Author manuscript, published in "International Product Development Management Conference Ireland (2014)"

hal-00969096, version 1 - 24 Jul 2014

CAN VENTURE CAPITAL FOSTER INNOVATION? A STUDY OF THE COUPLING BETWEEN INNOVATION AND FINANCE

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ABSTRACT

Venture Capital is recognized to be a key link in the complex chain of financing for young innovative firms. By helping them at critical stages of innovation development, it would help an economy to leverage its public research and sustain its growth. However, recent research reveals that the performance of VC funds, both internal (profitability) and external (growth), does not reach the expectations. In this paper, we aim at explaining this paradox and suggesting new patterns to articulate venture capital and innovation management. We build upon the literature on VC to show that the theoretical model of VC does not take the management of innovation into account, and makes unrealistic assumptions on the composition of project portfolios. Conversely, based on interviews with some VC funds managers, we show that actual funds can invent alternative management models, for example based on the structuration of ecosystems for the start-ups, the development of "external valuation" mechanisms, or the creation of synergies between financed projects.

I. INTRODUCTION

I.A. Context of the research

For a few decades, venture capital has been considered to be a promising mechanism to support innovation and growth (Gompers & Lerner, 2001), notably in public policies. It is indeed supposed to address the “equity gap” that penalizes innovative start-ups by providing financing and tools to accompany the first stages of innovation (Florida et Kenney, 1988). The start-ups backed by VC would be more innovative than the others (Kortum et Lerner, 2000), and leading companies would then invest in corporate venture to develop their

[1] The authors are grateful to the CDC Entreprises for its support in this research.

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innovative capabilities (Engel, 2011) (Birkinshaw et al., 2002). It has also become a means for public policy to foster some technological or environmental transitions (eg. Cleantech) (Hargadon et Kenney, 2012).

However, recent research reveals that the profitability of venture capital funds is rather low (Mulcahy et 2012) and that their impact on innovation is more uncertain than expected (Mason et Harrison, 2002), thus putting the model of venture capital itself into question.

This raises the opportunity to review the canonical model of venture capital as presented by the economic and management literature, to exhibit its major assumptions and to assess whether these assumptions have been verified in practice for the past decades. As a mechanism to foster innovation for young firms in highly technological and capital-intensive sectors, we also think that it is of interest to question whether this model takes recent advances in innovation management into account, or whether it is a mostly finance-based model that does not try to couple with a representation of innovation processes.

I.B. Methodology and Research Questions

Hence our two research questions:

1. What are the theoretical models behind venture capital rationale? How to explain their failure?
2. To which model of innovation management is this rationale coupled?

We organize our research setting in three steps. First, based on the founding literature on the organization of Venture Capital, we characterize the expected behavior and functioning of the average Venture Capital fund and compare it to the recent advances of literature in innovation management. With this data, we build a theoretical model of VC in which the grounding hypotheses to ensure its success are made clear. Our first result is to show that this model, mainly directed towards risk management only, does not take into account the management of innovation itself. Indeed, beyond the classical syndication and diversification of portfolio, models of venture capital often refer to real options management (van Putten et MacMillan, 2004; Wadhwa et Basu, 2013). And a lot of criteria, selection logics and coaching or monitoring instruments are presented in the literature (Freeman et Engel, 2007) (Kortum et Lerner, 2000). But our analysis reveals that they generally do not really take into account neither the specificity of radical innovation (Colarelli O'Connor et Rice, 2001; Leifer et al., 2000) nor the managerial levers for creative design (Hatchuel et Weil, 2009), and consider most of the time the essential features of the start-up as exogenous variables.

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Second, based on a more critical current of the literature on VC and its actual performance, we further characterize the limits of the average model by highlighting its flaws, especially due to the fact that some of the major grounding assumptions cannot be verified in practice. Indeed, venture cap is based on logic of risks diversification, which should suppose that funds finance a high number of independent and high-potential start-ups (Bengtsson, 2011). Yet, the financing schemes of the funds themselves lead to cut radically the number of potential candidates that experts examine, raise the capital invested in each project, and target sectors that funds know best. Besides, statistical studies have shown that the probability of very high success (e.g. x10) is too low to sustain this diversification model.

Lastly, we conduct semi-structured interviews with 9 managers of French venture capital funds, in diverse sectors (e.g. pharmaceuticals, entertainment, tourism, etc.) to balance the theoretical model with an investigation on the actual functioning of some venture capital funds. We show that, compared to the expected behavior according to the theoretical model, managers of VC funds can actually reflect on an implicit model of innovation management and play on some variables, such as the probability of success or the value of the projects. We identify original ways VC funds use to couple financing decisions and innovation management. For instance, we observe how VC funds can build on the absence of independence between start-ups to foster the development of a synergistic ecosystem. We also identify that VC funds play on the "external value" of the project by actively exploring, through adequate corporate alliances, companies whose capabilities could be the most expanded by the project. We thus claim that our analysis can contribute to a more grounded model of VC logics, with actionable methods both for founders and investors of start-ups.

II. THE CLASSICAL STRUCTURE OF VENTURE CAP PORTFOLIOS

According to the literature, private equity investment (and more especially seed funding and venture capital) aims at bridging an identified "equity gap" between the available investment funds and the needs of young firms (and in particular capital-intensive technological start-ups) for stable financing.

Conventional investment does not indeed distribute equitably along all the development phases of the firms. Front-end phases of start-up development are notably the riskiest (Macmillan 1931), which should entail a higher remuneration of the capital ("risk premium") than conventional schemes. They also require a higher illiquidity than most other investments,

given the time needed for young start-ups to reach profitability or, if applicable, an appropriate selling value. This also entails an “illiquidity premium” that adds to the first one.

The economic consequence of this observed equity gap is the undervaluing of research outputs, especially public research outputs, and consequently a negative influence on economic growth. This analysis justifies the common emphasis put on the role of the States to bridge this gap, especially because New Technology-Based Fimrs (NTBF) are pivotal actors in the modern technological transitions. Regarding public policy, private equity investment has also become a means to leverage the development of innovative sectors with strong social or environmental impact. Through the participation to specialized funds, States may for example contribute to the development of sectors such as “Clean Technologies”.

Historically, the support of the States became necessary given the importance of the financing of start-ups to boost competitiveness and growth, and also to contribute to the promotion of (public) research. This can be seen through the creation of specific tax-favored statutes, and new guarantees.

II.A. Institutional structure: General and Limited partners

The capital investment is born in the United States. In 1958, the Small Business Investment Act codifies the rules of the U.S. financial and tax advantages granted to the venture capitalists who invest in new projects and accompany entrepreneurs until these projects become profitable. But the first "professional" investment structures were already recognized in the United States since 1940 (Investment Company Act). The first funds to be established, just after the war, were legally partnerships with public shares that could easily be exchanged. So was the famous ARDC (American Research Development Corporation) founded by General Doriot.

However, the difficulties created by the volatility of investors, who did not always remain involved for the expected period, led subsequently to promote the so-called “closed” funds. After the first introduced SBIC ("Small Business Investment Companies"), in 1957, it has been the "Limited Partnership" that spread the most in the common law countries. Its model is as follows:

• A fund is usually established as a Limited Partnership for a limited time (usually 10 years). Investors (called Limited Partners, LPs thereafter) own the majority of the shares

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(more than 90%) but do not take investment choices nor decisions about the management of ventures. In return, their liability is limited, unlike that of the General Partners.

• Conversely, the General Partners (GPs) own only a small amount of capital, but are being entrusted with the management. They are paid in two ways ("2-20 rule"): they earn a 2% commission on the funds raised upon the LPs and 20% of the generated profit, if any (Bengtsson, 2011).

• Funding is done by conditional steps and funds often work by "syndicating", which allows the pooling of risks and also promote learning (Ferrary, 2010).

II.B. Underlying hypotheses of the classical model

Based on these general principles, private equity investment requires the description of a few additional hypotheses to understand the financing rationale with a rather simple model:

Hypothesis 1 – Investments are independent from each other.

VC funds follow classic principles of risk management: they aim at building diversified portfolios of projects, which decreases the overall risk of the entire portfolio. This assumes that the possible projects of start-ups to be funded follow an initial structure of independence. According to this hypothesis, the success of some of the projects compensates the failure of the others. Each VC fund would then have an incentive to maximize the number of funded projects, and to reduce its share in each.

Hypothesis 2 – There is a sustainable probability for projects with high potential (the "gold nuggets")

The profitability of the VC funds relies on the assumption that even if the majority of the funded start-ups might result in an economic failure, there is a certain amount of them that will succeed with a "multiple" high enough to cover the losses. In other words, there is a hypothesis that every funded start-up has a certain probability – admittedly low, but high enough – to reveal a very high potential value (at least ten times the initial investment), thus making the financing operation globally sustainable.

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This should help motivating management teams: the GPs are indeed typically paid on the "2-20" rule: they keep 20% of the generated profit. This clearly encourages them to maximize the capital gain. More especially, it is the potential capital gain on the resale of the shares (or the gain through IPO) that is supposed to be attractive, and notably high enough to statistically compensate projects that fail.

Hypothesis 3 – VC funds have the capability to make their investment progressively more reliable by learning about the probability of success of projects they support within their ecosystems.

Start-ups have a probability of success that is *a priori* unknown. But the model of VC relies on the idea that if the funds can not act to change this probability, it is however possible to conduct increasingly accurate investigations to establish presumptions of success or failure, and therefore more reliable investment:

- Investment in a start-up is analysed through the principle of *real options*. Following a first round of investment with small amounts, aiming at create on "option" to further invest, the more information is gathered on the investment project, the more the risks become clear. The investors then have the opportunity to invest, if they wish, for a second round. This model of "options" has notably inspired investment logics in large enterprises (Battistini et al., 2013).
- Besides, the main role of the GPs is to follow the "Due Diligence", which is the required research and control of information to help them having a sound judgment on the activity, financial situation, results, development perspectives and organization of the funded enterprises. In other words, the GPs are responsible for seeking information needed for the evaluation and control of start- ups and their business plans. In addition, they provide resources and custom-made monitoring for start-ups teams. Literature showed that there exist diverse profiles of venture cap investors: human-based, financial or technological... (Knockaert et al., 2010). But the hypothesis remains nonetheless that the probability of success is intrinsic to the project, or in other words "exogenous" to the work of the GPs. It is worth noting that this competence of selection and monitoring is the one to be valued by investors (LPs) in their choice of GPs teams to whom they entrust their funds.

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III. THE LIMITS OF THE MODEL

III.A. Does this Venture Capital model really foster innovation?

There is a growing consensus in the literature over the demonstration that large industrial groups do not support themselves the renewal of their products and technologies. Their processes of risk management and NPD contribute on the contrary to prevent disruptions and radical innovations. Conversely, start-ups backed by venture capital funds are deemed to be more innovative and job-creating than others small or large firms. Incidentally, some large companies draw their inspiration from this model to develop their own investment capabilities (Engel, 2011).

More generally, Venture Capital is seen as a new model for specific innovation, which is neither that of the company or of the entrepreneur: according to Florida, VCs would provide a "gatekeeping function". The development paths being generally constrained and dependent on institutional and social contexts, technological breakthroughs would then contribute to open new blank design spaces. By gathering information on these new design spaces in an organized way, VC would then help developing these new potentials. They support the creation of companies and the required investments to overcome technical frontiers. At the end of the day, their choices would then steer the socio-technical trajectories and sow the seeds and create appropriate conditions for future developments (Florida et Kenney, 1988).

In addition, several studies have sought to show that statistically, VC backed firms were more innovative, especially in terms of number of patents filed. Thus, for (Kortum et Lerner, 2000):

> "*Focusing on a conservative middle ground, a dollar of venture capital appears to be about three times more potent in stimulating patenting than a dollar of traditional corporate R&D. Our estimates therefore suggest that venture capital, even though it averaged less than 3 % of corporate R&D from 1983 to 1992, is responsible for a much greater share – about 8% – of U.S. industrial innovations in this decade.*"

These figures are yet to be taken with caution: it should be noted that a third variable might mediate this relationship. VC operations generally occur where major technological breakthroughs have recently emerged, which may explain the unusual frequency of patents (Gompers et al., 2009).

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Beyond any doubts that we can raise about the ability of VC backed firms to file more patent than corporate R&D, there are several other issues that worsen the picture: our analysis shows that the results of private equity investment remain desperately low, be it in terms of economic growth, or even in terms of return on investment (profitability).

III.B. Private equity investment only partially resolves the "equity gap"

Although private equity is deemed to bridge the equity gap by providing financing solutions where usual funding is insufficient, biases in the selection of companies are both remarkable and detrimental.

First, to qualify for very high yields, investors privilege start-ups whose technologies have applications for very large and rapidly deployable markets. Hence a preference for applications whose markets are clearly identified, mostly B2C, and, as Hargadon emphasizes it, “scalable” and with “rapid pay-off” (Hargadon et Kenney, 2012). Typically, VC investors prefer applications in digital technologies, software, or biotech to application in more heavy industrial fields. Consequently, although Venture Capital was supposed to help investing in sectors with strong impacts (ecological transition, etc.), Clean Techs are for example excluded from the scope of its business. Indeed, the risks generated by a still unpredictable regulatory intervention are too strong, the willingness to pay of potential customers is too volatile, government support is a major factor, etc.

Second, the rules of remuneration of GPs urge them to invest in a lower number of projects, with higher amounts. Indeed, insofar as each considered case requires due diligence and a strong analysis effort, while GPs earn a riskless 2% per year of the total volume of funds raised (independently from the number of projects in which these funds are distributed), the teams of analysts are not incited to increase the number of expensive tests for applicants. Over the average course of an investment cycle (about 10 years), GPs thus recover 20% of the initial funds, a riskless return that is quite comparable (if not higher) to the overall 20% uncertain return on generated profit (see below). Thus, for a given overall investment volume, the GP will prefer a small number of investments, with larger amounts, just the opposite of the diversification hypothesis on which the initial model was based. As a direct result, start-ups asking for more funds at the beginning have paradoxically a greater chance of being supported by VC funds!

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III.C Venture Capital suffers from low financial returns

In addition, venture capital funds do not achieve the levels of return on investment that were expected at their creation. According to the literature, this is due to the agency relationship between LPs and GPs, and precisely to the risk of opportunism thereof. More specifically, the proposed reasons for the low profitability are twofold:

- Quite typically, the intermediary structure between LPs and GPs is criticized by the risk of opportunism that it generates. For example, the limited lifespan of the fund and the method of compensation for GPs lead to sub-optimal behaviours: instead of following the "real options" mechanism, projects that have passed the first round keep on being financed until the end of the fund so that GPs collect the annual 2% return, even when they have information showing that they have a high chance of filaure (Kandel et al., 2011).

- More surprisingly, the behaviour of investors themselves is put in question: they seem to fall for promises of extraordinary profitability, and **do not question counter-productive management rules**. A recent report from the Kauffman Foundation, eloquently subtitled "*We have met the enemy and he is us*", is a severe blow to the classical model (Mulcahy et 2012). According to this institutional investor, who has invested in hundreds of funds for years, the system has provided more than 20 billons dollars per year for 15 years, but was only marginally profitable compared to the financial markets. According to the report, this is because LPs have mandates to invest pre-determined amounts of cash. Therefore, they invest in volume on the whole, instead of case by case, thus including funds that are far from being top-performers. Furthermore, the evaluation criteria are misleading and inappropriate:

- "Top quartile" or Internal Rate of Return are self-referencing criteria, which mean nothing on performance relative to the market
- The myth of the J-Curve normally justifies the patience of investors, but lacks of evidence in practice...

In addition, for every investment in advanced technological areas, venture capitalists are said to suffer a "double tyranny": the first facet is the high degree of risk they face in nascent technological fields, and the second is the impossibility for funds to organize a true diversification of the portfolio, given the high level of expertise and specialization that each investment in such technological companies require (Murray et Marriott, 1998).

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Nevertheless, the analysis of the financial results of VC calls for a deeper questioning: admittedly, according to studies, financial performance greatly varies depending on the chosen funds, and they emphasize the cyclical nature of performance. But more importantly, the results are highly dependent on the observation rule: they can be seen as extremely good if one only considers companies that have made an Initial Public Offering (IPO). According to Cochrane (2005):

"*The average return to IPO or acquisition is an astounding 698 %.*" However, "*there are a few truly outstanding returns of thousands of percent and many more modest (≅ 100%)*" (Cochrane, 2005).

Cochrane insists on the bias of considering only listed companies: by definition, these are the cases where the highest return are expected (because the higher the company valuation, the greater the chance of an IPO). Once this bias is corrected, the "real" return is estimated at 5.2 % per year. Which is significantly lower, and notably lower than the return of the S&P 500 (15.7 %) and that of the average Management Buy-Out (17.6%) (Murray et Marriott, 1998).

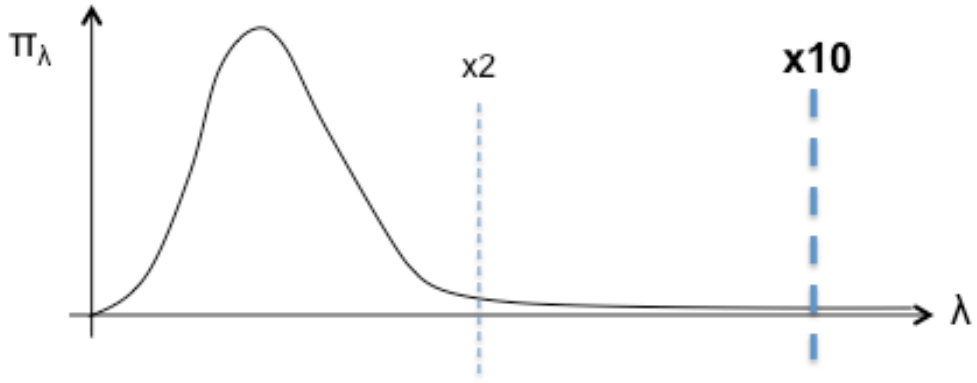
These weak returns are confirmed by other studies, and statistics show that, despite some companies that are able to generate returns in the order of x10, the normal distribution of portfolios is overall too low to ensure the sustainability of venture capital. For instance, according to (Florida et al, 1988), surveys on the performance of 10 leader funds from 1972 to 1983 show that over 525 investments, only 56 were "winners" (10.7%) and generated more than half (540 million of 823) of the portfolio's value, and more than half of the investments (266) have hardly been profitable. According to (Mason et Harrison, 2002) a survey over 383 investments harvested by 13 venture capital funds from 1969 to 1985 shows that only 6.8% of investments make x10 returns, against 60% that result in losses. Overall, "*almost 50% of the total final value of the funds came from just 6.7% of investments.*"

IV. QUESTIONING THE FOUNDING HYPOTHESES OF VC

This leads us to question the hypotheses at the base of VC: as we have seen, the model is based on the assumption that random "gold nuggets" are frequent enough to compensate the losses of the majority of projects. However, the analysis shows that **the profitability of a**

couple of "golden" companies is in fact not sufficient to finance the investigation of a broad portfolio.

In particular, if the highly successful projects only generate ten times the initial investment, then to be profitable VC funds would require that more than 7% of the population of start-ups turn out to be "gold nuggets". What seems to be contradicted by the facts.



To summarize, there are two major contradictions in the initial model:

- First, there is a contradiction of interests on the amounts of investments: LPs would benefit from increasing the number of projects (to reduce the average investment ticket) in order to diversify risks. GPs instead have an incentive to minimize the number of cases studied and selected.

- The second contradiction comes from the insufficient frequency of profitable companies to justify a portfolio approach.

Summary of the hypotheses and contradictions

Parameters	**Classical model of Venture Cap Funds**	**Practical functioning of VC Funds**
Size of portfolio of investment projects	High amount of total investment High number of funded projects	High amount of total investment as a whole Limited number of funded projects
Structure of portfolio	Independent projects	Projects treated as independent but in same technological domains

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Amount invested in each project	Low and distributed	High and concentrated (=> no real diversification)
Probability of return on investment	Exogenous	Exogenous
Probability of high return (x 10)	High enough to reach profitability	Thought to be high enough but limited in practice

However, is this canonical model really the one that is followed by venture capitalists? As we have seen, this model is expressed in purely financial terms (classical risk management) and is not connected to any innovation rationale. We could wonder if, in practice, VCs do not have a different reasoning to select and support their investments. In particular, do they have means to:

1) play with the probability distribution?

2) or with the valuation of projects?

3) Do not they also have other payment methods that avoid the bias shown above?

V. EMPIRICAL ALTERNATIVES: COUPLING BETWEEN INNOVATION AND FINANCING

At this point, it appears that the literature has not taken sufficient account of the practices, sometimes very different, of contrasting funds. Yet, our interviews shed light on interesting forms of coupling between the investment rationale of some VC funds and their management of innovation. We can give some first examples of these couplings, showing how they change the parameters of the classical model.

V.A. A model of interdependence between projects and external valuation in the ecosystem: Innobio

Innobio is a fund created by a French public actor in private equity (CDC Entreprises), which specializes in a specific area: the fund is positioned on "biotech products for health that enable considering collaborations with pharmaceutical companies".

As a “sector fund”, we could have assumed that it undergoes the so-called “double tyranny”. But it actually takes advantage of a position on a particular field of innovation, where subscribers (LPs) are not just investors. These are big pharmaceutical companies (such

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as Sanofi, Merck, ...), that therefore meet to scrutinize various areas of innovation they can not handle alone.

- Innobio has thus established a strategic committee, composed of experts from the different pharmaceutical companies. Thanks to this committee, the fund significantly increases its analysis capacity and its ability to monitor funded start-ups (risk and innovation analysis, access to competences etc.). **Therefore it directly increases the probability of project success**.
- Then, the interest for the LPs is not limited to a start-up project in particular: pharmaceutical companies in fact invest in the fund for the overall strategic monitoring it allows them to make. One can then talk about "cross value" or synergies, insofar as **the value of investing in a particular company in fact influences the successes of the others**.
- Lastly, Innobio significantly increases the value of start-ups by playing on the "external" valuation factor. Unlike the value revealed by the business plan (typically, expected revenue from the product launch), the challenge is to promote the potential of start-ups for the pharmaceutical companies themselves. Some of the technologies or processes can in fact leverage or amplify the potential of these large companies: one can speak of potential for expansion. It is usually this type of valuation that leads to very high prices for the selling of start-ups (e.g. Instagram, etc.).

In conclusion we can identify a first underlying model of innovation behind the rationale of Innobio. One can call it a model of **venture cap with "cross value" and "external potentiation" effect**.

V.B. A model of "prudent broker" with focus on external valuation: Scientipole Initiatives

Our second case, the fund named "Scientipole Initiatives" shows another configuration.

"Evergreen" model

First of all, the structure of the fund differs from the Limited Partnership with General and Limited Partners. Like the usual company, the equity to be invested in start-ups is the capital stock of the company, which is not separated in different "tickets" with expected

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investment duration. The fund thus invests directly, without distinguishing LP GP. It avoids the problem of the large number of investments and rather focuses on a "flow" of projects with limited involvement.

"Prudential" model:

Compared to traditional funds that select a few high return sectors, what furthers the "equity gap" for a whole part of the industry, "Scientipole Initiative" is not positioned on a specialized field, but plays more on the independence between projects. Indeed, the evergreen model and the research of varied industrial applications enable keeping low invested amounts per project, and guaranteeing the diversity required for a true risks portfolio management.

Accordingly, it does not look for very high multiples. Instead of focusing on "gold nuggets" to compensate the failures, the issue here is primarily to sustain the activity for every project, by fetching buyers or investors that are able to sustain the project. One can say that the financing policy is prudent: Scientipole's goal is to boost the distribution curve on near $\lambda = 1$ returns, instead of only promoting high returns. This enables reopening the portfolio of industrial investments (e.g. Muses, niche electric vehicles) and secondly significantly reduces risk.

"External valuation" model:

But the efforts of Scientipole initiative clearly reside on the external valorization of the projects: instead of trying to be competent on the core businesses of every start-up (which are all the more varied and ever-changing between Internet, automotive technologies, cultural events, etc.), the team encourages entrepreneurs to make frequent prototypes and discuss with buyers or potential clients. Rather than ensuring very high cash flows, the challenge is to secure the expansion potential that the projects may create for other companies. This translates into practice by contracts that focus less on the mathematical valuation of future cash flows (Net Present Value) when the fund sells its shares, than on the valuation for the ecosystem. Hence the importance of "accretion" mechanisms, which allow entrepreneurs to redeem some of the shares in their company, and thus capture a greater part of the value, if the market valuation for the company finally exceeds the expected offering price set at the first estimate (for the first round of investment) by contract between start-up founders and investors.

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So one can describe the model of Scientipole Initiatives as of a “prudent broker focusing on high external valuation”. Again, the main assumptions of the initial model of VC are challenged and a strong coupling with the innovation strategy appears.

V.C. A model with minimal investment: Innovigo.com

In some cases, the creation of a fund is compromised by the low probability of high return. When investment amounts in the sector are generally low, as it may be the case for Internet start-ups, then 2% of the funds raised are not sufficient to run a team of GPs. In these cases, some investors, such as Innovigo, adopt another strategy.

Innovigo is a support structure in the highly specialized field of leisure services and tourism on the Internet. In this case, the field is highly specialized so one cannot assume anymore that the projects are independent. Instead of investing in start-ups, Innovigo chose to give them advice (selective advice) aiming at accelerating the business development in the niches with the highest potentials. The logic is basically the same as those of investment funds. Yet, the remuneration is very different and Innovigo builds experimentation and collective exploration devices by connecting start-ups with traditional businesses.

- Innovigo is funded primarily by providing consultancy to large companies seeking to understand and follow new logics of consumption on the Internet.
- In this context, these large companies accept to conduct experimentations for start-ups : they test for instance the feasibility and usefulness of a specific data collection (e.g. customer online profiles for a hotel chain, etc.).
- If start-ups, thanks to Innovigo support, achieve certain objectives (increase of turnover, etc.) then Innovigo is also compensated in equity thanks to stock options of equivalents.

One can see that, as of Innobio, Innovigo leverages the ecosystem around Internet services in a particular domain. Interactions between large companies and start-ups enable identifying a “coupled” value, which literature had already highlighted.

One can thus describe Innovigo’s model as coupling between a system of "venture consulting" and a “cross value” and “external potentiation” model.

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Parameters	"Mutual synergies" model	"Prudent broker" model	"Minimal investment" model
Size of portfolio of investment projects	High amount of total investment Small number of funded projects	Lower amount of total investment (evergreen) Comparatively high number of projects	No private equity (support structure) High number of projects
Structure of portfolio	Innovation field with interdependences, cross value & synergies	Independent projects in a high variety of fields	Synergies and joint experimentations (sectorial fund)
Amount invested in each project	High	Limited investment, with accretion clauses	Coaching time
Probability of return on investment	Increased by expertise and monitoring by scientific committee of pharmaceutical firms	Focus on medium return by structuration of ecosystem of knowledgeable actors	Increased by experimentations with big players and monitoring
Probability of high return (x 10)	Increased by involvement of big players in the field	Irrelevant	Enough to be paid by Stock Options
Features of the model	**Scientific innovation field structuration**	**Ecosystem structuration, insertion, and innovation steering capabilities**	

CONCLUSION

In conclusion, the classical model of venture capital seems to be built on problematic assumptions. These could partly explain the low returns observed so far. In particular:

- The structure of compensation for funds management teams led to increase the invested amounts in each project, which is contrary to the principle of diversification of portfolios.

- In addition, the statistical model is based on an assumption of frequency of "gold nuggets" to be high enough, which does not seem to be verified in practice.

More generally, the statistical model does not take into account possible levers of innovation management. Yet, in fact, some funds clearly articulate their investment strategy on methods of innovation management. Our analysis reveals several possible variables for the coupled innovation-financing strategy:

- Structuring of a field of innovation,
- Insertion in an ecosystem
- External valuation.

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Further research is required to validate these initial findings and to identify other models of coupling between investment and innovation. The research will include studying the conditions and modalities to increase the potential value of a start-up.

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