Intuitive Optimizing for Time Allocation Decisions in Newly Formed Ventures

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This article investigates whether decision makers intuitively optimize close to the normative prediction in entrepreneurial decision situations where their time must be allocated between a wage job and a newly formed venture. We offer an analytical model based on maximizing expected utility, and derive an optimal time allocation strategy for decreasing, constant and increasing returns from time invested in the venture. The model's predictions are tested in a simple questionnaire experiment where respondents have to detect corner solutions, that is, they should allocate to the venture either the maximum or the minimum possible time. Respondents are found to allocate time relatively close to the normative predictions, although with systematic deviations that are consistent with well-known decision anomalies. Risk propensity is found to have an impact on the decisions, but it should not according to the model. Respondents appear to use an anchoring and adjustment procedure and are influenced by the so-called affect heuristic, which may explain why those who do not mathematically optimize have their decision partially driven by their risk propensity. Implications of our findings for entrepreneurs and institutions dealing with entrepreneurs are discussed.

Key words: Decision Making, Intuitive Optimizing, Micro Economics Model, Time Allocation Strategy, Entrepreneurship, Questionnaire Experiment.

Introduction

There are many decision situations where individuals have to *intuitively optimize* on economic variables. By intuitive optimization we refer to a method where an individual makes a decision based on intuition rather than using a formal procedure that identifies the optimal solution, and thus leads to perfect optimization. Perfect optimization may not always be possible because there is not enough information available to formulate a complete model, real decision makers may be boundedly rational, and decision makers do not always have enough time for determining the optimum. These three conditions apply to most entrepreneurial decision situations since these situations are by and large new and unique, entrepreneurs may not always have received a formal training in optimization, and there is serious time pressure involved.

In this paper we analyze a time allocation situation typically faced by entrepreneurs in newly formed ventures: how to distribute time between their own newly formed enterprise and a wage job. First, we formulate a formal model and derive predictions on optimal behavior in different decision situations, assuming that individuals' preferences obey certain rationality axioms and that these individuals perfectly optimize. Second, we test these predictions with real decision makers using simple questionnaire experiments where respondents must detect corner solutions in different experimental conditions, that is, solutions where they allocate either the maximum or the minimum number of hours to the venture. To test the sensitivity of our optimization model with respect to risk propensity, we also measure this construct on each individual. Third, we compare model's predictions to experimental data and provide behavioral interpretations of discrepancies. We find that, although respondents are relatively close to the normative predictions, deviations are systematic and worth exploring. Many individuals seem to utilize an anchoring and adjustment procedure and seem to be strongly influenced by a so-called affect heuristic.

The paper is organized as follows. The second section offers a brief overview of related literature and our contributions. The third section presents the formulation of the decision model and specifies the propositions to be tested in a questionnaire experiment. The fourth section reports on the results of the experiment, whereas the final two sections discuss and interpret the experimental findings and offer implications for entrepreneurs and institutions dealing with them.

Related Studies

There are relevant empirical studies involving the allocation of time in new ventures. These studies include the work of McCarthy, Krueger, and Schoenecker (1990) who study the relationship between a firm's early stages of development and its founder's time allocation pattern on a sample from the retail industry. They found that entrepreneurs spent more time dealing with employees at later points in these stages - - arguably due to a larger number of employees as a result of expansion - - but no significant differences in time allocations for dealing with record keeping, customers, production, maintenance, suppliers, financing, and planning. More recently, Cooper, Ramachandran, and Schoorman (1997) investigate the time allocation of entrepreneurs via a conceptual framework based on the occupational choice and entrepreneurial typology literatures. From a three-year longitudinal study they found that craftsmen-entrepreneurs devote less time to administrative activities while entrepreneurs with managerial experience are less likely to follow the objectives of craftsmen-entrepreneurs and devote more time to administrative activities.

There also is fundamental analytical research in career choice to draw upon in developing our model. Lévesque and MacCrimmon (1997), who build upon Becker's (1965) time allocation framework, offer a dynamic analytical model that addresses the question of when the best time is for an entrepreneur to leave a wage job and become a full-time entrepreneur. They show that the optimal time-allocation policy is driven by the entrepreneur's tolerance for work and by how returns from time invested in the venture behave with respect to time allocated to that venture. Others have investigated the choice of moving in and out of self-employment. Lévesque, Shepherd and Douglas (2002) offer a dynamic utility-maximizing model of career choice between self-employment and employment that takes into consideration the differences among people in terms of their initial attitudes towards income, work, risk and independence, and the likely changes to those attitudes as they mature.

Campbell (1992) also uses an economic decision model to study the decision to become an entrepreneur as an alternative to wage labor. Although Campbell does not investigate the dynamics of career choice, his framework offers a more explicit consideration of risk and implies that an increase in the probability of success induces an increase in the incentive to start an entrepreneurial venture. Also, risk-takers should be less inclined than risk-averters to increase entrepreneurial activity when the probability of success increases.

The entrepreneurship literature, however, mostly deals with risk propensity as a discriminator between entrepreneurs and non-entrepreneurs (Brockhaus 1982). There has been no evidence for risk-neutrality or even risk prone behavior of entrepreneurs as compared with others. In fact, entrepreneurs have a tendency to risk aversion (Knight, 1921; Brockhaus, 1982). The impact of risk propensity on entrepreneurial success has also been studied from a developmental psychological perspective, but no conclusive findings have been drawn (Schmidt-Rodermund 2001). Risk propensity should not impact the predicted optimal solutions according to the model we offer, but respondents may be boundedly rational and hence risk propensity may matter - - we therefore measure it in our questionnaire experiment.

We further build upon the above literature in three ways. First, our model is closer to reality by taking into account the riskiness of most entrepreneurial decision situations and differences in the "stakes" of certain newly formed ventures. Second, our model is "testable" since it is built upon a preference calculus that is consistent with rational decision making under risk. Third, we test in a questionnaire experiment whether respondents are able to intuitively optimize - - and thus behave in a rational manner - - and how close actual behavior is to the normative prediction.

Analytic Framework

The Entrepreneur's Decision

We offer an effort-allocation model where the entrepreneur's decision-making problem is based on a utility function consistent with rational decision making according to expected utility theory. Assume that the total work tolerance of an entrepreneur is given.[1] That is, there is a maximum of τ working hours that can be devoted either to the current wage job or to developing a new venture. The key decision is how many hours, h, to allocate to the new venture; then τ-h hours will be devoted to the wage job. Time allocation h is restricted to be above a certain minimal threshold, ε, for the new venture to stay alive (and generate uncertain payoff). Thus, along with the investment into the new venture, the entrepreneur commits to a minimal effort ε. Moreover, h must be below the work tolerance of the entrepreneur, τ.

Ventures' Characteristics

Different ventures can be described by different combinations of risk and return. Let s (> 0) be the stakes of the venture. s enlarges both payoff mean and variance, and thus captures the stakes (or "leverage") of the venture. One can think in terms of a high stakes venture for start-ups in the high-tech industry where enormous payoff may be expected, but

[1] A future specification of the model may take into account the total time allocation of an individual where the individual simultaneously decides on how much time to spend for relaxation, hobbies, free time, sleep etc. (for simplification: total "free time"), for the own venture, and for the wage job. We assume here a stepwise optimization where the first step - - the allocation in to total working time and free time - - already took place.

also low payoff can be encountered as the risk surrounding the purchase of expensive setups and equipment may result in an unprofitable venture. Low stakes ventures are associated with less ambitious start-ups such as those in the service industry.

Let V be the marginal payoff from the increase in the stakes of the venture. This marginal payoff is not only affected by the entrepreneur's effort into that venture, but also by exogenous risk (which probability distribution cannot be controlled by the entrepreneur). Let the random variable X represent this risk. Thus we obtain

$$V = f(h,x), \tag{1}$$

where x is a realization of risk X. Note that the only input upon which the effort-allocation decision is made is the entrepreneur's time allocation to the new venture, h. Any other inputs are assumed fixed, or their quantities already established beforehand.

Therefore, the entrepreneur decides upon her/his time allocation by facing a wealth, denoted by W, of

$$W(h,p) = \omega\,(\tau\text{-}h) + s\,f(h,x). \tag{2}$$

The first term on the right-hand side of (2) represents the (risk-free) payoff associated with the wage job.[2] Since the result of (1) is uncertain, the wealth of the entrepreneur will be uncertain at the time of the time-allocation decision. The welfare derived from wealth W can be formalized by the expected utility $E[U(W)]$, or by the entrepreneur's welfare U which is expressed in terms of the certainty equivalent

$$U(h,p) = u^{-1}(E[u(W)], \tag{3}$$

where u is the entrepreneur's Neumann-Morgenstern utility function. We suppose that the entrepreneur is risk neutral or risk averse, and thus u concave. Risk-loving behavior in the normative sense is atypical among regular subjects and, based on the empirical studies

[2] We assume no cost of effort since the total time allocated to working is not here a decision variable but fixed.

referred to in the previous section, we argue that it hardly ever applies to entrepreneurs - - entrepreneurs are no “gamblers”, they are just more or less risk averse.

We are able to study how an entrepreneur’s work tolerance, wage rate and characteristics of the new venture affect the time allocation that maximizes welfare by further specifying functions and variables as that utilized by the Linear-Exponential-Normal-Model (LEN-Model) (e.g., Spremann, 1987). The relevant assumptions underlying this model for our analysis are that: (a) the marginal payoff from increased stakes of the new venture *V* is *linear* in the risk *X*, and consequently payoff *linear* in *V*; (b) the entrepreneur’s utility function *u* is *exponential*; and (c) the risk from the new venture *X* follows a *normal* probability distribution. Assumptions (a) and (c) imply that the entrepreneur’ wealth is normally distributed. That, in conjunction with assumption (b), implies that the certainty equivalent (3) can be expressed as expected value minus half the variance times risk aversion (Bamberg and Spremann, 1981).

Therefore we select *X* normally distributed, $E[X] = 0$, $Var[X] = \sigma^2$, and the entrepreneur’s utility to be $u(W) = -e^{-\alpha W}$, with $\alpha > 0$. The entrepreneur selects a time allocation h^* that maximizes the certainty equivalent (3), which now reads as

$$U(h;\omega,\tau,s) = E(W) - \frac{\alpha}{2} Var(W) = \omega\ (\tau - h) + s \cdot g(h) - \frac{\alpha}{2} s^2 \sigma^2 . \qquad (4)$$

α measures the entrepreneur’s risk propensity.

We next characterize a time allocation strategy that optimizes the entrepreneur’s wealth for decreasing, increasing and constant returns from time invested in the new venture. We also investigate how this time allocation strategy is affected by changes in key model parameters.

Time Allocation Strategies and their Sensitivity Analysis

Ventures differ in the amount of payoff that results from different levels of time allocated to them. Some new ventures consume a lot of effort before they begin to pay off but when they do the payoff (e.g., financial) may become very large. This characterizes the case of increasing returns to entrepreneurial effort or when viewed in terms of the functional relationship between the payoff and time allocated, we say that the function *g* is convex.[3] An example is a business where reputation builds up such as consulting. Other new ventures give significant immediate payoffs when effort is first invested but then give decreasing marginal payoffs. This is a case of diminishing returns to entrepreneurial effort and is represented by a concave function *g*. Examples for such ventures include babysitting and catering in a small village where willingness to pay decreases with the number of customers already reached. In between is the case where every hour spent on the venture yields the same payoff, that is, the functional relation is linear. Taxi-driving in a big city may be regarded as an example for such a function. We will consider each of these three cases separately.[4]

Decreasing Returns to Time Allocated in the New Venture

We first investigate the case where *g* is strictly concave in *h*, and more specifically where $g(h) = ah^n$, $0 < n < 1$, and $a > 0$ is the non-random part of *V* from the first hour allocated to the venture. We select an exponent function because by varying the value of the exponent *n* one can "swipe" an infinite set of possible curves, making empirical validity of this functional form more likely. How, then, will the entrepreneur choose to allocate time between a wage job and developing a new venture? It is straightforward to verify that

[3] At least in the part of the wealth function relevant to *new* ventures; such a functional form is less plausible for large, long-existing ventures.
[4] Other possibilities can be formed from these basic cases such as having increasing returns and then decreasing returns (as represented by an S-shaped function).

sufficient and necessary conditions (e.g., Bazaraa, Sherali, and Shetty, 1993) for the optimization of (4) are satisfied for

$$h^* = \left[\frac{nsa}{\omega}\right]^{\frac{1}{1-n}}. \tag{5}$$

Therefore, since $\varepsilon \le h^* \le \tau$,

Proposition 1 (corner solutions). When returns to time allocated in the new venture are decreasing with $g(h) = ah^n, \quad a > 0, \quad 0 < n < 1$, it is optimal to allocate $h^* = \varepsilon$ hours in to this venture (the survival constraint of the venture) if $\left[\frac{nsa}{\omega}\right]^{\frac{1}{1-n}} \le \varepsilon$, and $h^* = \tau$ hours in to this venture if $\tau \le \left[\frac{nsa}{\omega}\right]^{\frac{1}{1-n}}$.

Proposition 2 (interior solution). When returns to time allocated in the new venture are decreasing with $g(h) = ah^n, \quad a > 0, \quad 0 < n < 1$, and $\varepsilon < \left[\frac{nsa}{\omega}\right]^{\frac{1}{1-n}} < \tau$, then it is optimal to allocate $h^* = \left[\frac{nsa}{\omega}\right]^{\frac{1}{1-n}}$ hours in to this venture.

Proposition 3 (sensitivity of the corner solutions). When returns to time allocated in the new venture are decreasing with $g(h) = ah^n, \quad a > 0, \quad 0 < n < 1$, and $\tau \le \left[\frac{nsa}{\omega}\right]^{\frac{1}{1-n}}$, a change in the wage rate (ω), the stakes of the new venture (s), or the non-random portion of V from the first hour allocated to the new venture (a) does not affect the time allocated to the new venture, unless **(a)** the wage rate becomes large enough, **(b)** the stakes of the new venture becomes small enough, or **(c)** the non-random portion of V from the first hour allocated to the new venture becomes small enough for τ to exceed $\left[\frac{nsa}{\omega}\right]^{\frac{1}{1-n}}$ (in which case the optimal time allocation becomes an interior solution and the results of Proposition 4 apply).

Proposition 4 (sensitivity of the interior solution). When returns to time allocated in the new venture are decreasing with $g(h) = ah^n$, $a > 0$, $0 < n < 1$, and $\varepsilon < h^* < \tau$, **(a)** the larger the wage rate, the smaller the time allocated to the new venture, i.e., $\partial h^* / \partial \omega < 0$; whereas **(b)** the larger the stakes of the new venture, the larger the time allocated to that venture, i.e., $\partial h^* / \partial s > 0$; and **(c)** the larger the non-random portion of *V* from the first hour allocated to the new venture, the larger the time allocated to that venture, i.e., $\partial h^* / \partial a > 0$.

Proposition 5 (invariance of optimal solutions to risk propensity). Optimal solutions as stated in Propositions 1 and 2 are independent of the entrepreneur's risk propensity α.

Increasing and Constant Returns to Time Allocated in the New Venture

With increasing returns to time allocated in the new venture, the optimal time is always a corner solution. The minimum or the maximum number of hours is allocated to the venture depending on how the average rate of returns compares to the wage rate. It is straightforward to verify that the following results hold (one can also refer to the analysis of the increasing return case in Lévesque and MacCrimmon, 1997).

Proposition 6 (optimal solution). When returns to time allocated in the new venture are increasing with *g* strictly convex in *h*, the optimal time allocation takes the form of a corner solution where $h^* = \tau$ hours in to this venture if $\omega < \dfrac{g(\tau) - g(\varepsilon)}{\tau - \varepsilon} \cdot s$ and $h^* = \varepsilon$ hours in to this venture if $\omega \geq \dfrac{g(\tau) - g(\varepsilon)}{\tau - \varepsilon} \cdot s$.

Proposition 7 (invariance of optimal solution to risk propensity). The optimal solution as stated in Proposition 6 is independent of the entrepreneur's risk propensity α.

When the returns from allocating time in to the new venture are constant, we select $g(h) = ah$. Since $U(h;\omega,\tau,s)$ in (4) becomes linear in h, it is straightforward to verify that the following results hold.

PROPOSITION 8 (OPTIMAL SOLUTION). When returns to time allocated in the new venture are constant with $g(h) = ah$, the optimal time allocation takes the form of a corner solution where $h^* = \tau$ when $\omega < as$ and $h^* = \varepsilon$ when $\omega \geq as$.

PROPOSITION 9 (INVARIANCE OF OPTIMAL SOLUTION TO RISK PROPENSITY). The optimal solution as stated in Proposition 8 is independent of the entrepreneur's risk propensity α.

Note that propositions 5, 7, and 9 are direct implications of a basic feature of our simple model. That is, our model does not exploit the potential tradeoff between the mean and variance of a business opportunity -- since time allocation is not affecting the variance term.

Experimental Design and Findings

Research in entrepreneurship has begun to build up from (behavioral) decision theory and to carry out questionnaire experiments on entrepreneurial behavior. For instance, Busenitz and Barney (1997) focus on overconfidence while Forlani and Mullins (2000) on various dimensions of risk. We chose to conduct an experimental study because of the likely difficulty in a field study to control for the broad array of factors believed to influence risky new venture decisions in natural settings (Baird and Thomas, 1985). This approach has advantages in internal validity for theory testing purposes, but may be criticized on the basis that the experimental task is not a real one with real payments. Given the newness of this research area, we believe this tradeoff is acceptable.

Design of the Questionnaire Experiment

In the questionnaire experiment we selected values for the model parameters in such a way that only corner solutions had to be detected by the respondents. We compared the optimal time allocation of situations with increasing versus decreasing returns to time allocated in the newly formed venture, low versus high stakes for the venture, and low versus high wage rate. We also manipulated the tolerance for work by initially fixing it in the different groups of respondents on different levels (i.e., 8 and 12 hours per day) and allowed for later adjustments on that tolerance for work. While some of these combinations should lead to the lower bound solution ($h^* = \varepsilon$), others should lead to the upper bound solution ($h^* = \tau$).

We therefore empirically investigate whether respondents are able to intuitively optimize in a manner such as that suggested by Propositions 1, 3, 5, 6 and 7. Table 1 presents predictions according to Propositions 1 and 6, along with experimental findings and numerical values utilized on the model parameters.[5]

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(Insert Table 1 about here)
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Respondents were asked to imagine being in an entrepreneurial decision situation and were provided with basic information such as how a normal distribution looks like. Each group of respondents (group 1: 12 hours work tolerance; group 2: 8 hours) had to decide on time allocation in the venture for different decision situations. Appendix A offers a sample of the experimental entrepreneurial story for the high work tolerance case (12 hours a day) with a high stakes venture, high salary wage job, and increasing returns to time allocated in the venture. Exact conditions, including payments, probability distributions (figures), earnings for an (additional) hour spent on the venture, and total earnings with specific time allocations,

[5] It is straightforward to replace these numerical values into the formulas of Propositions 1 and 6 to obtain the normative predictions reported in Table 1. We therefore chose to omit detailed computations.

were displayed in the questionnaire for each of the 16 cases (please refer to Appendix A for the 1st case). These 16 cases are referred to as "condition 1" to "condition 16" in Table 1.

In each of the high work tolerance cases the subject was asked the following: "We now want to know how many working hours you would allocate to your own venture in this situation, daily. Remember that you are willing to work a total of 12 hours a day. The rest will automatically be allocated to your wage job. You can report fractions of hours." In each of the low work tolerance cases the same text was given with 12 hours being replaced by 8 hours. Later in the questionnaire, the respondent was asked for each situation to state the total amount of time (in number of hours) s/he would be willing to work as well as the time (in number of hours) s/he would allocate to the new venture. More specifically we asked: "Imagine now that you could change the total hours you work daily (that you can move it upwards or downwards). How many total hours would you have liked to work in this situation, and how would you have liked to distribute these hours between your wage occupation and your own venture?"

Finally, to verify whether or not risk propensity has an influence on actual behavior - - according to Propositions 5 and 7 it should not - - we measure each respondent's risk propensity via the McCord and Neufville (1986) lottery comparison approach.[6] Appendix B presents the three decision situations we utilized. After pre-testing the experiment with a few master students, we ran the experiment on a total of 112 students of Humboldt-Universität zu Berlin, Germany. In general these students had a good formal education in decision sciences and game theory, and were stemming from different fields including business, economics, computer science, and pedagogy. The entire experimental design may be derived from Table 1, where the experimental findings are compared to the normative predictions of Proposition 1 and Proposition 6.

[6] Unlike the original approach of McCord and Neufville (1986), $U(X_{max})=1$ is replaced by $U(X_{max})=.5$ to accommodate for the use of an exponential utility function. Note, however, that a linear transformation on a utility function does not affect the order of preferences.

Testing Propositions 1, 3 and 6

12 Hours Work Tolerance Group

We first examine the results of the 12 hours work tolerance group. Since all answers are usable, subsequent calculations are based on the entire group of 52 respondents. Respondents *do* meet the normative prediction from interpreting predictions of 12 hours versus 1 hour spent in the venture as *directional hypotheses*. From Table 1, hours allocated to the venture are "high" when they should be, i.e., under conditions 1-4, and 7; whereas hours allocated to the venture are "low" when they should be, i.e., under conditions 5, 6 and 8. All relevant pair wise comparisons are highly significant (p-level [Wilcoxon]: .000, two-sided).

However, the interpretation of how close decision makers are to the absolute normative prediction - - the actual 12 or 1 - - must involve a discussion of deviations. Looking at individual data and referring to Table 1, 57.7% of the respondents selected the correct corner solution in condition 1, 28.8% in condition 2, 75.0% in condition 3, 55.8% in condition 4, 42.3% in condition 5, 51.9% in condition 6, 44.2% in condition 7, and 43.1% in condition 8 (one missing value). Based on a confidence interval analysis, under all conditions deviations from the correct corner solutions are significant at a 1%-level (one-sided).

If respondents' behavior differs significantly from the normative prediction, are the deviations systematic? Indeed they are. In the high-stakes/high-salary cases (conditions 1 and 2), the optimal solution is 12 hours whether returns from time allocated to the venture are decreasing or increasing (p-level [Wilcoxon]: .000, two-sided). However, many individuals rectified the number of hours allocated to the venture by adjusting that number downwards when returns from time allocated to the venture were decreasing as compared to when they were increasing. The same holds in the high-stakes/low-salary cases (conditions 3 and 4) (p-level [Wilcoxon]: .000, two-sided). In the low-stakes/high-salary cases (conditions 6 and 7), both increasing and decreasing returns should lead to a corner solution of 1 hour, but again the number of hours allocated to the venture was adjusted downwards in the decreasing returns case (p-level [Wilcoxon]: .000, two-sided).

One the other hand, low wages make the individuals adjust the hours allocated to the venture upwards, even though it should have no impact according to the optimization model. This holds for the high-stakes/increasing-returns cases (conditions 1 and 3; p-level [Wilcoxon]: .000, two-sided) and for the high-stakes/decreasing-returns cases (conditions 2 and 4; p-level [Wilcoxon]: .000, two-sided), which should all lead to a corner solution of 12 hours regardless of wages. The same holds for the low-stakes/decreasing-returns cases (conditions 6 and 8; p-level [Wilcoxon]: .001, two-sided), were both wage rates should lead to a 1-hour solution.

Finally, high stakes of the venture also make the individuals adjust the hours allocated to the venture upwards, even though it should have no impact according to the optimization model. Time allocation into the venture should be 12 hours for the increasing-returns/low-salary/high-stakes case and for the increasing-returns/low-salary/low-stakes case (conditions 3 and 7). The difference under these conditions is in favor of the high stakes venture where more time is allocated (p-level [Wilcoxon]: .000, two-sided). In summary, in the 12 hours work tolerance group we find weak support for Propositions 1 and 6, and Proposition 3 clearly has to be rejected.

8 Hours Work Tolerance Group

We next look at the same data for the 8 hours work tolerance group. Two respondents opted for more hours in their own venture then they were "allowed" to and one stated zero hour. These three respondents were eliminated from the following analyses (and in Table 1), leading to a total of 57 usable respondents in this group. As in the previous group, hours allocated to the venture are "high" when they should be, i.e., under conditions 9-12 and 15; whereas hours allocated to the venture are "low" when they should be, i.e., under conditions 13, 14 and 16. All relevant pair wise comparisons are highly significant (p-level [Wilcoxon]: .000, two-sided).

There is again a fraction of individuals in each condition who "detected" the correct corner solutions: 38.6% in condition 9, 28.1% in condition 10, 47.4% in condition 11, 49.1% in condition 12, 49.1% in condition 13, 58.9% in condition 14 (one missing value), 33.9% in condition 15 (one missing value), and 44.6% in condition 16 (one missing value). However, as in the 12 hours work tolerance group, we find an effect of normatively "irrelevant" conditions. Low stakes make working in the venture less attractive in the increasing-returns/low-salary case (p-level [Wilcoxon]: .000, two-sided) while low salaries make it more attractive in the high-stakes/increasing-return, high-stakes/decreasing-returns, and low-stakes/decreasing-returns cases (all p-levels [Wilcoxon], .000, two-sided). Also, decreasing returns make the enterprise less attractive in the high-stakes/high-salary cases (p-level [Wilcoxon]: .007, two-sided), high-stakes/low-salary cases (p-level [Wilcoxon]: .018, two-sided), and low-stakes/high-salary cases (p-level [Wilcoxon]: .001, two-sided). We therefore find in the 8 hours work tolerance group some support for Propositions 1 and 6, whereas Proposition 3 has to be rejected.

Testing Propositions 5 and 7

Table 2 reports on r^2 values and significance levels of linear OLS regressions. These regressions are run under the 16 conditions associated with both work tolerance groups. Risk propensity is the independent variable whereas number of hours allocated to the venture is the dependent variable. Surprisingly, and in direct contradiction with Propositions 5 and 7, six out of eight regressions (75%) in the 12 hours work tolerance group are at least marginally significant. In the 8 hours work tolerance group, only three out of eight regressions (37.5%)

are at least marginally significant. In other words, the number of hours allocated to the venture depends on the risk propensity under multiple conditions, but it should not according to the normative model.

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Insert Table 2 about here
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Furthermore, the signs of the regression coefficients in Table 2 offer interesting conclusions. First notice that based on our basic exponential utility function, the larger the risk propensity α the more risk averse the decision maker will be (as α increases the utility curve moves away from the straight line associated with risk neutrality). Second, according to our regression model ($h = \beta_0 + \beta_1\alpha$), the larger the risk propensity (α) the larger the time allocated to the venture (h) whenever the regression coefficient (β_1) is positive, but when that coefficient is negative it is a small time allocation to the venture that is associated with a large risk propensity. Therefore, in the 8 hours work tolerance group where the sign of the regression coefficient is always negative, the more risk averse the decision maker, the less hours s/he will allocate to the venture. In the 12 hours work tolerance group, the regression coefficient is negative in the cases where the upper bound on time allocated to the venture was predicted as optimal, but it is positive when the lower bound was predicted as optimal.

Behavioral Interpretation of Findings

Optimal Solutions

Respondents behave according to the normative predictions when interpreted as directional hypotheses. That is, when a corner solution with the maximum available time allocated to the venture was predicted, respondents did in fact allocate a high number of hours to the venture, whereas when a corner solution with the minimum input (1 hour) was predicted, they chose to allocate little effort into the venture. Nevertheless, only a subset of the respondents opted for the corner solution, and this percentage varies between experimental conditions. From a more careful analysis of the data, we find that our propositions (1, 3, 5, 6 and 7) are unsupported under each of the 16 experimental conditions of Table 1. Namely, our results are not consistent with the respondents selecting the corner solution, and deviations from optimal behavior are not only due to random errors. We detected a strong effect of factors that should have no impact: low wage rates, high stakes or increasing returns to time allocated in the venture lead to more hours spent on the venture. Without knowing the model's predictions, these deviations may appear reasonable at first sight.

What does it mean for our respondents' decision processes? A subgroup of respondents does in fact detect the corner solution as optimal. We argue that the remaining respondents make use of an anchoring and adjustment procedure (Tversky and Kahneman 1974). In such a procedure, respondents select a preliminary level of time allocated to the venture - - the so-called anchor. This anchor would start high in situations where the venture seems profitable and/or the wage job relatively unattractive, but low in situations where the venture appears relatively poor and/or the wage job relatively attractive. The anchor is then adjusted where a high stakes venture would justify more effort into the venture than a low stakes venture, a high wage job lead to a lower time allocation into the venture than a low wage job, and increasing returns to time allocated to the venture provide better incentive for more hours spent on the venture than decreasing returns. Respondents do not optimize and hence are unaware of the fact that some of these conditions require the same amount of hours spent on the venture, although initially these conditions may appear to differ in their attractiveness.

Risk Propensity

More surprisingly, risk propensity plays a role in the time allocation of our respondents. Individuals have been demonstrated in behavioral decision theory to disobey normative models of choice (Allais, 1953; Kahneman and Tversky, 1979; Hershey, Kunreuther, and Schoemaker, 1982; Currim and Sarin, 1989; Tversky and Kahneman, 1992). Also, recent studies demonstrate that affect and emotion may be more important than the objective analysis in many decision situations. According to the so-called affect heuristic, certain alternatives may intuitively appear riskier although this is not warranted by an objective analysis (see Slovic et al. 2001). Whilst adjusting the hours allocated to the venture upwards and downwards, respondents may take into consideration *subjective* risk differences. If a venture is just *perceived* as a more risky occupation than a wage job, the subjective risk may appear higher when allocating more hours to the venture, while that risk appears lower when allocating less hours to the venture.

This interpretation is consistent with observed behavior under all conditions in the 8 hours work tolerance group, and under all conditions where the upper bound is optimal in the 12 hours work tolerance group. However, since the entire payoff distribution is shifted upwards with every hour spent in the venture (under the conditions where the maximum number of hours should be allocated to the venture) our respondents seem to violate the principle of stochastic dominance. The risk of a loss diminishes as more time is devoted to the venture. It is a well-known fact that real decision makers have a tendency to be loss averse (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992) and one could argue that the enterprise "appears" more risky than the wage job. It is only if the enterprise appears to be a poor alternative and the respondent is allowed to work twelve hours that risk aversion leads to more hours spent on the venture. Only here, in the 12 hours work tolerance cases, the respondents may be forced to realize how close they are to incurring losses with their enterprise and opt to spend more hours on it to move the distribution upwards - - without being forced to reduce significantly the hours allocated to the safe wage job. In the 8 hours work tolerance cases, on the other hand, this relationship is not found since they prefer to allocate very little away from their safe wage job.

Implications and Extensions

Implications for Entrepreneurial Behavior and Education

Does it matter to teach optimization to entrepreneurs? Optimization methods can help to answer the "what should be" questions, and guide those entrepreneurs who wish to improve their decisions. Especially if systematic deviations from rational behavior - - i.e., behavior predicted from the model - - are observed empirically, decision makers may want to learn which mistakes are typical and how to steer against potentially inefficient decisions.

Are we successful in teaching optimization to entrepreneurs? The answer is probably not. What can we do to help entrepreneurs overcome inefficient decisions? We argue that a starting point is to teach them how to maneuver against these typical mistakes. In our decision situations, decision makers had a tendency to violate the principle of stochastic dominance by not realizing that working more in their enterprise did not make their position more risky but moved upwards the entire payoff distribution. We suspect that it would be easier to train people to become aware of such situations - - and avoid perceiving every hour spent on their own business as more risky than spending that hour on a wage job - - than making them apply a closed form solution from a mathematical model.

Implications on Incentives to Work in the New Venture

This work should be of interest to banks and venture capitalists in better understanding the disincentives to work in the new enterprise. As long as every hour worked in these enterprises is perceived as more risky than an hour spent in a wage job, entrepreneurs may opt to dedicate an insufficient amount of work to their company. Perhaps it would help to make potential entrepreneurs aware of a recent trend in some industries: their wage jobs may also be unsafe, that is, they may be laid off.

Implications on Labor Market Regulations

In Europe, the labor market is highly regulated so that time allocation in the investigated sense is difficult for the potential entrepreneur. An entrepreneur may face the alternatives of either working half time in the wage job, full time, or not at all. This makes starting its own business even riskier. In turn findings that demonstrate the relevance of these speculations to real (or at least experimental) entrepreneurs may convince politicians and labor unions of needed changes in the institutional environment to encourage entrepreneurship. Therefore, the design and experimental testing of a more refined model where the possibility to allocate time away from the wage job is limited would be desirable.

Experimental Study with Interior Solutions and Real Monetary Consequences

In our questionnaire experiment we focused on the selection of corner solutions, which may be thought off as being "unnatural". Real decision makers are known to perform better with intuitive optimization in realistic scenarios, and perhaps a more common situation is where an interior solution is optimal. Furthermore, questionnaire experiments are based on hypothetical decisions. In reality the gains and losses of entrepreneurs are monetary and, according to the experimental economics paradigm, incentive compatible, real payments, and real risks experiments are more appropriate to test for the rationality of economic behavior (Camerer, 1995). Consequently, decision anomalies such as those demonstrated in this paper are even more convincing under experiments with real economic incentives.

Mean-variance tradeoff

A natural extension to enrich the proposed model would capture the mean-variance tradeoff in entrepreneurial decision situations. The way to proceed is to allow the time allocated in a venture to also impact on the risk.

Conclusion

We offered a formal model where an entrepreneur must decide on how to allocate time between a wage job and a new venture. Predictions were derived on optimal behavior in 16 different decision situations, assuming individuals' preferences obey certain rationality axioms and they perfectly optimize. These predictions were tested with real decision makers using simple questionnaire experiments where respondents had to detect corner solutions in the 16 experimental conditions. These questionnaires were also utilized to test the sensitivity of the decisions with respect to risk propensity.

Model's predictions were compared to experimental data and found unsupported. Respondents behaved according to the normative predictions when interpreted as directional hypotheses, but only a subset of the respondents opted for the corner solution, and this percentage varied between experimental conditions. Also, the number of hours allocated to the venture depended on the risk propensity under multiple conditions, although it should have not according to the optimization model. We detected a strong effect of factors that should have had no impact, namely low wage rates, high stakes or increasing returns to time allocated in the venture led to more hours spent on the venture.

Our experimental findings are consistent with most individuals utilizing an anchoring and adjustment procedure and being influenced by affects, rather than a fully rational optimizing approach. The use of heuristics in decision making under risk is a relatively well-known fact in behavioral decision theory. And many recent studies deal with the impact of affects on choice. Here, many individuals seem to be misled by their subjective risk perception, i. e. by affects, to a degree that they violate the principle of stochastic dominance. An additional hour invested in the own enterprise appears riskier than investing that same hour in a wage job, although this was not the case.

Appendix A: Questionnaire

Experiment on Entrepreneurial Decision Making

In the following, we would like you to imagine being in hypothetical entrepreneurial decision situations. Please try to answer these questions as if you were actually facing these situations (in reality). We are interested in individual data, only. These data should not be influenced by other respondents' perceptions or decisions. Therefore, please concentrate on your own set of questions, and do not talk to other students during the experiment. Thank you!

Background

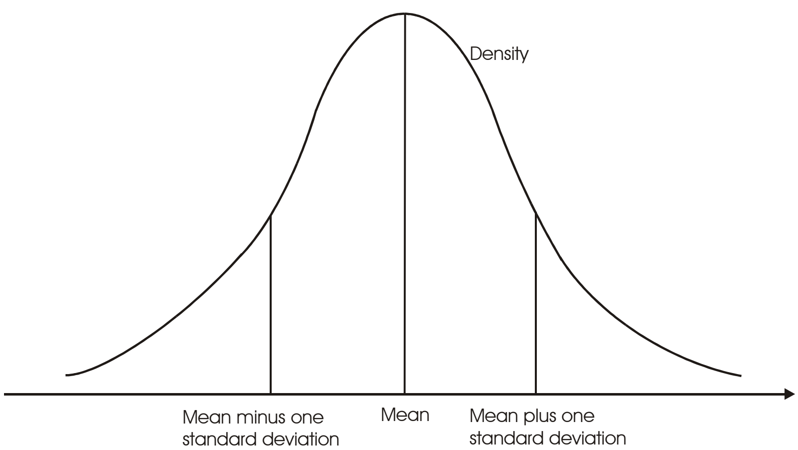
Imagine you are planning to start a small business and are currently working for a big company with flexible working times, i.e. you can allocate your working time to the wage job and to your own company as you like.

Since you are a high work tolerant, the total hours you are accepting to work a day is 12 hours. You are not planning to work during the weekends, however, you are planning to work five days a week.

We now want to know, how many hours of your daily working time you would allocate to your own venture in the following, eight different situations. Please consider your decisions carefully.

With your own enterprise, your expected returns are never certain but you are always facing a risk. Although the risk differs between high-stakes and low-stakes ventures as will be explained in detail, below, the distribution form of the risk is always the same:

The risk is normal distributed. A normal distribution has the following basic form:



Normal Distribution

Situation 1: High-stakes venture, high salary wage job, increasing returns of venture

The payment for your wage job is € 30,00 per hour. Also, since you already committed to your own business and invested some money, your minimum input to keep the business alive is one hour a day. Putting more effort into the business makes you in general earn more money from your business. Your business opportunity is a relatively high-stakes venture, i.e. you have an average net profit expectation of € 40,00 for the minimum working time (one hour) spent on your own business. If you spend one more hour, you will earn on average an additional € 42.82. (Or in other words, your expected profit of two hours work for your own venture is € 82,82.) For each additional hour spent on your business, your expected profit is increasing. For mean expected payoffs resulting from different hours allocated to your own venture see the table below.

Your business is however not risk-free. There is a large risk involved, i.e. you are facing a large variance on your expected earnings. The risk is normal distributed with an equal probability of obtaining less or more than you expected, and the probability of gaining or losing small amounts being higher than the probability of losing or gaining large amounts. **The standard deviation is € 44. See again the above figure for an interpretation.**

The following table now reports mean expected profits as well as the probabilities that the profits will eventually be situated in certain intervals, for 1, 2, 3, …, and 12 hours of work allocated to your own venture. The table reads very straightforward. If you want to know what the consequences of two hours of work allocated to your own venture are, just follow the row right of hours: "2". Note that all values are rounded. That is especially important with "0%". Note that with a normal distribution, there is never an interval where the probability that the profit will be located in is actually zero. Zero just stands for "the probability is very small".

Table A1 Consequences of *h* hours allocated to own venture: Increasing returns, high stakes, standard deviation of 44

		Payoffs									
Hours	**Mean**	**<0**	**[0;50]**	**[50; 100]**	**[100; 150]**	**[150; 200]**	**[200; 250]**	**[250; 300]**	**[300; 350]**	**[350; 400]**	**>400**
1	40,00	15,9%	44,0%	33,4%	6,4%	0,3%	0,0%	0,0%	0,0%	0,0%	0,0%
2	82,82	1,9%	18,7%	46,0%	28,7%	4,5%	0,2%	0,0%	0,0%	0,0%	0,0%
3	126,78	0,1%	2,7%	22,4%	46,8%	24,7%	3,3%	0,1%	0,0%	0,0%	0,0%
4	171,48	0,0%	0,1%	3,6%	25,9%	46,6%	21,3%	2,4%	0,1%	0,0%	0,0%
5	216,76	0,0%	0,0%	0,2%	4,6%	29,0%	45,9%	18,4%	1,8%	0,0%	0,0%
6	262,49	0,0%	0,0%	0,0%	0,2%	5,7%	31,8%	44,8%	16,0%	1,4%	0,0%
7	308,61	0,0%	0,0%	0,0%	0,0%	0,3%	6,8%	34,3%	43,5%	13,9%	1,1%
8	355,06	0,0%	0,0%	0,0%	0,0%	0,0%	0,4%	8,0%	36,5%	42,0%	13,1%
9	401,80	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,5%	9,2%	38,4%	51,8%
10	448,81	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,7%	10,4%	88,9%
11	496,05	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,8%	99,2%
12	543,50	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	100,0%

We now want to know how many working hours you would allocate to your own venture in this situation, daily. Remember, that you are willing to work a total of 12 hours a day. The rest will automatically be allocated to your wage job. You can report fractions of hours.

In this situation, I would allocate _____,____ hours to my own venture.

Imagine now that you could change the total hours you work daily (that you can move it upwards or downwards). How many hours would you have liked to work in this situation, and how would you like to distribute it to your wage occupation and to your own venture?

1. Total hours I would like to work daily: _____,____

2. Hours I would allocate to the wage job: _____,____

3. Hours I would allocate to my own venture: _____,____

Note that the sum of (2) and (3) should be equal to (1).

Appendix B: Measuring Risk Propensity

Description of the decision situations
In each of the three following decision situations, you can opt for becoming partner in one of two small enterprises: A or B, C or D, E or F. All reported profit shares are *net profits after taxes*.

Decision 1
In enterprise A you receive a profit share of € 3.875 with a probability of 60 %, and with a probability of 40 % a profit share of € 500.
In enterprise B you receive a profit share of € 5.000 with a probability of *p*, and with a probability of 1-*p* a profit share of € 500.
Approximately how high would the probability *p* have to be so that working in both enterprises is equally attractive to you?

The probability *p* would have to be around _______ %

Decision 2
In enterprise C you receive a profit share of € 2.750 with a probability of 60 %, and with a probability of 40 % a profit share of € 500.
In enterprise D you receive a profit share of € 5.000 with a probability of *p*, and with a probability of 1-*p* a profit share of € 500.
Approximately how high would the probability *p* have to be so that working in both enterprises is equally attractive to you?

The probability *p* would have to be around _______ %

Decision 3
In enterprise E you receive a profit share of € 1.625 with a probability of 60 %, and with a probability of 40 % a profit share of € 500.
In enterprise F you receive a profit share of € 5.000 with a probability of *p*, and with a probability of 1-*p* a profit share of € 500.
Approximately how high would the probability *p* have to be so that working in both enterprises is equally attractive to you?

The probability *p* would have to be around _______ %

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Table 1 Experimental Design and Daily Mean Hours Allocated to the New Venture

			Within subjects							
			High-stakes venture (expected payoff for the 1st hour is *sa* = 40 with a standard deviation of σ = 44)				Low-stakes venture (expected payoff for the 1st hour is *sa* = 20 with a standard deviation of σ = 22)			
			High-salary wage job (ω = € 30)		Low-salary wage job (ω = € 20)		High-salary wage job (ω = € 30)		Low-salary wage job (ω = € 20)	
			Increasing returns of venture (expected payoff function is $40h^{1.05}$)	Decreasing returns of venture (expected payoff function is $40h^{.95}$)	Increasing returns of venture (expected payoff function is $40h^{1.05}$)	Decreasing returns of venture (expected payoff function is $40h^{.95}$)	Increasing returns of venture (expected payoff function is $20h^{1.05}$)	Decreasing returns of venture (expected payoff function is $20h^{.95}$)	Increasing returns of venture (expected payoff function is $20h^{1.05}$)	Decreasing returns of venture (expected payoff function is $20h^{.95}$)
Bet-ween sub-jects	High work tolerance group (τ = 12 hours/day) n = 52	Normative predictions	12 condition 1	12 condition 2	12 condition 3	12 condition 4	1 condition 5	1 condition 6	12 condition 7	1 condition 8
		Experimen-tal findings	10.63	8.61	11.49	10.27	3.96	2.73	10.13	3.86*
	Low work tolerance group (τ = 8 hours/day) n = 57**	Normative predictions	8 condition 9	8 condition 10	8 condition 11	8 condition 12	1 condition 13	1 condition 14	8 condition 15	1 condition 16
		Experimen-tal findings	6.15	5.39	7.00	6.48	2.55	1.97*	5.37*	2.79*

Lower bound on time allocated in to the venture is ε = 1 hour/day.
* One missing value in the condition.
** Two subjects were eliminated from statingd more hours than permitted (> 8 hours). One was eliminated from stating zero hour.

Table 2 OLS Regressions with a Constant, Risk Propensity as Independent Variable and Hours Allocated to the Venture as Dependent Variable

		Adjusted r^2	p-level	Sign of the regression coefficient
Treatment 1 12 hours work tolerance	Condition 1	.210	.001	Negative
	Condition 2	.179	.002	Negative
	Condition 3	.043	.090	Negative
	Condition 4	.005	.278	Negative
	Condition 5	.076	.036	Positive
	Condition 6	.107	.015	Positive
	Condition 7	-.004	.376	Negative
	Condition 8	.120	.011	Positive
Treatment 2 8 hours work tolerance	Condition 9	.038	.092	Negative
	Condition 10	.174	.002	Negative
	Condition 11	.025	.138	Negative
	Condition 12	.075	.031	Negative
	Condition 13	-.016	.653	Negative
	Condition 14	-.010	.478	Negative
	Condition 15	-.006	.401	Negative
	Condition 16	.031	.118	Negative