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Option chain and change management: A structural equation application

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Summary Building on concepts from a resource-based view of a firm and real option theory we propose a model that describes the links between a firm options development and the expected profitability. Empirical results of structural equation models on the video-game industry indicate that (i) the balance between industry innovativeness and firm innovativeness affects the perception of potential option, (ii) the industry threats and firm competences mediate the transformation of real option into profitable product, (iii) the strategic choice of project to be developed in a creative industry can be satisfactorily modelled by the option chain model.

Introduction

The success of a firm depends on its ability to earn increasing returns or obtain performance by creating and exploiting new projects, routines and technologies in a more efficient way than the other firms in the industry (Teece et al., 1997). Those projects are competitive opportunities that the firms have to recognize, evaluate, and for which they have to build operating capabilities to take advantage of them. The general management responsible for the firm's strategic direction frequently fails to manage the organization's technological innovation and change processes that create these opportunities (Adner and Levinthal, 2004a).

To help managers in their decision making process in uncertain environments, new techniques and theories are developed, one of them is the real option theory. This conceptual decision making framework is about to become a standard (McGrath et al., 2004). The formal approach, originating from financial models, dealing with future uncertainties and the opportunities a firm can seize, is appealing for managers.

Bowman and Hurry (1993) present a conceptual model, called option chain (the successive steps of creation, development and use of a real option) aimed at bringing the real option logic from the financial field to the strategic management field. Their work was based on the intuition that people try to keep options open. The authors showed that the option chain could be seen as an analysis framework integrating many aspects of innovation management (resource allocation, sense making, organizational learning and stra-

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tegic positioning) and that their model could be useful to explain many aspects of the development of a firm, from both a theoretical and an empirical point of view.

The real option logic gains a broad success in financial and managerial literature but comparatively the concept of option chain is barely used in theoretical work and to our knowledge, no empirical work tries to represent it explicitly. This is regretful because the elimination of the causal logic behind the option chain pushes the managerial approach of real option into some wrong tracks, considering situations as options when there are not (Garud et al., 1998; Adner and Levinthal, 2004a,b; Kogut and Kulatilaka, 2004). Also, the partial consideration of the option chain, focusing only on the real option element, makes the financial approach still predominant and avoids many non-financial topics of innovation management that are important from a strategic point of view such as organizational learning or firm strategy–structure relations.

In this work we use the option chain to answer a major issue, almost ignored in this literature, the question of the origin of the real options a firm possesses from a theoretical point of view and we propose a possible empirical approach.

We suggest the use of the entrepreneur/manager duality to explain the creation of new options. This duality, often described by opposing two actors with different mind sets, responsibilities and abilities, can be found in many firms active in industry where constant innovation is a necessity.

The insights gained from considering real option and the entrepreneur/manager duality are bi-directional. On the one hand entrepreneurship, in a resource-based framework, can explain the origin of real option and contribute to a better evaluation of its value. On the other hand real option can explain the direction a decision maker gives to the development of the new capabilities and resources, as an entrepreneurial activity, by suggesting another use of the resources. Combining entrepreneurship and real option explains the heterogeneity of the firm and its resources collection and capabilities building.

The empirical approach we propose is based on a structural equation model allowing us to create latent variables close to the notions used in the option chain and to test the relationships (the paths) existing between those variables along the chain. Our endeavour is to make a structure apparent between the different kinds of options. To that end, structural equation modelling (SEM) is an appropriate tool (Tabachnick and Fidell, 2007: p. 30). The use of this tool in strategic management has strongly increased in recent years and, following Shook et al. (2004) and Henley et al. (2006), is able to generate insights in the strategic management where the constructs are complex and multidimensional. This exploratory study is carried out on innovative firms from the video-game industry.

In the next section we present the theoretical background: the option chain. This is done by introducing the original model by Bowman and Hurry (1993) and the incremental developments and improvements that have been made since, including the addition of our entrepreneur/manager duality. The section ends with the proposal of a conceptual model of the genesis of option and new product development. Subsequent sections transform this conceptual model into a structural equation model, present the data, the empirical analysis and the results. The paper concludes with the discussion on the findings and their implications in future research.

Theoretical background

An option gives the right but not the obligation to take a specific decision (invest, defer, alter) on an underlying asset, for a predetermined price at, or before, a certain time. For example, a firm can possess a production plant, and choose, depending on customer demand or competition, to construct a bigger capacity plant to obtain economies of scale (a growth option) or, on the contrary, to shut down momentarily the plant (option to defer production). The firm has the right, but not the obligation, to change its production capacity. This option, depending on the information at hand at the moment of exercise, allows the firm to seize new revenues flows or to reduce costs.

Figure 1 represents the successive developments of the real option chain in the strategic management literature. The following discussion and presentation of the option

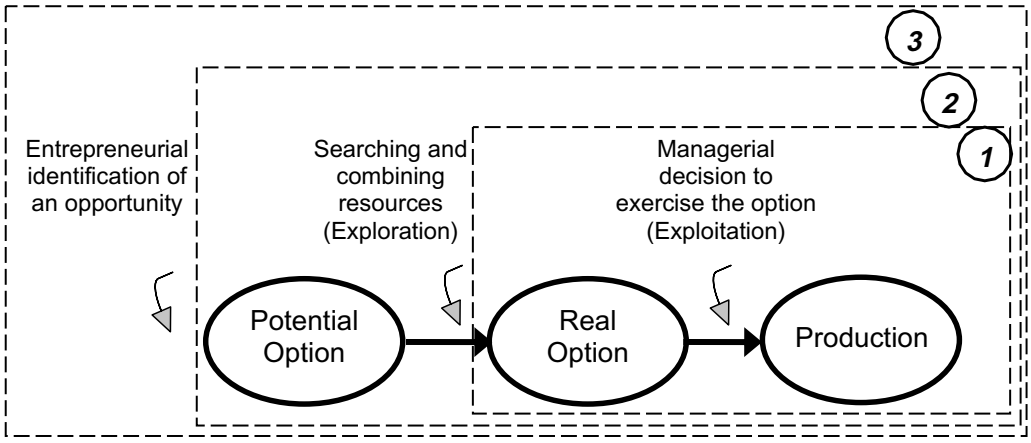

Figure 1 The option chain in the strategic literature.

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chain and the introduction of the entrepreneur/manager duality rely on that figure.

Standard option exploitation

The area labelled represents the initial step of the real option theory as it can be found in today's major textbooks on that topic (Trigeorgis, 1996; Amram and Kulatilaka, 1999) and is highly influenced by the financial literature. This short option chain is the following: the option is supposed to exist, to be available to the decision maker. The decision maker (always referred to as the manager in this literature) evaluates the option contingently to the future possible states, and decides whether to exercise it or not.

To exercise means that the project enters a phase of building and exploitation. Once the firm is in an exploitation phase new options can arise such as expanding the size of the plant, diversifying the production, or in the worst case, stopping the production and shutting down the factory.

Identification of opportunities, the emergence of the potential option

The previous representation, as noticed by academics in the strategic management field, makes the important assumption that the option exists and that the decision maker is informed of its existence. This is obviously not always the case. Bowman and Hurry (1993) struck by that implicit hypothesis, introduced the notion of shadow option (or potential option in the following), the option that a firm could exploit, or at least consider in its portfolio of choices but which it is not aware of. In other words the authors' intuition is that the firm possesses resources and knowledge giving its options that the decision makers ignore.

Opportunities (and not yet options) come into existence when individuals 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 being sought or that has spontaneously appeared. Once the potential option is taken into account (area Figure 1) the rest of the option chain can be considered in the same way as described above. When the shadow option is recognized, it moves from the potential option label to the real option label. The option has then to be evaluated, compared to the other options, by taking into account the probable interaction between the different options the firm possesses in its portfolio of choice.

The addition made by Bowman and Hurry (1993) does not completely answer the question of the origin of the real option, it merely shifts the debate. Instead of explaining the origin of the real option, the genesis of the potential option must be elucidated.

Introduction of the entrepreneur/manager duality

A historical approach of entrepreneurs in the microeconomic theory (Barreto, 1989) shows that when authors need to introduce novelties or special variations 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 which makes it possible to discover opportunities (Cohendet et al., 2000). 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 (or a group in the case of diffused entrepreneurship) has an insight into the value of a given resource while others do not.

Once the opportunity is identified one can notice that the entrepreneur certainly does not have the specific knowledge and expertise in all the domains necessary to fulfil its goal. This leaves it in charge of finding and combining the adequate resources to build new productive competences. This building process is not instantaneous, it is mainly path dependent and involves tacit knowledge acquired through learning by doing and experimentation (Kogut and Zander, 1992). This implies that firms which create knowledge are also option-creating firms. By creating new knowledge these firms expand their cognitive frames and therefore their real options. To explain that phenomenon McGrath and Boisot (2005) use a biological metaphor. The combination of different elements (like genes in biology) allows the firm to obtain a variety of different structures depending on the complexity of the possible combinations. The higher the degree of freedom of the combinations is, the broader the variety of potential outcomes will be. This degree of freedom in the combinations corresponds to the liberty the entrepreneurs take in their representations. This specific entrepreneurial mindset is a source of potential options. The value of the entrepreneurial resource derives here from its ability to combine different expert knowledge in such a way as to create and exploit opportunities. The conceptual liberty of the entrepreneur is a source of options, however this liberty has to match the flexibility of the firm. The complex recombination of elements envisaged by the entrepreneur must be put into practice by the firm, to this end the complexity of the firm must at least match the complexity envisaged by the entrepreneur to satisfy Ashby's law (Ashby, 1956).

The decision to exercise the option and to turn to a production phase corresponds 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, the knowledge is disperse and the manager is not aware of every pieces before the entrepreneur ends his action. Following March (1991), we could say that in the option chain, the entrepreneur is in charge of the explorative learning of the firm and the manager of the exploitative learning. The managerial decision depends on the balance between entering the market with the actual resources and knowledge or waiting for absorbing more capacities.

Empirical model development and hypotheses

Building on the notions and the conceptual model presented previously, we draw a path model capturing the relations

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and the logic behind the option chain. This model incorporates the following effects: (i) industry and (ii) firm specific effects on potential option generation, those constitute the necessary conditions for novelty, (iii) industry and (iv) firm specific effects on the development and exercise of the potential option into a real option, and (v) the expected influence of those options on the future performance of the firm.

The relations between industry and firm specific features on potential option creation

The effects of market and technological uncertainty on firm decision have received abundant attention over the years. In particular the relation between uncertainty and development of options and new competences has been developed. The relation between uncertainty and the elements of the firm is particularly discussed when the firm has to act in such an environment. The choices available to the firm are to stick to the existing few competences or to develop widely its portfolio of competences, which has implications from an organizational point of view and on the risk profile of the firm.

Following the option literature, the greater the technological uncertainty is, the more flexible the firm needs to be (Kogut, 1991; Folta, 1998). On the contrary when the uncertainty is relatively low, resources can be widely engaged in a few precise projects (McGrath, 2000).

Hypothesis 1a: The higher the innovativeness of the industry is, the greater the creation of potential options is.

Hypothesis 1b: The higher the innovativeness of firm employees is, the greater the creation of potential options is.

The relations between potential options and real options

The passage from a potential to a real option involves a managerial decision of allocation of resources to the development of a project. This requires to value the flexibility of the firm, and implies to acquire, retain, deploy or abandon some knowledge inventories and views developed by a part of the firm.

Levinthal and March (1993) described the knowledge inventory of a firm as ''a small number of specialized competencies maintained by the individuals and groups that make up the organization'' (p. 103). Managing knowledge inventories is problematic because ''where situations or proper responses are numerous and shifting, it is harder to specify and realize optimal inventories of knowledge. By the time knowledge is needed, it is too late to gain it; before knowledge is needed, it is hard to specify precisely what knowledge might be required or useful. It is necessary to create inventories of competencies that might be used later without knowing precisely what future demands will be'' (p. 103). This management problem is the source of myopias and decision biases. McGrath (1999) surveyed many of those myopias and decision biases that can be confronted by a manager or entrepreneur hindering the development of potentials into real capabilities or, in that case, real options. Miller (2002) proposes a model for assessing the difficulties of the managers to overcome these biases when allocating resources in a knowledge-based framework. Also Miller and Shapira (2004), in an experimental economic framework, show that the evaluation of opportunities, when they are presented in the form of options, is in practice difficult and does not always follow the direction and/or magnitude predicted by theory.

All those authors show that describing the link between the potential and the real option is difficult. However in a study of more than 300 projects, McGrath and Dubini (1999) show that the perception of option potential is a powerful driver of resource commitment and has implications in the organizational design. Accordingly we can say that the development of potential options fosters the existence of real options.

Hypothesis 2: The perceived development promises of the potential option increase the likelihood of being developed as a real option.

The relations between industry and firm specific features on the exercise of a real option

Amit and Schoemaker (1993) introduced the notion of strategic industry factors: the set of resources and capabilities that have become primarily determinant for the survival and development of the firms in a defined industry. These generic strategic assets are completed in each firm by firm specific strategic assets, referring to the resources and capabilities developed by a single firm to obtain and protect performances. In the light of those definitions, the strategic position of a firm evolves each time it — or a competitor — develops new resources or capabilities leading to a firm specific strategic asset. In the case of a major development in an industry those strategic industry factors can change considerably, creating the need for all the firms to develop new resources.

Following the previous discussion two hypotheses on the real option exercise can be formulated, in relation to the determinant of the industry strategic assets, and to the firm specific competences and resources.

Hypothesis 3a: The perceived threat of competitors is positively related with the exercise of real options.

Hypothesis 3b: The uniqueness of the competences developed is positively related to the exercise of real options.

The relations between potential options, real options and firm performances

The links between future performance and project development are explored theoretically and empirically in some studies, even if it is not always in a clear option formulation. Makadok (2001) presents a rent generation model

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where the firm can choose between building its own resources or picking up resources existing on the market. While the creation of resources entirely corresponds to our option chain and leads to higher performance, the picking up of resources corresponds more to a catching up strategy leading to a small advantage that is only possible when there are other firms in the industry which have built and stored those resources. Hence one could wonder if the fact the competitors have those resources is not a brake upon a superior profitability of the firm and whether those two resource acquiring techniques are not substitutes or complements, enhancing or detracting each other value. In an empirical work McGrath et al. (1996) identify drivers of future rents from innovation. Among these drivers are the understanding by the teams of the client satisfaction objectives, quality objectives, cost objectives, proficiency and the expectation of distinctive efficiency and value from the firm corresponding to the increase in value that customers will obtain from the firm rather than by products from competitors.

From these observations we formulate the following hypotheses linking real option, potential option and firm performance.

Hypothesis 4a: Expected Firm performance depends positively on the development of real options.
Hypothesis 4b: Expected Firm performance depends negatively on the perceived threat of competitors.
Hypothesis 4c: Expected Firm performance depends positively on the development of firm specific competences.

Methodology

Sample survey

The study consists in a survey conducted on 211 employees of different video-game companies based in Europe, Asia, USA and Canada. The survey is completed by employees from firms of different sizes. All the respondents were active in that industry by the time of the survey and participated in the development of new products. The product can be either the final product (the video-game) sold to the consumer, or a computer program needed in the development of a new game. This program can be developed for in-house utilization by another project group of the same firm or sold to another company.

The data are second hand, they were collected by a game developer survey conducted through internet (see Tschang, 2005 and Tschang, 2007, for details on the dataset building method) and was not conceived for testing the option chain but for evaluating the work conditions of the employees in that industry and their communication with the management. The data do not allow us to know the level of responsibility of the respondents (manager or another member of a project team) nor the activities of the respondents (programmer, artistic, design or integration activity, etc.).

But the survey is composed of many questions concerning the development of the firm, its evolution compared to competitors, and the sharing of opinions between management and employees that allow us to create latent variables corresponding to our needs.

Cadin et al. (2006) conducted a study on the HRM practices in the video-game business investigating industry and firm specificities. They consider the differences in the function of human resources, the employment model and the growth model of the firms and conclude that the video-game firms' needs (as organizations) and practices are the same in the US and in the EU. The HRM practice and the organizational scheme are contingent to the industry not to the country. Hence the variance introduced by the variety of the respondents belonging to firms of different sizes should be moderate and we can use our country heterogeneous data set in the following study.

On the other hand, it is probable that the size of the firm influences the employee rewards and career management possibilities and thereby affects the risk-taking behaviour and willingness to create more innovative products (a less conventional product can be seen as a riskier product). However all firms in this specific industry share the necessity to innovate, therefore this size effect should be of modest relevance.

Apart from these points there are other reasons why we have chosen the video-game industry for this exploratory study of the option chain. To ease our work, it is more likely to find a good representation of the option chain in an industry where the pace of new product launching is high and where the firm has constantly to reposition itself in a quickly evolving environment. In that case the set of internal competences and resources is dependent on and concurrent to those of the competitors. This is the case in this business as reported by Cadin et al. (2006:296): ''Everything in the game industry is based on confidentiality and anticipation (...) it is essential to stay in the race (...) it is more difficult to keep up to date with new technologies, competitors projects and trends''.

The dynamics of the industry is to a great extent imposed by the evolution of the underlying technology. The development of new computers and consoles every 5–6 years offers the video-game engineers new calculation power allowing them to conceive enhanced products but also confronts them with higher expectations from the customers (Burgelman et al., 2005; Schilling, 2003). This environment eases the adoption of a product development process in the form of an option chain.

Item development

The items in the questionnaire submitted to the employees are answered by giving a score on a 1–5 Likert type scale, where a higher score is associated to a higher approval of the item. Two choices are open to us to link the different questions to the latent variables. We can use a factor analysis and use the aggregated factor obtained to calculate the correlation matrix for the SEM analysis on the latent variables, or we can use a larger correlation matrix where all the items appear. As our main concern is to establish the simple link between potential and real options we use the first approach. This has another advantage, the distribution for each latent variable is closer to a normal distribution when we work on the aggregate latent variables and thus

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Table 1 Latent variable definition: the following questions have been used for creating the latent variables (1 – not at all, 3 – to some extend, 5 – to a very large extend)

Latent variable	Items
Industry innovativeness	– Other companies in the industry launch more innovative products than your company – Other companies in the industry produce a larger variety of products (RPG, FPS, etc.) than your company – Other companies in the industry produce for a larger variety of platforms (computer, console) than your company Cronbach α: 0.78
Firm innovativeness	– Most of the products development in your company are new, based on new ideas and/or new practices – Your company commits many employee to the development of new technologies/processes – Your company commits many physical, financial, organizational and logistical resources to the development of new technologies/processes – Your company innovates more than the majority of the firms in this industry – Your company places strong emphasis on R&D, technological leadership, and innovation – Your company tries to create small, autonomous units to encourage innovation and flexibility Cronbach α:0.84
Potential option	– The business practices, corporate culture and management style of your company gives you a lot of free decision possibilities – Your company is flexible according to her equipment and resources – Your company is flexible according to her human resource management practices and routines – Your company develops an exhaustive set of alternatives before making important management decisions – The project you are involved in will help the company to learn new manufacturing, production or operations skills – The project you are involved in will help the company to learn about new market segments and market opportunities – The project you are involved in will help the company to learn what product features and attributes our customers really care about Cronbach α: 0.81
Real option	– To use this technology/process your company had to invest significantly in specialized equipment and facilities – To use this technology/process your company had to invest significantly in skilled human resources – The technology/process your company develops or uses now is based on previous investment in equipment – The technology/process your company develops or uses now is based on previous investment in human resources – When your company sees business opportunities, she can seize them quicker than her competitors Cronbach α: 0.74
Industry threats	– It is difficult for competitors to imitate the product/technologies/process your company uses (scale inversed for the latent variable construction) – How do you rate your company ability to evaluate the market development of next generation game/console (scale inversed for the latent variable construction) – Your company believes that unstable, rapidly changing environments provide more opportunities than threats (scale inversed for the latent variable construction) Cronbach α: 0.69
Firm competences	– The technological risks (that the systems would not work as planned) of the projects your are involved in are usually mastered – The organizational risks (that the systems would not integrated with others, or are not reusable) of the projects your are involved are usually mastered – The financial resources are adequately dispatched between different projects – The human resources are adequately dispatched between different projects – People in your company accept change readily Cronbach α: 0.74
Performance–profit expectation	– With this project your company will achieve higher profit than competitors – As a result of this project, customers will be willing to pay a premium price for our offers – This project is likely to significantly improve the quality of our offers compared to past quality levels Cronbach α: 0.81

gives better overall results for the model estimation. The reliability of the construct obtained by grouping the items of the questionnaire is assessed with Cronbach's α. The α for each construct is above or close to the 0.7 recommended level (Hair et al., 2005), details are given in Table 1.

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Table 2 Latent variables descriptive statistics and correlation matrix

Latent variable	Mean	Standard deviation	Industry innovativeness	Firm innovativeness	Potential option	Real option	Industry threats	Firm competences
Industry innovativeness	2.59	0.92						
Firm innovativeness	3.08	0.59	0.08					
Potential option	3.78	0.49	0.24	0.08				
Real option	3.17	0.38	0.04	0.28	0.38			
Industry threats	3.53	0.89	0.17	−0.14	0.32	0.12		
Firm competences	3.3	0.57	0.09	0.11	0.27	0.29	0.41	
Performance—profit expectation	3.37	0.64	−0.11	0.29	0.44	0.28	−0.23	0.38

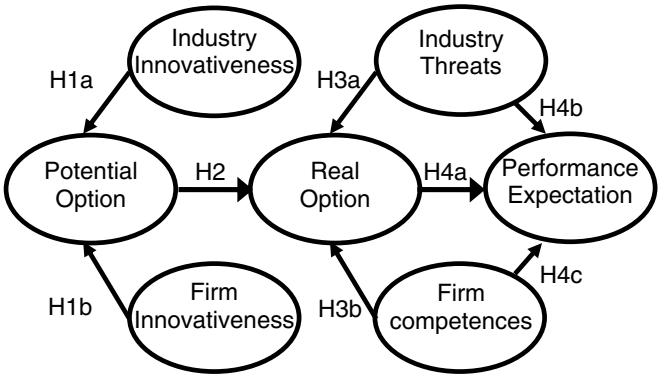

Figure 2 The structural model to be tested.

Results

Descriptive statistics and correlation matrix

Descriptive statistics and the correlation matrix for each of the latent variables are provided in Table 2. Figure 2 illustrates the relations between the construct involved in the option chain previously discussed.

Both industry innovativeness and firm innovativeness are positively correlated with potential options indicating that an innovative environment fosters the creation of options. Performance expectation is positively correlated with the firm competences and the different types of options but negatively with the industry variables. In the option chain, the highest correlation is between potential option and real option indicating a strong relation between these constructs. The highest correlation among all the parameters is between industry threats and firm competences. This somewhat troubling positive relation suggests that the competitors know each other very well and that the competition results in a positive emulation, this will be discussed in a community perspective in the conclusion.

The variables are not skewed except for those concerning the firm competences and innovativeness that are slightly skewed to the right (5 points). This can mean that people are optimistic in their own work, and see the development of new products necessary. It can also partly be the expression of over confidence (McGrath, 1999).

It should also be noted that the standard deviation of the industry innovativeness variable is about the same as the industry threats variable, the same can be said between firm innovativeness and firm threat variables. The standard deviation is higher in the variables in accordance with the competitor's reaction (industry related variables) than for the firm variables corresponding to a shared opinion in the firms. The relations in Table 2 are compatible with the path relation of our structural model and the underlying hypothesis we formulated.

Structural analysis

We employ Amos 4.0 to develop a structural model that tests the relations proposed and some alternative path models employing the same constructs with different paths or leaving out some of the constructs and paths.

The main model we tested obtained a χ^2 value of 11.59 with 13 degrees of freedom and p-value of 0.562. This means that the null hypothesis (the model fits the data) cannot be rejected. The results are listed in Table 3, alternative measures of fit are given in Table 4. All paths are significant, the fit indicators are on average acceptable.

As expected, the analysis shows that potential options are highly associated with real options and that both industry and firm innovativeness affect the potential options. So far the hypotheses H1a, H1b and H2 cannot be rejected, although the influence of the industry innovativeness is small compared to the firm effects. The option chain continues through hypothesis H4a where real option affects the performance expectation. The representation of the option chain is therefore achieved. We can notice that industry

Table 3 Structural model results, $N = 211$, $\chi^2 = 11.59$, probability level = 0.562

Path	Maximum likelihood estimation	Standard error
Industry innovativeness to potential option (H1a)	0.066	0.14
Firm innovativeness to potential option (H1b)	0.357	0.25
Potential option to real option (H2)	0.344	0.18
Industry threats to real option (H3a)	−0.087	0.12
Firm competences to real option (H3b)	0.430	0.29
Real option to performance expectation (H4a)	0.285	0.22
Industry threat to performance Expectation (H4b)	−0.241	0.13
Firm competences to performance expectation (H4c)	0.511	0.33

Table 4 Goodness of fit for the measurement model

	Initial model	Best revised model	Desired levels
χ^2	11.59	7.069	Smaller
Df	13	10	–
χ^2/Df	0.89	0.7069	<3.0
p-Value	0.562	0.719	>0.05
GFI	0.878	0.918	>0.9
AGFI	0.738	0.769	>0.8
Standardized RMR	0.049	0.035	<0.05

threats affect negatively the performance expectation and the real option creation, suggesting that whenever the competition is tough, firms focus on some projects reducing their real options.

The statistical analysis we perform implies that the data fit the model, but this does not mean that no other models exist that have a similar or perhaps better fit. Then, understandably, we consider alternative models.

Alternative models

The alternative models we test correspond to the dismissal or addition of different paths. The main alternative models tested are listed in Table 5. The dismissal of one path leads generally to a shrinking of the p-value and to the rejection of the model (e.g. model 2). The model general fit is only slightly modified when the hypotheses H3a and H3b affecting the real option variable are dropped. Permutation between H3a,b and H4a,b paths shows that the model needs a link between industry threats and firms competences with either the real option or performance expectation variable but there is no clear preference which should be taken. Also a correlation path between industry innovativeness and firm innovativeness leads to a minimal improvement of the model. This is somehow surprising when we consider this industry as innovation oriented.

The addition of a path between performance expectation and potential option does not lead to an improvement of the model (model 4). Therefore the recursive part of the option chain, mentioned in the work of Bowman and Hurry (1993), is not empirically represented with these data.

The model with the best fit, built with paths in accordance with our framework, is obtained by adding a path between firm innovativeness and firm competences and concentrating the relations on the real option variable. This result echoes the dynamic capabilities approach of the firm, where the capacity of a firm to innovate is considered as a competence.

Through this analysis, we see that our initial model gives fair results compared to alternative models, only a few of

Table 5 Test of alternative models

Model	Path differences with initial model	χ^2	*p*-Value
1	Initial model + industry innovativeness → firm innovativeness	10.40	0.58
2	Initial model without H4b and H4c	13.91	0.45
3	Initial model without H3a and H3b	12.33	0.58
4	Initial model + performance expectation → option potential	11.55	0.48
5	Initial model + firm innovativeness → firm competence Industry innovativeness → real option Firm innovativeness → real option Without H4b and H4c	7.06	0.71

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them are acceptable in the same range as our model and hardly any fits better the data than our representation. We now turn to the discussion of these results.

Discussion

The purpose of this study was to examine the relationship between the options perceived by the members of an industry, the expectation of the future performance produced by the exercise of these options and firm's or industry's specific factors. Building on concepts from the resource-based view of the firm, real option theory and the economic approach of strategy, we propose a model that describes the links between a firm option development and the expected profitability. Empirical results of structural equation models indicate that (i) the balance between industry innovativeness and firm innovativeness affects the perception of potential option, (ii) the industry threats and firm competences mediate the transformation of real option into profitable product, (iii) the strategic choice of project to be developed in a creative industry can be satisfactorily modelled by the option chain model conceived by Bowman and Hurry (1993). Let us discuss each of these points before broadening the debate.

(i) The fact that the balance between industry innovativeness and firm innovativeness affects the perception of potential option was a predictable result. What is interesting is that the influence of both types of innovativeness (firm and industry) has a positive effect on the perception of potential option. This result suggests a true emulation between the actors of this industry as described recently in a case study by Tschang (2007).

(ii) The industry threats and firm competences mediate the transformation of real option into profitable product. The members of an organization recognize that the differences between their own competences and those of the competitors are the source of profits obtained by catching the consumer's demand. The employees of the firms account simultaneously for the demand pull and technology push implication of product development. The differential in resources and competences existing between a firm and the industry is the origin of the performance expectation which is in line with the arguments of the resource-based view of the firm. The historically dependent accumulation of resources and the idiosyncratic routines developed are at the source of the higher performance of firms and influence their capacity to change dynamically (for a broad survey of these questions Foss, 1997; and a more management oriented perspective in Pfeffer and Salancik, 2003).

Finally (iii), and this was our main endeavour, we show that we can empirically test the concept of option chain. We strongly belief that this concept has many future application, especially in the strategic management of creative firms and the evaluation of project. We mentioned that the firm capacity to change dynamically is of utmost importance in such industries, and that the value of the option chain is directly linked to this capacity. This dynamic capacity depends on the one hand on the industry and on the other hand on the competitive advantage of the firm in comparison to other firms. The competition on industry level has already been analysed, at least in theory, with a real option lens. But, some other critical issues in strategic management are still to be modelled and empirically tested in that way.

The different approaches of competition on an industry level modelled with options are for instance the rivalry among existing firms (Smit and Trigeorgis, 2004), threats of substitute products (Kester, 1984) or threats of potential entrants (Smit and Ankum, 1993). The search for the best investment timing and evaluation of the projects or firms calculated in those works depends on technological uncertainty but also market uncertainty.

To conclude, we discuss two elements of this work, the future development of the option chain and the implication of the video-game industry data we used.

These results we found support those of other authors linking the fields of innovation management and investment decision (Van de Ven, 1986; Brown and Eisenhardt, 1995; McGrath and Dubini, 1999; Tushman and Anderson, 2004; Cho and Pucik, 2005) and suggest some new paths for future research.

The option chain with other critical issues in strategy

Brown and Eisenhardt (1995: p. 374) note that the creative processes where the competences of the firm are ''matched'' with the market needs in such a way as to create new products should be explored. In particular the firm governance mechanism between top management and project management to evaluate, create and exploit synergies between competences in the firm are to be investigated in the light of the real option theory.

Recent developments in organization theory and theory of the firm see this in the rebirth of the old duality between entrepreneurs and managers in the charismatic lead of the firm and in the decision power to allocate resources between exploration and exploitation. In that stream of literature, Gupta et al. (2006) restate the differences between exploration and exploitation, and conclude that they are the two ends of a continuum. For these authors organizations achieve a balance between exploration and exploitation by different means, one of them is to consider the firm as a sum of different subsystems each piloted by a specific actor. We mean that these actors could be a manager or an entrepreneur. In a software development context, more related to the topic of this work than the general article of Gupta et al. Boh et al. (2007) show the limits of the sole manager when learning processes are involved in order to achieve productivity gains. Therefore the duality entrepreneur–manager seems to be correlated with the successful development of the option chain. Burger-Helmchen (2008), with the help of a simulation model, shows in a firm competition model based on technology development, the outcomes in terms of option creation and survival of the firm when there is a manager oriented decision maker or an entrepreneurial oriented decision maker.

The economic distinction between an entrepreneur as an innovator as opposed to a manager responsible for the administrative tasks is not sufficient anymore. Both of them have to answer problems of sense making, diffused entrepreneurship, networked organization and entrepreneurial

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and managerial life cycles among others. Those domains influence the way a firm develops its strategy and impacts directly on the option chain that appears here too linear. We can advocate that it could be difficult to empirically test a more complex option creation and utilization model, but this remains a possible future path of research.

An important issue, not mentioned in that work, is linked to the type of performance created. Options on new technologies can produce Schumpeterian rents, options on trademarks or licenses allow the firm to seize monopoly rents. Accordingly, the specificity of an option developed by the firm allows it to seize a specific type of rent (performance) and therefore some option chains are more valuable for the firm than others. In that sense, the option chain approach could be another way of defining dynamic capabilities. A firm with good dynamic capabilities is a firm which is able to move faster or slower on some options chains and can link them together for achieving unique resources. We line up here with the approach of Mathews (2003) who characterizes the firm strategic moves by expanding their real options via external resources acquisition. In this work he lists the advantages and disadvantages (even feasibility) of internal and external development of real options. As we do in our work he insists on the option chain structure and the simultaneous consideration of the industry and firm innovativeness and threats.

But both works do not tackle the dynamic capabilities and rent generating mechanism with the option chain, leaving it open for further research.

The limits due to the video-game industry data used

The video-game industry and the underlying problematic of new product development in an evolving industry fit perfectly the purpose of the option chain. However the data used in this study were collected during a particular period of the video-game industry corresponding to a certain level of uncertainty that could have an impact on the results. Data came from the period before the launch of new platforms, when firms had to reinvent the electronic entertainment. Schilling (2003) studied such a period of technological and business uncertainties during a plate-form change. She concluded that the firms are obsessed by the technology gap and their capacity of using the full potentiality of the calculation capacity of the platform. Therefore the importance given to uncertainty and innovativeness in the empirical findings can be somehow overestimated.

The other problem specific to this industry is that the firms are organized — deliberately or not — in communities. Therefore the opinions and practices are largely shared industry-wide. Dougherty (2001) analyzed the innovation procedure of several firms and showed that there are significant differences between the firms successful in their innovation process and the others. The central reason comes, for this author, from the project orientation of the different teams, and the integration of the outputs from the different teams. The successful innovators are those who dispatch the problems in different workgroups corresponding to the competences of the individuals and to their competitive advantage. The individuals see themselves as belonging to communities of practice with a specific task or problem to solve. The individuals of those firms understand that the value created by establishing and developing a long term relation with the customer on the basis of their innovative products is important. In addition to the community perspective, the organizational structures of the firms in the video-game industry are almost similar, consequently the opinions and expectations of small working groups are largely the same. Only major strategic moves, corresponding to major investments for the firms can make significant differences in the types of products developed. This is not captured at employee level, but rather at the decision level which is not taken into account in that study.

Related to this is the control of the specific organization of work flows in the video-game industry (and other innovation oriented industries) that critically relies on some individuals who act as sense makers. Simon (2006) shows on case studies of a large video-game company that the existence of shared meaning of the project and the interrelation of the different projects within the firm and its co-evolution with the practice of the industry are a key factor of success. This integration capacity is not clearly mentioned in our dataset and deserves attention in future work.

Finally, the further development of the real option construct in the strategic management should try to replicate this approach in other industries. As suggested by authors in strategic management (Barnett, 2003) and finance (Zingales, 2000) the next step should be the identification of the main elements of the theory of the firm that could be used to represent adequately the option chain concept in a framework better suited for strategic management analysis than for the traditional Black-Scholes financial approach.

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