The Innovative Personality[*]

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ABSTRACT: We consider the joint role of individual traits and information/experience in driving innovative behavior. Using a laboratory experiment, we are able to disentangle the role of traits on information demand versus directly on innovation. We find no evidence that individual traits unambiguously drive innovative behavior. Instead, we find evidence of a trait-based comparative advantage; that is, certain traits are assets when paired with some forms of information, but liabilities with others. Further, individuals optimally leverage their trait-based advantage when demanding information. Our results have implications for how we study the role of individual traits in labor markets, particularly entrepreneurship, with various sectors.

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1   Introduction

The role of the individual entrepreneur in fostering innovation and economic growth has obtained nearly folkloric stature. Knight (1921)'s sentiment that a society's economic fortune rests upon its supply of "entrepreneur qualities" is echoed by Schumpeter (1947), who notes that producing "caviar from sawdust" is the result of "only one man or a few men who see the new possibility". These early scholars ignited a large literature in economics and business, as well as psychology and neuroscience, that attempts to characterize the preferences, personality and even the biological underpinnings of innovative behavior (see Åstebro et al. (2014) for a current review).

The recent literature in economics has taken on the question of who becomes a successful entrepreneur from two distinct perspectives. One strand of literature has sought to characterize the traits and preference parameters of individuals who become entrepreneurs. Knight (1921) emphasized the role of risk tolerance as a defining characteristic of the entrepreneur, a notion later formalized by Kihlstrom and Laffont (1979). Although intuitive, there is no solid empirical evidence that entrepreneurs are less risk-averse than non-entrepreneurs (Elston et al., 2006). More recently, research has turned to linking personality traits and entrepreneurship (Brandstätter, 1997; Caliendo et al., 2011; Evans and Leighton, 1989; Fairlie and Holleran, 2012; Hamilton et al., 2014). Using the Big Five Personality construct (Costa and McCrae, 1985), Caliendo et al. (2011) find a positive relationship between Extraversion, Openness, Neuroticism and Agreeableness and self-employment, while Hamilton et al. (2014) find that increased Openness, Conscientiousness, and Agreeableness are a liability among the self-employed and increased Extraversion is an asset. On the other hand, Fairlie and Holleran (2012) find little association between entrepreneurship and personality.

A second strand of literature characterizes the types of experiences, knowledge and skill-sets that are predictive of successful entrepreneurship. Lazear (2004)'s "Jack of All Trades" theory of entrepreneurship and Gompers et al. (2005)'s theory of small firms argue that individuals who accumulate a general skill set or a wider breadth of knowledge are most likely to become entrepreneurs.[1] Åstebro and Thompson (2011), however, point out that observing entrepreneurs who look like "Jacks of All Trades" is also consistent with an individual who has a "Preference for Variety" (Ghiselli, 1974), whereby individuals sort into entrepreneurship based individual preferences.[2] Further, Elfenbein et al. (2010) provide evidence in support of both preference-based sorting and human capital accumulation: small firms may foster entrepreneurial-relevant human capital, and individuals who have a strong preference for autonomy have a preference for working

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[1] There are other forms of information accumulation. The literature in economics and entrepreneurship identifies several channels through which innovation-inducing information may be acquired: formal education, peers (Lerner and Malmendier, 2011; Minniti, 2005; Nanda and Sørensen, 2010), and government-sponsored programs (Fairlie et al., 2015).

[2] While Wagner (2003) finds support in favor of the Jack of All Trades theory of entrepreneurship,Silva (2007) does not and Åstebro and Thompson (2011) find evidence that supports the "Preference for Variety" theory.

for a smaller firms and are likely to become entrepreneurs.

This paper attempts to link these two strands of literature by considering the joint role of traits and knowledge/information accumulation on innovative behavior. We depart from most previous studies and examine innovation in the laboratory because the laboratory allows for us to control the information acquisition process.[3] The main task in our experiment, the Industry Game, is adapted from Ederer and Manso (2013) and Herz et al. (2014) and embodies the trade-off between exploration and exploitation (March, 1991). Subjects take on the role of a manager in which they must decide which Industry to enter and how to invest their money across the Industry's products. The objective in each of the 20 rounds of the Industry Game is to maximize earnings. In each Industry, there is an unknown optimal product mix that maximizes the subject's investment in the Industry and an unknown Industry-specific fixed cost. Thus, to maximize earnings subjects must decide when to explore new Industries or investment strategies and when to exploit (or fine tune) their current strategy.

We employ a between-subject design where our main treatment manipulation is information or feedback in the Industry Game. Subjects are randomly assigned to one of four treatments: No Information, Investment Information, Cost Information or Information Choice (i.e., subjects choose the type of information they prefer to receive). The No Information treatment provides subjects only with earnings feedback after each round. By contrast, in the Investment Information and Cost Information treatments, we randomly assign subjects to receive either Investment Information *or* Cost Information, in addition to the earnings feedback. Investment Information consists of an unbiased signal about the optimal industry-specific investment level relative to their current investment strategy (this is equivalent to the feedback in Ederer and Manso (2013) and Herz et al. (2014)), whereas Cost Information consists of an unbiased signal about the subject's industry-specific fixed cost. In the fourth treatment, the Information Choice treatment, subjects *choose* the type of information that want to receive: no information (Control), Investment Information, or Cost Information. Importantly, the first three treatments *assigns* subjects to an information sector (i.e., No Choice treatments),[4] while the fourth treatment allows subjects to *self-select* into their preferred information sector. In addition to the Industry Game, we elicit Big Five personality traits (Costa and McCrae, 1985),[5] locus of control Rotter (1971),[6] risk prefer-

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[3]Notable exceptions include Charness and Grieco (2013); Ederer and Manso (2013); Herz et al. (2014); Meloso et al. (2009). Of these studies, only Herz et al. (2014) relate individual traits to innovative behavior and find that optimism is related to increased exploratory behavior, while overconfidence is related to less exploration. Charness and Grieco (2013) and Ederer and Manso (2013) focus on the effects of incentive schemes on creativity and innovation.

[4]To our knowledge, Fairlie et al. (2015) is the only other study that looks at the effect of exogenous information on innovative behavior. They report results from a large-scale field experiment in which aspiring entrepreneurs are randomly assigned to a training program, while the control treatment receives no training.

[5]Recent literature links the Big Five to a host of factors that may affect labor market outcomes (Barrick and Mount, 1991; Caliendo et al., 2011; Fletcher, 2013; Hamilton et al., 2014; Cubel et al., 2016).

[6]Rotter's External-Internal Locus of Control is designed to determine the extent to which an individual views his life as under his control. Individuals with an internal locus of control view their life as under their direct control

ences and cognitive ability Raven and Court (1998), thus also contributing to a growing literature of non-cognitive skills on economic outcomes (see Almlund et al. (2011) for an overview of this literature).

Roy (1951)'s model of occupation choice provides a framework for understanding the implications of selection bias that can occur when individuals select-into occupations or sectors.[7] The underlying difficulty in these questions is that the researcher only observes earnings conditional on self-selection, rather than for the entire population, leading to the development of formal statistical models to address the issues of selection (Maddala, 1977, 1983; Heckman and Honore, 1990). Our experiment purposefully circumvents this problem by including both the No Choice and Information Choice treatments.

In fact, our pattern of findings closely mirror the predictions put forth by Roy (1951). In particular, there are significant innovation and earnings' disparities when information is randomly assigned, but that disappear when subjects are able to leverage their comparative advantage and self-select into their preferred information sector (Heckman and Honore, 1990). For example, subjects randomly *assigned* to Cost Information explore more, innovate less successfully and earn significantly less than subjects randomly *assigned* to Investment Information, but we find no significant differences in the Information Choice treatment when subjects *self-select* either Investment or Cost Information. Roy's prediction stems from the idea that when selection occurs, individuals are able to leverage their comparative advantage. This is exactly what we find: subjects leverage their trait-based comparative advantage, rather than a single set of traits or information sector being universally advantageous.[8] We find that extraversion and risk tolerance are assets for subjects *assigned* to Cost Information, but liabilities for subjects *assigned* to Investment Information. In the Information Choice treatment, subjects who are more extraverted and risk tolerant are significantly more likely to select Cost Information than Investment Information.[9] Finally, we show that subjects select optimally–on average, subjects who choose Cost (Investment) Information earn more using Cost (Investment) Information than they would have had they chosen Investment (Cost) Information.

More broadly, observable labor market data more closely resembles the data from the Information Choice treatment; that is, we do not observe the information or experiential accumulation phase that leads to labor market outcomes, and in particular, entrepreneurial outcomes. One

and influence, a trait that is linked to need for high achievement and a preference for autonomy (McClelland, 1965) and subsequently to a preference for entrepreneurship (Brandstätter, 1997; Caliendo et al., 2011; Evans and Leighton, 1989).

[7] Roy models have been used in a variety of contexts to better understand how the interaction of self-selection and individual characteristics drive different earnings' patterns, including immigration (Borjas, 1987), college attendance (Willis and Rosen, 1979), and labor force participation (Gronau, 1974; Heckman, 1974).

[8] Similarly, Lundberg (2013) finds that personality traits interact with socio-economic status such that Conscientiousness was associated with better educational outcomes for advantaged males, whereas Openness was associated with better outcomes for dis-advantaged males.

[9] Fréchette et al. (2011) also finds evidence that personality predicts information demand.

important finding that our experiment brings to the forefront is the potential for traits to have different returns in different entrepreneurial sectors. More specifically, when subjects are randomly assigned Cost Information their propensity for exploration is consistent with a "Jack of All Trades" entrepreneur, while fine-tuning of subjects randomly assigned to Investment Information is consistent with a "Specialist" entrepreneur. This cannot be identified using the Information Choice treatment (or observable data) because of selection. However, this suggests a new way forward for studying the role of traits in entrepreneurship and innovative behavior, and perhaps, labor markets more generally.

2   Experimental Design & Data

The experiments were run at the University of Sydney in May and October 2014. Our sample consists of 208 subjects recruited through ORSEE (Greiner, 2015) and the experiment was programmed using Z-Tree (Fischbacher, 2007). Sessions lasted approximately 90 minutes and the average earnings were approximately 33 AUD. During the experiment, subjects could earn money during an Industry Game (20 Rounds), a lottery task (45 lottery choices) and a cognitive test (answer up to 12 questions, earn $5 per correct question). This means, there were 66 items (20+45+1) for which the subject could earn money. At the end of the experiment we randomly choose one of these decisions for payment. Additionally, subjects completed unincentivized personality and locus of control assessments. See Supplementary Material D for the experimental instructions and screenshots.

2.1   The Industry Game

The Industry Game used in our experiment is heavily adapted from the Lemonade Stand Task in Ederer and Manso (2013) and the Ice Cream Stand Task in Herz et al. (2014).[10] While there are small changes in the structure of the game, the main elements remain the same. The Industry Game captures the idea that innovative activity involves finding new ways to combine existing resources that exploit complementarities to generate a profit (Schumpeter, 1947; Meloso et al., 2009). Galenson (2004) refers to this type of creativity as experimental innovation, where innovation comes from trial and error and occurs, as opposed to a "stroke of a genius". This notion of experimental innovation highlights the important of learning and experience for innovation.

In the Industry game, subjects take on the role of a manager who must decide how to invest resources for 20 rounds. At the beginning of each round, each subject i is endowed with 100 Australian dollars (AUD) and must make two choices: first, the subject chooses which of four industries to operate (Industry A, Industry B, Industry C, or Industry D); second, the subject

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[10]The authors thank Florian Ederer and Holger Herz for generously sharing their Z-Tree programs.

decides how to invest in his chosen industry. Each subject has an unknown industry-specific fixed cost drawn randomly from a uniform distribution between 50 and 100, which remains fixed throughout the 20 rounds of the Industry game, $f_{i,I} \sim U[50, 100] \; \forall I \in \{A, B, C, D\}$. The subject knows that if he enters Industry A, B, and C he will have to make a positive investment by allocating his endowment across three investment products, x, y and z. The subject does not have to invest the entire endowment; any endowment that is not invested is considered savings for that round, although subjects are informed that savings do not carry over between rounds. The profit function is defined so that within each Industry, there is a unique, profit-maximizing investment strategy, $(x_I^*, y_I^*, z_I^*) \; \forall I \in \{A, B, C\}$. Subjects do not know the exact profit function, but they do know that their earnings depend on the amount invested, the distance their investment is from this bliss point, and their industry-specific fixed cost.[11] Alternatively, subjects can exercise an outside option and enter Industry D. Industry D differs from the other three Industries in that there are no investment decisions to be made and subject always earns 100 minus his Industry D fixed cost. After an investment decision is made, the subject learns his earnings for the round and then proceeds to the next round. Subjects are also told that the maximum they can earn is 150 AUD (i.e., invest the entire endowment at the bliss point, which earns the subject 200 AUD and have the minimum possible fixed cost, 50 AUD) and that there is limited liability so any negative profits results in a payoff of 0 AUD.

There are four treatments: the Control treatment, the Investment Information treatment, the Cost Information treatment and the Information Choice treatment. In the Control treatment, subjects play the Industry Game, as described above, and receive profit feedback after every round. The other three treatments, described below, provide profit feedback in every round as well as an additional piece of information, to be described, after each of the first 10 rounds.

Investment Information Treatment In the Investment Information treatment, subjects receive an unbiased signal about their investment strategy. The computer randomly determines whether to give information about one of the three products and then provides feedback about whether the subject should increase, decrease or not change the investment level in that product. For example, if a subject has over-invested in product x and product x is randomly chosen by the computer, then his signal will be to decrease his investment in product x. This information is equivalent to the "customer feedback" in Ederer and Manso (2013) and Herz et al. (2014).

Cost Information Treatment In the Cost Information treatment, in addition to profit feedback, subjects also receive an unbiased signal about their industry-specific fixed cost. The information is relevant to the Industry in which they are operating. Thus, if the subject is operating in Industry A, then he receives information about the fixed cost only in Industry A. For example,

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[11]Appendix Supplementary Material C.1 shows the Industry-specific bliss points and profit functions.

if a subject's fixed cost in Industry A is 62, then the computer will randomly draw a number, z, from $Z \sim U[50, 100]$. If z is greater than 62, then the subject will receive a signal that says his fixed cost is less than z.[12]

Information Choice Treatment   In the Information Choice treatment, subject choose whether they prefer to receive Cost Information, Investment Information or No Information during the first 10 rounds. Before the game begins, subjects are shown each type of information and then asked to choose a single type of information to receive throughout the first 10 rounds. This treatment is designed to explore whether certain types of individuals prefer one type of information over the other and whether personality indirectly affects innovation through information choice.

In rounds 1-10, subjects are in an information accumulation phase. Upon reaching Round 11, subjects assigned to the Investment Information Treatment have accumulated different knowledge than subjects in the Cost Information Treatment. Investment Information provides highly specialized feedback whereas Cost Information provides more general information. In this sense, Cost Information is valuable because the subject can quickly gain broad cross-industry information; whereas the value of Investment Information is that provides detailed industry-specific information.

2.2   Risk preferences, cognitive and non-cognitive skills

After subjects completed the Industry Game, we elicited risk preferences, cognitive ability and personality traits. During the experiment, the elicitation of personality was always the final task. During approximately half of our sessions we elicited risk preferences before cognitive ability and switched the order for the other half. We conduct all four treatments of the Industry Game with both task orders.

Risk preferences   We elicit risk preferences following Hey and Orme (1994). Subjects faced a series of 45 lottery pairs and were asked to choose which lottery in the pair they preferred. We then follow Andersen et al. (2014) and estimate risk preferences at the individual-level, assuming CRRA utility, via maximum likelihood.

Cognitive Skills   We use the Raven's Advanced Progressive Matrices test to measure cognitive ability (Raven and Court, 1998), an intelligence test that is designed to be culture-free since it does not rely on language or cultural references. The test consists of 12 diagrams with a missing piece and eight suggested answers to the missing piece. The subject's task is to choose one of

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[12]S2 formally describes the signals.

the eight suggested answers. During the experiment, subjects have 12 minutes to complete 12 questions without feedback. We measure their cognitive ability as the number of correct answers.

Personality Traits We use the The Big Five Personality inventory to assess personality.[13] We measured the Big 5 using the 120 item short form developed by Johnson (2014).

We use Rotter's External-Internal Locus of Control test to measure locus of control (Rotter, 1971). The test consists of 29 pairs of statements and subjects are asked to indicate which of the two statements are consistent with their own views. The contemporary scoring system, which is the opposite of Rotter's original scoring rule, associates higher scores with a more internal locus of control.

2.3 Data

Table 1 presents summary statistics of our sample. Note that the sample size is 194, rather than 208, due to technical difficulties in a session in which data from the Industry Game was collected, but data from the risk elicitation, cognitive test and personality surveys were lost. The Big Five personality test is designed so that the median score for each trait is 50, with a standard deviation of 10. Also consistent with other findings, the subjects in our experiment are weakly risk-averse, with an average estimated CRRA coefficient of .89. Half of our subjects are female and the average age is just under 23 years.

The Industry Game is designed to measure degrees of exploration, but can also distinguish between exploration and "successful innovation". Throughout our analysis, our main outcome variables are (1) exploration, (2) distance to the bliss point and (3) earnings.

Exploration Ederer and Manso (2013) and Herz et al. (2014) measure exploration as the subject's average industry-specific standard deviation in investment strategies. This measure captures the variance in the subject's investment strategies, but does not capture the frequency with which the subject changes industries. A change in industry is perhaps the biggest exploration since it requires an entirely new and unknown investment strategy and, in our setting, an unknown fixed cost. Our measure of exploration, the Exploration Index, captures the degree of change in investment strategies and industry switches into a single measure.[14] The Exploration Index scores the subject's industry choice and investment strategy by how similar it is to all previous investment

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[13]The Big 5 include Extraversion, Openness, Conscientiousness, Agreeableness and Neuroticism. Extraversion is associated with high energy, assertiveness, and positive affect. Openness reflects the degree of intellectual curiosity, creativity and is associated a preference for a variety. Conscientiousness is associated with a tendency to be organized, efficient, dependable, and self-disciplined. Agreeableness is associated with the tendency to seek compromise and cooperation. Neuroticism is associated with being emotionally unstable and a tendency to experience anxiety and anger.

[14]In the Supplementary Material, we shows that we obtain qualitatively equivalent results using the measure of exploration proposed in Ederer and Manso (2013) and Herz et al. (2014).

	Mean (sd)
Openness	46.03 (9.01)
Extraversion	49.09 (8.04)
Neuroticism	48.96 (7.61)
Conscientiousness	49.36 (8.77)
Agreeableness	48.18 (8.44)
Locus of Control	11.49 (3.95)
CRRA coefficient	.81 (.78)
Raven Score, Cognitive Ability	7.20 (2.36)
Female	.55 (.50)
Age	22.74 (3.85)
Observations	194

TABLE 2: We were unable to estimate risk preferences for 8 subjects. See Table S1 for more detail on sample sizes.

choices within the industry and assigns a score based on the its similarity to the most similar strategy previously used. This allows us to identify when a subject returns to a previously tried idea (even when that choice happened several rounds before). We normalize the index between 0 and 1, inclusive. If a subject exactly replicates a previously used industry-investment choice or enters Industry D, then his Exploration Index in this round is 0. When a subject enters an Industry for the first time, his Exploration Index is 1.
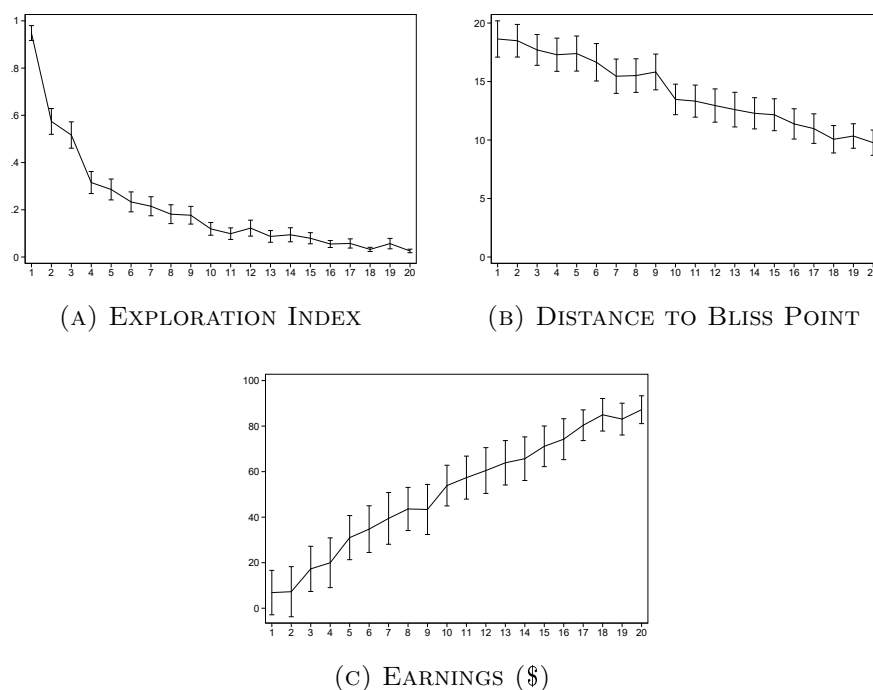
We obtain the Exploration Index for subject i in period n in the following way. Define $I_{i,j} \in \{A, B, C, D\}$ be the industry chosen by subject i in period j. Let $(x_{i,j}, y_{i,j}, z_{i,j})$ be a vector of subject i's investment strategy in period j. Define the Exploration Index of subject i in period j as follows

$$EI_{i,j} = \begin{cases} 0 & \text{if } I_{i,j} = D \\ 1 & \text{if } \forall \, j' < j \ I_{i,j'} \neq I_{i,j} \\ \kappa \times \min_{j'|I_{i,j'}=I_{i,j}} |\, x_{i,j} - x_{i,j'} \,| + |\, y_{i,j} - y_{i,j'} \,| + |\, z_{i,j} - z_{i,j'} \,| & \text{otherwise.} \end{cases} \quad (1)$$

where $\kappa = \frac{1}{200}$, which is the maximum deviation possible between two investment strategies, normalizes the Exploration Index so that it is between 0 and 1.[15] The average Exploration Index with 95% confidence intervals for each of the 20 periods is shown in Figure 1a with 95% confidence

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[15]For example consider an investment strategy in period 1, $(x_{i,1}, y_{i,1}, z_{i,1}) = (100, 0, 0)$ and an investment strategy in period 2 of $(x_{i,2}, y_{i,2}, z_{i,2}) = (0, 100, 0)$ in Industry I. Then, the Exploration Index is given by $\frac{200}{1} \times \kappa = 1$.

(A) EXPLORATION INDEX

(B) DISTANCE TO BLISS POINT


(C) EARNINGS ($)

bands.

Successful Innovation We also measure the degree to which subjects successfully innovate. We have two measures of successful innovation: (1) the distance from the industry-specific bliss point; and (2) the amount of money earned (see Figure 1c). The distance from the bliss point is calculated as a sum of the absolute deviation for each investment product. Figure 1b shows the average distance from the bliss point, with 95% confidence intervals for each of the 20 rounds. Figure 1c shows the average earnings in each period. In both Figures, the trend shows that subjects perform better as the game unfolds, both in terms of finding the bliss point and earnings.

2.4   Effect of Information

Prior to exploring the role of traits, we first examine whether our main treatment manipulation, information, results in differential outcomes for innovation and earnings.[16] Figure 2 shows the average outcomes for exploration, successful innovation and earnings during the first 10 rounds by treatment (i.e., (1) No Information; (2) Investment Information; (3) Cost Information; (4) Information Choice-split by choice). We make three observations. First, subjects assigned to the Cost Information treatment explore significantly more during the first 10 rounds than subjects

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[16]In Table S2, we present evidence that shows that subjects effectively use the information they receive by changing industries or adjusting their investment strategy.

FIGURE 2: AVERAGE TREATMENT EFFECTS

(A) EXPLORATION

(B) DIST TO BLISS POINT

(C) EARNINGS
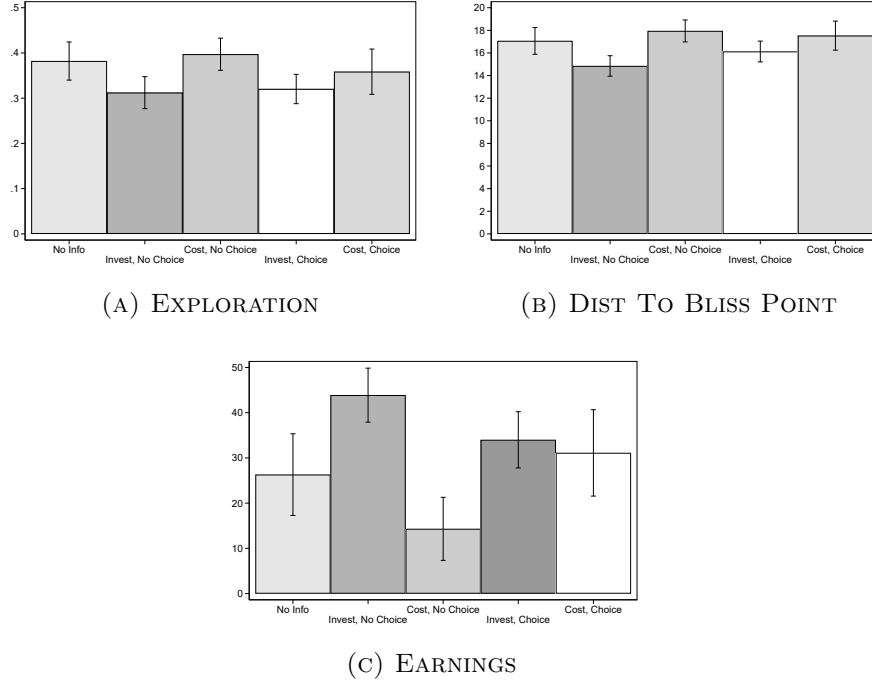
assigned to the Investment Information treatment. This means, that at the conclusion of the first 10 rounds subjects assigned to receive Cost Information have experienced a wider breadth of investment strategies and industry choice combinations due to their greater propensity for exploration than subjects assigned to receive Investment Information.[17] Due to their lower propensity to explore, subjects assigned to the Investment Information treatment have more finely-tuned and specialized knowledge. We conclude that to two types of entrepreneurs emerge: Cost Information generates entrepreneurs that look like "Jack of All Trades" while Investment Information results in entrepreneurs that behave like "Specialists".

Second, the fine-tuning strategy of the subjects assigned to Investment Information appears to advantageous; random assignment to Investment Information, compared to Cost Information, leads to significantly more successful innovation and increased earnings. Third, and as predicted by Roy (1951), these behavioral and earnings disparities disappear when subjects have the opportunity to select their preferred type of information. In Supplementary Material B.1, we find a positive selection bias for subjects who choose Cost Information and a negative selection bias for subjects who choose Investment information. Thus, subjects who choose Investment information perform worse than subjects randomly assigned to Investment information and vice-versa for subject who choose Cost Information.

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[17]In Table S3 we follow the measurement of exploration in Ederer and Manso (2013) and Herz et al. (2014) and show the average standard deviation in investment strategies is significantly greater for subjects in the No Choice Cost Treatment than in the No Choice Investment Treatment. We also show that subjects in the No Choice Cost Treatment explore significantly more industries on average than subjects in the No Choice Investment Treatment.

2.5 Effect of Traits

We now examine the role of traits on innovative behavior. To do so, we regress our three main outcome measures–Exploration Index, Successful Innovation and Earnings–on a vector of individual traits and treatment dummies using data from the No Choice Treatments only (i.e., when information sector is exogenously assigned). In sum, we find that the Big Five personality traits are not jointly predictive of exploration, successful innovation or earnings and that there is no specific trait that plays a significant role.

TABLE 3: EFFECT OF INDIVIDUAL TRAITS

	Exploration	Dist to Optimum	Earnings
Investment Info	-0.07***	-2.66**	17.27**
	(0.02)	(1.28)	(8.14)
Cost Info	-0.02	0.78	-9.47
	(0.02)	(1.30)	(9.14)
Extraversion	0.0005	0.07	-0.37
	(0.001)	(0.08)	(0.48)
Openness	0.0005	0.02	-0.52
	(0.0008)	(0.06)	(0.41)
Neuroticism	0.0007	0.06	-0.13
	(0.001)	(0.09)	(0.59)
Agreeableness	-0.0008	-0.1	0.64
	(0.0008)	(0.06)	(0.45)
Conscientiousness	-0.0005	0.02	0.04
	(0.001)	(0.08)	(0.48)
Risk Tolerance	-0.02*	-0.53	7.09*
	(0.009)	(0.59)	(4.04)
Internal Locus of Control	-0.007***	-0.34***	2.30***
	(0.002)	(0.13)	(0.69)
Female	-0.0003	0.56	-14.30*
	(0.02)	(1.04)	(7.54)
Constant	0.74***	25.27**	64.77
	(0.12)	(9.83)	(63.32)
Observations	2074	2031	2074
R^2	0.32	0.27	0.23
F-test			
Cost Info=Invest Info	9.19***	8.47***	11.38**
Big Five traits	.65	1.17	.88
Controls			
Cognitive Skill FE	Y	Y	Y
Round FE	Y	Y	Y
Round 1 Pay-Off	Y	Y	Y
Age & Year in School FE	Y	Y	Y
Order FE	Y	Y	Y

OLS estimates. Robust Standard Errors clustered at the subject-level in parentheses and *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

2.6 Hypotheses

In Sections 2.4 and 2.5, we established two findings: (1) behavioral and earnings disparities emerge when information is randomly assigned, but disappear when information is chosen; and (2) traits do no unambiguously drive innovative behavior. These two findings suggest that traits and information interact and that we may expect to find a pattern of selection predicted by Roy (1951) and inform our four main hypotheses.

Hypothesis 1. *Information interacts with individual traits to drive innovation. The return to traits and information are interdependent.*

Our first hypothesis posits an interaction effect between traits and information. To test this hypothesis, we estimate equation 2 for subjects assigned to Investment Information and Cost Information, separately.

$$Y_{i,j} = \beta_0 + \beta_{\text{Traits}} \times \mathbf{X}_i + \beta_{\text{Controls}} \times Z_i + \eta_{i,j} \tag{2}$$

If the interaction effects between traits and information are sufficiently strong, then, following Roy (1951), we expect that (1) information demand will be trait-based and (2) individuals optimally demand information. We turn to these hypotheses now.

Hypothesis 2. *Individuals will demand information that leverages their trait-based advantage. In particular, if a trait is an asset when assigned Investment Information, but a liability when assigned Cost Information, then an individual with this trait will be more likely to choose Investment Information.*

We test this information demand hypothesis using data from the Information Choice treatment and estimating the following probit regression

$$Pr[\text{Cost Information} = 1] = P_0 + \mathbf{P}_{\text{Traits}} \times \mathbf{X}_i + \varepsilon_i, \tag{3}$$

where the outcome variable takes a value of 1 if subject i chooses Cost Information and a value of 0 if the subject chooses Investment Information.

Our third hypothesis pushes the trait-based advantage further to better understand the nature of the selection problem. We hypothesize that individuals not only leverage their trait-based advantage through information demand, but that they do so optimally; that is, on average, individuals could not have done better had they chosen a different type of information in the Information Choice treatment.

Hypothesis 3. *Individuals who chose Investment (Cost) Information could not have made more money choosing Cost (Investment) Information.*

To construct the counterfactual estimates of earnings and successful for subjects in the Choice Treatments, we use the estimates obtained from estimating equation 2 to predict the counterfactual outcomes. For subject who chose Investment (Cost) Information, we use the estimated effects of individual traits from the average individual assigned to Cost (Investment) Information to predict what these subjects would have made if they had chosen the other type of information. We then construct four residual terms and test whether the residuals are consistent with subjects choosing optimally.

$$
\begin{aligned}
E[\text{Dist To Optimum}_1|\text{Invest Info=1}] - E[\text{Dist To Optimum}_2|\text{Invest Info=1}] &< 0 \\
E[\text{Earnings}_1|\text{Invest Info=1}] - E[\text{Earnings}_2|\text{Invest Info=1}] &> 0 \\
E[\text{Dist To Optimum}_2|\text{Cost Info=1}] - E[\text{Dist To Optimum}_1|\text{Cost Info=1}] &< 0 \\
E[\text{Earnings}_2|\text{Cost Info=1}] - E[\text{Earnings}_1|\text{Cost Info=1}] &> 0
\end{aligned}
\tag{4}
$$

We estimate equation 4 by regressing (via OLS) the difference in the outcome variable in the chosen information sector with the predicted outcome variable in the alternative information section on a vector of individual traits and a constant. Thus, the constant represents the average difference in the residual, controlling for individual traits. A positive (negative) constant in the Earnings (Distance to Optimum) indicate that, on average, individuals perform better in their chosen information sector than they would have in the alternative.

3 Main Findings

We now present our main results. We begin with a statement of the result, followed by a brief discussion.

Result 1. *Individual traits interact with information to drive innovation. In particular, Extraversion and risk tolerance are assets when using to Cost Information, but liabilities when using Investment Information.*

In Table 4, we present the estimates from equation 2 to test Hypothesis 1. We find that increased Extraversion and risk tolerance is a liability for "Specialists" but an asset for "Jacks of All Trades". For example, a standard deviation increase in Extraversion leads to an average 12 dollar loss in earnings for Specialists, but a 16 dollar gain for Jacks of All Trade. By contrast, Locus of Control, Neuroticism, and Agreeableness play similar roles in the exploration, successful innovation and earnings for both types of innovators.[18]

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[18]There are traits that play a significant role for one type of entrepreneur and an insignificant role for the other type of entrepreneur. We focus on those traits that have significant and opposite effects.

TABLE 4: EFFECT OF INDIVIDUAL TRAITS ON OUTCOMES BY TREATMENT, NO CHOICE TREATMENTS ONLY

	Investment Info Only			Cost Info Only		
	Exploration	Dist to Optimum	Earnings	Exploration	Dist to Optimum	Earnings
Extraversion	0.004**	0.31***	-1.32***	-0.0007	-0.52***	1.63**
	(0.002)	(0.09)	(0.48)	(0.002)	(0.15)	(0.66)
Openness	-0.0003	0.04	0.08	-0.0009	0.06	-0.78**
	(0.0008)	(0.06)	(0.33)	(0.001)	(0.07)	(0.38)
Neuroticism	0.003**	0.26***	-1.69***	0.004***	-0.16	-1.26***
	(0.001)	(0.09)	(0.52)	(0.002)	(0.12)	(0.47)
Agreeableness	-0.002**	-0.2**	0.39	-0.006***	-0.43***	4.32***
	(0.0009)	(0.08)	(0.52)	(0.002)	(0.13)	(0.45)
Conscientiousness	-0.0000669	0.16	-1.17*	0.002	-0.01	-0.53
	(0.001)	(0.11)	(0.61)	(0.002)	(0.1)	(0.41)
Risk Tolerance	0.03	4.05***	-24.92***	-0.02**	-2.76***	18.03***
	(0.02)	(1.33)	(7.05)	(0.008)	(0.51)	(2.21)
Internal Locus of Control	0.0002	0.004	-0.06	-0.001	-0.51**	0.91
	(0.002)	(0.13)	(0.59)	(0.003)	(0.2)	(0.74)
Female	0.03	1.99	-7.12	-0.02	-8.90***	24.27***
	(0.02)	(1.81)	(8.78)	(0.03)	(1.69)	(8.69)
Constant	0.24	-33.73***	356.09***	0.64**	99.18***	-315.68***
	(0.16)	(11.71)	(78.38)	(0.27)	(21.41)	(87.78)
Observations	769	757	769	623	612	623
R^2	0.22	0.38	0.34	0.5	0.44	0.42
F-test						
Big Five traits	2.77**	4.14***	3.70***	5.05***	6.52***	34.22***
Controls						
Cognitive Skill FE	Y	Y	Y	Y	Y	Y
Round FE	Y	Y	Y	Y	Y	Y
Round 1 Pay-Off	Y	Y	Y	Y	Y	Y
Age & Year in School FE	Y	Y	Y	Y	Y	Y
Order FE	Y	Y	Y	Y	Y	Y

OLS estimates. Robust Standard Errors clustered at the subject-level in parentheses and *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Result 2. *Individuals leverage their trait-based advantage when demanding Information. Increased Extraversion and risk tolerance is associated with a significantly increased likelihood of choosing Cost Information.*

Next, we turn to the Information Choice Treatment, where subjects are asked whether they prefer to receive Cost Information or Investment Information after they have had a chance to learn about each type of information.[19] Of the 79 subjects assigned to the Information Choice treatment, 52 chose Investment Information and 27 chose Cost Information. In Table 5, we present estimates from equation 3 and find that an increase in one standard deviation in Extraversion and Risk

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[19]They also had the choice to choose No Information (i.e., the Control Treatment), but no subject made this choice.

Tolerance is associated with 20 percentage point and 12 percentage point increase, respectively, in the likelihood of choosing Cost Information.

TABLE 5: EFFECT OF INDIVIDUAL TRAITS ON INFORMATION DEMAND, CHOICE TREATMENTS ONLY

	Pr[Cost Info=1]		
Risk Tolerance	0.14*	0.13*	0.16**
	(0.07)	(0.08)	(0.08)
Neuroticism	0.01	0.01	0.02
	(0.01)	(0.01)	(0.01)
Conscientiousness	0.002	0.003	0.008
	(0.008)	(0.008)	(0.009)
Openness	-0.007	-0.008	-0.006
	(0.007)	(0.007)	(0.008)
Agreeableness	0.01	0.01	0.01
	(0.009)	(0.009)	(0.009)
Extraversion	0.02**	0.02**	0.02*
	(0.01)	(0.01)	(0.01)
Internal Locus of Control	-0.002	-0.01	-0.002
	(0.02)	(0.02)	(0.02)
Cognitive Ability	-0.002	-0.01	.
	(0.02)	(0.02)	
Female	0.1	0.05	0.02
	(0.14)	(0.14)	(0.16)
Observations	76	76	73
Pseudo R^2	.	.	.
Controls			
Age, Year	No	Yes	Yes
Cognitive Ability FE	No	No	Yes
Task Order FE	No	Yes	Yes

Marginal effects from a probit regression. Robust Standard Errors in parentheses and *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Result 3. *Individuals optimally choose Information type; that is, individuals who choose Investment (Cost) Information earn more than they would have if they had chosen Cost (Investment) Information.*

Table 6 presents estimates from equation 4 to test whether individuals earn more in their chosen information sector than they would have if they had chosen the alternative information sector. We report the estimated mean residual calculated at the average of the covariates of personality, risk, locus of control and cognitive ability. Overall, subjects have higher earnings and innovate more successfully in the regime they selected into than they would have in the alternate information sector.

TABLE 6: COUNTERFACTUAL: TEST OF RESIDUALS

| | Investment Info Only | | Cost Info Only | |
	Dist to Optimum	Earnings	Dist to Optimum	Earnings
Constant	0.8	15.77**	-6.91***	19.97*
	(1.18)	(6.90)	(2.10)	(10.53)
Observations	980	980	540	540

OLS estimates. Robust Standard Errors clustered at the subject-level in parentheses and *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

4   Conclusion

Understanding the innovative personality has been a fascination among scholars dating back at least to Knight (1921), spurring two literatures in economics that have approached this question from different angles. One literature studies the role of individual traits on the decision to become self-employed and the success in self-employment. The other literature focuses on the role of past experiences in shaping entrepreneurship. Both literatures have been inconclusive and even contradictory.

In this paper, we step back from the traditional approach of studying entrepreneurship and innovation and go into the laboratory. By doing so, we are able to directly study the interaction of individual traits and selection, in the form of information acquisition, that drives innovative behavior. We find that there is no individual trait that unambiguously drives exploration or successful innovation, but rather that traits drive information demand and jointly determine innovative behavior. We find that individuals are leverage their trait-based advantage and, when given the opportunity, optimally demand information.

Our findings suggest a variety of ways forward in studying the role of the individual in entrepreneurship and innovation. First, acknowledging and differentiating between types of entrepreneurship may be fruitful for identifying whether individual traits are assets or liabilities. Surely, the individual who starts a high-tech company out of his garage using highly specialized knowledge is very different than a restauranteur who manages a large staff of employees and diverse business relationships. Second, the paths taken by the high-tech specialist versus the restauranteur, such as previous employment or investment decisions, are also likely to be shaped by individual traits and preferences. Thus, it may be just as necessary to study the path to entrepreneurship as it is the decision to enter entrepreneurship.

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