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Spécialité SCIENCES DE GESTION

Préparée au sein de l'Université de Caen Normandie

Financial evaluation of entrepreneurial strategic choice

Présentée et soutenue par
Yasuharu IMAI

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Doctoral Dissertation

The financial evaluation of entrepreneurial strategic choices

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NIMEC, IAE Caen (Université de Caen Normandie)

15th October, 2019

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Part One:

Introduction and perspectives of this dissertation

I. Outline

To get started, this section describes the outline of this doctoral dissertation. First, the motivation is presented. Second, the objective of this dissertation follows. Lastly, the structure of this dissertation is shown.

1. Motivation and objective

Fostering start-up, or new venture creation, is important for the national economy, and the number of new companies has increased in recent years. According to the statistic of KPMG (2019), for example, the VC-backed companies raised the funds of $63.9 billion funds in the 4-th quarter in 2018 all over the world, and this amount is increasing year-by-year. This growing industry could also have a large impact on global economy. The report of "Entrepreneurship at a Glance 2017" by OECD states that "In all OECD countries enterprise creation rates in services outpaced those for the industrial firms, contributing around two-thirds of all jobs created in new firms in 2014. But in most economies new industrial firms contributed less than 15% job created[1]". Looking back to the past, we know that the so-called "Internet bubble" occurred in the

[1] see. http://www.oecd.org/sdd/business-stats/entrepreneurship-at-a-glance-22266941.htm

beginning of 2000, and burst during the financial crisis in 2007 and 2008. However, the interest in new enterprise creation has not been declining. Rather, entrepreneurship has attracted attention not only of academic researchers but also of the practitioners. Currently, even employees working for large public firms are encouraged to create their own start-up or venture project, which is sometimes called as "intrapreneurship". Moreover, some large firms that have abundant cash are trying to launch corporate venture capital (CVP).

As he sets up a new company, the entrepreneur often has a problem of fund raising. Not limited to the creation of start-ups, financing and investment issues are also central problems to be addressed for intrapreneurship or corporate finance venture projects. Traditionally, those issues have been dealt with using corporate finance tools. However, the financial issues related to start-ups and venture projects have unique characteristics which are not always captured by traditional corporate finance methods. Entrepreneurship is a new and often innovative business creation process, and more specialised finance concepts are required. Entrepreneurial finance is the study that deals with that kind of financial issues, focusing on entrepreneurship, and thus, understanding it well is critical in order to lead the new businesses into growth and success.

Both entrepreneurial finance and entrepreneurship are relatively new research areas. Consequently, there are still debates on the theoretical basis and common knowledge. There is a surge of interest in academic research on those topics and many excellent research papers have being published. However, in practice, the theories and knowledge of traditional corporate finance and market finance are forcibly and directly applied to financial issues related to entrepreneurship or start-up creation. For example, the well-recognised tools of Discounted Cash-Flows (DCF) and Internal Rate of Return (IRR) are widely used as the primary and only valuation methods when making financing and investment decisions concerning start-ups and new ventures. It is true that there are many practical scenes in which these methods are still useful, however, we can also find situations where these methods do not work well (the detailed explanations are presented in the section II). This mismatched utilisation of valuation methods is to be resolved, and this is one of the three objectives of this dissertation.

As it will be explained in more details in the section II-5, one of the situations where the DCF and IRR may not be applied directly is the phase of 'contract negotiation.' Specifically, financing and investment decisions into start-ups and ventures are vulnerable to the unignorable issues of 'risk' and 'information asymmetry' (see the section II-2,3), and these are closely linked to 'contract negotiation.' However, more and more researchers are interested in understanding the economic and financial analysis and evaluation of this stage of the contract. Moreover, the contract negotiation process in entrepreneurial finance is a 'Black Box' by nature. Its economic and/or financial aspect requires predictions and estimations, for example to forecast the actions of other players and the prospective economic outcomes caused by these actions. Needless to say, there are few researches so far, which are trying to provide quantitative valuation models that describe the contract negotiation processes of financing and investment. Furthermore, during the financing negotiation, the entrepreneur seldom has a stronger bargaining power than prospective investors as he/she lacks experiences and expertise in negotiations, while investors have often deep knowledge of negotiating. Thus, such negotiations could be unfair between entrepreneurs and potential investors. If quantitative evaluation methods were adopted, the financing negotiation would become fairer and smoother as these could provide an objective evaluation. Here is the second motivation of this dissertation.

Instead of valuation methods such as DCF and IRR, a method called 'Real Options Analysis' (or 'ROA'; see the section IV) has recently been recognised by both academic researchers and practitioners. In particular, many academic researchers admit that the ROA is a useful tool for decision-making because of its unique capability of capturing flexibility. Consequently, it is suitable to apply it to entrepreneurial finance (e.g., Smith et al. (2011): see the section IV-3). As mentioned above, predictions and estimations are required during contract negotiation in entrepreneurial finance. Thus, at least theoretically, the ROA may be suitable. However, the ROA has not yet been widely used in practice and it is not a common and shared method amongst financial practitioners. As explained in the later sections, the introduction of the ROA enables to better and more realistically understand the financing and investment process into start-ups and ventures. Thus, the ROA should also be used more widely in practice, which is the third motivation of this dissertation. Along with these motivations above, the objective and contribution of this dissertation are to develop quantitative methods for the financial valuation of contracts based on the ROA. This valuation shall be usage-oriented in entrepreneurial finance area. The ROA uses a lot of mathematical

equations and its technical aspect (or mathematical manipulations) is emphasised when building up models which incorporates this method. However, the objective of this dissertation is not limited to a focus on the technical aspects, but it also aims at providing useful practical insights for both entrepreneurs and investors, which facilitate decision-makings in contract negotiations for financing and investment into start-ups and ventures.

Those decision-makings are often characterised as 'strategic'. 'Strategic' means here that each player, entrepreneurs and investors, will take actions by taking the other player's actions into consideration in order to maximise their own outcomes, which is similar explanations to the ones in traditional microeconomics or game theory. In general, the problems to be solved in finance are divided into two large categories: strategic aspects and financial ones. As Smith et al. (2011) highlighted, strategic and financial aspects are not separable for small and medium enterprises. Actually, the interests of both entrepreneurs and investors are aligned in entrepreneurial finance, while it can be disconnected for large listed firms in traditional corporate finance. It is sometimes comprehended that entrepreneurship and entrepreneurial finance are the two wheels of the same car, which means that these are closely linked. Furthermore, as mentioned above, the consequences of the financing contract negotiation tend to be unfair, thus, not only entrepreneurs but also investors shall be 'strategic' in order to obtain favourable outcomes. Therefore, the title of this dissertation embraces the 'strategic choice' along with the objective mentioned above.

In general, the participants in the contract negotiation should be strategic. In particular, the financing and investment contract negotiation requires quantitative analysis. As explained in the section III, the main research question is settled as "How should strategic choices in contract negotiation be financially evaluated?" This question might be a bit ambiguous. Thus, the answer to the question shall be discussed in the three typical but unique problems in entrepreneurial finance: licencing contract, use of convertible notes and exit choice through IPO vs acquisition.

2. Structure of this dissertation

As mentioned in the previous section, it is necessary to design both new theories and techniques for entrepreneurial finance. This dissertation is trying to cover essential and basic topics concerning entrepreneurial finance. The structure of this dissertation consists of two parts. Part One presents the necessary basic knowledge for the introduction to Part Two. These are definition of entrepreneurial finance, the four key characteristics of entrepreneurial finance (stages, risk, information asymmetry and contract negotiation) and the definition of the real options analysis as the common methodology in this dissertation. The main objective of section II of Part One is to present the basic knowledge for the research question settlement and the concept of entrepreneurial finance is introduced. In section III, the grand research question (central problem) is proposed. Finally, in section IV, the concept of real options is introduced as an analytical tool for this dissertation. In Part Two, three articles, which are studying different topics, are presented. The first article focuses on financial contract dynamics, the second article deals with the decision-making cost for new equity investor, and the third article analyses the exit strategy choice options. Finally, Part three gives the concluding remarks and some discussions.

II. The perspectives of this dissertation

This section explains the four key concepts, 'stages,' 'risk,' 'Information asymmetry' and 'contract negotiation,' which are used as the foundation of the discussions in this dissertation. In particular, different perspectives between entrepreneurial finance and the traditional corporate finance and market finance are at the origin of these concepts. These are applied in the three application articles included in Part Two.

1. What is entrepreneurial finance?

'Entrepreneurial finance' is one of the subcategories of finance dealing with financial issues in entrepreneurial ventures and start-ups. It has been recognised as an independent field only recently. According to Wright and Robbie (1998), entrepreneurial finance is a distinctive subset of traditional corporate finance. Traditionally, corporate finance focuses on established listed companies, while entrepreneurial finance largely focuses on younger, privately-owned firms (Cumming et al., 2019). Many standard textbooks for the university students and/or financial professionals have been published on this topic: e.g., "Advanced Introduction to Entrepreneurial Finance" by Landström (2017), "Entrepreneurial Finance" by Leach and Melicher (2016), "Entrepreneurial Finance: Strategy, Valuation, and Deal Structure" by Smith et al. (2011). Although the precise definition of entrepreneurial finance is not well established, many researchers discuss on the basis of a common concept accepted widely. Cumming and Johan (2017, p. 357) define entrepreneurial finance as follows: "*Entrepreneurial finance encompasses the intersection of the two separate fields of "entrepreneurship" and "finance.*" Similarly, Landström (2017) defines entrepreneurial finance as a field at the intersection between entrepreneurship and corporate finance theory. Another definition is proposed by Leach and Melicher (2016) who describe it as the application and adaption of financial tools, techniques, and principles to the planning, funding, operations, and valuation of an entrepreneurial venture.

1.1. Entrepreneurship and entrepreneurial finance

The definitions proposed by the authors include the two main elements of entrepreneurial finance. One is that the entrepreneurial finance has been built on the basis of 'entrepreneurship.' The notion of 'entrepreneurship' is also relatively new and there are many definitions. These are similar but not yet well established, though the notion has been widely recognised. The definition by Schumpeter (1934), which may be the most famous, is that entrepreneurship is the innovation that changes the market from equilibrium to disequilibrium. However, the notion has evolved. For example, a famous management scholar, Peter Drucker (1985), describes entrepreneurs as the persons who create "something new, something different; they change or transmute values." His definition may become the foundation of the concept of entrepreneurship, and in recent years, common definition is shared among researchers. Smith et al. (2011) argue that entrepreneurship is the pursuit of opportunities to combine and redeploy resources, without regard to current ownership or control of resources. They also highlight that entrepreneurship suggests a multidimensional process. Leach and Melicher (2016) define entrepreneurship as the process of changing ideas into commercial opportunities and creating value. Landström (2017) also makes a quite similar argument saying that entrepreneurship is the process of changing ideas into commercial opportunities through the creation of new and growing ventures. The common core idea lies on the fact that entrepreneurship is "the business creation process." This kind of business creation, by nature, requires willingness to change habitual business situations or attitudes toward innovation and this should be taken into account into the definition of entrepreneurial finance. In other words, entrepreneurial finance emphasizes the activities of an individual entrepreneur, whereas traditional finance has been developed from the perspective of financial markets which puts less stress on individual behaviours. This shift of perception is in line with the core concept of this dissertation as discussed in later sections. Therefore, entrepreneurial finance should be interpreted as the application of finance to the valuable brand-new business creation process.

1.2. Entrepreneurial finance as a subset of corporate finance

The other important point described by Landström (2017) is that entrepreneurial finance is the adaptation of corporate finance. As a major academic research field, 'finance' can be divided into two major categories, market finance and corporate finance. In general, the former is the study of the structure and mechanisms of financial markets where financial assets, such as stocks, bonds and derivatives, are traded. On the other hand, corporate finance is the study of financial activities of firms, often focusing on large and well-established firms. Corporate finance concerns financial decisions related to running a corporation (Landström, 2017), usually including issues such as:

(1) the acquisition of capital and the capital structure of corporation
(2) the use of financial capital for different purposes, for example, in the form of investment or as working capital; and finally,
(3) decisions regarding the size of the capital in a corporation.

The primary goal of corporate finance is to maximise the value of shareholders. For example, according to one famous corporate finance text book written by Brealey and Myers (2013, p. 1), "*A large corporation may have hundreds of thousands of shareholders. These shareholders differ in many ways, such as their wealth, risk tolerance, and investment horizon. Yet we shall see that they usually share the same financial objective in entrepreneurial finance. They want the financial manager to increase the value of the corporation and its current stock price. Thus the secret of success in financial management is to increase value*". Moreover, they state that: "*Corporate finance is all about maximizing value." In order to realise it, the managers of the firm/corporation must make full use of management techniques, such as strategies, marketing, and financial tools, and decision-making to maximise the shareholders' and firm's value.*" Corporate finance is thus the study of decision-making on the firm's financial matters.

1.3. What is entrepreneurial finance?

Then, what is entrepreneurial finance? From the discussions above, we can deduce that entrepreneurial finance could be defined as the study of decision-making on financial issues, especially on the entrepreneurial business creation process. As far as the entrepreneurship process is concerned, entrepreneurial finance could also be defined as the application and adaptation of corporate financial tools and techniques for newly created and growing ventures. In either way, the idea that entrepreneurial finance concerns decision-making should be emphasised, rather than the application of financial tools or techniques. We can also compare entrepreneurial finance and market finance. Market finance supposes that market participants such as investors are anonymous, homogeneous and price-taker. Thus, the emphasis is on the price movement of financial assets or on the techniques for analysing financial markets themselves. Human characteristics or behaviour are not emphasised[2]. Nonetheless, in the field of corporate finance, the firm's managers are not necessarily anonymous nor homogenous. Even in a large firm, in which decision-makers are embodied by several directors, the question of 'who the decision-makers are' is a matter of concern as their perspectives can impact all stakeholders. This means that decision-makers' behaviours should be emphasised when we consider an individual firm. The managers' decision-making process has a great impact on new business creation and development. Therefore, the concept of decision-making in entrepreneurial finance should be put forward in this dissertation.

1.4. What are the main contributions of research in entrepreneurial finance?

Corporate finance itself includes the characteristics of decision-making and this topic has recently been developed more widely and deeply by researchers and practitioners. Thus, the following question will arise: "Why is it necessary to think about entrepreneurial finance?" This question can be rewritten as "Are the concepts and tools of corporate finance insufficient when considering entrepreneurial venture creation?" This kind of question is not new. For example, Smith et al. (2011, p. 29) have already proposed

[2] Although some new scientific research fields, such as behavioural economics or cognitive finance have emerged, I do not dive into these topics in this dissertation. The start point or fundamental assumption of such fields are quite different and sometimes contradictory to traditional market and corporate finance. Thus, it should not be incorporated in order to keep the coherence of this dissertation.

that "*It is natural to wonder why entrepreneurial finance is worthy of special study? Why aren't the principles of corporate finance directly applicable in an entrepreneurial setting?*" One of the answers is that the main topic of corporate finance is large and well-established firms and its theories are built in order to explain the financial activities of such firms, rather than small, young and new ventures. To borrow the phrases of Smith et al. (2011, p. 29), "*After all, a basic course of corporate finance concerns investment and financing decisions of large public corporations and generally introduces valuation techniques such as discounted cash flow and cost of capital analysis.*" The issues of valuation techniques which they pointed out are also essential to consider and will be discussed in the later sections.

Then, the next question arises: "Are there any differences between large firms and new ventures? Are there any contradictions in applying the traditional tools and methods of corporate finance to new ventures?" Before answering these questions, it is worth explaining the argument put forward by Mitter and Kraus (2011). They define entrepreneurial finance as the acquisition and the use of capital, as well as the decisions regarding the size of capital in new and growing ventures, and particularly it focuses on the characteristics and particularities of the development phase of the ventures. The essential point of their definition is located in the expression of 'particularities of the development phase of the ventures.' For explaining the 'particularities', it is necessary to address the differences between corporate finance and entrepreneurial finance.

On this point, Smith et al. (2011, p.30) give us a summary about these differences by proposing eight highlights:

(1) The inseparability of new venture investment decisions from financing decisions
(2) The limited role of diversification as a determinant of investment value
(3) The extent of managerial involvement by investors in new ventures
(4) The substantial effects of information problems on the firm's ability to undertake a project
(5) The role of contracting to resolve incentive problems in entrepreneurial ventures
(6) The critical importance of real options as determinants of project value
(7) The importance of harvesting as an aspect of new venture valuation and the investment decision
(8) The focus on maximizing value for entrepreneur as distinct from maximizing shareholder value

Their summary is comprehensive and unerring. Thus, it can be the basis for the discussion of what entrepreneurial finance is and why it is necessary. The point (1) is the fundamental difference with traditional corporate finance setting. In large corporations, there are often independent departments such as accounting department, finance department, and marketing department. In addition, large corporations often have a large amount of internal cash available. Thus, the investment decisions and financing decisions do not always need to be interlinked. Decision-makings for investment and financing are the two primary issues in all finance areas. In corporate finance, these two are separable and different (see, for instance, Brealey and Myers (2013)). According to the corporate finance textbook by Vernimmen et al. (2018, p. 1), "*The primary role of the financial manager is to ensure that his company has a sufficient supply of capital.*" The supply of capital refers to financing decisions and is a different issue from investment decisions. On the contrary, start-ups or new ventures often have few staff and insufficient amount of internal cash available. Thus, when their managers want to implement new projects, they often have to find external sources of financing. They must often explain how much fund they need and why they need it. Furthermore, they need to justify their method of calculation to outside investors. This means that investment and financing decisions can be inseparable in start-ups and new ventures settings, though those are not completely independent even in large public corporations.

It is usual that start-ups or new ventures cannot implement several projects at the same time due to the lack of both finance and staff. In this context, as highlighted in the point (2), the influence of diversification strategy of investment is different in entrepreneurial setting from traditional corporate settings. As entrepreneurial ventures lack human resources, the points (3) and (4) are logical. In particular for the third point, situations in which only a few investors engage in financing is exceptional in large corporations as a lot of stakeholders usually participate. Thus, the impact of each investor must be relatively small.

Conversely, only a few investors usually participate to the financing of start-ups or new ventures. The points (5) and (6) are the other major differences with traditional corporate finance perspectives. This dissertation is focusing mainly on the points (5) and (6), and the details will be discussed in the later sections. The last point (8) is quite specific of the entrepreneurial process and interrelated to (5). In later sections, these details are also discussed. The point (7) is also dealt as one of the topics in Part Two of this dissertation.

Another synthesis is proposed by Landström (2017) as shown in Table 1. This summary can be complementary with the work described previously and can also be useful to discuss further what entrepreneurial finance is and why it is necessary. In particular, it provides answers for the questions: "Are there any differences between large firms and new ventures? Are there any inconsistencies to apply the traditional tools and methods of corporate finance to new ventures?" We propose that there are many 'particularities' in the entrepreneurial process, especially related to financing issues. This is why we must use specific valuation methods for entrepreneurial finance. The discussions of this dissertation are developed on the basis of this framework.

< Table 1 Basic argumentation in entrepreneurial finance (Landström, 2017) >

	Entrepreneurial ventures	Established corporations
Internal characteristics	• Non-financial incentives and non-economic rationality in decision-making • Integration between owners and managers • Large fluctuation in performance over time and extensive risk of failure (high risk)	• Maximising shareholder's value and economic rationality in decision-making • Separation between owners and managers • Established corporations do fail, but the risk is not as ever-present as in entrepreneurial ventures.
Financial market characteristics	• No well-functioning capital markets (imperfection) • Access to external capital is relatively expensive	• Well-functioning capital markets, including debts and equity capital, with competing actors who have equal access to information
Relationship to external capital providers	• External capital providers have imperfect information about the venture	• Accurate information is available for banks and external capital providers
Internal finance	• Heavily dependent on internal source of finance, for example, entrepreneur's saving, private credit cards and internally generated funds	• Retained earnings are an important source of finance
External finance	• Limited access to external finance. Access to only a part of the capital market. Banks are usually the only external capital provider	• Multiple sources of external finance are available both on national and international levels

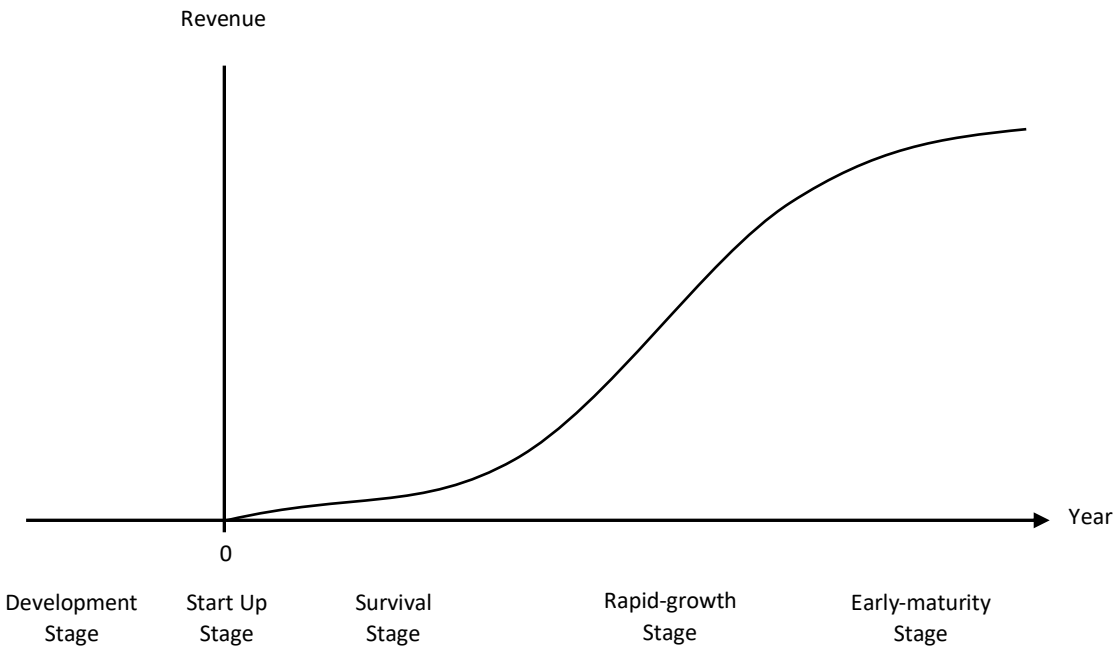
2. *Characteristics of entrepreneurial finance: Stages*

2.1. What is the venture life cycle?

As explained in the previous section, entrepreneurial finance is characterised as the two dimensions of 'process' and 'particularities.' As far as process is concerned, many textbooks dealing with entrepreneurial finance introduce the concept of 'venture life stage' or 'venture life cycle'. Leach and Melicher (2016) provide an excellent explanation of the 'venture life stage,' which refers to the stages of a successful venture's life from development through various steps of revenue growth. In addition to that definition, they introduce the detailed classification of the stages as follows: Development stage, Start-up stage, Survival stage, Rapid-growth stage, and Early-maturity stage (see Figure 1).

Before a start-up or new venture is created, the entrepreneur usually finds a new business idea and attempts to develop it as a product or service. This stage should be called as the 'Development stage' or 'Start-up stage,' according to Leach and Melicher. The former refers to the period involving the progression from an idea to a promising business opportunity, and the latter refers to the one when the venture is organised and developed and initial revenue model is put in place. Through the following 'Survival stage,' the revenue from the business increases at a high rate and it reaches to the peak. The final stage is called as 'Early-maturity stage' (also see Table 2). That classification may be the most precise one so far, though other textbooks also introduce such a classification in a similar way (e.g. Leach and Melicher, 2016; Smith et al., 2011). Therefore, this dissertation is based on their classification.

< Figure 1 The successful venture life cycle (Source: Leach and Melicher, 2016) >



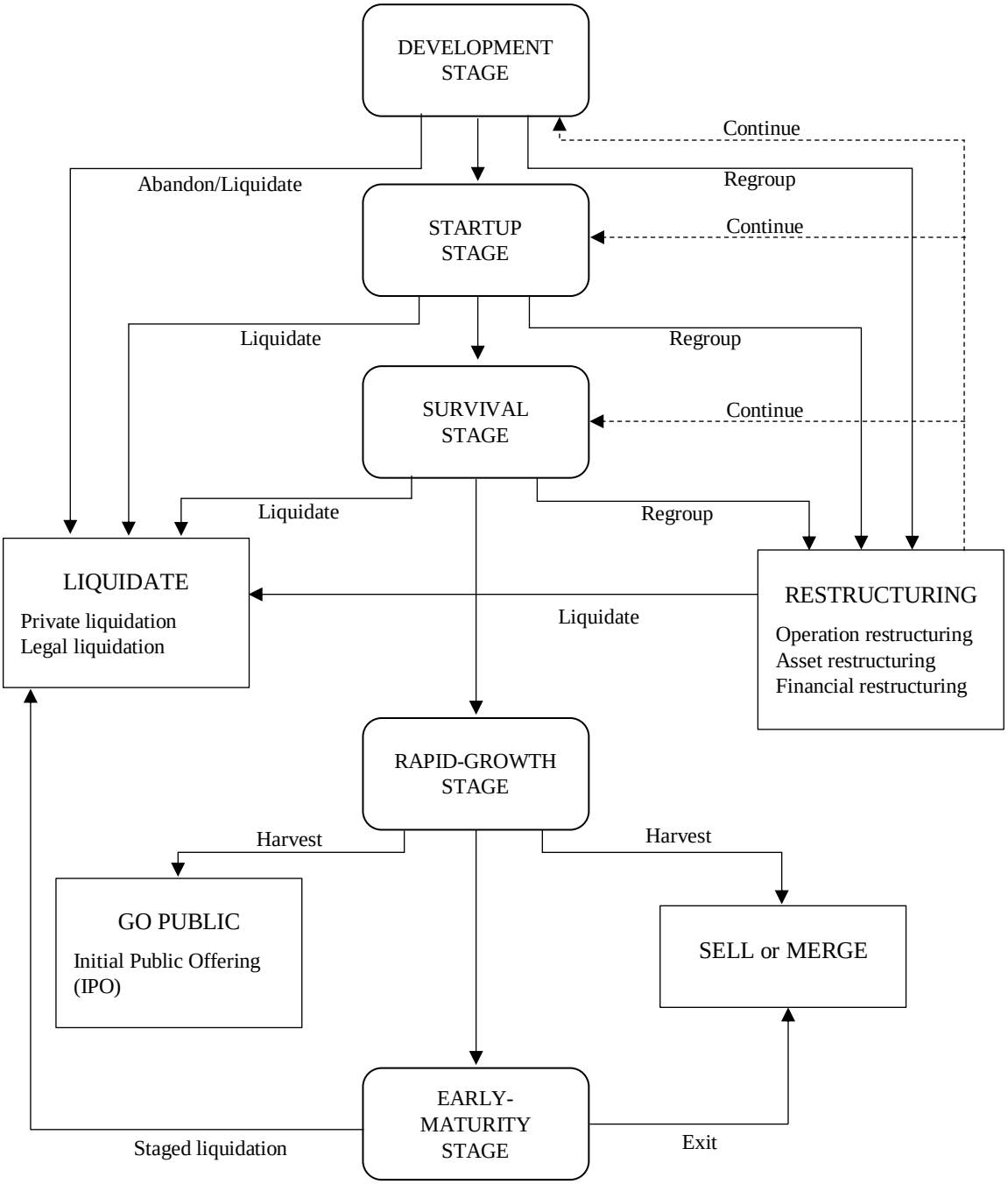
< Table 2 The venture life cycle (Source: Leach and Melicher, 2016) >

Life cycle stage	**Life cycle entrepreneurial process activities**	**Types of financing**	**Major sources/players**
1. Venture Financing			
Development stage	Developing opportunities	Seed financing	Entrepreneur's assets Family and Friends
Start-up stage	Gathering resources	Start-up financing	Entrepreneur's assets Family and Friends Business angles Venture capitalists
Survival stage	Gathering resources, Managing and building operations	First-round financing	Business operations Venture capitalists Suppliers and Customers Government assistance programs Commercial banks
Rapid-growth stage	Managing and building operations	Second-round financing Mezzanine financing Liquidity-stage financing	Business operations Suppliers and Customers Commercial banks Investment bankers
2. Seasoned Financing			
Early-maturity stage	Managing and building operations	Obtaining bank loan Issuing bonds Issuing stock	Business operations Commercial banks Investment bankers

2.2. Stages derived from the venture life cycle

One of the reasons why this kind of classification by stages is widely accepted and discussed especially in the field of entrepreneurial finance is that financing and investment issues are specific for each stage. As the revenue grows, in other words, as the business becomes larger, the internal organisational structure has to change. At the Development or Start-up stage, only the entrepreneur him/herself, or a few actors in some cases are operating the company. As the business grows, the organisational structure would become complex with more employees. At the same time, the characteristics of the financing and investment issues also become different in each stage. At the Development stage or Start-up stage, it is not uncommon that few investors are willing to offer funds to entrepreneurial projects and the entrepreneur often relies on his / her family and close friends. The entrepreneur has sometimes no other choices as a financing (or investment) option than using his/her own pocket money or soliciting for funds to relatives. However, as the business grows, the company may attract more attention from investors and some might be willing to provide funds. At this point, the entrepreneur can even choose prospective providers of funds and negotiate with them. In this way, the classification by stages makes sense to be a general model of the process of start-ups and ventures in entrepreneurial finance. The differences and features of financing and investment issues in each stage are well summarized by Leach and Melicher (see Figure 2 and Table 2). We can recognise that each stage has its unique issues to be resolved, and all are equally important. This dissertation contains three articles in Part Two, and each article deals with a stage of the classification and tries to provide solutions and suggestions to both entrepreneurs and investors for realising better financing negotiations.

< Figure 2 The life approach (Source: Leach and Melicher, 2016) >



2.3. How should entrepreneurial firms be characterised?

As a company progresses through the different stages of the classification, it differs in respect to its size and organisational structure. Consequently, we need to characterise and name companies for each stage. Different names are used in the literature: e.g., young firm/company, start-up, venture, SMEs (small and medium enterprise), private firm/company (privately held firm/company), or family firm. All these names correspond to different contexts and we will make a distinction. However, no common definition has been agreed upon in academic research. In fact, some terms such as 'young firm,' 'venture' and 'start-up' are used interchangeably, and the term 'venture' is often used to represent all the names listed above.

However, as discussed, the characteristics of a firm vary in each stage, and the terms should be distinguished. In fact, it is better to have a clear image of the firm's characteristics as there exist definitive distinctions amongst the terms. In particular, 'start-up' has a clear definition, and it could hardly be confused with a publicly traded large company (or listed company). On the other hand, many academic papers dealing with the issue of exit strategies in the later stage do not use the term 'start-up' but 'venture' (see. References for Part Two). Therefore, this dissertation tries to create an ambitious distinction of these two terms, 'start-up' and 'venture', which is based on the stages classification as follows:

'start-up' refers to an entrepreneurial firm that is progressing from the 'Development stage' toward the 'Survival stage.'

'venture' refers to an entrepreneurial firm that passes the 'Survival stage' and enters into the 'Rapid-growth stage' or later.

Those different terms have a common focus on the entrepreneurial dimension. As it will be explained in the next subsection, the term 'SME' is sometimes used for representing a small firm run by a family or a small business which is tightly regulated. These types of business do not focus on entrepreneurship explicitly and usually do not undergo through a strong growth. Consequently, we will implicitly distinguish these firms from the ones, which change habitual business situations or have a propensity

toward innovation. We also do not use terms such as ‘young firm,’ ‘small firm’ and ‘private firm’ because ‘young firms’ do not necessarily aspire to a rapid growth, and ‘private firms’ are always oriented towards innovation. In particular, this dissertation focuses on the aspect of entrepreneurial finance, thus the company should be oriented towards entrepreneurship conceived as an innovation-oriented process to enhance the company’s growth. Although there is no clear evidence nor any shared agreement, the other terms (different from ‘start-up’ and ‘venture’) do not express this sense of entrepreneurship. We demonstrate that the terms ‘start-up’ and ‘venture’ convey the sense of entrepreneurship explicitly. Therefore, this dissertation will adopt only these two terms hereafter, and avoid using other terms which indicate the similar meanings of ‘start-up’ and ‘venture’.

3. Characteristics of entrepreneurial finance: Risk

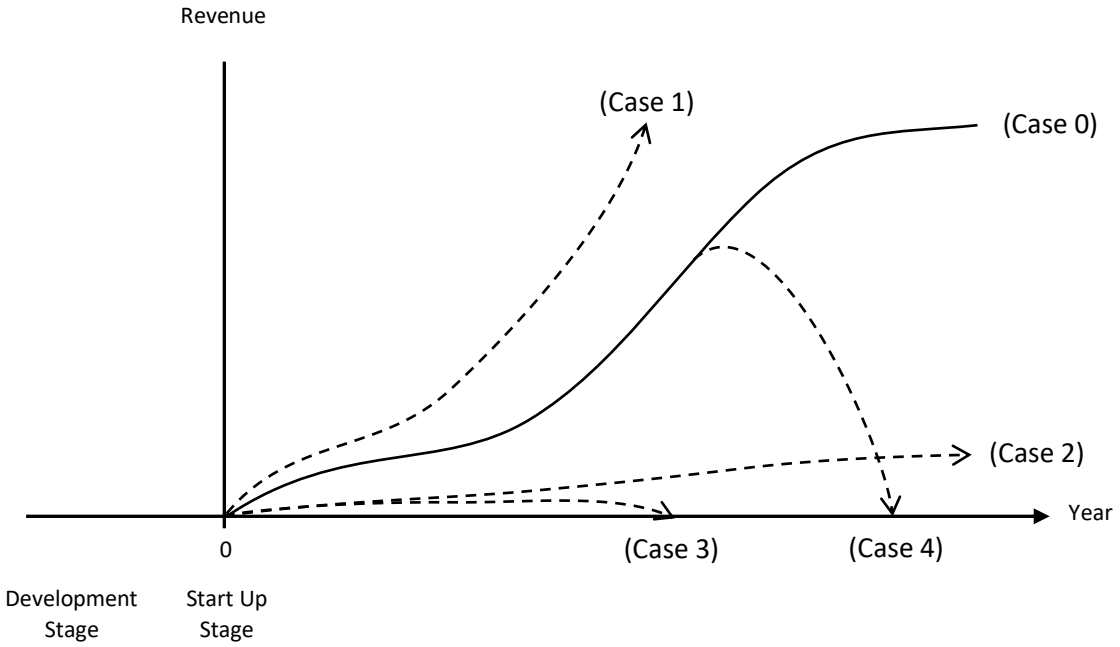
3.1. ‘Unsuccessful’ trajectories in the venture life cycle

While the classification discussed in the previous section is widely accepted, we should be aware of an important assumption in it; it is assumed that ventures will expand their business successfully and increase their revenues. In particular, the growth period is often called as ‘Rapid-growth stage,’ according to the explanation by Leach and Melicher (2016). The ‘Rapid-growth stage’ refers to the period when revenues and cash flows from operations increase very rapidly. In fact, start-ups in this stage have successfully passed the previous ‘Survival stage’ and obtained substantial gains in the market share whereas companies, which have not reached this stage are struggling. Unfortunately, such a favourable situation does not always occur. In fact, most start-ups cannot put their projects and/or businesses on the trajectory that was planned before launching. Figure 3 shows some examples of trajectories.

Case 0 is supposed to be the ideal trajectory of the successful venture life cycle as explained by Leach and Melicher (2016). The start-ups, described in Case 1, will grow more rapidly than the ideal case. Case 0 is not impossible but quite rare. Those would sometimes be called as “unicorn” in the Silicon Valley. On the

contrary, Cases 2, 3 and 4 are the most likely. Case 2 represents the trajectory of the start-ups which have a steady business activity and revenues, which increase quite slowly or remain flat. This trajectory cannot be considered as unsuccessful or a failure. In fact, such firms can be seen everywhere and this situation is not uncommon for SMEs. For example, a pharmacy can often be classified as an SME but not as an entrepreneurial venture as several statutory regulations constrain its business form and prevent it from innovating. Furthermore, SMEs do not always have an objective to enlarge the size of their business in a short time. Family-run wineries, for example, place the conservation of their long traditions in the centre of their value and control their business size, rather than expanding their business to increase their sales. Therefore, firms that follow or aim at the trajectory of Case 2 are not classified as start-ups in this dissertation. On the other hand, Cases 3 and 4 should be regarded as the cases that can usually be observed when considering the trajectory of venture life cycle. Case 3 would be observed most frequently. It deals with the start-ups that could not achieve the expected goals at all and must choose to wind-up their project or business. Case 4 shares similarities but is different from Case 3. The start-up grows and the revenues increase as expected in the earlier stages. However, it fails at the later stage due to some accident, for example. A biopharma venture that seeks to sell a new drug exemplifies the trajectory of Case 4. It is not so uncommon that a drug candidate (chemical compound) would not be approved by the authority at the final phase and the company would fail to release it in the market, though the biotech start-up would have actually succeeded in finding and developing a product at the expense of huge amount of time and money.

< Figure 3 The ‘unsuccessful’ venture life cycle (based on Leach and Melicher, 2016) >



3.2. The concept of risk versus uncertainty

Those cases description show that the probability of success of entrepreneurial business is quite low. According to Landström (2017, p.9), “*Lending money to or investing in an entrepreneurial venture involves a certain degree of risk and uncertainty. We also know that new ventures are at higher risk of default than established businesses, and a large proportion of new ventures never experience their own five-year anniversary.*[3] ” In other words, the concept of ‘risk’ and ‘uncertainty’ should be placed as one of the central issues related to the ‘particularities’ of entrepreneurial finance, and it also should be regarded as the main characteristics.

[3] In this sentence, ‘new ventures would include both start-ups and ventures defined in 3.3.

The terms ‘risk’ and ‘uncertainty’ are not differentiated in common language. According to the Cambridge English Dictionary, ‘risk’ is defined as “the possibility of something bad happening” or “If you risk something important, you cause it to be in a dangerous situation where you might lose it.” ‘Uncertainty’ is defined as “a situation in which something is not known, or something that is not known or certain,” as well. Nevertheless, ‘risk’ as financial glossary does not necessarily signify something ‘bad’ or ‘danger.’ Both practitioners and academic researchers agree on common definitions of those terms, especially in the field of corporate and market finance.

The main distinction between ‘risk’ and ‘uncertainty’ is the fact that risk can be measurable. Actually, if the probability (distribution) for each future event or outcome can be allocated, the situation or state which we want to understand becomes measurable (or known) and it is called ‘risky.’ Otherwise, as it is not possible to capture the feature with mathematical probability distributions (or unknown), the situation is characterised as ‘uncertain.’ The origin of the definition comes from an idiosyncratic economist Frank Knight (1921) who was the first to distinguish ‘risk’ from ‘uncertainty.’ In his 1921 book, “Risk, Uncertainty, and Profit.” He wrote that “*there is a fundamental distinction between the reward for taking a known risk and that for assuming a risk whose value itself is not known. (p.21)*” Whether the risk is ‘known’ or ‘not known’ is of great importance. “A known risk” in this context can be rephrased into effectively measurable with mathematical equations and/or probability distributions, while “true uncertainty” is not susceptible to measurement. The latter is known as ‘Knight uncertainty.’ This distinction becomes significant for financial practitioners. Technically speaking, it is impossible to allocate the probability to each outcome in ‘uncertain’ situations, and any quantitatively manageable method (by using a mathematical model) is unenforceable. Thus, it means that there is no way for human being to manage it. On the contrary, we can manage ‘risky’ situation even though being not for sure. In particular, financial risk managers who are working with mathematical models every day because these models are based on the assumption that the application of some probability distributions (normal distribution is often adopted) can quantify the complex market movements that appear to be completely random. If the movements are not supposed to be risky but uncertain, they would be almost impossible to apprehend and we cannot predict them.

The distinction by Knight is quite well-grounded, and thus, both financial practitioners and economists follow his argument. Friberg (2015), who is a professor of industrial organisation, states in his book that "we define 'risk' as the randomness of a variable that can be reasonably described by an objective probability distribution" and "as noted in the introduction, we follow Knight (1921) and rely on the distinction between risk and uncertainty." It is worth mentioning that risk and uncertainty are not always mutually exclusive. Friberg (2015) demonstrates it with the examples of industry analysis, as shown in Table 3. He explains that all businesses normally contain both characteristics of risk and uncertainty and it is essential to consider which characteristic should be focused when analysing the businesses.

< Table 3 Matrix of risk and uncertainty with examples (Friberg, 2015, p.10) >

		Uncertainty	
		Low	High
Risk	Low	• Local bus service with a regulated monopoly	• Pharmaceutical products • Informational technology
	High	• Raw material extraction • Farming	• Airplane production

He continues: "*Local bus service with a regulated monopoly in a stable regulatory environment will have few risks and uncertainties to ponder. (p.10)*" It is normal that state-run or strictly regulated businesses have stable cash flows, thus both risk and uncertainty are quite low. "*A firm engaged in extraction of raw material or farming of a volatile cash crop may find profits highly variable. (p.10)*" These kinds of businesses have some risks of the exact amounts of outcome. However, it is risky but not uncertain because 'the oil is there' or 'the wheat will be harvested in the autumn' has already been known, for example. On the other hands, the examples which are classified as 'High uncertainty' are different. As Friberg explains, "*A pharmaceutical firm, costs may largely consist of wages that are stable, but new competing products or surprises at the late stages of medical testing may induce dramatic shifts in profits. (p.10)*" "*Consider competition in wide-bodied aircraft between Airbus and Boeing. Uncertainty is linked to technical problems for own models or those of the competitor, and there is also strategic uncertainty related to that*

your profits depend closely on the actions of one competitor. The outcomes of negotiations with a handful of large customers are another source of uncertainty, as are possible changes in environmental regulations, in addition, exchange rate swings can make or break the profit margin. (p.10)" These examples include something which cannot be known beforehand, and thus, these should not be classified as risky.

3.3. Risk in the context of entrepreneurial finance

Friberg's explanation gives us an insight for better understanding risk and uncertainty in the context of entrepreneurial finance. It is true that they are normally distinguished clearly especially in financial risk management as it is by nature relatively easy to encompass the concept of risk and uncertainty. Consequently, by distinguishing these two concepts, this field of study succeeds in expressing quantitatively different outcomes and provides better management methods. On the contrary, the businesses in non-financial sectors actually include both characteristics of risk and uncertainty and sometimes it is difficult to differentiate them. This concerns particularly all entrepreneurial firms. However, practitioners do not distinguish between risk and uncertainty and these two seem to be used interchangeably even in some academic papers. One of the reasons may be that the managerial suggestions or practical consequences would not differ even though we differentiate between risk and uncertainty. For decision makers or managers, such a strict theoretical distinction might not even make sense. However, it does not mean that we can mix up these two concepts in entrepreneurial finance. When paying attention to the theoretical aspects in order to capture the unique features of businesses, it is necessary to apprehend the specificities of situations. As Friberg (2015) exemplifies, the risky and uncertain aspects should be specified when possible, even if they are hard to distinguish. Moreover, if we could identify the risky aspects, especially from the businesses of start-ups and ventures, we would likely be able to introduce a quantitative model for better capturing the features of the businesses. Furthermore, as far as the information asymmetry issue (introduced in the next section) is concerned, the assessment and dealing with 'risk' are meaningful as it would become impossible to manage information asymmetry if we assume that the situations were completely 'uncertain.' Although many academic researchers seem not to distinguish the two concepts so clearly, this dissertation is focusing on 'risk' rather than 'uncertainty,' and is trying to establish quantitative models in Part Two.

As we intend to define the concept of 'risk,' as the probability of winning or losing something worthy, it is noticeable that the definition of 'risk' in finance should take both upside and downside possibilities into consideration. For example, McNeil et al. (2005) define 'risk' as "mostly only the downside of risk" and, rarely a possible upside, i.e. the potential for a gain. For financial risks, which are the subject of the book quoted above, we might arrive at a definition such as "any event or action that may adversely affect an organization's ability to achieve its objectives and execute its strategies" or, alternatively, "the quantifiable likelihood of loss or less-than-expected returns". While this captures some of the elements of risk, no single one-sentence definition is entirely satisfactory in all contexts. Taking into consideration both upside and downside possibilities would make it possible to better explain the features that are described in Figure 3. The project or business of a start-up sometimes grows more than the entrepreneur had expected, and conversely, we can also often observe that it turns out to be unsuccessful. In short, nobody can know whether a start-up will grow as successfully as predicted. That perspective leads us to consider the Real Options Analysis, and to apply it, which will be explained in the section VI. We first define information asymmetry and relate it to risk then we explain the contributions of the real option analysis.

4. Characteristics of entrepreneurial finance: Information asymmetry

Together with the concept of risk and uncertainty, entrepreneurial finance has another major problem to be scrutinised: information asymmetry. As introduced by Smith et al. (2011) in the previous section, one of the eight distinguishing features between entrepreneurial finance and corporate finance is that "The substantial effects of information problems on the firm's ability to undertake a project." Many recent academic papers pick up the information asymmetry problem as one of the major issues in entrepreneurial finance, and as a unique feature distinguishing it from traditional corporate finance (e.g. Bellavitis et al., 2017, Cumming et al., 2019).

4.1. Origin of the information asymmetry problem in market finance

The theory of information asymmetry comes from the researches carried out in the 1970s by the following famous economists: Akerlof (1970), Spence (1973), and Rothchild and Stiglitz (1976). They particularly focus on economic transactions through market mechanisms. Akerlof, Spence and Stiglitz received the Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel, in 2001, "for their analyses of markets with asymmetric information." In short, the theory proposes that the imbalance of sharing information between buyers and sellers (especially financial securities, such as stock) could cause the inefficiency in the financial markets. In this theory, "inefficiency" means so-called market inefficiency (or the opposite term "market efficiency" is often utilised). This concept was developed from the 1960s to the 1970s mainly by another famous economist Eugene F. Fama. Market efficiency refers to the degree of the usage of information for market participants to determine the price of financial securities. When the market is efficient, the information available is fully incorporated into the decision-making process of buyers and sellers in the market (or participants), and it is reflected completely in the price of the securities that are being transacted. If the market is inefficient, the price that emerges in the market does not reflect all the information available. As a consequence, the market participants may lose their willingness to buy and sell financial securities, and the market may not be able to bring out its full potential for active transactions. In this dissertation, information asymmetry is conceived as an imbalance of sharing information. When the material information is not shared equally, some have more information and the others have less. Then those who have more information are willing to go into transaction, while those who have less are not willing to do so. Thus, the transaction might not be completed. This dissertation also focuses on this possibility of failure of transaction.

4.2. The problem of information asymmetry in entrepreneurial finance

The idea proposed above by Fama is called "the efficient market hypothesis (or EMH)." Whether the market is efficient or not has not yet clearly been proved, and it is still a "hypothesis." The participants in financial markets can be assumed to form large organisations and an individual is not considered as a price-maker but as a price-taker. In addition, the recent development of internet or other related IT

technologies can "*lead to low-cost or even free access to information*" (Hauswald and Marquez, 2015, p. 921), and information will be shared among market participants. Even if an individual owns sensitive information relative to the price of securities, such information can be immediately incorporated into the price. Fama explains that this situation refers to the efficient market. In this efficient market, the issue of information asymmetry might not be significant nor be worth considering because all the market participants can share the information equally.

Then, is it possible to think that this problem of information asymmetry would be insignificant in entrepreneurial finance? We are going to demonstrate that the answer is negative. Such an argument could be held only in some areas of market finance and traditional corporate finance. As mentioned in the previous section, the corporate finance setting is quite different from the entrepreneurial finance setting. The tools and concepts of corporate finance cannot be directly applied to entrepreneurial process. Looking back to Table 1, the financial market characteristics are imperfect for the entrepreneurial finance setting, and thus, external capital providers inevitably have imperfect information about ventures. The imbalance of information sharing among entrepreneurs and external capital providers does exist. There are usually few participants in transaction, and the information that an individual owns could have a great impact on the outcome of the decision-making. To borrow the explanation of Landström (2017, p. 10), "*the market information available about new ventures is normally very limited in both scale and accuracy. The entrepreneur is more likely to be better informed about his/her venture than external capital providers but is often reluctant to fully disclose information about the venture. Thus, we can assume that it is difficult for external capital providers to ascertain the quality and potential value of a new venture*". As it happens that some information is possessed only by one side of the transaction parties, the probability that a transaction is not done would increase more significantly than in the case of market finance and corporate finance. As Landström states: "*this is particularly true in the early stage of venture development and in ventures that have a large knowledge base and new aspects of doing business, in which entrepreneurs might have a great deal more knowledge about their own venture. (p.10)*" For technology-oriented start-ups, in particular, their core technologies and know-how are top secret and vital lifeline. It is normal that they tend to strongly refuse to unveil them even when they enter into negotiations to obtain external funds. Consequently, from the discussions above, we can understand that the problem of information asymmetry is critical in entrepreneurial finance. Actually, several academic researches dealt with this problem as a

central matter. For example, Casamatta (2003) discusses the moral hazard problem whereby two agents (entrepreneur and venture capitalist) must exert effort to improve the probability of a venture. She concluded that *"without moral hazard, it is optimal that both exert effort. With moral hazard, if the entrepreneur's effort is more efficient (less costly) than the advisor's effort, the latter is not hired if she does not provide funds. (p.2059)*"

Even though entrepreneurs and investors often face the problem of information asymmetry, this topic is rarely addressed as a central matter in practice. While negotiating financing contracts, licencing agreements or even merger and acquisition, and so on, entrepreneurs or investors often face such problems. However, few practical oriented textbooks about entrepreneurship and entrepreneurial finance address this issue as an independent chapter or as one of the main topics to be considered. On the other hand, the issues related to risk (and uncertainty in some cases) have been well recognised as central for practical decision-makings concerning financing and investment into start-ups and ventures, and some specific financial tools, such as convertible bonds are adopted. One of the reasons could be that risk has relatively a higher affinity for mathematics than the information asymmetry problem. Nevertheless, both issues are equivalently important and must be equally considered. Consequently, this dissertation tries to establish quantitative models dealing with both issues simultaneously in the second article in Part Two. We have presented the main concepts of this dissertation. In the next part, we explain the main problem of this dissertation.

5. Contract negotiation: A Central issue in this dissertation

As explained in the previous section, the three key concepts, 'Stages', 'Risk' and 'Information asymmetry,' are essential concepts in this dissertation. Actually, the concept of 'Stages' is quite popular among entrepreneurs and investors, such as business angels and venture capitalists. Then, the subjects of 'Risk' and 'Information asymmetry' are often dealt with in the fields of traditional corporate finance and market finance. The literature allows us to understand the mechanisms, structure, and relationships among corporate managers and/or market participants. However, these topics are not directly applicable to

entrepreneurial finance because, although corporate finance and entrepreneurial finance share similarities, they are different as mentioned above. Rather, contract negotiation should be a topic of interest for entrepreneurial finance. Regardless of the type of businesses, negotiations for contract agreement are quite frequent in practice. However, the mechanisms of contract negotiation have not been well-studied in academic literature so far, and it has become popular as a new research area (e.g., Cumming et al., 2019). Consequently, we are going to detail recent developments about contract negotiation in entrepreneurial finance.

5.1. Closing up the negotiation aspect

In traditional corporate finance settings, the participants of financial transactions are often assumed to be anonymous. Similarly, the same logic presumes that market participants are just depersonalised price-takers because the stock in the secondary market is thought to be freely transacted and the shareholders are supposed to change very frequently. On the contrary, in entrepreneurial finance settings, it is not the case. As mentioned above, investments in start-ups and ventures do not often take place in the open market like the New York Stock Exchange. Rather, the transactions tend to be executed closely in many cases. One of the good examples is that when early stage start-ups call for investment, so-called 'angel investors' (or simply 'angels') who are often the expert of the same industry become interested in the business model and would usually begin a face-to-face negotiation about financing with the entrepreneurs. These start-ups are not listed yet and their equity shares are not available to the public. For the investors who want to buy the stock of the listed companies, they must comply with well-established regulations. Such financial transactions are well-standardised and regulated by the authorities, and there is almost no room left to negotiate for prospective investors. However, the negotiations about the financing or investments into start-ups or ventures are usually fulfilled through the direct and private negotiations between entrepreneurs and investors, and are specific. Such negotiation procedures toward the financing contract are not always well-standardised. These are completely different from the ones that occur in the cases of equity investment agreements with large investment banks. Therefore, the negotiation aspects must be considered in entrepreneurial finance.

5.2. Contract negotiation in entrepreneurial finance

The discussion above suggests that the entrepreneurial finance setting requires different viewpoints, principles and mechanisms from traditional corporate finance or market finance. More particularly, it requires an examination of contract negotiation specificities. 'Contract negotiation' is not a technical term but a word in general use, though we often encounter it in business. The goal is for an agreement to be made that is beneficial to all involved parties. Discussions may go back and forth among parties until all points have been agreed upon. The end goal is an arrangement that is both fair and equitable to each party" (http://www.businessdictionary.com/definition/contract-negotiation.html). The meaning of contract negotiation in entrepreneurial finance does not differ from the daily usage. Rather, the latter explanation covers the whole process in the context of entrepreneurial finance. Similarly, the financing and investment in start-ups and ventures aims at signing an agreement that is beneficial to all involved parties. Consequently, the phrase of "both fair and equitable to each party" in the last sentence is critical. As discussed in 1.1. above, entrepreneurs and investors should not be treated as anonymous but as independent individuals whose characteristics are unique and visible. Bargaining powers during negotiations is not equal. In particular, the entrepreneur has usually less options to access funds (e.g., start-ups cannot usually access the financial market directly), and must ask for financing to investors, such as angels and/or venture capitalists individually. The entrepreneur is generally less well-positioned to take advantage of the situation than investors. In addition to the lack of funds, the entrepreneur is struggling to find solutions for proceeding in the entrepreneurial project and business. As Casamatta (2003, p. 2060) discusses, "*Entrepreneurs endowed with the creativity and technical skills needed to develop innovative ideas may lack business expertise and need managerial advice… even if the entrepreneur is not wealth constrained and could himself fund all the initial investment, he chooses to obtain funding from the advisor, thus relying on VC advising rather than on consultants… Of course, when the entrepreneur's wealth constrained, VC financing is all the more desirable.*" The entrepreneur must ask for the advice or suggestions to the fund providers, such as venture capitalists. Thus, ensuring fairness and equitable conditions are essential during the contract negotiation in entrepreneurial finance, as being highlighted in contract law.

In the field of legal study, the contract law has a long history and is highly referred to in both academic and practice. Many countries have their own established legal resolution system corresponding to a variety of conflicts related to contract negotiation, and it usually works well not only in business but also in daily life. Nevertheless, the economic and/or financial aspects have not been well studied yet. Thus, in 2016 Oliver Hart and Bengt Holmström were the first ones who were awarded the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel "for their contributions to contract theory." Their contributions to contract theory are not necessarily market-oriented but focus on the activities and interactions among individual economic agents when making contract. Even though the contract theory is not directly market-oriented, it has been developed on the basis of traditional microeconomics and corporate finance (Bolton and Dewatripont, 2005; Hart, 1995). Thus, it cannot sometimes be applied directly to the negotiation of contract in entrepreneurial finance and some modifications along with the context of financing negotiation may be necessary. Still, the economic and/or financial aspects of individual interactions are essential when considering contract negotiation. Thus, it is all the more to be pushed forward. Therefore, this dissertation will incorporate this aspect and contains the following four key fundamental concepts:

- *Stages,*
- *Risk,*
- *Information asymmetry,*
  and
- *Contractual negotiation*

5.3. Principal-agent problem in contract negotiation

As we introduce the aspect of contractual negotiation, an additional topic has to be dealt with. This is the so-called 'principal-agent problem' in economics. In the traditional corporate finance setting, it can be expressed by the question of "for whom should the value of the firm or project be maximised?" In the relationship of principal-agent, generally speaking, an agent is expected to act for the benefits of the principal, and the legal effects and consequences by the agent generally belong to the principal. However, the agent does not always act in line with the benefits for the principal. The agents sometimes act for their

own benefits at the expense of the principal's losses. Thus, it becomes 'problematic.' For publicly traded companies, the equity shareholders (investors) stipulate the owner's status pro rata to the number of shares they hold, and the separation of ownership and management is normal in such companies. The relationship between shareholders and managers can be expressed as principal and agent in a clear manner. Shareholders correspond to the principal, and the managers to the agent, respectively.

On the other hand, in the entrepreneurial settings, the separation of ownership and management is not usual. In addition, the relationship between the manager in start-ups or ventures and the investor cannot be described as clearly as the one in the traditional corporate finance setting. Thus, the answer to the question above is not an easy one in entrepreneurial finance. The investor or prospective equity shareholder would say that the answer is "for us, as is in the case of listed companies" and the entrepreneur would also say that the answer is "for us, too, because we are not your agent." With regard to this matter, for example, Smith et al. (2011) stand by the thought that the objective of entrepreneurial finance is to maximise the value for the entrepreneur. They also say that their thought is consistent with Schumpeter's one, stating that the entrepreneur's motive is to make the entrepreneur better off. The following counterargument could be possible: "How about the objective for social entrepreneurs?" Smith et al. has already given the answer. They are insisting that "*Similarly, it makes sense to view the social entrepreneur's objective as maximizing value. While social ventures may be designed to create significant value for society, the venture still generates earnings for the entrepreneur and residual cash flows (which are not called profits) that the entrepreneur can use. (P.13)*" Their argument is just one perspective among others. This dissertation, however, stands by Smith et al.'s perspective as it is logical that the entrepreneur should be treated as an 'homo economicus' who wishes to maximise the amount of funds that could be provided at least at the moment of the negotiation on investment and financing. This means that he/she acts for himself/herself. In reality, the monetary remuneration or compensation is essential to continue his/her business regardless of his/her ultimate goal. This principle-agent problem related to the financing issue is particularly discussed in an application proposed in II in Part Two from the perspective of entrepreneurial finance.

Complementary to the principal-agent issue, the incentive problem has also to be addressed. In general, a contract is essentially aligned with the participants' incentives. This means that strategically thinking is

required simultaneously. As often discussed in the field of game theory for example, strategic thinking by nature aims to maximise or optimise the consequence that the participants desire, and it is the other side of the same coin of the incentive issue in the context of contract negotiation (Game theory will be explained more in VI 4.1.). The incentive problem has been dealt with in the market finance and corporate finance settings. In contrast to those settings, the number of the investment or financing negotiation participants is limited, the negotiation is done on almost an equal footing, and the contract is negotiated on a face-to-face basis in many cases. The incentive for each participant has a great impact on the process in such a situation. Moreover, the incentive problem becomes closely linked to the issue of information asymmetry especially in entrepreneurial finance settings. Although few academic researches explicitly target the issues of economic incentives and the design of contract so far, we should be aware that those issues are emerging everywhere in practice.

III. Main research question of this dissertation

As we have defined and explained the major role of the four fundamental concepts of risk, stage, information asymmetry and contract negotiation, this section aims to settle the grand research question of this dissertation. In order to deal with the financing issues specifically in the area of entrepreneurial finance, we need to determine the interrelationships among the four concepts. The contract negotiation is defined at the central issue which links the other three concepts. Thus, the research question should also be established along this idea. The following part starts with the relationships among the four concepts.

1. Interlinkage between the four key fundamental concepts

The four key fundamental concepts discussed above are not completely independent, rather they interlink with each other. Specifically, understanding the relationships between 'stages,' 'risk' and 'information asymmetry' is crucial in the context of entrepreneurial finance.

The concept of 'stages' is derived from the venture life cycle (see the section II.3.). Entrepreneurs propose some idea by creating the products and/or services and start a new business. After that, this life cycle assumes that the business grows successfully as the entrepreneur desires and increases the business revenue until the business reaches a so-called (early) maturity stage. However, this expected situation does not always come true, rather many businesses could not celebrate their fifth anniversary and disappeared. The report by Grant et al. (2019) states that the 5-year survival rate is around 10%. According to the survey in 2018 by the research company CB INSIGHTS, for example, only 48% of 1,098 US tech companies in the seed round could survive to a second round of funding in 2008-2010. In the third round, the survival

rate becomes 11%[4]. It means that roughly 89% of start-ups failed within 3 years. This situation can be described as 'risky.' (The interlink between 'stages' and 'risk' will be explained in the section II.4.)

The relationships between 'risk' and 'information asymmetry' can be related to the issues about financing and investment into start-ups and ventures. For both the investors who wish to invest in the publicly traded companies and those who have willingness to provide funds to start-ups and ventures, 'risk' is well-recognised as the source of economic returns because 'risk' has both aspects of gain and loss (see the section II.4.). For angels and venture capitalists, in particular, the expectation of future larger economic returns than the ones that can be expected by the equity investments into the publicly traded companies is one of the motivations to provide funds to start-ups and ventures (and often with their expertise and experiences). However, such an expectation is possible only after resolving the issue of information asymmetry, which is necessarily emerging with these investment transactions. The financial markets that are dealing with the investments into the equities of publicly traded companies have long histories and are well-regulated by the authorities, and the transactions are standardised. On the other hand, the transactions to provide funds for start-ups and ventures are not well standardised. The negotiations between the entrepreneur and investors are by nature direct and private in many cases because it is rare that the entrepreneur has the competence of accessing the financial markets directly, whereas the large listed companies are normally equipped, in general. Related to this difference, the degree of sharing information between the entrepreneur and investors should be taken into consideration. While the entrepreneur knows not only the pros and cons but also the prospects and limitations about their own business, investors cannot obtain so much information as the entrepreneur even if they have enough experience of the investments into start-ups and ventures in their familiar fields. Thus, the issue of 'Information asymmetry' between the entrepreneur and investors becomes more significant than the one in the case of equity investment in large listed companies (see the section II.5.).

As far as the financing and investment transactions in the field of entrepreneurial finance are concerned, there are several methods for resolving the 'information asymmetry' problem. The one that we use is 'staging,' and it allows dealing with both risk and information asymmetry with a financing method called

[4] cf. https://www.cbinsights.com/research/venture-capital-funnel-2/

as milestone or staged-financing. This method is common and well-recognised amongst both academic researchers and practitioners. Dahiya and Ray (2012, p. 1210) highlight that "*Staged financing is a fundamental feature of the venture capital market. VCs do not fund new ventures all at once, but instead deliver the investments in stages, forcing the project to clear a sequence of milestones in order to guarantee future funding. Not only is staged financing efficient, but it skews the allocation of investment towards later stages*". Their argument is constructed based on the assumption that staged financing is one way of protecting an investor from 'risk.' In reality, we can encounter the fact that this method is explained in almost all the books for entrepreneurs and other practitioners, such as venture capitalists, which deal with the topic of how to raise funds (e.g., Feld and Mendelson, 2016). In the academic literature, Neher (1999, p. 255) insists that "*Though efficient, financing the venture up front may be infeasible because the entrepreneur cannot commit to not renegotiate down the outside investor's claim once she's sunk her investment. Staging the investment over time helps to mitigate this commitment problem*".

As far as the relationship between 'stages' and 'information asymmetry' is concerned, the contract plays a critical role in order to resolve the information asymmetry problem. Wang and Zhou (2004, p. 131) argue that "*In particular, we show that when used together with a sharing contract, staged financing acts as an effective complementary mechanism to contracting in controlling agency problems*". The term "sharing" in this context means that private or even secret information is shared and the information asymmetry problem is resolved. The incentive problem is attached to contract negotiation (see the subsection 5.3.), and many research papers point out the importance of the analysis of the interrelationship between contract and information asymmetry problem. For example, Smith et al. (2011) suggest in their textbook that the contracting to resolve the incentive problems in entrepreneurial ventures plays a key role. The characteristics of contract negotiation and the ones of other three key fundamental concepts introduced in the previous section are a little bit different. Nevertheless, there exists a clear link between 'contract' and 'information asymmetry' problem (and also 'stages' and 'risk'). What the authors did so far is only pointing out the necessity of research, and the detailed solutions or actual resolution methods to be implemented are missing. Therefore, this dissertation is trying to achieve this objective in Part Two.

2. Setting the grand research question (central problem) of this dissertation

After introducing the key four fundamental concepts, the perspectives of this dissertation were explained in the section II. In the previous subsection, the interlinks among the four concepts was also shown. The three concepts, 'stages,' 'risk' and 'information asymmetry' are closely linked. On top of those, 'contract negotiation' should be settled as the central problem, especially when considering the financing and investment issues into start-ups and ventures. Considering the analysis of this kind of issues from the perceptive of entrepreneurial finance, we should shift our focal point from the principal-agent relationship in the traditional corporate finance setting to the negotiation that requires an equal footing among participants over the decision-making process. When considering such negotiations, their characteristics shall be switched from 'anonymous market participants/standardised transactions' to 'visible individuals/case-by-case negotiations.'

Now, one question arises: "What is the problem really worth being resolved in such case-by-case negotiations by visible individuals?" If we refer to the objective of traditional corporate finance, "Corporate finance is all about maximizing value", we could combine this objective with decision-makings of investment and financing, as Brealey and Myers (2013) state it. This dissertation argues that entrepreneurial finance should also be aimed at value maximisation, although the decision-making processes would be different. In traditional corporate finance, the value should be maximised mainly for shareholders. Conversely, value maximisation should be valid for both entrepreneurs and investors in entrepreneurial finance as the principle of separation of ownership and management is no longer adequate. From this standpoint, the central problem in the financing and investment into start-ups and ventures is "How can the values for both entrepreneurs and investors be maximised through negotiations?" Consequently, we can notice that quantitative evaluation methods become necessary in order to maximise values. Thus, the answer to the question above could be as follows: "the central problem for the financing and investment into start-ups and ventures is how to evaluate the consequences or outcomes of contract negotiations financially or quantitatively." More precisely, it is "How to build the models which can capture the properties of contract negotiation processes and express in a quantitative (mathematical) manner." As we can know by looking into the website of Google Scholar, for example, the main stream

of entrepreneurial finance research is empirical qualitative study, and the number of academic researches about the quantitative model building is limited (e.g., Bellavitis et al., 2017, Cumming et al., 2019). However, quantitative models and corresponding simulations shall be quite useful for giving managerial insights for all the parties concerned by the contract negotiation. Therefore, providing the quantitative models for financially evaluating the negotiation contract value is set as the primary objective of this dissertation.

As already known, traditional corporate finance has developed a variety of methods to measure financial value. The most famous and widely-used method is DCF method, which is applicable to the evaluation for both investment and financing processes. The IRR method is another one. The point is that the financial evaluation methods used in the traditional corporate finance (or market finance) settings, such as DCF and IRR, do not take the assumption that the expectation of the future cash flows in the investment decision process is relevant to the financing strategy. Investment decisions must not necessarily be closely linked to the question of how to obtain funds in large public corporations. Nevertheless, the process is different in the case of start-ups and new ventures. The question of where to invest is inseparable from the one of how to collect money. As mentioned before, in order to obtain funds, start-ups and ventures must explain their business models and prediction to prospective investors, thus the strategies related to how to obtain funds from investors should be tightly linked to investment strategies. This means that the DCF and IRR may not be immediately applicable to the financial evaluation in the entrepreneurial finance setting. There are some situations where these methods could be applicable directly. For example, when the prototype of some medical device has already been developed especially in the later stage, and the entrepreneur can show its sales prediction to potential investors, DCF or IRR is quite useful for evaluating this project. However, in situations where entrepreneurs must negotiate over the amount of funds with the potential investors on a future and risky project, is the direct application of DCF or IRR still useful for evaluating the amount of funds? As mentioned, the negotiation is characterised as face-to-face, and the value maximisation should be for both the entrepreneur and investors. In such a situation, how should we incorporate the other factors (such as the strategies for the next steps and the behaviour of the entrepreneur) to evaluate the value of the project? This mismatched utilisation of valuation methods is to be resolved, and this is one of the objectives of this research. Thus, another objective of this dissertation is to exemplify

in which situations the ROA can be used in the entrepreneurial finance setting, especially in the financing contract negotiation.

Then, summarising these kinds of questions, the grand research question (central problem) of this dissertation emerges:

< Main research (central problem) question >

How should strategic choices in contract negotiation be financially evaluated?

This question seems a little bit abstract. To discuss it in more details, three specific individual problems will be addressed and are described in Part Two. We propose to use a quantitative method other than DCF or IRR, which is quite suitable for analysing the strategic choices in general, the "Real Options analysis." In the next section, this methodology will be explained.

IV. The main method of this dissertation: Real Options Analysis

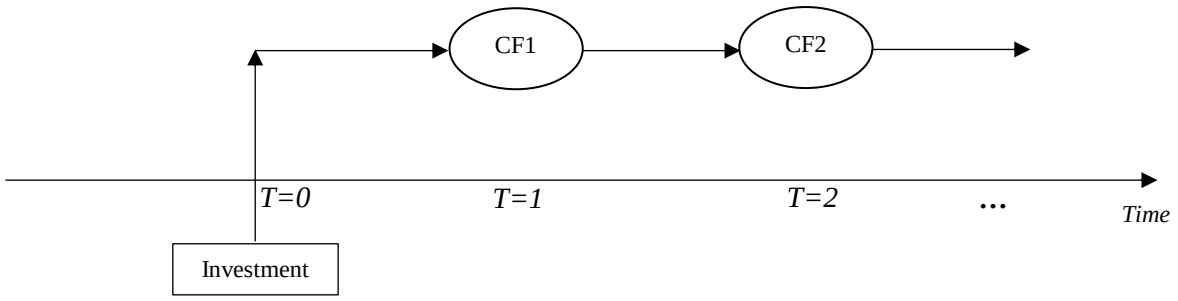
In this section, the details of the Real Option Analysis (ROA) are explained. Although this method is relatively new, it has been recognised these days. There are a lot of research papers using the real options, not only in finance but also in environmental economics, etc. (e.g., Chesny et al., 2016). We can also find several books especially for financial practitioners (e.g., Mun, 2016), which are based on this method. In addition, there is an annual international conference that is specialised for the ROA (see. http://www.realoptions.org/). Furthermore, the ROA is adequate in entrepreneurial finance to improve decision-makings related to financing and investment issues. The following sections define and explain the ROA.

1. What is the Real Options Analysis (ROA)?

In general, the 'real options analysis' is conceived as a financial evaluation method of business, project and investment by applying the concept of financial option. The real options may generally be recognised as the extended interpretation and application of the financial options. In fact, Hull (2015, p .792) says in his representative textbook of "Options, Futures, and Other Derivative that "*In this chapter (= the chapter for the real option), we explore how the ideas we have developed (= financial options) can be extended to access capital investment opportunities in real assets such as lands, buildings, plant, and equipment*". Then, we could explore further the concept. Myers (1977) pioneers works on real options. He wrote in the very first paragraph of his study: "*Many corporate assets, particularly growth opportunities, can be viewed as call options. (p.147)*" He also described: "*The value of the firm as a going concern depends on its future investment strategy. Thus, it is useful for expositional purposes to think of the firm as composed of two distinct asset types: (1) real assets, which have market values independent of the firm's investment strategy, and (2) real options, which are opportunities to purchase real assets on possibly favourable terms. (p.163)*" As this paper was published, there has been a surge of academic interest for real options.

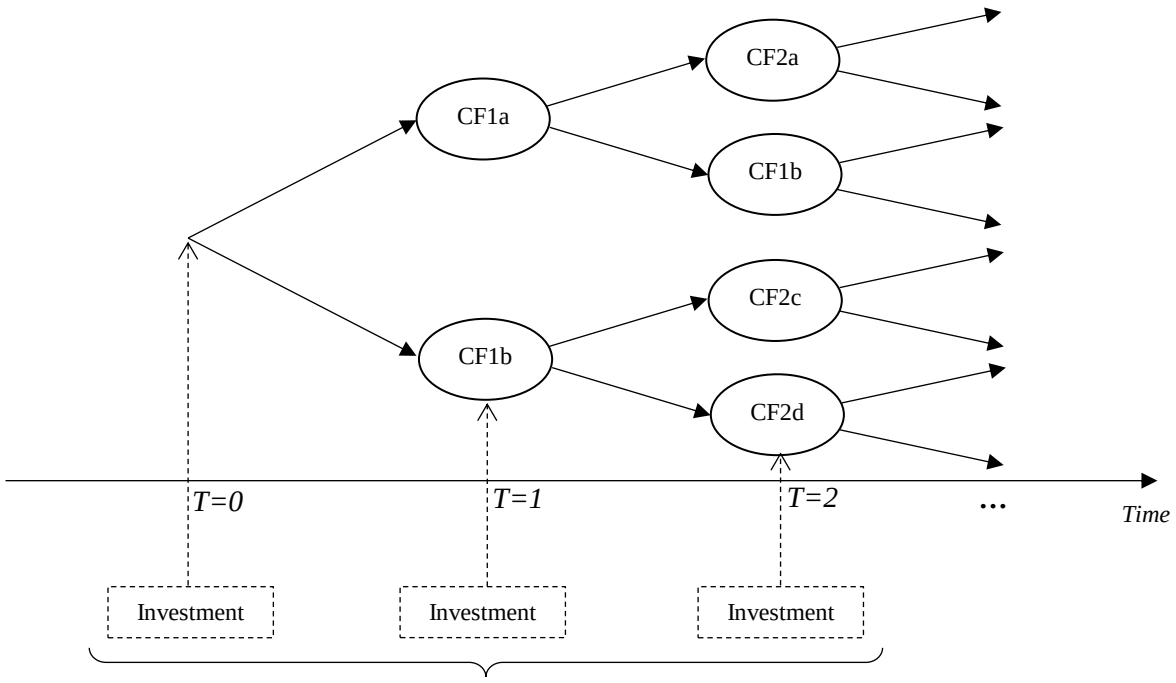
One of the breakthroughs that led real options to be widely recognised even in the practice may be the release of the famous textbook by Dixit and Pindyck (1994) that introduced the investment model. Their significant contribution would be the statement that "*it assumes that either the investment is reversible, that is, it can somehow be undone and the expenditures recovered should maker conditions turn out to be worse than anticipated, or, if the investment is irreversible, it (=the net present value rule) is a now or never proposition, that is, if the firm does not undertake the investment now, it will not be able to in the future. (p.6)*" They pointed out that the investment appraisal method generally accepted, which is the net present value rule (NPV rule) has some deficiencies. In other words, the NPV rule ignores the reversibility point of the business/project. In addition to that point, Dixit and Pindyck (1994) suggested to take into account the value of timing. According to their statement, "*There may be a cost to delay – the risk of entry by other firms, or simply foregone cash flows – but this cost must be weighed against the benefits of waiting for new information. Those benefits are often large. (p.9)*" As the proverb of "The early bird catches the worm," it is believed that one will have an advantage if he/she does something immediately or before anyone else does it. However, Dixit and Pindyck insisted that delaying an investment strategy is sometimes more beneficial than an immediate investment strategy. This concept is called as 'flexibility' which is the core characteristic of the ROA. These discussions are explained in the figures below.

< Figure 4 A representation of the net present value (NPV) rule >



Investment timing is 'now or never.'

< Figure 5 A representation of the real options >



Decision makers have the flexibility of the investment timing.

Figure 4 represents the NPV rule. (In Figure 4, CF represents the expected cash flow in each time node.) In the NPV rule, the prediction of the cash flows is executed first. Then it is interpreted as the backwardly sum of the present values (PVs) by using the discounted cash flows (DCF) method. Comparing the NPV and the investment amount, the investment would be done if the investment amount is greater than NPV. This valuation method is simple and understandable, thus, widely used both in academic and in practice even now. However, the problem is that the NPV rule is too rigid, and there is no room for flexible decisions. As Dixit and Pindyck argued, the investment timing is only 'now or never.' Conversely, the proposition of the real options is more sophisticated. First, the possible cash flows are expected in each time node. In figure 5, only two possibilities are represented but in fact, there may be three or more possibilities. Second, the mathematical expectation of the possible cash flows is calculated in each time

node. Then, these expectations are interpreted as the backwardly sum of the present values as is the same with the NPV rule. The main difference is that the investment timing is not 'now or never,' rather, flexible for the decision maker. The decision maker can choose the timing *T=0*, as well as *T=1* or *T=2*. It is sometimes better to wait until the timing *T=1*, or *T=2*, because the prediction becomes an actual condition and the decision maker could choose the more favourable one at that time node. In 2003, another famous textbook written by Copeland and Antikarov about the real options was published. The book by Dixit and Pindyck provided the continuous time model. The one by Copeland and Antikarov provided a discrete time model aiming at facilitating the practical use, as the subtitle of the book indicates it "a practitioner's guide." Copeland and Antikarov (2003, p .5) define the real options as "*the right, but not the obligation, to take an action (e.g., deferring, expanding, contracting, or abandoning) at a predetermined cost called the exercise price, for a predetermined period of time – the life of the option*". They described an important point that the real options are: "the right, but not the obligation." Although flexibility is the core characteristic of ROA as mentioned above, the concept of 'right' or 'obligation' does not always include flexibility. Nevertheless, it could be said that the concept of 'right but not obligation' is thought to be a general definition of the real options, and the real options is defined as a flexible decision-making tool. Strictly speaking, the real options should be 'a flexible right but not an obligation as a decision-making tool.'

In addition to their definition, another contribution of Copeland and Antikarov (2003) could be their clear explanation of the five essential variables plus one for ROA (p.6). These are as follows:

1) The value of the underlying risky asset
2) The exercise price
3) The time to expiration of the option
4) The standard deviation of the value of the underlying risky asset
5) The risk-free rate of interest over the life of the option

and,

6) The dividends that may be paid out by the underlying asset

The ‘exercise price’, which is also called as ‘strike price’, may require an explanation. According to Copeland and Antikarov, this is the amount of money invested to exercise the option if you are “buying” the asset (with a call option), or the amount of money received if you are “selling” it (with a put option). That is to say, the threshold amount that have been predetermined for the options. We can decide whether to exercise the ‘right’ of option with reference to this amount.

The assumption of the modelling for the ROA is set in order to analyse corporate financial issues. This is the reason why the last variable is specially incorporated. Recently, the ROA has been applied not only in the corporate financial setting, but also extended to a variety of fields in order to manage risky or uncertain situation in a quantitative manner. Quantitative analysis requires mathematical model building. At this moment, the first five variables must be settled in the ROA model building even if the interpenetration of each variable could differ in some sort. With such a perspective, Copeland and Antikarov provided the foundation for the application of the ROA into practice. As a consequence, this dissertation adopts the following as the definition of ROA combined with the discussion above: a flexible right but not obligation as a decision-making tool for which the financial option methods are applied.

2. The styles and extension of the real options

The ‘real options’ derives from financial options. As is the same with financial options, several types of the real options are known, and new type creation is also possible. It is worth showing these types for understanding the real options more precisely. Although the classification of the types of the real options varies amongst researchers, there are three well-known types: the option to expand, the option to abandon, and the option to defer. As Hull (2015) says, “*Those options are very difficult to value using traditional capital investment appraisal techniques. The approach known as real options attempts to deal with this problem using option pricing theory. (p.792)*” The following explanations are basically derived from the textbook of Hull (2015).

A. The option to expand (Expansion option)

This is the option to make further investments if conditions are favourable in order to increase the output. For example, when a firm wants to enter into a geographically new area in order to expand its business, this option would be considered. It is an American call option on the value of additional capacity, which means that the timing of this type of option is not fixed and it can be exercised every time it seems to be a good solution. The exercise price can be interpreted as the cost of creating this additional capacity discounted to the time of option exercise. The exercise price often depends on the initial investment. If management initially choose to build capacity in excess of the expected level of output, the exercise price can be relatively small. This concept is illustrated in Figure 6.

B. The option to abandon (Abandonment option)

In contrast to the previous 'options to expand,' this is an option to sell or close down a project (and/or a business). It is an American put option on the project's value. For example, in the recession, the project and/or business would be shut down if its value falls below the pre-determined criterion. This criterion is the exercise price of the option. Thus, the exercise price is the liquidation (or resale) value of the project minus any closing-down costs. When the liquidation value is low, the exercise price can be negative. Abandonment options mitigate the impact of low investment outcomes and increase the initial valuation of a project. This concept is illustrated in Figure 7.

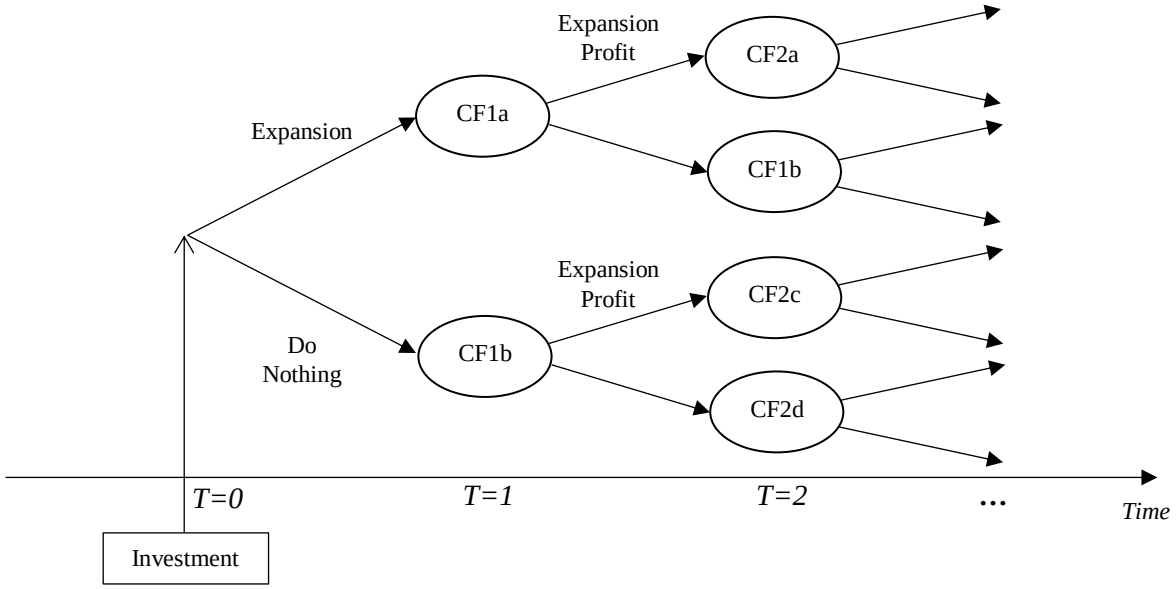
C. The option to defer

One of the most important options which is open to a manager is the option to defer a project. This is an American call option on the value of the project, and often treated as equivalently as the option to abandon. This is also illustrated in Figure 7.

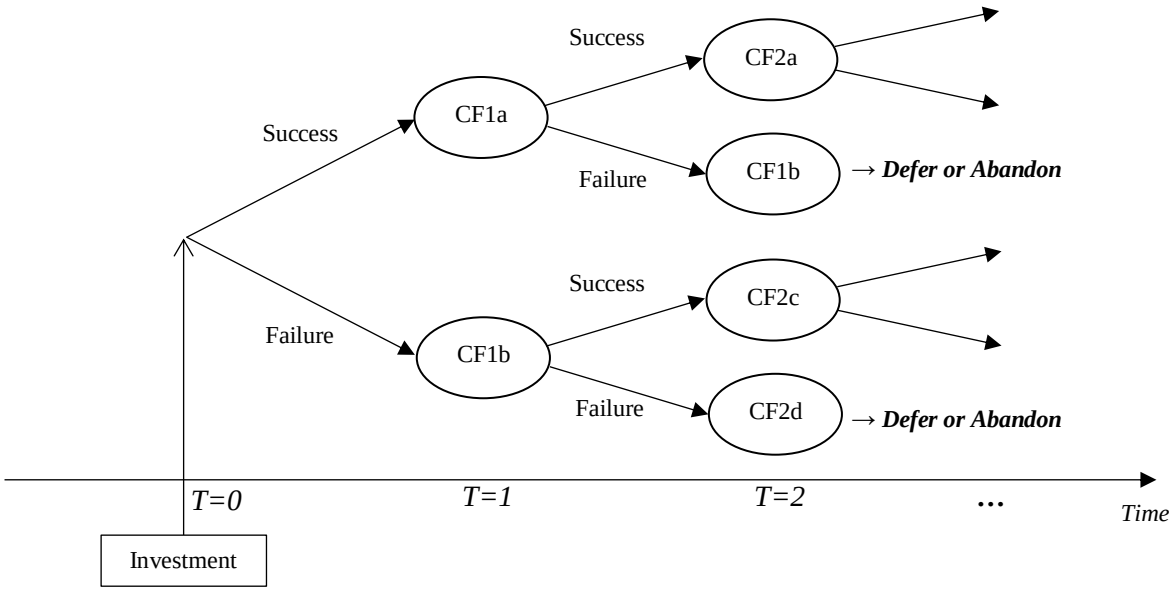
There are other types of options which are classified as the real options, such as contraction option. Although all the types are not exhausted, the others can be basically classified as the variation of the three types above. Conversely, the variety of the real options can be extended on the basis of these types. Therefore, along with the development of the types of real options, the definition could vary. In fact,

nowadays, the definition of ROA has been interpreted more broadly, though it has not yet been widely shared. Some still argue that the definition of the real options should be conceived within the context of the investment appraisal method for real assets. However, this dissertation upholds the position that the extension of ROA should not be limited to it. The main reason is that the Real Option Conference (see. http://www.realoptions.org/), which is the largest academic community of researchers about real options considers all the possibility of the extension of the concept of ROA and its applications to a variety of fields. Within the community, it is said that only if the following three factors are included in the analytical model, we can say that the method is ROA: 'Uncertainty situation', 'Threshold value (such as exercise price)', and 'Flexibility in decision making.' This dissertation also upholds this position and the three articles in Part Two are written based on this conceptualisation.

< Figure 6 The option to expand >



< Figure 7 The option to abandon and defer >

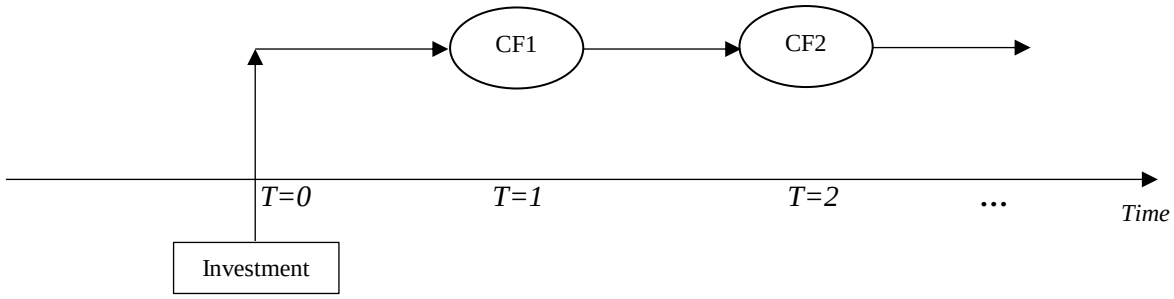


3. Why is the ROA useful for entrepreneurial finance?

As we already pointed it out, the entrepreneurial finance has the unique characteristics of "the inseparability of new venture investment decisions from financing decisions," which is shown in I.1.4. At the same time, it deals with the strategic choice to manage risk and uncertainty in the contractual context and this is an essential element by nature. When adopting the real options as a flexible decision-making tool of a right but not obligation for which the financial option methods are applied, as defined above, the ROA is a quite useful tool for entrepreneurial finance. Many researchers would agree to it, for example, Smith et al. (2011) emphasise the importance of real options as determinants of project value (p.13, p.125).

The ROA has its origin in the financial options and its differentiated feature is flexibility for decision-making. In addition to those, the other well-known advantage of ROA is the fact that it can overwhelm the deficiency of the NPV rule (or the DCF method).

< Figure 8 The deficiency the net present value (NPV) rule >



$$NPV = -(Investment) + \sum_{T=1}^{n} \frac{CF_T}{(Discount\ Factor)}$$

NPV often becomes 'negative.' Does it really mean that Investment is inappropriate?

Figure 8 shows the deficiency of the application of the NPV rule for the entrepreneurial finance setting. In general, when the calculated NPV becomes negative, the investment should be considered to be inappropriate. The calculation depends largely on the prediction of the future cash flows and the estimation of the discount factor. As its name suggests, the discount factor is the ratio which should be applied for decreasing values. The ratio would be large due to the high degree of risk or uncertainty in future situations, including the ones where information asymmetry exits. For example, it is not uncommon that the prediction of the future cash flows related to the start-ups or new ventures is judged as 'uncertain' due to the lack of actual experiences, and the ratio tends to be large. Therefore, the value of NPV often becomes negative and we should refrain from the investment if we comply with the NPV rule. It is obvious that the rule has deficiency at least for the entrepreneurial finance setting because the judgement is made with the concept of 'now or never' on the assumption of stable future cash flow estimation. The start-ups and ventures are assumed to grow up and enlarge their business. The prediction of future cash flows should neither be treated as stable nor movable linearly, though it is sometimes valid. We can expect a huge

growth of the future cash flows, and at the same time, we can also expect a huge drop (This situation can be captured in the standard deviation (or volatility) introduced by Copeland and Antikarov in the previous section). Although the NPV rule is simple and understandable, thus widely used, its effectiveness is quite doubtful when applying it for entrepreneurial finance. Smith et al. (2011) say that "*even in the corporate setting, the approach of NPV is oversimplified, expect with respect to the most basic independent investment projects. (p.33)*"

If the ROA is defined as a flexible right but not an obligation as a decision-making tool for which the financial option methods are applied, it can overwhelm the deficiency of the NPV rule. Comparing with the NPV rule, the ROA can capture flexibility by incorporating the concept of options. Actually, it would allow deciding whether the investment should be done with the benefit of being able to take the decision after knowing the realised future situation. This is the most important advantage of the ROA for the entrepreneurial finance setting. Moreover, taking 'Stages' into consideration is essential for entrepreneurial finance. In this regard, Smith et al. (2011) says, "*Staging capital infusions, abandonment of the project, growth rate acceleration, and a variety of other choices all involve real options. (p.33)*" As a whole, the entrepreneurial process itself is full of 'risky' situations (or states), thus, traditional inflexible analysis methods are difficult to apply directly. It could rather be said that we must deal with issues related to entrepreneurial finance ad hoc. Even in the large public corporate finance setting, the business environment could change rapidly, which would render methods such as NPV obsolete because it has either explicitly or implicitly an assumption of stability. Consequently, new methods are required for the entrepreneurial finance setting. Therefore, ROA, which can deal with 'risky' situations in the rapidly changing business environment is one of the quite useful tools for it.

4. Expansion of the ROA: Incorporation of game theory

As is mentioned in the previous subsections, the usage of the ROA is ideal in the field of entrepreneurial finance. Its general usefulness derives from the unique capability of reflecting the flexibility qualitatively and quantitatively for decision-makings toward risky future situations. In particular, as we consider the

issue of decision-makings as core for obtaining funds, we should focus on contractual negotiations, as mentioned in the previous section. The characteristics of this contractual negotiation could be captured with the ROA, and expressed as models described by mathematical notions. Nevertheless, applying only the ROA might be too simple to explain the contractual negotiation features in some cases because any negotiations require for us to consider its strategic dimensions. Considering strategic dimensions means that we must take the others actors' actions into consideration in order to obtain the results that we expect. In this context, game theory is a quite useful tool, and in effect, it has been well studied in economics in particular. It is rational that game theory could be incorporated into the ROA, and actually, this idea has already been developed. In the following subsections, the combination of the ROA and game theory is discussed.

4.1. What is game theory?

The concept of game theory first appeared in the book which is titled "The Theory of Games and Economic behavior." This book was written in 1944 by the two intellectual giants, John von Neuman (mathematician) and Oskar Morgenstern (economist). Since then, game theory has been well-known among both economists and mathematicians, and developed as an analytical tool in a mathematics-oriented manner.

Then, what is game theory? According to the famous textbook by Osborne and Rubinstein (1994), "*Game theory is a bag of analytical tools designed to help us understand the phenomena that we observe when decision-makers interact. (p.1)*" Another textbook that has been recently published by Maschler et. al (2013) explains that "*Game theory is the name given to the methodology of using mathematical tools to model and analyse situations of interactive decision making. These are situations involving several decision makers (called players) with different goals, in which the decision of each affects the outcome for all decision makers. (p.23)*" Although these explanations are not completely similar, the common term of 'interaction' emerges. It is clear that game theory deals with the issues that decision-makings are significantly affected by the others actors' (re)actions. As Maschler et. al (2013) continues, "*This interactivity distinguishes game theory from standard decision theory, which involves a single decision*

maker, and it is its main focus. (p.23)" "Standard decision theory" is explained by Peterson (2017), for example, as "*Decision theory is the theory of rational thinking. ... A decision maker, ... chooses an act from a set of alternatives. (p.1)*" It assumes a single decision-maker and treats the issues of how to prioritise the options. In this sense, game theory and decision theory are similar but different.

The consideration of 'interactions' is not the only common term for game theory. Osborne and Rubinstein (1994) add that, "*The basic assumptions that underlie the theory are that decision-makers pursue well-defined exogenous objectives (they are rational) and take into account their knowledge or expectations of other decision-makers' behaviour (they reason strategically). (p.1)*" Also, Maschler et. al (2013) mention that "*Game theory tries to predict the behaviour of the players and sometimes also provides decision makers with suggestion regarding ways in which they can achieve the goal. (p.23)*" In these descriptions, "objective(s)" or "goal(s)" are other keywords for game theory. What is "objective(s)" or "goal(s)"? Generally being discussed in game theory, these are "outcome(s)" that each player desires to obtain or realise finally. As it is not only mentioned by Osborne and Rubinstein but also widely discussed in the economic research arena, everyone has his own desire and wants to pursue it. Friberg's comments (2015) in his book about game theory in the context of industrial organisation is insightful. He says that "*... many firms will be in an intermediate situation where the behaviour of a small set of competitors customers, or regulators has the potential to affect profits greatly. It is often the case that not only do your outcomes depend on what they do, but also their outcomes depend on what you do. (p.133)*" An actor cannot pursue his/her own goal by him/herself. Rather, the outcomes which an actor can realise depend on the influences of the other actors. At the same time, this actor him/herself has an impact on the outcomes of the other actors. This is the abstract meaning of 'interaction,' however, it should not be ignored that such an interaction cannot be caused without his desire. Others explanations of game theory in other textbooks (e.g., the one by Tadelis,2013) are similar as they mention the interactions and goals. Therefore, game theory can be defined as a mathematics-oriented analytical tool for analysing the direct interactions among the players who are pursuing the objectives or goals they desire.

4.2. Application of game theory into contractual negotiation

Currently, game theory is successfully applied not only to economics but also to a variety of fields. Maschler et. al (2013) gives several examples, such as political science, military applications and even biology. It can be applicable to businesses as well. We can easily find many books dealing with 'strategically thinking' using the essence of game theory (e.g. "The Art of Strategy – A Game Theorist's Guide to Success in Business and Life" by Avinash K. Dixit and Barry J. Nalebuff (2010). Thus, game theory can also be applied to the contractual negotiations for entrepreneurial financing issues, which is the central issue of this dissertation. In corporate finance which usually deals with the financing issues of large listed companies, a large majority of equity investors who provide funds in the secondary stock markets, are often assumed to be anonymous. It is also often thought that individual investors are bundled as representatives of whole market participants or equity holders, and they are treated as a price-taker. This means that individual investors have theoretically no competence of negotiating stock prices with the issuer company, and the only option they have is to accept the price which are determined by the market. On the other hand, when considering financing issues for start-ups, ventures and SMEs which are normally not listed, the fund providers, such as venture capitalists and angels, are never anonymous. They must be treated as a human being whose face and characteristics are clearly made out. In other words, the entrepreneurial financing issues should be dealt as a matter of face-to-face negotiation between the provider and receiver. Therefore, the importance of game theory stands out.

In fact, Feld and Mendelson (2016) argue in their book for the venture finance practitioners that "*A venture financing is one of the easiest games. ... Since the VC and entrepreneur will need to spend a lot of time together post investment, the continued relationship makes it important to look at the financing as just one negotiation in a very long, multiplay game. ... When you encounter VC who either have a reputation for or are acting as though every negotiation is a single-round, winner-take-all game, you should be very cautious. (p.152)*" They assume the influence of 'Stages' as discussed in the previous subsection, and they insist that the relationship between VC and entrepreneur is not a one-time transaction such as equity investment in the large listed companies, but it is a series of 'interactions' directed to increase the value of the project and the firm in the later stages. Consequently, game theory is quite adequate to analyse such financing negotiations. Tadelis (2013) also says that "*Game theory provides a framework based on the*

construction of rigours models that describe situations of conflict and cooperation between rational decision makers. (p.9)"

Although game theory can be applied to the analysis of negotiations as mentioned above, it would not necessarily be suitable to all negotiation cases. It may be true that fundamental concepts and essences of game theory are implicitly found in all negotiation cases as interaction and goals almost always appear in any type of negotiations. However, it does not mean that the application of game theory for analysing negotiations is always required. Friberg (2015) argues that "*One way to model the uncertainty linked to the behaviour of others is via game theory. (p.133)*" "Uncertainty" in his argument does not necessarily mean that "it cannot be measured" as discussed in the previous subsection, but it does mean that the reactions are not easy to predict deterministically though the possible outcomes can be recognised in advance. This is the very cases that game theory should be applied to. In those cases, direct interactions of the players are essential to achieve their goals. Otherwise, game theory should not necessarily be applied to the case. In Part Two of this dissertation, the third article deals with the direct interactions over the exit choices between venture capitals and the entrepreneur, and game theory is applied. On the other hand, the first and second article implicitly assume standard decision theory, and it is necessary and sufficient to explain the situations. Thus, game theory is not explicitly applied.

4.3. Incorporation of game theory into the ROA

Academic research papers, which combine game theory and ROA and are so-called 'game-theoretic ROA,' have begun to be published in the middle of 1990s (e.g. Smit et al. 1993), and they were recognised by others researchers in the early 2000s, especially in the field of corporate finance. The publication of the book titled "Strategic Investment - Real Options and Games" by Smit and Trigeorgis (2003) is symbolic. As this book approaches, the main topic for applying the combination analysis at that period was the investment issues in the area of industrial organization, especially targeting for the large listed manufacturing companies in the highly competitive business environment. The idea was how to incorporate the game-theoretic analytical method into the investment decision-making processes, using the ROA, in order to assess such a competitive environment more precisely.

Needless to say, this original idea is crucial even now, and composes the foundation of its application and further development. Furthermore, implementing that combination is suitable in terms of the natures and characteristics of game theory and ROA. Actually, those approaches share two similar points. First, both models are described mathematically and expressed using decision trees. ROA is originated in order to complement the deficiency of DCF, which is its lack of flexibly. DCF is expressed as mathematical equations, and the ROA extends the idea of DCF using the form of decision trees. In game theory, there are two forms to express, matrix form and extensive form. The latter is almost the same as the decision tree form. Second, both considers the possible outcomes in advance when modelling. It corresponds to the first point. In general, all the possible outcomes must be prepared in order to create decision trees, and this is common for both ROA and game theory. Thus, it could be said that the combination of ROA and game theory is adequate by nature.

Then, what are the benefits of incorporating game theory into the ROA? The feature of the ROA is to have a capability of capturing flexibility in the decision-making process and deferring the decision. However, the ROA could be rather classified as a "standard decision theory," and suitable to analyse individual behaviours. On the other hand, game theory allows describing the interactions among two or more individuals and set the prediction of outcomes. Therefore, ROA and game theory are complementary to each other, and we can understand flexible decision-making in situations where several players interact if these are combined. Smit and Trigeorgis (2003) indicate this thought by using the following equation (p.432):

Expanded (strategic) NPV = (passive) NPV + flexibility (options) value + strategic (game-theoretic) value.

The (passive) NPV means the traditional NPV, and they explain that the combination can capture the missing values of flexible decision-making and game theoretic approach. They continue to explain that the combination can be beneficial to bridge the gap between 'finance' and 'strategy.' In this context, 'finance' means the traditional NPV and it is analysed in the rigid and inflexible manner. 'Strategy' means the way of thinking which incorporates the competitors' actions and reactions. Although these are normally dealt with separately, especially in the traditional corporate finance (e.g. financing and investment are different matters), they insist that the combination of ROA and game theory could treat them in a uniform manner. For example, it can approach the complex and highly competitive business environment in the manufacturing industry more precisely. Moreover, as mentioned in the previous

section, dealing with both strategy and finance uniformly is essential for entrepreneurial finance. Consequently, combining an application of ROA and game theory in the financing negotiation cases would bring new insights in the entrepreneurial fields, and in effect, the third article in Part Two tries to establish a theoretical model with a game-theoretic approach and ROA.

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Part Two: Applications

In Part One, the general perspectives and overviews of entrepreneurship and entrepreneurial finance for this dissertation have been outlined. In particular, the following four key fundamental concepts, 'stages,' 'risk,' 'information asymmetry' and 'contract negotiation' have been introduced. In this Part Two, three articles are presented on the basis of these concepts, however, 'contract negotiation' is settled as the core issue. The collection of the following three articles is trying to cover the whole venture life cycle and to provide a sweeping view for evaluating the financial contracts in the entrepreneurial context. Although they deal with different topics and address more specific and detailed problems, all problems are subordinated to the grand research (central problem) question of "How should strategic choices in contract negotiation be financially evaluated?" The ROA is chosen as a central methodology for building up quantitative models in order to apprehend the complex contract negotiation processes and to make better and fair decision-makings between the entrepreneur and prospective investors.

The main research question appears to be a little bit abstract. To approach this question by exemplifying in more precise manner, three specific individual problems are selected in Part Two. The first article deals mainly with the early stages, such as survival stage. However, it does not mean that the application should be limited to these stages. This article is about the development of a novel valuation model to value a licensing contract with a bio-pharmaceutical venture. A licencing strategy is critical in that it is one of the effective ways of obtaining cash for such a kind of venture. The unique feature of this practical usage-oriented model is that it incorporates the dynamic assumption of risk perception in licensing contract. In order to analyse the perception, the real options analysis is useful. The results of the model simulation show that the optimal payout ratio from the licensee to the licensor is greater in the earlier phase, and smaller in the later phase. Interestingly, the simulation results also show that the investment cost plays an important role in each phase, and it may determine the effectiveness of licensing contract as well as the market volatility of the drug.

The second article deals with the financing issues related to the usage of convertible notes which is one of the common financing methods in both the early and middle stages, such as rapid-growth stage. Although convertible note is favourably used for early stage start-up financing, its usage creates a complicated situation among entrepreneur, convertible note holders and new equity investors in the second-round financing negotiation. The main objective of this article is to build a model dealing with the interactions of these three key parties. This article aims to figure out the cost for equity investment decision-making by incorporating the real option structure of the conversion of convertible note into equity, as well as the adverse selection problem in the financing negotiation. The results of case simulation suggest that the discount and valuation cap that are accompanied with the convertible note contract have great impacts on the cost for equity investment decision-makings, and entrepreneur should consider it when entering into the financing negotiation in the second financing round.

The third article examines the early mature stage or later stages. In those stages, the exit choice is the most important strategies to be considered. In particular, companies may compare IPO with other options, such as acquisitions. In this context, "IPO valuation premium puzzle" is an intriguing issue for the entrepreneurial exit strategy. This refers to a situation where many private firms choose to be acquired rather than to go public at higher valuations by market participants. The objective of this article is to explain this "puzzle" from the viewpoint of the interactions between an entrepreneur and a venture capitalist. The theoretical analysis of the "private benefits of control" (Bayar and Chemmanur, 2011, 2012) with the game theoretic real options approach shows that the "puzzle" is not really a puzzle. In addition, a new exit choice criterion is provided. The results of the numerical simulation show that even when the start-up business is highly evaluated by the market, acquisition and IPO is indifferent. This also suggests that the "puzzle" is not really a puzzle.

Part Two: Application I.

Real Option Valuation in Licensing Contract with Bio-Pharma venture

1. Introduction

Firms, which confront rapid changes of their business environment, cannot cling to traditional and familiar strategies. The pharmaceutical industry is one of the typical industries in which continuous improvements and/or innovations are required. In this industry, companies need to develop and release new medicines into the market and it is quite difficult to stay ahead of competitors. Even large firms with the latest Research & Development (R&D) facilities and abundant resources are struggling to find chemical compounds for future new drugs. There are still many unmet medical needs and patients have been waiting for new medicines or treatments. However, it has become difficult to release drugs, with high returns on investments and to fuel the R&D "pipeline", that is, to line up new candidate drugs within one firm. Actually, the easy cases for new drug R&D have already been exhausted and only difficult diseases to be tackled remain. Thus, large pharmaceutical firms are always looking for new technologies. At the same time, they are also trying to find opportunities to collaborate with or buy innovative companies which have such technologies.

Recently, alliance has been perceived as one of the important firm's strategies for resolving this harsh situation (Mani and Luo, 2015). Alliance does not occur only among large firms, but it is not uncommon that a large firm seeks an entrepreneurial firm as an alliance partner. In the pharmaceutical R&D industry, licensing is the most popular strategy (see e.g. Nisijima and Okada, 2014; Owena and Yawson, 2015). In fact, a small bio-pharma entrepreneurial start-up or venture often has a new technology and/or know-how

that large pharma firms have been looking for. In today's pharmaceutical industry, large pharma firms are actively searching for start-ups and ventures who are specialized in the bio-pharma arena, and are trying to collaborate with them, including under the cases of mergers and acquisitions. Therefore, there is a surge of research focusing on licensing contracts between large firms and bio-pharma start-ups and ventures. In academia, on the other hand, the topic of alliance has been usually discussed as the one of alliance portfolio in the pharmaceutical industry (see e.g. Vapola et al, 2010; Mouri et al, 2012; Haeussler et al, 2012). Studies dealing with licensing contracts between a large firm and such a small venture are quite limited. Thus, this article tackles this particular situation.

The essential matter in licensing contract is "how much should each side be paid?" Some researchers have developed a valuation model about R&D licensing contract (e.g., Crama, 2013; Lo Nigro et al, 2014, 2015). In general, this type of valuation model must have the following characteristics: it must contain the well-explanations that captures the theoretical aspects fully. At the same time, it must be feasible for practical application. These two characteristics are not always present in one model, and there still exists a large gap between theoretical model building and its usage in practice. For example, the real options analysis (ROA) is recognized as one of the excellent methods for modelling contingent claims, which extends the idea of financial option, and many models with the ROA have been provided (e.g., Pennings and Sereno, 2011; Lo Nigro et al., 2014, 2016).

Unfortunately, these models have not been widely used in practice. Hartmann and Hassan (2006) show that the ratio of usage of the ROA is around 25% while the ratio for traditional Net Present Value (NPV)/Discounted Cash Flow (DCF) is over 85%. They also explain that the prevention for its practical usage lies in the difficulty of understanding its mathematics and the complexity of the manipulation in many cases. Regarding to this issue, Lo Nigro et al. (2014) have provided a theoretical model about drug R&D valuation that can also be feasible in practice. In addition to that, they mentioned the possibility of an extension of their model to licensing contract. Nevertheless, they have not shown the details about it. The main objective of this article is to develop a further model of licensing contract based on the one by Lo Nigro et al. (2014, 2016). Trying to incorporate the two characteristics required for any quantitative measurements, 'theoretical explanation' and 'feasibility in practice,' this model aims at providing the managerial insights for fair contract negotiation between a large pharmaceutical firm and a start-up and/or

venture. The contribution of this literature is twofold. First, this model captures the different perceptions and stances between large companies and small start-ups and/or ventures, which are to be considered for licensing contract, into the model. For a bio-pharma start-up or venture, the firm's strategy and finance are closely linked, rather almost identified, while these two are clearly separated in the large firms (Smith et al, 2011). This difference should be reflected in a valuation model. Moreover, this model also incorporates the unique concept of risk perception (Das and Teng, 2001) into the licensing contract negotiation and explains its dynamics. Second, the simulated optimal shared ratio for the contract could serve to provide the managerial insights and criterion for licensing contract negotiation.

As discussed in the section II in Part One, 'start-up' and 'venture' should be distinguished. However, large pharmaceutical companies would not be sensitive to this distinction when they consider the collaboration and/or licensing contract in the technical R&D area, and are trying to search and find such new firms. Thus, hereafter, also for the reason of simplicity, the terms 'start-up' and 'venture' will be unified as 'venture' in this article.

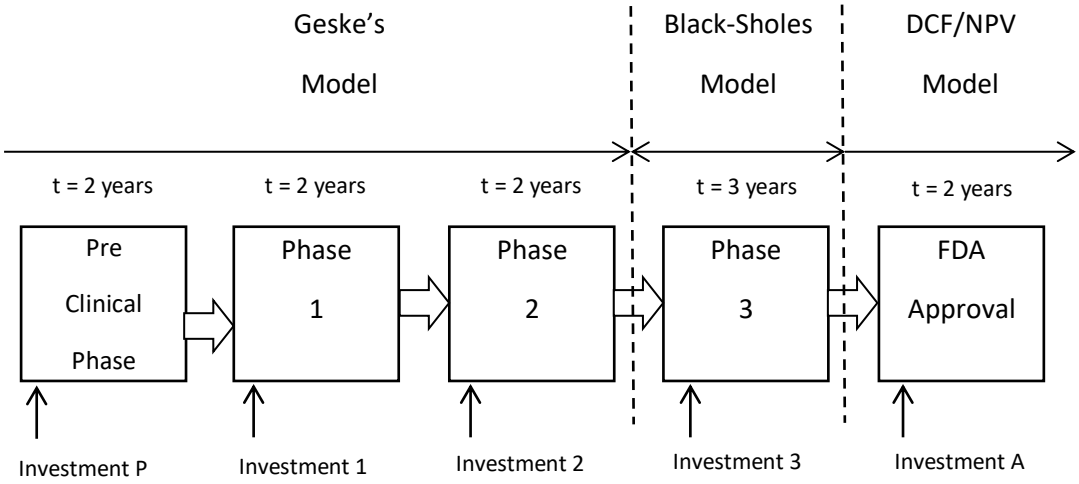
2. Literature review and Model Construction

2.1. The basic model of Lo Nigro et al.

Lo Nigro et al. (2014, 2016) introduced a new drug R&D portfolio selection model to maximize value. New drug R&D process is generally divided into five critical phases as shown below. Although these phases can be divided into more detailed phases, considering only five parts is enough to build this valuation model. Focusing on these five stages, Lo Nigro et al. allocate three types of formulas in the whole drug R&D process as illustrated in Figure 9. Hence, the DCF/NPV model is allocated to the Food and Drug Administration (FDA) approval stage, the Black-Scholes formula is allocated to Phase 3, and Geske's formula is allocated to all the other stages of Preclinical, Phase 1 and Phase 2. While it is usual

that one concept gives one formula in the previous studies like Rogers et al. (2002)'s, allocating the different types of formulas to each phase is an interesting contribution by Lo Nigro et al (2014). Moreover, it must be mentioned that their primary objective is to facilitate the practical usage of the model with the ROA. It is epoch-making that the authors focus on the feasibility of their model, as they assert that their model can be implemented even with a widely-used spread-sheet, such as Microsoft Excel®.

< Figure 9 New drug R&D process (Source: Adapted from Lo Nigro et al., 2014) >



When calculating the value captured by ROA for the decision-making at the beginning of each phase, it is executed with the backward induction method. The process of the calculation by the ROA flows to the reverse direction, from FDA Approval to Pre-Clinical Phase, while the timeline flows from Pre-Clinical Phase to the direction of FDA Approval. Along with this reverse flow of calculation, the simplest DCF/NPV model can be chosen in FDA Approval stage because the new drug is ready to be released in the market and is waiting for only the approval by FDA in this phase. The success rate is very high (91% according to Paul et al., 2010), and the estimation of future cash flows is not difficult because the market research would be already finished in most cases. There is little risk in this phase and the concept of (financial) option is not necessary, thus, DCF/NPV model is suitable. This model is described as follows:

< DCF/NPV formula >

$$C = V_0 - InvA \ldots (1)$$

Where

$V_0 = current\ value\ of\ the\ drug\ which\ represents\ the\ expected\ NPV$

$InvA = investment\ cost\ of\ developmental\ FDA\ Approval\ phase\ for\ the\ drug$

In Phase 3, the concept of option becomes necessary for the decision-making, though the value at the end of Phase 3 is determined without risks. Black-Scholes formula can be allocated for assessing the value of drug in this phase. Lo Nigro et al. (2014) argue that "*B&S formula can be used if a drug has only two development phases left (p.186).*" In general, Black-Scholes formula is the European option pricing model (Black and Scholes ,1973), and the timing of exercise of European option is limited only at the maturity. Moreover, the good feasibility of Black-Scholes formula when calculating the option value is the reason why it is now widely used in real business. These characteristics are quite suitable for the evaluation of the value of the drug R&D process. To use the Black-Scholes formula, 5 parameters are required: underlying asset value, exercise value, risk-free rate, maturity, and volatility of underlying asset. Lo Nigro et al. proposed their model based on these parameters as illustrated below.

< Black-Scholes formula >

$$C = V_0 \cdot N(d_1) - Inv3 \cdot e^{-r \cdot T} \cdot N(d_2) \ldots (2)$$

Where

C= the value of the drug

$d_1 = ln\left(\frac{V_0}{Inv3 \cdot e^{-r \cdot T}}\right) / \left(\sigma \cdot \sqrt{T}\right) + \frac{\sigma\sqrt{T}}{2}$, $d_2 = d_1 - \sigma\sqrt{T}$

σ = estimated annual market volatility for the drug

r = risk free interest rate

$Inv3$ = The investment cost of phase3 for the drug

T = The length in years of the development phase3 (3 years)

Considering the bio-pharma ventures, the value is primarily derived from C. Thus, the computation of the value of the drug C is the main concern. In the case of drug R&D process, managers must make a decision whether the investment should be executed or not at each stage. They are willing to pay in order to obtain profit in return. This scheme is similar to buying a risky underlying asset with taking the ROA into consideration. In this context, the formula for calculating C should be proposed as a call option.

For the remaining three phases (Phases 2, 1 and Preclinical phase), the Geske's formula (Geske,1979) is allocated. Geske develops Black-Scholes formula by introducing compound options, and argues that a contract specifies the terms of the opportunity, or details what financial economists call the option's boundary conditions. Many opportunities have a sequential nature, where latter opportunities are available only if earlier opportunities are undertaken. Such is the nature of the compound option or option on an option. In Phase 2, it is impossible to ignore the risks in Phase 3 when calculating the value of the drug C because the value at the end of Phase 2 should be known. Thus, the concept of compound options is necessary and Geske's formula is appropriate. Lo Nigro et al. also argue that "Geske's formula should be used when a drug has to pass through more than two phases before being commercialized".

< Geske's formula >

$$C = V_0 \cdot N_2(a_1, a_2, \rho) - Inv3 \cdot e^{-r \cdot T_2} \cdot N_2(b_1, b_2, \rho) - Inv2 \cdot e^{-r \cdot T_1} \cdot N(b_2) \ldots(3)$$

With

$$b_1 = \frac{ln(V_0/V\prime) + \left(r - \frac{1}{2}\sigma^2\right)T_1}{\sigma\sqrt{T_1}} \quad b_2 = \frac{ln(V_0/Inv3) + \left(r - \frac{1}{2}\sigma^2\right)T_2}{\sigma\sqrt{T_2}}$$

$a_1 = b_1 + \sigma\sqrt{T_1} \quad a_2 = b_2 + \sigma\sqrt{T_2} \quad \rho = \sqrt{T_1/T_2}$

Where

T_1 = *The length in years of the development phase for the drug*

T_2 = *time to maturity of the underlying call option* = Total years of phase 2 and 3

N_2 = *The bi-variate cumulative normal distribution function*

$Inv2$ = *The investment cost of phase2 for the drug*

V' = *The solution of* $C - Inv2 = V' \cdot N(d_1) - Inv2 \cdot e^{-r \cdot T} \cdot N(d_2) - Inv2 = 0$

In addition, Lo Nigro et al. (2014) insist that "*if there are only three development phases left, the traditional Geske's formula can be used. (p.186)*", which is valid as the two-compound options structure is mathematically applicable to the situation consisting of three or more elements. This is similar to a Russian "Matryoshka doll." In this article, not only is Geske's formula applicable in Phase 2, but also possible in Phase 1 and Preclinical phase. At the end of Phase 1, it is necessary to consider the risk of Phases 2 and 3, for example. The practical situation of Phase 1 might be different from the one in Phase 2, however, both model structures are exactly the same for valuation because only the value at the end of each phase should be known. Therefore, in Phase 1 and even in Preclinical phase, the Geske's model is still applicable.

2.2. Extension of the basic model

2.2.1. Background situation

In the pharmaceutical industry, Mergers and Acquisitions (M&A) among large firms are still active though their success is rare (i.e. Kirchhoff and Schiereck, 2011). Furthermore, M&A between a large firm and a

bio-pharma venture have become not uncommon these days. There are many bio-pharma ventures with a niche but epoch-making technology, know-how, and/or product that the large firm desires for filling its pipelines (or sometimes, ideas for solutions). In spite of its excellent technology or product, bio-pharma ventures often suffer from the shortage of funds and sales channels. When M&A are conducted between a large pharmaceutical company and a bio-pharma venture, their benefits can be expected for both parties. However, even in the case of M&A in which ventures are acquired and absorbed by a large company, it is often said in practice that the same obstacles for the success of M&A remain as with the cases among large firms. Considering such experiences, many large pharmaceutical firms are taking alliances into consideration as an alternative strategy. In contrast to M&A, a venture firm can still exist and obtain cash and sales channels in an alliance. For a large company, costs and efforts of making an alliance deal can be less than that of M&A. As an alliance is likely to be more beneficial for both parties, thus, alliance has become a major tactic recently, especially in the bio pharma industry. There are many types of strategic alliances, such as Joint Ventures, Outsourcing, Affiliate Marketing, Technology Licensing, Product Licensing, Franchising, R&D, Distribution, and Distribution Relationship (Isoraite, 2009; Uddin and Akhter, 2011). Considering the characteristics of drug R&D procedure where the chemical and biotechnological aspects are strongly emphasized, licensing is chosen as the most favourable method for a strategic alliance.

For the model construction, there is a critical point in the work of Lo Nigro et al. (2014). As they argue, their model can be extended for applying to the licensing (alliance) valuation model between a large pharmaceutical firm and a bio-pharma venture. They have already shown the following equation as a general concept;

$$C_{licence} + P - I = C_{nolicence} - I \quad \ldots \text{(a)}$$

P refers to upfront and/or interim payment by contract, and I refers to investment cost of developmental phase. Considering the current trend of licensing in the pharmaceutical industry, developing the detailed licensing model is essential. However, the authors have not mentioned details of the equation, and thus, it is worth analysing them. This is the starting point, and also the motivation of this article.

2.2.2. Theoretical assumption: Financial structure of licensing

Licensing is a contract, thus, there must be a licensor and a licensee. When a large pharmaceutical company and a bio-pharma venture make a licensing contract, the former becomes the licensee and the latter becomes the licensor. A large pharmaceutical firm has several projects of new drugs, and has its own established sales network. If its new drug R&D succeeds, the probability of releasing its new product in the market would be very high. However, it is often the case that some technologies or know-how which are required to complete these R&D are missing. On the other hand, bio-pharma ventures have sometimes developed and already obtained them. Therefore, a bio-pharma venture can be a licensor that provides its specific technology or know-how, and a large pharmaceutical firm can become a licensee that pays the compensation for it to licensor. Moreover, a large pharmaceutical company needs to select its pipelines of future new drug candidates carefully first, and arrange the strategy of obtaining the necessary technologies or know-hows prior to the licensing contract negotiation with bio-pharma venture. This is the point that Lo Nigro et al. (2014) aim at for their model presentation.

The equation (a) above represents the fundamental financial structure of licensing in the pharmaceutical industry. From the licensee's point of view, $C_{nolicence} - I$ means the net value or net cash flows that the licensee could obtain if he/she accomplishes R&D by himself/herself. $(C_{licence} + P) - I$ must be equal to $C_{nolicence} - I$, because the cash flows that the licensor could obtain as the payments, P, come only from the resource of licensee. There are several components of P, such as milestone payments, royalties, and upfront payment. Although these are different from each other in the practical contract situation, all of them are expenses for the licensee and are financial resources for the licensor in financial model-building context. Therefore, one parameter, P, is sufficient to represent the payments from the licensee to the licensor.

2.2.3. Theoretical assumption: Compensation depending on risk

Evaluating the value of the parameter, P, is equivalent to the issue that how $C_{nolicence}$ should be divided into $C_{lincence}$ and P. In other words, this issue is about how much both the licensor and the licensee should be compensated economically. It is logical to think that each party must be economically compensated depending on its risk. It would sometimes be called as a fair contract. When licensor (bio-pharma venture) enters the license contract, it can obtain certain cash flows from the licensee and avoid highly risky investment. The licensor must give up selling its products, patents and know-hows in exchange of the cash inflows. This condition of the licensing contract is usually protected legally, thus, the licensor can be under far less risky situation than the licensee from a financial viewpoint. On the other hand, the licensee (a large pharmaceutical firm) bears the greater risks, such as the probability of the failure of R&D, and of sales as the success of the release in the market is difficult to predict. This is incorporated in the market volatility of σ. Even if market sales would not be as high as expected and $(C_{licence} + P) - I$ becomes negative, the licensee still has a legal responsibility of making payments to the licensor. Hence, the licensee must be compensated more than the licensor.

In addition to the general idea above, it is necessary to consider that the degree of bearing risk would vary depending on the phases. In an early phase, preclinical phase for example, licensor could obtain some amount of cash flows when the licensing contract is made while the licensor's technology or product would not be decisive whether this could contribute to the increase of success rate of licensee's R&D or not. Thus, the licensee must be economically compensated far more than the licensor. In a later phase, such as Approval phase, the licensor might be able to release its products in the market by itself. If the licensing contract is made in a later phase, the licensor could only obtain small and pre-determined amount of cash flows. Thus, the licensor must be compensated more than the licensee. About this issue, Bogdan and Villiger (2009, 2010) show this as "Value share rules of thumb, licensor's share" as follows; the share of 'Big pharma' is 80-90% in Discovery/Preclinical phase, 60-80% in Phase1, 40-60% in Phases 2 and 3, and 20-40% in FDA approval phase.

2.2.4. Dynamic assumption with risk perception

When interpreting the equation (a), it is necessary to recognize an assumption that both licensor and licensee accept the contract condition as it is. The licensee accepts its riskier situation with no further action and the licensor enjoys its relatively certain cash inflows. Moreover, the licensee has a stronger negotiating power not only theoretically but also practically, and demands more compensation to the licensor. This situation could be called as "static". Nevertheless, is it actually realistic when negotiating a licensing contract? Do the parties really accept such a situation as it is? For answering these questions, the framework of risk perception provided by Das and Teng (2001) is helpful. They argue that managerial risk perception affects significantly the strategic alliance structuring, and it mediates the objective environment and strategic decisions. This means that a special attention should be paid to risk perception. Two key concepts are introduced: relational risk and performance risk. According to them, "*relational risk is concerned with the probability and consequences that a partner firm does not commit itself to the alliance in the desired manner (p.6)*", and "*performance risk refers to those factors that may jeopardize the achievement of strategic objectives, given that the partners co-operate fully. (p.6)*" These two risks are independent from one another. In particular, the former concept gives a critical insight into building valuation model in licensing contract with bio-pharma ventures. They argue that the relational risk reflects the decision-makers' concerns about the level of co-operation between the partners. This concern comes from the so-called opportunistic behaviour of the partners of an alliance. Furthermore, they explain that "*another source of perceived relational risk may arise from expected inequities regarding payoffs in alliance. (p.7)*" "*If one partner feels that the other partner gains too much from the alliance as compared to its own gains, it may begin to commit itself less, notwithstanding its own sake. (p.7)*" Therefore, the full cooperation of alliance could no longer be realized when the manager of one alliance member firm has concerns about the partner firm's opportunistic behaviour and feels the contract unfair.

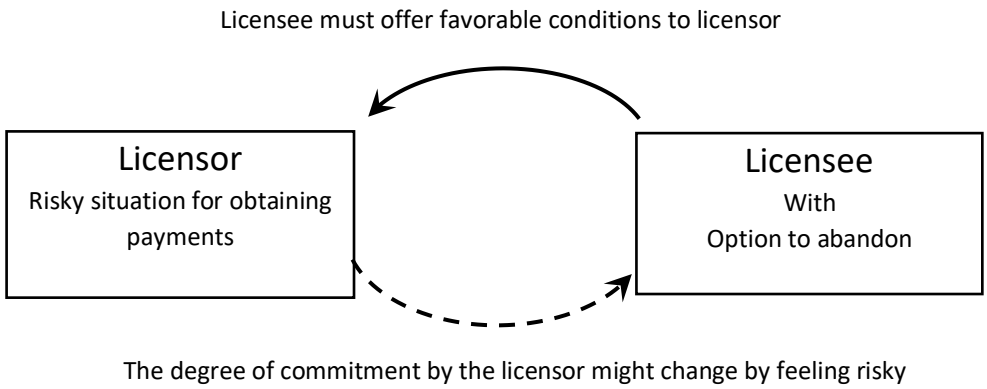
Looking back to the licensing structure between a large pharmaceutical firm and a bio-pharma venture, the assumption of equation (a) suggests that a large pharmaceutical firm as a licensee would take an opportunistic action. This means that $(C_{licence} + P) - I$ and $C_{nolicence} - I$ can be regarded as the payoff of call option. In effect, Lo Nigro et al. explain that I is the exercise price, and $C_{licence}$ and $C_{nolicence}$ are the underlying values. From the viewpoint of Real Options Analysis (ROA), the licensee has an option to

abandon. When the expected payoff is not attractive, the licensee can abandon the project early in order to avoid incurring significant losses (Kodukula and Papudesu, 2006). The licensee is bearing the technical risk during the new drug R&D, and must always make a decision by comparing the expected drug value with its costs or expenses. While the costs and expenses are relatively certain, the expected drug value is risky as shown with estimated annual market volatility for drug.

However, licensor may consider that such an embedded option for the licensee is unfair. Moreover, the probability of option exercise by the licensee could be a great threat because it is the licensee who can decide whether to continue or abandon the project. Villiger and Bogdan (2010, p.161) pointed out this issue, saying that "the *licensor* is 'short position' in control." When the project is abandoned, all rights will be given back to licensor. However, the situation will not be simple. In the new drug R&D, even one chemical compound could become a so-called block-buster, and only one technique could change the prototype drug into an epoch-making one. The licensor is usually a small firm, and may have devoted all the resources for developing its unique product, technique, and know-how. Thus, once licensing contract is made and committed to the project, all of these might be unveiled to the licensee. As a result, the licensor may face the great risk of losing everything it has ever developed, even if the licensor has already received some amount of money. This issue could lead to the following theoretical assumption for building the valuation model in licensing contract with a bio-pharma venture. The licensee bears more risk than the licensee, has an option to abandon, and acts along with the option value criteria, whereas, the licensor may not have an enthusiasm to devote all available resources to the project in such a risky situation that the licensee may exercise the option to abandon. Consequently, the commitment into new drug R&D might not be full, which would not rise the probability of success. Neither licensee nor licensor desire the failure of the drug R&D. Rather, they want to do their best for achieving the new drug development because they can share more benefit due to the cooperation as licensing. In order to keep or rise the probability of success, the licensee has to offer attractive conditions so that the licensor would commit to the project fully. For example, the licensee could promise to make more payments to the licensor. This assumption can be called as "dynamic" (see Figure 10).

< Figure 10 Dynamic assumption for licensing negotiation

(Source: Adapted from Villiger and Bogdan, 2010) >



3. Numerical simulations

3.1. Outline of simulations

The most useful and fundamental information for the managers of a large pharmaceutical firm is the estimated future profit at every phase, which should be maximized. This refers to the value of drug C. The main point of the simulation in this article is to estimate the value of drug C by changing key parameters, and to use it as a decision criterion. Nishijima and Okada (2014) suggest that the decision making in a new drug R&D must be phase specific. Managers in the large pharmaceutical firm need to rethink at each phase whether the next investment for the R&D project should be continued or abandoned. The new drug R&D process has been standardized at least among developed countries. What to do in each phase is

predetermined precisely. Therefore, the prerequisite amount of finance for each phase can be predictable, and the computation of the value of drug C becomes possible.

3.2. Parameters setting

As discussed above, in order to compute the value of drug C, as the value of call option in which $I - P$ can be the exercise price, different calculations are required because the three corresponding models, DCF/NPV formula (equation (1)), Black-Scholes formula (equation (2) and Geske's formula (equation (3)), are allocated to each phase, and the numerical simulation is conducted according to this phase-specific classification. For implementing the numerical simulation of the value of drug C, the variables which have already been indicated in the paper of Lo Nigro et al. (2014, 2016) are available, V_0= 100, for example. Other parameters required should be prepared.

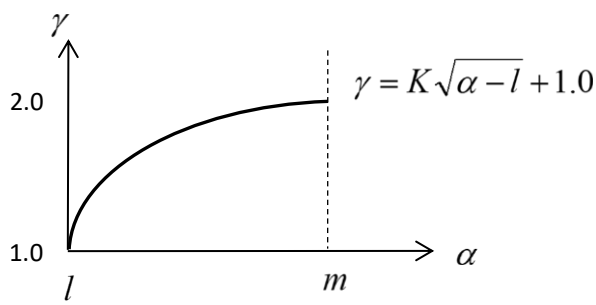
One of the key parameters is the payout ratio α. They prepare the parameter of α $(0.0 \leq \alpha \leq 1.0)$, which represents the payout ratio from licensee to licensor in the licensing contract. In the licensing contract negotiation, deciding the ratio that the licensee offers to the licensor is a critical issue. The value of drug C is also a function of the payout ratio α, thus the impact of this ratio is worth examining. The investment cost for each phase, I, is important. Unlike the payout ratio α, this is not determined through negotiation but has been already predicted before negotiation.

The relationship between the amounts of cost and the future profit is unclear, because a large cost does not guarantee the larger profit, nor the larger profit always requires a large cost. Thus, the investment cost should be treated as a kind of given condition. In this simulation, I is set as 20, 50, and 80. The estimated market volatility for drug σ should also be the key parameters. The greater the volatility becomes, the greater the value of drug C can be. The market volatility is not negotiable, and an exogenous variable. Thus, this variable should be also a kind of given condition. In this simulation, σ is set ranging from 0.2 to 0.8 as Lo Nigro et al. proposed.

On conducting the simulation of the value of drug C, the term of $V_0 \times \gamma \times (1-\alpha)$ in the original three models should be used as the underlying asset value instead of the simple variable V_0 in equation (1), (2) and (3). The "amplification factor, γ" which is defined by Lo Nigro et al. (2014) should be adopted for the underlying asset value. According to their explanation, "the amplification factor, γ, represents the measure of value added to the project by the bio-pharmaceutical alliance," and this γ is set ranging from 1.0 to 1.9. When γ equal to 1.0, it means the situation of no value added. It is obvious that the deeper the alliance partners commit, the more the drug R&D value can increase. Some empirical studies have confirmed this proposition (i.e. Anand and Khanna 2000; Rothaermel, 2001), thus, this simulation adopts the range.

Based on the dynamic assumption discussed in the previous section, the amplification factor γ can be the function of α. If the licensee admires the licensor's product or technique and offers the most favourable condition (increase of the payout ratio α), the licensor would be more willing to devote itself to the project. In contrast, if licensee offers only the minimum ratio of 'rule of thumb', the licensor might lose its enthusiasm for achievement. It is no doubt that γ goes up as α increases. However, a linear relationship between the two would be too simple. Then, taking that characteristics of γ into consideration, this article decides to adopt the non-linear relationship that is expressed as $\gamma = K\sqrt{\alpha - l} + 1.0$. This equation itself is arbitrary. However, the range of γ is from 1.0 to 1.9 as explained above. Furthermore, if we follow "Value share rules of thumb, licensor's share" (which appears to be adopted in practice), the payout ratio α can be preliminarily set depending on the phases, as shown in Figure 11 and Table 4. Then, the minimum and maximum percentage of the payout ratio α, l and m, and the coefficient K are obtained, as also represented in Figure 11.

< Figure 11 The relationship between γ and α >



Licensing phase	Payout ratio ($l - m$)	K
Discovery / Preclinical	0.1 – 0.2	3.1623
Phase I	0.2 – 0.4	2.2361
Phase II / Phase III	0.4 – 0.6	2.2361
Approval	0.6 – 0.8	2.2361

In summary, the parameters are shown in Table 4.

< Table 4 Variables for simulation >

V_0		100
I		20, 50, 80
r		0.05
σ		0.2 – 0.8
α	Phase2 etc.	0.2 – 0.4
	Phase3	0.4 – 0.6
	FDA approval phase	0.6 – 0.8

3.3. Results

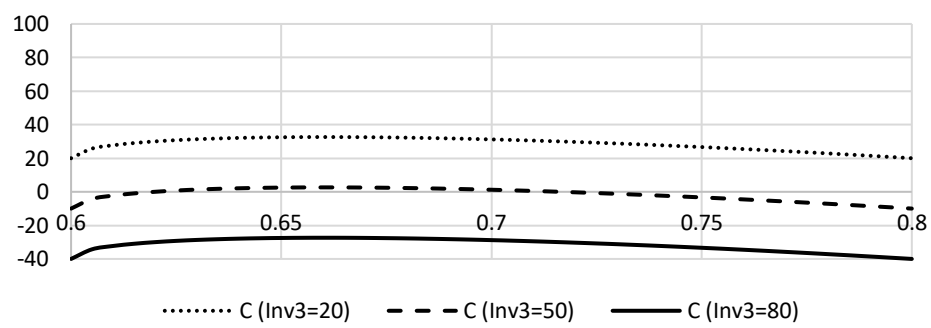
This section shows the simulation results with three theoretical models.

Table 5 and Figure 12 show the result in FDA approval phase.

< Table 5 Results in FDA approval Phase >

	C max	α
Case1: InvA=20	32.62	0.66
Case2: InvA=50	2.62	0.66
Case3: InvA=80	-27.38	0.66

< Figure 12 Result of FDA Approval Phase >



The value of drug C is calculated by using the equation (1). In this phase, the market volatility of drug σ has already been incorporated into the original V_0, therefore, σ is not considered in the simulation. The optimal payout ratio α is 0.66, which is smaller than the average ratio 0.7 in all amounts of investment costs. This leads to the following suggestion. When the licensee aims at the licensor's deep commitment into the drug R&D project and at maximizing the value of drug, offering more payout ratio would not

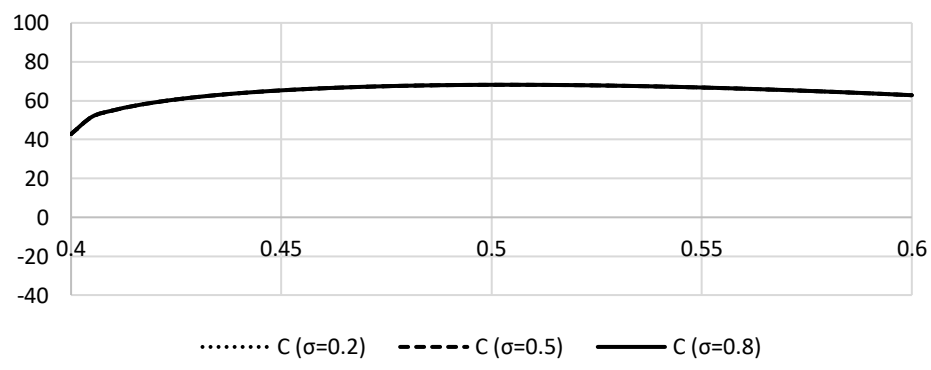
bring favourable consequences for the licensee (and for the completion of R&D project) in the FDA approval phase. The result also shows that the value of drug C is quite sensitive to the investment cost in this phase. If the investment cost of this phase is expensive, the value of drug C may be almost zero, or even negative regardless of payout ratio. This suggests that making a licensing contract in FDA approval phase is effective when large profit can be expected, and vice versa.

Table 6 and Figures 13-15 show the results in Phase 3.

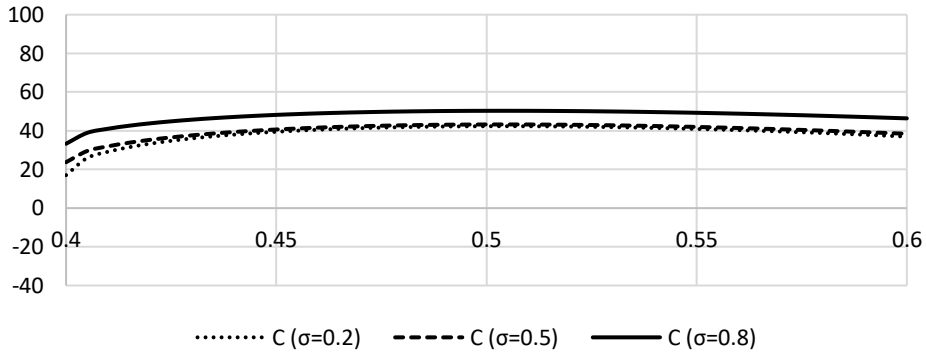
< Table 6 Results in Phase 3 >

σ	0.2	0.3	0.4	0.5	0.6	0.7	0.8
α	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Case4: C max (Inv3=20)	68.14	68.14	68.14	68.14	68.14	68.15	68.15
Case5: C max (Inv3=50)	42.32	42.32	42.47	43.23	44.91	47.36	50.30
Case6: C max (Inv3=80)	17.86	22.05	27.15	32.31	37.31	42.08	46.59

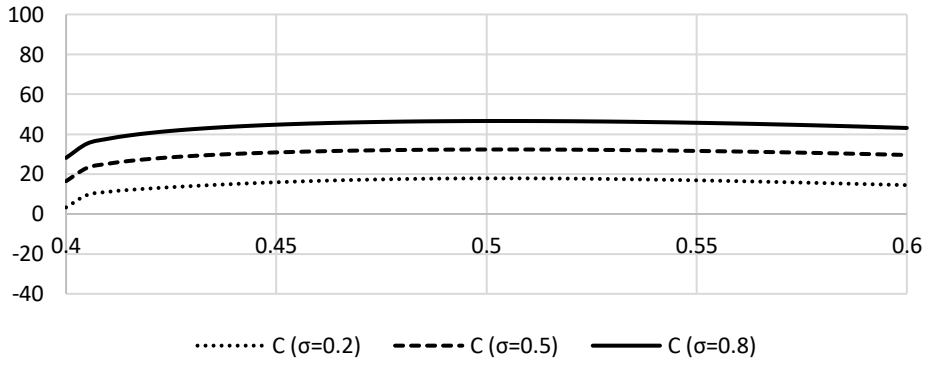
< Figure 13 Result of Phase 3 (Inv3=20) >



< Figure 14 Result of Phase3 (Inv3=50) >



< Figure 15 Result of Phase3 (Inv3=80) >



The value of drug C is calculated by using the equation (2). In Phase 3, the optimal payout ratio α is 0.5, which is the average ratio in all σ and I. This means that 'not too much and not too little payment' is optimal in Phase 3. Further, offering too much payment cannot always bring the desired consequences for the licensee in this phase.

Interestingly, the relationship between the value of drug C and both σ and I is clear. The smaller the investment cost is, the weaker the impact of the market volatility on the value of drug C becomes. This suggests that the impact of market volatility might be ignored depending on the amount of investment cost

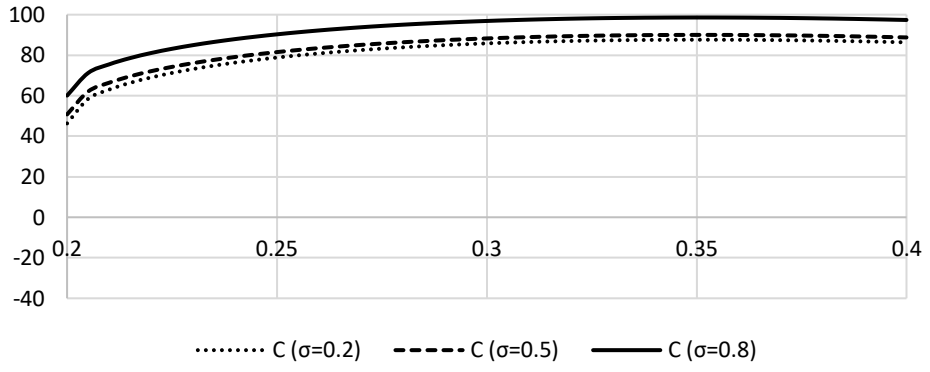
if a large profit is expected. Moreover, the investment cost has a greater impact on the value of drug than the payout ratio in Phase 3. The results also show that the licensee must pay attention to the market volatility when the investment cost is large and the expected profit is small. If the market volatility is predicted to be small, the value of drug C could become less than a half.

Table 7 and Figures 16-20 show the results in Phase 2.

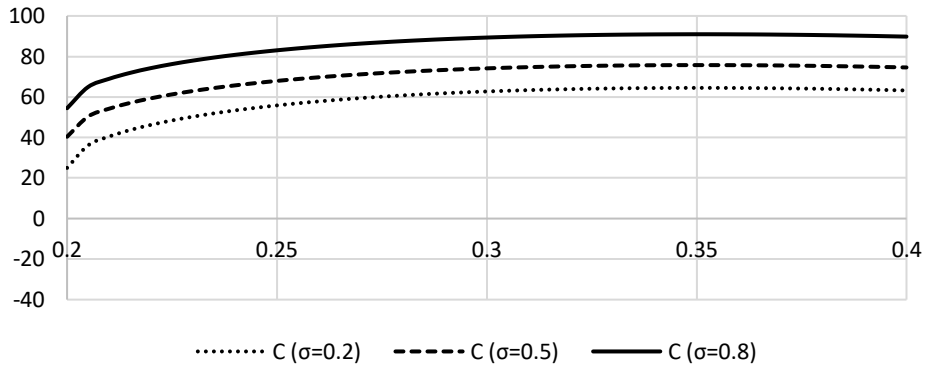
< Table 7 Results in Phase 2 >

σ	0.2	0.3	0.4	0.5	0.6	0.7	0.8
α	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Case4: C max (Inv2=20, Inv3=20)	87.62	87.69	88.34	90.01	92.51	95.47	98.60
Case5: C max (Inv2=20, Inv3=50)	64.49	66.65	70.75	75.73	80.96	86.09	90.96
Case6: C max (Inv2=50, Inv3=50)	37.63	41.87	49.18	57.38	65.49	73.14	80.16
Case7: C max (Inv2=50, Inv3=80)	19.54	30.05	40.79	50.89	60.22	68.75	76.49
Case8: C max (Inv2=80, Inv3=80)	-4.82	9.84	24.04	36.92	48.52	58.97	68.33

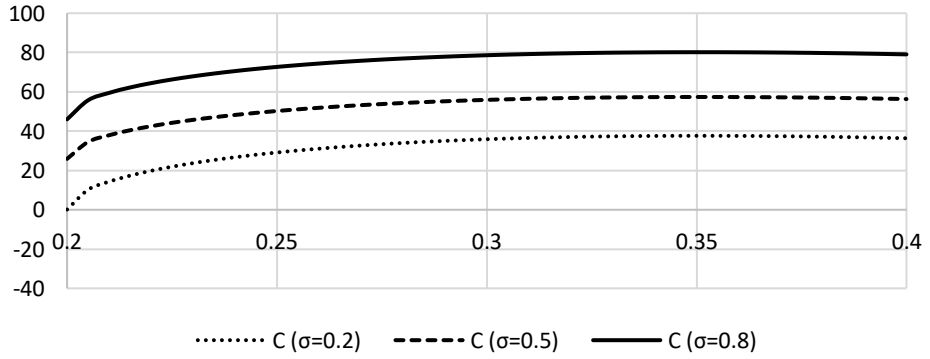
< Figure 16 Result of Phase (Inv2=20, Inv3=20) >



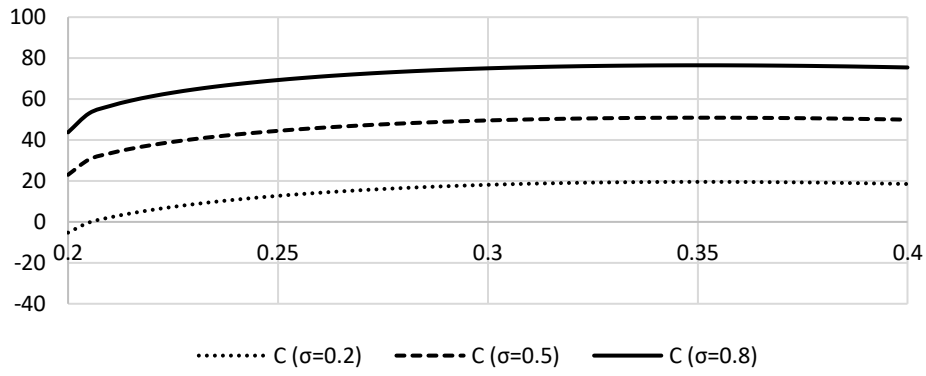
< Figure 17 Result of Phase2 (Inv2=20, Inv3=50) >



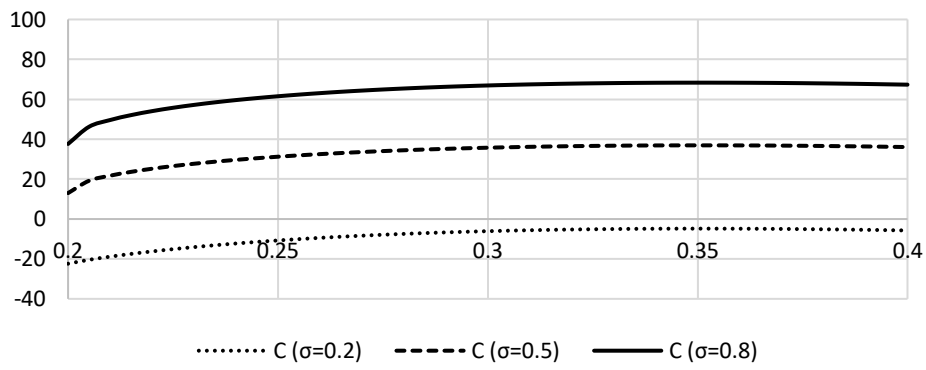
< Figure 18 Result of Phase2 (Inv2=50, Inv3=50) >



< Figure 19 Result of Phase2 (Inv2=50, Inv3=80) >



< Figure 20 Result of Phase2 (Inv2=80, Inv3=80) >



The value of drug C is calculated by using the equation (3). In phase 2, the optimal payout ratio α is 0.35 in all σ and I, which is greater than the average. Moreover, offering a greater payment to licensor could bring higher value of C. This result suggests that a higher payment ratio might bring favourable consequences for the licensee by enhancing the commitment of the licensor, and a licensing contract is preferable in this phase. It is also possible to observe a clear relationship between the value of drug C and both σ and I in phase 2. The smaller the investment cost I is, the weaker the impact of market volatility σ becomes. The larger the investment cost I is, the more sensitive to the market volatility σ the value of drug C is. For phase 2, specific simulation cases are prepared. While the two consecutive investment costs are assumed to be the same in cases 4, 6 and 8, those amounts are assumed to increase in later phases in

cases 5 and 7. Comparing case 4 with case 5, or case 6 with case 7, the value of drug C decreases significantly only when the investment cost in later phase increases for a given σ. This means that if the investment cost is maintained as the same level as in the previous phase, or at least is not increased, the influence of market volatility σ is not significant. Conversely, the value of drug C is sensitive to the market volatility σ when the investment cost is expected to increase. This suggests that the licensing contract is still effective even when the investment cost is expected to increase, as long as the market volatility is predicted to be high.

Overall, the simulation results may not show a steep curve or clear cut. However, for realising a fair licencing contract negotiation, it is not meaningless but there still exits the peak of the drug value in each phase, and it varies depending on the phase. Thinking about the contract negotiation in general, it would be normal that we prepare the acceptable range that is predetermined beforehand. Also, it would not be uncommon that some unpredictable events or accidents would incur in the process of negotiation. Thus, if there is still the pointed peak, which could be the desirable target, we would not have to be so upset in the contingency situations for fear of losing the best consequence. When the acceptable range is wide, we could take steps for obtaining better outcomes of negotiations than the best one.

4. Conclusion

This article aims at providing a decision-making criterion and management insights for a licensing contract with a Real Option Approach. Constructing a model which incorporates the dynamic assumption of risk perception concept is the main contribution of this article. The results of the simulation show that a greater ratio is better in earlier phase, and a smaller ratio is better in later phase as a whole. The licensee can expect favourable consequences by increasing the licensor's commitment to R&D project by offering more payout ratio in early phase. In contrast, offering too much ratio might not be effective in later phases. This result is valid from the viewpoint of risk bearing and economical compensation. The licensee must pay a fixed amount to the licensor and bears the technical risk of R&D and the market risk when both

parties enter a contract in earlier phase. On the other hand, the licensor bears greater risk of relinquishing its innovative technology and/or secret know-how that has been incubated for a long time in later phase.

Interestingly, the simulation results also show that the investment cost plays an important role in each phase. It may determine the effectiveness of licensing contract as well as the market volatility of the drug. In later phase, the licensing contract itself may turn out to be doubtful if the investment cost is high. The licensing contract could become effective even if the investment cost is high, as long as the market volatility is predicted to be high. Moreover, the effectiveness of licensing contract could be valid even if the investment cost in the next phase is expected to increase when the market volatility is predicted to be high in early phase. In the case of low investment cost, the value of drug would not be affected so much by the market volatility of it.

As a summary, when entering a licensing contract, managers and those who are in charge of negotiation should take many factors into consideration such as the phase, the investment cost prediction, and the market volatility. In addition, incorporating the behavioural interactions of both parties to the licensing contract is critical for constructing a simulation model. In particular, the viewpoint of dynamic interaction is quite important and essential.

For improving this model, further theoretical developments are possible. For example, taking the concept of information asymmetry into account could make the model more precise, especially in terms of risk perception. This could make the simulation more realistic. For setting the value of the parameters, the method of game theory might be suitable. In addition to that, the topic of dynamic assumption of risk perception has also a room for the application. It is applicable not only for the drug R&D process but also for other evolving processes. The risk concept has become essential for all the investment decision issues. Further industry-tailored applications will be expected.

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Part Two: Application II.

Equity investment decision-making cost under the existence of convertible note holder in the second financing round

1. Introduction

In the textbooks of entrepreneurial finance, equity is the favourable form of the financing method for start-ups in the earlier stage because entrepreneurs do not need to pay the money to the equity investors (e.g., Smith et al., 2010, Leach and Melicher, 2016). However, convertible note is also one of the financing methods for start-ups in the earlier stages. Di Bacco and Ryan (2018) report that convertible debt financing has been a very popular method of fundraising for start-ups in the earlier stages. There is also the survey in 2015 by Marianne Hudson, who is an ACA (Angel Capital Association) Executive Director, 78% of ACA members had used at least one convertible note within the last 18 months[5]. Because of the high demand of the use of convertible notes, it is not difficult to find websites or books for entrepreneurs, which clearly explain the details of how to use convertible notes as a financing method and how to calculate the share after the note is converted into equity. This article is also using practical oriented books as a reference of the basic scheme of convertible notes, such as the one by Feld and Mendelson (2016) and by Poland (2017).

Although convertible notes are a common financing method for start-ups and venture businesses, it is not easy to deal with. Convertible notes are classified as 'mezzanine financing' which has both characteristics of debt and equity (e.g., Nijs, 2014). Convertible notes have the feature of option, in other words, the debt

[5] see. https://www.forbes.com/sites/mariannehudson/2015/08/12/convertible-notes-the-debate-continues/

holder has a right to convert it to equity if the situation becomes favourable. Thus, the existence of a convertible note holder could create a complicated situation, especially in the second financing round, if the entrepreneur wants to raise funds as equity. The interests of these three parties (the entrepreneur, the convertible note holder and new equity investors) are not always aligned. For a new equity investor, as well as the entrepreneur, whether the convertible note holder exercises the conversion option or not is a grave concern because the equity share could be diluted after the investment, at the expense of the increase of the share of the convertible note holder. Therefore, considering these parties' interactions is essential in the financing negotiation. However, so far, there are few academic researches and practical oriented guides that are dealing with this complicated relationship as a main topic.

In addition to the inherent complex features related to the use of convertible notes, investment and financing activities often lead to information asymmetric problems (e.g., Neher, 1999, Bengtsson, 2013). In the negotiation of investment and financing, the parties would normally be reluctant to reveal all the information they have in order to seal a deal as favourable for themselves as possible. Thus, an informational asymmetric situation is created because the parties are divided into the ones who are informed and the ones who are uninformed. Many academic researchers have addressed this issue related to the use of convertible notes. For example, Stein (1992) insists that corporations may use convertible bonds when adverse selection problems make a conventional stock issue unattractive. Lewis (1998) suggests that some issuers design convertible debt to mitigate asset substitution problems, while others design it to reduce adverse selection problems. Related to it, Bascha (2001) argues that the ex-ante agreed optimal exit policy can be implemented with convertible securities. Krishnaswami and Yaman (2008) argue that moral hazard and adverse selection are important determinants of the likelihood of issuing convertible bonds over straight bonds. Wang et al. (2009) explain the reason why convertible notes would be chosen by introducing two academic approaches: 'asymmetric information approach' which focuses on the mitigation effect of convertible note and 'incomplete contract approach' which focuses on the renegotiation possibilities after the investment.

Building on the explanations in Part One and the discussions above, we can understand that the asymmetric information problem is critical for financing negotiations especially when using convertible notes. As will be explained later, adverse selection is the important issue in this case. There are many

academic discussions which are focusing on the interactions between the convertible note holder and the entrepreneur in the early stage. Furthermore, the new equity investor who enters in the second financing round, so-called the Series A round, for example, should not be ignored. Nevertheless, the number of researches which are dealing with the whole relationship amongst the three actors are limited. Therefore, one of the objectives of this article is to build a model that is dealing with the interactions among these three key parties in the financing negotiation.

Furthermore, it can be logically predicted that the new equity investor must bear a kind of additional cost under the existence of a convertible note holder when entering the financing negotiation. In the financial literature, the costs related to the investment and financing have been discussed. This topic seems traditionally to be recognised as post-investment monitoring costs. For example, Gompers (1995) examines the structure of staged venture capital investments when agency and monitoring costs exist. Neher (1999) explains that the venture capitalists cannot observe whether the project has become a failure without bearing a monitoring cost. Pagano and Röell (1998) insist that the optimal ownership structure generally involves some measure of dispersion, to avoid excessive monitoring by other shareholders.

Considering both post investment monitoring cost and procurement cost is critical. Lewis et al. (2003) point out in their empirical study that convertible debt can be designed to mitigate different combinations of debt- and equity-related costs of external finance. However, it is not these kinds of costs but rather the cost for 'investment decision-making' that we should focus on especially in the second-round financing negotiation. The main objective of this article is to figure out this type of cost. In other words, this article is trying to reveal the mathematical form of cost for equity investment decision-making. In particular, the unique feature of the model is trying to incorporate the real option structure, as well as the adverse selection problem. In addition, for better understanding the cost, the case simulation is also implemented on the basis of the effect of discount rate and valuation cap that are accompanied with the convertible note contract (these are also explained in the later section).

The structure of this article is as follows. In section 2, the use of convertible note as a financing method is explained, along the line of basic financing scheme. In section 3, the model of cost for equity investment

decision making is developed. In section 4, the case simulation by using an actual start-up's data is conducted. In the section 5, conclusion is remarked.

2. Usage of convertible note as a financing method

2.1. What is convertible note?

Convertible note is classified as one of mezzanine financing methods. As its name suggests, mezzanine financing is classified as a financing method with an intermediate characteristic between debt and equity. From the perspective of an investor, the main feature of debt is financial obligation and contractual claim on the firms' assets, while the main feature of equity is the residual claim. Several famous mezzanine financing methods are known, such as convertible note, preferred share, option-linked bonds, step-up rate loans, second lien debt, PIK (Paid-in-kind) note, profit participating loans/rights, silent participation (Nijs, 2014). Although they belong to the same 'mezzanine financing' category, the degree of characteristic between debt and equity of each financial instrument is different. Preferred share is similar to equity because it is usually not prior to senior debt, while option-linked bonds are close to debt because their basic characteristic is contractual claim, for example.

Convertible note, which is sometimes called as convertible bond or convertible debt, has both features of debt and equity. Its basic feature is financial obligation. However, the convertible note holders have a right to convert the note to equity under some conditions after obtaining it as debt. This means that they can choose whether they keep it as debt or change it to equity, depending on the situations. In practice, it would be rational that the convertible note holders exercise their right to convert when the economic situation has changed and they could benefit by doing so. The definition of convertible note is provided from this perspective, and the way of defining it is almost the same in academic and in practice. As an example of definition in academic literature, Tirole (2006, p. 77) defines convertible note as "*one of the*

many claims that take the form of an option, which the holders can elect to exercise if circumstances are favourable. Convertible debt is basically debt, except that its holders can exchange it for the firm's shares at some predetermined conversion rate." On the other hand, from the practical perspective, for example, in his book for practitioners, Poland (2017, p.11) defines convertible note as follows: "*In a convertible debt investment deal (also referred to as a convertible note), the investor makes a loan to the company (the debt), and that loan converts into equity at some point in the future, with an extra bonus to the investor for taking on higher risk of the early-stage startup.*" The "extra bonus" in the last sentence of his definition can be interpreted as the similar meaning by Tirole of "at some predetermined conversion rate." The future convertible note holders can negotiate over the condition of conversion for their benefice as the compensation of bearing the debt with higher credit risk when convertible note is bought. Here, credit risk is the one that borrowers fail to meet their financial obligation in the due date. On the flip side, it can also be explained that the prospective convertible note holders can have a large expectation of the high valuation of the business in the second-round financing stage, which leads to favourable conditions for them to convert it to equity, thus they are willing to bear the credit risk. Therefore, convertible note is recognised as a tool for the holder to increase the future economic or financial benefits adjusting to its circumstance.

2.2. Why is convertible note used for start-up financing?

It would be rational to say that debt is not selected as an instrument for financing start-ups especially in the early stage, such as in the seed round, because the probability of failure of financial obligations is relatively high from the perspective of credit risk. In fact, however, convertible notes are favourably selected in this stage, as mentioned before. The prospective convertible note holders can expect that the business of the start-up will go well and that the value of the firm will increase in the near future. In that situation they could be more economically compensated by holding as equity (receiving dividends and selling out the share) rather than as debt (receiving the interests and repayment of its principal). This is not the only reason why convertible note is used for start-up financing. Although there is no widely accepted explanation in academic so far, several technical advantages are pointed out in practice. Poland (2017) points out three advantages: speed (of obtaining money at hand), lower legal fees, and delayed

valuation. It is often said (e.g., De Vries et al. 2016, Fled and Mendelson, 2016, Poland, 2017) that the valuation of the firm for equity investment, in the case of start-ups in particular, is onerous and time-consuming because it requires severe and detailed negotiations between the entrepreneur(s) and investor(s) until they reach an agreement. Moreover, the negotiation process for funding with convertible note is relatively simple. The parties must agree on only a few deal points and obtain money quickly. Start-ups need funds for achieving their goals, and the moment when they can have money at hand is a critical matter for them. Thus, speed is one advantage of using convertible notes for funding start-ups. Closely related to this matter, the legal processes for equity investment, including valuation and financing contract documentation, for example, is not simple, but rather complicated, and it is necessary to ask legal professionals such as attorney (or barrister) for advices (e.g., De Vries et al. 2016, Fled and Mendelson, 2016, Poland, 2017). Hence, the fees become more expensive than in the case of negotiations for funding with convertible notes. While these two matters are critical, the most important advantage of using convertible notes is for both entrepreneur(s) and investor(s) to delay the firm's or the project's valuation. Rather, it is to be able to avoid any complicated valuations at this moment. In the timing of funding with convertible notes, the business has just begun, and only the prototype product and/or service have been prepared. In this stage, the exact valuation of the firm or the project is almost impossible because little information is available, even though the investors have a feeling of great growth potential of the entrepreneur's business ideas and plans. It is not too late for both entrepreneur(s) and investor(s) to put a valuation after observing the realisation of its planned product and/or service and evaluating the progress of the business growth.

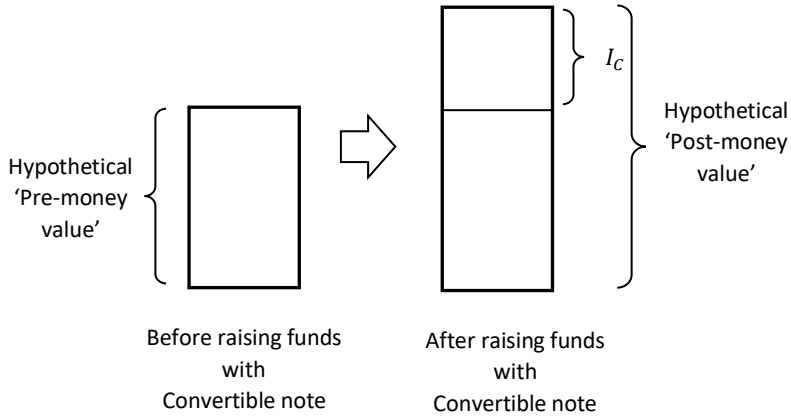
2.3. Basic scheme of procurement with equity and convertible note

In this subsection, the basic scheme of investment with convertible note is reviewed. Figure 21 shows the valuation in the early stage, such as Seed round. When entrepreneurs need funds for the business in the seed round, the investors such as Angels (or venture capitalists) would provide the necessary (or desired by entrepreneur) fund with a form of convertible note. I_C refers to the amount of investment as convertible note.

As mentioned above, while it would be normal that no valuation is agreed upon between the entrepreneur and the investor at the Seed round. At this round, hypothetical ‘pre-money value’ and ‘post-money value’ would be adopted, and, both entrepreneur and investor can enter into the financing negotiation less stressfully than in the equity financing negotiation which requires precise valuation. Thus, until the following financing round with equity such as Series A, B, C etc., they defer the difficult precise valuations (Figure 21).

Introducing the concepts of hypothetical ‘pre-money value’ and ‘post-money value’ can explain why convertible note is favourable for the entrepreneur in the early stage. For example, if the entrepreneur can succeed in raising money of $100K by convertible note and the hypothetical ‘pre-money value’ (=V_0) of its business can be evaluated as $100K, then the share for the entrepreneur is 50.00% and the one for the convertible note holder is also 50.00%. If the entrepreneur can succeed in raising money of $100K by convertible note and the hypothetical ‘pre-money value’ of its business can be evaluated as $900K because the time passes and the outcomes turns out to be better, then the share for the entrepreneur is 90.00% and the one for the convertible note holder is also 10.00%. Although this story is theoretical, the takeaway from it is that too early valuation could bring significantly lower share to the entrepreneur. In addition to the difficulty of valuation itself, this is also the reason why the entrepreneur wants to avoid too early valuation.

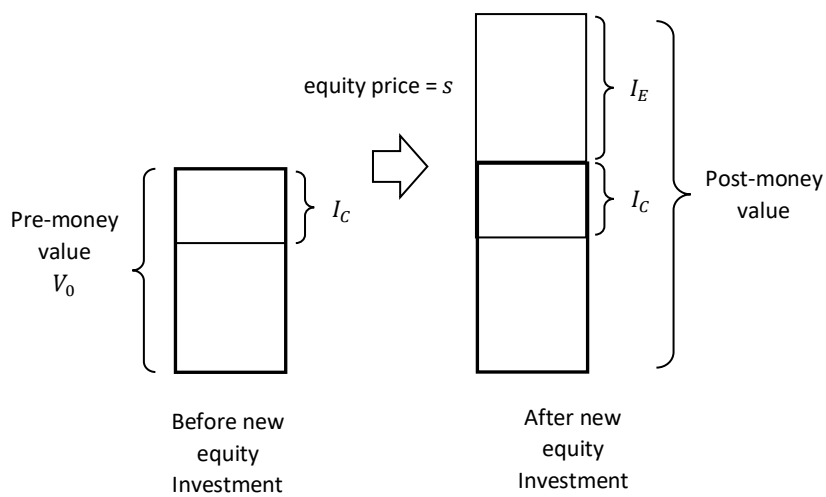
< Figure 21 The valuation in the Seed round >



The convertible note investors normally expect that the entrepreneur will progress towards his/her project realization and his/her business will grow enough to be able to encourage new equity investors, or enable 'second-round equity investors' to invest and to establish a next 'Series A round'. The period between the Seed round and the Series A round seems to be 6 to 12 months in many cases. Figure 22 shows what will be done at the Series A round.

In such a situation, the entrepreneur will explain the current situation and the prediction of his/her project and/or business to potential investors, and will propose the amount which he/she needs and wants to procure as equity (=I_E) in order to take a further step of his/her project and/or business. If potential investors are interested and fascinated by the explanations, the negotiation about the price of the new equity (=s) will begin. At the same time, the amount of the pre-money value at this moment (=V_0) will be also negotiated and determined, on the basis of the hypothetical 'post-money value' in the Seed round. If they reach an agreement, the equity investment will be implemented.

< Figure 22 The valuation in the Series A round >



2.4. Dilution problem for equity investors in the presence of convertible note

On the contrary to the procurement with debt instruments, the entrepreneur does not need to repay the money when it is procured with equity. However, it does not mean 'free-lunch.' The effect of share dilution for the entrepreneur should be considered. The problem should also be critical for potential equity investors, when convertible note holders exit before they make their investment decision. The share of equity represents the degree of controlling power of running the firm. Thus, the dilution problem is quite sensitive for both the entrepreneur and investors, and this problem is the central topic of this article.

Tables 8 and 9 show this situation (in practice, it seems to be called as 'cap table'). The share for entrepreneur will decrease 100% to $\frac{V_0}{V_0+I_C} \times 100$ % in the case without convertible note holder, and to $\frac{V_0}{V_0+I_c+I_E} \times 100$ % in the case with convertible note holder. The share for the second-round equity investor will also decrease from $\frac{I_E}{V_0+I_E} \times 100$ % to $\frac{I_E}{V_0+I_c+I_E} \times 100$ % in the presence of convertible note holder.

< Table 8 Share at the second round (without conversion) >

	< Number of shares >	< Percentage of shares >
Entrepreneur	$\frac{V_0}{s}$	$\frac{V_0}{V_0+I_E} \times 100$
Second-round equity investor	$\frac{I_E}{s}$	$\frac{I_E}{V_0+I_E} \times 100$
< Total >	$\frac{V_0+I_E}{s}$	100

< Table 9 Share at the second round (with conversion) >

	< Number of shares >	< Percentage of shares >
Entrepreneur	$\frac{V_0}{s}$	$\frac{V_0}{V_0 + I_c + I_E} \times 100$
Convertible notes holder	$\frac{I_C}{s}$	$\frac{I_C}{V_0 + I_c + I_E} \times 100$
Second-round equity investor	$\frac{I_E}{s}$	$\frac{I_E}{V_0 + I_c + I_E} \times 100$
< Total >	$\frac{V_0 + I_c + I_E}{s}$	100

There are other factors that can be considered in this dilution problem when raising funds with convertible notes: the business practice of 'discount' and 'valuation cap'. The former means that the negotiated new equity price (=s) should be reduced to some extent when calculating the share for the convertible note holder. The latter means that that the pre-money value is fixed at the pre-agreed value between the entrepreneur and the convertible note holder, no matter how much the pre-money value is agreed in the equity investment negotiation. These can be used as either a single practice or a combined one.

For better understanding, let's consider the following simple numerical example. An Angel investor invests \$25k in a start-up's seed round using a convertible note with a \$5M cap, 20% discount. The start-up succeeds in raising money as equity, with a pre-money valuation of \$10M and an equity price of \$5.00 at the Series A round. If the discount is applied, the equity price for calculating the convertible note holder's share should be \$5.00×(100 – 20%) = \$4.00. If the valuation cap is applied, then the price should be \$5.00×(\$5M cap ÷ \$10M pre-money value) = \$2.50, which is equivalent to a 50% discount. When calculating the share, the latter is favourable for the convertible note holder because the share is

determined by the equation of the investment amount of \$25k ÷ the equity price calculated. Thus, if this price of \$2.50 would be adopted, the share will be 10,000. On the contrary, if a pre-money valuation is \$6M, and the discount is applied, the price should be the same one of \$4.00. If the valuation cap is applied, then the price should be \$5.00×(\$5M cap ÷ \$6M pre-money value) = \$4.17. In this case, if the price of \$4.00 is adopted, the share will become 6,250.

As can be seen from the above example, both 'discount' and 'valuation cap' can reward the convertible note investors who bear the high risk of the start-up's business failure by increasing the equity share after conversion. Hence, both the discount rate and the amount of cap are important topics for the convertible note investor in the negotiation with the entrepreneur. The earlier they invest, the deeper discount and/or the lower amount of the valuation cap would be required. Although there are no academic researches, it is said that this discount rate is set within the range between 15% to 25% in practice, according to Poland (2017), for example.

One might argue that the discount and the valuation cap are different. However, for modelling the situation from the viewpoint of the dilution problem, these can be expressed as the discount rate because both are represented with the equity price. In addition to this point, the discount rate is numerically easier to be handled than the valuation cap. Let the discount rate be α $(0.00 < \alpha < 1.00)$. The equity price for calculating the share for the convertible note holder should be changed from s into $s \times (1 - \alpha)$. Table 9 is changed into Table 10.

< Table 10 Share at the second round (with convertible note holder' discount) >

	< Number of shares >	< Percentage of shares >
Entrepreneur	$\frac{V_0}{s}$	$\frac{V_0}{V_0 + I_c/(1-\alpha) + I_E} \times 100$
Convertible notes holder	$\frac{I_C}{s(1-\alpha)}$	$\frac{I_C/(1-\alpha)}{V_0 + I_c/(1-\alpha) + I_E} \times 100$
Second-round equity investor	$\frac{I_E}{s}$	$\frac{I_E}{V_0 + I_c/(1-\alpha) + I_E} \times 100$
< Total >	$\frac{V_0 + I_c/(1-\alpha) + I_E}{s}$	100

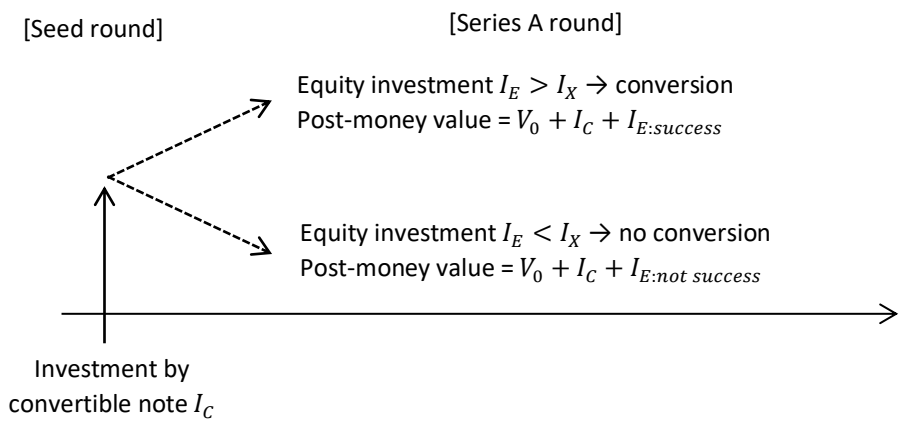
2.5. Conversion into equity: real option structure

According to the relationship of the equity price and the effect of discount and/or valuation cap above, it can be written as $\mathrm{s} \times (1-\alpha) = \mathrm{s} \times (V_{cap}/V_0)$, or $1-\alpha = V_{cap}/V_0$, where V_{cap} represents the amount of valuation cap that is determined through negotiation between the entrepreneur and the convertible note holder. It is obvious that the greater the pre-money value of V_0 becomes, the greater the discount α should be. This means that if the business goes well and the expectation of the future success increases, in other words, the pre-money value is evaluated to be high, the effect of valuation cap becomes larger. It is the very situation where convertible note holders are expecting because they can convert their debt into equity, which becomes more favourable in such a situation. New equity investors would also be attracted to the project and be willing to invest their funds. On the contrary, if the business does not go as desired, and the pre-money value is evaluated to be not so high as estimated, or lower, this situation is not suitable for convertible note holders to convert their debt right now. They would rather wait to execute the conversion, because whether they execute it or not is by nature a right but not an obligation.

This mechanism is the answer to the question of "when the conversion will be executed?" In practice, three conversion trigger cases are often pointed out. According to Poland (2017), these are on 'threshold financing', on IPO, and by 'elective conversion'. The first one means that conversion is executed when the entrepreneur succeeds in raising funds more than the pre-agreed amount in the next financing round. The second one means that conversion is executed only when an IPO is realised. The last one means that conversion is executed at any time if 'threshold financing' is not implemented. Although there is no clear guidance of conversion in academia so far, the first one of conversion on 'threshold financing' may be the most common in practice, especially in the United States (Poland, 2017). Along the 'elective conversion', in this case, the conversion will be executed when the entrepreneur succeeds in obtaining more amount of investment from new equity investors than the pre-determined 'threshold' amount, which is represented as I_X, in the Series A round.

Taking the situations above into consideration, the real options analysis can be applicable to this conversion mechanism. According to Copland and Antikarov (2003), the real option is the right, but not the obligation, to take an action (e.g., deferring, expanding, contracting, or abandoning) at a predetermined cost called the exercise price, for a predetermined period of time. In this case, the pre-determined amount of investment from new equity investors corresponds to the 'exercise price', and a 'predetermined period of time' is the one between the Seed round and the Series A round, which is around twelve months. The conversion mechanism can be characterised as the option to wait (or option to defer) for convertible note holders to convert their debt to equity. Wang et al. (2009) explain that convertible notes give the firms a "back door" to equity and give investors an opportunity to wait and see if the project is worth investing in. This is represented in Figure 23 below.

< Figure 23 Real Options structure of conversion >



3. New equity investors' concern: Adverse selection

3.1. New equity investors' concern

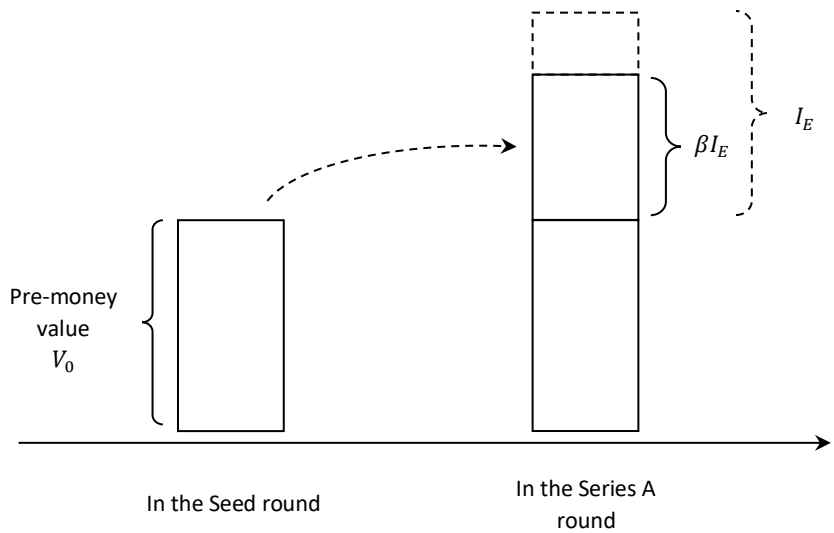
The methods of both discount and valuation cap in the previous subsection are a reward for the convertible note holder who has borne credit risk and provided funds to the start-up business in the earlier stage. Due to the effect of discount and/or valuation cap, nevertheless, the situation becomes unfavourable for new equity investors because they must reconcile to the lower share, comparing to the situation where convertible note holders do not exist. Thus, the negotiation between new equity investors and the entrepreneur might not proceed smoothly in the second financing round. In fact, Feld and Mendelson (2016, p. 109) point out this concern as follows: "*Unlike equity, which is issued and can't be changed, the new equity investors could refuse to fund unless the debt investors remove or change the cap. Keep in mind that VCs will normally focus and peg their valuation of your company on that cap.*" The debt

investors in this context means convertible note holders. As far as the valuation cap is concerned the negative influence for new equity investors is not differentiated from the case of discount.

The most important point to be noticed in their statement is that "the new equity investors could refuse to fund." This statement could be backed by the following simple numerical example. Let's assume that $V_0 = 2.0$, $I_C = 0.5$, $I_E = 2.0$ (all are \$M). If $\alpha = 0.2$, the share of the convertible note holder and the one of Second-round equity investor are 13.51% and 43.24% respectively, according to Table 10. If $\alpha = 0.6$ due to the effect of valuation cap etc., the shares are 23.81% and 38.10%. Thus, the share of the Second-round equity investor is still greater. On the contrary, in the case where $V_0 = 2.0$, $I_C = 1.0$, $I_E = 2.0$ (all are \$M), if $\alpha = 0.2$, the share of the convertible note holder and the one of the Second-round equity investor are 23.81% and 38.10% respectively. If $\alpha = 0.6$, the shares change into 38.46% and 30.77%, in other words, the share of the Second-round equity investor can be lower than the one of the convertible note holders.

Even if this might be an extreme case, it can be said that the new equity investor shall always be cautious about the pre-determined term conditions of conversion when the convertible note holders exist. In fact, the new equity investor is not always willing to provide the full amount of fund requested by the entrepreneur, and the amount that would be actually invested is normally determined though negotiations. On the other hand, bargaining parties generally would not like to reveal all the information they have during the negotiation. Material information should, of course, be opened for better dealings. However, some of the private information would still remain unveiled to obtain as favourable term conditions as possible. It is also true for financing contract negotiations between an entrepreneur and new equity investors in the Series A round. As Hsu (2010) points out, it may be because the main goal of an entrepreneur is to maximize a probability of raising funds in the next financing round, while the aim of an equity investor is to maximise the value of firm or project. Thus, when the new equity investor is in such a situation, but he/she still has an interest in the venture project and an expectation of success, it is rational to assume that he/she would propose a reduced amount. Introducing a reducing investment coefficient β ($0.00 < \beta \leq 1.00$) can represent the degree of concern for the new equity investor, as also shown in Figure 24 and Table 11.

< Figure 24 The valuation in the Series A round Under the existence of convertible note holder >



< Table 11 Share at the second round (with new equity investor's concern) >

	< Number of shares >	< Percentage of shares >
Entrepreneur	$\frac{V_0}{s}$	$\frac{V_0}{V_0 + I_c/(1-\alpha) + \beta I_E} \times 100$
Convertible notes holder	$\frac{I_C}{s(1-\alpha)}$	$\frac{I_C/(1-\alpha)}{V_0 + I_c/(1-\alpha) + \beta I_E} \times 100$
Second-round equity investor	$\frac{\beta I_E}{s}$	$\frac{\beta I_E}{V_0 + I_c/(1-\alpha) + \beta I_E} \times 100$
< Total >	$\frac{V_0 + I_c/(1-\alpha) + \beta I_E}{s}$	100

If a new equity investor proposes a reduced amount to the entrepreneur, the share of the new equity investor becomes lower. Using the numerical example above again for better understanding, in the case where $V_0 = 2.0$, $I_C = 1.0$, $I_E = 2.0$ (all are \$M), if $\alpha = 0.2$ and $\beta = 0.5$, the share of the convertible note holder and the one of the second-round equity investor are 29.41% and 23.53% respectively, while if $\alpha = 0.6$, the shares become 45.45% and 18.18%. In both situations, the share of the new equity investor is lower than that of the convertible note holder. However, if the new equity investor evaluates that the project is economically attractive as one component of his/her portfolio, he/she could still provide some amount of funds and obtain some equity share, though he/she must give up controlling power as a majority (This can be represented as over 33.33%, for example).

3.2. Adverse selection problem in equity financing contract

One question arises: what kind of problem should be incorporated? The economics literature on asymmetric information problems is very well developed. The common subtitles of asymmetric information are moral hazard, adverse selection and signalling. In the microeconomics literature, Mankiw (2007), for example, defines these concepts as follows: Moral hazard is "*the tendency of a person who is imperfectly monitored to engage in dishonest or otherwise undesirable behaviour. (p.507)*" Adverse selection is "*the tendency for the mix of unobserved attributes to become undesirable from the standpoint of uninformed party. (p.505)*" *Signalling is "an action taken by an informed party to reveal private information to an uninformed party. (p.508)*" Macro-Stadler and Pérez-Castrillo (2001) set forth these in a more precise way: "*a moral hazard problem exists when the agent's action is not verifiable, or when the agent receives private information after the relationship has been initiated. (p.9)*" "*an adverse selection problem appears when the agent holds private information before the relationship is begun. (p.11)*" *"(signalling) this situation is similar to adverse selection. However, after learning his type, and before signing the contract, the agent can send a signal that is observed by the principal (p.12.)*" Salanié (2005) explains these terms for the purpose of modelling: moral hazard refers to "the uninformed party moves first and is imperfectly informed of the actions of the informed party." Adverse selection refers to "the uninformed party is imperfectly informed of the characteristics of the informed party; the uniformed party

moves first." Signalling refers to "the informational situation is the same (with adverse selection) but the informed party moves first."

Macro-Stadler and Pérez-Castrillo are explaining these terms from the principle-agent model perspective. They are at the same time explaining the following three basic features for modelling principle-agent relationship: (1) The principal designs the contract, or set of contracts, that he/she will offer to the agent. (2) The agent accepts the contract if he/she desires, that is if the contract guarantees him/her greater expected utility than other opportunities available to him/her. (3) The agent carries out an action or effort on behalf of the principal. Looking at the contract negotiation in the Series A round from the perspective of principle-agent model, it is the new equity investor who offers equity (as I_E or βI_E), and it is the entrepreneur who accepts the offer and carries out the effort to grow the venture business by using this equity. Therefore, the new equity investor corresponds to the principal and the entrepreneur corresponds to the agent. It is the new equity investor who has concerns about the possibility of dilution problem due to the existence of the convertible note holder, and it is the entrepreneur who has all the information about the term conditions with the convertible note holder and the more private (insider) information about their business. In other words, it is the new equity investor who is the 'uninformed party' and it is the entrepreneur who is the 'informed party'. In addition, in the Series A round, the new equity investor as 'uninformed party' moves first, though the entrepreneur provides the draft offer before going into negotiation. Taking all these into consideration, there is in this situation an adverse selection problem.

4. Modelling the cost for equity investment decision making

4.1. Modelling of adverse selection effect: Two-type model

The modelling of adverse selection is often discussed on the basis of the principal-agent model which assumes two types of agents. The model constructed in this subsection is inspired by the one of Macho-Stadler and Pérez-Castrillo (2001) and Salanié (2005).

In the adverse selection model, the entrepreneur (agent) is imperfectly observed by the new equity investor (principal). In this article, the two types of entrepreneurs (agents) are defined as 'good' type and 'bad' type. This concept is in line with the modelling by Koufopoulos (2009) of securitizing under the existence of information asymmetry. The former 'good' type can be interpreted as the entrepreneur who is relatively willing to reveal the information about the contract with convertible note holders to the new equity investor in the financing negotiation in the Series A round. This could be because such an entrepreneur would often be confident in the success of the venture business, thus, the convertible note holder would not have asked for the deep discount and/or small amount of valuation cap, and the entrepreneur has fewer reasons to be reluctant to share the information he/she has in the negotiation. Therefore, such 'good' type of entrepreneur could obtain the higher equity. On the contrary, the latter can be interpreted as an entrepreneur who has the opposite characteristics. Such 'bad' type of entrepreneur would be relatively reluctant to reveal the information, not only about the contract with the convertible note holder but also about the likelihood of the venture business success. The convertible note holder may have asked for the deep discount and/or small amount of valuation cap. The new equity investor may also have some kind of anxiety and the amount of investment would be lower.

For starting to construct the adverse selection model, it is normal to set the utilities for both the new equity investor (principal) and the entrepreneur (agent). In the context of second-round financing, the entrepreneur obtains an economic benefit with the form of fund at the expense of giving up some

proportion of control benefit, which is represented as equity share. Borrowing the idea proposed by Salanié (2005), the utility for the entrepreneur can be written as follows:

$$U_{entrepreneur} = \theta q - t$$

Where

q: equity investment amount that entrepreneur obtains (or, investor offers: $q_g > q_b$)

θ: index of entrepreneur type

t: control benefit associated with the share of equity

The first term of θq represents the economic benefit. θ represents the index of entrepreneur type (or the agent's private characteristics), and θ_g indicates the 'good' type, θ_b is the 'bad' type ($\theta_g > \theta_b$). In the context of financing, the more shares the new equity investor grasps, the more deeply they can become engaged in the venture business. Many academic researches show that the engagement of venture capitalists can have positive influences on the venture business and become helpful for an entrepreneur to progress his/her business (e.g., Bertoni et al., 2011, Croce et al., 2013). As defined above, the 'good' type of entrepreneur is relatively willing to reveal the information, and in exchange for it, he/she will be able to succeed in the financing negotiation contract. As a consequence, he/she can obtain more amount of investment and easily gain the more advice for the business success in proportion to the equity share of the new investor, such as an experienced venture capitalist. On the other hand, the 'bad' type of entrepreneur does not have a willingness to reveal the information actively, and it might be difficult to gain the investment and support. Therefore, the degree of θ can be interpreted as the degree of help obtained from venture capitalists as represented by the positive function of the proportion of its equity share, in exchange for the tender of the private information that the entrepreneur has. The control benefit, which is represented by t, is associated with the share of equity. This benefit is closely linked to the power of voting right for the company's material decision-makings. As Fled and Mendelson (2016, p. 38) argue: "*Control refers to the mechanisms that allow the investors either to affirmatively exercise control over*

the business or to veto certain decisions the company can make." In this case, if the entrepreneur could obtain larger amount of funds as equity, then he/she must give up more control benefit.

For financing, the new equity investor provides the fund, and in exchange for it, he/she can obtain the control benefit as the equity share. Borrowing the idea proposed by Salanié (2005) as well, the utility of the new equity investor can be written as follows:

$$U_{new\ equity\ investor} = t - C(q)$$

Where

$C(q)$: cost for decision-making of new equity investor

This cost means the necessity for the new equity investors to implement due diligence when they scrutinise whether they invest or not. As mentioned before, the new equity investor does not know well the characteristics of the entrepreneur nor about the degree to which the entrepreneur is willing to reveal the private information. This due diligence is not an easy task. Therefore, it is rational to think of this kind of cost. Needless to say, the cost required for the new equity investor is not limited to the due diligence of the entrepreneur's characteristics. The due diligence of the product and/or service is also necessary, for example. However, for simplicity, this article focuses only on the cost due to the information asymmetry caused by the characteristics of the entrepreneur or the willingness of unveiling the private information. In this sense, this cost could also be called as "additional" cost.

According to the microeconomic theory, if a seller of some kind of goods (e.g. smart phone) as principal can observe the type θ_i (e.g. i = 'big fun of the seller' as 'good' type or 'normal type' as 'bad' type) of the buyer as agent, the principal can charge higher price to 'good' type of buyer than to 'normal' type because the former type wants to obtain the goods literally at any cost, even if the price is higher. This is called as first-best or perfect discrimination, and the principal's surplus is maximised. For the equity

financing round, the same structure can be thought. In the case that the new equity investor can observe whether the entrepreneur is 'good' type or 'bad' type, the new equity investor as principal will solve the following problem:

$$\max_{q_i, t_i} \left(t_i - C(q_i) \right),$$

Subject to

$$\theta_i q_i - t_i \geq 0$$

For the principal, zero surplus left for the agent can lead the optimum of the utility, thus, it can be thought as:

$$t_i^* = \theta_i q_i^* \quad (i = \text{'good' or 'bad'})$$

In the adverse selection model, the new equity investor (principal) is assumed not directly to be able to observe the type of entrepreneur (agent). Thus, the perfect discrimination is infeasible, and it is necessary to consider the second-best. In this situation, the principal will design the menu of contract: It is (q_g, t_g) (q_b, t_b). According to the revelation principle, the 'good' type will choose the former, and the 'bad' type will do the latter. Assuming that the principal only knows that the probability of encountering the 'bad' type entrepreneur, which is represented as π. The focus is on the best pair of contracts (the second-best optimum), and this is obtained by solving the following:

$$\max_{q_b, t_b, q_g, t_g} \left[\pi \times \left(t_b - C(q_b) \right) + (1 - \pi) \times \left(t_g - C(q_g) \right) \right]$$

Subject to

$$\theta_b q_b - t_b \geq \theta_b q_g - t_g \text{ (IC}_1\text{)}$$

$$\theta_g q_g - t_g \geq \theta_g q_b - t_b \text{ (IC}_2\text{)}$$

$$\theta_b q_b - t_b \geq 0 \text{ (IR}_1\text{)}$$

$$\theta_g q_g - t_g \geq 0 \text{ (IR}_2\text{)}$$

The first two constraints are called as the incentive compatibility constraints (IC_1, IC_2). They state that each agent prefers the contract that was designed for him. The last two constraints are called as the individual rationality or participation constraints (IR_1, IR_2). They guarantee that each type of agent accepts his/her designed contract.

If IR_1 is inactive, so would be IR_2, and if it can be assumed to increase t_b and t_g by the same amount. This would increase the principal's utility without any effect on incentive compatibility. Thus, IR_1 should be active and $\theta_b q_b = t_b$. In a similar way, if IC_2 is inactive, then $\theta_g q_g - t_g > \theta_g q_b - t_b \geq \theta_b q_b - t_b = 0$. Thus, it is possible to increase t_g without breaking the incentive compatibility constraints or the individual rationality, and can lead to increase the principal's utility. It is not optimal. Therefore, IC_2 should be active, and

$\theta_g q_g - t_g = \theta_g q_b - t_b \Leftrightarrow t_g = t_b + \theta_g(q_g - q_b)$. Considering the case of first best contract for 'good' type, $q_g = q_g^*$, $t_g = t_b + \theta_g(q_g - q_b)$ can be $t_g = t_b + \theta_g(q_g^* - q_b)$

Then, $\max\limits_{q_b, t_b, q_g, t_g} \left[\pi \times \left(t_b - C(q_b)\right) + (1-\pi) \times \left(t_g - C(q_g)\right)\right]$ can be rewritten as follows:

$$\Leftrightarrow \max_{q_b, t_b, q_g} \left[\pi \times \left(\theta_b q_b - C(q_b)\right) + (1-\pi) \times \left(t_b + \theta_g(q_g^* - q_b) - C(q_g^*)\right)\right]$$

$$\Leftrightarrow \max_{q_b, q_g} \left[\pi \times \left(\theta_b q_b - C(q_b)\right) - (1-\pi) \times \left((\theta_g - \theta_b) q_b + \theta_g q_g^* - C(q_g^*)\right)\right]$$

In the optimal situation, $\theta_g q_g^* - C(q_g^*) = 0$, thus,

$$\Leftrightarrow \max_{q_b} \left[\left(\theta_b q_b - C(q_b)\right) - \frac{1-\pi}{\pi} \times \left((\theta_g - \theta_b) q_b\right)\right]$$

$$\Leftrightarrow C'(q_b) = \theta_b - \frac{1-\pi}{\pi} \times \left(\theta_g - \theta_b\right) = \frac{1}{\pi}\theta_b - \frac{1-\pi}{\pi}\theta_g$$

In the perspective of mathematics, a constant value should be necessary when reverting the first derivative to its original function. In the course of discussion above, it can be interpreted as the minimum cost for equity investment decision-making. However, this value can be zero because the due diligence is not necessary when the investment amount q_b is zero, in other words, the equity financing is not provided. Therefore, for the new equity investor, the form of the cost of decision-making under the informational asymmetry situation can be expressed as follows:

$$C(q_b) = \left(\frac{1}{\pi}\theta_b - \frac{1-\pi}{\pi}\theta_g\right) \times q_b \ \ldots (1)$$

In this context, $q_b = \beta I_E$. Furthermore, this cost should be positive, and the following non-negative condition is added:

$$\frac{1}{\pi}\theta_b - \frac{1-\pi}{\pi}\theta_g > 0 \Leftrightarrow 1 - \pi < \frac{\theta_b}{\theta_g} < 1$$

4.2. Incorporation of real option structure into modelling of the index of entrepreneur type

Assuming that the 'good' type entrepreneur will settle the second-round financing negotiation successfully and obtain the full investment amount that he/she has desired beforehand, the 'bad' type will not be able to do as he/she has expected. The consequence influences on whether convertible note is converted into equity. As also mentioned in the section of 2.5, this structure can be the real option. If the entrepreneur fails to obtain more equity amount than the pre-determined 'threshold' I_X, the convertible note holder will exercise the option to defer for the conversion. At the same time, θ represents the characteristics of the

entrepreneur as defined above. Considering that θ is a component of the economic benefit term of θq, it is the indicator or index of the beneficial effect of advice for the business success, which can be obtained in proportion to the equity share of the new equity investor. The 'bad' type entrepreneur would find it difficult to gain enough supports from venture capitalists, comparing to the 'good' type. Being based on the real option structure, θ corresponds to the percentage of share of the new equity investor as follows:

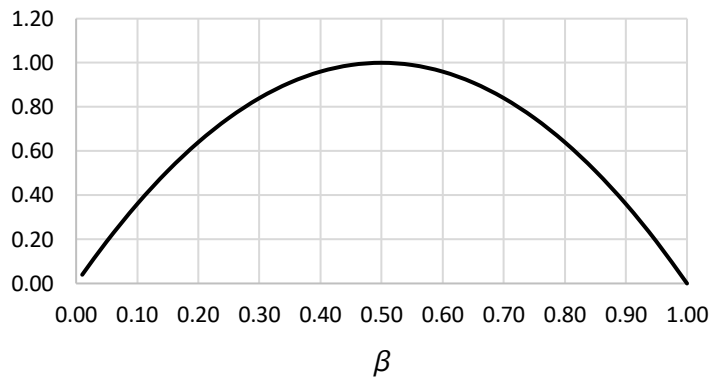
$$\theta_g \rightarrow \frac{I_E}{V_0+I_c/(1-\alpha)+I_E},$$

$$\theta_b \rightarrow \frac{\beta I_E}{V_0+I_c/(1-\alpha)+\beta I_E} \ (\textit{conversion}), \text{ or } \ \theta_b \rightarrow \frac{\beta I_E}{V_0+\beta I_E} \ (\textit{non-conversion})$$

Whether the conversion is implemented or not is a quite critical concern for new equity investors because their share will decrease from $\frac{\beta I_E}{V_0+\beta I_E}$ to $\frac{\beta I_E}{V_0+I_c/(1-\alpha)+\beta I_E}$, especially when considering the case of the 'bad' type entrepreneur. This influence of conversion can be expressed by using the rate of change of $\left(\frac{\beta I_E}{V_0+\beta I_E} - \frac{\beta I_E}{V_0+I_c/(1-\alpha)+\beta I_E}\right) / \frac{\beta I_E}{V_0+\beta I_E}$.

From the convertible note holder perspective, the likelihood of conversion is not constant, rather it depends on the equity investment amount, which is represented with βI_E. In the situation of lower β where the new equity investor is reluctant to invest, the convertible note holder would almost certainly wait to convert his/her debt. In the situation of higher β where the new equity investor is willing to invest, the convertible note holder would certainly convert. Whilst these situations are not so problematic for the new equity investor, and the degree concern is low, the situation of neither low nor high β makes their degree of concern increase. Thus, the influence of conversion should be modified by this factor. Let's call this factor an impact modification factor, and it can be assumed as $-4(\beta - 0.5)^2 + 1$, as shown in Figure 25.

< Figure 25 Impact modification factor >



Recalling the situation how the entrepreneur obtains the advice and support from equity investors, such as venture capitalists, the 'good' type will be able to enjoy fully the benefits of advice and support from venture capitalists, while the 'bad' type will not be able to do so and his/her index can be set as the reduced value. Thus, the index of this 'good' type can be set as a benchmark of 1:

$$\theta_g = 1 \ldots (2)$$

In addition to those above, the non-negative condition of $1 - \pi < \frac{\theta_b}{\theta_g} < 1$ should be taken into account. For mapping a variable x in the range of $0 < x < 1$ into the range of $1 - \pi < x' < 1$, the mathematical manipulation of $x' = \pi \times x + (1 - \pi)$ is added.

Combining all the discussions above, θ_b can be obtained as follows:

$$\theta_b = \pi \times \left[\left(\frac{\beta I_E}{V_0 + \beta I_E} - \frac{\beta I_E}{V_0 + I_c/(1-\alpha) + \beta I_E}\right) / \frac{\beta I_E}{V_0 + \beta I_E} \times (-4(\beta - 0.5)^2 + 1)\right] + (1 - \pi) \ldots (3)$$

Plugging θ_g (equation (2) and θ_b (equation (3)) into the cost function of decision-making (equation (1)), we can obtain the model that evaluates how the cost will be affected by the discount rate α and the reducing investment coefficient β. In this process, the effect of π can be eliminated.

In the next section, the case simulation is implemented for the purpose of better understanding of this cost which is theoretically derived from the discussions above.

5. Numerical simulations

In this section, the numerical simulation is implemented by using the data example based on actual medical start-up. This company was able to succeed in raising funds as convertible notes of $3.85 million, and later, called for the equity of $11.80 million as shown in Table 12.

< Table 12 The realised investment amounts >

Date	Type	Offered (million$)	Sold (million$)
31/Jul/20X7	Convertible Securities	3.85	3.85
13/Nov/20X7	Series A	11.80	4.00

The values for this simulation are as follows:

$V_0 = 4.00$ (million$)

$I_C = 3.85$ (million$)

$I_E = 11.80$ (million$)

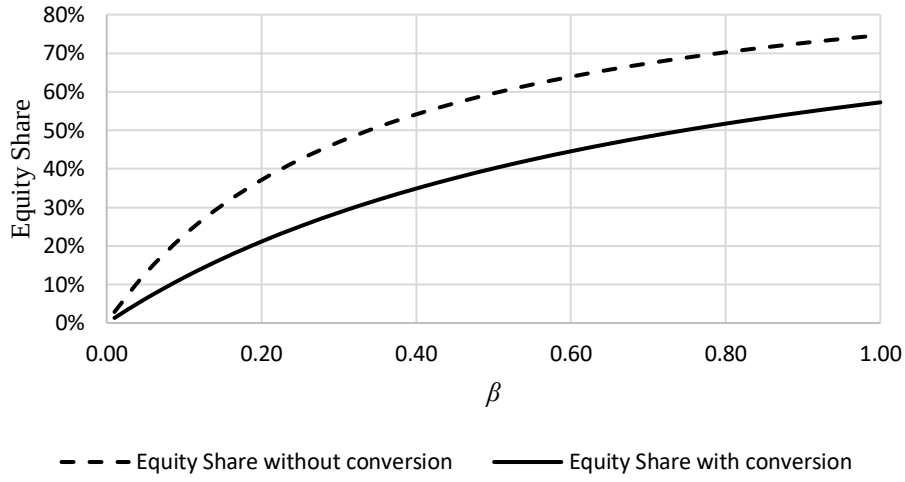
If the new equity investors agree to the entrepreneur's request, they will provide 11.8 million $. Although the actual pre-money value is not possible to be known, the estimated value of $4.00 million is used.

5.1. Simulation result of the effect of discount rate for convertible note holder

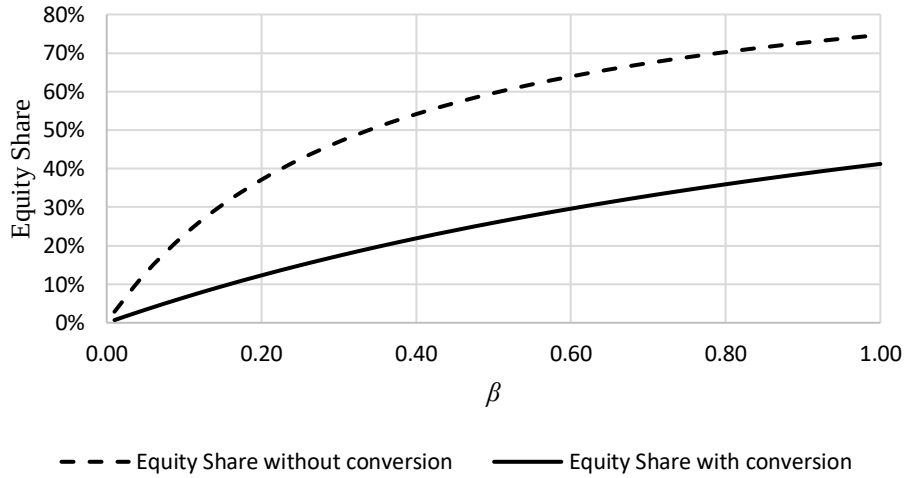
As mentioned in the section 3.1, the new equity investor is quite concerned about the existence of convertible note holders because whether the debt is converted into equity is uncertain. In addition, what amount of the discount rate or valuation cap have been determined is also quite difficult to know for new equity investors because this is one of the materials for financing negotiation. Thus, the effect of discount rate (or valuation cap) is a critical element to understand. The equation for this simulation comes from Table 8 and 9, and the results are shown in Figure 26 and 27.

Figure 26 shows the simulation result in the case of the discount rate $\alpha = 0.20$. This rate may be the normal setting in the negotiation between the entrepreneur and the convertible note investor. If this discount rate is applied, the share for new equity investor will be diluted by the range from 23% to 54% when the convertible note holders exercise their conversion option. This effect is large in the range of lower coefficient β, however, the conversion will normally be deferred. Thus, the effect of dilution shall be thought around 25% to 30%. As shown in Figure 27, it is not uncommon that the convertible note investor requires the deep discount $\alpha = 0.70$, for example, as the small amount of valuation cap against pre-money valuation. In this case, the share for the new equity investor will be diluted by around 45% to 55% in a similar manner. We can verify even in the practical financing situation that the dilution effect by the discount rate and valuation cap is significant, and it is no doubt that the new equity investor will have concerns about the contract details with the convertible note holder when negotiating the amount of equity investment with the entrepreneur in the second financing round, such as the Series A.

< Figure 26 Equity Share for new investors (α=*0.20*) >



< Figure 27 Equity Share for new investors (α=*0.70*) >



5.2. Simulation result of the cost of equity investment decision-making

As being verified above, the impact on the dilution of equity share by the discount rate and valuation cap is significant. If the entrepreneur reveals this kind of contract details with the convertible note holder, the new equity investor's concern will be largely resolved. Nevertheless, if the entrepreneur's main goal was just to maximise a probability of raising funds in the next financing round, the information would be revealed only within the necessity of negotiation, and it may be still kept unveiled. Thus, the cost of equity investment decision-making becomes unignorable for the new equity investor under such a situation of asymmetric information. In particular, the relationship between the effect of discount rate and valuation cap and the cost for equity investment decision-making becomes essential.

The simulation result of the cost for equity investment decision-making is shown in Figure 28. When the new equity investor provides the full amount that the entrepreneur desires or calls for beforehand ($\beta = 1.00$), the cost will be zero because it is assumed that the entrepreneur is willing to reveal all the information, thus, no concern is generated for equity investment decision-making. In a similar manner, the cost will also be zero when the investor does not provide any funds ($\beta = 0.00$). On the other hand, when the new equity investor is wondering what amount of equity should be provided, the cost for decision-making becomes increased. These are the extreme situations that are almost free from the information asymmetry problem.

< Figure 28 Cost of equity investment decision-making >

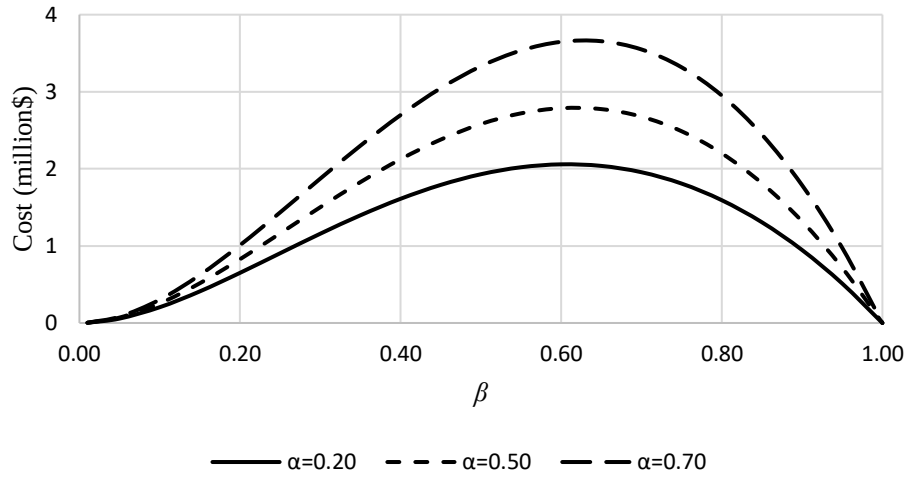


Figure 28 shows that the cost becomes expensive when the new equity investor is thinking of reducing the investment amount, in which the information asymmetry problems stand out. According to the simulation result, the cost becomes maximised at $\beta = 0.61$ when $\alpha = 0.20$, at $\beta = 0.62$ when $\alpha = 0.50$, and at $\beta = 0.63$ when $\alpha = 0.70$, respectively. The result shows that under the existence of convertible note holder and information asymmetry, the new equity investor's cost for investment decision-making becomes maximised if they aim to the target amount as around 40% reduction of the original offer by the entrepreneur. This is compatible with the practical situations. As mentioned before, the convertible note holder's conversion option is not mandatory and the new equity investor is normally unable to reveal the details. On top of that, the convertible note holder will exercise the option only when the entrepreneur succeeds in fund raising of more than the threshold amount I_X. Therefore, it is rational that when the likelihood of conversion becomes higher, the new equity investor's concern becomes maximised and the most careful due diligence is necessary. This leads to the situation where the cost for decision-making becomes maximised. In this start-up's case, it is the situation where around 40% reduction is targeted. Taking one step further, we might be able to guess that I_X was βI_E = 0.62×$11.80 million = $7.32 million, for example.

This result gives the entrepreneur an insight for financing negotiation. The result that the cost for the new equity investor becomes maximised at around $\beta = 0.6$ means that setting the negotiation goal at an investment amount of 60% is quite difficult to realise. Even if this goal is being targeted, the new equity investor would not want to agree on this amount, rather, he/she would try to settle either at lower or higher amount in order to avoid the higher cost for investment decision-making. The new equity investor would normally agree at a lower amount. In effect, in this start-up case, the deal was settled at $\beta = 0.34$. Although there are other reasons why the deal was settled at this figure, such as consideration of the prospective of the business, the higher cost for investment decision-making could become a rational explanation.

The great impact of α on the cost is also to be noticed. The maximum value is \$2.06 million when $\alpha = 0.20$, \$2.79 million when $\alpha = 0.50$, and \$3.67 million when $\alpha = 0.70$, respectively. The deeper the discount is, the larger the cost becomes. Comparing the maximum cost when $\alpha = 0.70$ and the one when $\alpha = 0.20$, the former is 1.78 times. This is also compatible with the practical situations. As the simulation result of the equity share shows, the impact of discount and valuation cap on the equity share is significant. In addition to the concern about whether the convertible note holder exercises the conversion option, the new equity investor would have deep concern about how much the discount and valuation cap have been agreed between the convertible note holder and the entrepreneur. Therefore, the new equity investor must bear greater amount of cost for investment decision-making, especially when the deeper discount and smaller valuation cap is suspected. In this sense, the simulation result showing that cost will increase by 1.78 times would be serious for this start-up's case.

As for the financing negotiation, the entrepreneur can obtain another insight from this result. If the entrepreneur had accepted the contract that allows the deep discount and/or small valuation cap with the convertible note holder in the early stage, it might make the equity financing negotiation quite difficult to be settled as desired in the later financing round. The convertible note holder expects to gain a lot in exchange for bearing risks with the investment as convertible note in the early stage, and thus, he/she requires the deep discount and/or small valuation cap. The entrepreneur who has neither bargaining power nor confidence in the business may agree on such a contract because it does not affect the debt amount

itself. However, it will impose the new equity investor higher cost for investment decision-making. Therefore, the entrepreneur had better recognise that it might be a pitfall in the second financing round.

6. Conclusion

Convertible note is often used for the early stage start-up financing. However, its usage creates a complicated situation among entrepreneurs, convertible note holders and new equity investors in the second-round financing negotiation because the conversion of convertible notes into equity causes the dilution problem of the equity share of new equity investors and entrepreneurs. The main objective of this article was to build a model that is dealing with the interactions of these three key parties. Another important objective of this article is to figure out the cost for equity investment decision-making by incorporating the real option structure of the conversion of convertible notes into equity, as well as the adverse selection problem in the financing negotiation.

According to the results of the simulation with actual start-up data, it can be verified that the discount and valuation cap have great impacts on the cost for equity investment decision-makings. The results show that, under the existence of convertible note holders, if the entrepreneur aims to seal the financing negotiation at around 40% reduction of investment, the cost for decision-making becomes highest, and thus, the new equity investor may reduce the investment amount more (or increase in some cases). The results also show that the deeper the discount and the smaller the valuation cap, the larger the cost becomes, and thus, the likelihood of success of the financing negotiation becomes difficult. Therefore, the entrepreneur should take this into consideration when entering into the financing negotiation in the second financing round.

This model can be improved. First, it assumes that the impact modification factor is symmetric. If there are some researches or data that show the practical distribution pattern, the model would be more precise.

Second, this model assumes three parties. In practice, even within the convertible note holder and the equity investor, there are sometimes different types. Thus, this matter could also be incorporated in future research.

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Part Two: Application III.

The IPO valuation premium "puzzle" for an entrepreneur's exit choice

1. Introduction

Entrepreneurial exit is a major event in the development of a venture (De Tienne et al., 2015). It seems often to be thought that achieving IPO (Initial Public Offering or going public) is no doubt favourable for both entrepreneur and venture capitalist because huge returns could be predicted. Unfortunately, it is not uncommon at the later stage of the venture projects that the business turns out not to be successful and the desired return cannot be expected even if IPO has been prepared (see. the section II.3. in Part One).

Is IPO always expected to bring about the huge return? It is necessary to point out the under-pricing of the share of IPO firms. Under-pricing means the phenomenon that the first trading price on the secondary market becomes lower than the issue price of a new share. For example, the empirical study by Allen and Faulhaber (1989) shows that in certain periods and in certain industries, new issues (initial public offerings) are underpriced. Jain and Kini (1994) find post-issue declines in the market-to-book ratio, price/earnings ratio, and earnings per share. Ljungqvist and Wilhelm Jr. (2003) argue that following the so-called "dot-com bubble" (which occurred around 1997 to 2001), IPO underpricing reached astronomical levels during 1999 and 2000. Despite of the underpricing issue, however, IPO may still be superior to acquisition as long as entrepreneurs and venture capitalists are expecting to obtain greater financial returns from IPO than that from acquisition. Carter et al. (1998) found an interesting result about the underperformance of IPO stocks, showing that IPOs managed by more reputable underwriters are associated with less short-run underpricing.

In addition, the financial market characteristics should be taken into account in order to assess whether a huge return can be expected by IPO. On this point, the American IPO markets is the largest and most active in the world (see for instance "Global IPO trends: Q3 2017" released by Ernest & Young), while the European IPO market remains fragmented (Andrieu 2013). Andrieu also points out that banks play a great role in the venture financing in Europe, and bank-affiliated venture capital (VC) firms dominate the VC market in continental Europe. In other words, these countries rely on bank-centred capital markets, whereas the United States is stock market-oriented. As for another aspect of market characteristics, Santana Félix et al. (2013) argue that the size of the M&A market is relevant in explaining VC investment, and the VC market may grow in countries with vibrant M&A markets even if their IPO market is not very developed. Bertoni and Groh (2014) give an interesting suggestion about the exit strategy for young high-tech companies backed by VC in seven European countries, saying that the impact of cross-border investors on the exit mode also depends, more specifically, on the exit opportunities available there (local exit condition). This "local exit condition" is related to the M&A market in Europe, and the authors also point out that the mechanism is stronger for trade sales than for IPOs. These evidences would suggest that mergers and acquisition is not considered as an inferior exit strategy compared to IPO, at least. The priority of IPO to acquisition as an exit option might not be conclusive when taking the local market conditions for IPO and M&A market conditions into consideration. The exit strategy choice might not be an easy task especially in Europe. If so, then one question arises: "which exit option should we choose, IPO or acquisition?"

Bayar and Chemmanur (2011) are the first researchers who answer this question and provide a theoretical model. The most important point to be noticed in their work is that they are trying to address an intriguing issue, named "IPO valuation premium puzzle" (Bayar and Chemmanur, 2011, 2012). According to their definition, "IPO valuation premium puzzle" refers to a situation where many private firms choose to be acquired rather than to go public at higher valuations. As mentioned above, if we think of IPO as being a superior exit strategy to acquisition, it is true that, from the view point of "homo economicus", choosing acquisition rather than IPO is not rational even when a business is highly valued and investors can expect high economical return. Thus, they call this situation "puzzle." It is a quite interesting point and worth scrutinising because this "puzzle" situation might be directly linked to the answer of the question above.

Then, the next question arises: Holding the assumption of a rational homo economicus, why does this puzzle occur? Before answering this question, Bayar and Chemmanur (2011) propose the following assumptions, in their theoretical model: the entrepreneur, being a long-term investor, may be concerned about the sustainability of high valuation, and the VC, being a short-term investor, may be less affected by such concern. Based on this idea, they insist that entrepreneurs choose acquisition over IPO when the long-term expected pay-off will be lower in the case of an IPO compared to its acquisition value. That is to say, the choice of an exit strategy, IPO or acquisition, by an entrepreneur should be determined by the market value, and in some cases at least theoretically, the value obtained by choosing IPO can be lower than the one by acquisition. They describe this condition as "IPO valuation premium disappears." They have already designed an empirical research, and proved the existence of this condition (Bayar and Chemmanur, 2012), which relates to the fact that IPO valuation premium vanishes even for larger non-venture capital backed firms and shrinks substantially for smaller firms as well.

Their theoretical model can answer the dilemma between IPO and acquisition, by solving the maximisation problem. This model's answer results mainly from market conditions. As IPO valuation premium disappears, acquisition should be chosen. As mentioned above, there is also empirical evidence. Thus, their model can with no doubt be ground breaking toward practical applications for the exit strategy planning. However, one variable named as "private benefits of control, B," should be handled with care due to its intrinsic property, which does not come from the market conditions. It is just simply added into their theoretical model with the other variables of the Expected NPV, the sell fraction of shares and the probability of choosing IPO by entrepreneur. On the other hand, they explain one of their empirical findings (Bayar and Chemmanur, 2012) as follows; firms which are harder to value by IPO market investors, more capital-intensive firms, and those operating in industries characterised by greater private benefits of control, are more likely to go public rather than to be acquired. Their theoretical model assumes that the determining factor for choosing either IPO or acquisition is mainly market conditions. If their empirical finding is correct, "private benefits of control" is also an important determining factor for that choice. This suggests that we should not put too much weight only on market conditions. Therefore, the importance of this "private benefits of control" must have been clearly explained, and its property must be much further emphasised, not as it is simply put in the theoretical model.

The main objective of this article is to analyse the property of "private benefits of control" by a game theoretic real options approach and to reveal the importance of its role as a criterion of choosing the exit option. In addition, this article is also trying to understand what the "IPO valuation premium puzzle" actually is. It could be quite helpful for setting up an exit strategy effectively.

The contribution of this article is to analyse the "IPO valuation premium puzzle" from the different perspective from the one proposed by Bayar and Chemmanur (2011, 2012). It is true that understanding the exit strategy criterion from market viewpoint is essential. At the same time, the perspective of the players should not be ignored. In other words, both macro and micro viewpoints should be combined. This article is mainly written from this viewpoint. In this sense, this article is complementary with the work by Bayar and Chemmanur (2011, 2012). The topic about the venture exit choice is relatively new, and few researches have been done so far. Thus, this article contributes to the development of an exit strategy planning method in a scientific way.

The rest of this article is organised as follows; Section 2 reviews the exit strategy choice model by Bayar and Chemmanur (2011). Section 3 analyses the "private benefit control" by a game-theoretic real options approach. Section 4 explains "IPO valuation premium puzzle." Section 5 presents a numerical simulation and its results. Finally, Section 6 concludes.

2. Review of the exit strategy choice model by Bayar and Chemmanur

When thinking about the exit strategy choice, IPO or acquisition, for the ventures and/or venture projects in the later stage (e.g., 'Early-maturity' stage), it is good to start reviewing the theoretical model provided by Bayar and Chemmanur (2011). They explain the criterion to define a strategy to be chosen as a solution of the maximisation problem as shown below;

$$max_{a\in\{0,1\}}\ a\cdot\left[\delta_E(1-\gamma)\left(\alpha_E P_{IPO}^E+(1-\alpha_E)\left(I+V_q\right)+B\right)\right]+(1-a)\cdot\delta_E\rho V_A$$

Where

a: the exit choice ($a=0$: acquisition, $a=1$: IPO),

α_E: the entrepreneur's the sell fraction,

δ_E: the entrepreneur's initial holding fraction,

γ: the fraction of shares sold to new shareholders,

P_{IPO}^E: the IPO valuation,

I: the investment by acquiring firm,

V_q: the expected NPV when the firm goes public,

ρV_A : the acquired firm's project NPV,

B: the private benefits of control.

Their fundamental assumption for modelling is "The entrepreneur faces following trade-offs between IPO and an acquisition: First, depending on the IPO market conditions and the intrinsic value of his own firm, the entrepreneur might be able to benefit from a high IPO valuation of his firm… Second, he will retain a fraction… of the outstanding shares of the public firm with an expected NPV." As a whole, this model assumes that the exit choice is primarily determined by the project or venture firm' value depending on the market condition, and entrepreneur should compare the maximised value between the one in the case of acquisition or the one in the IPO. If the acquisition is chosen ($a=0$), then, the equation to solved becomes as follows:

$$max_{a=0}\ \delta_E\rho V_A\ \ldots\ (1)$$

This means that only the entrepreneur's initial holding fraction and the project NPV do matter. Bayar and Chemmanur explain that "*acquirers can have considerable bargaining power, allowing them to extract the firm's net present value from insiders*," thus, the entrepreneur can only consider his/her initial own holding fraction. On the other hand, if the IPO is chosen ($a = 1$), the equation becomes as follows:

$$max_{a=1}\ \delta_E(1-\gamma)\left(\alpha_E P_{IPO}^E + (1-\alpha_E)\left(I + V_q\right) + B\right) \ldots (2)$$

Bayar and Chemmanur argue that "*atomistic investors in the IPO market would price the firm's equity competitively*." In other words, the fragmented equity investors cannot extract the whole value of the project and thus, the entrepreneur can enjoy not only his/her own holding fraction but also other values, even though he must give up some fraction. Thus, comparing the results obtained from the equation (1) and (2), then we can determine which choice is better. If (1) > (2), acquisition is the better choice for entrepreneur, and otherwise, IPO is better.

Looking into the equation (2), it consists of three subcomponents, $\alpha_E P_{IPO}^E$, $(1-\alpha_E)\left(I + V_q\right)$, and B. The first one is the market value of the project which the entrepreneur can obtain by the IPO itself. The second one is the value which the entrepreneur extract comparing with the case of an acquisition. The last one is the so-called "private benefits of control." We can find that the valuable of the "private benefits of control" has different property from the other two in the equation (2) because the other two derives from the market condition but the last one, B, does obviously not. It appears to be simply added. Bayar and Chemmanur explain why this variable is inserted only in the case of IPO (equation (2)). They insist as follows: "*The entrepreneur will also continue to enjoy his private benefits of control… if he chooses an IPO, but not if his firm is acquired (p.1767)*" and "*with the entrepreneur giving up control of the firm to the acquirer (p.1757)*," his benefit of control will be negligible. However, is it realistic that the choice of acquisition wipes out all the "private benefits of control" for the entrepreneur? If so, does it mean that no entrepreneur would like to join or stay in the acquiring firm (e.g., as the chief technical officer)? Furthermore, they did not explain why this variable 'can' be put theoretically. They seem to say that IPO has greater value than

acquisition thus the variable of "private benefits of control" exists. Their explanation is some kind of tautology, such as 'it is necessary because it is necessary.' If so, the "IPO premium puzzle" is neither an issue nor a "puzzle." It is rather simply the repetition of their model assumption. Thus, this article does not completely deny but not completely support their stance. Instead, the logic of this article is constructed based on the idea that the "private benefits of control" should be interpreted not simply from the market finance perspective but rather through the lens of the negotiation between an entrepreneur and investors, such as VC. As shown in Part One, the negotiations in entrepreneurial finance have unique characteristics. Therefore, it is worth scrutinising the property of "private benefits of control." In the next section, the property and the reason why it can be introduced are explained by using the game-theoretic real options approach.

3. *Explaining the "private benefits of control": A game-theoretic real options approach*

For explaining and re-interpreting the "private benefits of control," a game-theoretic real options approach is useful. As will be explained later, this approach is relatively new. this method is explained step by step in the following subsection from the perspective of the exit strategy choice. Before going into the details, it is necessary to understand the "private benefits of control."

3.1. How should the "private benefits of control" be interpreted?

Bayar and Chemmanur interpret that the "private benefits of control" should be grasped as the proportion of holding equity share which remains in the hand of entrepreneur (and also investor as well). They define as follows: "*An entrepreneur managing a private firm may derive personal benefits from continuing to manage it long term (private benefits of control) (p.1759)*." In addition, as Dyck and Zingales (2004) says, "*The benefits of control over corporate resources play a central role in a modern thinking about finance*

and corporate governance. (p.537)" These discussions are based on the traditional corporate finance perspective. The idea of "private benefits of control" is supposed to exist within the large listed companies, in which the principle of separation of ownership and management is vital. In these companies, it is normal to think of the relationship, or conflicts of interests in some cases, between the corporate executives and a lot of equity investors who are thought to be anonymous price-taker in the secondary market. Thus, the idea of "private benefits of control" can be interpreted simply as the matter of ownership. In effect, Dyck and Zingales argue that "*Two methods have been used in attempting to quantify them. The first one, pioneered by Barclay and Holderness (1989), focuses on privately negotiated transfers of controlling blocks in publicly traded companies… The second method relies on the existence of companies with multiple classes of stock with differential voting rights. (p.538)*" They obviously focus on the ownership.

The definition of the "private benefits of control" should be, and enough to be, interpreted as the proportion of ownership of the venture firm, such as voting right, and the value derives from the market conditions in the traditional corporate finance setting. It is valid for large listed companies. However, in the entrepreneurial finance setting, it is not enough because the principle of separation of ownership and management does not always hold, even in the case of the ventures in the later stage. As explained in Part One, entrepreneurial finance supposes that the entrepreneur's strategies, decision-makings and management are closely connected each other, and focusing only on the ownership is not enough to explain the whole picture. Even if the venture is preparing for IPO, the number of shareholders is limited yet. Rather, it would be usual that the entrepreneur still has a great influence on the management and decision-makings, and the ownership and management are not necessarily separated completely. In particular, we can observe that so-called unicorn companies do not choose IPO even after the value of the firm exceeds $1b (e.g., Airbnb). This suggests that the market value of the firm is not necessarily a determinate factor for private benefits of control. In this sense, interpreting the context of the "private benefits of control" would also be insufficient if we think that its value derives only from the market conditions.

On the other hand, there is an interesting discussion about private benefits of control. As Dyck and Zingales also describe, "*The theoretical literature often identifies private benefits of control as the "psychic" value some shareholders attribute simply to being in control. (e.g., Harris and Raviv, 1988,*

Aghion and Bolton, 1992). (p.540)" This idea of focusing on the "psychic" factor appears not be well accepted in the traditional corporate setting because it is hard to justify multimillion-dollar premia with the pure pleasure of command, as Dyck and Zingales continue. However, it is not always true in entrepreneurial finance. As discussed in Part One, the entrepreneurship distinguishes entrepreneurial finance from corporate finance. For the entrepreneurship, the passion (for innovations etc.) of the entrepreneur is critical. This would mean that psychic factors could occupy a central role in the entrepreneur's motivations and continuation for the business. In effect, there are many researches related to those psychic factors for entrepreneurship. For example, Papulová and Papula (2015) summarise the four motivations for entrepreneurship as motives connected to profit, professional, self-realization and emotional motives, social motive, and motives which are connected to external stimuli to company development, and they argue that the motivation for entrepreneurship is not limited to the one connected to profit. Stewart Jr. and Roth (2007) argue that "*The results indicate that entrepreneurs exhibit higher achievement motivation than managers and that these differences are influenced by the entrepreneur's venture goals… the difference between entrepreneurs and managers on achievement motivation is substantially larger… (p.401)*" Segal et al. (2005) suggest that "*Being an entrepreneur, one who is self-employed and who starts, organizes, manages, and assumes responsibility for a business, offers a personal challenge that many individuals prefer over being an employee working for someone else. (p.42)*" Furthermore, Casamatta and Haritchabalet (2014) discuss that "*They (= entrepreneurs) also derive a private benefit when successfully funding their projects. These private benefits can reflect entrepreneurs' satisfaction to see their idea implemented or their future reputation gains if the venture succeeds. (p.1744)*" Karabulut (2016) say that "*People who tolerate risks can have more entrepreneurial intentions... People who have entrepreneurial intentions can be more successful when they establish their ventures… Personality traits has a positive effect on entrepreneurial intention... (p.21)*" In summary, it could be said that the psychic factor of achievement motivation should not be ignored when considering the "private benefits of control" because it is the essential factor that determines whether the entrepreneurial business will become successful or not.

It is true, as Dyck and Zingales suggest, that "*By their very nature, private benefits of control are difficult to observe and even more difficult to quantify in a reliable way. (p.537)*" Nevertheless, even if so, the quantitatively measurable elements such as market value and equity share (or voting rights) are not the

only factor that shapes the “private benefits of control” in entrepreneurial finance. Still less, the variable which represents “private benefits of control” might not simply be put in the model just because it is necessary. In addition, entrepreneurs must negotiate with fund providers such as venture capitalists. If the “private benefits of control” contains only the monetary factor, it would be impossible to explain why the unicorn companies above exist. Therefore, this article adopts the idea that the “private benefits of control” should be interpreted as the variable that contains both economic reward and psychic factor of achievement motivation for the business.

3.2. Real options analysis (ROA)

As explained, the ROA can capture the value derived from such flexibility in the strategic planning, and thus, it has been nowadays widely applied (e.g. Copeland and Antikarov 2003, Dixit and Pindyck 1994). In the phase of the exit strategy choice, it would be applicable. In order to grow the business and arrive at the exit phase, entrepreneur needs the funds by external investors in most cases. Equity investors, such as venture capitalists, have more opportunities to control the business of the ventures they invest than debt investors, such as banks. Thus, the entrepreneurs’ financing choice from which they obtain funds has a great influence not only on the success of the business but also on the exit strategy. Moreover, many researches show that the support by venture capitalists increases the probability of success. Colea et al. (2016) compare the effect of two main sources of entrepreneurial finance, which are banks versus venture capital (VC), on small firm formation and growth. They find the effect of VC to be both economically and statistically significant in stimulating new firms, and do not find similar evidence for banks. Andrieu and Groh (2012) say that independent VC firms provide better support quality than by bank-affiliated VC firms, though the latter have access to very large financial resources. However, even if entrepreneur could obtain the support of VC, the success of the business is not sure and some risks remain. Therefore, it is necessary to manage these risks and the ROA is a quite useful tool because it enables flexible strategic choices.

3.3. Incorporating game theory: A game-theoretic real options approach

In addition to the issue of managing the risks above, entrepreneur must pay attention to the relationship with VC when deciding on an exit strategy option. Even if the probability of success could be increased by the support of VC, the entrepreneur's equity share decreases when the fund is provided as equity. For the purpose of analysing the "private benefits of control", this issue should be seriously considered. There are several percepctives that explain the relationship among economic players. In particular, game theory is one of the well-known methods. According to Rasmusen (2007), game theory is concerned with actions of decision makers who are conscious that their actions affect each other. This fits right in with the exit choice situation with the interaction of entrepreneur and venture capital. As shown in Part One, game theory itself is not a new method, in recent years, the theoretical combination of game theory and real options has been developed (e.g. Smit and Ankum 1993, Smit and Trigeorigs 2006). The exit option choice issue contains two main factors, the market conditions and the interaction between the entrepreneur and venture capitalists, therefore, it is possible to say that the game theoretic real options approach is a quite suitable analytical tool. In the following section, this game theoretic real options approach is employed for explaining the "private benefits of control" and modelling the exit strategy choice.

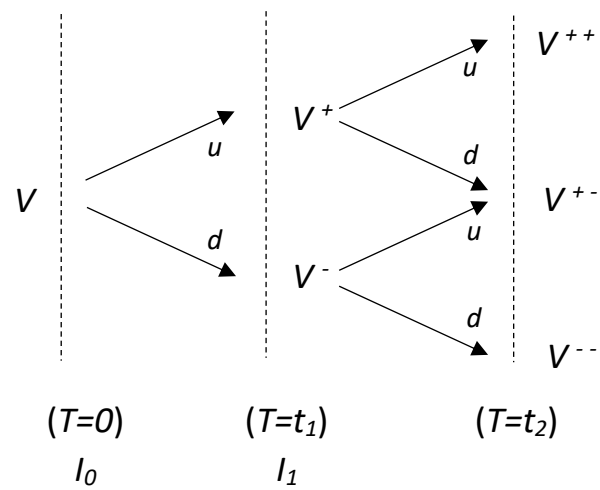
3.4. Two-period binomial tree model: Preparation of a game-theoretic real options model

For simplicity, it is usual to assume that both entrepreneur (Ent) and venture capitalist (VC) are risk-neutral, and the expected values of the venture business constitute a binomial tree. In general, both entrepreneur and venture capitalists will have to set up strategies under risky situations where they do not have sufficient information. Thus, they try to defer their decisions until the situation become realised and obtain certain information. This can be applied to the exit strategy setting up. It is clearly more favourable to avoid fixing their exit strategy at the early stage, and to make decisions after waiting and seeing how their business goes. Related to this point, De Tienne et al. (2015) say that while actual exits are important, the early stage and founders' ongoing actions and decisions are often based upon intended exit strategies. In this discussion, entrepreneur and venture capitalists are thus assumed to make their exit strategy

decisions not at the beginning but at some later period. In this sense, two-period binomial tree model is quite suitable to be applied as shown in Figure 29. It is assumed that they can set up their exit strategies at $T=t_1$ with the predictions at $T=t_2$.

Two-period binomial tree model is also quite compatible with the venture financing scheme. The value of the venture business that venture capitalists assess before investment (T=*0*), V, derives from the commitment of I_0 by the entrepreneur. In the case of the business being successful, the value at T=t_1 will be $V^+ = uV$, and $V^- = dV$ otherwise. In this timing, the entrepreneur asks for the additional equity capital to venture capitalists, and they provide the amount of I_1. The value at T=t_2 are expected to be $V^{++} = uuV$, $V^{+-} = udV$, or $V^{--} = ddV$. Let π be the risk neutral probability, it can be calculated as $\pi = (e^{rT} - d)/(u - d)$ where r represents the risk-free rate. This assumption is in line with the discussion by Faria and Barbosa (2014). They found that only the later-stage VC capital is promoting innovation. They also insist that their result is consistent with the view that the VC helps the commercialization of innovation rather than fostering its creation.

< Figure 29 The binomial tree value model >



In those instances when businesses are expected to be successful, the value outcome at $T=t_1$ for the entrepreneur, V_{Ent}^{+}, and for venture capitalists, V_{VC}^{+}, can be calculated as shown below, respectively;

$$V_{Ent}^{+} = \left[\pi \times \frac{I_0}{I_0+I_1} \times V^{++} + (1-\pi) \times \frac{I_0}{I_0+I_1} \times V^{+-}\right] \times e^{-r(t_2-t_1)}$$

$$V_{VC}^{+} = \left[\pi \times \left(\frac{I_1}{I_0+I_1} \times V^{++} - I_1\right) + (1-\pi) \times \left(\frac{I_1}{I_0+I_1} \times V^{+-} - I_1\right)\right] \times e^{-r(t_2-t_1)}$$

In the same manner, at $T=t_1$ when the business is expected to be unsuccessful, the proportion of the value can be calculated as follows:

$$V_{Ent}^{-} = \left[\pi \times \frac{I_0}{I_0+I_1} \times V^{+-} + (1-\pi) \times \frac{I_0}{I_0+I_1} \times V^{--}\right] \times e^{-r(t_2-t_1)}$$

$$V_{VC}^{-} = \left[\pi \times \left(\frac{I_1}{I_0+I_1} \times V^{+-} - I_1\right) + (1-\pi) \times \left(\frac{I_1}{I_0+I_1} \times V^{--} - I_1\right)\right] \times e^{-r(t_2-t_1)}$$

3.5. The "private benefits of control" as two Nash Equilibria: A game-theoretic real options model

Regardless of the choice of exit, either IPO or acquisition, entrepreneurs and venture capitalists are not able to obtain the whole value calculated above. They must let some proportion of their equity share off, and hold only the remaining fraction. Defining this remaining holding fraction as below, the value outcomes at $T=t_1$ for both entrepreneur and venture capitalist can be calculated.

$\alpha_{Ent}^{A}, \alpha_{VC}^{A}$: the fraction when acquisition is chosen as exit strategy

$\alpha_{Ent}^{I}, \alpha_{VC}^{I}$: the fraction when IPO is chosen as exit strategy

The values should be $0 < \alpha^{A} < 1$, and $0 < \alpha^{I} < 1$.

Based on these results derived from the market conditions, the entrepreneur and venture capitalists make an exit decision. As noted, however, not only are the market conditions the determining factors. It is necessary to consider the interaction between the entrepreneur and venture capitalists, and thus, a game theoretic framework can be adopted. In this point, although it is not uncommon to predict that there is some relationship between the exit choice and the support by VC, there seems to be no consensus about it at this moment. For example, the empirical study by Bayar and Chemmanur (2012) shows that the likelihood of an IPO over an acquisition is greater for venture backed firms and those characterized by higher pre-exit sales growth. On the contrary, the empirical research by Cumming (2012) shows that ex ante, stronger VC control rights increase the likelihood that an entrepreneurial firm will exit by an acquisition, rather than through a write-off or an IPO. Therefore, this modelling adopts a game theoretic situation in which both entrepreneur and venture capitalist can make decisions independently and these decisions do not affect each other. Those decisions occur during the negotiation. Thus, it can be possible to consider the game theoretic framework. In game theoretic framework, the 2×2 matrix drawn in Table 13-1 is normal, and it is also inspired by the one proposed by Smit and Trigeorigs (2006).

< Table 13-1 Theoretical value outcome (at $T=t_1$) >

		VC	
		Acquisition	IPO
Entrepreneur	Acquisition	(i) $\alpha_{Ent}^{A} \cdot V_{Ent}$ $\alpha_{VC}^{A} \cdot V_{VC}$	(ii) $\alpha_{Ent}^{A} \cdot V_{Ent}$ $\alpha_{VC}^{I} \cdot V_{VC}$
	IPO	(iii) $\alpha_{Ent}^{I} \cdot V_{Ent}$ $\alpha_{VC}^{A} \cdot V_{VC}$	(iv) $\alpha_{Ent}^{I} \cdot V_{Ent}$ $\alpha_{VC}^{I} \cdot V_{VC}$

($V_{Ent}: V_{Ent}^{+}\ or\ V_{Ent}^{-}$ and $V_{VC}: V_{VC}^{+}\ or\ V_{VC}^{-}$)

Both entrepreneur and investors would usually hope a great success of the business and set IPO as an intended goal when making a financing contract at $T=t_1$. This represents a situation in which the case (iv) can become the unique (pure-strategy) Nash Equilibrium in Table 13-1. This table is theoretical. Just for

better understanding the situation of the unique Nash Equilibrium, let put hypothetical numbers into this matrix. As we consider that the market value of the venture business is higher in the case of IPO than in acquisition, the unique Nash Equilibrium could be written as shown in Table 13-2.

< Table 13-2 Hypothetical value outcome (at $T=t_1$) >

		VC	
		Acquisition	IPO
Entrepreneur	Acquisition	(i) 1 2	(ii) 4 6
	IPO	(iii) 8 3	(iv) 10 7

However, as Bayar and Chemmanur (2011, 2012) also identify it as a "puzzle," not IPO but acquisition is actually selected in some cases. Again, the definition of "IPO valuation premium puzzle" refers to a situation where many private firms choose to be acquired rather than to go public at higher valuations. Although it may be normal that both entrepreneur and venture capitalist intend IPO, it is also possible to explain this 'contradictory' phenomenon in the game theoretic scheme. It can be realised theoretically as two Nash Equilibria. More precisely, the case (iv) in Table 13-1 is not always a unique Nash Equilibrium, but the case (i) can be another Nash Equilibrium. For realising this situation, some positive value must be added. This situation is described in Table 14-1 below. Then, introducing the new values, B_{Ent}, B_{VC}, Table 13-1 can actually be rewritten as Table 14-1 below. Let B_{Ent}, B_{VC} be the value of the "private benefits of control" for the entrepreneur and venture capitalists, respectively. In the same manner as Table 13-1 and 13-2, let add hypothetical numbers for better understanding the situation of two Nash Equilibria as shown in Table 14-2. In this case, the "private benefits of control" for entrepreneur is 7, and the one for venture capitalist is 3.

< Table 14-1 Theoretical value outcome with Private Benefits of control (at $T=t_1$) >

		VC	
		Acquisition	IPO
Entrepreneur	Acquisition	(i') $\alpha_{Ent}^{A} \cdot V_{Ent} + B_{Ent}$ $\alpha_{VC}^{A} \cdot V_{VC} + B_{VC}$	(ii') $\alpha_{Ent}^{A} \cdot V_{Ent}$ $\alpha_{VC}^{I} \cdot V_{VC}$
	IPO	(iii') $\alpha_{Ent}^{I} \cdot V_{Ent}$ $\alpha_{VC}^{A} \cdot V_{VC}$	(iv') $\alpha_{Ent}^{I} \cdot V_{Ent}$ $\alpha_{VC}^{I} \cdot V_{VC}$

< Table 14-2 Hypothetical value outcome value outcome with Private Benefits of control (at $T=t_1$) >

		VC	
		Acquisition	IPO
Entrepreneur	Acquisition	(i) 8 5	(ii) 4 6
	IPO	(iii) 8 3	(iv) 10 7

The most critical point in this article is that this positive value, which is theoretically required, should be thought as the "private benefits of control" named by Bayar and Chemmanur. They insist in the process of creating their model that this value should be taken into consideration when choosing either IPO or acquisition in order to solve the maximization problem. However, their argument may be some kind of tautology. Moreover, they appear to think that the variable corresponding to the "private benefits of control" could be derived only from the market condition. Is it really possible to explain the variable whose

property is "private" from the stand point of the open financial market such as the IPO market? It would be rather natural that the variable that has this kind of property should be explained within private negotiation processes. The next subsection provides more details.

3.6. The condition that forms the "private benefits of control"

For two Nash Equilibria to be realised, there must be theoretical (mathematically expressed) conditions. Comparing with Table 13-1, not only the case (iv') but also the case (i') can be Nash Equilibrium. In effect, these are the two Nash Equilibria if:

$$\alpha_{Ent}^{A} \cdot V_{Ent} + B_{Ent} > \alpha_{Ent}^{I} \cdot V_{Ent} \text{ and } \alpha_{VC}^{A} \cdot V_{VC} + B_{VC} > \alpha_{VC}^{I} \cdot V_{VC}.$$

These inequalities can be summarised as below:

$$B > (\alpha^{I} - \alpha^{A}) \cdot V \ldots (1)$$

The right side of the inequality (1) is composed of two parts, $(\alpha^{I} - \alpha^{A})$ and V. Quantitatively, the greater the difference of $(\alpha^{I} - \alpha^{A})$ is, the higher the level of the private benefits of control should be required for choosing acquisition rather than IPO as an exit strategy. In the same way, in order to let acquisition be a dominating strategy over IPO, a high level of private benefits of control should be required when the market value of the business is estimated to be high, such as V^{+} at T=t_1. Under this circumstance, the case (iv') can often be the unique Nash Equilibrium, and IPO will become a favourable choice. This makes sense in the context of the real business world because both entrepreneurs and venture capitalists hope that the business will be successful, and there is almost no reason not to intend to achieve IPO in such a situation.

In contrast, we must handle with care the situation where the business is not going well and the market value of the business is estimated not to be high, rather low, such as V^- at T=t_1. In this situation, a high level of private benefits of control is no more required for choosing acquisition according to the inequality and it leads to the consequence that both cases (i') and (iv') can be Nash Equilibria. Therefore, it is not often the case that IPO becomes the unique dominating exit strategy, and instead, acquisition enhances its presence as an alternative one in the game theoretic framework.

3.7. Choice of exit option: IPO or acquisition

Considering the value outcome for entrepreneur at $T=0$, Table 14-1 should be rewritten as Table 15 and 16. Although showing up 4×4=16 outcomes is mathematically sound, it might not be efficient in the context of practical business. As mentioned above, both entrepreneurs and venture capitalists usually desire the big success of their venture project and realise IPO as an exit strategy. In the process of the business development (at $T=t_1$), acquisition could sometimes turn out to be the alternative exit strategy. Therefore, it would make sense in general that considering the following two cases: one is the case (Case A) that aims at achieving IPO and is going forward to IPO. This can be represented as the combination of (iv') from Table 15 and (iv') from Table 16. The other one (Case B) is that aims at achieving IPO but shifts to acquisition. This can be represented as the combination of (iv') from Table 15 and (i') from Table 16.

< Table 15 Value outcome (V^+ at T=t_1) >

		VC	
		Acquisition	IPO
Entrepreneur	Acquisition	(i') $\alpha_{Ent}^{A} \cdot V_{Ent}^{+} + B_{Ent}$ $\alpha_{VC}^{A} \cdot V_{VC}^{+} + B_{VC}$	(ii') $\alpha_{Ent}^{A} \cdot V_{Ent}^{+}$ $\alpha_{VC}^{I} \cdot V_{VC}^{+}$
	IPO	(iii') $\alpha_{Ent}^{I} \cdot V_{Ent}^{+}$ $\alpha_{VC}^{A} \cdot V_{VC}^{+}$	(iv') $\alpha_{Ent}^{I} \cdot V_{Ent}^{+}$ $\alpha_{VC}^{I} \cdot V_{VC}^{+}$

< Table 16 Value outcome (V^- at T=t_1) >

		VC	
		Acquisition	IPO
Entrepreneur	Acquisition	(i') $\alpha_{Ent}^{A} \cdot V_{Ent}^{-} + B_{Ent}$ $\alpha_{VC}^{A} \cdot V_{VC}^{-} + B_{VC}$	(ii') $\alpha_{Ent}^{A} \cdot V_{Ent}^{-}$ $\alpha_{VC}^{I} \cdot V_{VC}^{-}$
	IPO	(iii') $\alpha_{Ent}^{I} \cdot V_{Ent}^{-}$ $\alpha_{VC}^{A} \cdot V_{VC}^{-}$	(iv') $\alpha_{Ent}^{I} \cdot V_{Ent}^{-}$ $\alpha_{VC}^{I} \cdot V_{VC}^{-}$

In Case A, the value outcome at *T=0* can be calculated as follows:

$$V_{Ent,0}^{I,I} = [\pi \times \alpha_{Ent}^{I} \cdot V_{Ent}^{+} + (1-\pi) \times \alpha_{Ent}^{I} \cdot V_{Ent}^{-}] \times e^{-rt_1} - I_0$$

In Case B, the value outcome at *T=0* can be also calculated as follows:

$$V_{Ent,0}^{I,A} = [\pi \times \alpha_{Ent}^{I} \cdot V_{Ent}^{+} + (1-\pi) \times (\alpha_{Ent}^{A} \cdot V_{Ent}^{-} + B_{Ent})] \times e^{-rt_1} - I_0$$

Where $B_{Ent} > (\alpha_{Ent}^{I} - \alpha_{Ent}^{A}) \cdot V_{Ent}^{-}$

The difference of these two value outcomes, $V_{Ent,0}^{I,A} - V_{Ent,0}^{I,I}$, becomes positive when acquisition is chosen over IPO:

$$V_{Ent,0}^{I,A} - V_{Ent,0}^{I,I} = [(1-\pi) \times (B_{Ent} - (\alpha_{Ent}^{I} - \alpha_{Ent}^{A}) \cdot V_{Ent}^{-})] \times e^{-rt_1} > 0$$

4. Explaining the "IPO valuation premium puzzle"

4.1. The minimum value of the private benefits of control

It is obvious that the condition of $B_{Ent} > (\alpha_{Ent}^{I} - \alpha_{Ent}^{A}) \cdot V_{Ent}^{-}$ is crucial for choosing either IPO or acquisition. In order to choose acquisition rather than IPO, the private benefits of control for entrepreneur must be greater than the minimum value, B_{Ent}^{min}.

$$B_{Ent}^{min} = (\alpha_{Ent}^{I} - \alpha_{Ent}^{A}) \cdot V_{Ent}^{-}$$

$$= (\alpha_{Ent}^{I} - \alpha_{Ent}^{A}) \times \frac{1}{1+(I_1/I_0)} \times (\pi ud + (1-\pi)dd)V \cdot e^{-r(t_2-t_1)} \ldots (2)$$

The third term in the equation (2) represents the net present value (NPV) of the market value of the business. The minimum value is the negative function of α_{Ent}^{A}. If the entrepreneur could obtain the larger remaining holding fraction through the negotiation with acquirer, the minimum level of control benefits would become smaller. In contrast, the minimum value is the positive function of the equity proportion of venture capital I_0 and the NPV of the market value of the business. If venture capitalists assess that the business is expected to be successful, then they would invest more and the equity proportion of venture capitalist I_1/I_0 would increase and the one of the entrepreneur would decrease. This would encourage the entrepreneur to increase the minimum level of control benefit because the entrepreneur and venture capitalists must divide the benefit that they could obtain by selling the business to acquirers. High NPV means that the success is highly expected, and merely keeping the equity share can be the source of economic benefit. At the same time, this action leads to the creation of benefits of control. As we can see, the minimum value of the private benefits of control, B_{Ent}^{min}, incorporates not only the market condition but also the contract aspect.

B_{Ent}^{min}, which can be a critical index is derived from the difference of the values between the two exit options of IPO and acquisition, especially when the market expectation for the business venture is not high. In other words, it can only be measured indirectly rather than directly measured or observed, but it can unveil that there must be something valuable. In this sense, it would be possible to say that it has a similar property as the 'Goodwill' in the financial accounting item, which is recognised as the benchmark of the expectation of the firm's business as the timing of the M&A is implemented. Therefore, it could become a new benchmark for the exit strategy planning.

4.2. Is the "IPO valuation premium puzzle" really a "puzzle"?

As mentioned before, the "IPO valuation premium puzzle" can be seen in the real business world. This game theoretic approach can be the very core explanation for the "IPO valuation premium puzzle", and the part that has not yet explained explicitly by Bayar and Chemmanur (2011, 2012). It is sometimes

thought in practice that IPO is the primary exit strategy to be chosen when the venture business becomes successful and acquisition can be the secondary strategy as some kind of risk hedge when it fails. This thought may be neither wrong or right. In fact, acquisition seems to be favoured by venture capitalists as a method of collecting as much cash invested as possible when the business turns out not to be as successful as they have desired. Nevertheless, the main purpose of acquisition must never be to recover from the failure of the venture project. Acquisition itself has its own practical benefits. As Bayar and Chemmanur (2012) say, the benefit of an acquisition over an IPO is that the acquiring firm can provide support to the acquired firm in product market competition by increasing its probability of success in the product market while a stand-alone firm has to fend for itself after an IPO. If entrepreneurs are offered some managing position inside the acquiring firm, such as technical chief of the product they invent, it could be said that they still have the control benefit because they have an opportunity to achieve their original goal through the acquiring firm's distribution channel (Roizen 2016). Furthermore, there is even a research by Rosenbusch et. al (2013), saying that performance effects, which are mainly related to firm growth, are reduced when the funded firms are very young or very mature. They also say that VC funding seems to lose value after the funded firm goes public.

When the value of the business is expected to be high, choosing acquisition over IPO may be a "puzzle" from a market viewpoint. However, as this theoretical analysis above shows, the exit option choice can be determined by evaluating whether the private benefits of control is greater than the minimum level of control benefit, B_{Ent}^{min}, or not. It is drawn not from the market condition, rather from its inherent property that can be explained by the game theoretic framework. Thus, IPO and acquisition should be compared equivalently especially when the market expectation for the business is not high. This view is different from the original one by Bayar and Chemmanur (2011). IPO contains intrinsically a high level of benefits of control because the holding fraction is usually quite large. In contrast, the fraction as acquisition is chosen tends to be small, though it depends on the bargain power balance between the entrepreneur and acquirers. Therefore, by using the value of B_{Ent}^{min}, as the entrepreneur is able to expect more benefits of control, acquisition is not the inferior exit choice to IPO. The "IPO valuation premium puzzle" is not really a "puzzle" when looking through the lens of the inherent property of the private benefits of control.

5. *Numerical simulations*

Although the origin of B_{Ent}^{min} has been revealed, the characteristics of B_{Ent}^{min} can become understandable more precisely by considering the multiplier of B_{Ent}^{min}/V which represents the ratio of B_{Ent}^{min} to the value of the venture business that the venture capital assesses before investment (T=*0*). Furthermore, the numerical simulation is useful in order to capture the behaviour of the multiplier. In order to implement the simulation, the following assumptions, $d = 1/u,\ \ t_2 = 2,\ \ t_1 = 1,\ \ r = 0.05$ are added. Then, the multiplier can be calculated as below:

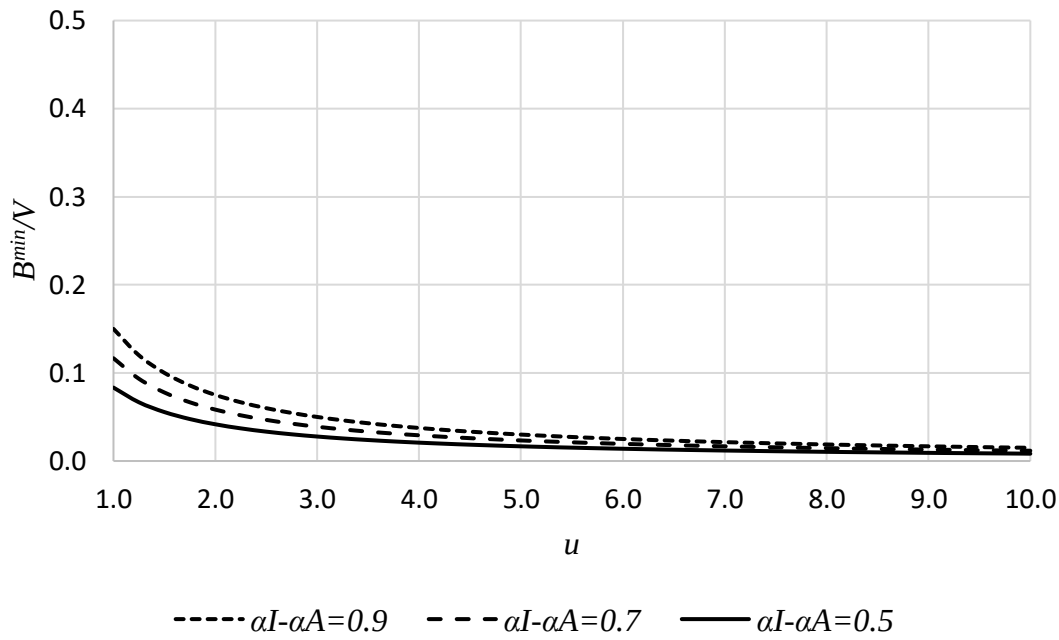
$$\frac{B_{Ent}^{min}}{V} = (\alpha_{Ent}^{I} - \alpha_{Ent}^{A}) \times \frac{1}{1+(I_1/I_0)} \times \frac{1}{u} \ldots (3)$$

When considering the exit strategy, how the business value would be predicted is the primary concern. Thus, it is logical that the multiplier should be compared with the variable u, which represents the amount of upper movement. The range of this variable is theoretically from 1.0 to infinite. In fact, the price of the securities can move up more than 100 times at IPO in the case of biotech or IT ventures. However, in this simulation, the variable u is assumed to range from 1.0 to 10.0. Two types of numerical simulations are possible according to changes in the multipliers of $(\alpha_{Ent}^{I} - \alpha_{Ent}^{A})$, or with the ones of (I_1/I_0). The following sections explain the simulation results of the equation (3).

5.1. *Simulation of the equation (3) with changing* $\boldsymbol{\alpha_{Ent}^{I} - \alpha_{Ent}^{A}}$

The difference of the remaining holding fraction between IPO and acquisition is assumed to range from 0.9 (i.e. $\alpha_{Ent}^{I} = 0.9, \alpha_{Ent}^{A} = 0.0$) to 0.5 (i.e. $\alpha_{Ent}^{I} = 0.8, \alpha_{Ent}^{A} = 0.3$). The case of $\alpha_{Ent}^{A} = 0.0$ is possible when the acquirer does not allow the original entrepreneurs to participate in the newly operating business. In this simulation, I_1/I_0, which represents the ratio of equity, is fixed to be 5.0 (times). The result of the simulation with changing the value of $\alpha_{Ent}^{I} - \alpha_{Ent}^{A}$ is shown in Figure 30.

< Figure 30 B^{min}/V with α^I-α^A >



We can observe two characteristics from this result. First, the multiplier varies little according to the value of $\alpha_{Ent}^{I} - \alpha_{Ent}^{A}$. This difference of the remaining holding fractions is closely related to the bargaining power of the entrepreneur in the acquisition contract negotiation. When the power is strong, α_{Ent}^{A} would become high and $\alpha_{Ent}^{I} - \alpha_{Ent}^{A}$ becomes small. In this sense, $\alpha_{Ent}^{I} - \alpha_{Ent}^{A}$ can be predicted to influence the minimum value of the private benefits of control, B_{Ent}^{min}, or the multiplier. However, the result does not support that prediction. This gives us an interesting suggestion that the entrepreneur's bargaining power in the acquisition contract negotiation with the acquirer would have little effect on the exit strategy planning.

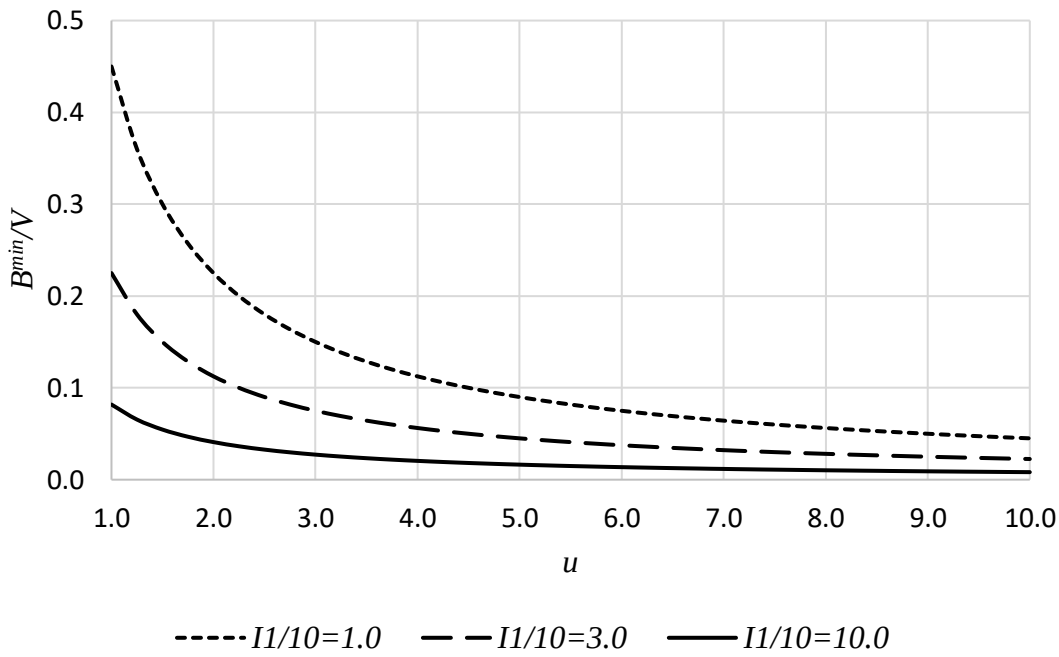
Second, the multiplier stays in the low level regardless of the upper movement u. This means that acquisition and IPO would be indifferent options for entrepreneur no matter what the market expectation is. In this simulation, I_1/I_0 is assumed to be 5.0, which represents a situation where several venture capitalists have already provided funds and have a relatively large equity share. In the situation where

entrepreneur has relatively small share of equity, the exit option choice would be irrelevant to the entrepreneur's private benefits of control level, and there would be less incentive for the entrepreneur to actively choose exit options. In the next simulation, the condition of the equity share varies.

5.2. Simulation of the equation (3) with changing I_1/I_0

The result of the simulation which has been conducted with the changes of I_1/I_0 is shown in Figure 31. $\alpha_{Ent}^{I} - \alpha_{Ent}^{A}$is fixed as 0.9, and I_1/I_0 is assumed to range from 1.0 to 10.0. In this result, we can find that the multiplier increases sharply as the upper movement u becomes lower, especially in the case of the lower ratio ($I_1/I_0 = 1.0$), though the result is the same with the one of the previous simulation in the high ratio case ($I_1/I_0 = 10.0$). This means that the ratio influences significantly the minimum value of the private benefits of control, B_{Ent}^{min}, or the multiplier. In contrast to the previous result, this suggests that the incentives for the entrepreneur to actively choose exit options increase as the entrepreneur obtains the larger equity share. In particular, the choice of the exit option becomes critical for the entrepreneur in the range of lower level of the upper movement u, where the market expectation for the venture business is low. In this situation, the value or benefit expected to be obtained from the market is quite low, and almost no benefit would remain for the entrepreneur if the equity ratio becomes high. Therefore, if acquisition is chosen as an exit option, it is logical for the entrepreneur to require the private benefits of control in exchange for giving up its majority of equity share. This could be reflected to the sharp increase of the multiplier in this range of u.

< Figure 31 B^{min}/V with I_1/I_0 >



Based on the results of both simulations above, it is also worth mentioning that the multiplier, or the minimum value of private benefits of control stays quite low as the upper movement u becomes large. Even when the equity ratio is low, this trend is hold. Therefore, when the venture business is highly evaluated by the market, acquisition and IPO would be indifferent regardless of the equity share and the entrepreneur's bargaining power with acquirer. As explained above, when the entrepreneur chooses acquisition as an exit options rather than IPO, it is called an "IPO valuation premium puzzle." However, according to the results, is not uncommon for the entrepreneur to choose acquisition over IPO even when the business is highly evaluated. "Puzzle" means incomprehensibility. Nevertheless, the results of these simulations also show that this phenomenon is comprehensible.

6. Conclusion

Planning exit strategies is one of the central issues not only for investors such as the venture capitalists but also for the entrepreneurs who have created their start-ups and make them grow larger to ventures. Firstly, this article is analysing the property of "private benefits of control" as a criterion of choosing the exit option, either IPO or acquisition. For the exit choice, there is an intriguing issue. There is a situation where many private firms choose to be acquired rather than to go public at higher valuations. Bayar and Chemmanur (2011, 2012) called this situation as "IPO valuation premium puzzle." This article is also trying to understand what the "IPO valuation premium puzzle" actually is, and scrutinizing whether "IPO valuation premium puzzle" is really a "puzzle".

As a venture exit strategy, IPO is often thought to be superior to acquisition from the viewpoint of the market expectation. However, from the game theoretic real options approach, IPO or acquisition should be treated equivalently, and the choice criterion can be explained with the concept of Nash Equilibrium. Consequently, "Private benefits of control" can be explained as the condition for holding the state of Nash Equilibrium between the entrepreneur and venture capital. Moreover, it seems that the phenomenon of "IPO valuation premium puzzle" is not really a "puzzle" when looking through the lens of the inherent property of private benefits of control.

In the course of the analysis, the minimum value of the "private benefits of control", B_{Ent}^{min}, is derived from the difference between the expected values of the two exit options, IPO and acquisition, especially when the market expectation for the venture business is not high. This critical index has two important components: One is the difference of the remaining holding fractions, $\alpha_{Ent}^{I} - \alpha_{Ent}^{A}$, which is closely related to the bargaining power of the entrepreneur in the acquisition contract negotiation. The other one is the equity ratio, I_1/I_0, which represents the entrepreneur's equity share.

Based on these components, two types of numerical simulations against the multiplier of B_{Ent}^{min}/V have been implemented. The results give us an interesting suggestion that the entrepreneur's bargaining power

in the acquisition contract negotiation with acquirer would have little effect on the exit strategy planning. However, the results also show that the equity share has a significant influence on that issue. The results suggest that there would be less incentive for an entrepreneur to actively choose exit options when the entrepreneur's equity share is relatively low. In contrast, the incentive for an entrepreneur to actively choose exit options would increase as the entrepreneur obtains the larger equity share. In addition, the results suggest that the phenomenon, which is so called as "IPO valuation premium puzzle" is neither incomprehensible, nor uncommon for entrepreneur.

The variable of the "private benefits of control", B_{Ent}^{min}, has a great potential to become a criterion for choosing the exit options between acquisition and IPO. It is similar to goodwill in the financial accounting item, and it could become a new benchmark for the exit strategy planning. Although a consensus on this issue has not yet been obtained, many approaches derive from the market viewpoint. These assume that the market condition would give the exit option criteria. Nevertheless, it is often the case that the interactions or internal relationships among players, such as entrepreneurs and venture capitalists have not been taken into consideration. Needless to say, the viewpoints of the players' interactions should not be ignored.

This article focuses on the relationships between entrepreneurs and venture capitalists. However, there are other players, such as banks or bank-affiliate venture capitalists, in the issue of venture financing. As they would provide funds as debt, especially as convertible bonds, the capital structure changes. Furthermore, it is not uncommon that the investment policies of individual venture capitalists are different. As a result, the control benefits would be affected. These issues should be incorporated in the exit choice process, thus further study and research are needed.

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Part Three: Concluding remarks

1. Concluding summary of Part One

The financing deal of start-ups and ventures has seen a surge of interest in practice. According to KPMG (2019), VC-backed companies raised $63.9 billion in funds during the 4-th quarter of 2018 all over the world, and this amount is increasing year-after-year. In academics, the study of entrepreneurial finance and entrepreneurship are attracting a growing interest. This dissertation, titled 'The financial evaluation of entrepreneurial strategic choices,' aims to serve as a cornerstone for these new research areas.

The study of traditional corporate finance and market finance has a long history. Entrepreneurial finance is a distinctive subset of traditional corporate finance (Wright and Robbic, 1998), and it is a relatively new research area. The theories and knowledge of valuation methods, which have been developed in traditional corporate finance (e.g., the DCR and IRR methods) are directly applied to the issues in entrepreneurial finance, though these are two 'distinctive' fields. This mismatched utilisation of valuation methods has to be resolved. This is one of the three objectives of this dissertation. This dissertation focuses on contract negotiation. We expect that if quantitative evaluation methods are adopted, financing negotiations would become fairer and smoother as an objective evaluation could be provided. Here is the second motivation of this dissertation. Strategic aspects should be considered during contract negotiation. As discussed later, the application of ROA is quite beneficial. Providing new models using ROA to enable strategic choices is the third motivation of this dissertation. There are few papers approaching both topics of contract negotiation and ROA in the entrepreneurial finance area. Therefore, the objective and contribution of this dissertation are to develop quantitative methods based on ROA to facilitate financial valuation of contract. This valuation shall be practical usage-oriented in entrepreneurial finance area. However, the objective of this dissertation is not limited to develop technical aspects, but it also aims at providing useful practical insights for both entrepreneurs and investors, which would facilitate decision-makings during contract

negotiations for financing and investing into start-ups and ventures. This chapter is structured in three sections. In part one, general perspectives, which can be adopted to individual issues of Part Two, are dealt with. Then, Part Three provides concluding remarks and discussions.

First of all, it is necessary to discuss what is entrepreneurial finance. Entrepreneurial finance can be defined as the intersection of 'entrepreneurship' and 'finance' (Cumming, Douglas and Sofia Johan 2017, Landström, 2017). The study of entrepreneurial finance is a relatively new area for both academics and practitioners. The theories and knowledge, which are well-established in corporate and market finance are forcibly and directly applied to financial issues in the entrepreneurship field, though entrepreneurial finance has different characteristics. Entrepreneurial finance is focusing on financing situation and has been developed as a branch of the corporate finance. Corporate finance focuses mainly on those financial issues related to large listed companies, which aim at maximising corporate value (Brealey and Myers, 2013, p.1). This corporate value derives from financial markets, such as stock maker. Thus, the relationship with shareholders or with the lenders of the debt is important for corporate managers (Brealey and Myers, 2013, p.1). However, entrepreneurial and market finance are not so closely interlinked. The common assumption of market and corporate finance is that investors, such as shareholders, are mainly secondary-market investors and are anonymous or price-taker. This means that they do not influence directly the market price movements and corporate managers' decision-makings are not taken by individuals but by groups of investors. On the contrary, investors in entrepreneurial finance settings, such as venture capitalists, are not anonymous. Consequently, even an individual investor has a great influence on the negotiation of financing and investment into start-ups and ventures, but he also has a great impact on the entrepreneur's decision-makings (see. section II.1.4.).

The difference between entrepreneurial finance and corporate finance is not limited to the property of investors. Smith et al. (2011, p.30) highlight eight characteristics of entrepreneurial finance compared to traditional corporate finance: The inseparability of new venture investment decisions from financing decisions, the limited role of diversification as a determinant of investment value, the extent of managerial involvement by investors in new ventures, the substantial effects of information problems on the firm's ability to undertake a project, the role of contracting to resolve incentive problems in entrepreneurial ventures, the critical importance of real options as determinants of project value, the importance of

harvesting as an aspect of new venture valuation and the investment decision and the focus on maximizing value for entrepreneur as distinct from maximizing shareholder value. Landström (2017) also summarises the differences between entrepreneurial finance and corporate finance in terms of internal characteristics, financial market characteristics, relationship to external capital providers, internal finance and external finance (see. section II.1.4.). Specifically, it is essential to take the following four characteristics of entrepreneurial finance into consideration: 'Stages,' 'Risk,' 'Information asymmetry' and 'contract negotiation' aspects.

Those four concepts are closely connected to each other. The concept of 'stages' is derived from the model of venture life cycle by Leach and Melicher (2016) (see the section II.2.). The venture life cycle begins when the entrepreneur comes up with a business idea and launches the project. Then, the mode and property of the entrepreneurial firm and its project may vary in each stage of the lifecycle. Leach and Melicher, for example, differentiate the stages in terms of 'life cycle entrepreneurial process activities,' 'types of financing' and 'major sources/players' (see the section II.2.1 Table.2). Consequently, this dissertation differentiates between the following two names of 'start-up' and 'venture' which both characterize firms that have entrepreneurial projects: 'Start-up' refers to an entrepreneurial firm that is progressing from the 'Development stage' toward the 'Survival stage.' 'Venture' refers to an entrepreneurial firm that passes from the 'Survival stage' and enters into the 'Rapid-growth stage' or later.

Although all entrepreneurs hope that their businesses get on the right track, the reality is not so sweet in many cases. In reality, Grant et al. (2019) report a 5-year survival rate around 10%. This situation can be described as 'risky' and can be measured with probability distributions. This concept has to be distinguished from 'uncertain' which is unmeasurable (see the section II.3.). 'Risk' should not always be avoided. For both the investors who wish to invest in publicly traded companies and those who have willingness to provide funds to start-ups and ventures, 'risk' is well-recognised as the source of economic returns because 'risk' has both aspects of gain and loss (see the section II.4.). However, such an expectation of gain would be possible only after resolving the issue of 'information asymmetry.' The issue of 'information asymmetry' refers to the fact that material information is eccentric. This issue is common in all the disciplines of finance. In market and corporate finance settings, investors have different pieces of information and the quality and quantity of information that they have influence their willingness to

participate to transaction. Consequently, the market itself might collapse (see the section II.5.). Actually, if we compare to secondary stock markets, those markets have a long history, and are often well-organised. The financing transactions are also standardised. New equity investors are supposed to be anonymous and price-taker in those markets. Conversely, the markets to which start-ups and ventures can access are not yet well-organised and financing transactions in entrepreneurial finance settings is not so standardised. Thus, entrepreneur and investors should negotiate face-to-face, and on a case-by-case basis. This situation is crucial in entrepreneurial finance and characterises financing contract negotiation. Consequently, entrepreneur and investors take actions by considering the other player's action in order to maximise their own outcomes. In addition, 'contract negotiation' should be discussed from the perspective of information asymmetry by nature, because not all the players could share the information equally. Therefore, 'contract negotiation' is set as a central issue in this dissertation (see the section II.5.).

Consequently, one question arises: "What is the problem really worth being resolved in such case-by-case negotiations by visible individuals?" The principles of corporate finance focusing on maximizing value (Brealey and Myers, 2013) can be applied to entrepreneurial finance. From this standpoint, thus, the answer to the question above could be as follows: "the central problem for financing and investment decisions into start-ups and ventures is how to evaluate the consequences or outcomes of contract negotiations financially or quantitatively." More precisely, it is how to build the models which can capture the properties of contract negotiation processes and express them in a quantitative (mathematical) manner. The main stream of entrepreneurial finance research is based on empirical qualitative studies, and the number of academic researches relying on quantitative models is limited. However, quantitative models and particularly simulations could be useful for giving managerial insights for all the parties concerned in contract negotiations. Consequently, the main research (central problem) question for this dissertation can be set as "How should strategic choices in contract negotiation be financially evaluated?" In order to answer this question, we build quantitative models to evaluate financially the value of negotiation contract, which is the main objective of this dissertation.

Financial tools aiming at describing the financial value of things, such as assets and liabilities of corporations, as well as financial evaluations require quantitative models. In corporate and market finance, the Discount Cash Flow (or DCF) and the Internal Rate of Return (or IRR) are widely-used. The critical

point to notice is that these financial evaluation methods do not allow deferment of decision-makings and thus do not enable flexible decision-making processes, which would take into account future outcomes. As Dixit and Pindyck (1994) said, the investment timing is only 'now or never.' Contract negotiations for financing start-ups and ventures normally include terms to defer and/or allow flexibility of decision-makings because there are risky conditions in venture businesses and projects, as discussed above. DCF and IRR cannot capture this property in entrepreneurial finance settings, another method is required. One well-known alternative method is Real Options analysis (or ROA). ROA is an extension of the DCF method, which incorporates the financial options theory. Copeland and Antikarov (2003) define real options as "*the right, but not the obligation, to take an action (e.g., deferring, expanding, contracting, or abandoning) at a predetermined cost called the exercise price, for a predetermined period of time – the life of the option. (p.5)*" (see the section VI.1.). Although many researchers would agree with it, for example, Smith et al. (2011) emphasise the importance of real options as determinants of project value (p.13, p.125), there is actually no evidence that many professionals, such as venture capitalists, use ROA as the main method for their investment decision-makings. It is true that DCF and IRR are simple to calculate and easy to understand. However, as discussed above, the characteristics of investment in entrepreneurial finance is different from the one in market finance and corporate finance. Thus, these are too simple, and sometimes unreliable, for taking the decisions of investing in risky entrepreneurial businesses and/or projects. Our research highlights the fact that ROA could be utilised more actively in practice. Thus, another objective of this dissertation is to exemplify in which situations ROA can be used in entrepreneurial finance settings, especially during negotiations of financing.

2. Three articles in Part Two

The main research question of "How should strategic choices in contract negotiation be financially evaluated?" may be a little bit broad and abstract. In order to approach this main research question, we use specific quantitative models. Thus, three models are proposed for analysing and resolving specific problems related to contract negotiation in entrepreneurial finance. The first article focuses on developing a quantitative model that determines how much the payout ratio from the licensee to the licensor should

be in licensing contract negotiations in the new drug R&D. One of the typical examples of this licencing contract negotiation is between a large pharmaceutical company and a biopharma start-up or venture. In this case, the licensee is a large company, and the licensor is a start-up or venture. The second article aims to provide a cost model for new equity investor's investment decision-making in the second financing round under the existence of convertible note holder. Convertible note is classified as a mezzanine financing method, which means that it has both characteristics of debt and equity. The investor, such as an angel, invests in start-ups using convertible notes as debt in the earlier stage, then, if the business goes well, the convertible note holder will convert them into equity in the second financing round. Otherwise, the convertible note holder will not convert them and keep them as debt. The third article tries to develop an exit choice model. The two major exit choices are initial public offering (IPO) and acquisition, and the financing negotiation between the entrepreneur and venture capitalists in the later stages is linked to the preparation for exit choice. It is believed that an IPO is a superior choice than an acquisition. The exit choice model between IPO and acquisition, which is proposed by Bayar and Chemmanur (2011, 2012), would be a cornerstone. However, as they point out, there is an issue of "IPO valuation premium puzzle." As the name suggests, even if the value of the entrepreneurial business and/or project becomes high enough to prepare for IPO, the entrepreneur dears to choose acquisition in some cases. Thus, the general belief that IPO is superior to acquisition might include some misconceptions or misunderstandings. Thus, this article scrutinises the model proposed by Bayar and Chemmanur, and tries to provide a new numerical criterion of exit choice.

As mentioned above, the selected three topics are unique but typical problems related to the contract negotiations of financing and investment in start-ups and ventures. The licensing contract is one form of alliance strategies. Alliance strategies are not specific to the pharmaceutical industry. This corporate level strategy is deployed in all the industries regardless of the size of companies. For example, the global alliance of airline companies is famous. In the electronic device industry, so-called 'cross licencing' is usual. In that situation, companies strategically exchange their patents and know-hows in order to develop a brand-new product. However, licencing/alliance contracts, which include the exchange of patents and/or know-hows are not always preferable in all industries. In the case of bio-pharmaceutical industry, one single chemical compound or one innovative method could create a so-called 'blockbuster,' which brings a high level of sales. However, the probability of finding or developing such a blockbuster is quite low

and incredible amount of time and money are necessary. In reality, even the large pharmaceutical firms for which a lot of highly educated and skilled researchers are working are struggling to develop the new drugs, and thus, they are always looking for licencing/alliance partners all around the world. The partners are often bio-pharma start-ups and ventures as these firms are often founded based on the innovative technologies and/or know-hows that the large companies want in order to fulfil the new drug candidate pipeline. For start-ups, their focus is on finding funding. They are devoting huge efforts in order to find and develop just one 'blockbuster' candidate under sever constrains of funds. As entrepreneurs are attached to their company, they may feel that entering into a licencing/alliance contract is almost the same as selling their business. Thus, it is natural that entrepreneur shall be very sensitive and cautious. In this sense, some might argue that licence/alliance is almost equivalent to 'mergers and acquisitions' in this industry. Actually, mergers and acquisitions are often used not only in the bio-pharmaceutical industry but also in all kinds of areas. However, while the licencing/alliance strategy does not change any of the companies' appearances, mergers and acquisitions will transform them. The strategy of mergers and acquisitions is too broad to deal with as a unique topic in entrepreneurial finance, though it is interesting to address. On the other hand, licencing/alliance is a well-targeted strategy, and the contract negotiation process is clearer than the case of mergers and acquisition. Thus, the first article focuses on the licencing contract.

Then, the issue of convertible note is a common financing method, especially for start-ups in the earlier stage. When considering whether to invest in the start-ups in the earlier stages, one of the most difficult problems for both prospective investors and entrepreneur is how to determine the value of the firm or project. At the timing of decision-making, it is usual that the entrepreneur has only a business idea, and not yet realised any prototype. Consequently, the valuation for equity investment is quite difficult because the series of future cash flows are almost impossible to predict. The estimation of these cash flows shall become unreliable, and the contract negotiation will become tough and time-consuming. In addition to that, the legal procedure for such an equity investment is often said to be expensive (e.g., the fees for lawyers). On the other hand, the utilisation of convertible note could mitigate these burdensome matters. As explained in the previous subsection, convertible note is classified as mezzanine financing method and has an option structure. Investors invest as a debt and they can choose whether to convert it to equity depending on the outcomes of the business. The debt contract is said to be less time-consuming and less

expensive. Historically, banks provide debt financing and they have developed standardised packages and credit risk management methods. On top of that, the debt financing contract does not need any valuations of the firm and/or project. The major concern of the debt financing contract is limited to whether the borrower can pay back the interests and principal at the due date. Although debt is preferable for entrepreneur in terms of low procurement cost and speedy contract negotiation process (Feld and Mendelson, 2016), it is not suitable for the start-ups in the earlier stages because the estimation of cash flows for repaying the interests and principal is unreliable. In this sense, convertible note issuing is preferably chosen because of its unique feature of ambivalence. Nevertheless, the existence of convertible note holder bothers the prospective equity investors in the later financing round. The convertible note holder has a right not obligation of conversion from debt to equity. If debt is converted into equity, the dilution problem for prospective equity investors become serious. Therefore, the contract negotiation shall be difficult and complex for all the participants. In particular, for the new equity investors, the existence of convertible note holder is quite sensitive, and the cost for investigating the current contract situation will be critical.

The exit choice is another unique but typical problem in entrepreneurial finance. As explained, IPO is believed to be a better choice compared to acquisition when the firm's or project value becomes high. Although Bayar and Chemmanur (2011, 2012) develop the exit choice model, they admire the existence of "IPO valuation premium puzzle" at the same time. The phenomenon that they call "puzzle" can be seen in practice. In the later stages, entrepreneur and investors, such as venture capitals, enter into the contract negotiation for financing the exit decision. In these later stages, both the business and the size of the firm may have grown and the entrepreneur should principally play a managerial and administrative role. It is not uncommon that the discrepancies between the entrepreneur and venture capitalist becomes large over the direction of the business which they foster cooperatively. It could be argued that IPO is not necessarily the best exit strategy for both entrepreneur and venture capitalist. Therefore, it is worth analysing the exit choice model.

3. Contributions and discussions

Entrepreneurial finance is a branch of corporate finance. Corporate finance has a long history and its theories have been developed based on market finance. There are well-recognised theories (e.g., the principle of separation of ownership and management) and knowledge (e.g., DCF and IRR). However, entrepreneurial finance has unique features, which distinguish entrepreneurial finance from traditional corporate finance and market finance. As introduced in Part One, Smith et al. (2011, p.30) characterises entrepreneurial finance with the following eight features:

(1) The inseparability of new venture investment decisions from financing decisions
(2) The limited role of diversification as a determinant of investment value
(3) The extent of managerial involvement by investors in new ventures
(4) The substantial effects of information problems on the firm's ability to undertake a project
(5) The role of contracting to resolve incentive problems in entrepreneurial ventures
(6) The critical importance of real options as determinants of project value
(7) The importance of harvesting as an aspect of new venture valuation and the investment decision
(8) The focus on maximizing value for entrepreneur as distinct from maximizing shareholder value

This summary is very useful to understand what is entrepreneurial finance comprehensively. In terms of practical financing and investment, we can notice that the contract negotiation is a central issue for both entrepreneur and investors according to features (5) and (8). In addition, we can also recognise that taking the strategic aspects into consideration should be emphasised, especially according to features (1), (3) and (4). Thus, this article tries to deal with the research question of "How should strategic choices in contract negotiation be financially evaluated?"

For tackling this question, utilising quantitative models is essential. Although qualitative analyses are also helpful, numbers could help different stakeholders to share sense during a decision-making process, especially over the issues of the financing and investment in start-ups and ventures. As a whole, the main contribution of this dissertation is to have succeeded in answering this question by building up the quantitative models for approaching three typical but unique financing and investment issues. In particular,

all these models have achieved in reflecting the unique and important features of information problems (4) and the real options (6) by approaching the individual specific issues. Moreover, all models are established based on the consideration of strategic aspects which are shown in (1) and (8).

3.1. Academic contributions

The first article tries to build up a quantitative model for analysing the issues incurring in a licensing contract negotiation between a licensor and a licensee in the bio-pharmaceutical industry. The work of Lo Nigro et al. (2014) describes portfolio selection criterion for new drug R&D clearly. However, they did not show the detailed criterion for licencing (alliance) contract which has recently become an important corporate strategy. The first article achieved in the detailed modelling of the licensing contract by developing the general idea for the criterion, which they suggest in their paper. Although they show the idea, any equations which provide the detailed criterion have not yet shown. Based on their model, the first article tried to realise the detailed quantitative criterion by modifying the variable that represents the drug value. In this process, the dynamic assumption of risk perception proposed by Das and Teng (2001) was incorporated. For building up the model, this assumption is quite useful in order to capture the property of the licencing contract. However, any quantitative equations have not yet been proposed. As it is, directly applying this assumption into the licensing contract negotiation model is impossible. The first article resolved this difficulty by taking into the degree of effort of licensor to engage in the new drug R&D project. The more the licensee (the large pharmaceutical firm) pays the money to the licence (bio-pharma start-up), the more licensee would commit their effort into the project. The first article achieved in expressing this behaviour in the (mathematical) square-root function. Then, as a whole, the licencing model could be finalised.

The second article succeeded in building up a quantitative model that shows the (due diligence) cost for new equity investors in the second financing round. As discussed above, convertible note has an option structure (real options) and this structure causes a dilution problem which means the share for new equity investors decreases when the conversion is done. In addition, new equity investors can neither know the internal information about how the business is actually going, nor what kind of contract (e.g., discount

and valuation cap) entrepreneur and convertible note holder have made (information asymmetry problem). Thus, the existence of convertible note holder is quite costly for new equity investors to make their investment decisions. Although these two issues are well known, few papers approach them at the same time. Moreover, almost no paper has tried to build up the quantitative model that can capture these two. The second article achieved it. The model building begins with the widely accepted basic knowledge of equity shares in practice (Poland, 2017), and develops the basic ideas of contract theory and information asymmetry introduced by Macho-Stadler and Pérez-Castrillo (2001) and Salanié (2005). The most distinctive point is to have succeeded in showing the detailed cost function.

The third article is successful in developing a new model for choosing an exit strategy. More precisely, the model identifies a new criterion on which an exit strategy should be chosen, either IPO or acquisition. The precursor of the exit choice criterion is the model proposed by Bayar and Chemmanur (2011, 2012). Although their model is sophisticated, there still remains an enigma. It is called as "IPO valuation premium puzzle." As explained above, entrepreneur will choose acquisition rather than IPO even if the market value of the entrepreneurial business is high enough to prepare for IPO. The "puzzle" would be caused by the assumption that all the variables in their model will be determined based on market conditions. However, one of the variables, called as "private benefits of control" (named by Bayar and Chemmanur, 2011) shall not only be characterised by the market conditions in terms of entrepreneurial finance because the investor's characteristic is supposed to be different. Unlike in market finance, the investors are not anonymous, and they must confront the entrepreneur during face-to-face negotiations. The "private benefits of control" should be interpreted in this context of contract negotiation. This article 3 succeeded in modelling the property of "private benefits of control" in a quantitative manner, by developing a game-theoretic real options approach proposed by Smit and Trigeorigs (2006). At the same time, this article could show that "IPO valuation premium puzzle" is no longer a "puzzle" but is explicable in the process of scrutinising the property. Depending on the value of "private benefits of control," acquisition can sometimes be a better choice than IPO. Furthermore, by expanding the quantitative model of "private benefits of control," this article achieved in the creation of a new criterion about which exit strategy, IPO or acquisition, should be chosen.

Another contribution of this dissertation is that the three articles do not only show theoretical models but also provide managerial insights by implementing numerical simulations. The results of the simulations could be helpful for both entrepreneurs and investors to facilitate decision-makings during contract negotiations for financing and investment. In particular, all the simulations have been done within Excel spread sheets. The software, Excel is not so difficult to handle with, compared to the other software for numerical simulations, such as Matlab and R. Thus, even if the models could be a bit complicated to understand, the simulations would not be so difficult. In this sense, it could be said that the models and simulations (results) in this dissertation are practical usage-oriented.

3.2. Managerial contributions

The first article implemented the simulation of the payout ratio from licensee (large pharmaceutical firm) to licensor (bio-pharma start-ups). The results show that the optimal payout ratio from the licensee to the licensor is a little bit different, depending on the phases of the new drug R&D. As a whole, the optimal payout ratio is greater in the earlier phase, and smaller in the later phase. In the licencing contract negotiation, it is rational that the licensee, which is a large pharmaceutical firm in this case, generally does not want to pay a lot of license fees to the licensor. It is also normal that the bargaining power of a large pharmaceutical firm is normally stronger than that of a start-up. Thus, a large pharmaceutical firm would try to reach an agreement to pay a small amount fees by using its great bargaining power in any situations. In the later phases, this strategy will work as the simulation results show. However, in the early phases where the risk for the achievement of R&D is great, this strategy is not recommended. In addition to that suggestion, the simulation results also indicate that the cost that is invested in the R&D project plays an important role in each phase. If the cost is large, the outcome of the negotiation strategies above will be emphasised. In other words, in the earlier phases in particular, an agreement to pay a small amount of fees would increase the probability of the failure of the new drug R&D when the project cost of the R&D is high. Furthermore, it is the same when the volatility of the estimated market value of the new drug is high. That means that the risk of the future revenue stream with the new drug is high, paying the sufficient amount of license fees to start-up and building up a strong cooperation between the two firms is the better contract negotiation strategy for the licensee. This would be a new insight for the contract negotiation.

The second article has two simulations. The first simulation deals with a simulation on the effect of a discount rate, which was agreed upon between the entrepreneur and convertible note holders before new equity investors make their decisions. As discussed in part one, convertible note issuing is preferred in the earlier stages. The risk for the success of the entrepreneurial business becomes high in these stages, and thus, convertible note investors tend to require deep discount (and/or small valuation cap). During such contract negotiation, investors have generally a greater bargaining power than entrepreneurs, and it would be rational to think that entrepreneur must accept the contract term of deep discount and/or small valuation cap. This contract would not always be revealed to new equity investors in the second financing round. The simulation result shows that the deeper the discount (smaller the cap), the larger the effect of equity share dilution. In other words, if the contract terms of deep discount (small valuation cap) agreement is hidden to new equity investors, the disadvantage for them becomes sever. Thus, entrepreneurs must recognise that the due diligence by new equity investors shall be stricter if they are not convinced that the entrepreneur is collaborative, when entering the contract negotiation in the second financing round. The other simulation is about the cost of equity investment decision-making. As discussed above, both the dilution and information asymmetry problems become significant for new equity investors under the existence of convertible note holders. Thus, it is rational that new equity investors may hesitate to agree to offer the full investment amount that entrepreneur demands. In particular, the simulation results show that the cost for new equity investor's decision-making becomes the highest in the situations where they think of reducing the investment amount by 40%. This tendency is enhanced if the discount is deeper (and/or the valuation cap is smaller). That means that it is quite difficult for entrepreneurs to prepare for a negotiation strategy to achieve the agreement of 60% of the full investment amount. Rather, only 20% or almost zero % would be rational. In the earlier stages, the financing strategies is critical for entrepreneur. It is necessary for entrepreneur to demand funds to investors in these stages and the form of convertible note is preferable as such funds, as discussed before. This means that accepting the convertible note holder is beneficial for entrepreneur especially in the early stages. However, at the same time, entrepreneurs had better to recognise that the financing negotiation would become disadvantageous under the existence of convertible note holder in the second financing round, as Poland (2017) or Fled and Mendelson (2016) argue.

The third article simulates how the minimum value of "private benefits of control" (or the multiplier), which is required for choosing acquisition rather than IPO, is affected. As the model indicates, there are two key factors: the bargaining power of entrepreneur in the acquisition contract negotiation (represented by $\alpha_{Ent}^{I} - \alpha_{Ent}^{A}$) and the entrepreneur's equity share (represented by I_1/I_0). The two simulations also are implemented, respectively. The simulation results against the former factor show that the effect of the bargaining power of entrepreneur has little influence on the choice of the exit strategy. In addition, the result indicates that the choice between acquisition and IPO would be indifferent to market expectation. Thus, we can notice that the "private benefits of control" is not necessarily derived from market conditions as Bayar and Chemmanur (2011, 2012) insist. The simulation results show that the entrepreneur's equity share has a great impact on the minimum value of "private benefits of control." The lower the equity share becomes, as well as the lower market expectation, the higher the importance of "private benefits of control." The critical contribution is that this property of "private benefits of control" can be expressed in a quantitative manner. For the negotiation of financing contract toward exit, both entrepreneur and investors could recognise on what point they should focus on from the standpoint of "private benefits of control," and also could predict what consequence would be achieved.

4. Target users of the models in this dissertation

This dissertation focuses on contract negotiation for financing and investment in start-ups and new ventures. Thus, the primary targets for the models and results of simulations in this dissertation are entrepreneurs and investors who are willing to provide funds to the start-ups and ventures or are looking for financing. The financing methods are usually divided into two kinds in corporate finance. One is equity, and the other is debt (e.g., Brealey and Myers, 2013). Thus, investors are characterised as equity investors and debt investors. Textbooks of entrepreneurial finance often explain that equity is a favourable form of financing and investment because the founding may not be return, notably if the business fails (Smith et al., 2011). On the other hand, debt is not preferable for entrepreneurial businesses because the entrepreneur must pay its interests periodically and finally repay the principal (e.g., Leach and Melicher, 2016, Smith et. al, 2011). The typical equity investors in entrepreneurial finance are venture capital and private equity.

Some books for entrepreneur and financial professionals (e.g., Poland, 2017, Feld et al., 2016) explain that venture capital is willing to provide funds to the start-ups in the earlier stages and private equity funds prefer to invest in the ventures in the later stages. However, there is no clear distinction between them in practice. As discussed in the applications of article 2 in Part two, another major financing and investment method in entrepreneurial finance is convertible note. Strictly speaking, convertible note is not equity, but it is preferably utilised for the investment in start-ups in the earlier stages. The typical note holder is an angel investor (or business angel), and he/she hopes to be able to convert his/her debt into equity. Block et al. (2018) also say that "*Venture capital (VC) and business angel (BA) financing have traditionally been advocated as important sources of financing for young innovative firms that find it difficult to access bank or debt finance (p.240).*" In summary, entrepreneurs, venture capitalists, private equity and angel investors, are actually main targets for the users of the models in this dissertation.

Furthermore, it is generally believed that debt is not preferable for entrepreneurial businesses. In academics, the advantage of debt is often perceived in terms of the value increase of the entrepreneurial businesses. Ueda (2004) argues that venture capitalists can assess an entrepreneur's idea and project better than banks. De Bettignies and Brander (2007) insist that the entrepreneur benefits from the venture capital's managerial input, and venture capital tends to be preferred to bank financing when venture capital productivity is high and entrepreneurial productivity is low. According to Colea et al. (2016), their empirical result shows that "*the effect of VC to be both economically and statistically significant in stimulating new firms, new establishments, new employment, and new payroll. We do not find similar evidence for banks. (p.60)*" Nevertheless, debt has recently been described as an alternative financing method of equity. According to the paper by Cumming and Johan (2017), the number of researches (the number of google scholar hits) related to 'Entrepreneur Debt' is increasing constantly. In particular, De Rassenfosse and Fischerd (2016) introduce the notion of "venture debt lenders (VDLs)." They explain that "*Venture debt lenders (VDLs) are specialized financial institutions that provide loans to start-ups. Loan recipients usually operate in high-tech industries such as biotechnology or information technology (IT). They have negative cash flows and no tangible assets to secure the loan. Venture debt financing is, thus, not traditional bank financing. This relatively new form of start-up financing lies at the intersection of venture capital and traditional debt. (p.235)*"

It is important to highlight that VDLs are "not traditional bank financing." Traditional bank financing is embodied in the contract by which the borrower must pay the interests periodically and repay the principal at the due date. It is usual that start-ups and ventures have negative cash flow, and the periodic payments are heavy burden for them. VDLs offer funds as debt, and at the same time, they require the patents that start-ups and ventures possess as collateral. Thus, the VDLs maybe the potential target for the models in this dissertation. The topic of debt investment is quite new, and the VDLs have not yet been popular even in the field of entrepreneurial finance. However, contract negotiation between the entrepreneur and VDLs could be an interesting topic for future research.

The discussions above implicitly assume the contract negotiation between two players: the entrepreneur and the investor. However, it is possible to think about the negotiations between different types investors: a venture capital vs other venture capital, for example. As Casamatta and Haritchabalet (2014) discuss, we can consider the case in which an entrepreneur goes into the negotiations with two or more venture capitalists. In this situation, as they also suggest, "*If he contacts both venture capitalists (VCs) simultaneously, he obtains high monetary profits. If he commits to a period of exclusive negotiation with one VC, he increases the probability to obtain financing but deal terms deteriorate. The optimal negotiation strategy results from this trade off. (p.1743)*" Although they have already proposed the equilibrium financial contract models and the implications for the venture capitals' portfolios and entrepreneurs' deals, their model has some rooms to be developed further. As discussed in the article 3 in Part Two, the "private benefits of control" should not be interpreted only in terms of market conditions, but rather, also be discussed as a 'psychic' factor for entrepreneur to start a new project. This 'psychic' element would not be easy to be represented quantitatively. However, it shall be worth trying to do so.

Focusing on the relationship between venture capitals themselves would be also interesting. In academics, the topic of venture capital syndication is discussed as to be favourable. For example, Tian (2012) argues that "*VC syndication creates product market value for their portfolio firms… Further, VC syndicates nurture innovation of their portfolio firms and help them achieve better post-initial public offering operating performance. (p.245)*" Du (2016) insist that "*The results reveal both benefits and costs for VCs that syndicate with other similar VCs: the transaction costs may be lower for homogeneous syndicates,*

but the opportunities for learning brought by heterogeneous partners may be more valuable in the long term. (p.12)"

At the same time, as Chahine et al. (2012) point out, principal–principal agency conflicts within venture capital syndicates would lead to additional principal–agent conflicts. Thus, the models in this dissertation could be extended to this direction. Nevertheless, the topic of venture capital syndication is a relatively new and further researches are expected. As Jääskeläinen (2012) argues, "*while the venture-level aspects are relatively well understood, the current literature lacks an understanding of how and why syndication affects the performance of VC firms. (p.444)*" In this sense, the application in article 2 might be a precursor of this kinds of researches because it deals with the relationship among the three players of entrepreneur, convertible note holder and new equity investor.

5. Other several avenues for future research

The research area related to contract negotiation, such as so-called 'contract theory' has become popular, and there are rooms for further researches. On another front, the recent development of applying mathematical methods into economic theories has been notable (e.g., continuous time series modelling using mathematical finance methods), and there is a need for quantitative analysis. New theories as well as models are still required in entrepreneurial finance.

Cumming et al. (2019) summarise three topics which are currently popular in entrepreneurial finance: 'the life cycle approach to entrepreneurial finance,' 'business angel research' and 'venture capital research.' As explained, the first topic is directly linked to contract negotiation. The authors suggest to choose debt especially in the financing of early stage start-ups. Traditional corporate finance highlights that the debt financing may not be adapted to such situations as start-ups must give the (monthly) interests and principal back to the lenders, such as banks, in spite of the lack of capability of generating cash, and thus, we should

choose equity. Although it is theoretically right, the trend of using debt can be seen in practice. Also, in academics, there are researches related to the adaptation of debt in the entrepreneurial finance area comparing to the equity financing by venture capitals (e.g., Hirsch and Walz,2019; Colea et al.,2016; Barry and Mihov,2015). The debt financing in entrepreneurial finance has several merits, such as the reduction of paper works at the contract agreement (comparing to the equity financing contract), thus, this topic could be developed as a future research topic.

Cumming et al. (2019) also point that there are several directions for further research specifically related to the contract negotiation, such as 'funding gaps' and 'the interplay between different types of investors.' They explain the first topic of 'funding gaps' as "*There has been much long-standing attention on the notion of funding and equity gaps in entrepreneurial finance*," which means that start-ups or new ventures need funds but scarcely obtain them. For this issue, Clarysse et al. (2007), for example, argue that "*spin-offs with formal technology transfer start with a larger amount of capital but subsequently do not raise more capital than spin-offs without formal technology transfer*." As Cumming et al. (2019) added, "to distinguish at least two funding gaps" is necessary. They continue "*one involving very early stage ventures requiring funding for the development of proof of concept and prototypes prior to revenue generation, and a second one involving somewhat older ventures that need significant levels of funds to realize growth potential beyond initial revenue generation.*"

This argument of distinguishing the stages by considering the timing of the revenue generation is quite interesting because the characteristics of funding and investment contract would change, and thus, it gives new managerial insights for contract negotiation assessment. Furthermore, this topic becomes closely related to the issue of information asymmetric, and could expand new research topics in that the different characteristics of contract could cause the varied information asymmetry problems. In effect, Hirsch and Walz (2019) say that "we observe significant heterogeneity in the financing decisions", which means that the information asymmetries between entrepreneurs and finance providers affect significantly financing decisions over the life cycle of start-ups and venture firms, for example.

The second topic of 'the interplay between different types of investors' is also closely linked to the analysis of financing contract negotiation. During contract negotiation, the players are supposed to be anonymous but visible individuals, and they negotiate face-to-face, as explained before. Cumming and Johan (2008) suggest that "*Important mechanisms used by investors to address agency issues are negotiating high-powered contracts and active involvement in their portfolio firms."* Cumming et al. (2019) argue that "*Most entrepreneurial finance research to date studies one type of investor in isolation, … Different types of investors have different goals and objectives, resource endowments, and investment methods. (p.257)*" Thus, knowing the types of investors and preparing the variations of negotiation strategies corresponding to those types are essential for entrepreneurs. This dissertation does take the variety of characteristics of investors into consideration in II in Part Two, and this topic can also be expanded further.

On a final word, the venture capital industry has been developing as the statistics by KPMG (2019) shows, which is introduced in the beginning of this chapter, and thus the importance of the related researches has also been increasing. I hope that this dissertation becomes a cornerstone for developing both entrepreneurial finance and entrepreneurship.

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Part Four:

Le résumé en français

Première partie : Introduction et contexte de la recherche

I. Le contexte de la thèse

1. Objectif et motivations

L'objectif de cette thèse est de développer des modèles quantitatifs utilisant les options réelles pour une évaluation financière des choix stratégiques entrepreneuriaux. Cependant, il ne s'agit pas seulement de développer des aspects techniques (ou manipulations mathématiques). En effet, les modèles proposés dans la thèse visent également à fournir des informations pratiques utiles à la fois aux entrepreneurs et aux investisseurs, afin de faciliter la prise de décision dans les négociations contractuelles pour le financement et l'investissement dans les start-ups et les firmes entrepreneuriales.

Le choix du sujet de thèse repose sur trois motivations principales. Premièrement, lors de la création d'entreprises, l'entrepreneur doit parvenir à mobiliser des ressources financières. Les problèmes de financement et d'investissement ne se limitent pas à la création des start-ups ; ils concernent également les projets entrepreneuriaux des grandes entreprises. Traditionnellement, ces questions sont traitées dans le champ de la finance d'entreprise. Cependant, les problèmes financiers des start-ups et des firmes entrepreneuriales présentent des caractéristiques spécifiques, notamment en termes d'asymétries d'information, qui ne peuvent pas toujours être bien prises en compte dans les approches traditionnelles de la finance d'entreprise. En pratique, les outils classiques des cash-flows futurs actualisés (DCF ou *Discounted Cash Flows*) et du TRI (Taux de Rendement Interne) sont très souvent utilisés comme

méthode d'évaluation pour les prises de décisions de financement et d'investissement dans les start-ups et les firmes entrepreneuriales. Toutefois, l'utilisation de ces outils classiques d'évaluation financière n'est pas toujours pertinente.

Deuxièmement, il existe des situations dans lesquelles le DCF et le TRI sont difficiles à appliquer directement. Une de ces situations est la phase de négociation du contrat. Peu de recherches ont tenté de proposer des modèles d'évaluation quantitative tenant compte des processus de négociation contractuelle relative au financement et à l'investissement. L'utilisation de telles méthodes d'évaluation quantitative permettrait de rendre les négociations sur le financement plus équitables et plus harmonieuses car elles pourraient fournir une évaluation non plus subjective mais objective.

Troisièmement, afin de pallier les limites des outils classiques d'évaluation financière tels que le DCF et le TRI, l'Approche par les Options Réelles (ou AOR ; voir la section IV) a été proposée par les chercheurs et les praticiens. Bien que l'AOR n'ait pas encore été largement utilisée en pratique, son utilisation permet de mieux comprendre le processus de financement et d'investissement dans les start-ups et les firmes entrepreneuriales.

2. La structuration de la thèse

Cette thèse se compose de deux parties. La première partie définit les concepts utilisés afférents à la question de recherche. Le concept de finance entrepreneuriale est d'abord exposé. Puis nous justifions la problématique centrale de la thèse. Dans une dernière section, l'approche par les options réelles est proposée comme outil d'analyse pour les différents articles de cette thèse. Dans la deuxième partie, nous présentons trois articles traitant de différents sujets en lien avec l'évaluation financière des choix stratégiques entrepreneuriaux. Le premier article analyse l'évaluation d'un contrat de licence dans le secteur biopharmaceutique. Le deuxième article s'intéresse à la question de la dilution pour les nouveaux actionnaires lors du deuxième tour de financement en présence de détenteurs d'obligations convertibles. Le troisième article aborde le choix d'une stratégie de sortie pour un entrepreneur (acquisition ou introduction en bourse). Enfin, la troisième partie de la thèse revient sur les principaux résultats de la recherche et conclut cette thèse.

II. Les concepts fondamentaux de la thèse

1. Qu'est-ce que la finance entrepreneuriale ?

La finance entrepreneuriale est un sous-ensemble distinct de la finance d'entreprise traditionnelle (Wright et Robbie, 1998). Traditionnellement, la finance d'entreprise se concentre sur les sociétés cotées établies, tandis que la finance entrepreneuriale se concentre principalement sur les entreprises plus jeunes non cotées (Cumming et al., 2019). L'entrepreneuriat peut être défini comme le processus de création d'entreprise (Leach et Melicher, 2016 ; Landström, 2017). Par conséquent, la finance entrepreneuriale doit être conçue comme l'application de la finance au processus de création d'une nouvelle entreprise. Landström (2017) souligne également que la finance entrepreneuriale est l'application de la finance d'entreprise traditionnelle à la création d'entreprise. Nous verrons que finance d'entreprise et finance entrepreneuriale partagent généralement le même objectif financier.

La finance entrepreneuriale peut ainsi être définie comme l'étude de la prise de décision portant sur des questions financières, en particulier lors du processus de création d'entreprises.

Smith et al. (2011) résument la différence entre la finance entrepreneuriale et la finance d'entreprise en identifiant huit faits saillants :

(1) L'inséparabilité pour les nouvelles entreprises des décisions d'investissement et des décisions de financement ;
(2) Le rôle limité de la diversification en tant que déterminant de la valeur d'investissement ;
(3) Le degré de l'engagement des investisseurs dans la gestion de nouvelles entreprises ;
(4) Les effets importants des problèmes d'information sur la capacité de l'entreprise à entreprendre un projet ;
(5) Le rôle des contrats pour résoudre les problèmes d'incitation dans les firmes entrepreneuriales ;
(6) L'importance critique des options réelles en tant que déterminants de la valeur du projet ;

(7) L'importance de la conséquence comme aspect de la valorisation d'une nouvelle entreprise et de la décision d'investissement ;

(8) L'accent mis sur la maximisation de la valeur pour l'entrepreneur, par opposition à la maximisation de la valeur pour les actionnaires.

2. *Les caractéristiques de la finance entrepreneuriale : les étapes*

La finance entrepreneuriale traite à la fois des processus et des particularités relatifs aux problèmes de financement et d'investissement. En ce qui concerne les processus, de nombreux auteurs en finance entrepreneuriale introduisent le concept de cycle de vie de l'entreprise ou du projet entrepreneurial (e.g., Berger et Udell, 1998 ; Smith et al., 2011 ; Leach et Melicher, 2016 ; Landström, 2017). Par exemple, Leach et Melicher (2016) décrivent les différents stades comme suit : l'étape de développement, l'étape de démarrage, l'étape de survie, l'étape de croissance rapide et l'étape de maturité précoce.

Ce type de classification mettant en avant des étapes est largement accepté et discuté dans le domaine de la finance entrepreneuriale (Smith et al., 2011) car il permet de mettre en évidence des particularités concernant les problèmes de financement et d'investissement correspondant à chaque étape. Cette thèse contient trois articles dans la deuxième partie qui correspondent à cette classification et tentent de proposer des solutions et des suggestions aux entrepreneurs et aux investisseurs pour améliorer les négociations financières.

Dans cette thèse, nous distinguons, à partir de la classification présentée ci-dessus, les termes "*start-up*" et "*venture*" de la manière suivante :

- "*start-up*" désigne une entreprise qui passe de l'étape de développement à l'étape de survie.

- "*venture*" caractérise une entreprise qui passe de l'étape de survie et entre dans l'étape de croissance rapide ou une autre étape.

3. Les caractéristiques de la finance entrepreneuriale : le risque

Le cycle de vie complet, décrit dans la section précédente, ne se réalise pas toujours entièrement. Ainsi, de nombreux projets et start-ups ne parviennent pas aux étapes de lancement ou de croissance. La probabilité de succès d'une nouvelle entreprise est très faible. Ainsi, les notions de risque et d'incertitude sont caractéristiques de la finance entrepreneuriale et elles doivent être placées au cœur des préoccupations.

Le risque peut être distingué de l'incertitude par son caractère mesurable. Le risque est, en effet, mesurable tandis que l'incertitude ne l'est pas. Dans cette thèse, nous mettons l'accent sur le risque plutôt que sur l'incertitude.

4. Une facette de la finance entrepreneuriale : l'asymétrie d'information

La finance entrepreneuriale permet d'aborder un autre élément qui caractérise les relations inter-firmes : l'asymétrie d'information. La théorie de l'asymétrie de l'information a été proposée par des chercheurs dans les années 1970 (Akerlof, 1970 ; Spence, 1973 ; Rothschild et Stiglitz, 1976). Elle traite du déséquilibre du partage d'informations entre acheteurs et vendeurs (en particulier de titres financiers, tels que les actions) qui pourrait être à l'origine de l'inefficience des marchés financiers. Ce déséquilibre, qui est au cœur de la finance entrepreneuriale, n'est pas pris en compte dans les approches classiques de la finance de marché ou de la finance d'entreprise alors que certains outils sont pourtant appliqués à des situations de création d'entreprise. Le processus entrepreneurial est caractérisé par un nombre limité de participants aux transactions et des enjeux importants liés à la détention d'informations.

5. La négociation du contrat

Cette thèse s'intéresse aux différentes étapes du cycle de vie définies en finance entrepreneuriale et prend en compte le risque et l'asymétrie d'information. En complément, les situations de négociation sont des

moments clés en finance entrepreneuriale. Ces situations, qui portent sur le financement ou l'investissement dans une start-up ou une nouvelle entreprise, se concrétisent normalement par des négociations directes et privées entre l'entrepreneur et l'investisseur, qui sont spécifiques. En effet, les procédures de négociation ne sont pas toujours bien standardisées.

La théorie contractuelle qui met l'accent sur les aspects économiques et/ou financiers de la négociation des contrats est un domaine de recherche relativement récent. Cette théorie a été développée à partir de la microéconomie traditionnelle et de la finance d'entreprise (Hart, 1995 ; Bolton et Dewatripont, 2005). Elle ne peut pas toujours être appliquée directement à la négociation de contrat en finance entrepreneuriale et certaines modifications ainsi qu'une prise en compte du contexte de négociation du financement peuvent s'avérer être nécessaires. Cependant, l'aspect économique et/ou financier des interactions individuelles est essentiel lors de la négociation de contrats en finance entrepreneuriale. Par conséquent, cette thèse intégrera cet aspect et traitera de la négociation des contrats en complément des concepts présentés précédemment.

Lorsqu'on introduit les aspects concernant la négociation de contrat, le problème économique du principal-agent doit être abordé. Ce problème principal-agent lié à la question du financement est traité dans le deuxième article de la deuxième partie.

III. La problématique de la recherche

Le cycle de vie de l'entreprise est risqué (voir la section IV.4). De nombreuses nouvelles entreprises ne fêtent pas leur cinquième anniversaire et disparaissent (Landström, 2017). Le risque peut cependant présenter des avantages pour les nouvelles entreprises car il induit non seulement une possibilité de perte mais aussi de gain. Le risque attire ainsi les investisseurs en capital-risque.

Les décisions de financement et d'investissement dans les start-ups et firmes entrepreneuriales mettent en évidence le lien entre le risque et l'asymétrie d'information. Plus l'asymétrie d'information est importante, plus le risque augmente. Le contrat joue un rôle essentiel pour résoudre le problème d'asymétrie d'information. Bien que de nombreux auteurs aient mis en évidence la nécessité de mener des recherches sur le sujet du contrat (e.g., Smith et al., 2011 ; Landström, 2017), peu de solutions détaillées ou de méthodes de résolution réelles ont été proposées.

Adopter la perspective proposée par la finance entrepreneuriale nous permet de centrer notre approche sur la négociation et une relation d'égalité entre les participants dans le processus de prise de décision, alors que la finance d'entreprise traditionnelle s'intéresse à la relation principal-agent. Comme l'indiquent Brealey et Myers (2013), « la finance d'entreprise consiste à maximiser la valeur ». De même, cette thèse a pour prérequis le fait que la finance entrepreneuriale devrait également maximiser la valeur. Toutefois, cette maximisation de la valeur concerne à la fois les entrepreneurs et les investisseurs dans le domaine de la finance entrepreneuriale car le principe de la séparation de la propriété et de la gestion n'est plus valable. De ce point de vue, la problématique centrale en matière de financement et d'investissement dans les start-ups et les firmes entrepreneuriales est la suivante : comment maximiser la valeur pour les entrepreneurs et les investisseurs lors des négociations ? Il s'agira d'évaluer les choix stratégiques en utilisant des méthodes quantitatives. Plus précisément, notre objectif dans cette thèse est de construire des modèles financiers pour modéliser les processus de négociation des contrats. En effet, les méthodes généralement utilisées comme le DCF ou le TRI ne sont pas adéquates pour effectuer une évaluation financière dans un contexte entrepreneurial. Ainsi, la problématique de cette thèse peut être formulée de la manière suivante :

Comment les choix stratégiques des start-ups et firmes entrepreneuriales devraient-ils être évalués dans le cadre des négociations contractuelles ?

Afin de traiter cette problématique, trois problèmes particuliers seront exposés dans la deuxième partie. Nous proposerons de les étudier à partir de l'approche par les options réelles qui convient parfaitement à l'analyse des choix stratégiques dans un contexte de finance entrepreneuriale.

IV. L'approche par les options réelles (AOR)

1. Définition

Le terme « options réelles » a été proposé par Myers (1977, p.147) qui indique que : « De nombreux actifs de l'entreprise, en particulier les opportunités de croissance, peuvent être considérés comme des options d'achat ». Les options réelles peuvent être définies comme un outil de prise de décisions qui confère un droit mais pas une obligation de prendre une décision stratégique, pour laquelle les méthodes d'option financière sont appliquées. Ainsi, une approche par la VAN ignore le point de réversibilité du business et du projet. Dixit et Pindyck (1994) insistent sur le fait que la stratégie d'investissement différé a parfois plus d'avantages que la stratégie d'investissement immédiat. Ce concept est appelé « la flexibilité », qui est la caractéristique principale de l'AOR. Les options réelles découlent des options financières. Comme pour les options financières, plusieurs types d'options réelles sont connus et la création de nouveaux types d'options est également possible.

L'AOR est un outil très utile à la finance entrepreneuriale. Smith et al. (2011) soulignent « l'importance cruciale des options réelles en tant que déterminants de la valeur d'un projet ». En comparaison avec une approche par la VAN, l'AOR peut permettre plus de flexibilité. Ainsi, les options permettent de décider si l'investissement doit être fait et cette décision peut être prise après avoir pris connaissance de la situation future réalisée. Le processus entrepreneurial lui-même est caractérisé par une multitude de situations (ou d'états) « risquées ». Il est donc difficile d'appliquer directement les méthodes d'analyse traditionnelles (comme la VAN ou le TIR) qui sont peu adaptables. En revanche, l'avantage principal de l'AOR pour la finance entrepreneuriale est de permettre une approche dynamique et flexible de l'évaluation.

2. L'extension de l'AOR : l'incorporation de la théorie des jeux

Maschler et al. (2013, p. 23) définissent la théorie des jeux comme : « la méthodologie consistant à utiliser des outils mathématiques pour modéliser et analyser des situations de prise de décision interactive ». Cette théorie s'intéresse aux interactions entre individus, ce qui distingue la théorie des jeux de la théorie de la décision. Selon Feld et Mendelson (2016, p. 152), « le financement d'une entreprise est l'un des jeux les plus faciles ». Tadelis (2013, p. 11) affirme également que « la théorie des jeux fournit un cadre basé sur la construction de modèles rigoureux, décrivant les situations de conflit et de coopération entre des décideurs rationnels ». Smit et Trigeorgis (2003) proposent la combinaison de la théorie des jeux et de l'AOR sous l'appellation « game theoretic ROA ». Ils défendent cette approche en utilisant l'équation suivante : « *VAN étendue (stratégique) = VAN (passive) + valeur de la flexibilité (options) + valeur stratégique (théorie des jeux)* ». Ils expliquent que la combinaison peut être bénéfique pour rapprocher « finance » et « stratégie ». Il est donc adéquat de proposer l'application combinée de l'AOR et de la théorie des jeux dans les négociations en finance entrepreneuriale. Le troisième article présenté dans la deuxième partie de la thèse vise à proposer un modèle à partir de l'AOR combinée à la théorie des jeux.

Deuxième partie : L'applications

Après avoir présenté, dans la première partie, le contexte général de la finance entrepreneuriale dans lequel s'inscrit cette recherche, nous présentons, dans cette deuxième partie, les trois articles qui couvrent l'ensemble du cycle de vie de l'entreprise et fournissent une vision globale de l'évaluation des contrats financiers dans un contexte entrepreneurial. Bien qu'ils traitent de sujets différents et abordent des problèmes spécifiques, ils sont liés à la problématique centrale de la thèse, à savoir : comment les choix stratégiques devraient-ils être évalués financièrement dans le cadre d'une négociation contractuelle ? L'AOR est choisie comme la méthodologie principale pour construire des modèles quantitatifs afin d'appréhender les processus complexes de négociation contractuelle et pour permettre de meilleures prises de décision qui soient plus équitables entre les entrepreneurs et les investisseurs potentiels.

Deuxième partie : L'application I.

L'évaluation d'une option réelle dans un contrat de licence avec une entreprise biopharmaceutique

1. La modélisation du contrat de licence

L'objectif principal du premier article est de développer un modèle de contrat de licence basé sur celui de Lo Nigro et al. (2014, 2016) qui est théoriquement bien détaillé et applicable en pratique. Cet article aboutit à deux contributions. Premièrement, le modèle tient compte des différentes perceptions et positions entre une grande entreprise et une start-up, qui doivent être prises en compte dans le modèle pour un contrat de licence. De plus, ce modèle intègre le concept de perception du risque (Das et Teng, 2001) dans la négociation du contrat de licence et en explique la dynamique. Deuxièmement, le taux de redevance optimal pour le contrat pourrait servir de critère pour la négociation du contrat de licence.

Lo Nigro et al. (2014, 2015) ont introduit un nouveau modèle de sélection du portefeuille de projets R&D des médicaments permettant de maximiser sa valeur. Ils utilisent trois types de formules pour les différentes phases du processus de R&D. Le modèle du DCF/VAN est affecté à l'étape d'approbation de la *Food and Drug Administration* (*FDA*), la formule de *Black-Scholes* à la '*Phase 3*' et la formule de *Geske* est affectée à toutes les autres étapes : '*Preclinical Phase*,' '*Phase 1'* et '*Phase 2*.'

Nous proposons d'étendre le modèle de Lo Nigro et al. (2014, 2016) en l'appliquant au modèle d'évaluation des licences (*alliance*) entre une grande entreprise pharmaceutique et une start-up biopharmaceutique. Les auteurs ont proposé l'équation suivante en tant que concept général : $C_{licence} + P - I = C_{nolicence} - I$ … (a). P fait référence à un paiement initial et/ou intermédiaire par contrat, et I à un coût d'investissement lors de la phase de développement. Etant donné le développement actuel des

licences dans l'industrie pharmaceutique, la proposition d'un modèle plus détaillé est particulièrement utile.

Dans ce modèle, du point de vue du preneur de licence, $C_{nolicence} - I$ fait référence à la valeur nette ou aux flux de trésorerie nets que le preneur de licence pourrait obtenir s'il accomplissait lui-même des travaux de R&D. $(C_{licence} + P) - I$ doit être égal à $C_{nolicence} - I$, car les flux de trésorerie que le donneur de licence pourrait obtenir sous forme de paiements, P, ne proviennent que de la licence.

Évaluer la valeur du paramètre P revient à se demander comment $C_{nolicence}$ doit être divisé en $C_{licence}$ et P. En d'autres termes, ce problème concerne le montant de la compensation économique accordée au donneur de licence et au preneur de licence. Il est logique de penser que chaque partie doit recevoir la compensation économique en fonction de ses risques. Il s'agirait alors d'un contrat équitable.

Lors de l'interprétation de l'équation (a), il est nécessaire d'accepter l'hypothèse selon laquelle le donneur de licence et le preneur de licence acceptent la condition du contrat telle qu'elle est. Cette situation pourrait être qualifiée de « statique ». Néanmoins, est-ce vraiment réaliste lors de la négociation d'un contrat de licence ? Les parties acceptent-elles vraiment la situation telle qu'elle est ? Le preneur de licence, qui supporte plus de risques que le preneur de licence, a une option d'abandon et agit en fonction de la valeur d'option. Cependant, le donneur de licence peut ne pas être enthousiaste à l'idée de tout consacrer au projet dans une situation où le preneur de licence risque d'exercer l'option d'abandon. Par conséquent, l'engagement des parties dans le processus de R&D pourrait ne pas être total, ce qui n'assurerait pas les chances de succès du processus. Ni le preneur de licence ni le donneur de licence ne souhaitent l'échec de la R&D. Au contraire, ils veulent faire de leur mieux pour réussir le développement du nouveau médicament parce qu'ils pourront partager davantage de bénéfices liés à la coopération grâce à la licence. Afin de maintenir ou d'augmenter la probabilité de succès, le preneur de licence doit offrir des conditions financières attrayantes afin que le donneur de licence s'engage pleinement dans le projet. Par exemple, le preneur de licence peut promettre davantage de paiements au donneur de licence. Cette hypothèse peut être qualifiée de « dynamique ».

2. Les simulations numériques

L'enjeu fondamental pour les dirigeants d'une grande entreprise pharmaceutique est d'obtenir des informations sur les bénéfices futurs estimés à chaque phase et de maximiser ces bénéfices. Cela fait référence à la valeur du médicament C. Le but principal de la simulation décrite dans cet article est d'estimer la valeur du médicament C en modifiant les paramètres clés et de l'utiliser comme critère de décision.

Dans leur article, Lo Nigro et al. (2014) ont déjà défini les valeurs réelles de certains paramètres. Nous les utilisons également pour notre simulation. Nous déterminons nous-mêmes les autres paramètres nécessaires à la simulation.

Les simulations permettent d'obtenir les résultats suivants. Tout d'abord, lorsque le preneur de licence souhaite que le donneur de licence s'engage activement dans un projet de R&D pharmaceutique et maximise sa valeur, il n'est pas souhaitable d'offrir un paiement plus avantageux car cela n'aurait pas de conséquence favorable pour le preneur de licence (et pour l'achèvement du projet de R&D) lors de la phase d'approbation de la FDA. De plus, la conclusion d'un contrat de licence au cours de cette phase est adéquate lorsqu'on peut s'attendre à des profits importants. Deuxièmement, il faut trouver un équilibre sur les montants financiers engagés et offrir un paiement trop élevé peut ne pas avoir les conséquences souhaitées pour le preneur de licence dans la Phase 3. Par ailleurs, l'impact de la volatilité du marché peut éventuellement être ignorée en fonction du montant d'investissement si un profit important est attendu. Enfin, offrir un paiement plus important au donneur de licence pourrait apporter une valeur plus élevée de C en phase 2 (et dans les phases antérieures). Selon ces résultats, plus le taux de redevance peut entraîner une conséquence favorable pour le preneur de licence en se traduisant par un engagement plus actif du donneur de licence, plus le contrat de licence est préférable. De plus, le contrat de licence reste performant même lorsque le coût de l'investissement augmente, tant que la volatilité du marché est estimée élevée.

En résumé, lors de la conclusion d'un contrat de licence, les dirigeants et les responsables de la négociation doivent prendre en compte de nombreux facteurs tels que la phase de développement, la prévision des coûts d'investissement et la volatilité des marchés. De plus, la prise en compte des interactions comportementales des deux parties lors de la négociation du contrat de licence est essentielle pour la construction d'un modèle de simulation, notamment en ce qui concerne l'interaction dynamique.

Deuxième partie : L'application II.

Le coût de la décision d'investissement en fonds propres en présence d'un détenteur d'obligations convertibles lors du deuxième tour de financement

Parmi les financements des start-ups lors de l'étape de démarrage, les obligations convertibles (*convertible notes*) peuvent être utilisées. Les recherches académiques ne traitent pas de la relation dans laquelle les nouveaux investisseurs entrent lors du deuxième tour de financement, appelée Série A. L'objectif de cet article est de construire un modèle traitant des interactions entre les trois parties clés (l'entrepreneur, le détenteur d'obligations convertibles et le nouvel investisseur en capitaux propres) dans la négociation liée au financement. Il est essentiel de prendre en compte le coût de financement et le coût de surveillance du post-investissement. L'objectif principal de cet article est de comprendre ce type de coût sachant qu'il existe peu de recherches sur ce sujet.

1. Le financement par obligations convertibles

Les obligations convertibles (OC) présentent à la fois des caractéristiques de dettes et de capitaux propres. Leur caractéristique fondamentale est leur caractère obligataire. Toutefois, les détenteurs d'OC ont le droit de les convertir en capitaux propres sous certaines conditions, après les avoir détenues en tant que dettes.

Par conséquent, les OC sont un outil permettant à leurs détenteurs d'accroître l'avantage économique ou financier futur en s'adaptant à la situation.

L'évaluation d'une entreprise en vue d'un investissement en capital, en particulier dans le cas des nouvelles entreprises, est souvent considérée comme onéreuse et très longue car elle nécessite des négociations ardues entre l'entrepreneur et les investisseurs jusqu'à l'obtention d'un accord. Le processus de négociation du financement par OC est relativement simple. Dans la mesure où les informations disponibles pour l'évaluation sont insuffisantes lors de l'étape de démarrage de l'entreprise, l'utilisation d'OC permet d'éviter toute évaluation compliquée lors de cette étape.

L'entrepreneur et l'investisseur peuvent négocier avec des valeurs hypothétiques appelées « *pre-money value* » et « *post-money value* ». En utilisant les OC, il est possible d'éviter l'évaluation de la valeur du projet entrepreneurial lors de l'étape de démarrage et de la différer à une date ultérieure. En effet, la valeur du projet entrepreneurial peut être déterminée lors du tour suivant de financement avec des capitaux propres (Séries A, B, C, etc.).

L'effet de la dilution des actions est crucial pour les investisseurs potentiels en actions lorsque le détenteur d'OC se retire avant de prendre sa décision d'investissement car la part en actions représente le degré de pouvoir et de contrôle sur la gestion de la société.

Lorsque les nouvelles entreprises se portent bien et que les perspectives sont favorables, les détenteurs d'OC peuvent convertir leurs dettes en actions. Au contraire, lorsque les performances ne sont pas au rendez-vous et que la valeur *pre-money* est inférieure au niveau prévu, les détenteurs ne sont pas dans une situation favorable pour convertir leurs dettes. Le mécanisme de conversion peut être considéré comme la structure des options réelles.

2. La préoccupation pour les nouveaux investisseurs en capitaux propres : la sélection adverse

Lorsque les nouveaux apporteurs de capitaux propres et l'entrepreneur doivent négocier sur le financement, la situation peut devenir plus complexe si des détenteurs d'OC sont présents lors du deuxième tour de financement. En effet, les différentes parties ne souhaitent généralement pas révéler toutes les informations dont elles disposent lors de la négociation. Il est donc logique de supposer que les nouveaux investisseurs en actions proposeraient un montant réduit. L'introduction d'un coefficient de réduction d'investissement β ($0.00 < \beta \leq 1.00$) permet de prendre en compte le degré de préoccupation des nouveaux investisseurs en fonds propres.

Selon Macro-Stadler et Pérez-Castrillo (2001), un problème de sélection adverse entre l'entrepreneur et les nouveaux investisseurs en capitaux propres va apparaître.

3. La modélisation du coût de la prise de décision en matière d'investissement en capitaux propres

3.1. La modélisation de l'effet de sélection adverse

Le modèle construit dans cet article est inspiré de celui de Macho-Stadler et Pérez-Castrillo (2001) et de Salanié (2005).

Tout d'abord, $U_{entrepreneur} = \theta q - t$, où

q: le montant de la participation au capital que l'entrepreneur obtient (ou offre de l'investisseur : $q_g > q_b$)

θ: l'indice du type d'entrepreneur

t: l'avantage de contrôle qui est associé à la quote-part des capitaux propres

Deuxièmement, $U_{new\ equity\ investor} = t - C(q)$, où

$C(q)$: le coût de la prise de décision du nouvel investisseur en capitaux propres

Finalement, le nouvel investisseur en tant que principal résoudra le problème suivant :

$\max_{q_i, t_i}\left(t_i - C(q_i)\right)$, Subject to $\theta_i q_i - t_i \geq 0$, où i = « bon » ou « mauvais » entrepreneur

Enfin, la forme du coût de la prise de décision dans une situation d'asymétrie d'information pour un nouvel investisseur en capitaux propres peut être exprimée sous la forme :

$$C(q_b) = \left(\frac{1}{\pi}\theta_b - \frac{1-\pi}{\pi}\theta_g\right) \times q_b.$$

Dans ce contexte, $q_b = \beta I_E$, où I_E est le montant de la participation au capital.

3.2. L'intégration de la structure d'option réelle à la modélisation de l'indice de type d'entrepreneur

Le « bon » entrepreneur est prêt à révéler les informations lors de la négociation du financement et il est donc probable que le montant total serait fourni par les nouveaux investisseurs en capitaux propres. En revanche, le « mauvais » entrepreneur n'est pas prêt à révéler toutes les informations et on ne peut donc pas attendre le montant total.

Nous supposons que le « bon » entrepreneur parviendra à régler la négociation de financement lors du second tour et qu'il obtiendra le montant total de l'investissement qu'il a souhaité initialement. En revanche, le « mauvais » entrepreneur ne pourra pas obtenir le montant attendu, ce qui aura une conséquence sur la conversion des OC. En combinant les différents arguments, θ_b peut être obtenu comme suit :

$$\theta_b = \pi \times \left[\left(\frac{\beta I_E}{V_0 + \beta I_E} - \frac{\beta I_E}{V_0 + I_c/(1-\alpha) + \beta I_E}\right) / \frac{\beta I_E}{V_0 + \beta I_E} \times (-4(\beta - 0.5)^2 + 1)\right] + (1 - \pi)$$

En insérant θ_b et θ_g dans la fonction de coût de la prise de décision, $C(q)$, on peut évaluer comment le coût sera affecté par le taux de discount (*discount rate*) α, et le coefficient de réduction de l'investissement β. Dans ce processus, l'effet de π peut être éliminé.

4. Les simulations numériques

La simulation est mise en œuvre via des données concernant une start-up médicale existante. Selon les résultats de la simulation portant sur ces données, il est possible de vérifier que le taux de *discount* et le *valuation cap* ont un impact important sur le coût de la prise de décision en matière d'investissement en actions. Les résultats montrent aussi qu'avec la présence d'un détenteur d'OC, un entrepreneur souhaitant sceller la négociation de financement avec une réduction de l'investissement d'environ 40 % engendrerait un coût de prise de décision plus élevé et, par conséquent, un nouvel investisseur par capitaux propres peut réduire davantage le montant du financement (ou l'augmenter dans certains cas). Les résultats montrent également que plus le taux de *discount* est élevé et moins le *valuation cap* est important, plus les coûts sont élevés, et la probabilité de succès de la négociation devient donc faible. Par conséquent, l'entrepreneur doit en tenir compte lorsqu'il entre en négociation lors du deuxième tour de financement.

Deuxième partie : L'application III.

Le « puzzle » de la prime d'évaluation de l'introduction en bourse pour le choix de sortie de l'entrepreneur

L'introduction en bourse (ou *Initial Public Offering* : IPO) et l'acquisition sont deux stratégies classiques de sortie pour les entrepreneurs. On considère souvent que l'introduction en bourse est très favorable pour les entrepreneurs et les investisseurs en capital-risque car des rendements élevés peuvent être attendus, même si les échecs ne sont pas rares. En revanche, l'acquisition semble être considérée comme une stratégie de sortie moins favorable que l'introduction en bourse.

Cet article s'intéresse au puzzle de la prime d'évaluation des IPO décrit par Bayar et Chemmanur (2011, 2012). Ces auteurs font référence à une situation dans laquelle de nombreuses entreprises non cotées choisissent d'être acquises plutôt que d'entrer en bourse à un prix plus élevé. Si nous considérons que l'introduction en bourse est une stratégie de sortie plus intéressante financièrement que l'acquisition, le choix de sortie d'un entrepreneur par une acquisition n'est pas rationnel. Ceci explique l'utilisation du terme « puzzle » par les auteurs. Le concept de « bénéfices privés du contrôle » est aussi utilisé dans le modèle proposé par Bayar et Chemmanur (2011). Bien que Bayar et Chemmanur (2011) ne proposent pas de définition des bénéfices privés dans leur article, ce concept est apparu dans les travaux de Grossman et Hart (1988) puis a été approfondi par La Porta et al. (1997, 1999). Il peut être défini comme l'ensemble des revenus que s'attribuent les actionnaires contrôlant la société, au détriment des autres actionnaires « extérieurs ».

L'objectif de notre troisième article est d'analyser la propriété des bénéfices privés du contrôle avec l'approche conjointe de la théorie des jeux et de la théorie des options réelles et de révéler l'importance de son rôle en tant que critère de choix de l'option de sortie. De plus, cet article tente également de comprendre ce qu'est le problème de la prime d'évaluation de l'introduction en bourse et de fournir un modèle qui pourrait être très utile pour mettre en place une stratégie de sortie la plus efficace.

1. L'analyse et la modélisation du choix de stratégie de sortie

1.1. Le modèle de choix proposé par Bayar and Chemmanur

Bayar et Chemmanur (2011) ont fourni un modèle permettant de choisir entre l'introduction en bourse ou l'acquisition comme la solution au problème de maximisation de la valeur au moment de la sortie de l'entrepreneur :

$$max_{a\in\{0,1\}}\ a\cdot\left[\delta_E(1-\gamma)\left(\alpha_E P_{IPO}^E+(1-\alpha_E)\left(I+V_q\right)+B\right)\right]+(1-a)\cdot\delta_E\rho V_A$$

Où a: le choix de sortie ($a=0$: l'acquisition, $a=1$: l'IPO), α_E: la fraction de vente de l'entrepreneur, δ_E: la fraction de détention initiale de l'entrepreneur, γ: la fraction d'actions vendues aux nouveaux actionnaires, P_{IPO}^E: l'évaluation pour l'IPO, I: l'investissement par l'entreprise acheteuse, V_q: la VAN attendue lorsque l'entreprise entre en bourse, ρV_A : la VAN du projet de la société acquise, B: bénéfices privés du contrôle.

Ce modèle suppose que le choix de sortie est essentiellement déterminé par la valeur de l'entreprise qui dépend des conditions de marché. Les valeurs de toutes les variables peuvent être déterminées en fonction des conditions de marché financier, sauf celle des bénéfices privés du contrôle. Cependant, en comparant avec les autres variables de l'équation, il apparaît que la propriété des bénéfices privés du contrôle est différente car les bénéfices privés du contrôle ne sont pas nécessairement déterminés par les conditions de marché financier. Cette variable doit donc être manipulée avec précaution.

1.2. L'analyse par l'AOR

Le choix de financement par un entrepreneur a une grande influence non seulement sur le succès de l'entreprise mais aussi sur sa stratégie de sortie. Le choix d'une option de sortie est également affecté directement par les attentes du marché quant à la valorisation de l'entreprise. De plus, la flexibilité est

essentielle pour les investisseurs en capital-risque et l'entrepreneur. Par conséquent, l'AOR est une méthode tout à fait appropriée pour comprendre les propriétés du choix de l'option de sortie.

1.3. L'approche conjointe de la théorie des jeux et de la théorie des options réelles

En complément de la gestion des risques afférents au marché, l'entrepreneur doit prêter attention à la relation avec le capital-risqueur lorsqu'il choisit la stratégie de sortie.

Pour des raisons de simplicité et de compréhension, il est courant de supposer que les entrepreneurs (Ent) et les investisseurs en capital-risque (VC) sont neutres au risque et que les valeurs attendues de la firme entrepreneuriale constituent un arbre binomial. Dans le cas où on s'attend à ce que l'entreprise soit couronnée de succès, le résultat est en valeur à $T=t_1$ pour l'entrepreneur V_{Ent}^{+}, et pour le capital-risqueur, V_{VC}^{+}. De la même façon, lorsque l'entreprise est en échec, ils sont V_{Ent}^{-}, et V_{VC}^{-}, respectivement.

L'entrepreneur et les investisseurs en capital-risque doivent renoncer à une partie de leurs actions et ne détenir que la fraction restante. Nous définissons cette fraction de participation restante comme $\alpha_{Ent}^{A}, \alpha_{VC}^{A}$ lorsque l'acquisition est choisie comme stratégie de sortie, et de la même façon, $\alpha_{Ent}^{I}, \alpha_{VC}^{I}$ lorsque l'introduction en bourse est choisie comme stratégie de sortie. Bien qu'il soit normal que l'entrepreneur et les investisseurs en capital-risque envisagent l'introduction en bourse, il est également possible qu'ils choisissent l'acquisition comme stratégie de sortie. En utilisant la théorie des jeux, ce phénomène contradictoire peut être décrit en tant qu'existence de deux équilibres de Nash qui sont présentés dans l'article de Bayar et Chemmanur (2011). Afin de maintenir cette condition, il faut considérer la valeur des bénéfices privés du contrôle. Ensuite, l'inégalité peut être calculée comme suit : $B > (\alpha^{I} - \alpha^{A}) \cdot V$

2. L'explication du « puzzle » de la prime d'évaluation de l'introduction en bourse

La condition de $B_{Ent} > (\alpha_{Ent}^{I} - \alpha_{Ent}^{A}) \cdot V_{Ent}^{-}$ est cruciale pour le choix entre l'introduction en bourse ou l'acquisition. Afin de choisir l'acquisition plutôt que l'introduction en bourse, la valeur des bénéfices privés du contrôle pour l'entrepreneur doit être supérieure à la valeur minimale, $B_{Ent}^{min} = (\alpha_{Ent}^{I} - \alpha_{Ent}^{A}) \cdot V_{Ent}^{-}$. Le choix de l'option de sortie peut être déterminé en évaluant si la valeur des bénéfices privés du contrôle est supérieure au niveau minimal de l'avantage du contrôle, B_{Ent}^{min} ou non. En utilisant cette valeur, s'il s'avère que l'entrepreneur puisse espérer le bénéfice de contrôle, l'acquisition n'est pas un choix de sortie inférieur à l'introduction en bourse. Le « puzzle » de l'évaluation de la prime d'évaluation de l'introduction en bourse n'est plus vraiment un « puzzle » si l'on considère la propriété inhérente aux bénéfices privés du contrôle.

3. Les simulations numériques

Pour la simulation numérique, on peut considérer que l'équation $\frac{B_{Ent}^{min}}{V} = (\alpha_{Ent}^{I} - \alpha_{Ent}^{A}) \times \frac{1}{1+(I_1/I_0)} \times \frac{1}{u}$ contient les deux éléments suivants : comment le multiplicateur se comporte-t-il avec les modifications de $(\alpha_{Ent}^{I} - \alpha_{Ent}^{A})$ et avec celles de (I_1/I_0). Selon le résultat de la simulation, le multiplicateur varie peu en fonction de la valeur de $(\alpha_{Ent}^{I} - \alpha_{Ent}^{A})$. Cela nous donne une suggestion intéressante selon laquelle le pouvoir de négociation de l'entrepreneur dans la négociation du contrat d'acquisition avec l'acquéreur n'aurait que peu d'effet sur la planification de la stratégie de sortie. De plus, le multiplicateur reste à un niveau bas quel que soit le mouvement supérieur u. Cela signifie que l'acquisition et l'introduction en bourse seraient des options indifférentes pour l'entrepreneur, quelles que soient les attentes du marché. Selon la dernière simulation, on peut reconnaitre que le multiplicateur augmente fortement lorsque le mouvement supérieur u diminue, en particulier dans le cas d'un rapport inférieur ($I_1/I_0 = 1.0$). Cela signifie que le niveau du ratio I_1/I_0 influence de manière significative la valeur minimale des bénéfices privés du contrôle, B_{Ent}^{min} ou du multiplicateur.

Troisième partie : Conclusion

La valeur minimale « *bénéfices privés du contrôle* », B_{Ent}^{min}, peut devenir un critère de choix des options de sortie : acquisition ou introduction en bourse. Elle est similaire au *goodwill* de la comptabilité financière et pourrait devenir une nouvelle référence pour la planification d'une stratégie de sortie. De nombreuses approches retenues dans la littérature considèrent que les conditions de marché déterminent les critères de l'option de sortie. Néanmoins, il est fréquent que l'interaction ou les relations internes entre les participants, tels que l'entrepreneur et les investisseurs en capital-risque, n'aient pas été prises en compte. Il va sans dire que les interactions des joueurs ne doivent pas être ignorées. Cet article a proposé d'incorporer cette idée et de la modéliser, ce qui constitue sa contribution principale.

Ainsi, la finance entrepreneuriale est un domaine relativement nouveau, y compris dans la littérature académique. En pratique, les théories et les connaissances qui sont établies dans le domaine de la finance d'entreprise et de la finance de marché sont appliquées directement aux problèmes de finance entrepreneuriale alors qu'elle présente des caractéristiques spécifiques liées aux étapes, au risque, à l'asymétrie d'information et la négociation du contrat.

En particulier, en finance entrepreneuriale, la négociation du contrat est idiosyncratique parce que les participants individuels, tels que l'entrepreneur et les investisseurs (potentiels), ne sont pas anonymes, alors qu'ils sont supposés être uniquement des preneurs de prix en finance d'entreprise traditionnelle et en finance de marché. En général, les transactions de financement et d'investissement sont mises en œuvre de manière privée, et non sur le marché, et des négociations en face à face et au cas par cas sont nécessaires.

Cette thèse était motivée par plusieurs raisons. Premièrement, il s'agissait de proposer des solutions pour faire évoluer les méthodes d'évaluation des choix stratégiques, qui sont mal adaptées pour la finance entrepreneuriale. Deuxièmement, si des méthodes d'évaluation quantitative étaient adoptées, les négociations sur le financement deviendraient plus équitables et plus faciles, car elles pourraient fournir

une évaluation non plus subjective mais objective. Enfin, l'AOR devrait être utilisée plus largement en pratique. Parallèlement à ces motivations, l'objectif principal de cette thèse était de développer des méthodes quantitatives basées sur l'AOR permettant une évaluation financière des contrats. Ce développement de la méthode d'évaluation ne se limite pas aux aspects techniques, il vise également à faciliter la prise de décisions plus éclairées en matière de financement et d'investissement dans des start-ups et des firmes entrepreneuriales. Les négociations des contrats, par nature, incluent l'aspect stratégique qui est souvent négligé dans les approches financières classiques.

Les contributions principales de cette thèse sont donc les suivantes : 1/ aborder les problèmes de la négociation des contrats liés au financement et aux investissements dans des start-ups et les firmes entrepreneuriales, et 2/ fournir des modèles quantitatifs de ce processus. Nous apportons ainsi une contribution originale à la littérature en finance entrepreneuriale car l'étude de la négociation contractuelle est un sujet de recherche assez nouveau et en cours de développement (par exemple, Cumming et al. (2019)).

Academic presentations

Annual International Real Options Conference (ROC)

June 15-18, 2016: in Oslo, Norway

Title: Real Option Valuation in Licensing Contract with Bio-Pharma venture

June 29-July 1, 2017: in Boston, United States of America

Title: Second round financing for start-ups with convertible notes: A Real Options Approach

June 21-23, 2018: in Düsseldorf, Germany

Title: The IPO valuation premium "Puzzle" for an entrepreneur's exit choice

(*Nominated for Best Student Paper Award*)

June 27-29: 2019: in London, United Kingdom

Title: Equity investment decision-making cost under the existence of convertible note holder in the second financing round

International Conference of the French Finance Association

(L'association française de finance: AFFI)

23-26 May, 2016: in Liège, Belgium

Title: Real Option Valuation in Licensing Contract with Bio-Pharma venture

May 31-June 2, 2017: in Valence, France

Title: Second round financing for start-ups with convertible notes: A Real Options Approach

June 17-19, 2019: in Québec, Canada

Title: Equity investment decision-making cost under the existence of convertible note holder in the second financing round