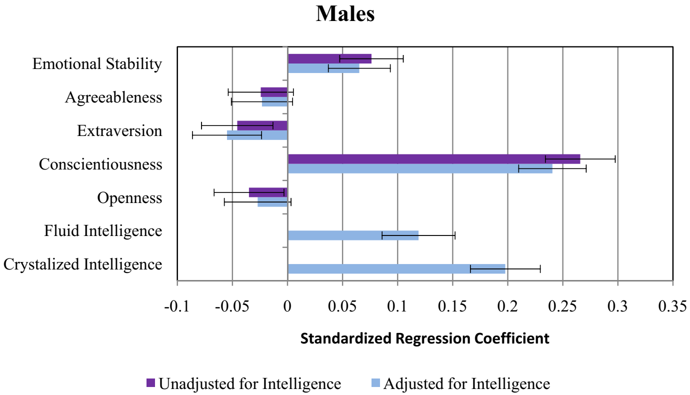
Personality and Health

Figure 12: Correlations of Mortality with Personality, IQ, and Socioeconomic Status (SES)



Notes: The figure represents results from a meta-analysis of 34 studies. Average effects (in the correlation metric) of low socioeconomic status (SES), low IQ, low Conscientiousness (C), low Extraversion/Positive Emotion (E/PE), Neuroticism (N), and low Agreeableness (A) on mortality. Error bars represent standard error. The lengths of the studies represented vary from 1 year to 71 years.
Source: Roberts, Kuncel, Shiner et al. [2007].

Figure 13: Association of the Big Five and intelligence with years of completed schooling



Notes: The figure displays standardized regression coefficients from a multivariate regression of years of school attended on the Big Five and intelligence, controlling for age and age squared. The bars represent standard errors. The Big Five coefficients are corrected for attenuation bias. The Big Five were measured in 2005. Years of schooling were measured in 2008. Intelligence was measured in 2006. The measures of intelligence were based on components of the Wechsler Adult Intelligence Scale (WAIS). The data is a representative sample of German adults between the ages 21 and 94.
Source: **?** German Socio-Economic Panel (GSOEP), waves 2004–2008.

Economic Models of Personality and Their Implications for Measurement of Personality and Preference

Prosociality Predicts Labor Market Success Around the World

Fabian Kosse & Michela M. Tincani

Nature Communications **volume 11**, Article number: 5298 (2020)

James J. Heckman

THE UNIVERSITY OF CHICAGO

Econ 350, Winter 2021

Results

Table 1 Prosociality predicts labor market success.

	(1)	(2)	(3)	(4)
Panel A	**Log household income**			
Prosociality (standardized)	0.079***	0.078***	0.060***	0.058***
	(0.009)	(0.009)	(0.009)	(0.012)
Controlling for gender, age, age^2	No	Yes	Yes	Yes
Controlling for cognitive ability	No	No	Yes	Yes
Sample restriction: not in partnership	No	No	No	Yes
Observations	77,522	77,522	77,522	32,074
Panel B	**Underemployed (0/1)**			
Prosociality (standardized)	−0.013***	−0.013***	−0.011***	−0.013**
	(0.004)	(0.004)	(0.004)	(0.006)
Controlling for gender, age, age^2	No	Yes	Yes	Yes
Controlling for cognitive ability	No	No	Yes	Yes
Sample restriction: not in partnership	No	No	No	Yes
Observations	45,677	45,677	45,677	17,314
Panel C	**Unemployed (0/1)**			
Prosociality (standardized)	−0.009***	−0.009***	−0.008**	−0.012*
	(0.003)	(0.003)	(0.003)	(0.006)
Controlling for gender, age, age^2	No	Yes	Yes	Yes
Controlling for cognitive ability	No	No	Yes	Yes
Sample restriction: not in partnership	No	No	No	Yes
Observations	45,677	45,677	45,677	17,314

Coefficients are OLS estimates, standard errors (clustered at country level) are displayed in parentheses, observations are weighted by the sampling weights provided by Gallup to achieve (ex post) representativeness. All regressions include subnational region fixed effects. Cognitive ability is proxied by self-reported maths skills[17]. Coefficients of the control variables are shown in Supplementary Table 1. Supplementary Table 2 displays correlations among all variables. Data source: GPS and Gallup World Poll (76 countries). Significance levels regarding two-sided *t*-tests: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 2 Analyses of nonlinear relations between labor market success and prosociality.

	(1) Log HH income	(2) Underemployed	(3) Unemployed
Base: Prosociality 1st quarter			
Prosociality in 2nd quarter (dummy)	0.088*** (0.019)	−0.019* (0.010)	−0.011* (0.006)
Prosociality in 3rd quarter (dummy)	0.155*** (0.020)	−0.038*** (0.010)	−0.021** (0.008)
Prosociality in 4th quarter (dummy)	0.188*** (0.024)	−0.033*** (0.012)	−0.021** (0.008)
Observations	77,522	45,677	45,677

Coefficients are OLS estimates, standard errors (clustered at country level) are displayed in parentheses, observations are weighted by the sampling weights provided by Gallup to achieve (ex post) representativeness. All regressions include subnational region fixed effects. HH means household. Base category are individuals with prosociality in the bottom 25% of the global distribution. Prosociality in 2nd quarter is a dummy variable indicating whether an individual's prosociality lies above the bottom 25% and below the median. Prosociality in 3rd quarter is a dummy variable indicating whether an individual's prosociality lies above the median and below the top 25%. Prosociality in 4th quarter is a dummy variable indicating whether an individual's prosociality lies in the top 25%. Data source: GPS and Gallup World Poll (76 countries). Significance levels regarding two-sided t-tests: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 3 Altruism, reciprocity and trust predicts labor market success.

	(1)	(2)	(3)
	Log household income		
Altruism (standardized)	0.057*** (0.008)		
Positive reciprocity (std)		0.074*** (0.007)	
Trust (standardized)			0.016** (0.007)
Observations	77,522	77,522	77,522

Coefficients are OLS estimates, standard errors (clustered at country level) are displayed in parentheses, observations are weighted by the sampling weights provided by Gallup to achieve (ex post) representativeness. All regressions include subnational region fixed effects and controls for age and gender (see Table 1, column 2). Data source: GPS and Gallup World Poll (76 countries). Significance levels regarding two-sided *t*-tests: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Discussion

Methods

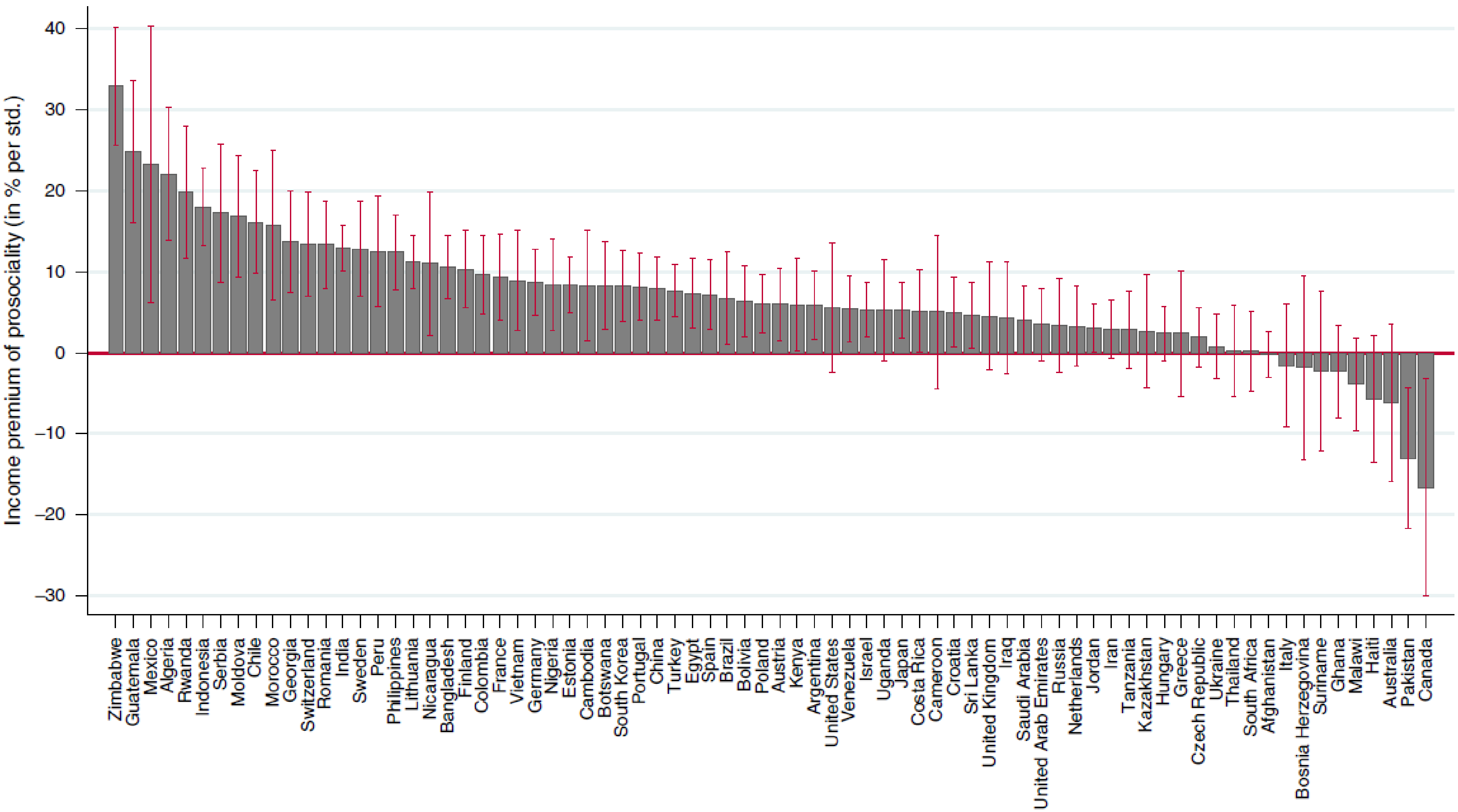


Fig. 1 Income premia of prosociality (in percent of household income) around the world. Displayed coefficients are country-specific estimates of the model shown in Table 1, Panel A, column 2, error bars indicate 90% confidence intervals.

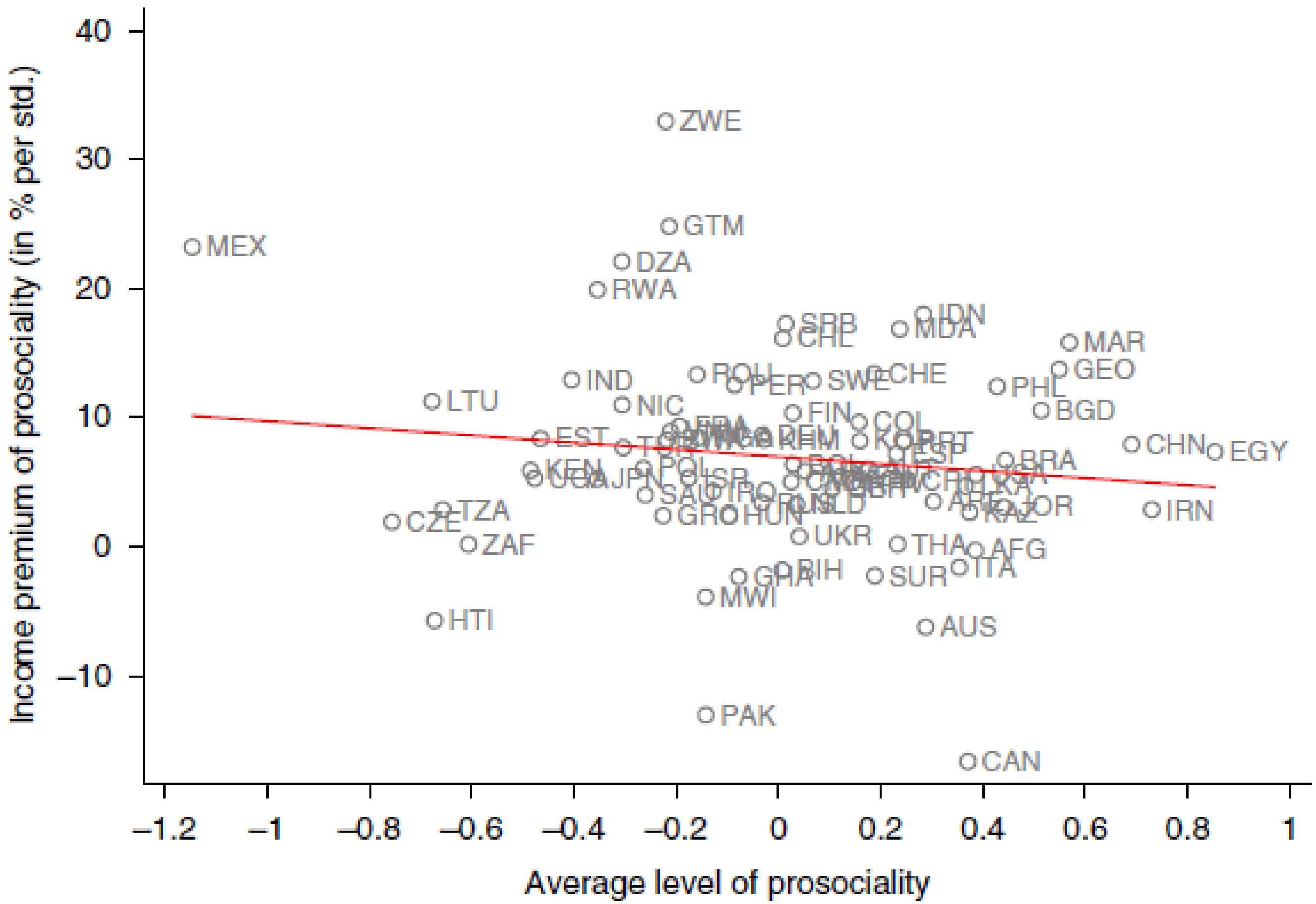


Fig. 2 The relationship between income premia of prosociality and the average level of prosociality. The red line indicates the prediction from a linear regression. The red line indicates the prediction from a linear regression. Spearman correlation: −0.091 ($p = 0.436$).

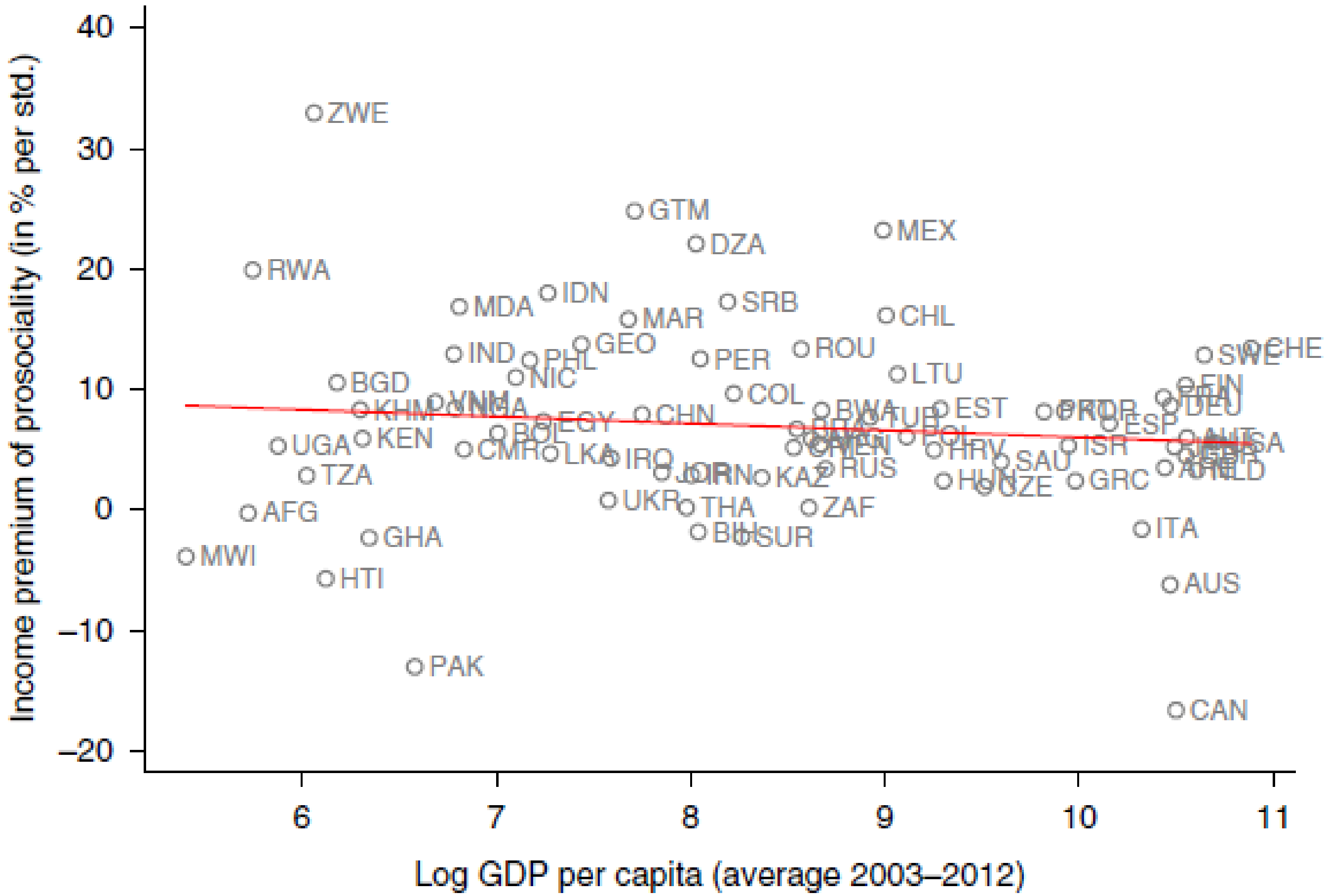


Fig. 3 The relationship between income premia of prosociality and log GDP per capita. The red line indicates the prediction from a linear regression. Spearman correlation: −0.065 ($p = 0.579$).

How to Conceptualize These Correlations and Establish a Causal Basis for Them? Place the concept of personality within economic model(s).

a. *Personality as a strategy*: Define personality as an *emergent property* of a system.
b. Use the economic model(s) to frame and solve a central identification problem in empirical psychology (cognitive and noncognitive).
c. How to go from measurements of personality to personality traits.

Economic Frameworks for Conceptualizing and Measuring Personality and Personality Traits

How to interpret personality measurements within economic models?

Through

- Preferences? (standard approach) – but which preferences?
- Constraints? (Borghans, Duckworth, Heckman and ter Weel) or
- Expectations? (recent papers) or
- Strategies? (social interaction and situation)
- All four

All measures are captured by performance on tasks

- All measurement systems in psychology are based on performance on these tasks gauged in various ways.
- Taking an IQ test is a task.
- Reporting a personality trait is a task.
- Distinction between traits and tasks is flimsy.

- All measurements of ability, personality, and motivation involve assessing performance on tasks.
- $a =$ actions taken.
    1. Produced by effort, goods, and personality traits.
- $a = f(\underbrace{e}_{\text{effort}}, \underbrace{X}_{\text{goods}}, \underbrace{\theta}_{\substack{\text{personality} \\ \text{``traits''}}})$
- $V(a, e, \psi)$: expected valuation function of actions.
- ψ: preference parameters.

- Suppose agents max V subject to

  a.
$$\underbrace{\bar{e}}_{\substack{\text{endowment}\\ \text{of effort}}} = \sum_{i}^{I} \underbrace{e_i}_{\substack{\text{effort allocated}\\ \text{to action } i}}$$

  b.
$$Y + w_j \underbrace{e_j}_{\substack{\text{effort}\\ \text{on job}}} = \underbrace{P'X}_{\text{price goods}}$$

Question: What is the distinction between ψ and θ?

- How can an economist define personality?

Question:

- How to identify "traits" for vectors of observed actions $a \in \mathcal{A}$?

Personality and Preference Parameters

Table 4: Overview of Empirical Studies of the Links Between Preferences and Traits

Preferences	Personality measure	Empirical study
Time Preference	Conscientiousness, Self-control, Affective mindfulness, Elaboration of consequences, Consideration of future consequences.	Daly, Delaney and Harmon [2009]
	Extraversion Time Preference	Dohmen, Falk, Huffman et al. [2010]
Risk Aversion	Sensation Seeking	Zuckerman [1994], Eckel and Grossman [2002]
	Openness	Dohmen, Falk, Huffman et al. [2010]
	Neuroticism, ambition, Agreeableness	Borghans, Golsteyn, Heckman et al. [2009]
	Balloon Analogue Risk Task	Lejuez, Aklin, Zvolensky et al. [2003]
Social Preferences		
Altruism	Neuroticism, Agreeableness	Ashton, Paunonen, Helmes et al. [1998],Osiński [2009] , Bekkers [2006]
Reciprocity	Neuroticism, Agreeableness, Conscientiousness	Dohmen, Falk, Huffman et al. [2008]
Trust	Neuroticism, Agreeableness, Openness, Conscientiousness	Dohmen, Falk, Huffman et al. [2008]

See ADHK for more complete discussion.

Investigating the Link: The Relationship Between Economic Preferences and Psychological Personality Measures

Anke Becker, Thomas Deckers, Thomas Dohmen, Armin Falk, and Fabian Koss (2012, *Annual Review of Economics*)

Link to Tomas Jagelka's 2018 Paper

Table 5: Overview of the experimental measures in data set from laboratory experiments among university students

Preference	Experiment	Measure
Time	Two lists of choices between an amount of money "today" and an amount of money "in 12 months".	Average switching point over both lists of choices from the early to the delayed amount.
Risk	Two lists of choices between a lottery and varying safe options.	Average switching point over both lists of choices from the lottery to the safe option.
Positive Reciprocity	Second-mover behavior in two versions of the trust game (strategy method).	Average amount sent back in both trust games.
Negative Reciprocity	Investment into punishment after unilateral defection of the opponent in a prisoner's dilemma (strategy method).	Amount invested into punishment.
Trust	First mover behavior in two versions of the trust game.	Average amount sent as a first mover in both trust games.
Altruism	First mover behavior in a dictator game with a charitable organization as recipient.	Size of donation.

Correlation Structure

Experimental Data

Table 6: Spearman correlation structure experimental data set

	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism	LoC
Time	0.0370	0.0057	−0.0084	0.1026**	−0.0518	0.0847
Risk	−0.0379	−0.0611	0.0762*	0.0202	−0.1201***	0.0434
Pos. Reciprocity	0.1724***	0.0140	0.0211	0.2042***	0.0361	0.0152
Neg. Reciprocity	−0.0885*	−0.0393	0.0943*	−0.1451***	−0.0136	−0.1418**
Trust	0.1232***	−0.1300***	0.0004	0.1665***	−0.0134	−0.0140
Altruism	0.1242**	−0.0979*	0.0249	0.1911***	0.0847*	0.0480

*, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. Correlations between economic preferences and the Big Five were calculated using 394–477 observations. Correlations between economic preferences and locus of control were calculated using between 254–315 observations. All measures are standardized.

Representative Experimental Data

Table 7: Pearson correlation structure representative experimental data

	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism
Time	−0.0080	−0.0682	−0.0655	−0.0830*	−0.0602
Risk	0.1356***	−0.0720	0.0757	−0.0941**	−0.0290

*, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. All measures are standardized.

Representative Panel Data

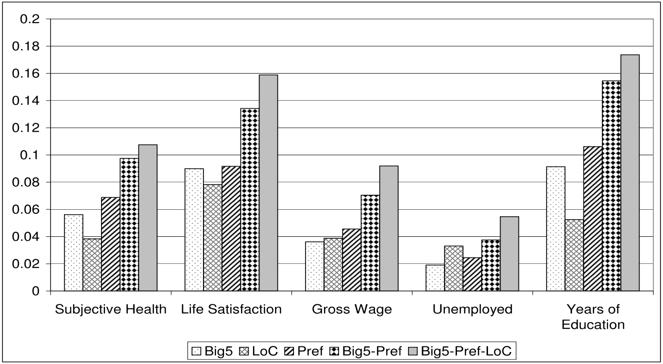
Table 8: Pearson correlation structure between personality measures and economic preferences from SOEP observations

	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism	LoC
Time	0.0183**	0.1122***	−0.0415***	0.3122***	−0.0584***	0.0681***
Risk	0.2793***	−0.0400***	0.2601***	−0.1454***	−0.0996***	0.1521***
Pos. Reciprocity	0.1814***	0.2520***	0.1473***	0.1842***	0.0872***	0.0954***
Neg. Reciprocity	−0.0522***	−0.1558***	−0.0264***	−0.3756***	0.0612***	−0.2154***
Trust	0.1272***	−0.0680***	0.0575***	0.0945***	−0.1919***	0.2094***
Altruism	0.1756***	0.1495***	0.1670***	0.2557***	0.0908***	0.0874***

*, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. Correlations are calculated using 14,243 observations. All measures are standardized.

Explanatory Power for Life Outcomes

Figure 14: Adjusted R^2 for Life Outcomes



Adjusted R^2's for linear regressions for life outcomes. The number of observations available varies for the different life outcomes: subjective health (14,218), life satisfaction (14,214), gross wage (7,199), unemployed (9,095), and years of education (13,768). Gross wage measures the gross hourly wage.

Models of Personality As A Strategy

Link to Appendix

Psychological Variables as Constraints: Another Way to Conceptualize Personality

- A constraint-driven model need not produce a unique choice outcome for all persons with the same constraints.

- Thurstone (1927), Block and Marschak (1960), Bock and Jones (1968), and McFadden (1974, 1981), write the utility of agent i for choice l as $U_{i,l}$.
- $U_{i,l}$ is the motivation for choice (goal) l by agent i.
- Choice sets, B_i, differ among persons depending on their capacities.
- Agent i chooses $\hat{l}_i$ as the maximal element in the choice set B_i:

$$\hat{l}_i = \arg\max_{l \in B_i} \{U_{i,l}\}$$

- A familiar model writes $U_{i,l} = V_{i,l} + \varepsilon_{i,l}$, where $V_{i,l}$ is agent i valuation for l and $\varepsilon_{i,l}$ is a random "taste" shock.
- When $V_{i,l} = V_l$, and $\varepsilon_{i,l}$ is iid extreme value type 1, the probability that l is selected from choice set B_i is

$$\Pr(l \mid B_i) = \frac{\exp(V_l)}{\sum_{j \in B_i} \exp(V_j)} \text{ for } l \in B_i$$
$$= 0, \text{ for } l \notin B_i. \tag{1}$$

- If agents have zero mean scale preference among the choices ($V_l = 0$) so that all choices (goals) have the same mean utility, we obtain a version of Becker's (1962) model of irrational behavior.

Depending on how the constraints are determined, one can capture a variety of aspects of choice behaviour.

- A shy person may limit her options in a way an extrovert does not.
- An intelligent person may have a much richer choice set not only because of greater earnings capacity but also because of much greater imagination.
- Much like greater pixel resolution in imaging machines, those with higher IQ may resolve reality in a more fine-grained and less biased way.
- We capture the effect of these traits on the choice sets, which may also depend on material endowments.

Another Model

Incorporating Personality and Cognitive Ability into Conventional Economic Models: A Simple Framework for Organizing the Evidence

- How should one incorporate psychological traits into conventional economic models?
- One could think of them as public goods.
- This is the approach implicitly adopted by most personality psychologists.
- One could also think of psychological traits as excludable private goods.
- More of a trait used in one activity means less of the trait available for use in other activities.

Digression on Becker's Household Production

Link to Appendix

Traits Entering Household Production

Link to Appendix

Link to Appendix for Becker et al.

Further information on the relationship between economic preferences and conventional personality measures

Other Research

Altruism and Social Preferences

- There is a large literature in economics on altruism and an emerging literature in economics on social preferences.
- Bergstrom (1997) and Laitner (1997) discuss models of interdependent family preferences.
- Andreoni (1995) shows that pure models of altruism are inconsistent with the evidence ("warm glow").
- Villanueva (2005) and Laferrère and Wolff (2006) summarize the mixed evidence on altruism in families.

- A recent literature explores social preferences which are distinct from altruism per se.
- Altruism is based on the assumption that the preferences of one agent depend on the consumption or utility of other agents.
- Social preferences are preferences that depend on agent's evaluations of a social condition (inequality, for example) or the intentions of other agents.
- Fehr and Schmidt (1999) analyze inequality aversion (in which people dislike inequality rather than valuing the consumption or utility of agents per se).
- Fehr and Gachter (2000), and Falk and Fischbacher (2006) present evidence on reciprocity and conditional cooperation, in which agents act in a pro-social or antisocial manner depending on the behavior of others with whom they interact.
- Fehr and Schmidt (2006) summarize the theory and empirical support for social preferences.

Identifying Personality "Traits" from Measured Performance on Tasks

- Key assumption: Some tasks may require only a single trait or a subset of all of the traits.

- Use performance on a task (or on multiple measures of the task) to identify a "trait" requires that performance on certain tasks (performance on a test, performance in an interpersonal situation, etc.) depends exclusively on one component of θ, say $\theta_{1,j}$, and we standardize for incentives and effort.

- Assumes task j output is

$$P_j = \phi_j\left(\theta_{1,j}, e_j\right).$$

- One must standardize for the effort at a benchmark level, say e^*, to use P_j to identify a measure of the trait $\theta_{1,j}$.

- The activity of picking a task (or a collection of tasks) that measure a particular trait ($\theta_{1,j}$ in our example) is called **operationalization** in psychology.
- Demonstrating that a measure successfully operationalizes a trait is called **construct validity**.
- *Need to standardize for effort to measure the trait*.
- Otherwise produces variation in the measured trait across situations with different incentives.

A Fundamental Identification Problem

- Operationalization and construct validation require heroic assumptions.
- Even if one adjusts for effort in a task, productivity in a task may depend on *multiple traits*.
- Thus two components of θ (say $\underbrace{\theta_{1,\mu}}_{\text{mental}}, \underbrace{\theta_{1,\pi}}_{\text{personality}}$) may determine productivity in j.
- Without further information, one cannot infer which of the two traits produces the productivity in j.
- In general, even having two (or more) measures of productivity that depend on $(\theta_{1,\mu}, \theta_{1,\pi})$ is not enough to identify the separate components.

- Ignore measurement error for now.
- Consider the following case of two productivity measures for the two tasks j and j':

$$P_j = \phi_j\left(\theta_{1,\mu}, \theta_{1,\pi}, e_j\right)$$
$$P_{j'} = \phi_{j'}\left(\theta_{1,\mu}, \theta_{1,\pi}, e_{j'}\right), \qquad j \neq j'.$$

- Standardize measurements at a common level of effort $e_j = e_{j'} = e^*$.
- Note that if the support of e_j and $e_{j'}$ is disjoint, no $\left(\theta_{1,\mu}, \theta_{1,\pi}\right)$ uniquely defined.
- If the system of equations satisfies a local rank condition, then one can solve for the pair $\left(\theta_{1,\mu}, \theta_{1,\pi}\right)$ at e^*.

- Note, however, that **only the pair is identified**.
- One cannot (without further information) determine which component of the pair is $\theta_{1,\mu}$ or $\theta_{1,\pi}$.
- In the absence of **dedicated constructs** (constructs that are generated by only one component of θ), there is an intrinsic identification problem that arises in using measures of productivity in tasks to infer traits.
- Analysts have to make one normalization in order to identify the traits.
- Need only one such construct joined with patterned structures on how θ enters other task to identify the vector θ (e.g., one example is a recursive, triangular structure).

Examples of Nonidentification Problems

IQ and Achievement Test Scores Reflect Incentives and Efforts, and Capture Both Cognitive and Personality Traits

Table 9: Incentives and Performance on Intelligence Tests

Study	Sample and Study Design	Experimental Group	Effect size of incentive (in standard deviations)	Summary
Edlund [1972]	Between subjects study. 11 matched pairs of low SES children; children were about one standard deviation below average in IQ at baseline	M&M candies given for each right answer	Experimental group scored 12 points higher than control group during a second testing on an alternative form of the Stanford Binet (about 0.8 standard deviations)	"…a carefully chosen consequence, candy, given contingent on each occurrence of correct responses to an IQ test, can result in a significantly higher IQ score."(p. 319)
Breuning and Zella [1978]	Within and between subjects study of 485 *special education* high school students all took IQ tests, then were randomly assigned to control or incentive groups to retake tests. Subjects were below-average in IQ.	Incentives such as record albums, radios (<$25) given for improvement in test performance	Scores increased by about 17 points. Results were consistent across the Otis-Lennon, WISC-R, and Large-Thorndike tests.	"In summary, the promise of individualized incentives contingent on an increase in IQ test performance (as compared with pretest performance) resulted in an approximate 17-point increase in IQ test scores. These increases were equally spread across subtests… The incentive condition effects were much less pronounced for students having pretest IQs between 98 and 120 and did not occur for students having pretest IQs between 121 and 140." (p. 225)

- Many other studies (see ADHK).

Hard Evidence on Soft Skills

- How are validities determined?

Table 10: Validities of GED Test

Test	Correlation	Source(s)
Armed Forces Qualification Test (AFQT)	0.75 - 0.79 †	?
Iowa Test of Educational Development	0.88 †	?
American College Test (ACT)	0.80 †	?
Adult Performance Level (APL) Survey	0.81 †	?
New York's Degrees of Reading Power (DRP) Test	0.77 †	?
Test of Adult Basic Education (TABE)	0.66-0.68†	?
General Aptitude Test Battery (GATB)	0.61-0.67†	?
National Adult Literacy Survey (NALS) factor	0.78 ‡	?

† Uses mean GED subtest scores
‡ Uses a general GED factor

Table 11: Cognitive Ability Validities

Test	Validation Domain	Estimate(s)	Source(s)
SAT (Achievement)	1st Year College GPA	0.35 - 0.53	?
ACT (Achievement)	Early College GPA	0.42	?
GED (Achievement)	HS Senior GPA	0.33 - 0.49	?
DAT (Achievement)	College GPA	0.13 - 0.62†	?
AFQT (Achievement)	9th Grade GPA	0.54	?
WAIS (IQ)	College GPA	0.38 - 0.43	?
WAIS (IQ)	HS GPA	0.62	?
Various IQ**	9th Grade GPA	0.42	?
WISC (IQ)	WRAT (Achievement)	0.44 - 0.75‡	?

Table 11: Cognitive Ability Validities

Test	Validation Domain	Estimate(s)	Source(s)
WISC-R (IQ)	WRAT (Achievement)	0.35 - 0.76‡	?
Various IQ**	AFQT (Achievement)	0.65	?
Stanford Binet (IQ)	WISC-R (IQ)	0.77 - 0.87	?, ?
Raven's (IQ)	WAIS-R (IQ)	0.74 - 0.84	?
WIAT (Achievement)	CAT/2 (Achievement)	0.69 - 0.83*	?

† Large range is due to varying validity of eight subtests of DAT
‡ Ranges are given because correlations vary by academic subject
* Ranges are given because correlations vary by grade level
** IQ is pooled across several IQ tests using IQ percentiles
Notes: WISC – Wechsler Intelligence Scale for Children, WISC-R – Wechsler Intelligence Scale for Children - Revised, WAIS - Wechsler Adult Intelligence Scale, Raven's IQ – Raven's Standard Progressive Matrices, GED – General Educational Development, DAT – Differential Aptitude Test, WIAT – Wechsler Individual Achievement Test, CAT – California Achievement Test, WRAT – Wide Range Achievement Test

Table 12: Correlations Among NLSY79 Measures of Cognition

	Correlation between IQ, AFQT, and GPA		
	IQ	Achievement (AFQT)	Grade Point Average (GPA)
IQ	1		
AFQT	0.65	1	
GPA(9th)	0.42	0.54	1

Source: National Longitudinal Survey of Youth (NLSY79). Pooled male and female random sample. Notes: The Armed Forces Qualifying Test (AFQT) was administered in 1980 when subjects were 15-22. AFQT is adjusted for schooling at the time of the test conditional on final schooling, following the procedure in **?**. AFQT is constructed from Arithmetic Reasoning, Word Knowledge, Math Knowledge, and Paragraph Comprehension tests. IQ and GPA are from high school transcripts. IQ is pooled across several IQ tests using IQ percentiles. GPA is the individual's core-subject GPA measured in 9th grade when virtually all sample participants are enrolled. Differences between males and females are slight. For the sake of brevity we report pooled results.

Table 13: Validities in Labor Market Outcomes from the National Longitudinal Survey of Youth, 1979

NLSY79 R^2 (tests and school performance)						
	Males			Females		
Outcomes	IQ	GPA (10th grade)	AFQT	IQ	GPA (10th grade)	AFQT
Hourly Wage Age 35	0.03	0.05***	0.05***	0.11***	0.10***	0.13***
Hours Worked Age 35	0.10***	0.12***	0.21***	0.02	0.10***	0.17***
Any Welfare Age 35	-0.09***	-0.11***	-0.23***	-0.20***	-0.23***	-0.36***

Source: **?**.

THE UNIVERSITY OF CHICAGO

Stability of Traits
Changing Preference Parameters and Psychological Traits?

- If they change, to what extent do environments and investments influence the developmental trajectories of personality traits?

THE UNIVERSITY OF CHICAGO

A Dynamic Model of Personality, Schooling, and Occupational Choice (Extract)

by Petra Todd, and Weilong Zhang (2018)

James J. Heckman

University of Chicago

Econ 350, Winter 2021

Data

Estimation is based on the Household, Income and Labour Dynamics in Australia (HILDA) longitudinal data.

- One in one thousand household-based panel survey.
- Collects information on household and family relationships, income, employment, health and education.
- Surveys individuals three times about their personality traits, so it is possible to observe changes over time.
- Our estimation focuses on males to avoid consideration of fertility decisions along with labor supply decisions.

Key findings

- Unobserved types are malleable during younger ages but stabilize around the mid-30s.
- Attendance at college is associated with changes in certain personality traits, especially with an increase in conscientiousness.
- We find the existence of "super type", individuals who tend to have high levels of cognitive skills and higher than average levels of personality traits in all dimensions. They also tend to complete more education and to work in white collar jobs.
- High cognitive skills go along with more desirable personality traits (noncognitive).

Key findings

- Evaluation of educational policy interventions (tuition subsidies, compulsory schooling)
  - Individuals are more responsive to both policies when types can vary with age rather than being fixed.
    - ★ Disadvantaged types respond more because there is a possibility of switching to a more advantaged type.
  - Ignoring how educational policies affect personality traits and affects types underestimates the incentives created by educational policies.
- Tuition subsidies mainly affect schooling and labor market outcomes of more advantaged types, whereas compulsory schooling affects less advantaged types.

Data: HILDA

The Household Income and Labour Dynamics in Australia (HILDA) longitudinal data set, males between age 15-58.

- General employment and education information annually 2001-2013.
- Personality traits surveyed in waves 2005, 2009 and 2013.
- Cognitive ability measured once in wave 2012.

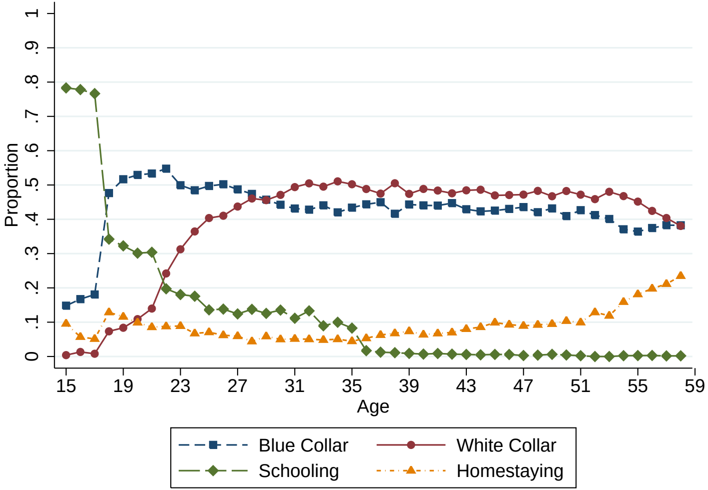


Figure 1: Work status and college attendance by age

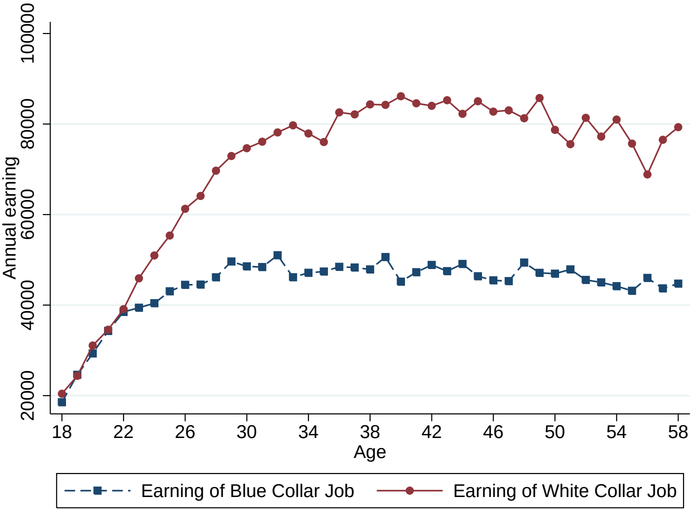
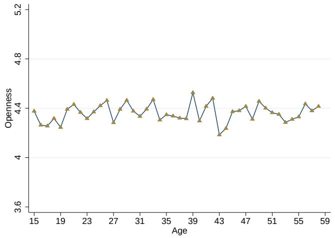
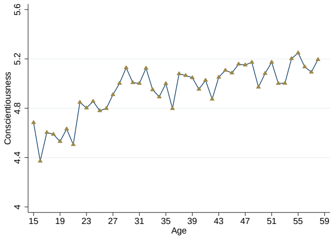


Figure 2: Average wage profile by occupation over life cycle

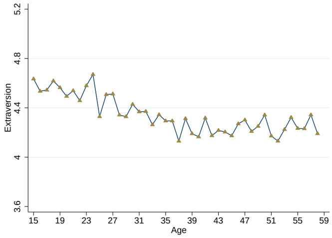
Figure 3: The scores on “Big-Five” personality traits over time



(a) Openness to experience

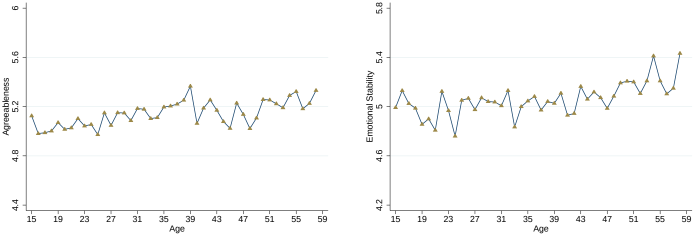


(b) Conscientiousness



(c) Extraversion

Figure 4: The scores on “Big-Five” personality traits over time



(a) Agreeableness (b) Emotional Stability

Table 4: Average personality traits by educational level

Occupation	Emotional Stability	Openness	Conscientiousness	Agreeableness	Extroversion
High School	-0.0478	-0.1414	-.0784	-0.0508	0.0393
or Lower	(0.0140)	(0.0139)	(0.0138)	(0.0141)	(0.0133)
College	0.0258	0.0605	0.1033	0.0765	-0.0056
Dropouts	(0.0354)	(0.0338)	(0.0349)	(0.0345)	(0.0358)
College	0.1043	0.3096	0.1430	0.0839	-0.0997
Graduates	(0.0208)	(0.0202)	(0.0217)	(0.0208)	(0.0232)

Note: Each personality trait was standardized to have mean 0, variance 1.
Source: HILDA, waves 5, 9 and 13.

Table 5: Average personality traits by occupation category

Occupation	Emotional Stability	Openness	Conscientiousness	Agreeableness	Extroversion
Blue-collar	-0.0366	-0.1715	-.0464	-0.0208	0.0215
	(0.0166)	(0.0162)	(0.0162)	(0.0168)	(0.0158)
White-collar	0.0797	0.1507	0.1360	0.0573	-0.0127
	(0.0166)	(0.0164)	(0.0171)	(0.0164)	(0.0179)

Note: Each personality trait has been standardized to have mean 0, variance 1.
Source: HILDA, waves 5, 9 and 13.

Table 6: Medium and long-run changes in Big-Five personality and education/occupation

	Extraversion		Agreeableness		Conscientiousness		Stability		Openness	
	Medium	Long	Medium	Long	Medium	Long	Medium	Long	Medium	Long
Education	-0.009	0.005	0.049**	0.032*	0.022	0.066**	0.004	0.017	0.022	0.012
	(0.022)	(0.017)	(0.023)	(0.018)	(0.023)	(0.018)	(0.026)	(0.020)	(0.023)	(0.018)
White Collar	-0.002	-0.008	0.007	0.006	-0.012	0.002	-0.010	0.001	0.000	-0.001
	(0.013)	(0.008)	(0.014)	(0.008)	(0.014)	(0.008)	(0.016)	(0.009)	(0.014)	(0.008)
Blue Collar	-0.011	−0.016**	0.014	0.011	0.003	0.001	-0.016	0.004	-0.013	-0.006
	(0.014)	(0.008)	(0.015)	(0.008)	(0.014)	(0.008)	(0.016)	(0.009)	(0.014)	(0.008)
Trend	0.004	0.031	-0.052	0.019	0.078	0.105*	0.142**	0.090	-0.039	0.044
	(0.056)	(0.053)	(0.060)	(0.056)	(0.059)	(0.057)	(0.067)	(0.064)	(0.059)	(0.056)

Note: * 10% significance level. ** 5% significance level. Standard errors in parentheses.

Source: HILDA, wave 5, 9 and 13.

Table 7: How personality traits and cognitive ability relate to schooling decisions

	Probit 1	Marginal	Probit 2	Marginal
Emotional Stability	0.084***	0.026	0.057*	0.017
Openness	0.228***	0.070	0.219***	0.066
Conscientiousness	0.137	0.042	0.142***	0.043
Agreeableness	-0.033***	0.010	0.028	0.008
Extraversion	-0.136***	-0.042	-0.150***	-0.045
Cognitive	0.514***	0.157	0.519***	0.157
Family Characteristics	No		Yes	
Observations	6101		4361	
R Square	0.1117		0.1255	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

End of Todd and Zhang (2018) slides

Figure 15: Mean Exectuive Function (MEF) App Mean Total Score by Age in Months in Typically Developing Children from 2-17.9 Years

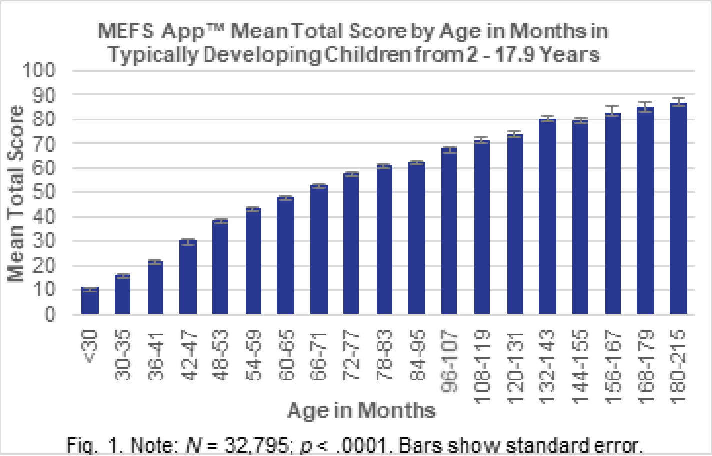


Fig 1. Note: $N = 32.795$; $p < .0001$. Bars show standard error.

Results from the Psychological Literature Based on Cross Sections

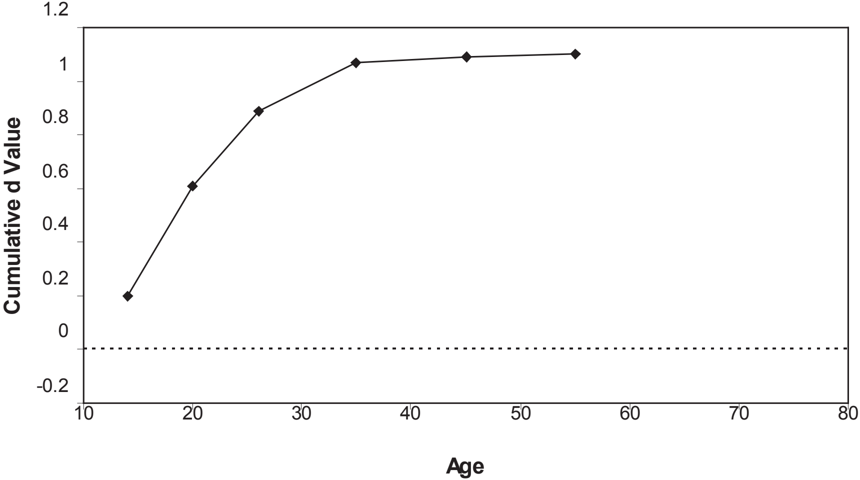
- The malleability of personality can be defined and measured in several ways: Mean-level change refers to change over time in absolute levels of a trait and is measured by changes in scores over time.
- Rank-order change, in contrast, refers to changes in the ordinal ranking of a trait in a population and is measured by test-retest rank correlations.
- Cognitive abilities exhibit dramatic mean-level change from early childhood through adolescence, but, over the same period, strong rank-order stability.

- A second useful dichotomy contrasts normative change, defined as changes that are typical of the average individual in a given population, and caused either by biological programming (ontogenic) or by predictable changes in social roles (sociogenic), and non-normative change, encompassing both intentional change, caused by deliberate, self-directed efforts, deliberately chosen changes in social roles and atypical life events (trauma, for example).

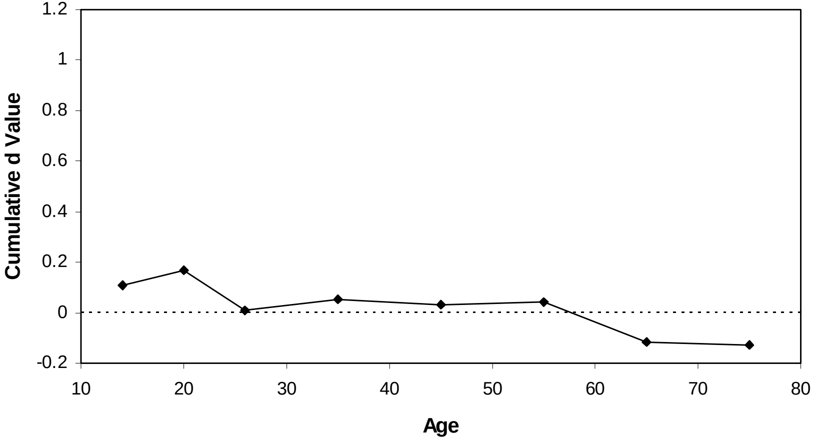
Mean Level Changes

- People typically become more socially dominant

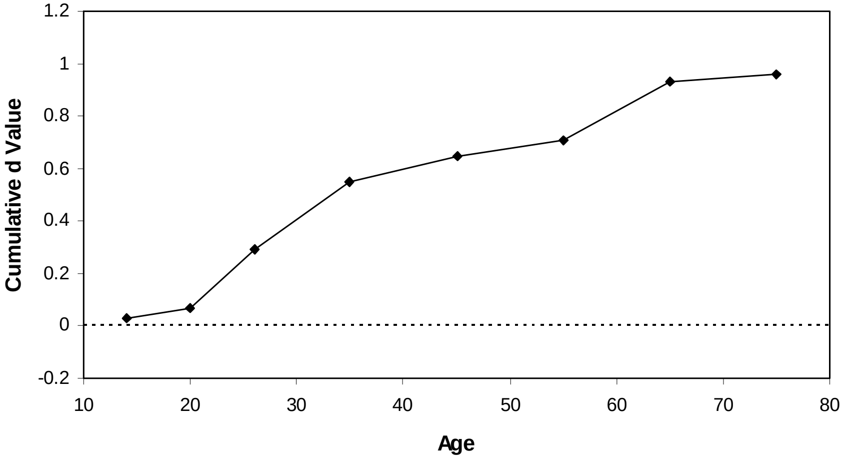
Social Dominance



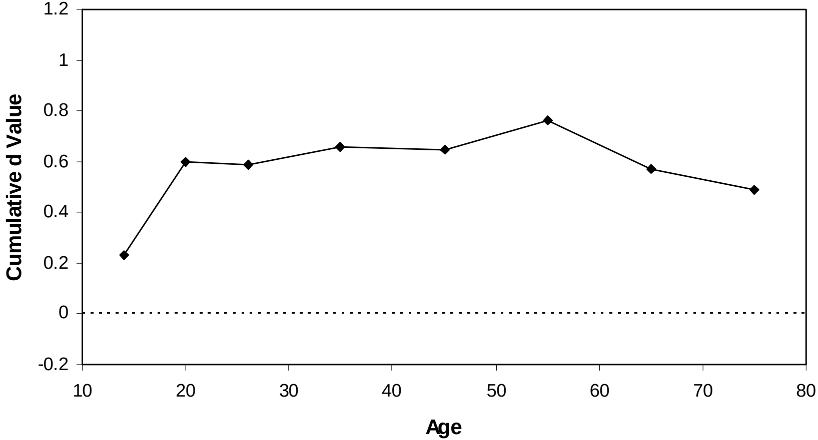
Social Vitality

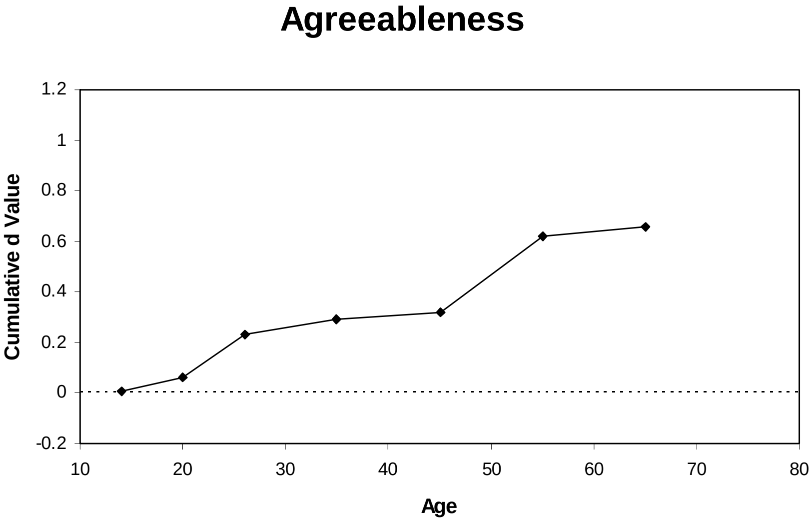


Conscientiousness

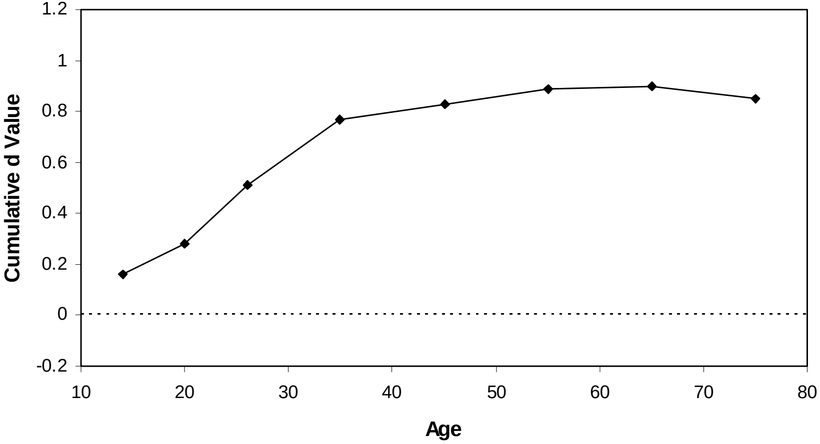


Openness to Experience




Agreeableness
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
Cumulative d Value
10
20
30
40
50
60
70
80
Age

Emotional Stability



- Figure 16a shows mean-level changes in cognitive skills using a longitudinal analysis, and the bottom panel of Figure 16b shows mean-level changes using a cross-sectional analysis.

Figure 16: Mean-Level Changes in Cognitive Skills Using a Longitudinal Analysis

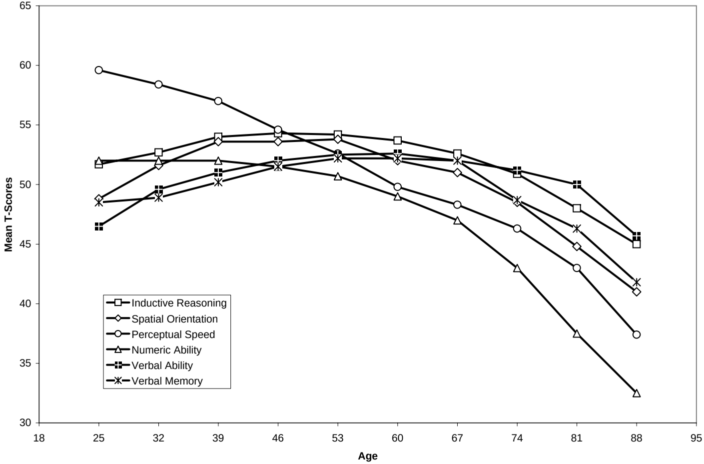
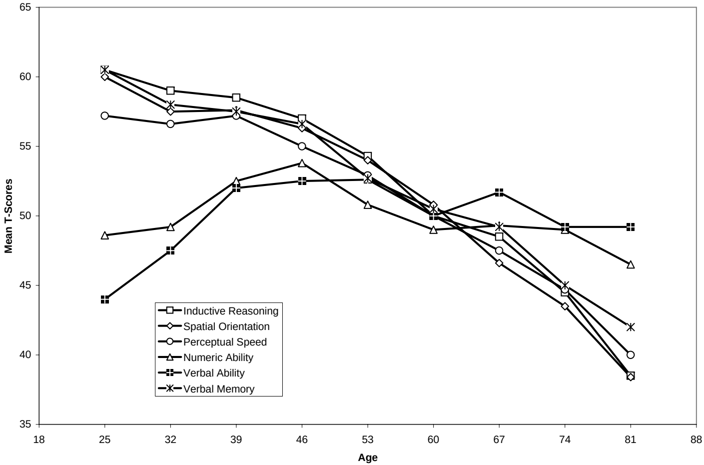


Figure 16: Mean-Level Changes in Cognitive Skills Using a Cross-Sectional Analysis



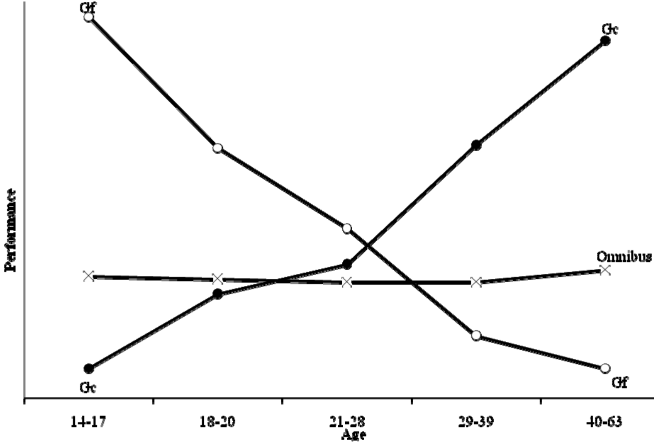


Figure 4c

Fluid intelligence decreases and crystallized intelligence increases across the lifespan

Note: Figure from Horn (1970). Used with permission of Elsevier.

Rank-Order Change in Cognitive and Personality Skills

- Figure 17a shows graphs of rank order stability of personality by age.
- Figure 17b shows rank order stability of IQ over broad age ranges.

Figure 17: Rank Order Stability: Personality by Age

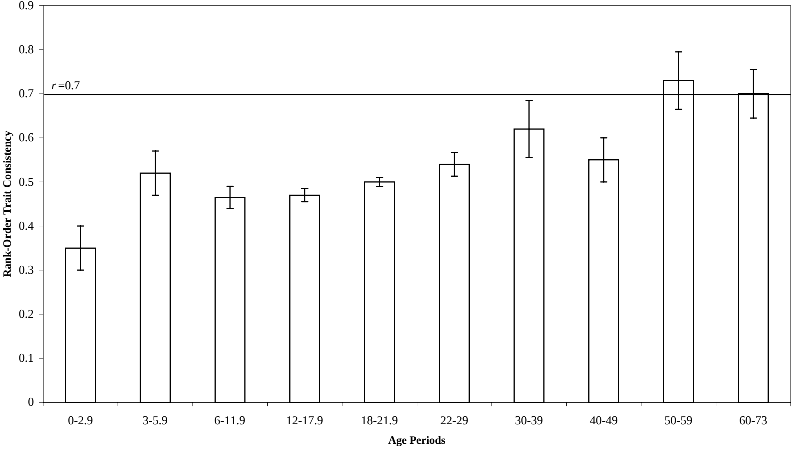
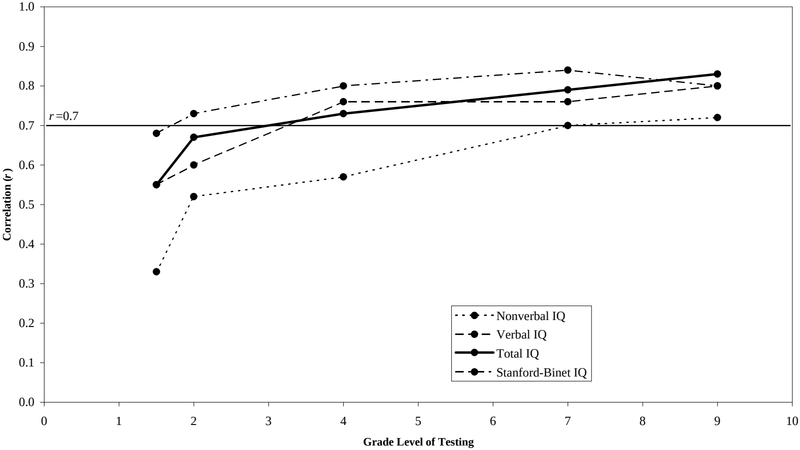


Figure 17: Rank Order Stability: IQ over Broad Age Ranges

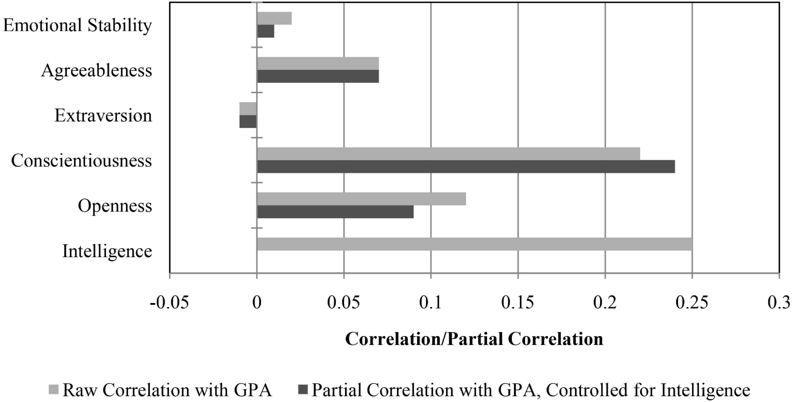


Factor Analysis: A Key Tool in Defining and Measuring Personality

Link to Appendix

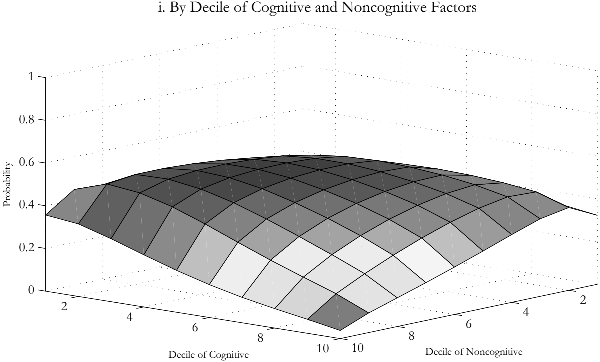
Appendix

Figure 18: Correlations of the Big Five and Intelligence with Course Grades



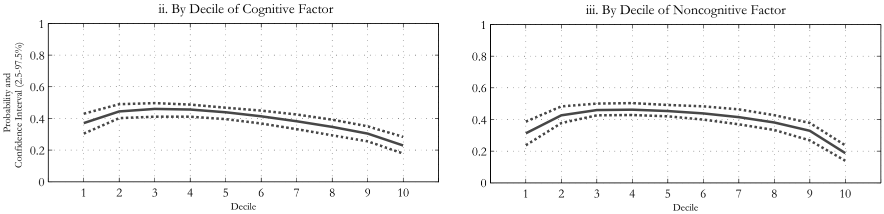
Notes: All correlations are significant at the 1% level. The correlations are corrected for scale reliability and come from a meta analysis representing a collection of studies representing samples of between N=31,955 to N=70,926, depending on the trait. The meta-analysis did not clearly specify when personality was measured relative to course grades.
Source: Poropat [2009].

Figure 19: Probability of Being a High School Graduate at Age 30 and Not Going on to Further Education, Males



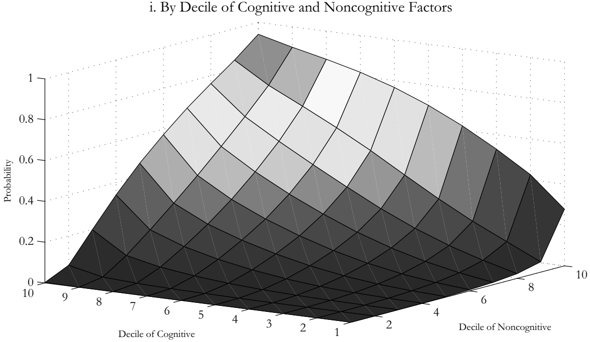
Notes: The data are simulated from the estimates of the model and the NLSY79 sample. Higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (200 draws). Solid lines depict probability, and dashed lines, 2.5%-97.5% confidence intervals. The upper curve is the joint density. The two marginal curves (ii) and (iii) are evaluated at the mean of the trait not being varied.
Source: Heckman, Stixrud and Urzua [2006, Figure 19].

Figure 19: Probability of Being a High School Graduate at Age 30 and Not Going on to Further Education, Males



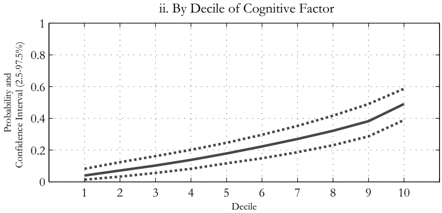
Notes: The data are simulated from the estimates of the model and the NLSY79 sample. Higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (200 draws). Solid lines depict probability, and dashed lines, 2.5%-97.5% confidence intervals. The upper curve is the joint density. The two marginal curves (ii) and (iii) are evaluated at the mean of the trait not being varied.
Source: Heckman, Stixrud and Urzua [2006, Figure 19].

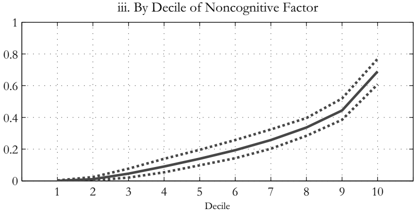
Figure 20: Probability of Being a 4-year-college Graduate or Higher at Age 30, Males



Notes: The data are simulated from the estimates of the model and the NLSY79 sample. Higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (200 draws). Solid lines depict probability, and dashed lines, 2.5%-97.5% confidence intervals. The upper curve is the joint density. The two marginal curves (ii) and (iii) are evaluated at the mean of the trait not being varied.
Source: Heckman, Stixrud and Urzua [2006, Figure 21].

Figure 20: Probability of Being a 4-year-college Graduate or Higher at Age 30, Males





Notes: The data are simulated from the estimates of the model and the NLSY79 sample. Higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (200 draws). Solid lines depict probability, and dashed lines, 2.5%-97.5% confidence intervals. The upper curve is the joint density. The two marginal curves (ii) and (iii) are evaluated at the mean of the trait not being varied.
Source: Heckman, Stixrud and Urzua [2006, Figure 21].

Return to main text

Appendix for Becker et al.
The Relationship Between Economic Preferences and Psychological Personality Measures Paper

Table 14: Spearman correlation structure experimental data set

	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism	LoC
Time	0.0388	0.0162	−0.0114	0.1077**	−0.0684	0.1063*
Risk	0.0027	−0.0486	0.0786*	0.0206	−0.0995**	0.0485
Pos. Reciprocity	0.1606***	0.0078	0.0177	0.2029***	0.0152	0.0441
Neg. Reciprocity	−0.0967*	−0.0221	0.0462	−0.083*	−0.0165	−0.1376**
Trust	0.1354***	−0.1198***	0.002	0.1696***	−0.002	−0.0648
Altruism	0.0969*	−0.0804	0.0034	0.2000***	0.0879*	0.0418

*, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. Correlations between economic preferences and the Big Five were calculated using 394–477 observations. Correlations between economic preferences and Locus of Control were calculated using 254–315 observations. All measures are standardized.

Table 15: Spearman correlation structure representative experimental data

	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism
Time	−0.0199	−0.0737	−0.0764*	−0.0829*	−0.0598
Risk	0.1315*	−0.0744	0.0661	−0.0854*	−0.0261

*, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. All measures are standardized.

Table 16: Spearman Correlation Structure SOEP

	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism	LoC
Time	0.0233	0.1192	−0.0342	0.3099	−0.0643	0.0709
Risk	0.2632	−0.0500	0.2452	−0.1496	−0.1049	0.1426
Pos. Reciprocity	0.1835	0.2622	0.1547	0.1947	0.0808	0.1041
Neg. Reciprocity	−0.0616	−0.1767	−0.0426	−0.3853	0.0572	−0.2257
Trust	0.1224	−0.0693	0.0523	0.0788	−0.1889	0.2012
Altruism	0.1693	0.1501	0.1602	0.2416	0.0860	0.0843

All correlations are significant at the 1% level and are calculated using 14,243 observations. All measures are standardized.

Figure 21: Kernel-weighted local linear polynomial regressions using experimental data

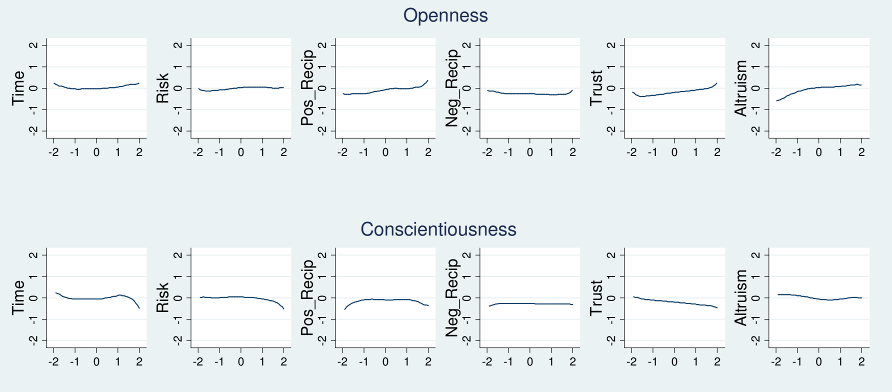


Figure 21: Kernel-weighted local linear polynomial regressions using experimental data Cont'd

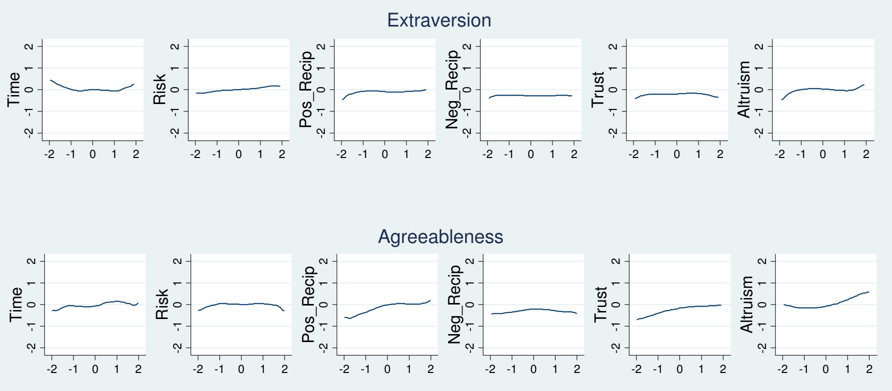


Figure 21: Kernel-weighted local linear polynomial regressions using experimental data Cont'd

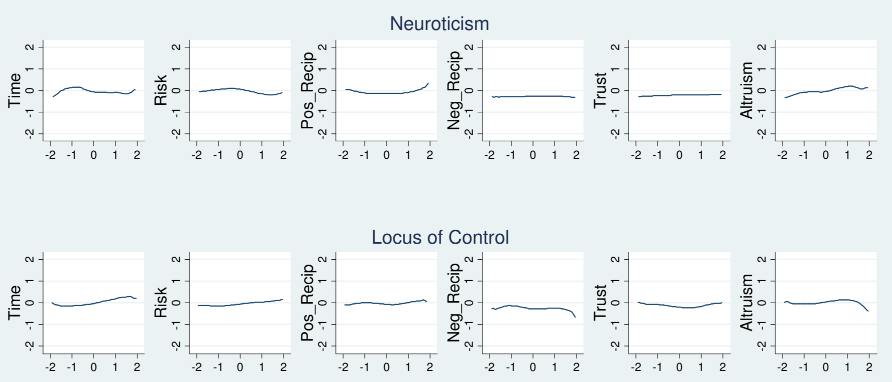


Figure 22: Kernel-weighted local linear polynomial regressions using SOEP data

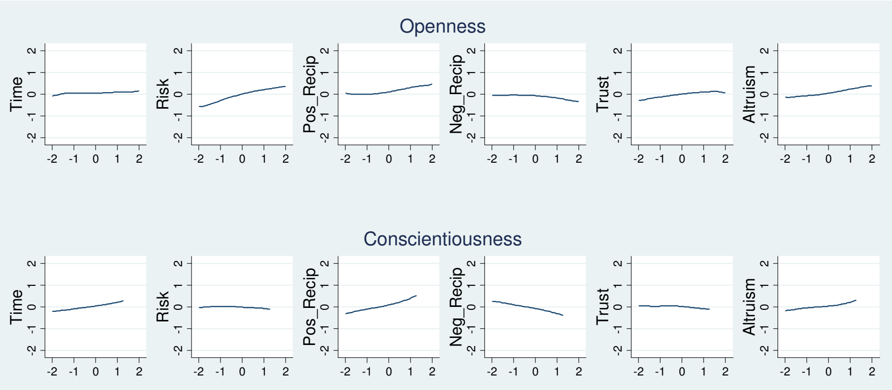


Figure 22: Kernel-weighted local linear polynomial regressions using SOEP data Cont'd

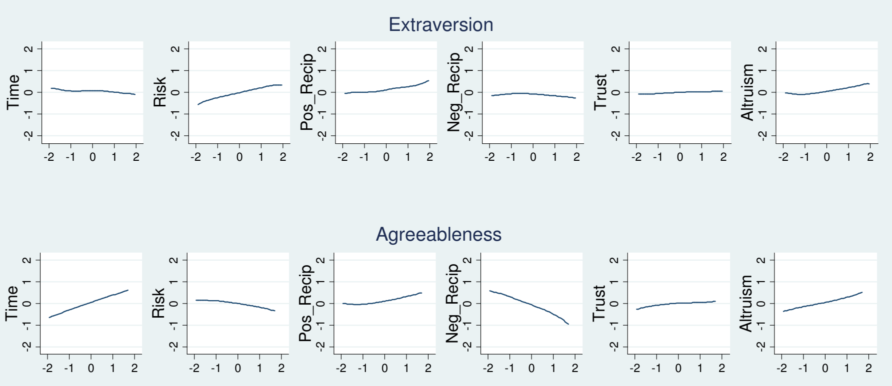


Figure 22: Kernel-weighted local linear polynomial regressions using SOEP data Cont'd

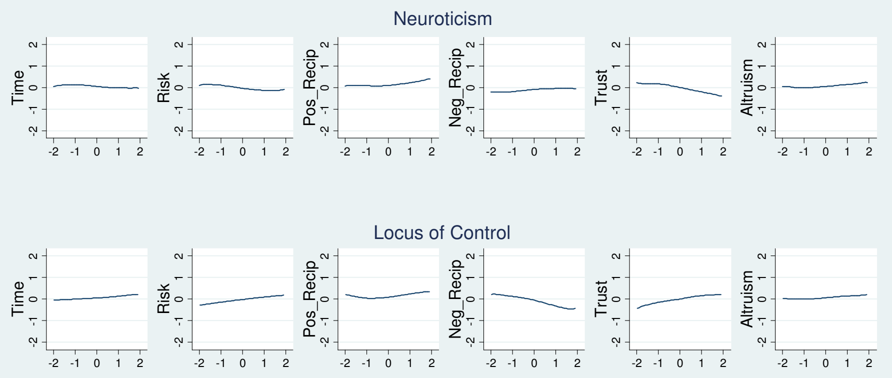


Table 17: Outcome Regressions: Representative Experimental Data

	(1)	(2)	(3)	(4)	(5)
Life Outcomes	Subj. Health	Life Satisf.	Gross Wage	Unemployed	Years of Educ.
Openness	0.043***	0.123***	0.989***	-0.018***	0.667***
	(0.009)	(0.017)	(0.162)	(0.004)	(0.027)
Conscientiousn.	0.038***	0.106***	0.565***	-0.014***	-0.182***
	(0.009)	(0.017)	(0.161)	(0.004)	(0.026)
Extraversion	0.026***	0.134***	-1.201***	0.006*	-0.309***
	(0.009)	(0.017)	(0.154)	(0.004)	(0.026)
Agreeableness	0.033***	0.139***	-1.288***	0.023***	-0.146***
	(0.010)	(0.018)	(0.165)	(0.004)	(0.028)
Neuroticism	-0.140***	-0.186***	-1.009***	0.018***	-0.272***
	(0.009)	(0.016)	(0.158)	(0.004)	(0.026)

*, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. All measures are standardized.

Table 17: Outcome Regressions: Representative Experimental Data Cont'd

	(1)	(2)	(3)	(4)	(5)
Life Outcomes	Subj. Health	Life Satisf.	Gross Wage	Unemployed	Years of Educ.
LoC	0.105***	0.307***	1.899***	-0.043***	0.421***
	(0.008)	(0.015)	(0.145)	(0.003)	(0.024)
Patience	0.024***	0.129***	-0.343**	0.001	-0.151***
	(0.008)	(0.015)	(0.136)	(0.003)	(0.023)
Risk	0.131***	0.076***	0.415**	0.003	0.210***
	(0.009)	(0.017)	(0.166)	(0.004)	(0.027)
Pos. Recip.	-0.035***	0.006	0.388***	-0.002	0.005
	(0.008)	(0.015)	(0.140)	(0.003)	(0.023)
Neg. Recip.	0.064***	0.039**	-0.329**	0.006*	-0.137***
	(0.008)	(0.015)	(0.147)	(0.003)	(0.024)

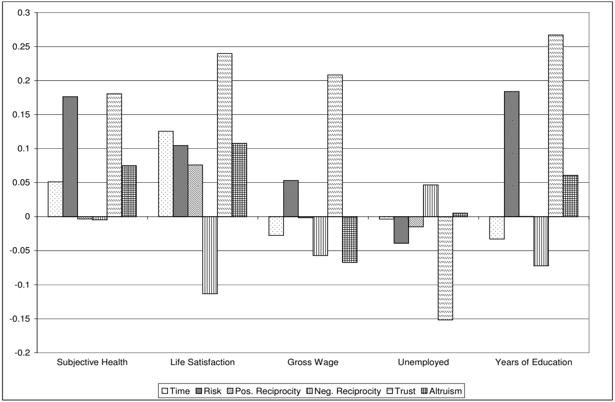
*, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. All measures are standardized.

Table 17: Outcome Regressions: Representative Experimental Data Cont'd

	(1)	(2)	(3)	(4)	(5)
Life Outcomes	Subj. Health	Life Satisf.	Gross Wage	Unemployed	Years of Educ.
Trust	0.122***	0.308***	1.763***	-0.035***	0.587***
	(0.009)	(0.015)	(0.145)	(0.003)	(0.024)
Altruism	0.070***	0.072***	-0.780***	0.005	0.084***
	(0.009)	(0.016)	(0.152)	(0.003)	(0.025)
Constant	3.300***	6.852***	16.100***	0.099***	12.346***
	(0.007)	(0.014)	(0.131)	(0.003)	(0.021)
Observations	14,218	14,214	7,199	9,095	13,768
Adj. R-squared	0.108	0.159	0.0919	0.0547	0.174

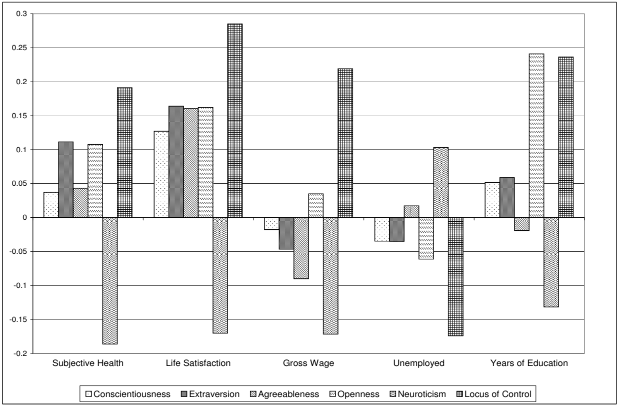
*, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. All measures are standardized.

Figure 23: Correlation Coefficients Between Preference Measures and Life Outcomes Using SOEP Data



Pearson correlation coefficients between preference measures and life outcomes using SOEP data. Trust always shows the strongest association with life outcomes. More trust and a higher willingness to take risk are always related to better life outcomes, e.g. better health and greater life satisfaction, whereas negative reciprocity is associated with less life satisfaction and lower wages. The number of observations available varies for the different life outcomes: subjective health (14,218), life satisfaction (14,214), gross wage (7,199), unemployed (9,095), years of education (13,768). Gross wage measures the gross hourly wage.

Figure 24: Correlation Coefficients Between Personality Measures and Life Outcomes Using SOEP Data



Pearson correlation coefficients between personality measures and life outcomes using SOEP data. The locus of control and neuroticism show the strongest associations with life outcomes. A more internal locus of control is always related to better outcomes (e.g. better health or more life satisfaction), whereas a higher degree of neuroticism is associated with lower wages or a higher probability of being unemployed. The number of observations available varies for the different life outcomes: subjective health (14,218), life satisfaction (14,214), gross wage (7,199), unemployed (9,095), years of education (13,768). Gross wage measures the gross hourly wage.

Table 18: Linear representation of outcome regressions

	Subjective Health (OLS)					Subjective Health (o. probit)				
	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC
adj. R^2/pseudo R^2	0.0561	0.0383	0.0688	0.0975	0.1075	0.0220	0.0145	0.0268	0.0388	0.0429
F-Test/LR-Test	170.04	567.35	176.01	140.59	143.72	834.99	550.62	1016.47	1471.22	1627.11
AIC	37833	38094	37641	37201	37043	37139	37415	36960	36515	36361
BIC	37878	38109	37694	37292	37142	37207	37453	37035	36628	36482
	Life Satisfaction (OLS)					Life Satisfaction (o. probit)				
	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC					
adj. R^2/pseudo R^2	0.0899	0.0782	0.0917	0.1342	0.1588	0.0261	0.0219	0.0256	0.0390	0.0467
F-Test/LR-Test	281.88	1206.91	240.08	201.27	224.67	1406.38	1178.16	1376.73	2098.73	2513.61
AIC	55038	55216	55012	54335	53926	52448	52668	52480	51768	51355
BIC	55083	55231	55065	54426	54024	52561	52751	52601	51926	51521
	Gross Wage(OLS)									
	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC	-	-	-	-	-
adj. R^2/pseudo R^2	0.0361	0.0388	0.0456	0.0704	0.0919	-	-	-	-	-
F-Test/LR-Test	54.97	291.20	58.31	50.57	61.71	-	-	-	-	-
AIC	55088	55088	55042	54857	54690	-	-	-	-	-
BIC	55102	55102	55090	54940	54779	-	-	-	-	-

Table 18: Linear representation of outcome regressions Cont'd

	Unemployed (OLS)					Unemployed (probit)				
	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC
adj. R^2/pseudo R^2	0.0191	0.0331	0.0245	0.0375	0.0547	0.0322	0.0527	0.0412	0.0648	0.0926
F-Test/LR-Test	36.34	312.13	39.05	33.22	44.82	180.12	294.52	230.37	361.89	517.42
AIC	3067	2932	3017	2900	2738	5420	5298	5372	5250	5097
BIC	3110	2946	3067	2986	2830	5463	5312	5422	5336	5189
	Years of Education (OLS)					Years of Education (o. probit)				
	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC					
adj. R^2/pseudo R^2	0.0914	0.0525	0.1061	0.1545	0.1736	0.0209	0.0126	0.0241	0.0359	0.0415
F-Test/LR-Test	277.93	763.89	273.29	229.74	242.03	1355.80	817.10	1563.14	2329.14	2688.38
AIC	65506	66078	65282	64520	64206	63490	64021	63285	62529	62171
BIC	65551	66093	65335	64610	64304	63641	64141	63443	62724	62375

Table 19: Outcome Regressions: Flexible Specification

	Subjective Health (OLS)					Subjective Health (o. probit)				
	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC
adj. R^2/pseudo R^2	.0632	.0388	.0714	.1054	.1165	.0251	.0146	.0282	.0435	.0483
F-Test/LR-Test	48.99	288.17	41.48	22.75	21.83	952.98	555.19	1068.56	1651.38	1834.03
AIC	37740	38088	37623	37142	36977	37051	37413	36949	36467	36310
BIC	37899	38110	37834	37732	37665	37232	37458	37184	37079	37021
	Life Satisfaction (OLS)					Life Satisfaction (o. probit)				
	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC
adj. R^2/pseudo R^2	.0948	.0783	.0948	.1397	.1659	.0278	.0219	.0273	.0422	.0505
F-Test/LR-Test	75.47	605.45	56.12	30.967	32.41	1493.78	1178.45	1470.26	2273.51	2715.76
AIC	54976	55214	54984	54311	53884	52391	52670	52428	51725	51309
BIC	55135	55237	55196	54901	54572	52617	52761	52708	52383	52065
	Gross Wage(OLS)									
	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC	-	-	-	-	-
adj. R^2/pseudo R^2	.0382	.0387	.0527	.0797	.1039	-	-	-	-	-
F-Test/LR-Test	15.30	145.74	15.84	9.092	10.27	-	-	-	-	-
AIC	55111	55090	55009	54851	54672	-	-	-	-	-
BIC	55256	55111	55202	55388	55298	-	-	-	-	-

Table 19: Outcome Regressions: Flexible Specification Cont'd

	Unemployed (OLS)					Unemployed (probit)				
	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC
adj. R^2/pseudo R^2	.0212	.0385	.0291	.0463	.0705	.0357	.0539	.0498	.0852	.1166
F-Test/LR-Test	10.87	183.13	11.11	6.73	8.66	199.54	301.02	278.38	475.96	651.83
AIC	3062	2882	2995	2882	2662	5431	5294	5366	5268	5118
BIC	3211	2903	3194	3437	3309	5580	5314	5565	5823	5766
	Years of Education (OLS)					Years of Education (o. probit)				
	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC	Big5	LoC	Pref	Big5-Pref	Big5-Pref-LoC
adj. R^2/pseudo R^2	.1043	.0525	.1200	.1771	.1982	.0243	.0126	.0281	.0433	.0497
F-Test/LR-Test	81.13	382.50	70.55	39.48	38.81	1575.60	817.25	1819.82	2808.59	3223.85
AIC	65324	66079	65087	64213	63869	63300	64023	63070	62181	61792
BIC	65482	66102	65297	64800	64554	63564	64151	63386	62874	62583

Return to main text

Appendix for Digression on Becker's Household Production

- We now formally introduce a revised theory of choice in which purchased goods are one of the inputs into the production of "commodities" that directly enter preferences.
- This approach reduces the need to rely on differences in tastes and increases the importance of differences in prices and incomes, the two parameters that can be treated by our framework.
- In addition, it incorporates the value of time systematically into the price structure and "full" income into the budget constraint.
- Preferences are assumed to be an ordered function of a set of commodities $Z_1, \ldots, Z_m$, and for the reasons discussed earlier, the indifference curves between different Z_i can be considered strictly convex.

Households themselves "produce" these commodities by combining different market goods, own time, and other inputs in the production functions:

$$Z_i = f_i(X_1, X_2, \cdots, X_i, t_1, t_2, \cdots, t_p; R) \tag{2}$$

- f_i = production function for Z_i
- $X_1, \cdots, X_i$ = inputs of different goods purchased into Z_i
- $t_1, \cdots, t_p$ = inputs of different kinds of time
- R = other variables

The production of a meal, for example, may require the input of bread, wine, steak, shopping time, preparation time, chairs, cookbooks, and so forth. This approach abandons the traditional separation between production and consumption and makes households producers as well as consumers.

Choices are restricted to the opportunity space determined by various constraints, one being the set of production functions. The total expenditure on market goods is limited by the money income available, as in

$$\sum_{i=1}^{m} p_i X_i = I \tag{3}$$

- X_i represents all the goods used to produce Z_i

During any period, the sum of the time used to produce different commodities plus the time spent at work must equal the total time available:

$$\sum_{i=1}^{m} t_i + t_w = t \tag{4}$$

- t is 168 hours per week, 720 hours per month, and so forth.
- An implication is that any time not spent at work, including time spent sleeping, would be an input into the production of some commodity.
- In rich countries especially, the time "budget" constraint is important as time is probably the major limitational factor.

Income not only equals the total expenditure on goods but also the sum of all factor payments, and can be written as:

$$wt_w + V = I = \sum p_i X_i \tag{5}$$

- $w =$ average wage rate
- $V =$ other income
- Hence, the separate goods and time constraints can be converted into a single total resource constraint by substituting for t_w from Equation 3:

$$\sum_{i=1}^{m} p_i X_i + \sum_{i=1}^{m} wt_i = wt + V = S \tag{6}$$

- If w were constant, the term S on the right would be a measure of income, not the actual income I, but the "full" income that would be realized if all time were devoted to market work.
- Unlike I, S is not affected by variations in time worked caused by unemployment, overtime, illness, or retirement.
- Thus, by using S to measure the constraint on resources, the major causes of the difference between actual and "permanent" earnings are automatically eliminated.
- The terms on the left show that full income is "spent" partly on goods and partly by foregoing earnings to use time in household production.
- The first term gives the goods component of the price of commodities and the second the time component.

- This interpretation becomes more transparent if a fixed amount of X_i and a fixed amount of t_i are always required to produce a unit of Z_i.
- Then the general production functions f_i could be written in the simple form

$$X_i = a_i Z_i ; t_i = b_i Z_i \tag{7}$$

- a_i and b_i are fixed input-output coefficients

$$\sum_{i=1}^{m} a_i p_i Z_i + \sum_{i=1}^{m} b_i w Z_i = \sum_{i=1}^{m} \pi_i Z_i = S \tag{8}$$

The term

$$\pi_i = a_i p_i + b_i w \tag{9}$$

is the sum of the cost of goods per unit of Z_i, given by $a_i p_i$, and the "shadow" or opportunity cost of time, given by $b_i w$, and is, therefore, the "shadow" price of a unit of Z_i.

- The cost of time is full integrated into the analysis and treated symmetrically to the cost of goods; indeed, in the United States, the opportunity cost of time may be more important than the direct costs of goods.
- Each household can be said to choose the Z_i subject to the single resource constraint.
- Put in this form, the analysis is formally the same as in the conventional approach, and the theorems derived earlier still hold.

- A weighted average of the full-income elasticities of the Z_i would add up to unity, and a "pure" decline in the relative price of Z_i would increase its quantity consumed.
- A major novelty of the new approach is in the effect of wage rates on consumption.
- An increase in the wage rate would increase the cost of all the Z_i, but especially of those Z_i with a relatively important time component. (Why?)
- The *relative* prices of these commodities would increase, and their consumption would be discouraged.

Environmental Variables

- In the new approach, the effects of age, education, climate, ability, and other "environmental" variables on behavior can be introduced through the household production functions instead of through tastes.
- These variables would be represented by R.
- For example, households in warm climates could produce a "comfortable indoor temperature" with smaller inputs of heating fuel, insulation, and clothing than could those in cold climates.
- Similarly, educated persons may be able to produce a given level of "health" with relatively small inputs of food and medical care because of greater awareness of the vitamin content off different foods, the deleterious effects of cigarette smoking, or the benefits of exercise.

- Again, “abler” housewives could produce better “meals” from a given expenditure on food and time.
- If an increase in one environmental variable, say, education, improved efficiency by reducing the a_i and b_i input coefficients, it would reduce the cost of producing commodities, and thus would expand opportunities, *even if full income were not affected*.
- If all input coefficients fell by the same percentage, all commodity prices would also fall by the same percentage (Why?), and no substitution effects would result.
- An income effect would result from the expansion in opportunities, and the Z_i would be increased in proportion to their income elasticities.

- What would be the effect on demand for different goods and time, which are more directly observable than the Z_i?
- If an increase in education reduced all input coefficients by the same percentage, the percentage increase in output from given inputs would be the same for all commodities.
- This would, however, be too small an increase for commodities with income elasticities greater than unity, too large for those with elasticities less than unity, and just right for those with elasticities equal to unity.
- Consequently, more of the goods and time entering the first set of commodities (the "luxuries") would be used, less of those entering the second set (the "necessities"), and the same amount of those entering the third.

- In this model, education and other environmental variables enter the demand functions for goods not because they change tastes, as in the traditional approach, but because they change the efficiency of household production.
- Moreover, their effects on demand can not only be *described* statistically, but can also be *predicted*.
- For example, even if (full) money income were held constant, an increase in education would tend to increase the demand for goods (and time) with high income elasticities and reduce the demand for those with low elasticities.
- By reducing the reliance on ad hoc shifts in tastes, this method of handling environmental variables is a powerful tool for greatly expanding the predictive content of economic theory.

Appendix of Chapter

1. Since the price of Z_i is $\pi_i = a_i p_i + b_i w$, the effect on π_i of a change in, say, education that did not change wage rates or market prices would be

$$\frac{d\pi_i}{dE} = p_i \frac{da_t}{dE} + w \frac{db_i}{dE} \tag{10}$$

or

$$\tilde{\pi}_i \equiv \frac{d\pi_i}{dE} \frac{1}{\pi_i} = s_i \tilde{a}_i + (1 - s_i) \tilde{b}_i \tag{11}$$

where

$$s_i = \frac{a_i p_i}{\pi_i}, \qquad \tilde{a}_i = \frac{da_i}{dE} \frac{1}{a_i}, \quad \text{etc.} \tag{12}$$

If $\tilde{a}_i = \tilde{b}_i$, clearly

$$\tilde{\pi}_i = \tilde{a}_i = \tilde{b}_i \tag{13}$$

and if $\tilde{a}_i = \tilde{b}_i = \tilde{a}_j$, all i and j, then

$$\tilde{\pi}_i = \tilde{\pi}_j \tag{14}$$

If real full income is defined as

$$S^* = \frac{S}{\pi} = \frac{S}{\sum \nu_i \pi_i} \tag{15}$$

where the ν_i are fixed weights, then abstracting from the effect of E on S,

$$\tilde{S}^* = -\pi = -\sum \left(\frac{\nu_i \pi_i}{\pi} \right) \tilde{\pi}_i \tag{16}$$

The above equation reduces to

$$\tilde{S}^* = -\tilde{\pi}_i \tag{17}$$

2. If the income elasticity of demand for Z_i were η_i, the increased demand for Z_i would be

$$\tilde{Z}_i^D = \tilde{S}^* \eta_i = -\tilde{\pi} \eta_i = -\tilde{\pi}_i \eta_i \tag{18}$$

The increased supply of Z_i from given inputs of X_i and t_i would be

$$\tilde{Z}_i^S = -\tilde{\pi}_i \tag{19}$$

and, therefore, the induced change in demand for X_i (or t_i) would be

$$\begin{aligned} \tilde{X}_i^D &= \tilde{Z}_i^D - \tilde{Z}_i^S \qquad (20) \\ &= -\tilde{\pi}_i(\eta_i - 1) \qquad (21) \\ &= -\tilde{\pi}(\eta_i - 1) \end{aligned}$$

3. The demand for Z_i would also be affected by a substitution effect; the total change would be

$$\tilde{Z}_i^D = -\tilde{\pi}\eta_i - \epsilon_i(\tilde{\pi}_i - \tilde{\pi}) \tag{22}$$

where

$$\epsilon_i = -\frac{\partial Z_i}{\partial(\pi_i/\pi)} \cdot \frac{\pi_i/\pi}{Z_i} \tag{23}$$

is the "pure" elasticity of demand.

Since $\tilde{Z}_i^S$ is still given above,

$$\tilde{X}_i^D = -\tilde{\pi}\eta_i - \epsilon_i(\tilde{\pi}_i - \tilde{\pi}) + \tilde{\pi}_i \tag{24}$$

or, by adding and subtracting $\tilde{\pi}$,

$$\tilde{X}_i^D = -\tilde{\pi}(\eta_i - 1) - (\tilde{\pi}_i - \tilde{\pi})(\epsilon_i - 1) \tag{25}$$

The derived demand for X_i and t_i would move in the same direction as the relative price of Z_i if the price and income elasticities of demand for Z_i both exceeded unity, and in the opposite direction if they both were less than unity.

Problems

1. When income, age, and a few other variables are held constant, more educated persons are healthier than less educated ones; yet probably the former spend less on medical care than do the latter. Can you explain this?
2. When permanent income is held constant, an increase in education appears to reduce the number of children and television sets a family has, and the pounds of food it consumes, at the same time that the amount spent per child, per television set, and per pound of food increases. Can you explain these effects by using the model of household production of commodities?

Return to main text

Appendix for Models of Personality As A Strategy

- Array the effort across tasks in vector $e = (e_1, \ldots, e_J)$.
- Direct value might be attached to the productivity in tasks arrayed in vector $P = (P_1, \ldots, P_J)$ with reward R_j.
- Output produces income:

$$\sum_{j=1}^{J} R_j P_j$$

which can be spent on goods X with associated prices W.

- A utility function over X, P, and e with preference parameter vector $\psi \in \Psi$.
- Preferences capture the psychologists' "goals."
- Utility need not be associated with "happiness."
- ψ associated with choices and choice behavior, not mental states.

- Preferences:

$$U\left(X, P, e \mid \psi\right), \tag{26}$$

- Agent maximizes (26) with respect

$$Y + R'P = W'X, \tag{27}$$

- Y is a flow of unearned income available

$$\sum_{j=1}^{J} e_j = \bar{e}. \tag{28}$$

- Preference specification (26) captures the notions that
  - a) agents have preferences over goods,
  - b) agents may value the output of tasks in their own right, and
  - c) agents may value the effort devoted to tasks.

Adding Uncertainty

- $\mathcal{I}$ is information possessed by the agent.
- "E" denotes the expectation operator.
- The agent can be interpreted as making decisions based on

$$E\left[U\left(X, P, e \mid \psi\right) \mid \mathcal{I}\right]. \tag{29}$$

- In a general specification, agents can be uncertain about their preferences (ψ), their traits (θ), the prices they face (W), the rewards to productivity (R), the outcomes of purchase decisions (X), and their endowments of effort ($\bar{e}$).
- Freudian version: Agents may not act on what they know but rather on what subconscious motives drive them.

An Economic Definition of Personality

- **Personality traits** are components of e, θ and ψ that affect behavior.
- We observe **measured personality—behaviors** generated by incentives, goals, and traits.

- One might define measured personality as the performance (the P_j) and effort (the e_j) that arise from solutions to the optimization problems previously stated.
- This approach does not capture the full range of behaviors considered by personality psychologists that constitute aspects of personality.
- The actions considered by psychologists include a variety of activities that economists normally do not study, e.g., cajoling, beguiling, bewitching, charming, etc.
- To capture these more general notions, we introduce a set of "actions" broader than what is captured by e.

Actions

- Actions are styles of behavior that affect how tasks are accomplished.
- They include aspects of behavior that go beyond effort as we have defined it.
- Tasks can be accomplished by taking actions.
- The i^{th} possible action to perform task j: $a_{i,j}$, $i \in \{1, \ldots, K_j\}$.
- Array actions in a vector $a_j = \left(a_{1,j}, \ldots, a_{K_j,j}\right) \in \mathcal{A}$.
- The actions may be the same or different across the tasks.
- The actions are strategies agents take in response to situations.

- The productivity of the agent in task j depends on the actions taken in that task:

$$P_j = \tau_j \left(a_{1,j}, a_{2,j}, \ldots, a_{K_j,j} \right). \tag{30}$$

- The actions themselves depend on traits θ and "effort" $e_{i,j}$:

$$a_{i,j} = \nu_{i,j} \left(\theta, e_{i,j} \right) \tag{31}$$

where

$$\sum_{i=1}^{K_j} e_{i,j} = e_j \text{ and } \sum_{j=1}^{J} e_j = \bar{e}.$$

- Actions generalize the notion of effort to a broader class of behavior.

- Agents may have utility over actions beyond the utility they get from consuming the outputs of tasks.
- Define utility over actions.
- Let a denote the choice of actions applied to all tasks: $(a = (a_1, \ldots, a_J))$.
- $\mathcal{M}$: the set of actions, including actions that do not directly contribute to productivity.

$$a_{i,m} = \nu_{i,m}\left(\theta, e_{i,m}\right), \; m \in \mathcal{M}$$
$$\mathcal{A} \subseteq \mathcal{M}.$$

- The agent solves

$$\max E\left[U\left(a, X, P, e \mid \psi\right) \mid \mathcal{I}\right]$$

with respect to X and e given the stated constraints.

Introducing Situations

- Situations indexed by $h \in \mathcal{H}$.
- For a person with traits θ and effort vector e_j with action $a_{i,j}$, using the specification (31), the action function can be expanded to be dependent on situation h:

$$a_{i,j,h} = \nu_{i,j}(\theta, e_{i,j,h}, h), \tag{32}$$

productivity on a task

$$P_{j,h} = \tau_j(a_{1,j,h}, ..., a_{K_j,j,h}) \tag{33}$$

or more generally

$$P_{j,h} = \tau_j(\theta, a_{1,j,h}, ..., a_{K_j,j,h}, h). \tag{34}$$

- Equations (32)–(34) resolve the person-situation debate.
- Failure to control for situation h, just like failure to control for effort, contaminates identification of traits using measures of actions or productivities.
- Let $T \in \mathcal{T}$ be the vector of traits $(\theta, \psi, \bar{e})$.
- The solution to the general constrained maximization problem is to pick goods X, situation h, actions $a_{i,j}$, and effort e_j, $j \in \{1, \ldots, J\}$ subject to the constraints.
- h is fixed if the situation is forced on the agent.
- For simplicity, we analyze this case.
- More generally, situations chosen.
- The situations are (strategic) interactions among agents.

- People may have different personalities depending on their trait endowments, constraints, and situations.
- The actions – not the traits – constitute the data used to identify the traits.
- Personality psychologists use actions (e.g., “dispositions”) to infer traits.
- The same identification issues previously discussed apply to a broader set of measurements of behaviors.

- Many personality psychologists define personality as

  "***enduring patterns of thoughts, feelings and behaviors***"

  that reflect tendencies of persons to respond in certain ways under certain circumstances.

- What are enduring patterns of actions?
- "**Enduring actions**"—average of the a functions for a person with a given trait vector $T = t$ over situations and efforts.

- For task j and trait vector t, the average action for information set $\mathcal{I}$ can be defined as

$$\bar{a}_{T,j,\mathcal{I}} = \int_{\mathcal{S}_{T,\mathcal{I}}(h,e_{i,j})} \nu_{i,j}\left(\theta, e_{i,j}, h\right) \, g\left(h, e_{i,j} \mid T = (\theta, \psi, \bar{e}), \mathcal{I}\right) \, dh \, de_{i,j}.$$

- $\mathcal{S}_{T,\mathcal{I}}(h, e_{i,j})$ is the support of $(h, e_{i,j})$ given T and $\mathcal{I}$.

- $g\left(h, e_{i,j} \mid T = (\theta, \psi, \bar{e}), \mathcal{I}\right)$ is the density of $(h, e_{i,j})$ given $T = (\theta, \psi, \bar{e})$ and information set $\mathcal{I}$.
- $\bar{a}_{T,j,\mathcal{I}}$ is the "enduring action" of agents across situations in task j with information $\mathcal{I}$, i.e., the average personality.
- If $\nu_{i,j}$ is separable in T, the marginal effect of personality trait vector θ is the same in all situations.

- One can define the "enduring traits" in a variety of ways, say by averaging over tasks, j, situations, h, or both.
- Only under separability in T will one obtain the same marginal effect of θ. (Same form of separability as in lab vs. field controversy; **?**.)
- **?** and a subsequent literature present evidence against nonseparability and in favor of an "enduring trait" that is common across situations.

Return to main text

Factor Analysis: A Key Tool in Defining and Measuring Personality

- $T_{n,l}$: trait l for person n.
- Use multiple measures on the same traits to control for measurement error.

Dedicated Factor Case

- $P^q_{n,l}$: qth measurement on trait l for person n.
- The qth measurement of factor l for person n is

$$P^q_{n,l} = \mu^q_l + \lambda^q_l T_{n,l} + \epsilon^q_{n,l}, \quad (35)$$
$$q = 1, \ldots, Q_l, n = 1, \ldots, N, l = 1, \ldots, L$$

- More general case:

$$P_{n,l}^{q} = \mu_{l}^{q} + (\boldsymbol{\lambda}^{q})' \boldsymbol{T}_{n} + \epsilon_{n,l}^{q}, \;\; q = 1, ..., Q_{l}. \tag{36}$$

- $\boldsymbol{\lambda}^{q}$ is a vector with possibly as many as L nonzero components.
- The $\epsilon_{n,l}^{q}$ are assumed to be independent of T_n and mutually independent within and across constructs (l and l' are two constructs).
- Cunha, Heckman and Schennach [2010] develop nonlinear factor models (nonlinear and nonparameteric).

- Conventional psychometric validity of a collection of items or test scores for different constructs has three aspects.

Discriminant Validity

a. Factor T_l for construct l is statistically independent of factor $T_{l'}$ for construct $l' \neq l$.

Convergent Validity

b. A factor T_l is assumed to account for the intercorrelations among the items or tests within a construct l.
c. Item-specific and random error variance are low (intercorrelations among items are high within a cluster).

Predictive Validity

- An alternative criterion for validating measurement systems is based on the predictive power of the tests for real world outcomes, that is, on behaviors measured outside of the exam room or observer system.

Problems with Predictive Validity

1. All measurements of factor $T_{n,l}$ can claim incremental predictive validity as long as each measurement is subject to error $\left(\epsilon^{q}_{n,l} \neq 0\right)$.
2. *Reverse causality*.
3. Especially problematic when interpreting contemporary correlations between personality measurements and outcomes.

- The problem of reverse causality is sometimes addressed by using early measures of traits determined well before the outcomes are measured to predict later outcomes.
- This approach is problematic if the traits the analyst seeks to identify evolve over time and the contemporary values of traits drive behavior.
- Trades a reverse causality problem with a version of an errors in variables problem.
- Early measures of the traits may be poor proxies for the traits that drive current measured behavior.

Factor Models: A Brief Digression

Suppose we have five measurements on R_i

- $i = 1, \ldots, 5$
- $\tilde{R}_i = \mu_i + R_i$
- $E(R_i) = 0$
- Then $E(\tilde{R}_i) = \mu_i$ and we identify means of measurements

Identifying Variances and Factor Loadings

$$R_1 = \alpha_1\theta + \varepsilon_1, \quad R_2 = \alpha_2\theta + \varepsilon_2, \quad R_3 = \alpha_3\theta + \varepsilon_3,$$
$$R_4 = \alpha_4\theta + \varepsilon_4, \quad R_5 = \alpha_5\theta + \varepsilon_5,$$
$$\varepsilon_i \perp\!\!\!\perp \varepsilon_j, \; i \neq j, \quad \theta \perp\!\!\!\perp \varepsilon_i, \; i = 1, \ldots, 5$$

$$E(\theta) = 0; \qquad E(\varepsilon_i) = 0; \; i = 1, \ldots, 5$$

$$Cov(R_1, R_2) = \alpha_1\alpha_2\sigma_\theta^2$$
$$Cov(R_1, R_3) = \alpha_1\alpha_3\sigma_\theta^2$$
$$Cov(R_2, R_3) = \alpha_2\alpha_3\sigma_\theta^2$$

- Normalize $\alpha_1 = 1$

$$\frac{Cov(R_2, R_3)}{Cov(R_1, R_2)} = \alpha_3$$

- $\therefore$ We know σ_θ^2 from $Cov(R_1, R_2)$.
- From $Cov(R_1, R_3)$ we know

$$\alpha_3, \alpha_4, \alpha_5.$$

- Can get the variances of the ε_i from variances of the R_i

$$Var(R_i) = \alpha_i^2 \sigma_\theta^2 + \sigma_{\varepsilon_i}^2.$$

- If $T = 2$, all we can identify is $\alpha_1 \alpha_2 \sigma_\theta^2$.
- If $\alpha_1 = 1$, and $\sigma_\theta^2 = 1$, we identify α_2.
- Otherwise model is fundamentally underidentified.
- One factor model requires three (or more) measurements, plus a normalization (to set scale)

2 Factors: (some examples)

$$\theta_1 \perp\!\!\!\perp \theta_2$$

(For example.) This is not required in general (but it is for this example).

$$\varepsilon_i \perp\!\!\!\perp \varepsilon_j \;\; \forall i \neq j$$

$$\begin{aligned}
R_1 &= \alpha_{11}\theta_1 + (0)\theta_2 + \varepsilon_1 \\
R_2 &= \alpha_{21}\theta_1 + (0)\theta_2 + \varepsilon_2 \\
R_3 &= \alpha_{31}\theta_1 + \alpha_{32}\theta_2 + \varepsilon_3 \\
R_4 &= \alpha_{41}\theta_1 + \alpha_{42}\theta_2 + \varepsilon_4 \\
R_5 &= \alpha_{51}\theta_1 + \alpha_{52}\theta_2 + \varepsilon_5
\end{aligned}$$

Let $\alpha_{11} = 1$, $\alpha_{32} = 1$. (Set scale)

$$Cov\left(R_1, R_2\right) = \alpha_{21}\sigma^2_{\theta_1}$$
$$Cov\left(R_1, R_3\right) = \alpha_{31}\sigma^2_{\theta_1}$$
$$Cov\left(R_2, R_3\right) = \alpha_{21}\alpha_{31}\sigma^2_{\theta_1}$$

- Form ratio of $\dfrac{Cov\left(R_2, R_3\right)}{Cov\left(R_1, R_2\right)} = \alpha_{31},$
- $\therefore$ we identify $\alpha_{31}, \alpha_{21}, \sigma^2_{\theta_1}$

$$Cov\left(R_1, R_4\right) = \alpha_{41}\sigma^2_{\theta_1}, \qquad \therefore \text{since we know } \sigma^2_{\theta_1} \therefore \text{we get } \alpha_{41}.$$
$$\vdots$$
$$Cov\left(R_1, R_k\right) = \alpha_{k1}\sigma^2_{\theta_1}$$

- $\therefore$ we identify α_{k1} for all k and identify $\sigma^2_{\theta_1}$.

Can Identify Other Parameters

$$\begin{aligned} Cov\left(R_3, R_4\right) - \alpha_{31}\alpha_{41}\sigma^2_{\theta_1} &= \alpha_{42}\sigma^2_{\theta_2} \\ Cov\left(R_3, R_5\right) - \alpha_{31}\alpha_{51}\sigma^2_{\theta_1} &= \alpha_{52}\sigma^2_{\theta_2} \\ Cov\left(R_4, R_5\right) - \alpha_{41}\alpha_{51}\sigma^2_{\theta_1} &= \alpha_{52}\alpha_{42}\sigma^2_{\theta_2}, \end{aligned}$$

- By similar logic,

$$\frac{Cov\left(R_4, R_5\right) - \alpha_{41}\alpha_{51}\sigma^2_{\theta_1}}{Cov\left(R_3, R_4\right) - \alpha_{31}\alpha_{41}\sigma^2_{\theta_1}} = \alpha_{52}$$

- $\therefore$ we also identify $\sigma^2_{\theta_2}$ for "2" loadings.

- If we have dedicated measurements on each factor do not need normalizations on the factors of R.
- Dedicated measurements set the scales and make factor models interpretable:

$$M_1 = \theta_1 + \varepsilon_{1M}$$
$$M_2 = \theta_2 + \varepsilon_{2M}$$

$$Cov\left(R_1, M\right) = \alpha_{11}\sigma^2_{\theta_1}$$
$$Cov\left(R_2, M\right) = \alpha_{21}\sigma^2_{\theta_1}$$
$$Cov\left(R_3, M\right) = \alpha_{31}\sigma^2_{\theta_1}$$

$$Cov\left(R_1, R_2\right) = \alpha_{11}\alpha_{21}\sigma^2_{\theta_1}$$
$$Cov\left(R_1, R_3\right) = \alpha_{11}\alpha_{31}\sigma^2_{\theta_1}$$

- Form the ratio

$$\frac{Cov(R_1, R_2)}{Cov(R_1, M)} = \alpha_{12} \qquad \therefore \text{ We identify } \sigma^2_{\theta_1}, \text{ etc.}$$

- $\therefore$ We can identify $\alpha_{12}, \sigma^2_{\theta_1}$ and the other factors.

General Case

$$\underset{T\times 1}{\boldsymbol{R}} = \underset{T\times 1}{\boldsymbol{\mu}} + \underset{T\times K}{\boldsymbol{\Lambda}}\underset{K\times 1}{\boldsymbol{\theta}} + \underset{T\times 1}{\boldsymbol{\varepsilon}}$$

- $\boldsymbol{\theta}$ are factors, $\boldsymbol{\varepsilon}$ uniquenesses

$$E(\varepsilon) = 0$$

$$Var(\boldsymbol{\varepsilon}\boldsymbol{\varepsilon}') = D = \begin{pmatrix} \sigma^2_{\varepsilon_1} & 0 & \cdots & 0 \\ 0 & \sigma^2_{\varepsilon_2} & 0 & \vdots \\ \vdots & 0 & \ddots & \vdots \\ 0 & \cdots & 0 & \sigma^2_{\varepsilon_T} \end{pmatrix}$$

$$E(\boldsymbol{\theta}) = 0$$

$$Var(\boldsymbol{R}) = \boldsymbol{\Lambda}\boldsymbol{\Sigma}_{\boldsymbol{\theta}}\boldsymbol{\Lambda}' + D \qquad \boldsymbol{\Sigma}_{\boldsymbol{\theta}} = E(\boldsymbol{\theta}\boldsymbol{\theta}')$$

- **The only source of information on Λ and Σ_θ is from the covariances.**
- Each variance is "contaminated" by a *uniqueness*.
- Associated with each variance of R_i is a $\sigma^2_{\varepsilon_i}$.
- Each uniqueness variance contributes one new parameter.
- How many unique covariance terms do we have?
- $\dfrac{T\,(T-1)}{2}$.

- We have T uniquenesses; TK elements of $\mathbf{\Lambda}$.
- $\dfrac{K(K-1)}{2}$ elements of $\mathbf{\Sigma}_{\boldsymbol{\theta}}$.
- $\dfrac{K(K-1)}{2} + TK$ parameters $(\mathbf{\Sigma}_{\boldsymbol{\theta}}, \mathbf{\Lambda})$.
- Need this many covariances to identify model *"Ledermann Bound"*:

$$\frac{T(T-1)}{2} \geq TK + \frac{K(K-1)}{2}$$

- (# of equations $\geq$ # of unknowns.)

Lack of Identification Up to Rotation

- Observe that if we multiply Λ by an orthogonal matrix $\boldsymbol{C}$, $(\boldsymbol{C}\boldsymbol{C}' = I)$, we obtain

$$Var\left(\boldsymbol{R}\right) = \Lambda\boldsymbol{C}\left[\boldsymbol{C}'\Sigma_{\boldsymbol{\theta}}\boldsymbol{C}\right]\boldsymbol{C}'\Lambda' + \boldsymbol{D}$$

- $\boldsymbol{C}$ is a "rotation."
- Cannot separate $\Lambda\boldsymbol{C}$ from Λ.
- Model not identified against orthogonal transformations in the general case.

THE UNIVERSITY OF CHICAGO

Some common assumptions:

(i) $\theta_i \perp\!\!\!\perp \theta_j, \forall\ i \neq j$

$$\Sigma_\theta = \begin{pmatrix} \sigma^2_{\theta_1} & 0 & \cdots & 0 \\ 0 & \sigma^2_{\theta_2} & 0 & \vdots \\ \vdots & 0 & \ddots & \vdots \\ 0 & \cdots & 0 & \sigma^2_{\theta_K} \end{pmatrix}$$

joined with

$$\Lambda = \begin{pmatrix} 1 & 0 & 0 & 0 & \cdots & 0 \\ \alpha_{21} & 0 & 0 & 0 & \cdots & 0 \\ \alpha_{31} & 1 & 0 & 0 & \cdots & 0 \\ \alpha_{41} & \alpha_{42} & 0 & 0 & \cdots & 0 \\ \alpha_{51} & \alpha_{52} & 1 & 0 & \cdots & 0 \\ \alpha_{61} & \alpha_{62} & \alpha_{63} & 0 & \cdots & 0 \\ \vdots & \vdots & \vdots & 1 & & \vdots \end{pmatrix}$$

Other Possible Assumptions

Example.

$$R_1 = \alpha_{11}\theta_1 + (0)\theta_2 + \varepsilon_1 \quad \text{(only one dedicated measurement on } \theta_1\text{)}$$
$$R_2 = \alpha_{21}\theta_1 + \alpha_{22}\theta_2 + \varepsilon_2$$
$$\vdots$$
$$R_T = \alpha_{T1}\theta_1 + \alpha_{T2}\theta_2 + \varepsilon_T$$

- The θ are freely correlated

Theorem 1

(Williams, 2011)

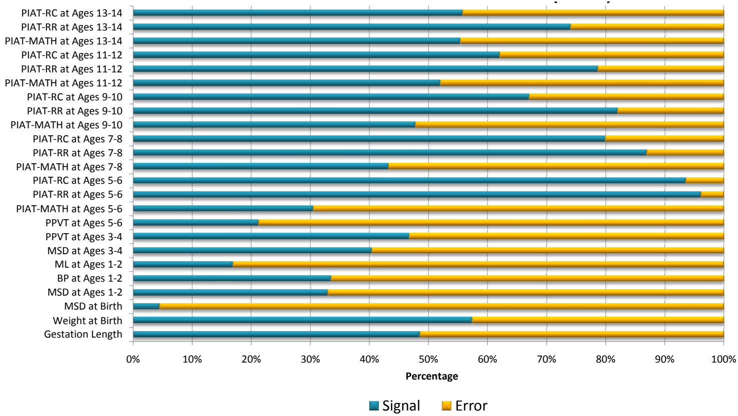
$$\text{If} \quad (\theta_1, \theta_2) \perp\!\!\!\perp (\varepsilon_1, \ldots, \varepsilon_T)$$
$$\varepsilon_i \perp\!\!\!\perp \varepsilon_j, \; \forall \; i \neq j$$
$$\theta_1 \not\!\perp\!\!\!\perp \theta_2$$

Model identified if we normalize (e.g.) $\alpha_{11} = 1$; $\alpha_{22} = 1$ *and set* $\alpha_{12} = 0$.

The Quantitative Importance of Measurement Error

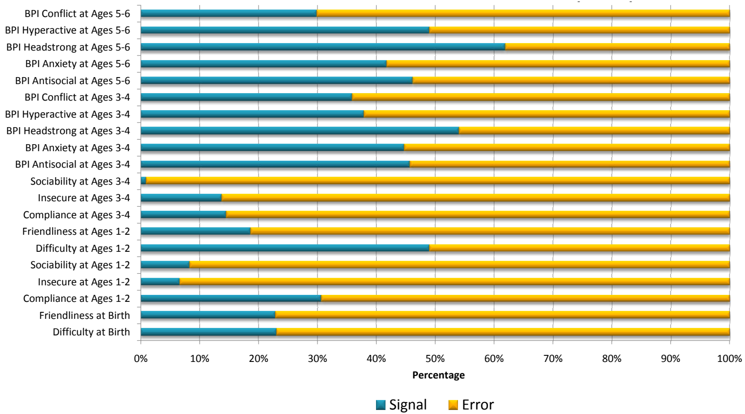
- The share of error variance for proxies of cognition, personality and investment ranges from 1%–90%.
- Not accounting for measurement error produces downward-biased estimates of self-productivity effects and perverse estimates of investment effects.

Table 20: Share of Residual Variance in Measurements of Cognitive Skills Due to the Variance of Cognitive Factor (Signal) and Due to the Variance of Measurement Error (Noise)



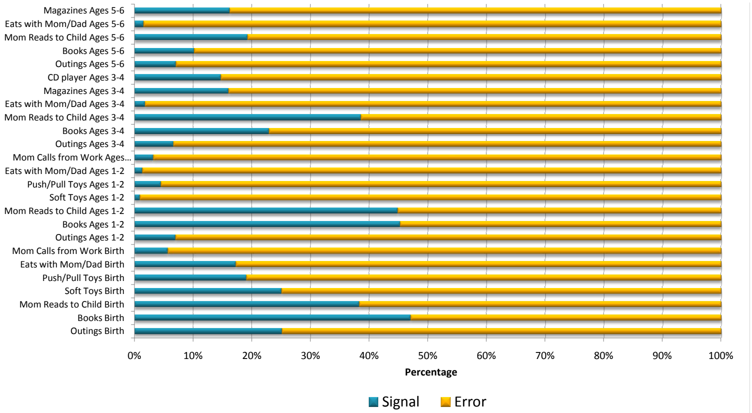
Source: Cunha, Heckman and Schennach [2010].

Table 21: Share of Residual Variance in Measurements of Socioemotional Skills Due to the Variance of Socioemotional Factor (Signal) and Due to the Variance of Measurement Error (Noise)



Source: Cunha, Heckman and Schennach [2010].

Table 22: Share of Residual Variance in Measurements of Investments Due to the Variance of Investment Factor (Signal) and Due to the Variance of Measurement Error (Noise)



Source: Cunha, Heckman and Schennach [2010].

THE UNIVERSITY OF CHICAGO

Faking

- "Faking" may corrupt measurements designed to proxy latent factors.
- There are at least two types of false responses:
  - a. those arising from impression management and
  - b. those arising from self-deception (Paulhus [1984]).

- Reference bias

Return to main text

Household Production

- Augment the task functions defined by Equation (1) to include levels of energy, and time, in vector e^j

$$T_j = h_j\left(\theta^j, e^j\right) \text{ for } j = 1, \ldots, J+1 \qquad (37)$$

θ^j is to be distinguished from θ_j, the j^{th} component of vector θ.

- Parallel notation for e^j.
- For a fixed input of psychological traits, higher levels of e^j may raise the output of the task.
- Thus if $e^j = 0$, the trait θ^j may be switched off. However, if some traits have negative productivity in some tasks more energy may be allocated to those tasks to offset the negative trait.

- Output in activity Z_j is

$$Z_j = \varphi_j\left(T_j, X_j\right) \text{ for } j = 1, \ldots, J+1 \tag{38}$$

- The outputs in activity j depend on the task output T_j and the goods input X_j.
- Agents have preferences over Z_j and e_j.
- The effort expended in an activity may have psychic costs or benefits.
- There may be psychic costs in using e_j to suppress the expression of a trait.

- Preferences may also depend on θ as well as other variables which we keep implicit.
- The utility function is

$$U = U\left(Z_1, \ldots, Z_j, e^1, \ldots, e^{J+1}, \theta\right) \tag{39}$$

- Income is return on asset flow Y plus labor earnings which we denote $Z_{J+1} = \varphi_{J+1}\left(T_{J+1}, X_{J+1}\right)$.

$$\sum_{j=1}^{J+1} P_j X_j = Y + Z_{J+1} \tag{40}$$

- Z_{J+1} is a hedonic earnings function which prices out traits and energy in the market.

Two Ways to Introduce θ

- It is possible to distinguish two different cases for θ.
- For psychological traits, we can distinguish the case where θ is a public good, $\theta^j = \bar{\theta}$ for all $j = 1, \ldots, J+1$.
- When it is a private good, $\sum_{j=1}^{J+1} \theta^j = \bar{\theta}$
- People are not stuck with their personality in all activities.

- For simplicity, we consider the pure private goods case and the pure public goods case. Assume that e is private.

		θ	
		Public	Private
e	Private	case I	case II

- In case I, the additional constraint operating on the consumer beyond the budget constraint (40) is

$$\theta^j = \bar{\theta}, \ \sum_{j=1}^{J+1} e^j = \bar{e}, \text{ for all } j = 1, \ldots, J+1. \tag{41}$$

- In case II, the operative constraints are

$$\sum_{j=1}^{J+1} \theta^j = \bar{\theta}, \sum_{j=1}^{J+1} e^j = \bar{e} \tag{42}$$

Case I: **Traits as Public Goods**

- In case I, different bundles of $\bar{\theta}$ across persons create comparative advantages for agents in different tasks and thus produce comparative advantages in different activities.
- Case I is a version of Michael's (1973) model of environmental variables in a household production framework.

- For analytical simplicity, suppose that Z_j and T_j, $j = 1, \ldots, J+1$, display constant returns to scale in non-public inputs.

- In terms of the technologies (1), when θ is a public good, we assume constant returns to scale in e^j but that $\theta^j = \bar{\theta}$ is a fixed, environmental variable.
- Different levels of $\bar{\theta}$ produce different productivities in different tasks.
- Feeding $\bar{\theta}$ into the activity functions (38), which are also assumed to be constant returns to scale, we can analyze the agent's problem of allocating effort among tasks and goods among activities using the analysis of Michael (1973).
- Financial and energy resources are not changed by $\bar{\theta}$ except for its effect on Z_{J+1}.
- Holding energy and money resources fixed, changes in $\bar{\theta}$ produce reallocations across budget categories.

Several Cases

- Consider an increase in conscientiousness.
- This will likely increase earnings (via Z_{J+1}), and will enhance productivity in some tasks intensive in conscientiousness and activities based on those tasks more than other tasks and activities.
- The increased income will support more of all activities.
- The differential shift in productivity across tasks and activities will reduce the prices of activities that are more intensive in the use of conscientiousness.
- If the demands for those activities are price elastic compared to the demands for the less conscientiousness-intensive activities, the demand for the inputs used in those activities will increase.
- If the demands are relatively inelastic, the demands will decrease because of the greater productivity for the inputs.
- Standard Marshall's 4 rules analysis.

- If a trait reduces productivity, the chain of logic just presented runs in reverse.
- With increases in (for example) neuroticism, shadow prices of activities intensive in that trait will increase.
- Labor earnings will tend to decrease.
- In the price-elastic case, consumers will tend to substitute away from activities intensive in the trait and the demand for inputs will decrease.
- In the inelastic case, input demands will increase as agents substitute goods and energy inputs into the activities that are inelastically demanded.

- The same level of the traits is found in all activities, but in general, energy or time will be allocated differentially among activities.
- A person who allocates more energy or time to a task will manifest more of the trait.
- If inputs are complementary, at the same scale of output more of the task will be demanded.
- Unless one controls for these inputs, one may fail to capture the uniformity of traits across tasks and activities.
- In all of these cases, purchase patterns of market goods will provide information on endowments and allocation of energy and traits.

Case II: **Traits as Private Goods**

- The case when traits are private goods produces the possibility of different levels of traits being used in different tasks and activities.
- Responses of activity levels to changes in rewards across activities will be more price-elastic when traits can be allocated across activities than when traits are fixed.
- Equiproportionate expansions in $(\bar{\theta}, \bar{e})$ differentially expand the consumption possibility set for activities intensive in (θ, e) and reduce their shadow prices, producing substitution effects in task production and activity consumption that promote consumption in activities intensive in the traits.

- The public goods case imposes more constraints on the system than the private goods case.
- Compared to the case of public goods for traits, agents will reduce their allocation of the trait from activities where their productivity is negative and will spend less effort (e) in overriding the effects of negative traits in productivity.
- The trait will be shifted into less costly activities and less energy will be spent controlling it.

The Evidence

- The evidence would seem to favor case II, since different levels of traits are often found in different activities.
- However, since most of the estimates reviewed do not adjust for the inputs that affect the manifestation of the traits, one must be cautious in reaching this conclusion.
- Such adjustments are indicated by the theory but are not yet standard in economics or psychology.

- The roles of time and energy in amplifying or reducing the effects of the traits in activities needs to be systematically explored to make the theory empirically operational as are the effects of traits on the purchase of related goods (for example, shy people may seek to live in secluded areas, houses with high walls and seek jobs with little human contact).
- In the private goods specification of the model (case II), the motivation for the supply of traits to different activities depends on preferences (utility rewards U), on productivity in Z_j, and in productivity in the tasks T_j. In this framework, it is possible to formalize many of the currently disparate concepts of personality psychology.
- It would be very informative to estimate both versions of the model and to test between them.

Return to main text

"Are Economists' Preferences Psychologists' Personality Traits?" by Tomas Jagelka (2018)

Are Economists' Preferences Psychologists' Personality Traits?

by Tomas Jagelka
2018

James J. Heckman

THE UNIVERSITY OF CHICAGO

Econ 350, Winter 2019

Motivation

"Despite [an] intuitive mapping of preferences to traits, the empirical evidence supporting such mappings is weak. The few studies investigating empirical links typically report only simple regressions or correlations without discussing any underlying model."
(Almlund, Duckworth, Heckman, and Kautz, 2011. "Personality Psychology and Economics")

Relevance

- Large variation in wealth accumulation, human capital investment, consumption decisions ...
- Evidence that preferences, ability, and personality predict those outcomes (Heckman et al., 2006; Becker et al., 2012; Brown and Taylor, 2014; Beauchamp et al., 2017)
- Quality of decision-making may also be important and exacerbate the inequalities (Choi et al., 2014)

The Millenium Foundation Field Experiment on Education Financing

- 1,224 Canadian high school seniors
- 103 incentivized choice tasks
  - 55 risk aversion
  - 48 delay aversion
- Large amount of background information including psychometric measures of cognitive ability and non-cognitive personality traits
- Descriptive Statistics

General Approach

- Jointly estimate risk and time preferences and the random components of decision-making based on observed choices
- Estimate a factor model of personality traits and cognitive ability using multiple observed measures
- Relate the two in a structural framework where structural parameters are a function of observed characteristics, underlying factors, and pure unobserved heterogeneity

Contributions - Connect Preferences and Traits

- Expose the biological underpinnings of economic preferences
  - The Big Five personality traits have been shown to have a heritability of about 50% (Bouchard and Loehlin, 2001)
  - Cognitive ability has heritability of 60-80% (Bergen et al. 2007)
  - Preferences may be just as heritable (Beauchamp et al. 2017)

Contributions - Correct Existing Biases

1. Estimate distributions of preferences using the Random Preference Model (RPM)
    - Desirable properties over the Random Utility Model (RUM) overwhelmingly used in previous research
    - Apesteguia and Ballester (2018) show that the RUM does not satisfy basic theoretical conditions for estimating risk aversion
2. Explicitly model for in(stability) of people's preferences and their propensity to make mistakes
    - Andersson et al. (2016) show that failure to properly account for random errors in decisions may have biased estimates of preferences and of their link to explanatory variables

Random Utility vs. Random Preference

- Assume a CRRA utility function. Then the expected utility of individual i from a lottery offering \$$a_1$with probability p_{a_1} and \$$a_2$ with probability $1 - p_{a_1}$ is:

$$E(U_i) = p_{a_1} * \frac{a_1^{(1-\Theta_i)}}{1-\Theta_i} + (1 - p_{a_1}) * \frac{a_2^{(1-\Theta_i)}}{1-\Theta_i} \qquad (1)$$

- When choosing between two such lotteries, an individual will compare his expected utilities from each
- In the RUM model, the **error term is appended to the difference in expected utilities** of the two lotteries
- In the RPM model, the **error term is added on to the preference parameter itself** (here risk aversion Θ)

Random Preference Model

- Define a threshold level of risk aversion $\Theta_{12,l}$ at which an individual *i* is indifferent between the two options in lottery *l*
- He will prefer the riskier option if his instantaneous manifestation of risk aversion is inferior to the threshold level of indifference associated with a particular choice task

$$\Theta_i + \sigma_{\Theta,i} * \varepsilon_{i,l} < \Theta_{12,l} \tag{2}$$

- This yields a closed form expression for the probability that individual *i* ***prefers*** the riskier option in *lottery l*:

$$P(R\boldsymbol{P}_{i,l} = 1) = \Phi(\frac{\Theta_{12,l} - \Theta_i}{\sigma_{\Theta,i}}) \tag{3}$$

Random Preference Model

- Contrary to the RUM model, the RPM predicts that dominated choices will never be chosen
- This is not the case in reality
  - "trembling hand" parameter K_i
  - an individual will choose his ***less*** preferred option $K_i\%$ of the time
- The probability of ***choosing*** the riskier option becomes:

$$P(R\boldsymbol{C}_{i,l} = 1) = P(R\boldsymbol{P}_{i,l} = 1) * (1 - K_i) + [1 - P(R\boldsymbol{P}_{i,l} = 1)] * K_i \quad (4)$$

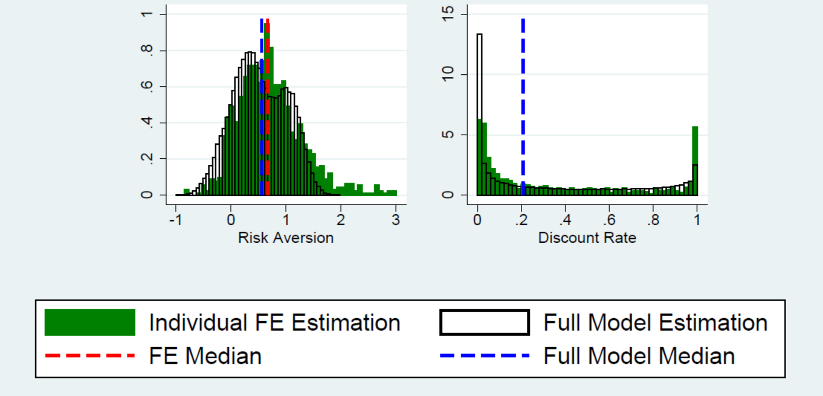
Definition - Economic Preferences

- Preference parameters
  - Coefficient of risk aversion
  - Discount rate
- Rationality parameters
  - The standard deviation of the coefficient of risk aversion
  - The standard deviation of the discount rate
  - The trembling hand parameter

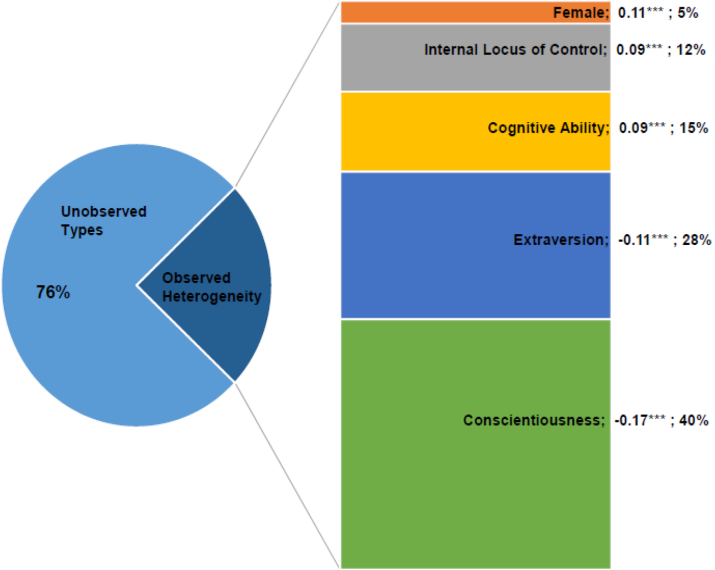
Definition - Personality Traits

- Competing measures, Big Five most prominent:
  - Neuroticism
    - external locus of control, low self-esteem, depression
  - Extraversion
    - excitement seeking, active, sociable, positive
  - Conscientiousness
    - self-discipline, order, ambition

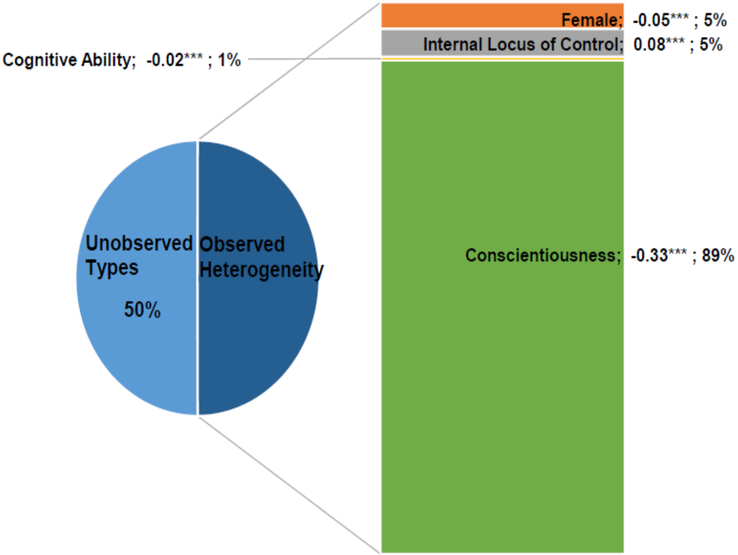
Distribution Comparisons



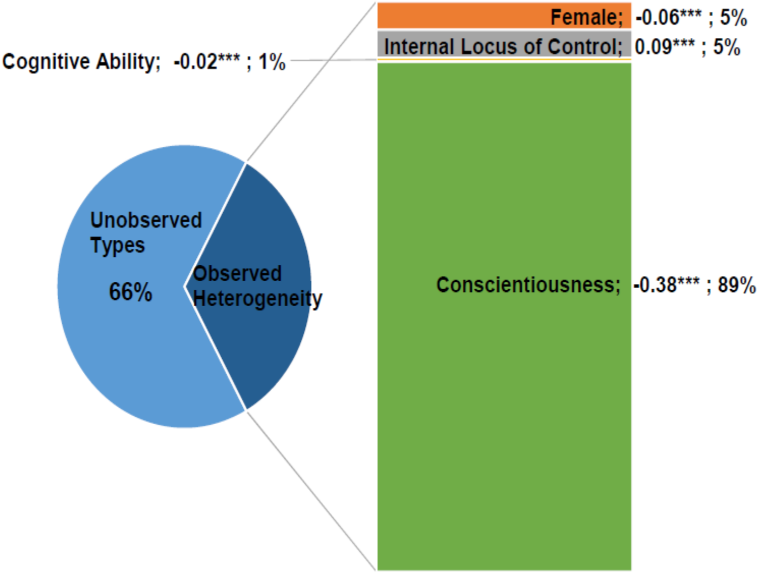
Heterogeneity Contributions - Risk Aversion



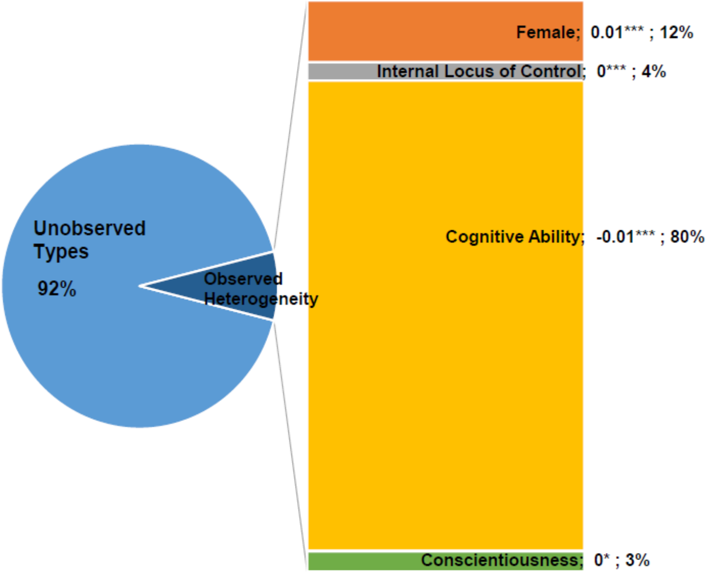
Heterogeneity Contributions - Discount Rate



Heterogeneity Contributions - Discount Rate SD



Heterogeneity Contributions - Trembling Hand



Preference vs. Rationality parameters

		# Safe Choices	# Immediate Payments	# Risk Reversals	# Time Reversals
All Parameters	R2	0,70	0,52	0,50	0,03
Preference Parameters	R2	0,68	0,47	0,01	0,00
		85,2%	97,6%	1,5%	8,7%
Rationality Parmeters	R2	0,12	0,01	0,49	0,03
		14,8%	2,4%	98,5%	91,3%
- Stability	R2	0,09	0,01	0,00	0,00
		90,0%	83,0%	0,1%	7,4%
- Kappa	R2	0,01	0,00	0,47	0,02
		10,0%	17,0%	99,9%	92,6%

Conclusion

- First paper to estimate distributions of economic preferences using the RPM with a factor structure
- Heterogeneity in personality and cognitive ability explains up to 50% of the cross-sectional variation in preferences
  - compared with around 5% using standard demographic and socioeconomic controls
- The inclusion of rationality parameters in the decision-making model lets us separate true preferences from random errors
  - preference stability explains the average number of risky/temporal choices and is related to conscientiousness
  - mistakes explain choice reversals and are related to cognitive ability
- All à priori expectations on the links between risk preferences and traits are verified
- The two concepts are related but distinct

Next Steps

- Traits
  - more traits
  - robustness regard to facets
  - more measures - estimate factors as FE
- Incorporate additional structural components into preference and rationality parameters
  - MPL vs. OLS type lottery
  - stakes
- Test model with either only MPL or OLS type questions
- Compare to RUM
- Test model with background consumption
- Time inconsistency

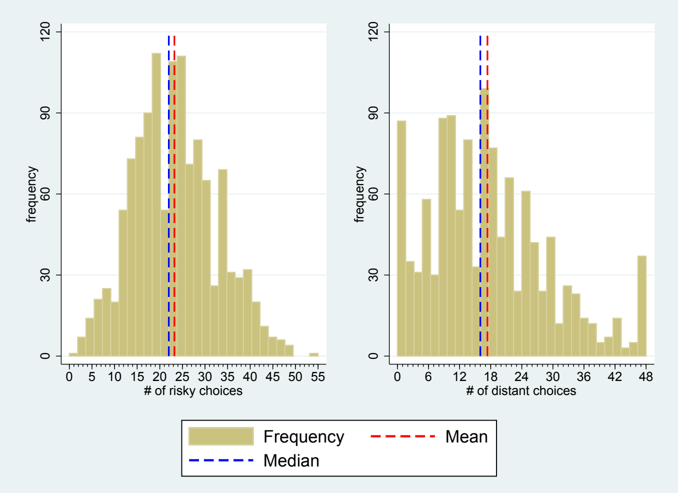
Implications

- Explaining inequality and the inter-generational transmission of socio-economic status
- Limits of revealed preference
- Preferences and traits impact outcomes (also) through one another
- Ability and personality can be a used as controls when preference estimates are unavailable
- Taking into account the full distribution of preferences is important for predicting behavioral responses to changes in economic variables and for calculating the welfare impacts of policy

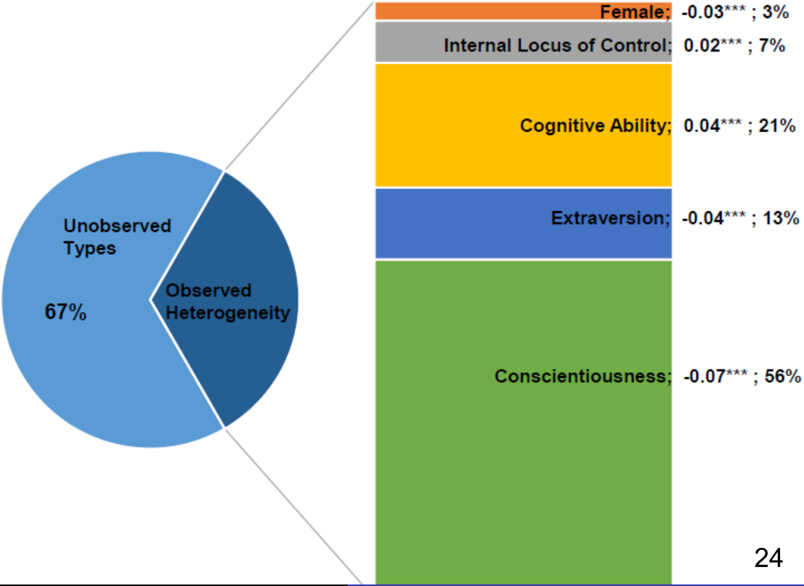
Research Questions

- Do psychometric measures of cognitive and non-cognitive traits explain individual choices through the intermediary of economic preference and rationality parameters?
- If they do, are personality traits more closely linked to the former or to the latter?
- After accounting for the individual factors, how much of the variation in individual preference and rationality parameters is explained by true heterogeneity (orthogonal to psychometric factors)?
- Overall, are individual choices better explained by preference or rationality parameters?

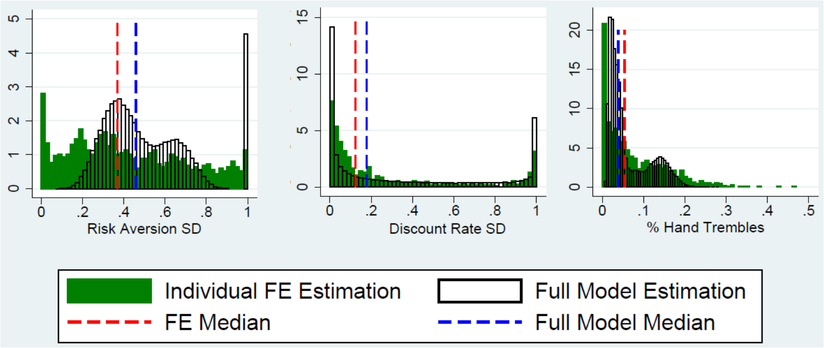
Choice Descriptive Stats



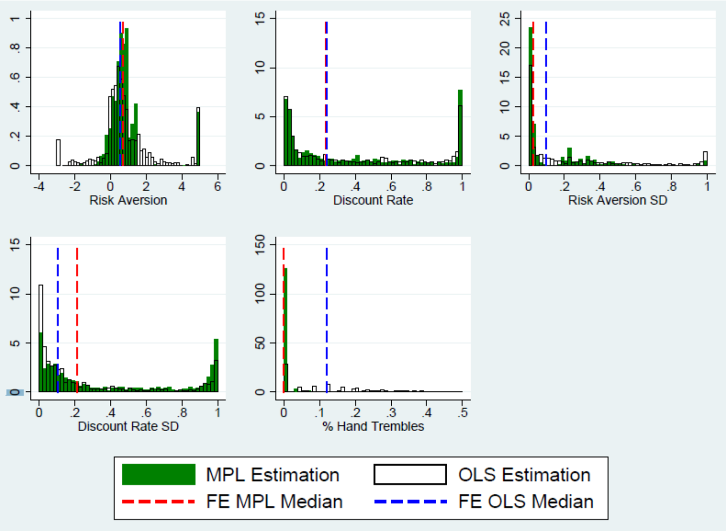
Heterogeneity Contributions - Risk Aversion SD



Distribution Comparisons



Distribution Comparisons - H&L v. OLS



Estimates Using H&L Lottery Choice Tasks

		# Safe Choices	# Safe Choices on H&L	# Safe Choices on OLS	# Immediate Payments	# Risk Reversals	# Risk Reversals on H&L	# Risk Reversals on OLS	# Time Reversals
All Parameters	R2	0,40	0,58	0,12	0,48	0,07	0,37	0,02	0,05
Preference Parameters	R2	0,39	0,56	0,12	0,42	0,01	0,01	0,01	0,00
		96,9%	98,6%	92,5%	96,7%	18,6%	1,5%	58,2%	3,5%
Rationality Parmeters	R2	0,01	0,01	0,01	0,01	0,05	0,35	0,01	0,03
		3,1%	1,4%	7,5%	3,3%	81,4%	98,5%	41,8%	96,5%
- Stability	R2	0,01	0,01	0,01	0,01	0,02	0,07	0,01	0,02
		79,4%	71,3%	84,5%	97,3%	39,8%	19,7%	87,2%	59,4%
- Kappa	R2	0,00	0,00	0,00	0,00	0,03	0,29	0,00	0,01
		20,6%	28,7%	15,5%	2,7%	60,2%	80,3%	12,8%	40,6%

Notes: Rows labeled "R2" list the R2 of the regression of the moment listed in each column title on the parameters identified in the row title.
Where applicable, the row below represents the relative explanatory power of the relevant subgroups of parameters, expressed as a percentage.

Preference vs. Rationality - OLS

Estimates Using OLS Lottery Choice Tasks

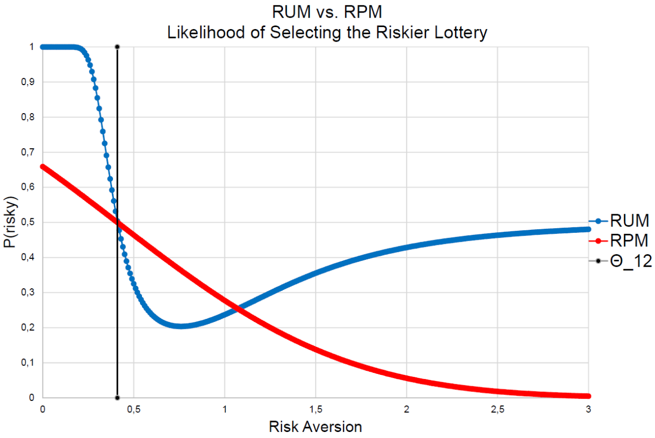
		# Safe Choices	# Safe Choices on H&L	# Safe Choices on OLS	# Immediate Payments	# Risk Reversals	# Risk Reversals on H&L	# Risk Reversals on OLS	# Time Reversals
All Parameters	R2	0,53	0,11	0,72	0,52	0,65	0,02	0,71	0,01
Preference Parameters	R2	0,51	0,11	0,68	0,45	0,00	0,00	0,00	0,00
		95,7%	95,0%	92,4%	97,9%	0,1%	3,5%	0,2%	19,9%
Rationality Parmeters	R2	0,02	0,01	0,06	0,01	0,65	0,01	0,71	0,01
		4,3%	5,0%	7,6%	2,1%	99,9%	96,5%	99,8%	80,1%
- Stability	R2	0,01	0,00	0,01	0,00	0,00	0,00	0,00	0,00
		54,1%	51,1%	22,7%	47,4%	0,1%	6,5%	0,0%	1,1%
- Kappa	R2	0,01	0,00	0,03	0,00	0,62	0,01	0,67	0,01
		45,9%	48,9%	77,3%	52,6%	99,9%	93,5%	100,0%	98,9%

Notes: Rows labeled "R2" list the R2 of the regression of the moment listed in each column title on the parameters identified in the row title.
Where applicable, the row below represents the relative explanatory power of the relevant subgroups of parameters, expressed as a percentage.

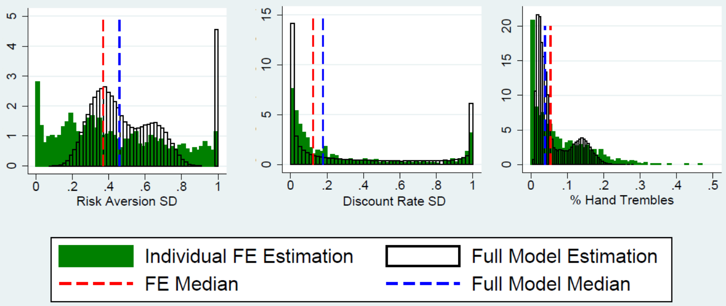
Estimating Risk and Time Preferences

- Joint estimation of risk and time preferences relatively scarce but seems important (Cohen et al., 2016)
- Assuming risk neutrality can bias discount rate estimation upward
  - Harrison et. all (2008) estimate r=28% assuming risk neutrality while Andersen et al. (2008) find r=10% on a similar population with joint estimation
- Recently Belzil and Sidibe (2016) estimated a distribution of the preference parameters as fixed effects
- θ estimated at <1 and r between 10% and 40%
-

Non-Monotonicity of RUM



Distribution Comparisons



Connecting the dots

- Dohmen et al. (2010) measure risk and time preferences using the switching point in lottery and temporal choice tasks. They report correlations between Big Five traits, cognitive ability, and the preferences.
- Bibby and Ferguson (2011) find a significant effect of extraversion on their measure of risk aversion while Borghans et al. (2009) find that neuroticism, agreeableness, and ambition lead to higher risk aversion but do not explain gender differences
- Daly (2009) found evidence of a link between discount rates and 4 biological and personality factors
- Anderson et al. (2011) find that facets of personality traits may be important

Holt & Laury's Multiple Price List (H&L) design

- Subjects are presented with an ordered array of binary lottery choices
- In each choice task they choose between lottery A (safer) and lottery B (riskier)
- In each row, the probability of the higher payoff in both lotteries increases in increments of 0.1
  - the expected value of both lotteries increases
  - the riskier option becomes relatively *more* attractive
  - first row: E(A)>E(B)
  - last row: E(B)>>E(A)
  - expected to switch from the safe to the risky option at some point
- Alternative OLS design

Binswanger's Ordered Lottery Selection (OLS) design

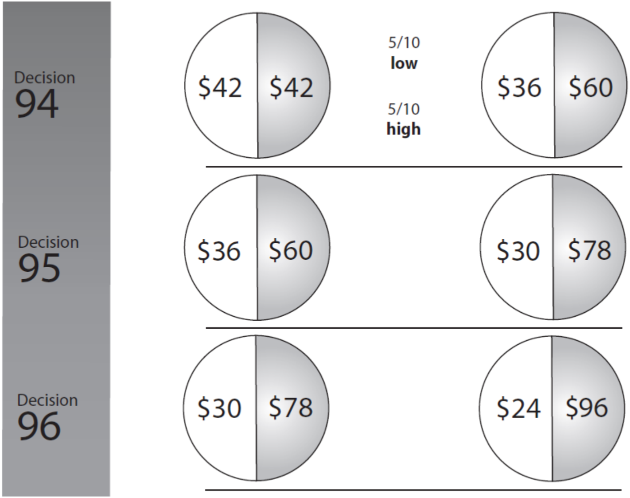
- Subjects are presented with an ordered array of binary lottery choices
- In each choice task they choose between lottery A (safer) and lottery B (riskier)
- In the first row, lottery A offers a certain amount
- All other alternatives increase in expected payoff but also its variance
  - the riskier option becomes relatively *less* attractive
  - expected to switch from the risky to the safe option at some point
  -

You must choose A or B:

	CHOICE A 	CHOICE B 
	$75 Tomorrow	$$ One month from tomorrow
Decision 1	❒ $75 Tomorrow	❒ $75.31 One month from tomorrow The additional **$0.31** represents the money you would have earned in a savings account for one month at **5%** annual interest.
Decision 2	❒ $75 Tomorrow	❒ $75.63 One month from tomorrow The additional **$0.63** represents the money you would have earned in a savings account for one month at **10%** annual interest.

Lottery Choice Task Example - MPL

Lottery Choice Task Example - OLS



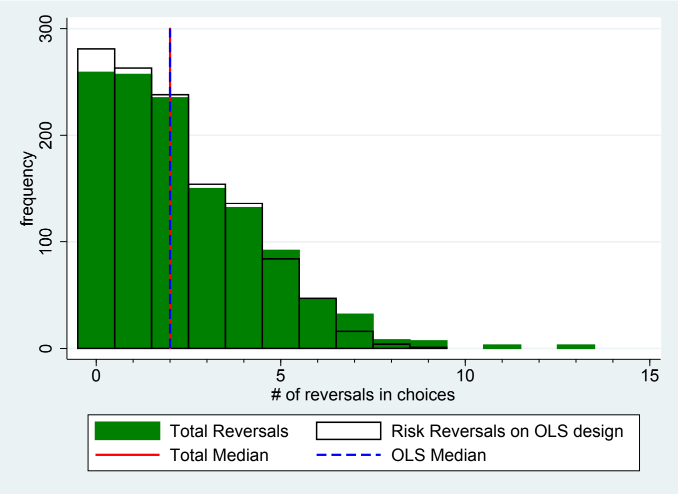
Measures of Cognitive Ability

1. In your last year of high school, what was your overall grade average, as a percentage?
2. How would you rate your ability to use a computer? For example, using software applications, programming, or using a computer to find or process information.
3. How would you rate your writing abilities? For example, writing to get across information or ideas to others, or editing writing to improve it.
4. How would you rate your reading abilities? For example, understanding what you read and identifying the most important issues, or using written material to find information.
5. How would you rate your oral communication abilities? For example, explaining ideas to others, speaking to an audience, or participating in discussions.
6. How would you rate your ability to solve new problems? For example, identifying problems and possible causes, planning strategies to solve problems, or thinking of new ways to solve problems.
7. How would you rate your mathematical abilities? For example, using formulas to solve problems, interpreting graphs or tables, or using math to figure out practical things in everyday life.

Conscientiousness Measures

1	I am not good about preparing in advance for things, even if they have direct bearing upon my future.	binary
2	I do things impulsively, making decisions on the spur of the moment.	binary
3	I select activities in terms of how beneficial they are to my future.	binary
4	I do not like to plan ahead.	binary
5	I would rather enjoy what I am doing now than be concerned about having fun tomorrow.	binary
6	I follow through with a course of action if it will get me where I want to be.	multi-valued
7	I am able to resist temptations when I know there is work to be done.	multi-valued
8	Generally, I am more focused on what is going on now than on what will happen in the future.	multi-valued
9	I often think about what I will be doing 10 years from now.	multi-valued
10	I try to live one day at a time.	multi-valued

Choice Descriptive Stats



Indifference Thresholds and Individual Choices

	Q1	Q2	Q3	Q4	Q5	Q6
R_{12} at Θ=-0.3	0,078	0,164	0,349	1,098	3,265	15,333
R_{12} at Θ=0	0,051	0,107	0,222	0,641	1,638	5,477
R_{12} at Θ=1	0,000	0,001	0,002	0,005	0,010	0,019
% choosing distant	9,6%	10,1%	16,3%	25,7%	45,9%	68,9%

Lottery Choice

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q51	Q52	Q53	Q54	Q55
Θ_{12}	-1,71	-0,95	-0,49	-0,14	0,15	0,41	0,68	0,97	1,37	Inf	1,54	0,51	0,30	0,20	0,00
% choosing risky	0,7%	0,9%	2,2%	8,5%	24,6%	38,2%	58,9%	79,2%	91,2%	99,8%	41,3%	54,7%	45,3%	30,7%	19,5%

Temporal Choice

	Q1	Q2	Q3	Q4	Q5	Q6
R_{12} at Θ=-0.3	0,078	0,164	0,349	1,098	3,265	15,333
R_{12} at Θ=0	0,051	0,107	0,222	0,641	1,638	5,477
R_{12} at Θ=1	0,000	0,001	0,002	0,005	0,010	0,019
% choosing distant	9,6%	10,1%	16,3%	25,7%	45,9%	68,9%

Empirical Approach

- Jointly estimate risk aversion, discount rates, and rationality parameters based on observed choices
- Estimate a factor model of personality traits and cognitive ability using multiple observed measures
- Relate the two in a structural framework where preference and rationality parameters are a function of observed characteristics, underlying factors, and pure unobserved heterogeneity

Random Preference Model

- Same idea for temporal choice tasks
- In this case, it is an individual's ***discount rate*** which is hit by a random shock in each time choice task
- Once again there exists a threshold level of the discount rate which makes him indifferent between the smaller earlier payment and the larger later one
- This threshold will depend ***both*** on the parameters of the specific time choice task ***and*** on the individual's risk aversion
  - joint estimation important
  - large differences in indifference thresholds depending on the level of risk aversion for the same choice task

Likelihood Contribution

- The likelihood contribution of individual i from his choices is the probability of jointly observing his 55 lottery choices and 48 temporal choices:

$$L_i = \prod_{l=1}^{55} P(RC_{i,l} = rc_{i,l}) * \prod_{t=1}^{48} P(TC_{i,t} = tc_{i,t}) \qquad (5)$$

- Allow preference and rationality parameters to be a function of observed and unobserved heterogeneity

$$\Theta_i = \theta_0 + \theta_1{}' X_i + \theta_2{}' F_i \tag{6}$$

- All parameters assumed to depend on the same set of explanatory variables

Observed Heterogeneity

- Directly observed characteristics
  - sex, language, age
- Unobserved traits noisily proxied for by observed measures
  - Cognitive Ability
  - Non-cognitive Traits

- Assume a factor stucture

- Assume a factor stucture
    - underlying latent factor driving observed measures
    - factor as a random effect
    - estimated using simulated maximum likelihood with 200 independent draws of each factor

Unobserved Heterogeneity

- Unobserved type: a vector of intercepts for each preference and rationality parameter

Unobserved Heterogeneity

- Unobserved type: a vector of intercepts for each preference and rationality parameter
- Pure unobserved heterogeneity

Unobserved Heterogeneity

- Unobserved type: a vector of intercepts for each preference and rationality parameter
- Pure unobserved heterogeneity
- Each individual equally likely to be any type
    - his likelihood contribution is a weighted average of the individual type likelihoods

Full Likelihood

- Probability of jointly observing the factor measures and individual choices

Full Likelihood

- Probability of jointly observing the factor measures and individual choices
- Integrate out the unobserved factors through simulation
- Weigh over unobserved types to obtain unconditional individual likelihood
  - weights are the estimated population prevalence of each unobserved type
- Finally, take logs of the individual likelihoods, sum them up, and maximize the likelihood over the structural coefficients

Caveats

- External validity
- Model structure
- Likelihood maximization

Heterogeneity

- Allow preference and rationality parameters to be a function of observed and unobserved heterogeneity

$$\Theta_i = \theta_0 + \theta_1{}'X_i + \theta_2{}'F_i \tag{7}$$

$$\sigma_{\Theta,i} = \Phi(s_{\theta,0} + s_{\theta,1}{}'X_i + s_{\theta,2}{}'F_i) \tag{8}$$

$$R_i = \Phi(r_0 + r_1{}'X_i + r_2{}'F_i) \tag{9}$$

$$\sigma_{R,i} = \Phi(s_{r,0} + s_{r,1}{}'X_i + s_{r,2}{}'F_i) \tag{10}$$

$$K_i = \Phi(\kappa_0 + \kappa_1{}'X_i + \kappa_2{}'F_i) \tag{11}$$

-

Factors

- The factor itself is composed of a deterministic part and of a orthogonal random part following Chamberlain (1980)
- $$F_{i,f} = \alpha_0 + \alpha_f{}' X_i + \widetilde{F}_{i,f} \qquad (12)$$
- $\widetilde{F}_{i,f} \sim N(0, \sigma_f^2)$

Factor Measures

- Underlying latent variable $M_{i,j,f}$ is assumed for each measure j of factor f for individual i

$$M_{i,j,f} = \gamma_{0,j,f} + \gamma_{1,j,f} * F_{i,f} + \varepsilon_{i,j,f} \quad (13)$$

- where:
  - $\gamma_{0,j,f}$ is the measure population mean
  - $\gamma_{1,j,f}$ is the loading of factor f in measure j
  - $F_{i,f}$ is the value of factor f for individual i
  - and $\varepsilon_{i,j,f}$ represents measurement error and follows a Normal distribution with mean 0 and variance 1.

Measure Likelihood Contributions

- Binary Measures with factors as random effects
- $$P(M_{i,j,f} = 1) = \int_{-\infty}^{+\infty} \Phi\Big(\gamma_{0,j,f} + \gamma_{1,j,f} * (\alpha_f{}' X_i) + \gamma_{1,j,f} * \widetilde{F}_{i,f}\Big) * \frac{1}{\sigma_{F_f}} \phi\left(\frac{\widetilde{F}_{i,f}}{\sigma_{F_f}}\right) d\widetilde{F}_{i,f} \quad (14)$$
- Integral approximated using simulated maximum likelihood (SML)
  - 200 independent draws of $\widetilde{F}_{i,f}$ per individual from standard normal distribution

Full Likelihood

- Integrate out the unobserved factors with their orthogonal components assumed independent:
-

$$L_i \Big| (UT_i = ut_i) = \int_{\widetilde{F}_i} \cdots \int \prod_{f=1}^{F} \prod_{j=1}^{J} P(M_{i,j,f} = m_{i,j,f} \Big| \widetilde{F}_{i,f})$$

$$* \prod_{l=1}^{55} P(RC_{i,l} = rc_{i,l} \Big| \widetilde{F}_i, UT_i) *$$

$$* \prod_{t=1}^{48} P(TC_{i,t} = tc_{i,t} \Big| \widetilde{F}_i, UT_i) * \frac{1}{\sigma_{F_1}} \phi\left(\frac{\widetilde{F}_{i,1}}{\sigma_{F_1}}\right) * \ldots * \frac{1}{\sigma_{F_F}} \phi\left(\frac{\widetilde{F}_{i,F}}{\sigma_{F_F}}\right) d\widetilde{F}_i \quad (15)$$

Full Likelihood

- Empirically through SML:
- $$L_i \Big| (UT_i = ut_i) = \frac{\sum_{\widetilde{F}_i=1}^{200} L_i \Big| \widetilde{F}_i, UT_i}{200} \qquad (16)$$

- Finally, weigh over unobserved types to obtain unconditional individual likelihood
- $$L_i = \sum_{ut=1}^{UT} (L_i \Big| ut) * p_{ut} \tag{17}$$
- Where p_{ut} is the prevalence of unobserved type ut in the overall population
- Final log likelihood to be maximized:
- $$logL = \sum_{i=1}^{N} ln(L_i) \tag{18}$$

Full Model with 5 Unobserved Types - Intercepts

	Risk Aversion		Risk Aversion SD		Discount Rate		Discount Rate SD		% Hand Trembles	
Female	0,11	***	-0,07	***	-0,16	***	-0,18	***	0,09	***
	0,03		0,01		0,01		0,01		0,02	
Internal Locus of Control	0,25	***	0,17	***	0,79	***	0,82	***	0,07	***
	0,01		0,00		0,01		0,00		0,00	
Cognitive Ability	0,28	***	0,36	***	-0,25	***	-0,26	***	-0,34	***
	0,01		0,03		0,01		0,01		0,03	
Extraversion	-0,13	***	-0,10	***	-0,05	***	-0,01		0,01	
	0,02		0,00		0,01		0,01		0,01	
Conscientiousness	-0,20	***	-0,21	***	-1,41	***	-1,44	***	0,02	*
	0,05		0,00		0,01		0,01		0,01	

Full Model with 5 Unobserved Types - Average Individual

	Prevalence	Risk Aversion	Risk Aversion SD	Discount Rate	Discount Rate SD	% Hand Trembles
Average		1,14	0,59	0,20	0,25	0,05
Female Average		1,18	0,58	0,18	0,22	0,05
Male Average		1,08	0,61	0,23	0,28	0,04
Type 1 Average	0,08	5,00	1,00	0,01	0,00	0,08
Type 2 Average	0,32	1,05	0,64	0,01	0,01	0,04
Type 3 Average	0,13	-0,14	0,32	0,79	1,00	0,02
Type 4 Average	0,24	0,24	0,38	0,69	0,56	0,14
Type 5 Average	0,24	0,47	0,39	0,29	0,23	0,02

Return to main text