How do real options come into existence?

A step toward an option-based theory of the firm

Thierry BURGER-HELMCHEN

PhD Student in economics

BETA

Bureau d'Economie Théorique et Appliquée

University Louis Pasteur

61 Avenue de la Foret Noire

67085 Strasbourg

France

(33) 03.90.24.20.90

burger@cournot.u-strasbg.fr

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Abstract (99 words)

To be relevant to a firm a real option needs to fit into a theory of the firm explaining its existence, exercise conditions and value. We make a step toward an option based-theory of the firm by describing the emergence of a firm's options and the strategic building of new competences for exercising these options. We explain the creation of a real option as an entrepreneurial process which transform inventive ideas into profitable innovation. The subsequent development of competence necessary to exercise the option gives boundaries, based on theories of the firm, for the often overoptimistic real option evaluation.

Key words: Real Option, Theory of the Firm, Capabilities

Decision-making based on real option is about to become a standard in investment textbooks (Brealey & Myers, 2002). The formal approach, originating from financial models for introducing future uncertainty and the opportunities a firm can size is appealing. However the use of this approach raises many questions linked to the theory of the firm (Leiblein, 2003) and strategic management (Smit & Trigeorgis, 2004). A major issue, almost ignored, is the question of the origin of the real option.

This field was pioneered by Bowman and Hurry (1993) who remarked that real options must be identified before being assessable and put in use by the firm. They proposed a two-staged framework, named "option chain", for analysing the strategic options of a firm. The option exists at all stages of the chain but the firm is not always aware of it. At the beginning the options are unseen and are all called "shadow options". The first stage consists in recognizing the options, turning them from shadow to real options. The second stage of the option chain consists of taking the decision of exercising these options.

For us this approach leaves some important questions open, namely: who recognizes the real option value and from where does the initial shadow option stem? Other questions are directly related to the understanding of the label *real* option. Too often, if not exclusively, the adjective "real" is explained by making reference to financial theory arguing that financial options refer to a financial traded underlying asset. In opposition the real option refers to a non financial (real world) asset, in e.g. a production facility or an R&D patent. This definition is true according to the origin of famous option calculation formulas but incomplete in terms of the problematic underlying non-financial assets. Carr (2002) and Kogut and Kulatilaka (2004) pinpointed that many firms, even aware of the existence of an opportunity of profit, do not possess the option to exploit the opportunity or cannot exercise the option correctly. This

limitation arises, among others, from the lack of knowledge and competences needed to exploit the opportunity. Knowing that an opportunity exists and being able to exploit that opportunity are different things. This differentiation is for us at the root of the real options.

In this work we try to explain the origin of the real and shadow options and provide some new basics for the evaluation of option by using a theory of the firm perspective. We use the *entrepreneur* as the resource recognizing and creating options. The seminal work of Nelson and Winter (1982) in evolutionary economics stresses that entrepreneurs are important, if not *the* elements of novelty creation in the economy. Later strategic management authors, such as Conner 1991; Rumelt, 1987, introduced this feature in their works when the resource-based theory framework exploded in the management literature.

The lack of consideration devoted to entrepreneurship by most real option research works (exception can be found in Foss & Manhke, 2000) explains why real option theory focuses mainly if not exclusively on the valuation of existing options and not on their creation. The insights gained from considering real option and entrepreneurship are bi-directional. Entrepreneurship can explain the origin of real option and through resource based theory explain the value of the option. The real option can explain the direction a decision maker gives to the development of the capabilities and resources of a firm by suggesting another use of the resources. Combining entrepreneurship and real option gives an explanation of the heterogeneity of the firm and its resources collection and capabilities building.

In the following we first explain why we use a resource-based theory of the firm. In our second chapter, we present the creation of a shadow option and the mechanism by which it is

turned into a real option. In the third chapter, we give some general boundaries for the evaluation of a real option based on our resources-based discussion.

REQUISITES FOR AN OPTION-BASED APPROACH OF THE FIRM

The influence exercised by the firm strategy on her resource and structure, and in return the effects of the resources on the strategy are a fundamental insight in the strategic theory of the firm as noted by Teece *et al*., 1994. The early work from Chandler stressed this point.

"*The thesis that different organization forms result from different types of growth can be stated more precisely if the planning and carrying out of such growth is considered a strategy, and the organization devised to administer these enlarged activities and resources, a structure. Strategy can be defined as the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals*", Chandler (1962:15-16).

Following this definition, a firm needs a structure to conceive a strategy, and in return, a strategy modifies the structure and resources of the firm so as to be able to follow long-term goals. The most obvious of these long-term goals is the survival of the firm. The survival is achieved by seizing profitable opportunities when these opportunities arise or are pushed to arise. As stated by Penrose: "*In the long run (...) the profitability, survival and growth of a firm does not depend so much on the efficiency with which it is able to organize the production of even a widely diversified range of products as it does on the ability of the firm to establish one or more wide and relatively impregnable 'bases' from which it can adapt and extend its operations in an uncertain, changing, and competitive world*", Penrose [1959:137]

Penrose's work largely influences what is today called the competence-based approach of the firm and has constituted a major contribution to the strategic management literature since the early 90s. Several quotations from her work we use in this paper are related to nowadays option consideration that she introduced for obtaining a dynamic view of the firm. Attempts at formulating a dynamic theory of the firm based on competence and knowledge were made by many contributors since several decades as shown in Foss (1997), including Wernerfelft (1984), Barney (2001), Conner and Prahalad (1996), Teece *et al*.(1997), Nelson and Winter (1982).

The value of a firm in these approaches is directly linked to the resources of the firm. These resources are tied together in a firm specific way, giving a firm the capability of achieving some tasks better than others. Barney (1991) explains that the heterogeneity in resources is a main reason why firms exhibit different profits and survival rates. The modification of the productive capability can be done by modifying the resources. As human resources are the repository of productive knowledge (including tacit and explicit knowledge) and competences their modification highly influences the modification of productive capabilities. Creating new knowledge, the most important task of the firm, enables the firm to produce new goods, create a new organization, or upgrade her efficiency. The learning mechanisms, in addition to the resources, are at the origin of the competences of the firm. The core competences of a firm (what the firm is really good at…) allow her to grasp new opportunities, Prahalad and Hamel (1990). Making good use of an opportunity that brings value to the firm is nowadays called the real option, so holding and being able to strike this real option depend fundamentally on the competences and learning activity of the firm.

To identify the distinctive core competences of the firm conditions have to be fulfilled. It is to be noted that core competences share conditions of existence with the real options. The conditions of irreversibility, flexibility and uncertainty.

Holding a specific resource implies some irreversibility. A specific resource cannot -or can only with difficulty- be sold or used for another purpose, this makes the investment in that resource irreversible. Consistent with the definition of irreversibility given by Henry (1974): "*A decision is considered irreversible if it significantly reduces for a long time the variety of choices that would be possible in the future*", investing into a specific resource locks for a certain time the capabilities of a firm into a certain state. The irreversibility condition is also an entry barrier to potential imitators. The sustainability of the profits flowing from a core competence or an option depends on the difficulty to imitate them. The difficulty of imitating knowledge as described by Dierickx and Cool (1989) comes from the fact that knowledge is path dependent to the process of accumulation. The accumulation and management of knowledge are extremely expensive, this high cost suggests that a firm can only have a limited number of core competencies. These characteristics hold also for real option as will be shown in the following.

Building competences has also an effect on another important value driver of real option: uncertainty. Uncertainty can increase or diminish the value of a real option. It is usual to distinguish between market uncertainty that yields a positive effect and technological uncertainty that has a negative effect on the value of the real option. Market variability uncertainty corresponds to exogenous uncertainty against which the firm can undertake relatively little action. In fact the firm is not willing to undertake any action because the very nature of the option is made to catch the value included in that uncertainty in an asymmetric

way. Huchzermeier and Loch (1999) qualify that statement. Nonetheless in the case of exogenous uncertainty with negative effect on the option value the search for information is always possible, e.g. demand estimation with market studies or customer taste forecasting. By contrast technological uncertainty is mainly endogenous and has to be reduced for increasing the value of the option. Technological uncertainty refers to the capacity of the firm to use the option. For example the technological uncertainty of a computer maker to achieve the devising of a new smaller computer. This uncertainty leads to delays in the timing of the option exercise. To reduce this uncertainty the firm needs to produce new knowledge and recombine existing resources (Nonaka & Takeuchi, 1995). Learning and building new competences appear to be key elements. This argumentation, in an option like rhetoric, can also be found in Penrose (1959): "*A firm is basically a collection of resources. Consequently, if we can assume that businessmen believe there is more to know about the resources they are working with than they do know at any given time, and that more knowledge would be likely to improve the efficiency and profitability of their firm, then unknown and unused productive services immediately become of considerable importance, not only because the belief that they exist acts as an incentive to acquire new knowledge, but also because they shape the scope and direction of the search for knowledge*", Penrose [1959:77].

The process that changes the unknown and unused productive service into a real option depending on what an individual believes is our concern in the following.

THE CREATION OF SHADOW AND REAL OPTIONS

As mentioned in the introduction to possess real options a firm must recognize opportunities and have the capabilities to exercise the option. We argue that entrepreneurship, or

entrepreneurial resource plays an important role in this action. The presentation is split into two parts, the identification and the building of new competences. The general steps of our approach in comparison with Bowman and Hurry (1993) are depicted in Figure 1.

Insert Figure 1 about here

Identification of opportunities, the emergence of the shadow option

Opportunities (and not yet options) come into existence when individuals (individuals, decision makers, firms) have different beliefs in the possibilities offered by the available or potential resources to transform some inputs into some outputs that can be sold and raise a profit (Kirzner, 1979). An opportunity is a favourable, momentary circumstance or situation that has been recognized after one has searched for it or has spontaneously appeared. Schumpeter (1934) distinguished between the notions of invention and of innovation, we draw a paralleled between these notions and the notion of option. An invention is the discovery of an opportunity, what Bowman and Hurry (1993) described as a shadow option. An innovation is a transformed invention, originated by an opportunity, into an exploitable and hopefully profitable option. When the opportunity becomes exploitable the firm possesses a real option. The transformation of the invention into a profitable innovation depends on whether the firm has the appropriate resources at the right moment.

The entrepreneurial resource

Barreto (1989), in an historical approach of entrepreneurs in microeconomic theory, showed that when authors need to introduce novelties or special variation into a theory of the firm they often refer to the figure of the entrepreneur. In this work we consider entrepreneurship as a resource of the firm (Alvarez & Busenitz, 2001; Cohendet, Llerena & Marengo, 2000) and a opportunity exploiter (Choi and Shepherd, 2004). The characteristics given to entrepreneurs are widely influenced in economics by the work of Schumpeter (1934) and Kirzner (1979). Kirzner introduced the concept of "entrepreneurial alertness" as the special ability of the entrepreneur to see where products (or services) do not exist and can be profitably exploited. Alertness exists when one individual has an insight into the value of a given resource while others do not. From this perspective, entrepreneurial alertness refers to "flashes of superior insight" that enable one to recognize an opportunity when it presents itself (Kirzner, 1997). Unfortunately Kirzner's "flashes of superior insight" are rather difficult to create in a firm but conditions can be created to favour the obtaining of inventions.

As mentioned the starting point of the shadow option is the identification of an opportunity. This identification is often a *vision*, a representation of what could be an opportunity. This stretching between a vision of what could be and current conditions lies at the heart of the entrepreneurial resource. The notion of *imagination* (Witt, 1998) is a key concept for understanding the specific role of the entrepreneur. We suggest that people sometimes act *as if the future already existed*. As noted by Loasby (2001:397) "*The past cannot be changed, but it can, in part, be known; the future cannot be known, but it can be imagined, and by acting on that imagination it can, in part, be changed. Imagination is shaped – though not determined – by the interpretation of environment and experience. However, most of what is*

imagined turns out to be impossible; and so progress depends on both the variety of imagination and some process for selection among this variety – the essentials of evolution." The identification of a shadow option is a blind variation, a "mutation" or an "anomaly" something impossible in the normal representation of business that the entrepreneurs try to turn into reality. The mechanism of this mutation can be due to the entrepreneur's inherent characteristics, or behavioural traits, the circumstances in which he or she may be, or an accident, or simply a mistake – and possibly a combination of these (Aldrich & Kenworthy, 1999). Whatever its origin, it is sufficient for this discussion to assume that the mutation consists of an alteration of the entrepreneur's representation of the world. Then the entrepreneur acts in accordance with his/her, newly created, state of the world. As a consequence, the entrepreneurial resource will begin to dispatch information about his findings. The discovery of an opportunity is information. After that begins the search for resources and creation of knowledge for transforming this shadow option into a real option. The search process that follows is widely influenced by the vision of the entrepreneurial resource.

McGrath *et al*. (2004) remind us that innovative ideas are difficult to predict, not to mention the difficulty to identify the options that are contingent to the innovation. As Harper (1994:51) stated "*Given that economic agents base their* [assumptions and] *action on their individual stocks of knowledge and that they cannot predict their own future knowledge, it follows then that they cannot predict their own future actions* [or options like parameters for future actions] *in any detail at the time of formulating their initial plans*" (text enclosed in brackets by McGrath, Ferrier & Mendelow, 2004). Such an approach of course limits, if it does not annihilate all attempts at using real option in an *ex ante* analysis. This can be bypassed by employing basic assumptions of the knowledge-based theory of the firm that are

also common in the resource-based approach. Knowledge depends on beliefs and interpretations, in Penrose's words (1959:40) "*The growth of knowledge is not simply a Bayesian process of induction from unambiguous facts, but a process of interpretation of the events to which members of the firm are exposed, often as a consequence of their own business initiatives*".

The approval of the decision makers can be stopped to some extent by the difficulty of sharing a vision. There are common biases in decision making that apply here, including the "not invented here" syndrome or over confidence in the strategic direction chosen by the firm and lack of importance given to the competitors movement, see McGrath (1999) for a development of such a decision bias as option.

Entrepreneurs, options and heuristics

The entrepreneur's representation of the world and behaviour for searching how to move from the shadow to a real option is a special kind of heuristics. Kogut and Kulatilaka (2001) give an insightful approach of real option, capabilities and heuristics. The authors split heuristics into two parts, a cognitive frame and rules of search. A cognitive (or heuristic) frame refers to the representation of the problem and the expected solution space. The heuristic rules of search are the algorithms by which solutions are found in the represented solution space.

Kogut and Kulatilaka (2001) identify four qualities of a good heuristics, it is easy to use, easy to communicate, it provides a better direction than the ones currently employed, and it motivates people who have to implement the strategy. The well-known matrix for portfolio analysis of the Boston Consulting Group is a perfect example of a heuristics. The vision span

in this matrix is a child's play, the pictures of cow, dog, star and question mark are understood and remembered by everybody, from a first year management student to the executive, (Macmillan & Tampoe, 2000). The BCG matrix example is only one part of a heuristics, it represents the cognitive frame. March and Simon (1958) and later Nelson and Winter (1982) used the notion of routines, which is organizational enactment of heuristic problem solving for representing the second part of a heuristics, the rules of search.

The definition of vision and imagination that we developed previously implies a special cognitive frame. For Busenitz and Barney (1997) entrepreneurs use heuristics more extensively than managers in larger organizations. In using heuristics they make simplifications that allow the development of ideas, enable them to continue without answering all possible problems that can arise. Especially in complex situations where less complete or uncertain information is available such behaviours ease the evolution of the organization. The differences in the use of heuristics between entrepreneurial and managerial firms reside in the fact that entrepreneurial ones are more responsive to opportunities. The differences in their appraisal of the future suggest a difference in the option identification. Also the heuristic-based logic enables entrepreneurs to make sense of uncertain and complex situations more quickly than hierarchic management. Gavetti and Levinthal (2000) pinpoint that decision making in such a context is forward looking, as opposed to backward looking procedures that develop no options but focus on resources already in use. Achieving new understandings, interpretations and insights is central to most models of learning. The sense making process of how organizations discover, think, or act in order to see what they want, before they are aware that a decision has to be made is depicted by Weick (2001), the entrepreneurial initiative leading to modifications in the firm resource after an opportunity discovering is part of that process.

Seldom do ideas become innovation by following a logical and clear path. Fransman (2004) shows for the mobile communication industry that the desired evolution of the industry has only rarely followed the imagined course allowing to use the intended options. Nonetheless he shows that the errors and mistakes made previously shape the condition for another development on the basis of the resource accumulated for the unused options. McGrath's (1999) approach on how valuable errors made by entrepreneur are for the firm confirms that point.

Combining resources, the emergence of the real option

Once the opportunity is identified Kirzner (1979) noticed that the entrepreneur certainly does not have the specific knowledge and expertise in all domains necessary to fulfil his goal. This let him in charge of finding and combining the adequate resources for his endeavour. The acquisition of a new productive capability by building a new competence is not instantaneous. The building process is mainly path dependent and involves tacit knowledge acquired by learning by doing and experimentation. This holds the implication that firms who create knowledge are also option-creating firms. By creating new knowledge these firms expand their cognitive frames, part of the real option heuristics. The value of the entrepreneurial resource appears again here in the way that it as the ability to combine different expert knowledge in way to exploit opportunities. This description fits with notion of combinative capabilities (Kogut & Zander, 1992) and speaks in favour of a dynamic label of a theory of the firm creating options.

Creation of new capabilities and productive knowledge

Once the entrepreneurial resource obtains commitment for searching resources and creating new knowledge the shaping of the real option begins. The search for appropriate resources can be done inside or outside the firm. An intuitive solution for the search of new resources is to rely on communities. Communities, according to the knowledge-based theory of the firm are the intangible places where knowledge is shared and created (Amin & Cohendet, 2004).

Considering the firm as a construction of communities is a view introduced by Brown and Duguid (1991). Each community has her own specificities, concerning the modes of learning, the type of knowledge created, autonomy, and hierarchical architecture. The organizational and knowledge environment of communities has thus important consequences for our understanding of how co-ordination, motivation and sharing of visions work, and how they structure the firm enabling options. The nature of the activities concerned (production, research development, finance, etc.), the goals and motivations of the potential users and developers of the innovative idea contribute to the speed, the inflexibilities, and the different dimensions of the emerging routines used to give consistence to the emerging real option.

Two major types of communities are usually presented in the literature, communities of practice and epistemic communities. The key point to distinguish them, as noted by Cohendet and Llerena (2003), is that epistemic communities are truly oriented toward new knowledge creation, whereas communities of practice are oriented toward the achievement of the activity.

Creating the underlying knowledge necessary to transform a shadow option into a real option is a task corresponding to the attributes of an epistemic community. Using the real option and

enhancing the practical implementation of a productive process are tasks corresponding to a community of practice. The passage from a shadow to a real option correspond to the modification of the epistemic community into a community of practice. The type of management has also to change from an entrepreneur to a manager. Nooteboom (2000) building on a different representation of exploitation and exploration as the shadow and real option we us come to the same utilisation timing between entrepreneur and manager.

From entrepreneur to manager

A recurrent if not fundamental problem in real option valuation is the definition of the value of the option. The determination of the value of the option is a critical aspect because it determines if the option is used or not, and if it is when it is appropriate to use it. Troubles arise when trying to identify numbers for the different variables used in real option formulas, as Luehrman (1998) suggests practitioners often have to "*take an educated guess*". Borison (2003) illustrates the confusion that exists in the real options calculation. He shows that different approaches exist for performing the numerical analysis of the real option and that these approaches differ in many ways including the results obtained. Nonetheless the author shows that each approach has its usefulness depending on the hypotheses made (e.g. complete markets, probabilities, forecasting assumptions).

The decision to exercise the option and to turn to a production phase correspond to a managerial decision making process. A reason why the manager does not enter the option chain earlier comes from the nature of the output of the shadow option. The output of the knowledge building process (what is done during the shadow option) is difficult to evaluate, because the knowledge is dispersed and the manager is not aware of all pieces (Foss, 1999)

before the entrepreneur ends his action. The managerial decision depends on the balance between actually entering the market with the actual resources and knowledge or waiting for absorbing more capacities. As shown by Lane *et al.* (1998) managerial capabilities are developed by training, repetition in decision-making, rules of thumb implementation and day-to-day management. This approach of managerial decision is in fact the situation mostly described by real option valuation problems. Handling basic managerial economics inputs such as cost or existing demand (including some standard deviation), but already existing data made by entrepreneurial action for fixing the situation and convincing of the accuracy of their first vision. At this point we catch up with existing literature of real option concerned with evaluation based on some informative inputs. This leads us to give a description of value determination of the option based on theories of the firm consideration.

EVALUATION ALONG THE OPTION CHAIN

The nature of real option and the nature of the firm

One of the major questions that can be addressed to our analysis when we try to include real option into a theory of the firm is, why should real option theory need a theory of the firm? The main reason for us to combine real option theory with notions of theories of the firm is to obtain a more accurate vision of the value driver of the firm and her options in relation with the environment.

In Coase's framework of "the nature of the firm" evaluation is done in terms of transaction costs. Transaction costs focus on the allocation and coordination of resources. If a specific combination of resources gives an option, could this specific combination be achieved through the market with the same efficiency as in a firm? The creation and exercise of real

options only through the market is an idea pushed forward by some authors including Scholes (1998:367), who highlights the possibility in the future for a non-financial firm to work only by selling and buying options for all her productive and allocative activities. Nonetheless this implies that the firm is specialised in writing contracts and is able to coordinate all the contracts.

Williamson (1975) argued that when a transaction involves specific investments, such as competences built for exercising an option, a more hierarchical form of governance is preferred over less hierarchical forms. This hierarchical form corresponds to the structure of the firm. Also the adequate resource portfolio needed for turning an invention into an innovation can, we propose, only be done in a firm. The bundling of resources in a suitable manner by the entrepreneur needs a physical area to be done and the interplay of financing capacities that can only be gathered by a manager. This necessitates a hierarchical structure, not for intervening in the community creative activities, but to give them a legal boundary for the future production. Conner and Prahalad (1996) show that the firm is the most appropriate form when there is uncertainty about the future behaviour that must be adopted because contracts are not necessarily rewritten for each transaction. Liebeskind (1996) puts forward that the firm is the most appropriate form for protecting knowledge and patent. These two arguments speaks for the development of option in the firm.

Concerning the contract rewriting argument the real option is here in fundamental opposition to the financial option. The financial option is one contract specifying the different “options” the buyer and the seller have, and none can influence the value of the option. In the opposite for a real option, the different action that the firm as a whole or the different individuals composing the firm can undertake change the value of the firm. This is especially due to

uncertainty. In the case of financial option the uncertainty is on the underlying asset movements, there is no uncertainty in the course of action that must be taken to maximise the value of the option holder e.g. if the price of the underlying asset is above the striking price at the expiration date, exercise the option. For real options the course of action that must be taken is more uncertain and can be modified by organisational pressure. All modifications in the resources a firm holds is a justification to rewrite the contracts (if they are complete). So under the assumption of incomplete contracts the firm is a more adequate framework for building and using real options. We can also mention the "Knowledge substitution effect" as described by Conner and Prahalad (1996). This effect considers the gain in time a firm can realise when a decision-maker substitutes his vision for the vision of the other individuals in the firm by giving orders and so pushing forward the competence building without waiting for the understanding of all the individuals.

Concerning the protection of knowledge and competences of the firm for the nascent option, Liebeskind (1996) describes the superiority of the institutional capabilities of the firm over market contracting. In particular she notes two argumentations that fit our option considerations. Firstly, the firms can better align incentives than markets, which reduces the cost of negotiating and extends the scope of control over knowledge transactions to residual rights and the associated rewards. This includes all possible offsprings of the new knowledge and competence created securing the future profit of the option for the firm. Secondly, the firm decides the employment rules. Especially if new valuable knowledge is created the firm can reduce employee mobility (and so the mobility of the tacit knowledge) and increase the monitoring of the employees. In doing so the firm prevents the loss of newly and costly created knowledge and the underlying option by imitation.

Implication for approaching real option evaluation

In the following we present an original approach for assessing the value of the real option based on the difference between shadow and real option. We do not pretend to give a unique and exact value, rather an interval where the "*real*" real option value should be.

We determine boundaries for four variables that intevene in the real option analysis namely: the premium that is endured to acquire the option, the striking price for exercising the option, the gain if the option is exercised and the value of the option. Two parameters usually found in real option are omitted, the interest rate (assumed constant) and the time to expiration. The variables are discussed for both types of option, shadow and real. Of course it is difficult to assign directly costs to an inventive activity as necessitate the formulas in particular for the shadow option. Also these costs can be incurred by the firm without obtaining an option. On the contrary the costs supported by the firm can serve to generate more that one shadow option. These costs can be taken in two different ways. If the firm deliberately tries to create a favourable environment for inventive ideas the costs are accountable and justifiable. If the firm does not support these costs deliberately the occurrence of the shadow option is just a non-intended event that the inefficient organisation produces by chance. The following discussion is summarised in table 1.

Insert Table 1 about here

The shadow option

- The premium of the shadow option includes the cost supported by the firm for being aware of the existence of an opportunity. It includes at the individual level the cost of the entrepreneurial resources which launch the process expressed in wages and training cost of the employee without a direct link to the actual production. At the organization level it necessitates some weak ties between the task of an individual and its productive behaviour. The creation of an option should here be linked to organizational slack. March (1979:17) defines organizational slack in the following statement "*Since organizations do not always optimise, they accumulate spare resources and unexploited opportunities which then become a buffer against bad times. Although the buffer is not necessarily intended. Slack produces performance smoothing, reducing performance during good times and improving it during bad times*". Organizational slack costs are the costs of the resources that a firm acquires and that are not committed to a direct use or/and necessary expenditure. Bourgeois (1981:35) depicted slack as a facilitator of strategic behaviour. Of course the kind of inventive idea arising from an employee as a manager or as a product line agent creates a different type of option at different costs, e.g. product innovation, process innovation…

- The exercise price of the shadow option includes the costs that are necessary to transform the shadow option into a real option. They are costs of negotiation (in time) that the entrepreneur spends explaining the idea and convincing the decision makers in the firm to spend financial resources in the competence building process. If the firm decides to build the competences (after eventually some market analysis costs) the costs come from the activity of search and combining of different types of resources in such a way as to

produce new knowledge needed to practically implement the inventive idea. Good proxies for such costs are R&D expenses or start-up creation outlays (in the sense that start-ups are legally different entities created to try to transform an idea into something profitable).

- The gain if the shadow option is exercised depends on the best use of the new combination of resources the firm has realised. The best use determines the highest gain the firm can obtain by combining resources, through internal use of the resources or by selling them on a market. The combination can have a value of zero if no productive use following the investment can done, or on the contrary the uniqueness of the combination can be highly valuable if the opportunity it provides to size is considerable.

- The value of the shadow option is generally divided in two parts, the intrinsic value or the speculative value. In the case of a shadow option the value is at minimum the gain of selling the resources built on the market price (which can be zero) and a maximum value incorporating all future strategic options that can be built on the basis of these resources. In this analysis the boundaries of the shadow option are zero and infinite. This approximation is of course not of great help for one who tries to identify the exact value of the firm's option. But we have to notice that this value is in constant variation. So this framework shows clearly that real options are only useful as a tool if decision makers agree to monitor them often and to specify boundaries of acceptance in advance (e.g. rules of thumb) and to stick to this boundaries (Kogut & Kulatilaka, 2004). Also the value of the shadow option is mainly influenced by its speculative value. Many overoptimistic analyses that are performed confuse the value of the shadow option with the value of the real option they try to evaluate. For us the value of the shadow option is only a transition point to guide an effective real option evaluation.

The real option

- The premium of the real option depends on the previous initiatives of the firm. If the firm as already invested in the shadow option or not. If the state of the firm follows the exercise of the shadow option than the sum of the exercise price and the premium of the shadow option forms the premium of the real option. If the firm hasn't previously invested in the shadow option the cost are at least equivalent to the gain of the shadow option. This mean that the firms who want a certain bundle of competences have the choice of building this resources inside the firm what can be extremely time consuming, or buy them on the market what can be expensive. The interest of many firms for a rare resource increases the price on the market. Langlois (1992) gave an example of cost that influencing the ranking of activities (and competences) a firm can acquire. If the shadow option costs are supported, the ranking of the profitable activities a firm can expect to enter is different from the ranking of a firm that has not incurred these costs.

- The cost of exercising the real option. Now that the firm is assumed to possess the necessary competences to exploit an opportunity, e.g. to enter the productive stage, it has to hire employees, build a productive plant etc…The firm can also switch employees from an existing production plant, abandoning an older product for launching a new one (as depicted in the BCG matrix). These costs are usually the only ones taken into account in standard real option evaluation.

- The remaining two points, gain when the option is exercised and value of the real option are consistent with the definition widely found in corporate finance books. The gain obtained when the real option is exercised is the present value of the cash flow generated

by the option and the value of the real option is given by adequate formulas depending on the market structure, the demand of the consumer's variation…

DISCUSSION

We have examined the role of entrepreneurship and resources in the valuation and development of real option. We suggest that entrepreneurship in a new firm, or an existing firm is at the origin of real option. We use the concept introduced by Bowman and Hurry (1993) of shadow option and option chain in our presentation and we enhance them with resources-based considerations.

As we have shown a firm with an entrepreneurial heuristics will give a different value to resources and to options than other firms. The value of the competence is a capital part of the real option value, and conversely future option determines partly the competences value. As noted by Kogut and Kulatilaka (2001) "*It is the identification of the opportunity set, as established through market valuations, that should drive the identification and valuation of core competence*". This statement is, however, rather problematic. It is difficult to say that A (resource) explains B (options) and B explains A at the same time. Nonetheless we argue that an arbitrage between A and B is a useful guide for a better valuation of both resources and option. The resource-based analysis gives us minimal values of the real option, and real option analysis can give us the maximal values of the resources. So we obtain lower and upper limits, the value of the firm must be somewhere between those two extremes.

Future development of real option should increase the integration of real option consideration into the theory of the firm, or more precisely a strategic theory of the firm.

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FIGURE 1: THE REVISITED OPTION CHAIN

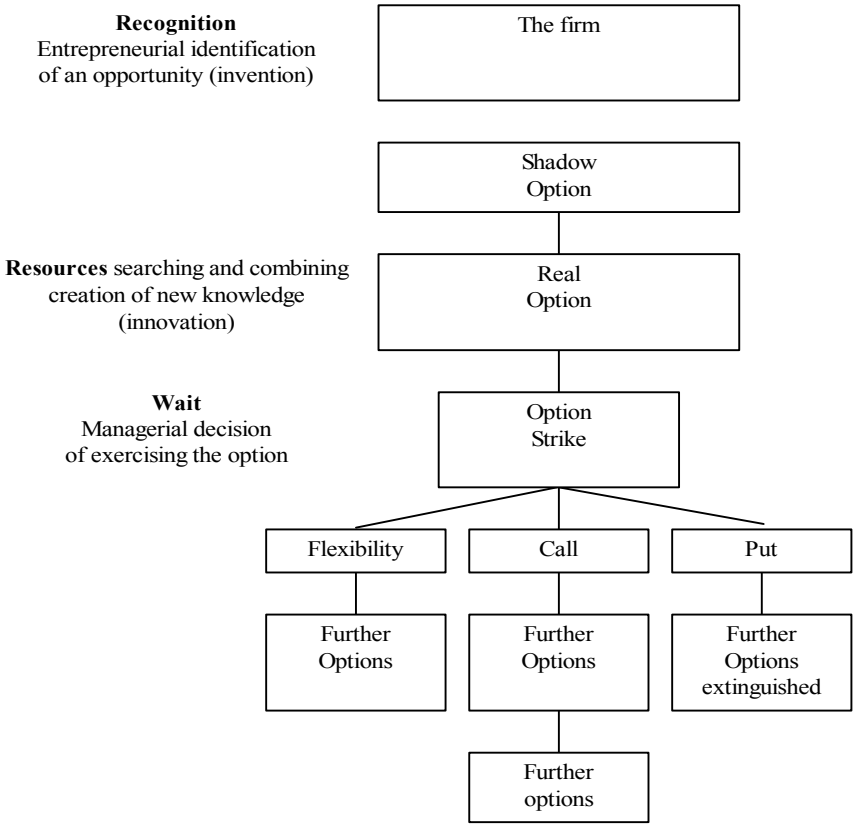

TABLE 1: COST AND VALUE OF THE SHADOW AND REAL OPTIONS

	Shadow option (SO)	Real option (RO)
Premium (P)	P_{SO} -The cost of the entrepreneurial resource that launches the process. -Organizational Slack -Cost of additional formation, without a direct link to productivity.	P_{RO} -If follows the exercise of the shadow option, the exercise price and the premium of the shadow option ($P_{SO} + K_{SO}$). -If the firm does not have the previous shadow option, at least S, given though dynamic transaction costs.
Exercise price (K)	K_{SO} -Cost of convincing decision maker to spend financial resources to search and tie row resources. - Cost of monitoring the employee.	K_{RO} Cost to acquire the necessary assets to enter production (plant, workers…)
Gain if exercise (S)	S_{SO} The value of best use of the new combination of resources.	S_{RO} Present value of future cash flows generated.
Value of the option (V)	V_{SO} The value of the shadow option is greater than the gain S because it incorporates the strategic possibilities of the future.	V_{RO}. As calculated by traditional real option evaluation models (uncertainty on demand, further development etc…)