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Holding On for Too Long? An Experimental Study on Inertia in Entrepreneurs' and Non-Entrepreneurs' Disinvestment Choices

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Abstract

Disinvestment, in the sense of project termination and liquidation of assets, is an important realm of entrepreneurial decision-making which has still not been entirely investigated. This study presents the results of an experimental investigation modelling the choice to disinvest as a dynamic problem of optimal stopping in which the value of flexibility is manipulated and the patterns of decisions of entrepreneurs and non-entrepreneurs are compared. The experimental evidence is then confronted with the benchmark predictions of traditional and new investment theory, as represented respectively by the Net Present Value and Real Options Approach. The experimental results reject the Net Present Value approach and reveal a significant correlation between the behavior observed experimentally and the theoretical predictions of the Real Options Approach, but also provide evidence for psychological inertia, which can be related to the status-quo phenomena. The study provides evidence for entrepreneurs being slightly more prone than non-entrepreneurs to holding on to a project for too long.

Keywords: Real-Options, Disinvestment, Exit Behavior, Experimental Economics

Zusammenfassung

Desinvestitionsentscheidungen, im Sinne von Projektabbruch und Liquidation, stellen einen sehr wichtigen Aspekt der unternehmerischen Praxis dar, für den nach wie vor ein erheblicher Untersuchungsbedarf besteht. Diese Studie präsentiert die Ergebnisse einer experimentellen Untersuchung bei der eine Desinvestitionsentscheidung als dynamisches Optimal-Stopping-Problem mit unterschiedlichen Volatilitäten modelliert wird. Darüber hinaus werden die Entscheidungen von Unternehmern denen von Nicht-Unternehmern gegenübergestellt. Die experimentellen Resultate werden mit den normativen Vorhersagen der traditionellen und der neuen Investitionstheorie (am Beispiel des finanztheoretischen Gegenwartskonzeptes bzw. des Realoptionenansatzes) konfrontiert. Die experimentelle Ergebnisse lehnen die deskriptive Validität des finanztheoretischen Gegenwartskonzeptes ab und deuten auf die signifikante Korrelation zwischen dem Verhalten im Experiment und den Vorhersagen des Realoptionenansatzes hin. Die Befunde liefern darüber hinaus Evidenz für psychologische Inertia, die mit dem Status-Quo-Phänomen in Verbindung gebracht werden kann. Die Studie zeigt weiterhin die leichte Tendenz von Unternehmern auf, eher als Nicht-Unternehmer an einem laufenden Projekt festzuhalten.

Schlüsselwörter: Realoptionen, Desinvestition, Exit-Entscheidungen, experimentelle Ökonomie

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1. Introduction

This study aims at investigating the effects of irreversibility, in the sense of asset specificity and risk,[1] on the disinvestment behavior of entrepreneurs. In spite of the importance of disinvestment decisions, including termination of projects and entrepreneurial exit, this topic still received insufficient attention in the entrepreneurial research (DeTienne, 2008; McGrath, 1999). Trying to contribute to filling this gap, this study investigates, via an experiment on asset liquidation, the timing with which the decision to abandon a project with uncertain returns is taken.

Concerning entrepreneurial disinvestment choices, there is no more than anecdotic evidence of founders dying "in the saddle" rather than selling their venture "under price" as well as of young entrepreneurs developing their project by burning their own and the aunt's bank account instead of terminating their business idea. With the main aim to explain the reluctance to "pull the plug" on a business, sticking to it for too long and postponing its termination and selling of underlying assets, this study tests whether the Real Options Approach provides a suitable theoretical framework according to which the tendency to postpone exit and termination choices can be rationalized.

In the same experimental setting we tested and compared disinvestment behavior of high-tech entrepreneurs and non-entrepreneurs, relying thus on the experimental method as a way to analyze entrepreneurial behavior and, interpreting entrepreneurial decision making as a paradigm, to gain a deeper insight on the decision mechanisms underlying entrepreneurial choices (Schade / Burmeister-Lamp, 2009). Testing the response of entrepreneurs might yield interesting results, as professionals can be expected to be more acquainted than non-entrepreneurs with investment tasks and therefore to rely on different decision heuristics and strategies. Furthermore, empirical research on entrepreneurial decision-making has demonstrated that entrepreneurs might differ from other individuals in their personality traits, cognition (Busenitz / Lau, 1996), and behavior, as they might be differently affected by certain cognitive biases (Busenitz / Barney, 1997; Parlich / Bagby, 1995). Among else, they seem to be more susceptible to overconfidence (Olson, 1986; Forbes, 2005; Koellinger et al., 2005), to over-value their chances of success (Cooper et al. 1988), and to make more extensive use of some heuristics (Busenitz / Barney, 1997).

The relevance of our research question for entrepreneurship makes the comparison between termination choices of entrepreneurs and non-entrepreneurs essential: project termination and entrepreneurial exit are associated with a very significant flow of economic resources and yield profound implications for the dynamics of an economic system. A better understanding of

[1] More specifically, an irreversible decision can be defined as a decision which "shrinks the space of available options" (Ramani / Richards, 1993), or in other words a decision evoking an outcome that cannot be reversed at least in the short term (Henry, 1974) and / or for free (Pyndick, 1991).

drivers and patterns of behavior of entrepreneurs dealing with disinvestment might therefore provide useful implications. It could for example account for the reluctance to invest and the tendency toward conservativeness as they can be observed in the realm of agricultural investments (Odening / Mußhoff / Balmann, 2005), but might also help us understand some dynamics underlying project termination and entrepreneurial exit regarding its timing. Gaining a more realistic insight on disinvestment choices might also contribute to consulting practice in particular for overwhelming what can be labelled as "anti failure bias" (which, as e.g. signalised by McGrath, 1999, also affects entrepreneurship research) and overcoming some typical behavioural biases.

Two experiments on irreversible project termination choices were run, observing respectively how individuals deal with different volatilities and whether disinvestment behaviour differs between high-tech entrepreneurs and non-entrepreneurs. The study tests the normative predictions of the traditional and new investment theory (respectively represented by Net Present Value and Real Options approach) as well as behaviourally motivated hypotheses, encompassing findings from cognitive psychology regarding choices under risk (Kahneman / Tversky, 1979), and discusses the occurrence of biases (Burmeister / Schade, 2007). In particular, we differentiate between an 'options-based'-based, i.e. consistent with the Real Options predictive, and a psychological inertia, which can be linked to the tendency to stick to the status-quo and to hold on to a project for too long.

The experimental examination of 'options like' situations is still in its beginning, so that even in this regard the present research moves from a relatively unexplored terrain. Among the previous experimental studies coming closest to the spirit of our investigation, a still un-published paper by Friedman, Oprea, and Anderson (2007) can be mentioned, which analyses whether individual behavior in an investment setting might, by learning, approximate the optimal exercise frontier for available options. Further, Rauchs and Willinger (1996), focussing on how increased expected information affect subjects' choices, provides evidence for the irreversibility effect, while Sirmans and Yavas (2005) try to elicit, in a very simple setting, subjective valuation for an option by asking the participants to submit a bid for it. Another option related design is discussed in Barner et al. (2005) which focus on information arrival and aggregation in an experimental asset markets.

As far as we know, the present study is however the first contribution dealing with disinvestment behavior and also measures individual coefficients of relative risk aversion. While in an investment task the timing cannot be disentangled from risk aversion, in the setting of project termination the effects of exit time preferences and risk attitudes may be mutually exclusive, depending on the risk preferences: while considering investment choices risk aversion should induce the postponement of entry time (so that the effects of encompassing the value of waiting and risk propensity might overlap), considering the choice to disinvest, risk aversion works opposite to the assessment of the termination option. This does not hold, however, for more risk seeking individuals, as it has been alleged to be the case for entrepreneurs. However, evidence on the risk attitudes of entrepreneurs is mixed (Brockhaus,

1980), with e.g. also differences between full- and part-time entrepreneurs (Elston / Harrison / Ruthström, 2005).

After deepening the motivation of this study, i.e. the significant advances a more realistic characterization of entrepreneurial disinvestment and exit choices might yield for the understanding of the entrepreneurial process, the theoretical background to which the study refers and the main normative propositions that can be derived on its basis are presented. A discussion of the behavioural hypotheses and the characterization of the experimental setting underlying two experiments on project termination choices follow. Differences of considering participants of different status (i.e. entrepreneurs vs. non entrepreneurs) are discussed as well. The experimental findings are then confronted with normative propositions and behavioural hypotheses and the behavior of entrepreneurs and non entrepreneurs is compared. This inspires some concluding remarks and implications of the study. Limitations of the present investigation and perspective for further research conclude.

2. Entrepreneurial Disinvestment and Exit

Disinvestment encompasses a broad and important spectrum of entrepreneurial choices, ranging from the decision to terminate a project, to liquidate assets in order to reorganize the business, up to the cession of a venture and the decision to leave the business. Decisions of this kind are extremely relevant for the entrepreneurial process and the life of a venture, as each entrepreneur will be, sooner or later, inevitably confronted with disinvestment choices of some sort, at least when he / she will decide to leave the venture. In spite of its relevance, there is still much need for analysis concerning the dynamics and the drivers which inspire, at the entrepreneurial level, the decision to disinvest as well as its timing.[2]

Further, even entrepreneurial exit can be modelled as an irreversible disinvestment decision. Exit choices are not deterministic decisions, as they do not only relate to the business profitability but also have to do with the options available to the entrepreneurs. The decision to exit a business emerges from a highly context dependent and subjective mixture of motivations (for more on entrepreneurial motivation see Shane / Locke / Collins, 2003), intentions (Krueger / Reilly / Carsrud, 2000), opportunity costs, options (McGrath, 1996), aspirations and goals (Sarasvathy, 2004). Far from being equivalent to failure, the decision to terminate a project is a constitutive part of the wealth creation which is associated with a business venture (Holmberg, 1991). Nevertheless, failure and the decision to disinvest and exit a business are still often associated, in particular in the case of lifestyle entrepreneurs, rather than with regard to serial (Ucbasaran / Wethead / Write, 2001) or habitual (MacMillan, 1986) entrepreneurs.

[2] For the application of a theory of entrepreneurship to entrepreneurial exit, modeling it like business transfer, see e.g. Holmes / Schmitz (1990).

Entrepreneurial exit can be defined as "the process by which founders of privately held firms leave the firm they help to create; thereby removing themselves, in varying degree, from the primary ownership and decision-making structure of the firm" (DeTienne, 2008, p. 2). In particular, there are different exit strategies, different reasons for exit and (within a certain interval) flexibility with respect to the exit time. Furthermore, each of these aspects might be differently characterized in the context of the various phases of the entrepreneurial process (DeTienne, 2008). It is thus clear that only "a greater understanding of the entrepreneur will provide insight into the process of entrepreneurial exit" (DeTienne, 2008, p. 2) and that it won't be possible to gain a deeper and more realistic view on this process without explicitly focussing on the entrepreneur as unit of analysis. This is coherent with a paradigmatic view on entrepreneurial decision-making, which adopts a specific way to look at the entrepreneurial process focussing on the dynamics of entrepreneurial decision-making (Schade, 2008).

There is a considerable amount of resources which are reallocated as a consequence of entrepreneurial exit, firm disappearance, and / or transfer and which have profound implications also for the industry and the economy (DeTienne, 2008). Accordingly, it is an important concern for policy makers to facilitate business transfer, as it is estimated that in Europe approximately one third of the entrepreneurs "will withdraw from their business over the next ten years" and that while "the transfer of a business within the family is still the most frequent case, the number of transfers to third parties is increasing" (European Commission, 2006).

Even if we interpret disinvestment in the more conventional sense of terminating a specific project by selling its underlying assets, it is easy to figure out the far reaching implications it has in determining structural change in specific sectors, which is, in essence, the outcome of aggregated investment and disinvestment decisions.

3. Theoretical Background and Normative Propositions

A value of waiting is present in various decision problems that are characterized by irreversibility, uncertainty, and flexibility. In this paper we describe the value of waiting in the context of a simple, two-period disinvestment problem. Consider an already existing project that currently earns an annual cash flow X_0. In period 1 this cash flow will either increase by a value $h > 0$ with probability p or decrease by h with probability 1-p. Thereafter uncertainty is completely resolved[3]. The project has an infinite lifetime, thus its present value is either $V^u = X_1^u / r = (X_0 + h)/r$ or $V^d = X_1^d / r = (X_0 - h)/r$ where r is an interest rate. We assume a risk neutral decision maker who has to decide whether to continue or to abandon the project. Termination of the project yields a salvage value L in addition to the cash flow of the current period. The project cannot be restarted once it has been terminated, that means the decision is

[3] In contrast to standard options models we assume an additive model of uncertainty instead of a multiplicative one. The additive model has been chosen for the subsequent experiments because it is easier to handle in a multiperiod framework. The hypotheses that we derive are valid for an additive as well as for a multiplicative model of uncertainty.

irreversible. Traditional investment theory asserts that the project should be terminated if the liquidation value L exceeds the continuation value $\hat{C}$. Hence the decision rule is:

$$D_1 : \max\left(\hat{C}; L + X_0\right) = \hat{F}_0 = \max\left(X_0 + p \cdot V_1^u + (1-p) \cdot V_1^d; L + X_0\right) \tag{1}$$

The situation is different if the decision on the termination of the project can be deferred to period 1. Using financial wording the decision maker now has an abandonment option in period 0 that he / she can either exercise or keep alive until maturity (period 1 in this case). Deferring the decision has the potential advantage that it allows to take into account information arriving in period 1. The decision rule now modifies to:

$$\begin{aligned} &\max\left(\widetilde{C}; L + X_0\right) = \\ &\max\left(X_0 + p \cdot \max\left(V^u; (L + X_1^u)/(1+r)\right) + (1-p) \cdot \max\left(V^d; (L + X_1^d)/(1+r)\right); L + X_0\right) \end{aligned} \tag{2}$$

Of particular interest is the situation where $V^d < L < V^u$. In this case the optimal stopping rule becomes:

$$D_2 : \max\left(X_0 + p \cdot V^u + (1-p) \cdot (L + X_1^d)/(1+r); L + X_0\right) = \widetilde{F}_0 \tag{3}$$

In general, the myopic decision rule D_1 differs from the optimal stopping rule D_2. First of all, the classical net present value of the project, $\hat{F}_0$, is less than or at most equal to $\widetilde{F}_0$, which is sometimes called the strategic (expanded) net present value (Trigeorgis 1996). Moreover, decisions built on theses strategies may deviate. This becomes obvious by comparing the respective disinvestment triggers (i.e. the point in time where it is optimal to disinvest) which can be derived by equating the continuation value and the termination value and solving for X_0. According to D_1 the project should be terminated if the current cash flow falls below

$$\hat{X}_0 = L \cdot r - h \cdot (2p - 1). \tag{4}$$

The optimal disinvestment trigger referring to D_2 is:

$$\widetilde{X}_0 = L \cdot r - h \cdot \left(\frac{(2p-1) \cdot r + p}{r + p} \right) \tag{5}$$

Apparently $\widetilde{X}_0$ is smaller than $\hat{X}_0$ which leads us to the following proposition:

P1: A rational decision maker, obeying D_2 will tolerate lower cash flows before immediately terminating a running project compared with a myopic decision maker who follows D_1 and thus ignores the value of waiting.

(5) also allows investigating the impact of increasing uncertainty on the optimal decision rule D_2. Increasing uncertainty in period 1 is considered by a mean preserving spread of the

cash flow in period one. This can be implemented in our simple model framework by replacing the additive shock h (i.e. random influence on the value of the investment) by $h' > h$. The optimal disinvestment trigger now becomes:

$$\widetilde{X}_0' = L \cdot r - h' \cdot \left(\frac{(2p-1) \cdot r + p}{r + p} \right) \tag{6}$$

Obviously the relation $\widetilde{X}_0 > \widetilde{X}_0'$ holds. This finding is reflected in Proposition P2:

P2: The optimal disinvestment trigger under a high variance regime is smaller than the disinvestment trigger under a low variance regime.

So far the myopic and the optimal decision rule have been derived assuming a risk neutral decision maker. In the context of financial options this assumption is not restrictive as the resulting prices and exercise strategies are independent of the risk preference of the decision maker[4]. However, in the context of real options risk preferences come into play at least if it is impossible to set up a replicating portfolio of traded assets that duplicates the stochastic outcome of the (dis)investment project under consideration (cf. Dixit and Pindyck 1994). The valuation of the risky prospects can be conducted, for example, in an expected utility framework either by replacing uncertain outcomes by their certainty equivalent or by using risk-adjusted discount rates. Let $r^* > r$ denote the risk adjusted discount rate. Then the modified disinvestment triggers for the myopic decision maker and the rational decision maker read as:

$$\hat{X}_0^* = L \cdot r^* - h \cdot (2p-1) \tag{7}$$

$$\widetilde{X}_0^* = L \cdot r^* - h \cdot \left(\frac{(2p-1) \cdot r^* + p}{r^* + p} \right), \tag{8}$$

respectively. A comparison of (4) and (5) with (7) and (8) shows that risk aversion increases the disinvestment trigger of both decision rules.

Even though this change has no impact on the validity of our propositions, the effects of risk propensity can be taken into account as explained in Proposition 3:

P3: The larger the individual risk aversion, the earlier is the disinvestment in comparison to the decision rule D_2.

In other words, the more risk averse the individual, the higher his / her disinvestment trigger, meaning that he / she would consider disinvestment when investment returns are, for a risk-neutral individual, still too high to leave the ongoing investment.

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[4] Note that the calculation of arbitrage-free option prices is based on „risk-neutral“ probabilities instead of actual probabilities as in our model (cf. Hull 2006)

Real Options are an extremely flexible approach which applies whenever there is uncertainty concerning future developments, costs are at least partially irreversible, and there is flexibility with respect to time. This approach has been applied to a variety of economic settings[5] and some authors have also discussed it with reference to entrepreneurial decision-making. It has been e.g. applied to business incubation (Hackett/Dilts, 2004), organizational resource investment (Bowman/Hurry, 1993), and intergenerational transfer (Miljkovic, 2000). Real Options reasoning has also been used to capture the strategic nature of entrepreneurial creation of wealth (McGrath, 1996) and postulated like a way of managing the costs of entrepreneurial failure (McGrath, 1999).

Several studies (e.g. Ingersoll / Ross, 1992, and Paddock et al., 1988) postulate the advantages of the new investment theory, which in essence rely on emphasizing the role of uncertainty and irreversibility for the investment behavior. In spite of its interesting practical implications, empirical testing of the Real Options Approach is still lacking (for an overview see e.g. Hinrichs / Mußhoff / Odening, 2008). It is difficult to collect proper data, partly because of the complexity of the model (which admits analytical solutions only for certain specifications of the underlying stochastic processes), partly because most of the model's components either emerge from subjective valuations or are represented by variables that cannot be directly observed (see for more Odening / Mußhoff / Utesch, 2004).

A fundamental limitation of the Real Options Approach is constituted by the restrictive assumptions on which it is based and by the complexity of the normative framework, which "makes it impractical as a general decision-making aid for most business managers" (Busby / Pitts, 1997, p. 170). Those and additional reasons why the Real Options Approach may not be applied in management decisions are discussed by Adner / Levinthal (2004). Our position is far less radical. We believe that the value of waiting makes sense for most individuals also intuitively, and we are interested in how close such intuitive behavior of entrepreneurs and non-entrepreneurs can be approximated by either the Real Options Approach in the sense of an 'options-based' inertia or whether waiting is more in tune with a psychological inertia as explicated in the next paragraph.

The experimental method represents a way to overcome the difficulties of an empirical test of Real Options theory, as it allows obtaining data under controlled conditions (in which the stochastic specification of variables is a priori defined), to elicit important variables, and to disentangle risk and time preferences.

[5] Real Options have been e.g. applied to environmental and agricultural economics (Arrow / Fisher, 1974; Pietola/Myers, 2000; Purvis et al., 1995; Richards/Patterson, 1998), to land conversion and conservation intervention (Titman, 1985; Quigg, 1993; Cunningham, 2003), as well as to the economic policy of reforms (Dewatripont / Roland, 1995).

4. Behavioral Hypotheses

The normative propositions stated in Section 3 rely on the interpretation of human decision making as fully rational and based on Bayesian optimization of subjective utility, which rather stems from the axiomatic characterization of utility and subjective probability than from the direct empirical observation of the human economic behaviour (Selten, 1999). This approach has been however deeply challenged, both concerning its interpretation of decision-making and the assumptions on which it is based. Critiques also come from interdisciplinary studies which integrate economics with findings from psychology, neurology, research on artificial intelligence and cognitive disciplines in general.[6] The bounded rationality approach decisively simplifies the abilities that are involved in the decisional process and is therefore based on extremely simple dynamics, which do not involve complex analytical and computational capabilities (Simon, 1955). By doing that, it challenges normative benchmarks of standard rationality by formulating behaviourally motivated hypotheses.

4.1 General Behavioral Expectations

Specifically with regard to the decision problem which is the focus of this study, intuition can be expected to play a central role, as it is often the case for tasks involving the evaluation of uncertainty and assessment of probabilities, in which prediction can be seen as the result of the interaction between *"judgement, intuition, and educated guesswork."* (Kahneman / Tversky / Slovic, 1982, p. 414).

In general, concerning the observed task of terminating an investment project, individuals can be expected not to perfectly adjust their behavior to the uncertainty degree (as this would require fairly sophisticated computations). Among the behavioural phenomena that might motivate that and influence the trigger to terminate a project, a psychologically motivated inertia is expected, which can be related to the tendency to stick to the status-quo (Samuelson, 1988; Kahneman / Knetsch / Thaler, 1991), to resistance to change (Grabitz, 1971), and to procrastination (O'Donogue / Rabin, 1999; 2001). This leads to the formulation of the following behavioural hypothesis:

H1: individuals are susceptible to a psychological inertia

Furthermore, anchoring and adjustment heuristics (Kahneman / Tversky, 1982) and extremeness aversion (Simonson / Tversky, 1992) are also likely to occur in the setting observed.

The tendency to procrastinate tasks and to postpone irreversible decisions is a phenomenon which can be observed in many situations. Procrastination of tasks has been typically explained through present-biased preferences and anomalies of intertemporal choices (O'Donogue / Rabin, 1999; 2000; Ferrari et al. , 1995). In the observed setting, the tendency towards

[6] For a critical approach to full rationality see e.g. Kahneman (2002), Gigerenzer / Selten (2001), Güth / Kliemt (2004b), March (1994), Simon (1990) and (1957). A more philosophical approach is discussed e.g. in Kliemt (2001).

procrastination can be expected to be an important driver of behavior, which can also overcome risk aversion. This is related to reluctance to change and might reflect into inaction inertia (Tykocinski / Pitman, 1998). In the behavioural literature, inertia and reluctance to change have typically been motivated by cognitive dissonance (Festinger, 1957) and linked to information selection (Grabitz, 1971) and regret (for mixed evidence in this regard see Zeelenberg et al., 2006). In this study, however, we use the concept of psychological inertia to label what can be in essence associated with a status-quo phenomenon.

The status quo bias (Samuelson, 1988; Kahneman / Knetsch / Thaler, 1991), which can be defined as the frequent tendency to opt for already chosen alternatives and might result into innovation aversion (Porter / McIntyre, 1984), has been proven to be a quite robust behavioral effect that might also reduce ambiguity aversion (Roca / Hogarth / Maule, 2006) and influence extremely relevant real life decisions such as organ donations (Johnson / Goldstein, 2003). It has been experimentally shown to apply under different settings (Samuelson / Zeckhauser, 1988) and its occurrence seems to be robust, even though with different intensities, across social groups (Burmeister / Schade, 2007).

The status quo bias can be at a general level related to reference dependence and loss aversion, as encompassed by prospect theory (Kahnemann / Tversky, 1979; Tversky / Kahnemann, 1992). It can be therewith associated with the endowment effect (Thaler, 1980), according to which possession increases the individual valuation of a certain good, as well as to the disparity between willingness to pay and willingness to accept (the so-called WTP-WTA disparity) (Kahnemann et al., 1991).

In the decision problem which is analysed in this study, the tendency to postpone abandonment and support losses, and the biased adjustment of average choices to the degree of uncertainty can be reasonably expected and interpreted as an argument for the tendency to stick to the status quo. Using the concept of psychological inertia we want to recall the same dynamics of the status-quo bias, but at the same time to more accurately point out the differences between a typical setting in which the status-quo bias can be observed and that of the decision problem we focus on. In the decision problem observed individuals are namely confronted with a sequential choice over several periods, in which they do not really have the option to “repeat” already done choices, but either to wait or to stop an ongoing investment with uncertain revenues.

4.2 Entrepreneurs Vs. Non- Entrepreneurs

The decision to compare the choices of entrepreneurs and non-entrepreneurs is inspired by the idea that experience and aquaintedness with certain tasks and problems matter in influencing problem-solving activities and decision-making. Specifically, we build on previous research on biases’ occurrence among professionals, e.g. when they have to solve problems on an intuitive basis (Tversky / Kahneman, 1982). As these fields of research essentially point out, the occurrence of specific biases depends on the experience the subjects have regarding a certain task, as well as on its formulation, which might e.g. influence the ease with which the experimental task is associated with habitual settings (Tversky / Kahneman, 1982).

Besides, it has been argued, both relying on a conceptual basis (e.g. Baron, 1998) and on the empirical analysis of the behavior of entrepreneurs, that entrepreneurs might reveal different patterns of behavior and cognition (Busenitz / Lau, 1996). Entrepreneurs apply in some cases different behavioral heuristics and are also differently susceptible to certain behavioral biases. Among else, they seem to be more overconfident than others (Olson, 1986; Forbes, 2005; Koellinger et al., 2005), and tend to overestimate their chances of success (Cooper et al. 1988).

Even though experimental research on entrepreneurial behavior is still a quite new and open field of research, differences between entrepreneurs and others have also been experimentally confirmed: entrepreneurs seem e.g. to be less prone to encompass the opponents' situation (Boewe et al., mimeo) in their own calculus, and less affected by gender effects (Schade / Boewe / Krause, mimeo).

In the disinvestment setting we modeled, we expected the choice of entrepreneurs to be at least similarly affected by inertia as that of non-entrepreneurs. This behavioral expectation is expressed by the following behavioral hypothesis:

H2: entrepreneurs are similarly prone to a psychological inertia than non-entrepreneurs

We support this expectation with findings on the occurrence of the status-quo bias among entrepreneurs (Burmeister / Schade, 2007) and relating it with evidence on the disposition effect and the tendency in finance to hold losing stocks for too long (Shefrin / Statman, 1985). In particular, Burmeister / Schade (2007) find evidence that entrepreneurs who were significantly older (thus more experienced)[7] than non-entrepreneurs were similarly affected by the status-quo bias than non-entrepreneurs and less than bankers of similar age. They relate their findings to the tendency of entrepreneurs to be more open to changes and innovation and to be therefore, by similar experience, less affected by the status-quo effect. Relying on an unidirectional effect of age and experience on resistance to changes and status-quo bias (Burmeister / Schade, 2007) and since our comparison is also with students, we do not expect a different inertia between younger students and older entrepreneurs.

In the experimental task, different drivers can be expected to play a role: even though on one hand, entrepreneurs might, because of their openness to innovation and changes, be less attracted by the status-quo, they might be, on the other hand, more biased toward project continuation, might engage more easily in the escalation of commitment (Staw, 1981), and get emotionally involved into projects (Cardon et al., 2005). This might corroborate the idea of higher psychological inertia among entrepreneurs. Notwithstanding risk-propensity of entrepreneurs, for which we do not formulate expectations, because of the existing mixed evidence in this regard (Brockhaus, 1980; Elston / Harrison / Ruthström), we expect entrepreneurs to be biased towards project continuation and to postpone disinvestment more than optimally. The discussion on procrastination with disinvestment and exit choices in

[7] More experienced individuals tend to be more attracted by the status-quo, as their "thoughts may tend to become increasingly channeled by their past experience" (Shepperd et al., 2003, p. 383).

Section 0 provides some further elements for this hypothesis. Overall, however, the effects of lower susceptibility to the status-quo bias (by similar age and experience) and escalation of commitment might be expected to counterbalance, with entrepreneurs being similarly prone to psychological inertia as non-entrepreneurs.

The choice to formulate the decision problem in abstract terms aimed at isolating project termination from other individual drivers and motives which affect disinvestment and exit choices. At the end of the game-playing sessions entrepreneurs were asked to mention whether they have associated the experiment with some real-life situations.

Table 1 provides an overview on the normative propositions (P) and behavioural hypotheses (H) that have been tested and also foreshadow the results to be reported in Section 7. To simplify the notation, it is henceforth referred to Real Options as "RO" and Net Present Value as "NPV." The Net Present Value theory becomes our null hypothesis (P0).

Table 1: Testing of normative propositions and behavioral hypotheses

Propositions and hypotheses	**1st study low volatility**	**1st study high volatility**	**2nd study high volatility**
P0: A decision-maker consistent with the myopic decision rule D_1 (classical investment theory, NPV) disinvests if the liquidation value exceeds the project's continuation value	Not supported	Not supported	Not supported
P1: A decision maker consistent with D_2 (new investment theory, RO) tolerates lower cash flows before terminating a running project	Partially supported	Supported	Supported
P2: The optimal disinvestment trigger with high variance of returns is smaller than with low variance	Not supported	Not supported	n.a.
P3: The larger the individual risk aversion, the higher the disinvestment trigger, i.e. the more risk averse an individual, the earlier (in comparison to the decision rule D_2) is disinvestment	Not supported	Not supported	Not supported
H1: individuals are susceptible to a psychological inertia (status-quo bias)	Supported	Supported	Supported
H2: entrepreneurs are similarly prone to such a inertia than non-entrepreneurs	n.a.	n.a.	Partially Supported

5. Experimental Setting

The experimental setting consisted in a problem of optimal stopping, stylising a context-less choice to abandon a project for a constant termination value. Relying on this design, we run two different studies: in the first large scale experiment we compared the effects of different volatilities, while in the second small scale experiment we replicated the high volatility treatment among entrepreneurs.

Both experiments were followed by a session of Holt and Laury (2002) lotteries with real payments for eliciting risk-attitude of the participants. In this way, it was possible to estimate the individual coefficients of constant relative risk aversion. Specifically, lotteries comparison has been preferred instead of the certainty equivalent method because this method permits to avoid the possible distortions of the certainty effect (Levy / Levy, 2002).

Returns from the existing project were modelled according to an arithmetic Brownian motion with drift equal to 0 and a certain value for the standard deviation. First period revenues were set equal to 1.000 points. For simplicity of calculation for the participants, the risk-free interest rate was fixed at 10 %. Abandoning the project yielded a constant revenue of 11.000 points, was allowed in each of the 11 periods and made compulsory in the last period.

In a between-subjects design the first experiment was articulated into two treatments, differing in the volatility degree. Specifically, the standard deviation was set equal to 200 points in the low volatility and 500 points in the high-volatility treatment. The participants were informed about all the parameters and assumptions underlying the experimental setting and could see on their screen a complete representation of the binomial tree of revenues with associated probabilities, which were updated after each period. Choice was not time constrained. Each subject was confronted with 20 (individually) randomly determined paths of the binomial tree and did not receive any payoff feedback, except in the trial period. With no feedback and randomly determined paths of revenues we controlled for reinforcement and qualitative learning was discouraged.

The final payment was referred to one of the 20 repetitions (randomly chosen). The trial, during which the participants had the opportunity to become acquainted with the experiment and could ask questions about the instructions, was excluded from payment. The experiment was neutrally framed and presented as a problem of optimal stopping (for a translation of the instructions see the Appendix).

The experiment was programmed in Z-tree (Fischbacher, 2007) and was run in August 2008 in the laboratory of a major German University.

Each session lasted for about one hour and was made up of 20 game-playing periods, plus the trial one. A total of 84 subjects (39 undergraduate students of different schools and 37 non-students) participated in the experiment, i.e. 42 per treatment. Average earnings were 11.78 €.

The second experiment was a replication of the high volatility treatment with high-tech entrepreneurs. The only differences were that, because of time restrictions, entrepreneurs played in only 10 instead of 20 randomly chosen paths of the binomial tree and that the incentives were upgraded to the higher opportunity cost of a subject pool of entrepreneurs (700 points /€ instead of 3500 points /€). The experiment was run in March 2009 among entrepreneurs from an incubator of a major German city. The subject pool consisted in 15 founders of high-tech enterprises.

6. Experimental Results

The analysis of the experimental results aims at testing propositions and hypotheses stated above. To simplify the notation, normative propositions and behavioural hypotheses are labelled as in Table 1.

A fundamental part of data analysis is based on the observation of the correlation between observed and predicted choices according to the Real Options framework (i.e. applying D_2) per individual. In particular, we estimated the Kendall's Tau for each individual and interpreted it as a mathematical measure of the strength and direction of the relation between experimentally observed behavior and theoretically predicted choices.[8]

6.1 Large Scale Laboratory Experiment

For the first study, i.e. the one with non-entrepreneur participants, the choices of 6 participants have been excluded from data evaluation, as they stated risk preferences which were inconsistent with the expected utility theory. Specifically, data analysis refers to 40 independent observations for the low-volatility treatment and 36 for the high-volatility treatment. Slightly more females than males participated in the experiment (23 vs. 17 in the low-volatility and 20 vs. 16 in the high-volatility treatment). Average age was, in both treatments, 29 years, ranging from 19 to 67.

Test of P0

Overall, the results corroborate the hypothesis of late disinvestment and provide evidence for the unsuitability of the net present value benchmark (P0). Average choices per subject over the 20 games equal, in the mean, 6.93 in the low and 6.99 in the high volatility treatment. This provides evidence that individuals are not consistent with the myopic decision rule D_1 (classical investment theory, NPV) and that they do not disinvest as soon as the liquidation value exceeds the project's continuation value.

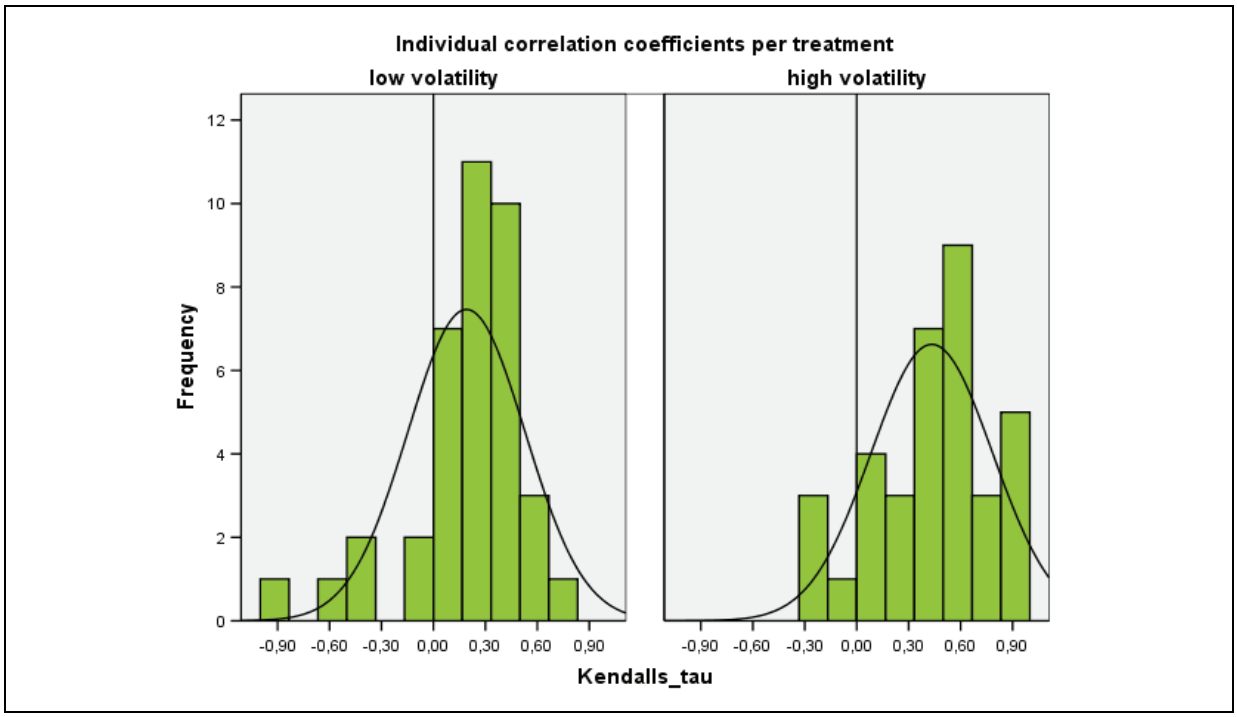
[8] The significance of individual correlation coefficients is not a relevant measure for this purpose.

Test of P1

In order to test the first normative prediction (P1), we focus on individual correlations coefficients between Real Options predictions and observed behavior.

As Fig. 1 shows, the experimental data reveal a significant correlation between the predictions of the Real Options approach and the observed behavior.[9] The null hypothesis of non-correlation could be rejected ($p<0.01$), proving thus that the individual rank correlation coefficients are on average positive and significantly different from zero. Mean correlation coefficients are higher under high volatility (0.44 vs. 0.19) and significantly differ among treatments ($p<0.005$).

Fig. 1: Individual correlation coefficients per treatment



Thus, choices revealed to be more consistent with the normative benchmark of Real Options under high risk, were nevertheless correlated with the RO-predictive in both treatments. This corroborates the normative proposition P1.

A linear regression of the individual correlation coefficients by status, i.e. student or non-student, and treatment reveals the significant effect of volatility (treatment).

[9] Concerning the significance of the coefficients at a 0.05 level, in the low-volatility treatment 12 of the estimated coefficients were significant (4 of which at the 0.001 level), while in the high-volatility treatment 23 coefficients were significant (12 of which at the 0.001 level).

Table 2: Treatment effects on individual correlation coefficients (R^2=0.106; adj. R^2=0.081)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	,201	,069		2,886	,005
	Student	-,033	,084	-,044	-,387	,700
	Treatment	,246	,084	,329	2,909	,005

a Dependent Variable: Kendall's Tau

Regressing also the variables of age, gender, and risk propensity yields no significant effects ($p>0.05$).

Data thus support the normative proposition P1. Overall, however, the descriptive validity of the normative benchmark of Real Options proves to be a subtler issue, as the test of P2 will show.

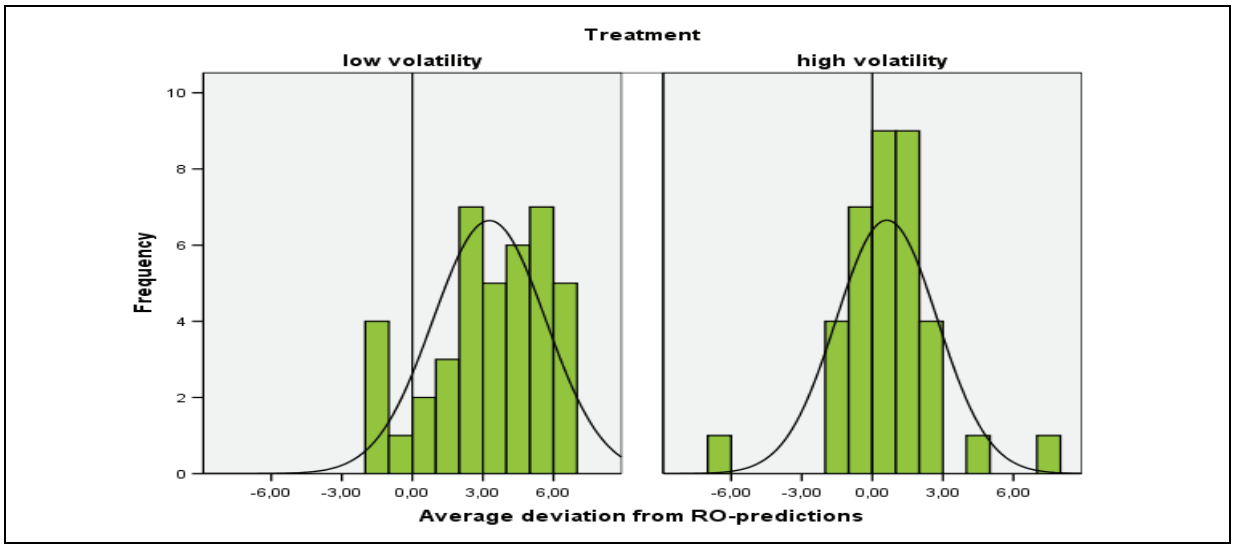
Test of P2

In order to test the descriptive validity of the second normative proposition, namely that the optimal disinvestment trigger with high variance of returns is smaller than with low variance (i.e. that individuals should disinvest earlier under low volatility), average individual deviations from the Real Options predictions can be compared among treatments.

Even though deviations from the benchmark of Real Options are on average smaller than deviations from Net Present Value and its predictions well approximate behavior under high volatility, the individuals do not seem to be able to correctly adjust their disinvestment trigger to risk, as there were no significant differences in the average choice per subject among treatments. Mean average choices per subject over the 20 games are similar in both treatments (respectively 6.93 in the low and 6.99 in the high volatility treatment) providing thus evidence that individuals are not able to correctly discriminate between different volatilities.

As visualized in Fig. 2, average individual deviation from this benchmark were significantly different among treatments ($p<0.001$).

Fig. 2: Average deviation from real options' predictions



In particular, under high volatility, the hypothesis of consistency with the normative benchmark of Real Options cannot be rejected, revealing thus the suitability of this approach for settings with high risk. It seems therefore that intuition works better when uncertainty is high, i.e. when postponing the commitment to an irreversible decision has more serious consequences for the individual payoffs.

A linear regression (R^2=0.309; adj. R^2=0.290) for the average deviation from Real Options' predictions reveals significant status (i.e. students versus non-students) and treatment effects (resp. $p<0.05$ and $p<0.001$).

Table 3: Status and treatment effects (R^2=0.309; adj. R^2=0.290)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	6,320	,792		7,976	,000
	Student	-1,142	,503	-,222	-2,270	,026
	Treatment	-2,509	,503	-,487	-4,984	,000

a Dependent Variable: Average Deviation from RO

As the negative coefficients point out, individuals in the high-volatility treatment and students in both treatments performed (in term of their respective average deviation from the Real Options predictions) significantly better.

Regressing also gender and risk propensity (expressed as number of less variable lotteries' choices) shows non-significant effects of these factors ($p>0.05$). This corroborates again the

idea that risk propensity does not play a decisive role in influencing individual decision-making concerning project termination.

Test of P3

Considering the responses of non-entrepreneurs, the Holt and Laury lotteries reveal the predominance of risk averse attitudes, which is consistent with previous experimental findings (cf. e.g. Holt / Laury, 2002). Out of the 76 individuals whose choices did not violate expected utility theory, 49 revealed risk aversion and 47 were risk seeking, for an average of 5.84 safe choices.

As posited by P3, the more risk averse an individual, the earlier (in comparison to the decision rule D_2) should he / she disinvest. Thus, an option-based inertia adjusted by the individual risk-propensity should be smaller that the inertia we would observe from the data. P3 should be therefore rejected.

The non-significant effect of risk propensity is consistent with the rejection of P3, as it shows that the individual attitude towards risk is not an important driver of behavior in the setting of optimal stopping and project termination. Again, within the given setting, late project termination cannot be supported by the dominant risk attitude, as risk aversion should have lowered the value of waiting for uncertainty to reduce and should have counterbalanced the tendency to postpone project termination. Rather, this tendency provides evidence for the occurrence of psychological inertia and status-quo bias, as postulated by H1.

Test of H1

Overall, the picture emerging from the experimental results corroborates the behavioural hypothesis of a psychological inertia inducing the individual to postpone disinvestment. The rejection of P0, the acceptance of P1, and the decline of P2 clearly point out the existence of a psychological inertia, going beyond an option-based inertia. Besides, the predominant risk aversion and the observed tendency to wait even beyond what a risk-neutral decision-maker consistent with Real Options would have done, clearly support H1.

6.2 Small Scale Laboratory Experiment with High-Tech Entrepreneurs

The second study investigates the behaviour of 15 high-tech entrepreneurs. Because of inconsistencies with expected utility theory in the Holt and Laury session, the choices of 2 participants have not been considered in the data evaluation. Data analysis thus refers to a subject pool of 3 female and 10 male entrepreneurs, having made 10 decisions each, yielding thus 130 decisions. Average age was 43.7, ranging from 22 to 66. Four of the participants declared to have a second job, one of which as consultant, the remaining four most probably into a dependent work relation. On average, they have been into business for 6.7 years, with a minimum of 1 year to a maximum of 17 years of entrepreneurial activity. Average earnings for around 60 experiments were of 56.67 €.

Test of P0

Also among entrepreneurs, P0 is not supported by the experimental evidence, as average choice is assessed around period 6.49. Even though this was expected from a theoretical perspective, the Net Present Value is still a very common and easy to implement method to evaluate investments. Therefore, assuming entrepreneurs to be acquainted with investment and disinvestment decisions it would not have been surprising to observe consistency with P0 in the choice of some individuals. This was not the case, as disinvestment in the very first period only occurred 5 times and none of the participants always disinvested in t =0.

Test of P1[10]

Before examining the individual correlations coefficients of entrepreneurs and comparing them to the coefficients of non-entrepreneurs, a premise is due. The entrepreneurs' correlation coefficients have been extrapolated out of 10 instead of 20 observations, as they played only 10 instead of 20 games, and correlations inevitably reflect this difference.[11]

Considering the data from both experiments and regressing individual correlation coefficients with gender, age, and risk preference and using the dummies "entrepreneur" and "high volatility" it emerges that only the dummy for treatment has a significant impact on the correlation with the Real Options benchmark (cf. Table 4).

Table 4: Treatment effects on individual correlation coefficients (R^2=0.118; adj. R^2=0.063)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	,166	,201		,826	,411
	Gender (M=0;F=1)	,067	,077	,095	,868	,388
	Age	,002	,004	,080	,663	,509
	Risk Preference (No of safe choices)	-,014	,021	-,071	-,654	,515
	Entrepreneur={0,1}	-,140	,127	-,143	-1,109	,271
	High Volatility ={0,1}	,238	,081	,334	2,919	,005

a Dependent Variable: Kendall's Tau

[10] Note that, entrepreneurs' correlation coefficients have been extrapolated out of 10 instead of 20 observations, as they played only 10 instead of 20 games, leading to only " 3 of the coefficients being significant at a 0.05 level. However, as posited in footnote 8, significance is not importance for our analysis.

[11] This reflects into the significance of the coefficients, with "only" 3 of the Kendall's Tau being significant at a 0.05 level. For the purpose of our analysis, however, the significance of the individual correlations does not matter.

Overall average deviations from the Real Options predictions were slightly higher than among non-entrepreneurs playing the high volatility treatment in the first experiment (mean = 2.02; standard deviation = 1.933). Mean and distribution of average deviations are however not significantly different ($p>0.05$), so that entrepreneurs do not seem to behave in a different way. Nevertheless, in comparison to the benchmark of Real Options, entrepreneurs reveal the tendency to overly postpone disinvestment, as their average deviations are significantly different from 0 ($p=0.003$).

Similarly than with the individual correlation coefficients, a linear regression for individual average deviations from the Real Options solution by gender, age, and risk preference and with dummies "entrepreneur" and "high volatility" shows that only the last dummy yields a significant effect (cf. Table 5). Thus, under high volatility individuals better assessed the optimal project termination point.

Table 5: Treatment's effect on average deviation from Real Options prediction (R^2=0.253; adj. R^2=0.208)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	3,517	1,273		2,763	,007
	Gender (M=0;F=1)	,224	,489	,045	,458	,648
	Age	,008	,024	,034	,313	,755
	Risk Preference (No of safe choices)	-,092	,130	-,070	-,711	,479
	Entrepreneur={0,1}	1,404	,816	,200	1,720	,089
	High Volatility ={0,1}	-2,719	,517	-,545	-5,262	,000

a Dependent Variable: Average Deviation from RO

Test of P3

The results from the Holt and Laury lotteries show the predominance of risk aversion, which is surprisingly even more accentuated than among non-entrepreneurs. The number of safe choices is 6.15 versus 5.84, the difference being however non-significant ($p>0.05$).

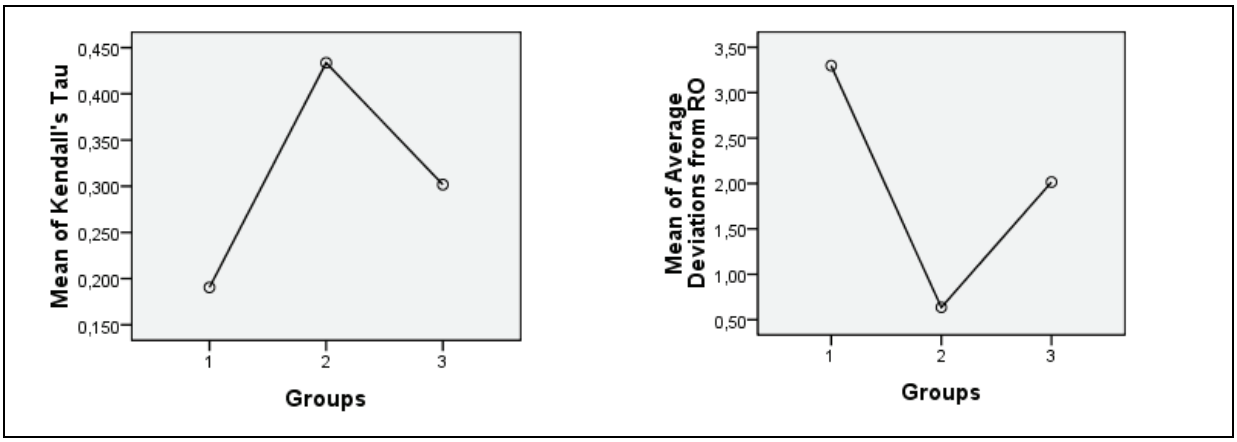
Mean choices per subject lie on average by period 6.49 and average deviations from RO-predictions are of 2.02. Thus, entrepreneurs tend to slightly overly postpone disinvestment, which cannot be traced back to a higher risk propensity. This leads to reject P3, which posits that taking risk aversion into account, individuals should have disinvested earlier than predicted by D_2 under risk neutrality.

Test of H1 and H3[12]

Also among entrepreneurs, the tendency to procrastinate disinvestment cannot be motivated by the dominant risk aversion, but can be rather associated with psychological inertia.

Overall, grouping the data into the three categories of "Non-Entrepreneurs; Low Volatility" (Group 1), "Non-Entrepreneurs; High Volatility" (Group 2), and "Entrepreneurs; High-Volatility" (Group 3), it emerges that the average individual correlation coefficients of entrepreneurs and the average deviations from Real Options predictions lie between the choices of students in the low and in the high-volatility treatment. (cf. Fig. 3).

Fig. 3: Mean of Kendall' tau and of average deviations from RO across groups



In particular, the differences between entrepreneurs and non-entrepreneurs acting under high-volatility regime are not statistically significant ($p>0.05$). Nevertheless, Fig. 3 points out the slight tendency of entrepreneurs to postpone disinvestment more than optimally and to stick too long to the ongoing investment. This is also supported by the marginal significance of the dummy "entrepreneurs" in Table 4. Thus, even though the differences between entrepreneurs and non-entrepreneurs do not run out to be large (as expected in H2), the experimental evidence provides some arguments for the tendency of entrepreneurs to be more biased towards project continuation and escalation of commitment and to be slightly more susceptible to psychological inertia, going beyond 'option-based' inertia.

At the end of the game-playing session, four of the entrepreneurs stated to have associated the experimental problem to a real-life situation and specifically respectively to technology marketing, customers' willingness to pay, investment strategy, and profitability of continuation of an ongoing project.

[12] As entrepreneurs only played under high-volatility regime, H2 does not apply and won't be therefore discussed in this section.

7. Discussion and Implications

Disinvestment and, in particular, entrepreneurial exit represent crucial decisions for business practice that cannot be entirely reduced to deterministic choices. Such decisions are namely not only related to business profitability, but to the alternative available options and their subjective evaluation by the entrepreneurs. It is in this spirit that, relying on an existing line of analysis (e.g. Mc Grath, 1999), the Real Options approach has been posited as a suitable normative benchmark with which to compare the subjectively estimated value of waiting.

The main findings from this experimental study are that individuals actually tend to postpone taking an irreversible decision, such as project termination. In this perspective, the rational benchmark of a forward looking decision-maker (encompassing a Real Options perspective) better applies to the behavior observed in the experiment than the paradigm of a myopic individual, and almost approximate observed choice with high risk. This finding could be interpreted as supporting the view that new investment theory provides a better rationale for analyzing dynamic investment behavior than the traditional approach of the Net Present Value.

Even though the Real Options approach better describes behavior than the Net Present Value approach (rejection of P0 and acceptance of P1), the results clearly support the idea that Real Options do not fully encompass the real motives of disinvestment postponement. The experimental evidence provides evidence for partially psychological, rather than option-based, inertia.

In particular, both 'options-based' intuition and other behavioral aspects seem to motivate the tendency to procrastinate disinvestment. Intuition seems to be more accurate with high risk, as decisions are more closely related to the Real Options predictions under high volatility regime, where consequences of choice have a higher impact on the individual payoffs. Thus, intuition is better when it really matters.

Overall, the experimental evidence clearly speaks for the occurrence of psychological inertia, which we associate with status-quo bias (Samuelson, 1988; Kahneman / Knetsch / Taler, 1991) and escalation of commitment (Staw, 1981). Given risk aversion, deviations from the presented Real Options decision rule that assumes risk neutrality would only have been fully consistent with an options-based reasoning, if and only if they had implied earlier disinvestment. This, however, was not the case, with individual average deviations being even beyond the Real Options benchmark under risk neutrality. Besides, risk propensity has been shown to be non-correlated and not significantly affecting choice.

From the study it further emerges that entrepreneurs are slightly more susceptible to psychological inertia than others, but this difference is only marginally significant. From the comparison of mean average choices and deviations from Real Options, entrepreneurs reveal a slight tendency to procrastinate more than other individuals the choice to abandon a project. We relate this finding to the tendency to stick too long to an ongoing investment, to develop an emotional binding to their projects (Cardon et al., 2005), and to the escalation of commitment

(Staw, 1981). We thus find first evidence for the alleged tendency of entrepreneurs to wait too long before terminating a project.

The implications of this tendency are immediate for entrepreneurship: that entrepreneurs "may have a tendency to become locked in to a course of action, throwing good money after bad or committing new resources to a losing course of action" (Staw, 1981, p. 578) is potentially dangerous for entrepreneurship and connected with a conspicuous waste of resources.

Given the good predictive power of Real Options with high risk, it might be useful for consulting practice to teach entrepreneurs fundaments of Real Options. As research on theory recursivity argues, it is important for effective consulting and advising, that theories and paradigms that are taught should take into considerations individual bounded rational processing of knowledge and information (Güth / Kliemt, 2004a; 2004b; Sandri, 2009). This experiment provides evidence of the affinity between Real Options and individual reasoning, so that Real Options schooling might warn individuals to discriminate between an option-based and a psychological inertia and not too indulge too much in a project.

8. Limitations and Future Research

In this study, disinvestment choices of entrepreneurs and others are analysed by means of an incentive compatible experiment (Smith, 1976). This method seems to be adequate to tackle such a research aim, as it enables to "tackle dynamics, but keeping incentives" (Schade, 2005, p. 410). The evidence gained from economic experiments can be then transferred into theory according to the so-called "parallelism precept" (Smith, 1982), which states that propositions that have been tested in laboratory microeconomies can be applied also to real (non-laboratory) microeconomies in which similar conditions hold.

As already pointed out, the experimental examination and testing of Real Options setting is in its beginning and experimental evidence on abandonment options is, to the best of our knowledge, still missing. Moving on a rather unexplored terrain, we consider our study a small but important first step on termination choices. In particular, much work is to be done in order to better understand what heuristics might inspire decision making. Among the limitations of this experimental setting (we were aware of and whose potential disadvantages we carefully weighted in advance), there might have been the discrete modelling of returns from the existing project and the coincidence of the normative prediction for a myopic decision maker with an extreme (period 0). While continuous returns would have enriched the nuances with which data could have expressed behavior (in particular concerning the heuristics applied) discrete returns have been adopted in order to keep the setting as clear and easy to understand as possible. Concerning the latter point (which was inspired to separate enough the two considered normative benchmarks while keeping volatility into a moderate range), results revealed this potential frailty of the chosen design not to really matter, as choices fell wide apart from the Net Present Value predictions and were significantly correlated with the alternative normative Real Options benchmark.

Concerning the small scale experiment with entrepreneurs, a main limitation is represented by the limited sample size: it is however extremely difficult to gather a larger number of entrepreneurs willing to take part (at a specific time and in a certain place) to an incentive compatible laboratory experiment. Nevertheless, we could collect 10 choices for each of the entrepreneurs participating in the study, yielding 130 entrepreneurial decisions.

In fact, laboratory evidence on the behavior of entrepreneurs is still lacking. We could consider a subject pool of entrepreneurs and let them interact in a controlled laboratory environment, as we were allowed to install a mobile lab in an entrepreneurs' incubator, where the entrepreneurs have their seat. As far as we know, this way of "bringing the lab into the field" is a unique and innovative way of research, which enables to collect controlled data from real decision-makers.

Further developments of this study could try to investigate the effect of framing on different groups of individuals. A development which we are going to carry on in an immediate future is to test the behavior of farmers, as they have been alleged to be particularly conservative and averse to changes (Jose / Crumly, 1993). Results could for example account for the reluctance to invest and the tendency toward conservativeness as they have been observed in the realm of agricultural investments (Odening / Mußhoff / Balmann, 2005).

9. Conclusion

This study provides experimental evidence that entrepreneurs as well as non-entrepreneurs understand the value of waiting in disinvestment decisions but are also influenced by psychological reasons for such inertia. Entrepreneurs' disinvestment decisions appear to slightly less 'options-based' and slightly more driven by 'psychological inertia' than those of non-entrepreneurs.

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Appendix

Instructions

Translation, from the German, of the experimental instructions for the large scale study with non-entrepreneurs, high-volatility treatment

Instructions

Welcome to this experiment! Thank you for your participation.

Please, read this instructions carefully. If you have questions, please raise your hand. Your questions will be answered to you in private. All participants of this experiment have received the same instructions as you.

The experiment will take approximately 120 minutes and it consists of two parts. After the first part, you will receive instructions for the second part. Please, read the instructions carefully, as your earnings from the experiment will depend on your decisions.

At the end of the experiment, you will receive your earnings in cash.

Feel free to use pen, scratch paper, and calculator available on your desk.

Please, remain seated and do not communicate with other participants during the experiment.

First Part

This first part of the experiment consists of a trial game, followed by 20 repetitions of the same game. The trial game is played to make you familiar and more confortable with the game. This trial game won't be considered for payment.

Each game consists of 11 rounds.

In each game you have to collect as much points as possible. Your earnings are proportional to the number of points you gain during the experiment.

Each 3.500 points you get 1 Euro.

At the end of the experiment, **one** of the 20 games will be randomly chosen (by the computer program) and you will be paid according to your individual score (i.e. the number of points you have accumulated) in this selected game.

Introduction

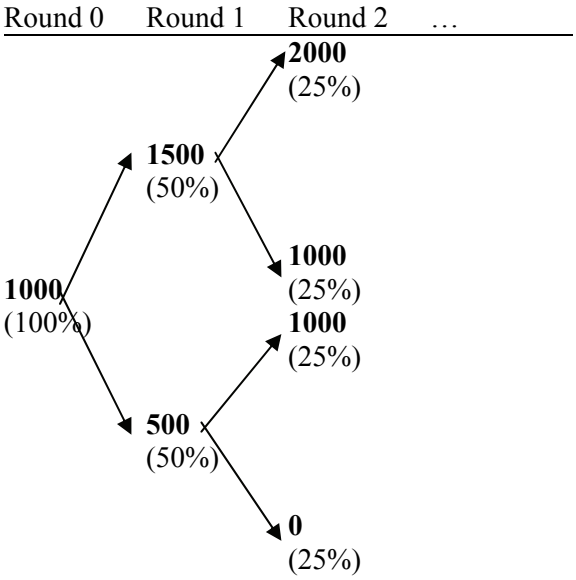
In each game you start in Round 0 with a score of 1,000 points. In the next round (Round 1) and in each subsequent round:

- Your points can either increase, with probability 50 %, of 500 points
- Or they can decrease of 500 points (also with probability 50 %).

For example, from Round 0 to Round 1 your points can in 50 % of the cases increase to 1,500 points (1,000+500), or they can decrease in the remaining 50 % of the cases to 500 points (1,000-500).

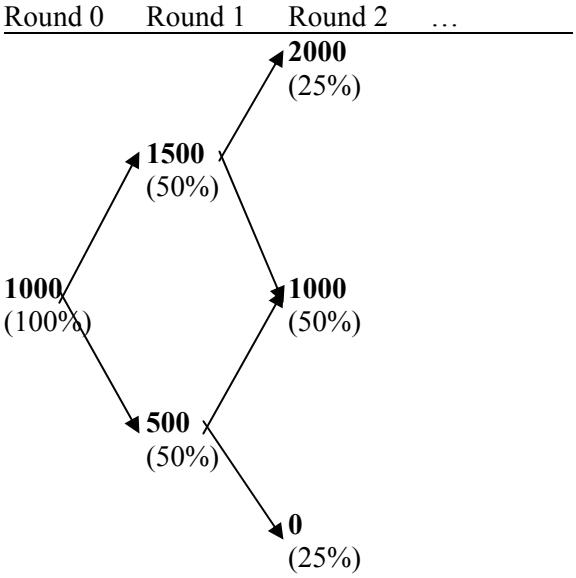
In the diagram, you can see an example of this dynamics for three rounds:

The probability, with which each possible score can occur, is written below the number of points for each round.



This can be also represented in a compact way. The only difference is that for Round 2 the score 1,000 is written just once and its probability equals the sum of the probabilities which were separately listed in the diagram above.

As follows, we will only use this compact diagram.



Your screen

On your PC-screen you can follow the development of the points round after round.

The development of your scores (of the points) will be represented (in a compact way) in the form of the following table:

Round 0	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6	Round 7	Round 8	Round 9	Round 10
1000	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**	**4500**	**5000**	**5500**	**6000**
100,00%	50,00%	25,00%	12,50%	6,25%	3,13%	1,56%	0,78%	0,39%	0,20%	0,10%
	500	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**	**4500**	**5000**
	50,00%	50,00%	37,50%	25,00%	15,63%	9,38%	5,47%	3,13%	1,76%	0,98%
		0	**500**	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**
		25,00%	37,50%	37,50%	31,25%	23,44%	16,41%	10,94%	7,03%	4,39%
			-500	**0**	**500**	**1000**	**1500**	**2000**	**2500**	**3000**
			12,50%	25,00%	31,25%	31,25%	27,34%	21,88%	16,41%	11,72%
				-1000	**-500**	**0**	**500**	**1000**	**1500**	**2000**
				6,25%	15,63%	23,44%	27,34%	27,34%	24,61%	20,51%
					-1500	**-1000**	**-500**	**0**	**500**	**1000**
					3,13%	9,38%	16,41%	21,88%	24,61%	24,61%
						-2000	**-1500**	**-1000**	**-500**	**0**
						1,56%	5,47%	10,94%	16,41%	20,51%
							-2500	**-2000**	**-1500**	**-1000**
							0,78%	3,13%	7,03%	11,72%
								-3000	**-2500**	**-2000**
								0,39%	1,76%	4,39%
									-3500	**-3000**
									0,20%	0,98%
										-4000
										0,10%

This table represents the following:

In the first round (Round 0) you receive ***1,000*** points (shown in ***italics*** in the diagram). The points you may realize in the next rounds are written in **bold**. The probability, with which you may get different scores in different rounds, are listed below each of them.

Assume, that the points you get from Round 0 to Round 1 increase from 1,000 to 1,500. The scores that are written in **grey** in the following table, are no longer possible, i.e. their probability is 0.

In this case, your PC-screen will look this way:

Round 0	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6	Round 7	Round 8	Round 9	Round 10
1000	***1500***	**2000**	**2500**	**3000**	**3500**	**4000**	**4500**	**5000**	**5500**	**6000**
0,00%	100,00%	50,00%	25,00%	12,50%	6,25%	3,13%	1,56%	0,78%	0,39%	0,20%
	500	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**	**4500**	**5000**
	0,00%	50,00%	50,00%	37,50%	25,00%	15,63%	9,38%	5,47%	3,13%	1,76%
		0	**500**	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**
		0,00%	25,00%	37,50%	37,50%	31,25%	23,44%	16,41%	10,94%	7,03%
			-500	**0**	**500**	**1000**	**1500**	**2000**	**2500**	**3000**
			0,00%	12,50%	25,00%	31,25%	31,25%	27,34%	21,88%	16,41%
				-1000	**-500**	**0**	**500**	**1000**	**1500**	**2000**
				0,00%	6,25%	15,63%	23,44%	27,34%	27,34%	24,61%
					-1500	**-1000**	**-500**	**0**	**500**	**1000**
					0,00%	3,13%	9,38%	16,41%	21,88%	24,61%
						-2000	**-1500**	**-1000**	**-500**	**0**
						0,00%	1,56%	5,47%	10,94%	16,41%
							-2500	**-2000**	**-1500**	**-1000**
							0,00%	0,78%	3,13%	7,03%
								-3000	**-2500**	**-2000**
								0,00%	0,39%	1,76%
									-3500	**-3000**
									0,00%	0,20%
										-4000
										0,00%

As you can see, the probability with which you may receive a certain score changes in each round, i.e. it depends on the outcome in the previous round.

Your decision and your profit

In each round you may:

- let your point score accumulate as described above (i.e. stay in the game)
- or terminate the game and accept a lump-sum payment of 11,000 points (eleven-thousand) (i.e. drop out the game).

The total number of points you carry on to each subsequent round increases by **10 %** for each round left in the game (irrespective of where you play all rounds or not) i.e. your total score will increase by one tenth and is then added to the points you will receive in the subsequent rounds. You can think of this increase as of an interest payment.

Similarly, the lump-sum payment of 11,000 points increases of 10 %. Specifically, it is added to the points you collect until you decide to terminate the game. Starting from the round in which you decide to terminate the game, this sum increases by 10 % for each remaining rounds.

Assume, you decide to terminate the game in Round X and receive the 11,000 points.

Your total score consists of:

- All points you have accumulated up to this round, respectively increased by 10 % per round
- Plus 11,000 points you get because you have decided to drop out of the game. 11,000 points also increase by 10 % for each of the remaining rounds (i.e. from Round X to Round 10).

If you stay in the game until the last round (i.e. play the entire game from Round 0 to Round 10), you automatically get 11,000 points at the end of the game (i.e. in Round 10).

Consider the following example:

Example
Imagine, you got the points printed in ***italics***:

Round 0	Round 1	Round 2	Round 3	…
1000	1500	2000	2500	
	500	***1000***	***1500***	
		0	500	
			-500	

In this case your total score is equal to:

- The 1,000 points you have in Round 0 increased by 10 % for each of the remaining 10 rounds of the game, i.e. $\underbrace{1000 \cdot 1.1 \cdot 1.1 \cdot \ldots \cdot 1.1}_{10 times} = 1000 \cdot 1.1^{10} = 2593.7$

- Plus 500 points you receive in Round 1 increased by 10 % for each of the remaining 9 rounds, i.e. $\underbrace{500 \cdot 1.1 \cdot 1.1 \cdot \ldots \cdot 1.1}_{9 times} = 500 \cdot 1.1^{9} = 1179$

- Plus 1000 points of Round 2 increased by 10 % for each of the remaining 8 rounds, i.e. $\underbrace{1000 \cdot 1.1 \cdot 1.1 \cdot \ldots \cdot 1.1}_{8 times} = 1000 \cdot 1.1^{8} = 2143.6$

- Plus 1500 points of Round 3 increased by 10 % for each of the remaining 7 rounds, i.e. $\underbrace{1500 \cdot 1.1 \cdot 1.1 \cdot \ldots \cdot 1.1}_{7 times} = 1500 \cdot 1.1^{7} = 2923.1$

- Plus 11000 points you receive in addition in Round 3 (because you have dropped out the game) also increased by 10 % for each of the remaining 7 rounds, i.e. $\underbrace{11000 \cdot 1.1 \cdot 1.1 \cdot \ldots \cdot 1.1}_{7 times} = 11000 \cdot 1.1^{7} = 21435.9$

Therefore, your total score in this game equals to:

$$2593.7 + 1179 + 2143.6 + 2923.1 + 21435.9 = 30275.3$$

I.e. in this game you receive a total of 30,275 points.

Please answer some control questions on your PC-screen before starting the experiment. This ensures that you understand of the rules of this experiment.

We wish you good luck!

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