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by

Agnes Bäker, Werner Güth, Kerstin Pull & Manfred Stadler

Faculty of Economics and Social Sciences
www.wiwi.uni-tuebingen.de

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Agnes Bäker*, Werner Güth**, Kerstin Pull* and Manfred Stadler***

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Abstract

Innovation economics is usually neglecting the psychological tradition of creativity research. Our study is an attempt to experimentally collect behavioral data revealing in how far personality characteristics like creativity, analytical skills and personality traits on the one hand and innovative capability, the topic of innovation economics, on the other hand are interrelated. We find that participants' performance in innovation games is related to their creativity, risk tolerance and self-control. Other personality traits such as participants' anxiety, independence, tough-mindedness, analytical skills and extraversion at best play a minor role.

Keywords: Creativity; personality traits; innovation games; experiments

JEL Classification: C91, L13, O31

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* University of Tübingen, Department of Business and Economics, Nauklerstraße 47, D-72074 Tübingen, Germany. e-mail: kerstin.pull@uni-tuebingen.de.

** Max Planck Institute of Economics, Strategic Interaction Group, Kahlaische Straße 10, D-07745 Jena, Germany. e-mail: gueth@econ.mpg.de.

*** University of Tübingen, Department of Business and Economics, Mohlstraße 36, D-72074 Tübingen, Germany. e-mail: manfred.stadler@uni-tuebingen.de.

1 Introduction

This paper explores special game experiments, used to measure individual capability to "innovate" in the lab, and analysis how creativity, analytical skills and personality traits are correlated with interactive innovation behavior in such games. Though the concept of capability has become increasingly prominent in the management research of recent years it is notoriously hard to find adequate operationalizations for it. Since typically such capabilities may depend on the strategic context reliance on personality variables alone, the standard approach in creativity research, seems insufficient. The capability to innovate is a case in point. Whether innovation success of individuals may be expected or not does not only depend on their personality but also on the market context in which they are acting. Though context may matter as much as individual traits in explaining individual innovation-game behavior, the way an individual responds to similar contexts may as well be an individual characteristic or character trait.

Assuming that context can be captured in a general and rather abstract way by "innovation games", adapted from the Industrial Organization literature (see, e.g., Malerba 2007, Vives 2008) we elicit individual context dependency or, more specifically, individual responses to innovation challenges via innovation-game experiments. Hopefully the experimental innovation games help to classify context dependency so that different individual responses to different contexts may be used along with personality traits to assess individual capabilities and proclivities to innovate.

Our empirical-experimental approach is no substitute for field research but avoids some of its problems, e.g., by allowing for better control in data elicitation.[1] However, our study has several disadvantages - an obvious one being that it targets undergraduate students rather than actual entrepreneurs and innovators and that it abstracts from the social skills of successful innovators.

[1] We decided to explore the topic experimentally because studies using questionnaire data on firms' innovative activities tend to suffer from two main shortcomings: (i) they do not provide information on individual capabilities and characteristics (other than fixed or random effects in the econometric estimation, see, e.g., Flaig and Stadler 1994, 1998, Kukuk and Stadler 2001, 2005) and (ii) it is not clear who answered the questionnaire and whether the person who did is responsible for innovative activities. The latter disadvantage can obviously be avoided by more costly interview techniques.

All participants in the experiment are confronted with all experimental tasks. While this within subject design is not entirely new, we add to the literature by focusing on the decision paradigms not only of the IO literature (see, e.g., Schmutzler 2012) but also of creativity research in psychology. The latter tries to explore how individuals differ in creative problem solving, and how this may be interrelated with personality traits (see, e.g., Furnham, Bachtiar 2008).

The remainder of the paper is organized as follows. In section 2, we describe our experimental protocol and how we attempted to assess participants' innovative capability, creativity, analytical skills, and personality. In section 3 we describe participants' behavior in the innovation games and then devote section 4 to the analysis of the relation between innovative lab behavior on the one hand and creativity, analytical skills and personality traits on the other with the help of correlation and regression analyses. To avoid too many spurious task-to-task correlations, we rely on self-constructed indices concerning innovative capabilities, creativity and analytical skills. Section 5 summarizes and discusses our main findings.

2 Design and Experimental Procedures

Our experiment confronts participants with a set of tasks to measure their innovative capability, creativity, and analytical skills. Further, we assessed their risk tolerance along with some other personality traits. We first describe how we assessed our central construct, participants' innovative capabilities, with the help of a set of IO games, and then how we measured participants' creativity, analytical skills, risk tolerance and personality traits.

2.1 Assessing Innovative Capabilities with the Help of Some Innovation Games

To take into account the diversities of context in which innovation takes place we included four different innovation games in our experiment (I1-I4): an R&D contest (I1), one market entry model with horizontal innovation (I2) as well as one with vertical innovation (I3), and a game of non-drastic process innovation (I4). When bringing the innovation games to the lab, we partly framed them and partly relied on neutral formulations (i.e., we spoke of "taking a position" rather than "entering a market") in order to see whether framing matters.

The first game, I1, is an *R&D contest game*. Two firms $i = 1, 2$ invest in R&D activities x_i to win the innovation prize V. Using a simple contest success function the expected firm profits are

$$\pi_i = \frac{x_i}{x_i + x_j + r} V - x_i \ , \quad i, j = 1, 2, \ i \neq j \ .$$

If $r > 0$ is interpreted as interest rate, the static game corresponds to a dynamic patent-race game with x_i as a constant innovation hazard rate (see Loury (1979), Nti 1997). We used the values $V = 15$ and $r = 2$ so that

$$\pi_i = \frac{15x_i}{x_i + x_j + 2} - x_i \ , \quad i, j = 1, 2, \ i \neq j \ . \tag{I1}$$

The symmetric equilibrium strategy of the firms in this game is $x^* = (7 + \sqrt{465})/8 \approx 3.57$. In the game, participants were endowed with a sum of 5 ECU (Experimental Currency Unit, where 1 ECU translated into 1 Euro). Participants could not enter the game and keep the 5 ECU for themselves or they could invest 1, 2, 3 or 4 ECU into the R&D game. We refrained from framing the game and did not speak of an R&D contest, but instead asked participants if they wanted to take part in a "bet".

The second game, I2, is a *market entry game*, based on the "Hotelling street"-like product space $[0, 1]$ where entering firms locate by choosing a product variety. We adopt the two-stage location-then-price competition model of D'Aspremont, Gabszewicz and Thisse (1979) with quadratic transportation cost, modified by concentrating demand on the support $x \in [1/4, 3/4]$ with density 2. Using the rather general solution procedure as suggested by Anderson, Goeree and Ramer (1997), the reduced-form profit functions, depending only on the locations x_1 and x_2, read as

$$\pi_i = (x_j - x_i)(1 + 2x_i + 2x_j)^2/36 \quad \text{if} \quad x_i \leq x_j$$
$$\pi_i = (x_i - x_j)(5 - 2x_i - 2x_j)^2/36 \quad \text{if} \quad x_i > x_j \ ,$$

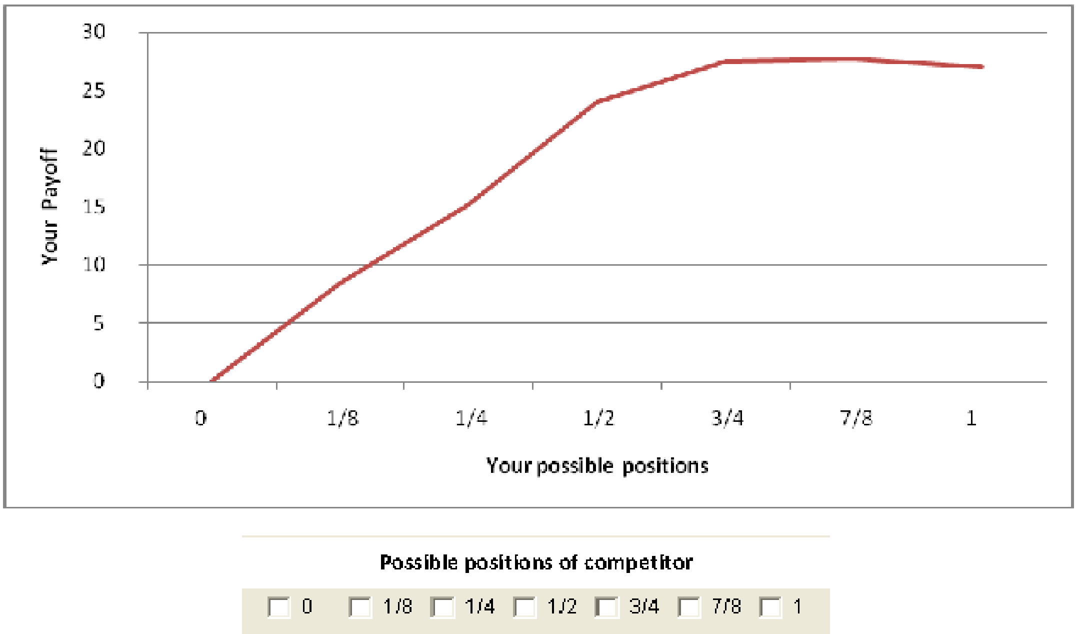

Figure 1: Screenshot I2

where $i, j, = 1, 2, i \neq j$. Multiplying the equations by 108 yields

$$\begin{aligned} \tilde{\pi}_i &= 3(x_j - x_i)(1 + 2x_i + 2x_j)^2 \quad \text{if} \quad x_i \leq x_j \\ \tilde{\pi}_i &= 3(x_i - x_j)(5 - 2x_i - 2x_j)^2 \quad \text{if} \quad x_i > x_j \ . \end{aligned} \tag{I2}$$

The equilibrium of this game is $(x_1^*, x_2^*) = (1/8, 7/8)$. In this market entry model participants again were endowed with a sum of 5 ECU, which they could either keep for themselves or invest in entering the market with a horizontal product innovation. Entering the game meant investing the whole sum and having to choose a position along the "Hotelling street". We supported participants in their decision by asking them to form expectations about the position their matching partner would possibly take and then confronted them with a graph displaying their payoffs depending on their own choice (see the screenshot displayed in Figure 1).

The third game, I3, is another *market entry game*. In contrast to I2 it is a model of vertical differentiation. Entering firms locate by choosing qualities $x_i \in [0, 1]$. We adopt the two-stage quality-then-price competition model of Choi and Shin (1992) whose reduced-form profit functions depend only on the qualities x_1 and x_2 according to

$$\pi_i = \frac{(x_j - x_i)x_i x_j}{(4x_j - x_i)^2} \quad \text{if} \quad x_i \leq x_j$$
$$\pi_i = \frac{4(x_j - x_i)x_j^2}{(4x_j - x_i)^2} \quad \text{if} \quad x_i > x_j \ ,$$

where $i, j, = 1, 2, i \neq j$. Multiplying the equations by 750 and 750/4, respectively, yields

$$\tilde{\pi}_i = 750\frac{(x_j - x_i)x_i x_j}{(4x_j - x_i)^2} \quad \text{if} \quad x_i \leq x_j \tag{I3}$$
$$\tilde{\pi}_i = 750\frac{(x_j - x_i)x_j^2}{(4x_j - x_i)^2} \quad \text{if} \quad x_i > x_j \ .$$

The equilibrium of this game is $(x_1^*, x_2^*) = (4/7, 1)$. Participants were also endowed with a sum of 5 ECU for this game which they could either keep for themselves or invest in entering the market with a vertical innovation. Entering the game again meant investing the whole sum and having to choose a position. Again, we supported participants in their decision by asking them to form expectations about the position their matching partner would take when investing and then confronted them with a graph displaying their payoffs depending on their own choice. In contrast to game I2 with horizontal innovation, we deliberately refrained from framing but instead used neutral language (“entering the game” instead of “entering the market”; “partner” instead of “competitor”).

The fourth game, I4, is a two-stage *R&D-then-price competition game* of a non-drastic process innovation, analogous to the R&D-then-quantity game of D’Aspremont and Jacquemin (1988). In the first stage, firms $i = 1, 2$ invest R&D expenditures x_i^2 and in the second stage they charge prices p_i. The firms’ profits are

$$\pi_i = [p_i - (c_i - x_i)](1 - p_i + p_j) - x_i^2 \ , \quad i, j = 1, 2, \ i \neq j \ .$$

Solving for the equilibrium prices in the second stage and substituting the resulting expression in the profit function gives the reduced-form profit functions depending only on x_1 and x_2 via

$$\pi_i = [1 + (x_i - x_j)/3)]^2 - x_i^2 \ , \quad i, j = 1, 2, \ i \neq j \ .$$

We multiply the equation by 20 to obtain

$$\tilde{\pi}_i = 20[1 + (x_i - x_j)/3)]^2 - 20x_i^2 \ , \quad i, j = 1, 2, \ i \neq j \ . \qquad \text{(I4)}$$

The symmetric equilibrium strategy of the firms in this game is $x^* = 1/3$. As in I2 and I3, in this process innovation game participants are endowed with a sum of 5 ECU, which they could either keep for themselves or invest in the game. Entering the game meant investing the whole sum and having to choose a position. Again, participants were asked them to form expectations about the position their matching partner would possibly take. Then a graph displayed how their payoffs would vary depending on their own choice, given their expectations. As in I1 and I3, we relied on neutral wording.

2.2 Assessing Creativity, Analytical Skills, Risk Tolerance and Personality Traits

Besides these four innovation games, we confronted participants with a set of further tasks designed to measure their creativity (C1-C4) and analytical skills (L1-L5).

Concerning *creativity*, we confronted them with a set of tasks that each required some kind of "stepping beyond" and leaving the traditional paths of thinking. In task C2, for example, we asked participants to rearrange as few bullets as possible in a pyramid such that it is turned upside down. Further, we asked them to name as many four-letter words as possible in colloquial German or English containing only the letters "o", "p", "s" and "t" in a given time frame (C4) and to draw different geometrical objects each connecting four given points (C1).

Concerning participants' *analytical skills*, among others, we built on standard IQ-test tasks. Specifically, we included numerical-analytical tasks (e.g., in L1 we asked participants to add up the numbers from 50 to 150 in a given time frame) as well as visual-analytical (L3, L5) and verbal-analytical tasks (L4).

Following the experimental tasks, we added a post-experimental questionnaire in an attempt to assess participants' risk tolerance and personality traits. Regarding participants' *risk tolerance*, we (i) confronted them with a lottery question (see Holt and Laury 2002) and (ii) asked them for a self-assessment with the respective question being taken from the German Socio-Economic Panel (GSOEP). When assessing of participants' *personality traits*, we relied on a validated scale by Brandstätter (2010) measuring participants' self-control, anxiety, independence, tough-mindedness, and extraversion.

2.3 Experimental Set-Up

Participants first received instructions that describe the general course of the experiment. Then participants were confronted with the different I-, C-, and L-tasks in random order. In the experiment, we included one more task where we tried to measure a combination of (verbal) creativity and innovative capabilities (the "k-task"). The k-task was based on the German parlor game "Nobody is perfect" (English equivalent: "Balderdash") where participants are confronted with real words they typically will not have heard of before. Players are asked to come up with definitions and then can decide whether to "enter the market" with their definition or not. "Entering the market" means that their definition is added to a list of potential definitions of the word in question from which the others have to choose the one they believe to be true. Points are awarded for every player who guessed that the provided definition was the correct one. In this paper, we focus on the separate I- and C-tasks, but will briefly report our results for the k-task which somehow seems to combine creativity in problem solving and competition in innovation. When we speak of innovation games, we exclude the k-tasks although they may capture more adequately our intuition of innovative behavior.

After completion of the tasks, participants were asked to fill out the post-experimental questionnaire. Besides a show-up fee of Euro 2.50, participants were paid for two randomly chosen tasks and for one incentivized question in the questionnaire (the lottery question to measure participants' risk tolerance). The experiment was programmed in z-tree (see Fischbacher 2007). We ran 5 sessions with 30 participants each. In the innovation games, we relied on a random strangers matching. Participants were told that in those tasks requiring interaction with another person, they would be matched randomly with another participant and that it was very unlikely that they would confront the same partner more than once. On average, one session lasted 105 minutes and participants earned, on average, Euros 19.64.

3 Descriptive Results from the Innovation Games

Since assessing participants' innovative capabilities is central, we devote this section to a detailed description of participants' choices and performance in the four innovation games. We start off with the participants' decisions on entering the games, the choices they took within the games and then report participants' performance in the innovation games as valued against the "market" in their respective session.

Starting off with the R&D contest game (I1), 66 percent of participants decided to participate in the "bet". On average, they invested 3.05 ECU. Minimum investment was 1 ECU and maximum investment was 4 ECU. Compared to the equilibrium solution of game I1, investment is a bit below the theoretical benchmark indicating that participants on average were risk averse.

Concerning participants' earnings in the R&D contest game, those deciding to enter the game on average earned considerably more (8.92 ECU) than those who did not (5 ECU). When assessing the innovation *performance* of entrants in I1, however, we did not take their actual earnings resulting from a specific match (which would render the resulting performance measure more volatile) but rather assessed entrants' performance "against the market", i.e., by subsequently matching them with all the other participants in the respective session and by taking the resulting average as a performance measure. The resulting performance measure for entrants and non-entrants lies between 5 and 9.49 with an average of 7.38. When only entrants are included in the measure, it lies between 7.06 and 9.49, averaging 8.60.

In the market entry model with horizontal innovation (I2), 72 percent of participants decided to enter the market. Of those entering the market, 26 percent chose an ex-ante optimal position (1/8, 7/8). A strikingly large percentage of participants (32 percent) decided for the corner positions 0 and 1. Figure 3 shows the distribution of chosen positions in I2 for the entering participants.

Concerning participants' earnings, again, those entering the game earned on average considerably more (12.34 ECU) than those who did not (5 ECU). With regards to the performance of entrants in I2, we again assessed it "against the market" - this time however only relying on those other participants in the same session who also entered.[2] The resulting performance measure for entrants and non-entrants lies

[2] The horizontal differentiation game is not appropriate for analyzing the monopoly case since,

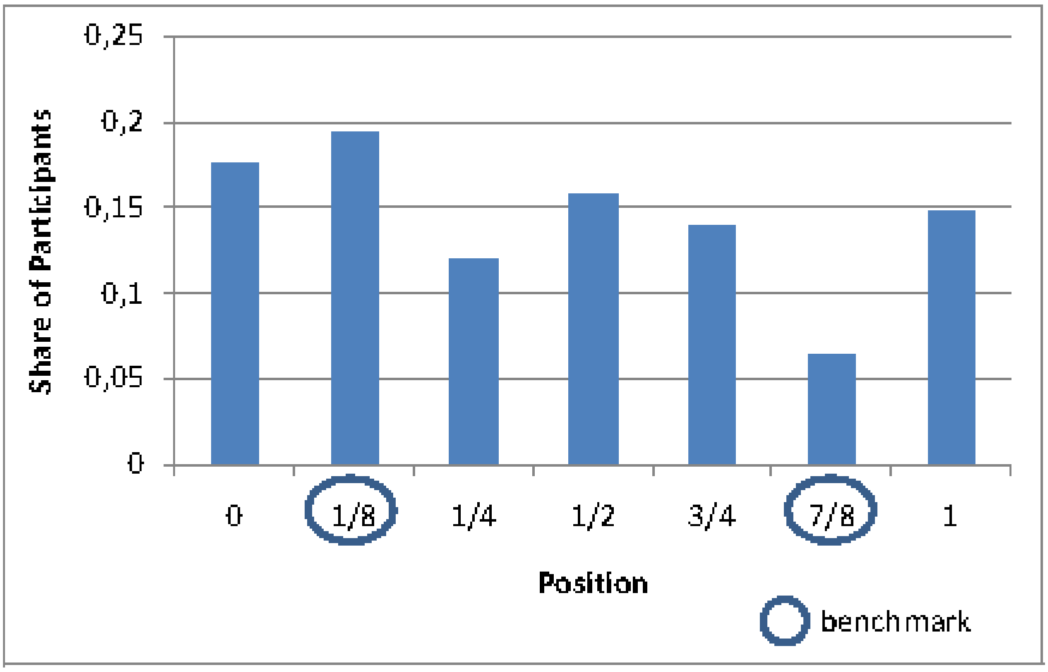

Figure 2: Relative Frequencies of Chosen Positions (I2)

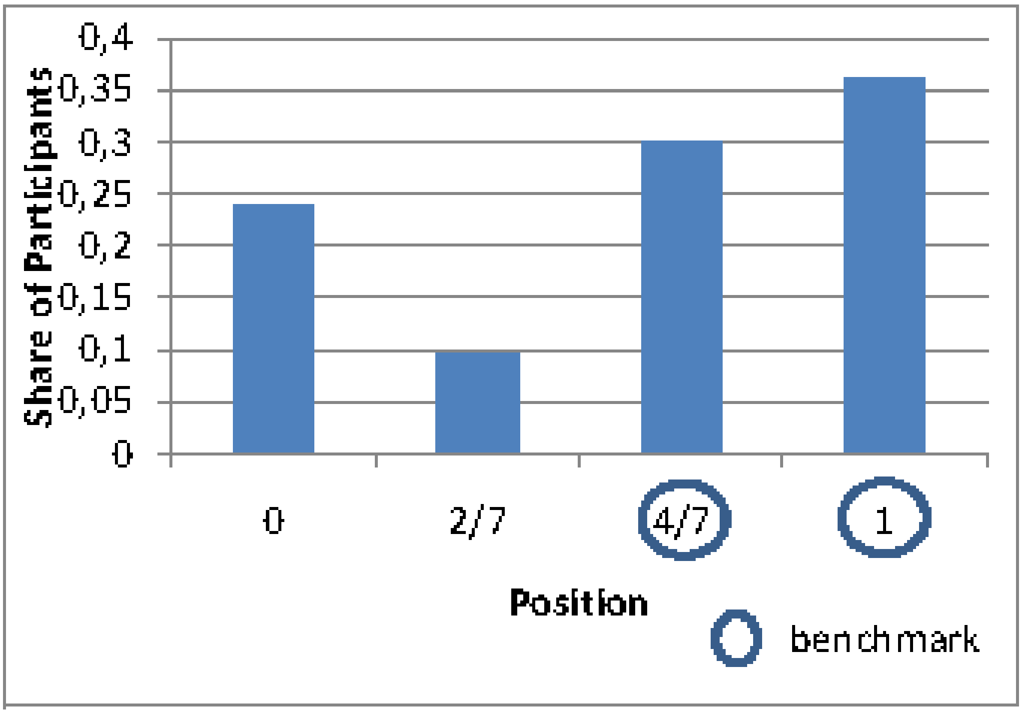

Figure 3: Relative Frequencies of Chosen Positions (I3)

between 5 and 16.21 with an average of 9.77. When only entrants are considered, the measure lies between 5.61 and 16.21, averaging 11.62.

In the market entry model with vertical innovation (I3), 75 percent chose to enter the game (neutral framing). 36 percent of those entering chose the ex-ante optimal position $x = 1$ and another 30 percent chose the inferior equilibrium position $x = 4/7$. Figure 4 shows the distribution of entrants' chosen positions in I3.

Again, participants entering the game earned on average considerably more (12.56 ECU) than those who did not (5 ECU). When assessing the performance of entrants in I3, we relied on the same procedure as in the innovation game with horizontal differentiation (I2). The resulting performance measure for entrants and non-entrants lies between 0 and 31.58 with an average of 11.42. When only entrants are included, the measure lies between 0 and 31.58, averaging 13.52.

due to the inelastic market demand, the position of the monopolistic firm does not matter.

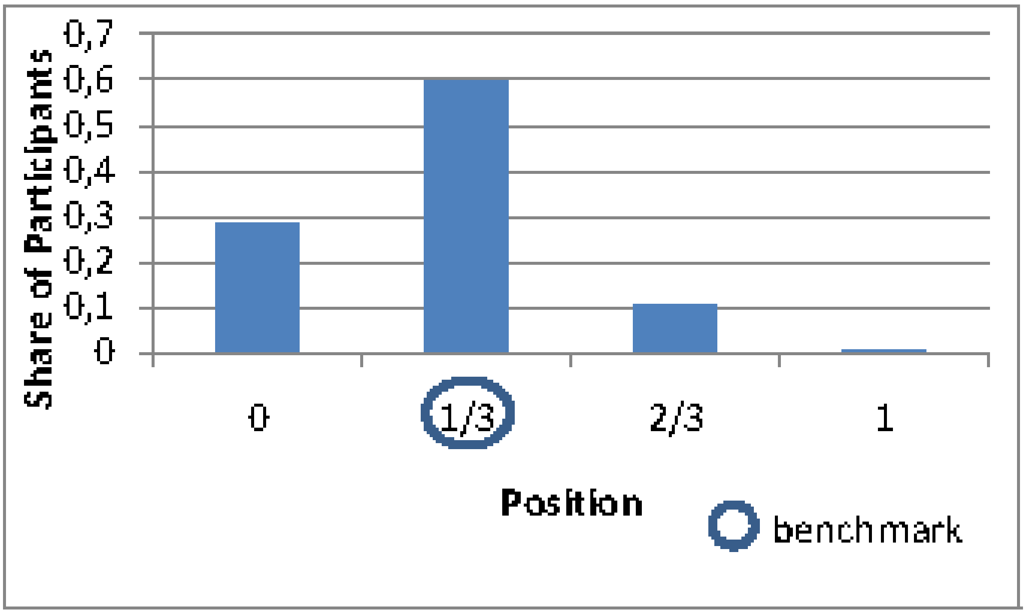

Figure 4: Relative Frequencies of Chosen Positions (I4)

In the process-innovation game (I4), an even higher percentage of participants (81 percent) chose to enter the game. 60 percent of those chose the ex-ante optimal position 1/3. Figure 5 shows the distribution of entrants' chosen positions in I4.

Concerning earnings, again those entering earned on average considerably more (17.74 ECU) than those who did not (5 ECU). When assessing the performance of entrants in I4, we relied on the same procedure than in game I2 and I3. The resulting performance measure for entrants and non-entrants lies between 5 and 19.32 with an average of 15.38. When only entrants are included, the measure lies between 11.23 and 19.32, averaging 17.76.

Altogether in all four innovation games at least two thirds of all participants have invested and usually earned considerable more than those shying away from risk and competition. In the following we will try to assess what distinguishes those who invest from those who prefer to play save by considering their individual traits and inclinations as elicited by the other tasks.

4 What Drives Innovative Capability? - Exploratory Results

To test whether innovative capabilities are related to analytical skills, creativity and personality, we relied on two basic measures of a participant's innovative capability: (i) a participant's decision to enter the market in the innovation games I1-I4, as a prerequisite for innovation (subsection 4.1) and (ii) a participant's performance in the innovation games - as assessed against the market of their respective session (subsection 4.2).

4.1 Market Entry

Let us first have a look at participants' entry decisions in the different innovation games. The share of participants entering these games varied between 66 percent in the R&D contest game (I1) and 81 percent in the process-innovation game (I4). The average earnings of those participants entering the game in I2, I3 and I4 are significantly above the earnings of those not entering. This suggests to explore the determinants of participants' entry decisions. More specifically we ask: is the entry decision of a particular participant in any of the innovation games related to his analytical skills, creativity, risk tolerance and personality traits?

Table 1 displays the correlations between entry in the different innovation games on the one hand and participants' creativity, analytical skills, risk tolerance and personality traits (self-control, anxiety, independence, tough-mindedness and extraversion) on the other. Concerning a participant's analytical skills and creativity, we measured these by performance indices, i.e., by the sum of a participant's standardized earnings in the L-tasks as a measure of his analytical skills and by the sum of a participant's standardized earnings in the C-tasks as a measure for his creativity.

We find that entry into the process innovation game I4 is positively related to creativity (r=0.24), analytical skills (r=0.14), self-assessed risk-tolerance (r=0.14), independence (r=0.16) and tough-mindedness (r=0.15). Market entry in the innovation game with vertical differentiation (I3) is only related to self-assessed risk tolerance (r=0.14), and market entry in I2 (horizontal differentiation) is positively related to risk tolerance (self assessed: r=0.27; lottery question: r=0.15). Market entry in the

	I1	I2	I3	I4	I-Index
Creativity				0.24***	0.17**
Analytical Skills				0.14*	
Risk Tolerance					
Lottery		0.15*			
Self-assessment		0.27***	0.14*	0.14*	0.25***
Personality					
Self-control					
Anxiety					
Independence				0.16*	
Tough-Mindedness				0.15*	
Extraversion					

*,** ,***: 10-percent-, 5-percent-, 1-percent-significance level

Table 1: Entry in I-Games: Correlations.

k-task that aimed at measuring a combination of innovative behavior and (verbal) creativity, is neither related to participants' creativity based on the different C-tasks, nor to their analytical skills or risk tolerance. Concerning participants' personality traits, we find a slightly positive relation (r=0.15 on a 10-percent significance level) between market entry in the k-game and extraversion, an aspect which often turns out as relevant (see, e.g., Brandstätter and Güth 2002, Brandstätter and Königstein 2001).

In addition to separately looking at market entry in the four innovation games, we created an additive index for the entry decisions in the four games. We find that the latter is positively related to a participant's creativity (r=0.17) and also to self-assessed risk tolerance (r=0.25). Summing up, risk tolerance and creativity seem to play the most important role in determining participants' entry decisions in the innovation games.

Result 1: Entry into the innovation games is positively related to risk tolerance and creativity.

4.2 Innovation Performance

As explained in section 3, we assess participants' innovation performance by looking at their earnings in the respective game. Regarding entrants, however, we did not take their actual earnings as a performance indicator, but rather assessed their performance against the respective "market" in their session. Besides looking at a participant's performance in each different I-task, we also created a performance index by summing up the (standardized) performance measures from the different I-tasks.

	I1	**I2**	**I3**	**I4**	**I-Index**
Creativity			0.27***	0.25***	0.24***
Analytical Skills			0.17**	0.16*	0.14*
Risk Tolerance					
Lottery					0.15*
Self-assessment	0.15*	0.21**			0.24***
Personality					
Self-control			-0.20**		
Anxiety		-0.18**			-0.16**
Independence				0.18**	0.14*
Tough-Mindedness				0.16*	0.15*
Extraversion					

*,** ,***: 10-percent-, 5-percent-, 1-percent-significance level

Table 2: Performance of all Participants in I-Games: Correlations.

Table 2 displays the correlations between the innovation performance measures (separate games and index) on the one hand and creativity, analytical skills, risk tolerance and personality traits on the other. Again, creativity and risk tolerance play the most important role (with r=0.24 for the innovation performance index), followed by analytical skills (r=0.14) and some of the personality traits. Concerning the latter, however, there does not seem to be a clear pattern with respect to the different games. Performance in the k-task measuring a combination of innovative behavior and (verbal) creativity, is - again - not related to participants' creativity based on the different C-tasks, analytical skills and risk tolerance. With the exception of self-control, where we find a positive relation of r=0.16 on a 10-percent significance level, performance in the k-task is also unrelated to participants' personality traits. Hence, we conclude:

Result 2: Participants' performance in the innovation games is positively related to their creativity, risk tolerance and - to a lesser extent - to participants' analytical skills.

	I1	**I2**	**I3**	**I4**	**I-Index**
Creativity			0.30***		0.22*
Analytical Skills			0.19**		
Risk Tolerance					
Lottery					
Self-assessment					
Personality					
Self-control		-0.19*	-0.29***		
Anxiety		-0.17*			
Independence					
Tough-Mindedness					
Extraversion	0.20*			-0.15*	

*,** ,***: 10-percent-, 5-percent-, 1-percent-significance level

Table 3: Performance of Entrants in I-Games: Correlations.

If we only include those participants in the correlation analyses who entered the market and actually played the innovation games and exclude those not entering by keeping their initial endowment (see Table 3), we do no longer find a correlation between innovation performance and risk tolerance. I.e., a higher risk tolerance increases the probability that a participant will enter the innovation games, but once somebody entered, innovation performance is no longer affected by risk tolerance. Also, the relation between innovation performance on the one hand and creativity or analytical skills on the other becomes weaker when the non-entrants are excluded from the analysis - partly resulting from the reduced number of observations. Concerning k-task performance, there are no changes compared to the analysis including entrants and non-entrants.

Result 3: Entrants' performance in the innovation games is not related to their risk tolerance.

	Ia	**Ib**	**IIa**	**IIb**
Creativity	0.22**	0.27***	0.25*	0.24
Analytical Skills	-0.01	-0.05	-0.14	-0.22
Risk Tolerance				
Lottery	-	0.06	-	-0.02
Self-assessment	0.07**	-	-0.02	-
Personality				
Self-control	-0.05*	-0.07**	-0.09**	-0.08**
Anxiety	-0.02	-0.04	-0.07	-0.06
Independence	0.03	0.03	0.05	0.05
Tough-Mindedness	0.02	0.01	0.01	0.02
Extraversion	-0.05	-0.03	-0.05	-0.06
Constant	0.68	0.78*	0.77	0.63
N	150	140	64	60
Prob>F	0.0002	0.0002	0.0044	0.0197
R^2	0.16	0.15	0.17	0.16

*,** ,***: 10-percent-, 5-percent-, 1-percent-significance level

Table 4: Performance in I-Games: OLS-Regressions.

In a last step, we analyzed the differential impact of the potential drivers of innovation performance by running a regression with the index of participants' innovation performance as the dependent variable and participants' creativity, analytical skills, risk tolerance (two different measures in two separate regressions) and personality traits as explanatory variables. If we include all participants (i.e., those entering the innovation games and those that did not, see Table 4, model Ia and Ib), we find participants' innovation performance to be significantly affected by their creativity, self-control and self-assessed risk tolerance (when we use the lottery question, the respective coefficient only slightly misses statistical significance with $p = 0.107$). If we only include the entering participants in the regression (see Table 4, models IIa and IIb), risk tolerance and innovation performance are no longer related (irrespective of the measure chosen). In the regression using the measure of self-assessed risk tolerance, however, creativity and self-control, remain influential.

Result 4: In a multivariate analysis, participants' innovation performance is related to their creativity, risk tolerance and self-control. Once participants decided to enter the innovation games, however, their innovation performance is no longer affected by their risk tolerance.

5 Summary and Discussion

Concerning the potential drivers of innovative capability, we find our measures of innovation performance and market entry to be related to creativity, self-control and risk tolerance. The latter, however, only influences participants' entry decision and not so much their performance as innovators. The capability to innovate thus seems to be the willingness to engage in risk and competition which is enhanced by individual creativity, self-control and risk tolerance.

Interestingly, a participant's success in the innovation games and his analytical capabilities are unrelated. This is surprising since analyzing the innovation games is quite demanding. Apparently, intuitive behavior seems to dominate throughout so that those capable of a more thorough analysis do not fare better. Of course, the graphs, provided to participants when choosing their investments, might have compensated for a lack in analytical skills.

Risk tolerance partly matters even when the innovation games are deterministic. This renders the "risk question" of GSOEP more adequate than the narrowly defined risk attitude, based on the curvature of utility curves.

Playing innovation games does not differ much from confronting the usual game-theoretic paradigms of experimental economics and (social) psychology. Does entering and acting in innovation games really capture innovative potential? We included the k-task which seems to better capture our intuition what innovation requires. Since the findings for the k-task (entering the k-task is unrelated to analytical skills and risk tolerance) mainly confirm those for the innovation games we are now more confident of using innovation games. Their main disadvantage is only that they capture insufficiently the organizational and social skills of successful innovators which could be related to extraversion, a personality trait weakly related to entering the k-task.

Our exploratory study suggests that the up-to now quite separate traditions of psychological creativity research and of innovation economics might be combined to promote a better understanding of innovation behavior in- and outside the lab. However, the fact that the measured correlations between innovation performance and creativity are not overwhelmingly large in size, hints at other factors apart from creativity being crucial for innovation behavior. As shown by Glynn (1996), "organizational intelligence" might be of particular relevance here which unfortunately is not or, at best, only poorly captured by our different tasks. In future research one might therefore complement out battery of tasks by further ones, suitable for assessing organizational and social intelligence as seemingly important aspects of innovative capability.

References

Anderson, S.P., Goeree, J.K., Ramer, R. (1997), Location, Location, Location. Journal of Economic Theory 77, 102-127.

Brandstätter, H. (2010), Persönlichkeits-Adjektiv-Skalen (PASK5) Manual. Universität Linz.

Brandstätter, H., Güth, W. (2002), Personality in Dictator and Ultimatum Games. Central European Journal of Operations Research 10, 191-215.

Brandstätter, H., Königstein, M. (2001), Personality Influences on Ultimatum Bargaining Decisions. European Journal of Personality 15, 53-70.

Choi, C., Shin, H. (1992), A Comment on a Model of Vertical Product Differentiation. Journal of Industrial Economics 40, 229-232.

D'Aspremont, C., Gabszewicz, J.J., Thisse, J.-F. (1979), On Hotelling's Stability in Competition. Econometrica 47, 1145-1150.

D'Aspremont, C., Jacquemin, A. (1988), Cooperative and Noncooperative R&D in Duopoly with Spillovers. American Economic Review 78, 1133-1137.

Fischbacher, U. (2007), Zurich Toolbox for Readymade Economic Experiments. Experimental Economics 10, 171-178.

Flaig, G., Stadler, M. (1994), Success Breeds Success. The Dynamics of the Innovation Process. Empirical Economics 19, 55-68.

Flaig, G., Stadler, M. (1998), On the Dynamics of Product and Process Innovations. A Bivariate Random Effects Probit Model. Journal of Economics and Statistics 217, 401-417.

Furnham, A., Bachtiar, V. (2008), Personality and Intelligence as Predictors of Creativity. Personality and Individual Differences 45, 613-617.

Glynn, M.A. (1996), Innovative Genius: A Framework for Relating Individual and Organizational Intelligence to Innovation. Academy of Management Review 21, 1081-1111.

Holt, C. A., Laury, S. K. (2002), Risk Aversion and Incentive Effects. American Economic Review, 92, 1644-1655.

Kukuk, M., Stadler, M. (2001), Financing Constraints and the Timing of Innovations in the German Services Sector. Empirica 28, 277-292.

Kukuk, M., Stadler, M. (2005), Market Structure and Innovation Races. An Empirical Assessment Using Indirect Inference. Journal of Economics and Statistics 225, 427-440.

Loury, G.C. (1979), Market Structure and Innovation. Quarterly Journal of Economics 93, 395-410.

Malerba, F. (2007), Innovation and the Dynamics and Evolution of Industries. Progress and Challenges. International Journal of Industrial Organization 25, 675-699.

Nti, K.O. (1997), Comparative Statics of Contests and Rent-Seeking Games. International Economic Review 38, 43-59.

Schmutzler, A. (2012), Cost-reducing Investments. Experimental Results. Homo Oeconomicus, this volume.

Vives, X. (2008), Innovation and Competitive Pressure. Journal of Industrial Economics 56, 419-469.