



# JENA ECONOMIC RESEARCH PAPERS



# 2011 – 056

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[www.jenecon.de](http://www.jenecon.de)

ISSN 1864-7057

The JENA ECONOMIC RESEARCH PAPERS is a joint publication of the Friedrich Schiller University and the Max Planck Institute of Economics, Jena, Germany. For editorial correspondence please contact [markus.pasche@uni-jena.de](mailto:markus.pasche@uni-jena.de).

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# Creativity, Analytical Skills, Personality Traits, and Innovation Game Behavior in the Lab: An Experiment<sup>+</sup>

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

November 2, 2011

## Abstract

Innovative behavior is mostly studied theoretically, e.g., in models of patent races, and empirically, e.g., by using R&D or patent data. This research, however, is only poorly informed about the psychological tradition of creativity research. Our study is an attempt to experimentally collect behavioral data revealing in how far creativity, analytical skills, personality traits and innovation game behavior in the lab are interrelated. With the help of a within-subject design we find that participants' performance in the innovation games is in fact related to their creativity, risk tolerance and self-control. Other personality traits such participants' anxiety, independence, tough-mindedness and extraversion, if any, only play a minor role, and the same is true for participants' analytical skills.

Keywords: Creativity; personality traits; innovation games; experiments

JEL Classification: C91, L13, O31

<sup>+</sup> The authors gratefully acknowledge the very helpful and constructive comments by Anke Gerber helping us with our revision after presenting the paper at the Ottobeuren Seminar.

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## 1 Introduction

In an increasingly globalized world, innovative capabilities gain more and more importance for the developed countries to stay ahead in technological competition. In order to maintain and enhance their innovative potential, developed economies increasingly rely on a large pool of entrepreneurs, inventors, and innovators as well as venture capitalists. While the institutional preconditions of an increased innovative potential have repeatedly been studied (see, e.g., Malerba 2007, Vives 2008), we explore if and how individual characteristics such as creativity, analytical skills and personality traits affect innovative capability.

To do so, we assume an empirical-experimental and very speculative approach. Instead of conducting a questionnaire-survey on startup firms, we rather explore the question experimentally. We do so because studies using questionnaire data on firms' innovative activities suffer from two main difficulties: (i) they often neglect or only eclectically elicit individual capabilities and characteristics (see, e.g., Flaig and Stadler 1994, 1998, Kukuk and Stadler 2001, 2005), and (ii) in general it is not clear who answered the questionnaire and whether the person who did is responsible for innovative activities.

What will be provided here is no substitute for field research on innovation and does not question its empirical superiority, but hopefully is a helpful supplement that avoids some of its problems, e.g., by allowing for better control in data elicitation. Further, in an attempt to measure innovative capabilities more robustly, we *systematically* bring different innovation games to the lab. 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 social skills of successful innovators.

In our paper, we study innovation behavior experimentally using a within subjects design (all participants in the experiment are confronted with all of the experimental tasks). While this is not entirely new (see, e.g., the review by Schmutzler 2011), we add to the literature by not only focusing on the decision paradigms studied in the IO literature but open our eyes to the field of creativity research in psychology where one tries to explore how individuals differ in creative problem solving, and how this may be interrelated with personality traits (see, e.g., Furnham, Bachtar 2008).

Including psychological creativity research implies that we focus on the individual

rather than on an individual's social and institutional embeddedness. This obviously neglects some crucial aspects of innovation, e.g., successful innovators' social network (see, e.g., Cowan et al. 2004, Goyal and Moraga 2001). Also because of this deficiency, we consider our experimental study only as a supplement of field research of innovation and of more broadly defined innovation experiments. However, the usual neglect of psychological creativity research, as undertaken, e.g., by Glynn (1996), might represent a serious drawback of the current innovation research in economics.

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 and personality traits. While the applied scales and measures of participants' creativity, analytical skills, risk tolerance and personality did not involve any interaction, we relied on strategic IO games to measure participants' innovative capability. In what follows, we first describe how we assessed our central construct, participants' innovative capabilities, with the help of a set of IO games, and then proceed with how we measured participants' creativity, analytical skills, risk tolerance and personality traits.

## 2.1 Assessing Innovative Capabilities with the help of IO Innovation Games

In order to grasp the diversity and width of innovation games and concepts, we included four different innovation games in our experiment (I1-I4): an R&D contest (I1), one market entry model with horizontal differentiation (I2) and one with vertical differentiation (I3), and a game of non-drastic process innovation (I4). When bringing the innovation games to the lab, we partly framed them and we 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 prize  $V$  of the contest. Using a simple contest success function the expected profits of firms 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 Nti 1997). We used the values  $V = 15$  and  $r = 2$  so that

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

The symmetric equilibrium strategy of the firms in this game is  $x^* = (7 + \sqrt{465})/8 \approx 3.57$ .

In the R&D contest game, participants were endowed with a sum of 5 ECU (Experimental Currency Unit, where 1 ECU translated into 1 EUR). Participants' decision was twofold: either they could decide not to enter the game and keep the 5 ECU for themselves or they could decide to invest 1, 2, 3 or 4 ECU in the 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 model, 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 of Anderson, Goeree and Ramer (1997), the reduced-form profit functions, depending only on the locations  $x_1$  and  $x_2$ , read as

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

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

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

The equilibrium of this game is  $(x_1^*, x_2^*) = (1/8, 7/8)$ .

In the market entry model with horizontal differentiation, participants again were 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 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 model. 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

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

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

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

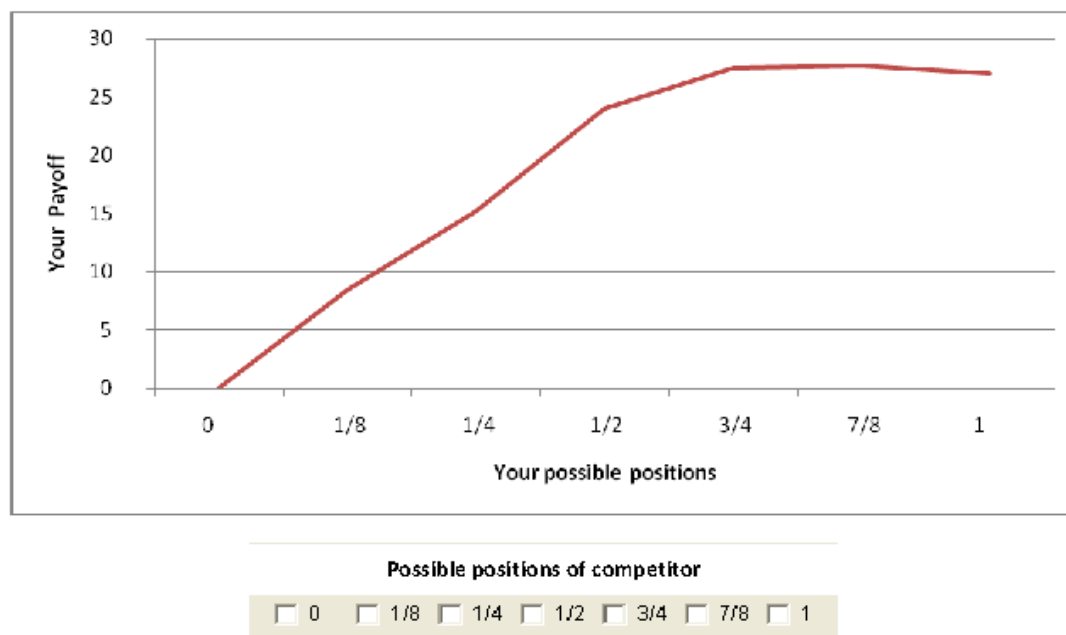


Figure 1: Screenshot I2

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

The equilibrium of this game is  $(x_1^*, x_2^*) = (4/7, 1)$ .

In the market entry model with vertical differentiation, participants were also endowed with a sum of 5 ECU, which they could either keep for themselves or invest in the game. 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 possibly take and then confronted them with a graph displaying their payoffs depending on their own choice. In contrast to game I2 with horizontal differentiation, we deliberately refrained from framing this question, 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 non-drastic process innovation, analogous to the R&D-then-quantity game of D’Aspremont and Jacquemin (1988). In the first stage firms  $i = 1, 2$  set R&D expenditures  $x_i^2$  and in

the second stage 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

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

The symmetric equilibrium strategy of the firms in this game is  $x^* = 1/3$ .

As in I2 and I3, in the process innovation game I4, participants were 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, 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 how their payoffs would vary depending on their own choice and given the expectations they formed. 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 participants with a set of tasks that each required some kind of “stepping beyond” and leaving the traditional paths of thinking. E.g., in task C2 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 (a) confronted them with a lottery question (see Holt and Laury 2002) and, (b) 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 as well. When, in the following, 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 on participants' risk tolerance).

The experiment was programmed in z-tree (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 that required 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 of participants' innovative capabilities is central, we devote this section to a detailed description of participants' choices and performance in the four IO 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 IO 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 put the resulting performance measure highly at random), 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.

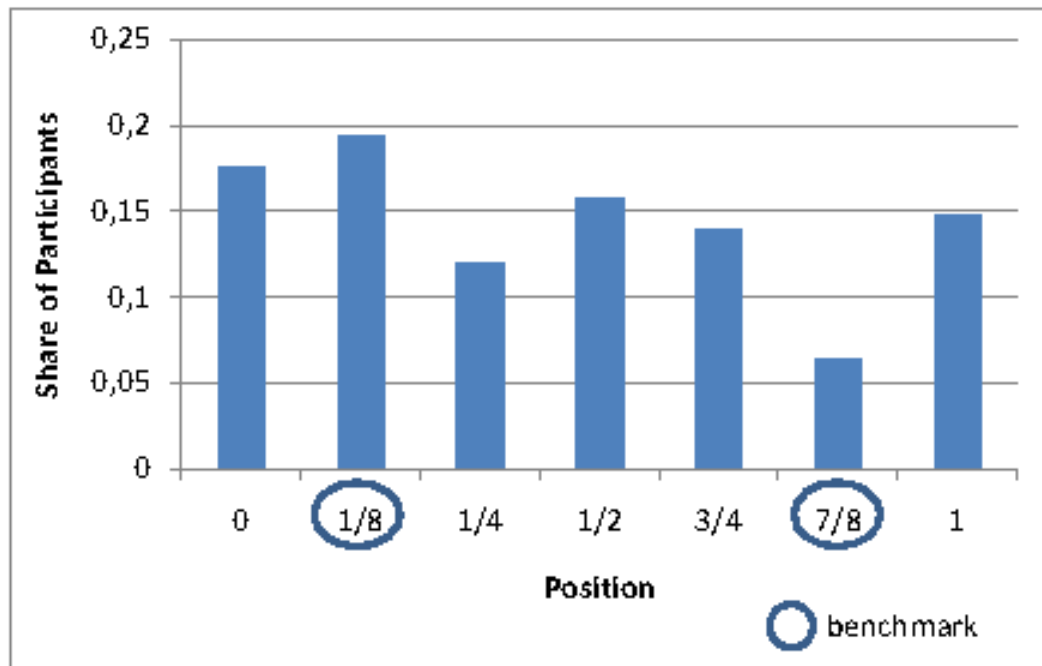


Figure 2: Relative Frequencies of Chosen Positions (I2)

In the market entry model with horizontal differentiation (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). When assessing the performance of entrants in I2, we again assessed their performance "against the market" - this time however only relying on those other participants in the same session who also entered. The resulting performance measure for entrants and non-entrants lies 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 differentiation (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

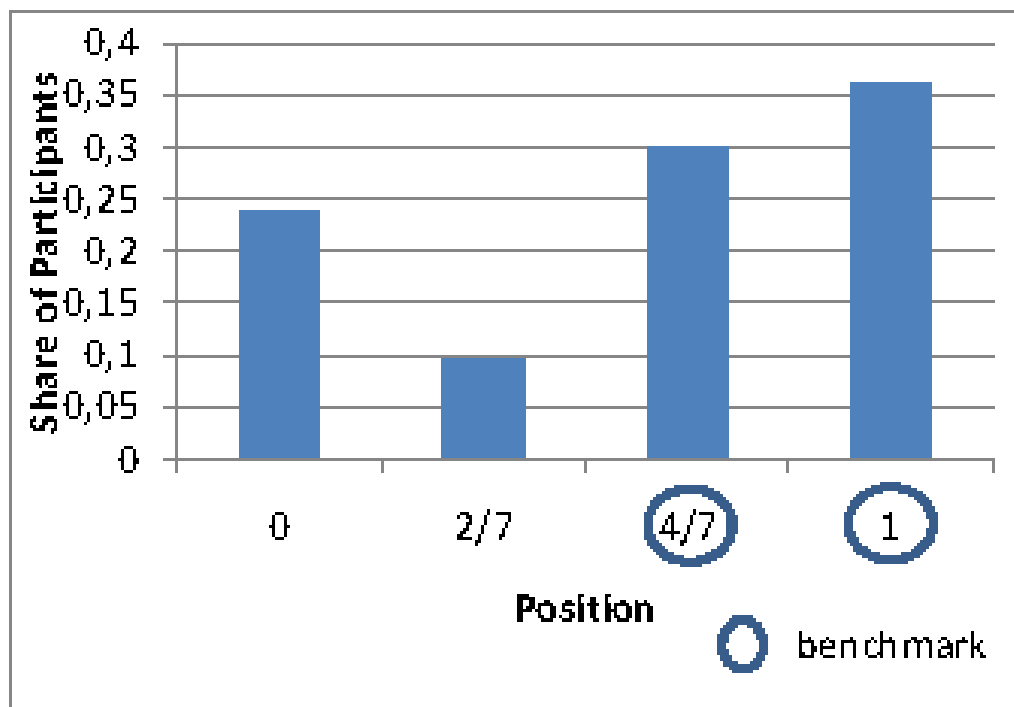


Figure 3: Relative Frequencies of Chosen Positions (I3)

$x = 4/7$ . Figure 4 shows the distribution of entrants' chosen positions in I3.

**Result 1:** When entering a horizontal or vertical location game, most participants try to avoid close interaction by distancing themselves from their competitor.

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.

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

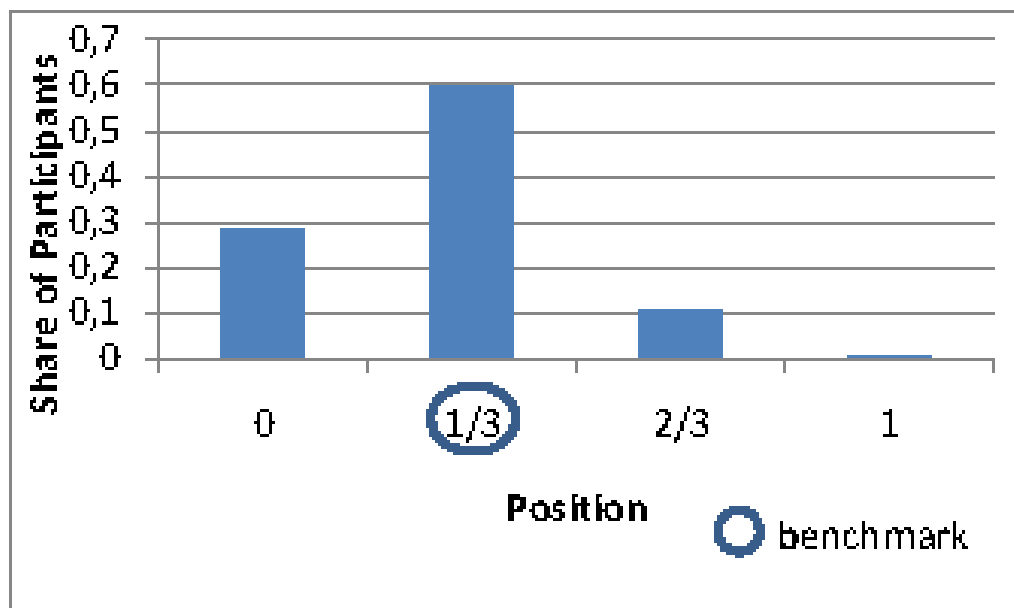


Figure 4: Relative Frequencies of Chosen Positions (I4)

(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.

**Result 2:** Without the possibility of learning the experimental support for equilibrium behavior is meager in case of multiple equilibria. This may reflect the coordination problem for which we did not offer any help like, for instance, allowing for “cheap talk”-communication and coordination.

#### 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:

(a) a participant's decision to enter the market in the innovation games I1-I4, as a prerequisite for innovation (see subsection 4.1) and (b) a participant's performance in the innovation games - as assessed against the market of their respective session (see subsection 4.2)

## 4.1 Market Entry

Let us first look at participants' entry decisions in the different innovation games. The share of participants entering the innovation 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. And more specifically: 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:  $r=0.15$ ). 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 his or her self-assessed risk tolerance ( $r=0.25$ ). Market entry in the k-task that aimed at measuring a combination of innovative behavior and (verbal) creativity, is neither related to participants'

|                          | I1 | I2      | I3    | I4      | I-Index |
|--------------------------|----|---------|-------|---------|---------|
| <b>Creativity</b>        |    |         |       | 0.24*** | 0.17**  |
| <b>Analytical Skills</b> |    |         |       | 0.14*   |         |
| <b>Risk Tolerance</b>    |    |         |       |         |         |
| Lottery                  |    | 0.15*   |       |         |         |
| Self-assessment          |    | 0.27*** | 0.14* | 0.14*   | 0.25*** |
| <b>Personality</b>       |    |         |       |         |         |
| 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.

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). Summing up, risk tolerance and creativity seem to play the most important role in determining participants' entry decisions in the IO games.

**Result 3:** Entry into the innovation games is positively related to participants' 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.

|                          | <b>I1</b> | <b>I2</b> | <b>I3</b> | <b>I4</b> | <b>I-Index</b> |
|--------------------------|-----------|-----------|-----------|-----------|----------------|
| <b>Creativity</b>        |           |           | 0.27***   | 0.25***   | 0.24***        |
| <b>Analytical Skills</b> |           |           | 0.17**    | 0.16*     | 0.14*          |
| <b>Risk Tolerance</b>    |           |           |           |           |                |
| Lottery                  |           |           |           |           | 0.15*          |
| Self-assessment          | 0.15*     | 0.21**    |           |           | 0.24***        |
| <b>Personality</b>       |           |           |           |           |                |
| 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 4:** Participants' performance in the innovation games is positively related to their creativity, risk tolerance and - to a weaker extent - to participants' analytical

skills.

|                          | I1    | I2     | I3       | I4     | I-Index |
|--------------------------|-------|--------|----------|--------|---------|
| <b>Creativity</b>        |       |        | 0.30***  |        | 0.22*   |
| <b>Analytical Skills</b> |       |        | 0.19**   |        |         |
| <b>Risk Tolerance</b>    |       |        |          |        |         |
| Lottery                  |       |        |          |        |         |
| Self-assessment          |       |        |          |        |         |
| <b>Personality</b>       |       |        |          |        |         |
| 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.

When 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 he decided to enter, 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 once the non-entrants are excluded from the analysis - possibly resulting from the reduced number of observations  $n$ . Concerning k-task performance, there are no changes compared to the analysis where we include entrants and non-entrants in the analysis.

**Result 5:** Entrants' performance in the innovation games is not related to their risk tolerance.

In a last step, we analyzed the differential impact of the potential drivers of innovation performance by running a regression with the index on participants' innovation

|                          | Ia     | Ib      | IIa     | IIb     |
|--------------------------|--------|---------|---------|---------|
| <b>Creativity</b>        | 0.22** | 0.27*** | 0.25*   | 0.24    |
| <b>Analytical Skills</b> | -0.01  | -0.05   | -0.14   | -0.22   |
| <b>Risk Tolerance</b>    |        |         |         |         |
| Lottery                  | -      | 0.06    | -       | -0.02   |
| Self-assessment          | 0.07** | -       | -0.02   | -       |
| <b>Personality</b>       |        |         |         |         |
| 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.

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. When 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  $p = 0.107$ ). When instead 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, creativity and self-control, however, remain influential.

**Result 6:** Also 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 for 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 innovation performance.

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. In fact, the graphs provided might have helped participants to compensate for a potential lack in analytical skills.

Risk tolerance partly matters even when the innovation games are deterministic what renders the "risk question" of GSOEP more adequate than the narrowly defined risk attitude, based on utility of money-curves. Playing innovation games, of course, does not differ much from confronting the usual game-theoretic paradigms of experimental economics and (social) psychology. We were sceptical whether entering and acting in innovation games captures innovative potential and therefore 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 our conclusions for the innovation games we are now more confident of using innovation games. It seems that what they mainly do not capture, are the organizational and social skills of successful innovators which could be related to extraversion, a personality trait which is weakly related to entering the k-task.

The major message of our exploratory study seems to be that the so far quite separate traditions of psychological creativity research on the one hand and innovation economics on the other should be combined in the future 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.

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