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Entrepreneurial decision-making using the knightian uncertainty approach

Maria Sylvia Macchione Saes
Universidade de São Paulo – São Paulo/SP, Brasil

André Cavalcanti Rocha Martins
Universidade de São Paulo – São Paulo/SP, Brasil

Paula Sarita Bigio Schnaider
Universidade de São Paulo – São Paulo/SP, Brasil

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RESUMO

Tomada de decisão empresarial sob incerteza: uma abordagem knightiana

Neste artigo, discutem-se os aspectos comportamentais que afetam a tomada de decisão dos empreendedores a partir da abordagem knightiana de incerteza. Uma vez que os lucros da atividade empreendedora representam a recompensa de um risco imensurável e subjetivo, tem-se como hipótese que os empreendedores inovadores possuem excesso de otimismo e confiança, o que os leva a investir em atividades de alto risco. Um modelo comportamental de tomada de decisão sob incerteza é usado para testar a hipótese de excesso de confiança. Esse modelo baseia-se na inferência bayesiana, que permite uma modelagem da hipótese de excesso de confiança desses agentes econômicos. Conclui-se que, sob a hipótese de excesso de confiança, esses empresários decidem investir, apesar do fato de o modelo de utilidade esperada indicar o contrário. Essa constatação teórica poderia explicar por que há um grande número de quebras de negócio nos primeiros anos de atividade.

***Palavras-chave*:** empreendedor, tomada de decisão, Knight, teoria da probabilidade adaptativa.

1. THE APPROACH TO THE ENTREPRENEUR

The logic behind entrepreneurial decision-making is an intricate issue, not clearly explained by the traditional economic theory, according to which the market dictates the firms' performance. Even in its most critical field, namely Industrial Organization, the entrepreneurial role is not relevant. According to

Maria Sylvia Macchione Saes, Doutora em Economia pela Universidade de São Paulo, é Professora do Departamento de Administração da Faculdade de Economia, Administração e Contabilidade da Universidade de São Paulo (CEP 05508-010 – São Paulo/SP, Brasil), Coordenadora do Núcleo de Pesquisa da Universidade de São Paulo *Center for Organization Studies* (CORS).
E-mail: ssaes@usp.br
Endereço:
Universidade de São Paulo
FEA – Departamento de Administração
Avenida Professor Luciano Gualberto, 908
Cidade Universitária – Butantã
05508-010 – São Paulo – SP

André Cavalcanti Rocha Martins, Mestre e Doutor em Física pelo Instituto de Física da Universidade de São Paulo, é Pós-Doutorando na Faculdade de Economia, Administração e Contabilidade da Universidade de São Paulo (CEP 05508-010 – São Paulo/SP, Brasil).
E-mail: amartins@usp.br

Paula Sarita Bigio Schnaider é Doutoranda em Administração no Departamento de Administração da Faculdade de Economia, Administração e Contabilidade da Universidade de São Paulo (CEP 05508-010 – São Paulo/SP, Brasil) e em Economia na *Université Paris 1 – Panthéon Sorbonne* (75004 – Paris, França), Bolsista Fapesp.
E-mail: paula.schnaider@usp.br

the structure, conduct and performance (SCP) approach, some basic conditions of the product — like its demand elasticity, scale and features — drive the industry structure, as if entrepreneurs could solely be mere passive spectators of the market forces (Scherer & Ross, 1990).

Thus, strategies are chosen according to prices, given the following data: consumers' preference, technological possibilities and resource endowment. That means that only a few activities are consistent with prices and quantities. The hypothesis of perfect entrepreneurial rationality leaves no role for the classical entrepreneurial task of coordinating, arbitrating, innovating and dealing with uncertainty (Rumelt, 1991; Bhidé, 2000). In this sense, the firm plays a game in which not only its outcome is known, but also that of its rivals.

Even considering recent approaches (Scherer & Ross, 1990) proposing that firms can modify the market structure, for instance, when they create entry barriers to the sector by adopting a differentiation strategy, nothing is known about how such a process happens or might happen. In other words, the model foretells what happens when technologies and preferences change, but cannot explain why it occurs (Bhidé, 2000).

By undermining the entrepreneur's role as the driving force of the capitalist economies' development, "conventional neoclassical models tell stories about the adjustment of known means to given ends, but they say very little about how those means and ends change or come into being in the first place" (Langlois, 2002, p. 16). In this sense, the neoclassical economics world has no real place for entrepreneurs (Baumol, 1968; Bianchi & Henrekson, 2005). As Casson (2005, p. 116) states, by neglecting the entrepreneurial dimension, the economic theory can only offer a partial explanation of the firm's behavior.

Bearing this in mind, this article seeks to provide a better understanding of the rationale that drives entrepreneurial investment decisions. To this end, we discuss the behavioral aspects that affect the entrepreneurs' decision making under the Knightian uncertainty approach.

We argue that the profit arising from entrepreneurial activity represents the reward of an immeasurable and subjective risk. Thus, we hypothesize that innovative entrepreneurs are often more confident than their peers, which leads them to invest in high-risk activities. A behavioral model of decision making under uncertainty is built in order to test this hypothesis. This model is based on the so-called Adaptive Probability Theory (APT) (Martins, 2006), which allows us to model the assumption that entrepreneurs are overconfident.

This paper is structured as follows: first, we discuss the role entrepreneurs play in Economic Theory. We then present the logic underlying the entrepreneurial decision-making process, highlighting the overconfidence cognitive bias that affects this decision. An interpretation to this rationale through the APT model follows. Finally, we discuss the implications of our findings.

1.1. The entrepreneurial role

One of the first thinkers to discuss the entrepreneurial role in the economic theory was Schumpeter, in 1912, in *The theory of economic development*[1]. The Schumpeterian entrepreneur is not a common businessman, but an innovator motivated by the opportunity of profit. This entrepreneur plays a key role in creating new businesses through a process of **creative destruction**.

Essentially, the entrepreneur undertakes tasks that are not performed in the ordinary course of the business routine. The entrepreneur is, therefore, the **first mover** that can be present both in a small activity and in large corporations, either as a single physical person or a group. The effect of innovation is to unbalance and alter the structure of the market until the exhaustion of this process occurs and the beginning of a new innovation wave appears.

It is worth noting that imitation or adaptation tends to be the rule in start-up firms[2]. These are not, however, the object of Schumpeter's analyses or of this study. "Entrepreneurship is about the new — new goods and services, but more generally new economic knowledge — and about how the new enters the economic system. To put it in another way, entrepreneurship is about change" (Langlois, 2005, p. 2).

Essential in the Schumpeterian approach is that entrepreneurship requires "intuition and the leap of logic", suggesting an action outside the familiar routine in the innovation process (Langlois, 2002, p. 18). From this viewpoint, the innovation concept is seen as exogenous to the economic system and independent from the market structure. This process comprises five cases:

> (1) the introduction of a new good — that is one with which consumers are not yet familiar — or a new quality of a good; (2) the introduction of a new production method, that is one not yet tested by experience in the branch of manufacture concerned, which need by no means be found upon a discovery scientifically new, and can also be a new way of handling a commodity commercially; (3) the opening of a new market, into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before; (4) the conquest of a new source of supply raw material or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created; (5) the carrying out of the new organization of any industry, like the creation of a monopoly position (for example, through trustification) or the breaking up of a monopoly position (Schumpeter, 1934, p. 66).

Although Schumpeter's view has played a major role in crafting what is now taken as entrepreneurship, his approach is also quite narrow. In fact,

> [t]he entrepreneurial function can be manifested in large and small firms, in old and new firms, by individuals or teams, across a variety of occupational categories, and so on. By focusing too narrowly on self-employment and start-up companies, the contemporary literature may be understating the role of entrepreneurship in the economy and business organizations (Klein, 2008, p. 177).

In this sense, it should be highlighted that although Schumpeter (1934) recognized the relevance of uncertainty in determining the success of an entrepreneurial strategy, his theory tended to avoid this effect in favor of other aspects of the entrepreneurial ability. This view becomes evident in Schumpeter's statement that the idea of uncertainty "[…] may be true but need not be added to the element of business ability and is of course, still more obviously, not quite the same as the element of risk: but we need not stress these relations" (Schumpeter, 1934, p. 67-68).

In contrast, the matter of uncertainty takes on a central role in Knight's theory. Whereas Schumpeter deals with the entrepreneur's role as an explorer, Knight (1964), in his 1921 work *Risk, uncertainty and profit*, explains the importance of the evaluation or judgment of an entrepreneur in decision-making under uncertain conditions. According to the author, the notion of entrepreneurial judgment is supported as a function of business uncertainty.

Thus, if uncertainty is just one factor in entrepreneurial decision-making for Schumpeter, for Knight it is determinant, since it is connected with the exercise of judgment or the opinion regarding the future course of events. Those who venture have expectations (and not scientific knowledge) of a result to be achieved, within limits that can be more or less narrow. The inclination to invest is thus guided by the opinion or belief in the real possibility of future gains (Knight, 1964, p. 237). "Judgment primarily refers to the process of businessmen forming estimates of future events in situations in which there is no agreement or idea at all on probabilities of occurrence" (Foss & Klein, 2004, p. 8).

It is worth noticing here Knight's distinction between measurable and immeasurable uncertainty. The measurable uncertainty, or risk, concerns a known distribution of the outcome in a set of instances (either through calculation *a priori* or from statistics of past experience), while, in the case of the immeasurable uncertainty, designated as uncertainty, this is not true, since it is usually impossible to form a group of instances once the situation dealt with is truly unique. The author also uses the terms **objective** and **subjective** probability to designate risk and uncertainty, respectively. For him, the best example of uncertainty is in connection with the exercise of judgment or the formation of those opinions as to the future course of events, in which opinions (and not scientific knowledge) actually guide most of our conducts (Knight, 1964, p. 233).

Thus, if adventurers are inclined to make ventures, their opinion is either an expectation of a certain definite gain or a belief in the real probability of a larger one. For this reason, Knight observes that it is correct to treat all instances of economic uncertainty as cases of choice between a small reward made with confidence or a large one with less anticipated confidence.

If a man undergoes a sacrifice for the sake of a future benefit, the expected reward must be larger in order to evoke the sacrifice if it is viewed as contingent than if it is considered certain, and it will have to be larger in at least some general proportion to the degree of felt uncertainty in the anticipation (Knight, 1964, p. 236).

At the bottom of the uncertainty problem in economics is the forward-looking character of the economic process itself. The entrepreneur faces two elements of uncertainty, which correspond to two types of foresight that must be exercised with regard to the production of goods aimed to meet consumers' desires. The first element regards the need to estimate the end of productive operations from the beginning. It is impossible to tell accurately what their results will be in physical terms (quantities and/or qualities of goods) before the resources are entered in the production process. Second, the needs that should be fulfilled by those goods are also in the future to the same extent, and their prediction involves uncertainty in the same way. Producers, then, must estimate (1) the future demand they are striving to satisfy and (2) the future results of their operations in attempting to satisfy that demand.

Knight, as cited by Coase (1997, p. 26), defends that

> in the first place, goods are produced for a market, on the basis of entirely impersonal prediction of needs, not for the satisfaction of the desires of producers themselves. The producer takes the responsibility of forecasting the consumer's desires. In the second place, the tasks of forecasting and at the same time a large part of the technological direction and control of production are still further concentrated upon a very narrow class of producers, and we meet with a new economic functionary, the entrepreneur.

Moreover, Knight (1964, p. 243-244) distinguishes five variable elements in individual attributes and capacities leading to variation in judgment: (1) individuals differ in their capacity by perception and inference to form judgments about the future. Capacities are not homogeneous. Especially important is the power to forecast human behavior, taking into account the great variability of result, as contrasted with scientific judgment in regard to natural phenomena; (2) individuals have different capacities to judge and to make the adjustments necessary to meet anticipated future situations; (3) there is a wide variation in the power to execute plans and make adjustments believed to be necessary and desirable; (4) there is a diversity in con-

duct in situations involving uncertainty, due to uncertainties in the feelings of confidence individuals have while making and executing their judgments; (5) different from confidence originated by an impulse to act in specific situations, in which a degree of confidence in the judgments is passed. Whereas some individuals want to be sure and do not dare to take risks, others love taking risks based on their hypotheses. Thus, it is not uncommon to see individuals acting in accordance either with their own beliefs or with the opinions of those who trust in their own luck[3].

"Entrepreneurship as uncertainty bearing is also important for Mises' theory of profit and loss [...] What Mises calls **economic calculation** is the comparison of these anticipated future receipts with present outlays, all expressed in common monetary units" (Klein, 2008, p. 178). "This view traces its origins to the first systematic treatment of entrepreneurship in economics, Richard Cantillon's *Essai sur la nature de commerce en géneral* (1755). It conceives entrepreneurship as judgmental decision-making under conditions of uncertainty" (Foss, Foss, Klein, & Klein, 2007, p. 1167). Klein (2008) subscribes to this view and adds that "[a]n entrepreneur is simply defined as an (any) individual who discovers and exploits an uncertain and novel business opportunity and bears the business risk of exercising her judgment" (Stieglitz & Foss, 2009, p. 69)

In that sense, it is worth highlighting that entrepreneurs have the exclusive capacity of not to share their judgment with their peers (Witt, 2000). Hence, individuals differ in their ability to process information. Even though information may originate in the same source, they interpret their expected gains in different ways (Casson, 2005). That explains the heterogeneity in the configuration of firms even within the same industrial sector. No firm is like any other, because each has its own printed logo: the judgment of its entrepreneur.

If that did not occur, i.e., should all entrepreneurs have the same judgment, they would all follow the same strategy at a given moment and the firms would not be heterogeneous. If the necessary resources to pursue this strategy were in the competitive market, all firms would reach a competitive equilibrium. If not, i.e., if resources were scarce, there would not be an equilibrium (like an Edgeworth Model). The competition among the firms for scarce resources would hinder the acquisition of resources (the price would be unstable). Thus, if there is different information (and perception) about the market, some entrepreneurs will have success with the differentiation strategy. "In a world of 'true' uncertainty, entrepreneurs are unlikely to know all relevant attributes of an asset when production decisions are made" (Foss & Klein, 2004, p. 13).

Thus, firms are different and are organized in a variety of forms, even within the same productive sector. Some of those differences are due to their life cycle, or their development stage (Rathe & Witt, 2001).

Bhidé (2000) states that firms pursue different opportunities with different levels of uncertainty and investment requirements according to their age. At the initial stage, entrepreneurs pursue highly uncertain projects that do not require many investments. When their businesses grow, there is a higher commitment of resources which reduces more risky initiatives (i.e., with more defined risks and returns) leading to more systematic routes and long-term planning. Initially, a great tolerance for indefinition, allied with a capacity for adaptation, is paramount; when the business develops, so does the entrepreneur's capacity to formulate and implement long-term strategies. Thus, in a mature corporation, the success of new initiatives relies more on disseminating organizational capacity than on the talent of decision-makers. Over time, those differences affect the development of new technologies and the way they interact with existing economic structures.

Although a rational conduct might reduce to a minimum the uncertainties involved in adapting (foresight) means to ends, economic agents know it is impossible to eliminate uncertainties (Knight, 1964). The possibility of reducing uncertainty depends on conditions that are closely related: (1) the characteristics of the groups, i.e., uncertainties are less in groups of cases than in single instances. Uncertainty tends to disappear altogether as the group becomes increasingly inclusive (as it occurs in the statistical probability, although in a smaller degree); (2) the possibilities of dealing with the different perceptions (and reactions) of individuals with regard to uncertainty. There are two fundamental ways of minimizing the effects of uncertainty: grouping and selecting the distinct types; (3) the possibility of controlling the future; (4) the increased power of foresight. Improved technology and increased knowledge decrease uncertainty; (5) the **diffusion** of the consequences of untoward contingencies; (6) the possibility of avoiding activities involving a greater degree of uncertainty.

Casson (1982) attempts to identify a shared element that runs through these theories by introducing the concept of entrepreneurial judgment. The attempt to identify a shared element suggests that Casson's theory has generalities, and may be applied to all kinds of entrepreneurship. The author (1982, p. 23) specifically defines an entrepreneur "as someone who specializes in taking judgmental decisions about the co-ordination of scarce resources". In his view, the entrepreneurial judgment concept is of paramount importance; judgment is not based on the simple application of marginal rules regarding resource allocation, but, rather, it is based on individuals, their perceptions and the information that they have available (or choose to acquire). Central to this concept is the recognition that different individuals will make different decisions that will produce different outcomes because information is necessarily imperfect and costly to acquire.

As we shall see next, those conditions allow for an understanding as to why innovative initiatives rely more on integrated governance structures than those that imitate or adapt successful strategies. They also allow foreseeing that uncertainty is reduced at a more advanced stage of the firm, thereby enabling a trend to less rigid governance structures.

2. AN ENTREPRENEURIAL DECISION PROCESS MODEL

As heretofore observed, in analytical terms, the entrepreneur's notion and the organization of the firm are inseparable. Being an entrepreneur means possessing residual decision rights to opinions or judgments on the future outcome of a business (Foss *et al*., 2007). We have also seen that the entrepreneur is an adventurer who needs to be able to deal with the risk that his or her judgments may be wrong (Casson, 2005). Dealing with risks requires adaptation, in the sense of experimenting with novel ideas and with completely new technologies to cope with complex problems and unanticipated opportunities (Bhidé, 2000).

But what is it that distinguishes entrepreneurs from other types of workers? In much of the literature on this topic, a striking characteristic seems to be a pronounced attraction to adventure. Adventurers ignore frontiers. Optimistic, they see the world as a generous place. Self-confident, they turn obstacles into opportunities. As Felin and Zenger (2009) point out, the entrepreneur's job is that of finding and perceiving the opportunities available in the environment (Krueger, 2003; Alvarez & Barney, 2007). In summary, all the conditions above were to be condensed into a single variable — that variable would be risk loving[4].

In the words of Knight, an entrepreneur is the individual who trades present gains for the probability of future gains that depend only on his or her subjective estimated gains.

Drawing on the works of Kahneman and Tversky (1979), researchers have argued that entrepreneurs show greater than normal reliance on a range of cognitive biases (Baron, 2004). Brockhaus (1980) verified that entrepreneurs are more optimistic about the future developments of the venture. They also consistently framed both the internal and external situation of the venture as less risky compared to non-entrepreneurs. Sarasvathy, Simon and Lave (1998) obtained similar results when comparing entrepreneurs and bankers. Entrepreneurs did not perceive less risk but, instead, used more personal values to frame venture risks. They were also more confident in their ability to influence the development of the venture in the future. Simon, Houghton and Aquino (2000) also found that entrepreneurs suffer from an illusion of control, i.e., they believed their skill will affect performance positively even in situations where it realistically cannot, or where it is evident that outcomes are highly dependent on chance.

Similarly, Busenitz and Barney (1997) posit that entrepreneurs are more overconfident and more likely to generalize from small random samples than managers. That would occur because by and large entrepreneurs take action without necessarily having all relevant information.

March and Shapira (1987) similarly found that company managers, after deciding on investment projects, suffer from the illusion of control while minimizing the probability of enterprise's failure. Bazerman and Neale (1992) add to this last statement that overconfidence can be regarded in different ways, such as the "better than average effect", the inaccuracy of forecasts and the illusion of control. The "better than average effect" stems from the fact that people generally consider themselves as good as others in their skills or personal characteristics. The inaccuracy, in turn, stems from the uncertainty of economic agents' expectations in relation to a given future *vis-à-vis* the actual results. Since the illusion of control arises from a behavior in which an agent has the perception of having great control and direction over a given result, that would lead him/her to believe in a greater probability of success than that guaranteed by the objective probability.

Baron (2004) highlights the advantage of — and even the need for — some cognitive biases to induce action in pursuit of risky opportunities. It may also be that certain biases, such as over-optimism, affect infusion, and the illusion of control help explain the decision to become an entrepreneur, whereas quite different mechanisms affect entrepreneurial success.

The next section presents an entrepreneur's decision model based on the overconfidence hypothesis or, in the words of Busenitz and Barney (1997, p. 14), "without some unsubstantiated enthusiasm, many ventures would never be started or would quickly die following their start-up".

2.1. An overconfidence-based model of entrepreneurial decisions

When describing the decision-making behavior of real humans, we cannot treat the Decision Theory as a descriptive model, since it has been shown in many experiments that people do not behave according to its tenets (Kahneman & Tversky, 1979, 1992; Plous, 1993). However, the experiments that have shown that humans are not perfectly rational decision-makers have also provided a description of the way people seem to reason. More recent models of our decision-making have been able to describe reasonably well the way people think under uncertainty (Birnbaum & Chavez, 1997; Birnbaum, 1999).

Recently, it has been shown that our reasoning might actually be less erroneous than a first analysis of the experiments seemed to indicate. Apparently, our biases can be understood as an approximation to a Bayesian inference (Martins, 2006). Also, recent findings (Frederick, 2005) seem to indicate that people who tested higher in a test designed to measure cognitive reflection (CRT, a measure that correlates positively with other IQ tests) are less risk averse and follow the proposed models for human behavior more closely, while people who scored worse tended to be more risk averse and depart even more from the utility maximizing behavior. This suggests that entrepreneurs, having an activity that requires a small risk aversion, might, in general, be among the group that scored higher in CRT (although, currently, there is no experimental evidence on this hypothesis) and, therefore,

be well described by applying behavior models based on altered utilities and probabilities.

Here, we will model the entrepreneur's decisions with a one-step, simplified model. At this step, the entrepreneur must decide if the investment is worth the risk. Our intention towards this model is that of providing one possible explanation as to why so many new enterprises fail. It is worth noting, however, that it would also make sense to discuss a second step, one that would only happen if the new business is in fact started and related with the daily management routine. Although those managerial tasks are performed on a regular basis, companies will still require entrepreneurs to make decisions concerning their business, assuming they are the ones in charge of actually running them. And, in order to make those decisions in an efficient way, entrepreneurs should bear in mind a model relative to the needs of their business. This updated model for management decisions will, however, be left for a future work.

2.2. Deciding whether to invest

Here, we will suppose that, facing the decision of whether or not to invest in a new enterprise, entrepreneurs do have a decision theoretic model of possible outcomes in mind. That is, they have a model of the possible returns for their investment, which we can represent as a utility function *u(x,d)* (or an altered value function, as those of Prospect Theory), where *x* represents the return entrepreneurs can obtain and *d* is an index to represent their actions. It is worth noting that there are at least two strategies available at the beginning: to invest or do nothing. In order to make the model more parsimonious, we will consider that there is only one possible investment and, should the entrepreneur decide to invest, there are exactly two possible outcomes, success or failure. The returns associated with each possibility will be represented by u_s and u_f. Of course, if entrepreneurs decide to do nothing, they will gain nothing and we can choose the utility scale, so that, in this case, the utility is zero.

Besides the utilities for their returns (which can be a simple linear function of the wealth or not), entrepreneurs also need, in order to make up their minds on whether to invest or not, a model for the chances that each return will be obtained. In other words, entrepreneurs will also use the probability associated with each possible return *x*, *p(x)*. Since, for the initial decision, we will use two possible outcomes, we only have one independent probability value to estimate — the probability that the investment will be a success, p_s to which we will refer, from this point on, as *p*.

However, it has been observed that when making decisions, real people do not use the probability value they believe to be correct, but rather, alter it. Even more so, it seems that descriptive models — models that build on utility maximization — are better matches for the behavior of intelligent people. Therefore, it makes sense to model any decision process, including the entrepreneurs' decision, as conforming to the rules people do follow and compare that process with the results of a rational choice.

This paper chose to model the human decision-making process though the APT model (Martins, 2005, 2006) in view of the many advantages brought by the Bayesian inference framework on which the APT model is built[5]. First, the investigation of the overconfidence problem becomes easier, since the framework easily allows for the incorporation of changes in prior information on the entrepreneurs' part. Also, since it is our intention to follow the analysis presented in this article with a model of the decisions faced by entrepreneurs when learning more about their businesses, a Bayesian framework allows for easily introducing learning rules.

Before proceeding, an explanation of the choice of APT as the theoretical basis for this paper is in order. From a numerical point of view, it deviates little from competing theories, such as Prospect Theory or configural weight models. In that sense, the results we will obtain, as approximations, will be as good using APT as they would be for the other choices. However, since APT poses the problem in a Bayesian framework, it allows for an easier manipulation of the model details, while still respecting its internal rationale. Introducing overconfidence becomes trivial and eventual extensions to learning problems can be more easily introduced due to the Bayesian framework. That is, no claim is made here that APT is more correct; it is just more useful under the current circumstances.

According to the APT model, as described by Martins (2005), entrepreneurs would substitute their probability estimates of enterprise success *p* before using it, for a weighting function *w(p)*, given by Equation [1]:

$$w(p) = \frac{a + pn}{a + b + n} \qquad [1]$$

where *n* is given by $n = 2[\min(p;1-p)]^{0.3}$; *a* and *b* are parameters that determine the prior estimate of the probability, if no information about *p* was available. It is interesting to notice that *a* is related to the number of success observed (or estimated) in a binomial problem and *b* is related to the number of failures. While *n* is formally a sample size, here it is only a variable with the functional shape needed to adjust the model to the laboratory observations. A discussion about this form can be found in the original papers on APT (Martins, 2005, 2006).

It is interesting to notice that a whole class of behavior models uses this same idea, with different (but close) functional shapes for the weighting function. Therefore, they should provide close descriptions to the one we obtain herein. In APT, for proposed gambles, the values *a=1* and *b=e-1* were observed to provide a good description of people's actual behavior, but those results mean that all probability is drawn towards the fixed point $p_f = a/(a+b) = 1/e \approx 0{,}368$, that is, any probability larger than this value is corrected down to a value closer to it. This does not correspond to the observation that entrepreneurs

tend to be overconfident about their success. However, APT allows for a simple correction of this fixed point, simply by choosing *a* and *b*, which will provide a different fixed point. Since experimental results seem to indicate that people move their evaluations towards 80%, an alternative initial choice would be *a=4* and *b=1*.

Still, we need to specify how entrepreneurs will deal with the expected return from their investment. One simple possibility is a linear utility function *u(x)=x*. This approximation is valid for small values of *x* (where it can always be seen as the first term in a Taylor expansion), but not necessarily true as *x* becomes larger. However, entrepreneurs are not typical people when bearing risks, since they are less risk averse than other people and, therefore, their real utility function would probably be closer to a straight line than the typical result and this approximation may provide reasonable results. In any case, the following results can be interpreted as referring to utility values, instead of monetary values, if the real utility function for the entrepreneurs is highly non-linear. The choice of whether to invest or not will be made according to the sign of the expected weighted return,

$$E_w[U] = w(p)u_s + [1 - w(p)]u_f \qquad [2]$$

Here, a positive expected return will cause entrepreneurs to invest their money; otherwise, they will not. The decision in Equation [2] will be the same if both utilities are multiplied by the same factor. We will choose an arbitrary value for the success return as $u_s=100$ (this can also be seen as a choice of monetary unit). As mentioned before, as we are dealing directly with the utility associated with the monetary value, the following results will hold, regardless of the shape of the utility function.

Since an individual would use a criterion other than the expected utility (EU) when choosing whether to invest or not, it is clear that there might be situations where the APT model will have the entrepreneur making a wrong decision, from the point of view of a decision-theoretic model. In order to illustrate this fact, Figure 1 shows the difference in the EU for the models, both for *a=1* and *b=e-1* — typical human decider in laboratory experiments, as described in Martins (2005) — and *a=4* and *b=1* (strong overconfidence) cases. It is easy to see, by looking at the contour lines, that there is a region where the APT model predicts a higher expected return than the EU model for probabilities of success smaller than the fixed point and smaller expected utilities above that point.

However, a higher EU does not necessarily mean a different choice. The choice criterion for both models is that entrepre-

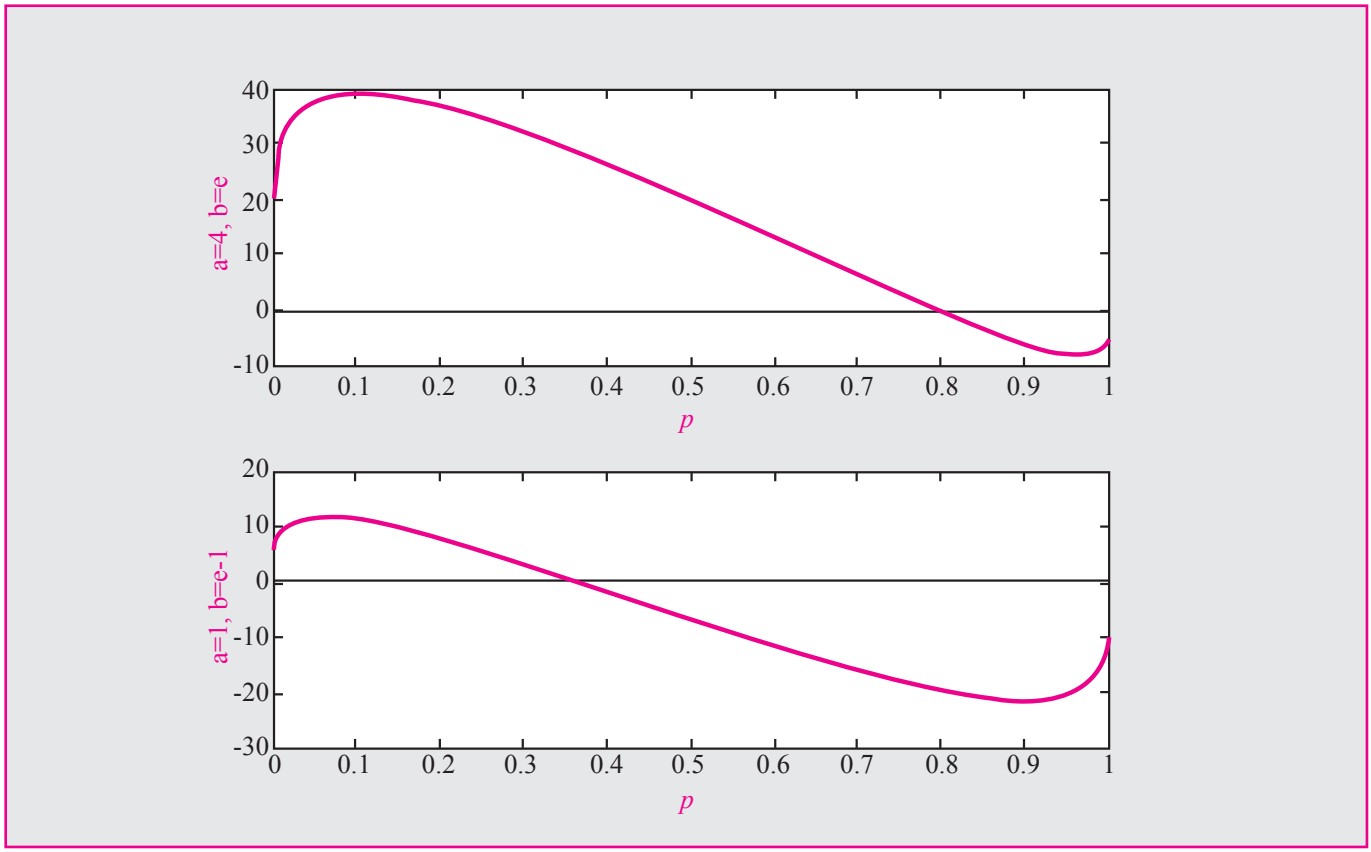

Figure 1: The Difference Between Expected Values of an Investment when Comparing the Adaptive Probability Theory Model with Expected Utility

neurs should only invest if their expected return is larger than zero. If both APT and EU predict a positive return, the decision will be the same, regardless of the values — the same happens if both predict negative returns. Therefore, it makes sense to wonder whether there are any areas where the signs of the expected returns are different.

Figure 2 shows the two regions where the APT model provides a different answer for the problem of whether to invest or not. The area enclosed by the solid lines corresponds to the scenario where entrepreneurs would decide to invest, by following APT, even though the EU of the enterprise is negative. In this case, entrepreneurs would accept to spend money on an investment that, according to their beliefs, will provide a negative EU return. That is, entrepreneurs would make, in such a situation, a wrong choice. The region between the dashed lines also corresponds to a wrong decision, but the opposite one. There, the EU of the investment is larger than zero; therefore, entrepreneurs should invest their money. However, APT provides a negative weighted expected return and they decide not to invest. Notice that, for the overconfidence hypothesis, there is a large area where entrepreneurs decide to invest despite the fact that EU would tell them not to. Of course, the *a=4* and *b=1* case might not correspond to the actual initial entrepreneurs' opinion (it corresponds to a strong case of overconfidence, but too strong to be financially healthy). If the initial opinion is less extreme, closer to 50%, the effect will be weaker.

This seems to indicate that there might be businesses in which, should entrepreneurs establish several enterprises, they would lose money average and, therefore, go bankrupt in the long run, even if all enterprises were not big (the region corresponds to the solid region). However, notice that the solid region corresponds to low probabilities of success, which are compensated by a larger return. For example, both prior choices show that, for an initial investment of 15, entrepreneurs would invest if they believed there was a 10% chance of success. As the expected return is 100, should the business prove successful, it would bring a very high return, but it will probably fail. Figure 2 illustrates the difference for the expected value of an investment between the APT model and the EU.

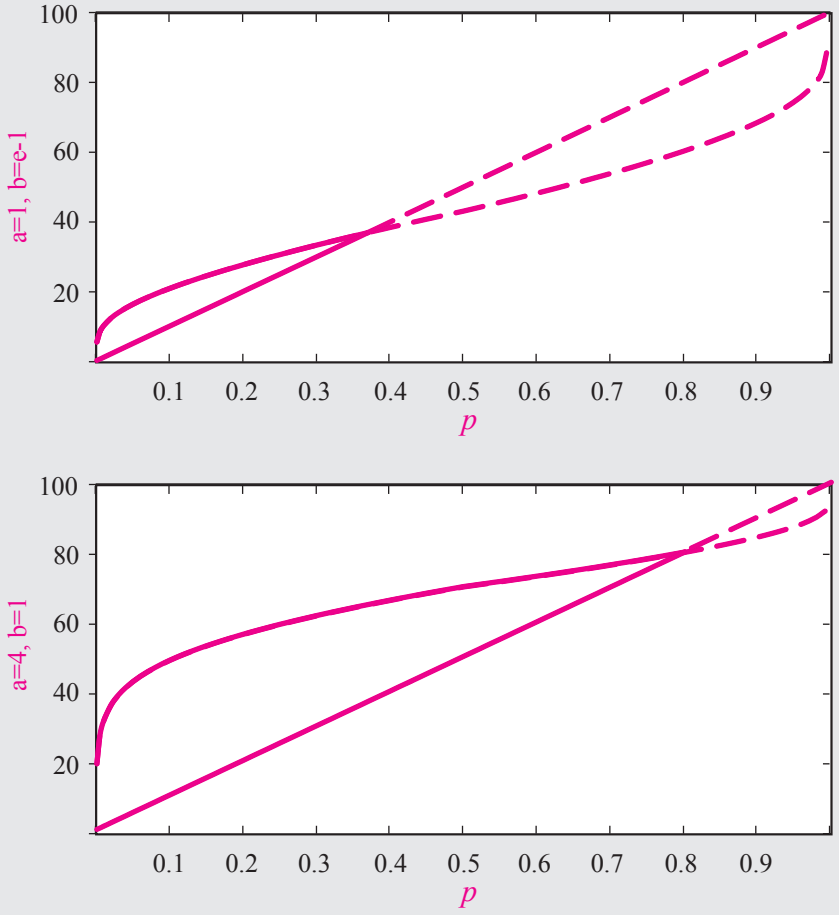

Figure 2: The Difference Between Expected Values of an Investment when Comparing the Adaptive Probability Theory Model with Expected Utility – Wrong Decision Regions

The slice shown was calculated only where the APT model instructs entrepreneurs to invest, while the EU tells them not to.

Given the overconfidence hypothesis, entrepreneurs decide to invest despite the fact that the EU would tell them not to far more often than if they were not overconfident. However, for small probabilities of success and large returns, this seems to correspond to a bad strategy, as they would tend to start a number of enterprises with negative EU. Therefore, it is reasonable to assume that entrepreneurs who avoid low probability enterprises in general will be more successful in the long run. This might help explain the differences in literature, in which entrepreneurs are described both as risk loving and risk averse. For small chances, successful entrepreneurs should be risk averse or risk bankruptcy. Also, for high probabilities of success (over the fixed point their overconfidence attracts the probabilities to), Figure 2 shows a region where entrepreneurs would avoid an enterprise with a positive EU, adding to their description as risk averse. On the other hand, entrepreneurs who do not consider a bad general idea to invest in low probability enterprises, will, by and large, invest in bad risks.

3. CONCLUSIONS

Drawing on the Knightian uncertainty approach, this article discussed the entrepreneurial decision-making behavior aimed at investigating the entrepreneurial decision rationale. A behavior model for decision-making, based on the idea that people mimic optimal decision-making when faced with uncertainty, was used in order to study the overconfidence hypothesis. We concluded that, under some circumstances, entrepreneurs might decide to invest despite the fact that their expected utilities would tell them not to far more often than if they were not overconfident (though different circumstances might lead to the opposite behavior).

To this end, we used the APT model. This choice was advantageous not only because it allowed for an easy modeling of the overconfidence hypothesis but also because modeling the entrepreneur's learning characteristics became an easier task. APT should also make the next step easier to implement, that is, the entrepreneurs' learning process as they learn about their businesses.

Opposing to the conventional Economic Theory, these findings support the empirical data regarding the large number of business breakdowns in the first years of activity. For instance, according to the Brazilian Micro and Small Business Support Service (SEBRAE, 2012), more than 470 thousand enterprises open in Brazil each year, within which almost 50% fail in two years and 60%, in four years. Similarly, nearly 50% of the new products that are introduced worldwide each year fail (Sivadas & Dwyer, 2000). In effect, this implication has been enabled by the substitution of the objective probability that typically composes the EU functions for a subjective estimation, which, in turn, reflects the overconfidence cognitive bias that characterizes the entrepreneurial decision-making process of the real world.

For future research, this study suggests specifying the linkages between the entrepreneurs' risk-loving characteristics herein discussed and their learning process over time, in order to investigate whether that learning can help increase their chances of success. Such a recommendation builds on the logic that entrepreneurs would enter projects with tentative hypothesis about their chances of success which are soon revised and refined through experimentation and adaptive answers to unexpected problems and new opportunities. ◆

NOTES

(1) In a later work, published in 1926, *Capitalism, socialism and democracy*, Scumpeter was concerned with the general process of concentration in the markets that started as of the early 20th century and the role of large corporations in the performance of capitalism. The author argues that innovations in the large companies prevailing in the world scenario as of this period routinely appeared in their research centers. For this reason, many authors interpret that there are, in effect, two Schumpeters, the later denying the earlier (Langlois, 2002).

(2) A start-up is a newly created company, usually in phase of development and/or research.

(3) Knight (1964) also emphasizes the almost universal tendency to believe in superstitions. Any coincidence is likely to become a law of nature, giving rise to a belief in an unerring sign. Even a mere feeling with no real or imaginary basis in the mind of the person him/herself may readily be accepted as valid ground for action and treated as an unquestionable verity.

(4) It is worth observing that Garrouste and Saussier (2005, p. 196) argue that "the entrepreneur has some essential characteristics that make him more optimistic, self-confident and risk averse." With respect to the last characteristic, it is clearly not in consonance with what is observed in entrepreneurs. If they are risk averters, they will not make investments; they will be waged workers.

(5) Bayesian inference is an iterative statistical method in which evidence is used to estimate the probability that a hypothesis is true. It is built on a process in which the collection of new evidence repeatedly modifies an initial confidence in the truth of a hypothesis.

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ABSTRACT

Entrepreneurial decision-making using the knightian uncertainty approach

The article discusses the behavioral aspects that affect the entrepreneurs' decision making under the Knightian uncertainty approach. Since the profit arising from entrepreneurial activity represents the reward of an immeasurable and subjective risk, it has been hypothesized that innovative entrepreneurs have excessive optimism and confidence, which leads them to invest in high-risk activities. A behavioral model of decision making under uncertainty is used to test the hypothesis of overconfidence. This model is based on Bayesian inference, which allows us to model the assumption that these entrepreneurs are overconfident. We conclude that, under the hypothesis of overconfidence, these entrepreneurs decide to invest, despite the fact that the expected utility model indicates the contrary. This theoretical finding could explain why there are a large number of business failures in the first years of activity.

***Keywords*:** entrepreneur, decision-making, Knight, adaptive probability theory.

RESUMEN

La toma de decisiones empresariales en condiciones de incertidumbre: enfoque de Knight

El artículo discute los aspectos comportamentales que afectan la toma de decisiones de los emprendedores a partir del abordaje knightiano de incertidumbre. Una vez que los lucros de la actividad emprendedora representan la recompensa de un riesgo inmensurable y subjetivo, tenemos como hipótesis que los emprendedores innovadores poseen exceso de optimismo y confianza, lo que los lleva a invertir en actividades de alto riesgo. Un modelo comportamental de toma de decisiones bajo incertidumbre es usado para testear la hipótesis de exceso de confianza. Ese modelo se basa em la inferencia bayesiana, que permite un modelado de la hipótesis de exceso de confianza de esos agentes económicos. Se concluye que, bajo la hipótesis de exceso de confianza, esos empresarios deciden invertir, a pesar del hecho de que el modelo de utilidad esperada indica lo contrario. Esa constatación teórica podría explicar por que hay un gran número de quiebras de negocios en los primeros años de actividad.

***Palabras clave*:** emprendedor, toma de decisiones, Knight, teoría de la probabilidad de adaptación.