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Gaps in academic literature on venture capitalists' decision-making on funding for early-stage, high-tech ventures

Abstract: Recognizing venture capital as a crucial source of funds for life science start-ups, this review paper focuses on the academic literature on venture capitalists' decision-making process on granting funding to early-stage, high-tech ventures. The review identified the following three issues: First, despite three dominant factors in venture capitalists' decision-making process, which are identified to be the human, technological and financial aspects of the potential start-up, a great variety of further factors exists and generalization to a great extent is difficult. Secondly, little research has been conducted in Europe and little research employed inductive, qualitative methods. Thirdly, the latest study focusing on a ranking of the importance of decision-making factors for venture capitalists lies 29 years in the past and has been conducted with a North-American sample, leaving a gap for future research in Europe.

Keywords: venture capital, decision-making, high-tech firms, context,

Introduction

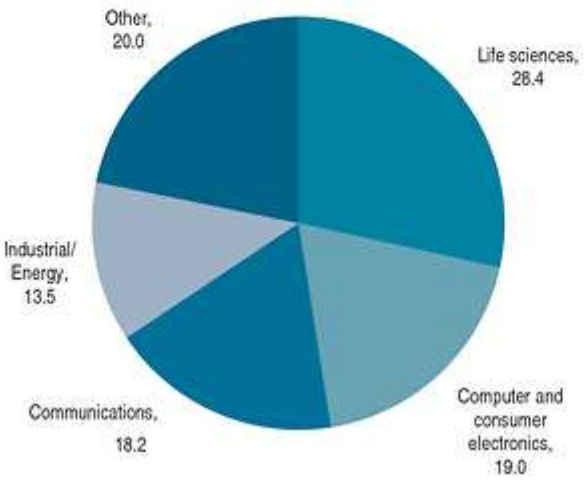
Venture capitalists fulfil the crucial role of providing aspiring entrepreneurs with risk capital unavailable to them from banks due to the high amount of risk involved in their undertaking (Andries and Debackere, 2006). It is common knowledge that the life science industry is one of the riskiest industries, partly due to the long road to the market, and yet little is known about how venture capitalists decide on whom to provide with capital and particularly little is known in respect to high-tech, high-risk firms like life science ventures in Europe. Still, as the OECD notes in its latest 'Health at a Glance' publication, "Life expectancy in OECD countries is rising, but so is the burden of chronic diseases" (OECD, 2013b, p. 1) and "Population ageing increases demand for long‑term care and puts pressures on public spending, despite informal care" (ibid., p. 2). The European Union proclaimed 2012 as the European Year for active aging and solidarity between generations (European Union, 2013) since the ageing society has been identified as a demographic phenomenon that needs special public policy attention in respect to health care (European Commission, 2014).

Arguably for its societal relevance as well as the potential profits that can be made from this fast-growing market, the life science industry is the most significant one in respect to venture capital sums invested. OECD data from 2012 shows that 28.8 percent of all venture capital in Europe is invested in

the life science sector, the second biggest sector being the computer and consumer electronics sector with only 19.0 percent (OECD, 2013a).

Figure 6.12 **Venture capital investments by sector, Europe**

Percentage, 2012



Source: OECD, 2013a

Recognizing the importance of the life science industry, the remainder of this article will argue that little is known about venture capitalists' decision-making process in respect to funding for early stage, high-tech ventures, particularly in a European context, given the heterogeneity of the venture capital market. Therefore, this article will review existing literature on venture capitalists' decision-making process and will show that three factors seem to dominate in that process. However, further factors exist, which change in importance in different contexts. Hence a call for future research particularly in a European context is made, suggesting inductive methods for a grounded theory approach (Glaser and Strauss, 1967).

In detail, the following literature was guided by the following review questions:

1. Who/What are information sources that venture capitalists use when deciding on funding?
2. Why do the different information sources matter?
3. How important are the individual decision-making factors?

Information venture capitalists rely on to judge on start-ups

One key characteristic of the venture capital decision-making process is the fact that several stages of decision-making take place during which different decision-factors can be of higher or lower importance (see Illustration 1). These stages are identified as the initial screening stage and later on the proposal assessment stage (Hall and Hofer, 1993). As the authors say: "we suspected that previous research on the criteria used by venture capitalists was not reconciled with the research on the process of venture capitalist decision-making, and therefore that the findings reported to date have probably "mixed" different stage criteria." (p. 40).

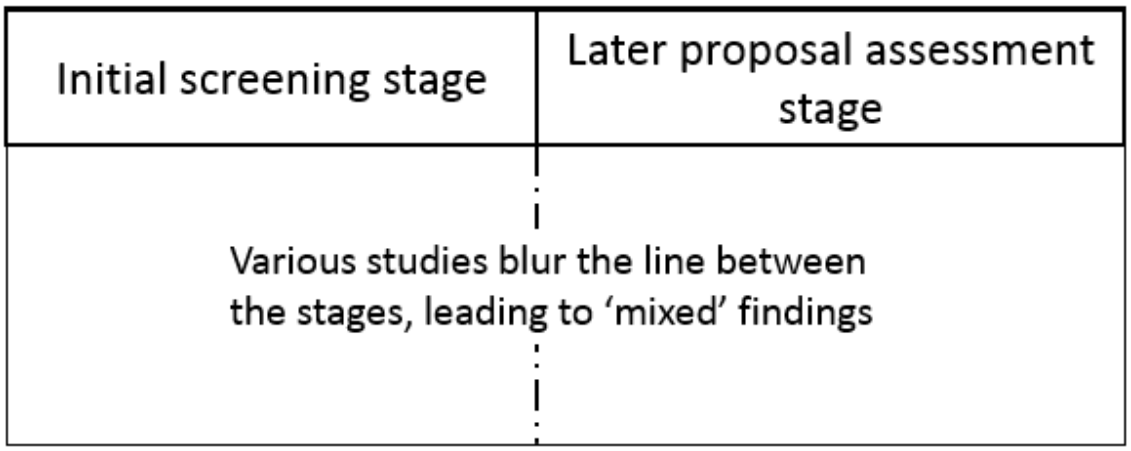


Illustration 1: Author's work

The following discussion of the literature on decision criteria will most likely also cite and refer to findings of mixed stages which cannot be prevented when previous research has not been put in precise boundaries. Furthermore several research papers do not even mention which stage they researched but simply refer to the venture capitalists' decision-making process in general. One important consideration for future research therefore should be to explore decision criteria rather than look for confirming evidence for previously identified criteria. The existing academic literature discussed in the following is helpful in so far as a researcher can enter the field with an open rather than a blank mind, proving particularly useful for future inductive, qualitative studies.

The importance of human, technological and financial aspects

In their research on venture capitalists' decision-making process, Knockaert et al. (2010a) defined 12 attributes which they used to let their participants judge on fictional business proposals. Those 12 attributes were the team, the entrepreneur, the contact with the entrepreneur, the uniqueness of the product, the protection of the product, its market acceptance, the degree of general-purpose technology, the location, the size and growth of the targeted market, time to break even and the

return on investment. Based on these 12 attributes I then concluded that they can be grouped into three categories, namely the human, technological and financial aspect (see Illustration 2).

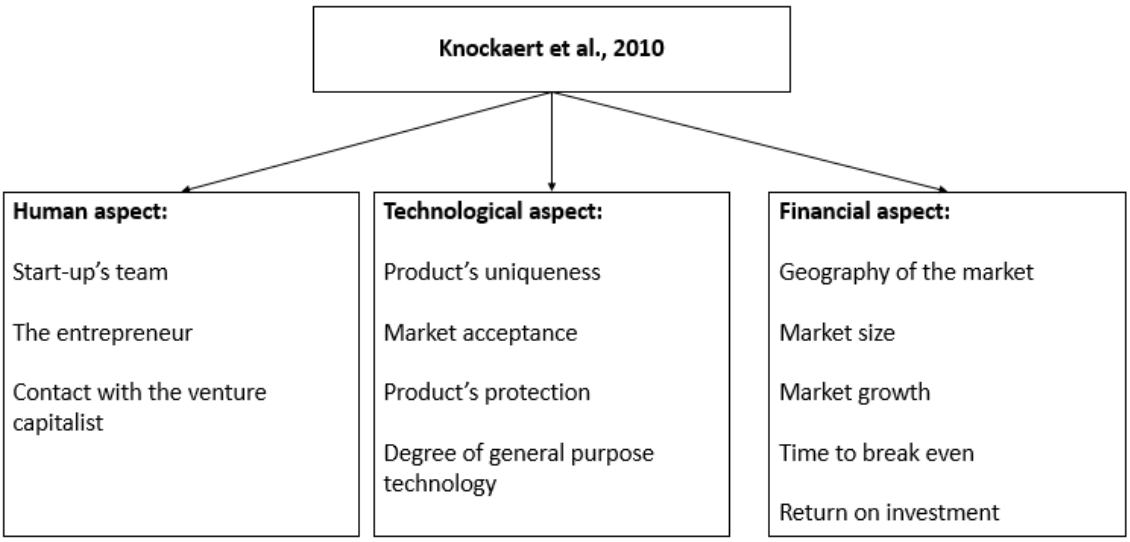


Illustration 2: Author's work

As information that I consider to belong to the group of human aspects I see the start-ups' team, the entrepreneur and the contact with the venture capitalist. As information that I consider to belong to the technological aspects I see the product's uniqueness, market acceptance, its protection and whether it is a general purpose technology. Thirdly the information considered as belonging to the financial category I see as the geography of the market, the market size, market growth, time to break even and return on investment. Based on this categorisation of information sources I found various articles whose findings and underlying information sources for the data collection confirm this categorisation (Zacharakis et al., 2007, Miloud et al., 2012, Baum and Silverman, 2004).

One of these articles confirming the above described classification is given by Zacharakis et al. (2007) who introduced eight decision factors that were given to their data collection participants to judge on 50 fictional business proposals. Those factors were leadership experience (average number of years of experience the management team has in leadership positions), proprietary technology (on a five-point scale ranging from no protection to extremely high proprietary protection), market familiarity (mean number of years of experience the team has in the market), start-up record (mean number of past start-up experiences for team members), market size (total revenues for most recent year), market growth (percentage growth in revenues over the last 5 years), number of competitors (number of direct competitors) and competitor strength (relative concentration of market on a five-point scale ranging from a few dominant competitors to an emerging market). While the proprietary technology confirms the technological aspect of my categorisation, three other factors mentioned by Zacharakis et al. (2007) are the market familiarity, leadership experience and start-up record and all confirm the

human aspect. The financial aspects finally are displayed by Zacharakis et al. (2007)'s decision factors of market size, growth and competitor strength and number.

Another article confirming the categorisation derived from Knockaert et al. (2010a) is evident in Miloud et al. (2012)'s article, which empirically studies start-up valuation by venture capitalists. They developed a framework based upon three perspectives namely industry organization economics, resource-based view and network theory. Their framework is based on the independent variables product differentiation, R&D intensity ratio, advertising intensity ratio, industry growth rate, entrepreneur/top management team, industry experience, top management experience, start-up experience, top-management team, solo vs. team founder, team completeness, and network size. Allocating these independent variables to the three categories of human, technological and financial aspects it becomes obvious that they mainly overlap. Product differentiation, advertising intensity ratio, and industry growth rate fall into the category of financial aspects. R&D is the only variable fitting the technological category and the entrepreneur/top management team, industry experience, top management experience, start-up experience, solo vs. team founder, team completeness all overlap with the human aspects as identified by Knockaert et al. (2010a). Only network size as a variable that relates to outside relationships of the considered start-up and is not incorporated in the categorisation of factors that receive so much confirmation. This information source however will be dealt with in the next sub-chapter and will show that this categorisation of human, technological and financial aspects as put forwards so far is not exclusive.

Furthermore there are several articles that also confirm the above given range of information sources however have a very limited data stock. Mason and Stark (2004) for example coded the responses to their conducted verbal protocol analysis into the categories entrepreneur/management team, strategy, operations, product/service, market, financial considerations, investor fit and business plan. The majority of these factors also overlap with the three categories I introduced in this chapter because the entrepreneur/management team and investor fit match the human category, the operations and product/service fit the technological category and market and financial considerations fit into the financial performance category. However the venture capital participants of Mason and Stark (2004)'s study also considered the business plan and strategy as important. Here two things need to be noted, first the business plan coding category is described as "the whole package" (p. 238) and the strategy as "the overall concept and strategy of the business" (p. 238) which both do not seem to deliver a lot of content and could have just been used for answers that were difficult to allocate to any of the more meaningful categories. Secondly, the participants sample consisted of 10 people, 3 bankers, 3 venture capitalists and 4 business angels all coming from the South of England area.

Therefore I think the results of that study need to be considered very carefully, however a general overlap of categories used in this article to the ones derived from Knockaert et al. (2010a) can be seen.

Finally, Baum and Silverman (2004) studied alliances, intellectual, and human capital as selection criteria in venture financing and performance of biotechnology start-ups. They define the top management of the start-up as the human capital and the protected intellectual capital such as patents as the intellectual capital which overlaps with Knockaert et al. (2010a)'s attributes of the team and entrepreneur and the uniqueness and protection of the product and thereby also confirm the two categories of human and technological aspects to be important for a venture valuation process. Besides the human and intellectual capital they however also discuss alliances that start-ups have with other firms or supply-chain partners.

Also questioning the importance of the three outlined factors, Hall and Hofer (1993) note that apart from the financial and technological information, the venture capitalists involved in their data collection were surprisingly unconcerned with the entrepreneurial team. As they are not the only ones questioning this troika of information sources and there are several other decision factors for venture capitalists being mentioned in the relevant literature the next sub-chapter will discuss this literature.

Other information sources mentioned in the literature

Even though the following information sources do not receive as overwhelming confirmation as the three categories derived from Knockaert et al. (2010a) there are several articles mentioning other information sources to be of relevance for venture capitalists when deciding upon funding for aspiring start-ups.

Briefly, these other information sources are identified as alliances among spin-offs and social ties (Baum and Silverman, 2004, Miloud et al., 2012), the familiarity of the venture capitalists with the industry who acquire their knowledge in an absorptive manner (De Clercq and Dimov, 2008), venture capitalists networks of informants (Fiet, 1995) and possibly lawyers and advisors that are identified to be under-researched (Lehtonen and Lahti, 2009).

These mentioned information sources show that the troika of human, technological and financial aspects is not exclusive and further information sources make the big picture on the venture capitalist decision-making process more detailed and complex and context-dependent (see Illustration 3).

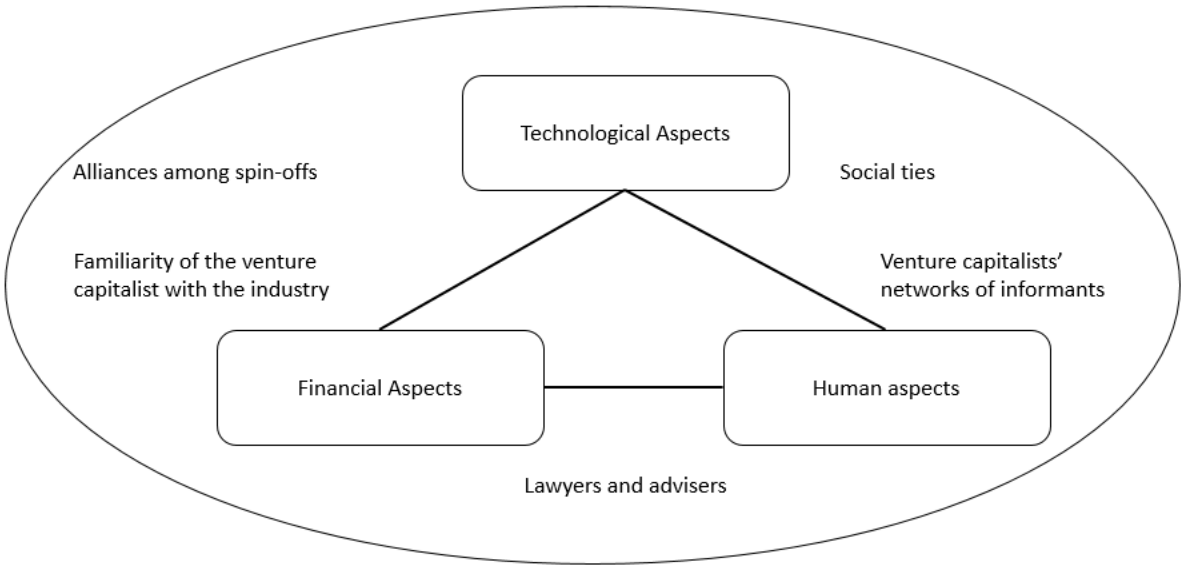


Illustration 3: Author's work

The next sub-chapter will show that besides various information sources that venture capitalists might rely on, they are also influenced by bounded rationality which makes it even more difficult to understand a venture capitalist's decision-making process.

The individuality and context-dependency of funding decisions

In addition to these aforementioned characteristics of the venture capital industry, exists the fact that venture capitalists are also deciding with bounded rationality, heuristics and biases.

"VCs are flooded with information from business plans, economic reports, outside consultants, meetings with the entrepreneur etc." (Shepherd and Zacharakis, 2002, p. 11) and therefore often rely on gut feeling and a sense of chemistry (Zacharakis and Meyer, 1998). Furthermore venture capitalists only regard information as cues but are aware of an information asymmetry between them and the potential investee, and the venture capitalists themselves are having only limited rationality as well as rely on heuristics and biases (see Illustration 4).

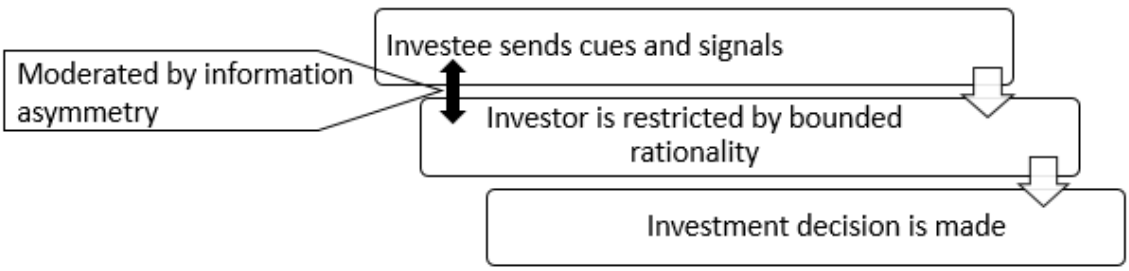


Illustration 4: Based on Levie and Gimmon (2008, p. 247)

To clarify the extent of biases and heuristics Shepherd and Zacharakis (in Landström, 2007) devoted several paragraphs on their influence on the decision-making process in the Handbook of Research on Venture Capital. They define heuristics as sub-optimal decision strategies, as road-maps that are applied to conserve cognitive resources. Biases on the other hand are directing the attention of the decision-maker to certain information. Even though the majority of literature on heuristics and biases has focused on entrepreneurs, Shepherd and Zacharakis argue that the majority of that research is also relevant for venture capitalists since they also operate in an environment of insecurity. Referring to other scholars' and own work, Shepherd and Zacharakis (in Landström, 2007) list several biases (see table 1) and also heuristics such as a non-compensatory strategy (not evaluating all information surrounding an alternative), a satisficing strategy where proposals are evaluated individually and the venture capitalist is just looking for one attribute to fail the proposal, and a representative heuristic (comparing current proposals to past successful ventures which then might entice into generalising from small samples) to show their influence on the decision-making process.

Biases in decision making	
Bias	**Description**
Availability	Focus on available information and neglect of unavailable information
Selective perception	Problems structured by an individual's prior experience
Frequency	Absolute cue frequency is used versus the relative occurrence
Concrete information	Concrete data dominates abstract data
Illusory correlation	Belief that two variables co-vary when in fact they do not
Data presentation	Evaluation biased by sequence, presentation mode, qualitative versus quantitative mixture, perceived display 'logic', and context
Inconsistency	Inability to apply judgement consistently
Conservatism	Failure to revise decision when faced with new evidence
Non-linear extrapolation	Underestimation of joint probabilities and growth rate
Habit	Previously successful alternatives are applied to solve problem
Anchoring/adjustment	Prediction results from upward or downward adjustment of a cue value
Representativeness	Evaluation based upon similar class of events
Law of small numbers	Small samples are believed representative
Justifiability	A rule can be used if it can be 'justified'

Regression bias	Predictions fail to recognise regression towards the mean
Best guess strategy	Simplification and ignoring data
Complex environment	Information overload and time pressure reduce consistency
Overconfidence	Belief that own decisions are correct more often than they are
Emotional stress	Induces panic judgements or reduced attention
Social pressure	Conformity or distortion of judgements
Consistent data sources	Increase decision confidence but not accuracy
Question format	Judgement process requirements or choice affects outcome
Scale effect	Measurement scale affects response perceptions
Wishful thinking	Preferences affect the assessment of events
Illusion of control	Perceived control resulting from activity concerning the outcome
Outcome irrelevant	Observed outcomes provide incomplete feedback for correction
'Gambler's fallacy'	Higher probability of event following unexpected similar chance outcomes
Success/failure attributions	Success is attributed to skill; failure to chance
Recall fallacies	Failure to recall past details leads to logical reconstruction
Hindsight bias	Plausible explanations can be found for past surprises

Table 1: Biases to decision-making

Source: Landström (2007, p. 187)

Due to the bounded rationality, the amount of heuristics and biases and the resulting subjectivity of the decision-making process Zacharakis and Meyer (1998) found that venture capitalists, even though they are consistent in their decisions, rarely understand it themselves and the greater the amount of information the less accurate their judgement. In addition Shepherd et al. (2003) showed in a study on the influence of experience of venture capitalists that more experience in judging start-up business proposals is not necessarily helpful as more experienced venture capitalists rather interpret than analyse information and thereby get caught in a confirming evidence trap. Apart from their increased time efficiency they also are over-confident, over-fitting from small samples and overgeneralize.
Therefore this sub-chapter calls attention to the subjectivity in the decision-making process of venture capitalists. Nevertheless the majority of relevant literature in this field has so far relied on quantitative methodologies (see table 2 for overview) and tried to generalize results for the entire industry which I think can only be of limited use when trying to understand decisions in its embedded context.

Authors	Methodology/Methods/Data analysis approach
Hall and Hofer (1993), Mason and Stark (2004)	Content analysis of verbal protocols
Wells (1974)	Statistical analysis of interviews
Pinch and Sunley (2009)	Case study with interviews
Colombo and Piva (2008)	Case study using interviews for theory-building, results empirically tested with Italian database RITA
De Clercq and Dimov (2008), Baum and Silverman (2004), Miloud et al. (2012)	Empirical theory-testing using financial databases
Ensley and Hmieleski (2005), Poindexter (1976), Tyebjee and Bruno (1981)	Statistical analysis of questionnaire sent to large sample
MacMillan et al. (1986)	Statistical analysis of interviews and questionnaires
Knockaert et al. (2010a), Shepherd et al. (2003)	Conjoint method to test hypothesises: large VC-sample was presented with a number of fictitious business proposals to be judged on Likert-scales, results quantified
Knockaert et al. (2010b)	Quantitative, theoretical analysis of interviews from large VC data-set
Lehtonen and Lahti (2009)	Multiple-case study, using in-depth interviews
Levie and Gimmon (2008)	Semi-structured interviews in multiple-case study to prove previous quantitative results
Mustar et al. (2006)	Review of 50 published articles
Ortín-Ángel and Vendrell-Herrero (2010)	Hypothesis-testing by using questionnaires from 64 technological firms
Zacharakis and Meyer (1998)	51 VCs presented with business proposals; Results put into regression analyses
Wright et al. (2006)	Interviews to build survey, statistical analysis of surveys, further interviews on key aspects from survey results
Silva (2004)	Inductive observation study
Fiet (1995)	38 Interviews to build questionnaire, hypothesis-testing of questionnaire results by the use of structure modelling

Table 2: Methodology overview

Source: Author's work

Despite a fairly strong focus on quantitative, homogenous datasets, several authors frequently mentioned and proved that the venture capital industry and the venture capitalists within cannot be considered as homogenous. In general, they can be classified by their legal context (Zacharakis et al., 2007), their investment aspect focus, their investment stage, time horizons and intensity of support (Elango et al., 1995, Colombo et al., 2010), their ownership structure and size (Gupta and Sapienza, 1992) and their differing role in venture capital firm syndicates (Rosiello and Parris, 2009). Also, the difference between the US and EU is stressed in several articles such as Colombo et al. (2010)'s discussion of three influential papers on venture capital and high-tech start-ups. They state that the majority of research on venture capitalists focused on the US, but the US differs strongly to the EU. The supply of venture capital is, among other factors, affected by different types of industries and their distinct characteristics as well as the regulatory framework and the macroeconomic setting.

The ranking of decision-factors for venture capitalists

Having reviewed the literature on different decision-making factors with the result that three factors dominate but are far from exclusive and to be taken out of context, this chapter turns to the next crucial question, namely how important each decision factor is. In this pursuit, this chapter mainly draws on four sources, Wells (1974), Poindexter (1976), Tyebjee and Bruno (1981) and MacMillan et al. (1986) who are the only ones having conducted research that focused on the need to rank the individual decision-making factors to identify which factors are actually crucial during the screening and evaluation process.

The most recent study therefore lies 29 years in the past and the data pool and data collection methods of these studies only partially take the heterogeneity mentioned above into account. Furthermore these studies, that are the only ones focusing on a ranking of decision-factors to distinguish the more important ones from the less important ones, have all been conducted in the US and stress the gap concerning the shortage of studies done in the EU.

Referring to Wells (1974) and Poindexter (1976) first, Silva (2004) summarised their work by saying that *"Wells (1974) found that VCs consider management commitment as the criterion having the highest weight in assessment of proposals. This criterion was closely followed by product, market and marketing skills. The results of Poindexter's study identify the quality of management as the criterion with the highest rank in the opinion of VCs followed by expected rate of return and expected risk."* (p. 126). Two aspects can be noted here, first, the criteria that the two scholars identified as being the

most important factors for venture capitalists overlap with the great consensus in the academic literature that the human, technological and financial factors are of significance for venture capitalists. Secondly, these two studies seem to overlap in their findings however do not mention any heterogeneity of the venture capital industry and within their sample.

Tyebjee and Bruno (1981) however note that Wells and Poindexter were the first to rank the decision factors but the criteria used by Wells were biased towards managerial abilities while the criteria used by Poindexter were biased towards financial aspects. They therefore saw the need to conduct research based on open-end question.

Therefore two studies on the same topic, namely the ranking of important decision factors for venture capitalists has been conducted by Tyebjee and Bruno (1981) and MacMillan et al. (1986). MacMillan et al. (1986) saw their study as a follow up of Tyebjee and Bruno (1981) but with larger a data pool and at a later point of time. They found that the criteria venture capitalists use can be grouped into the six categories of the entrepreneurs' personality, the entrepreneurs' experience, the characteristics of the product/service, the characteristics of the group/market, the financial considerations and sixth the composition of the venture team. Out of these six categories which are composed of 27 criteria in total, they identified the 10 most important ones for venture capitalists to be following:

- Being capable of sustained effort
- Thoroughly familiar with the market
- At least ten times return in 5-10 years
- Demonstrated leadership in the past
- Evaluates and reacts to risk well
- Investment can be made liquid
- Significant market growth
- Track record relevant to venture
- Articulates venture well
- Proprietary protection

Source: (See MacMillan et al., 1986, p. 123)

Interestingly, five out of the ten criteria belong to the category of the entrepreneur and all other important decision factors can be allocated to the three categories of human, technological and financial aspects as outlined in the previous chapter.

Tyebjee and Bruno (1981) on the other hand sent out evaluation sheets to venture capitalists and asked them to talk about seriously considered proposals they had received in the past, based on 26 items. Using a multivariate factor analysis they found 6 factors explaining 75% of the deal evaluation

made which were the profitability of the venture, market factors, management quality, uncontrollable risk, cash-out factors and the viability of the venture. Comparing their results to MacMillan et al. (1986)'s results I think it is fair to say a great overlap exists.

MacMillan et al. (1986) themselves, justifying the need for their research, say "*The major shift that has occurred since Tyebjee and Bruno's study is that venture capitalists in the mid-1980s have reduced their expectation of specific skills (marketing, technical, and so on) on the part of the entrepreneur and shifted these expectations to the venture team.*" (p. 126).

When referring to the methodology used, it can be noted that MacMillan et al. (1986) as well as Tyebjee and Bruno (1981) used interviews with venture capitalists in the first place to derive the 26/27 items that then were put in the questionnaires/evaluation sheets, thereby still following a mixture of an inductive and deductive approach. In addition, MacMillan et al. (1986) and Tyebjee and Bruno (1981) collected their data in the US.

Finally I would like to stress that the questionnaires used by MacMillan et al. (1986) and Tyebjee and Bruno (1981) were designed with a 4-point Likert scale. I think it can be seen controversial how much explanation power these rankings and ultimately the results have based on quite broadly ranged scales. Still, their work has been an important step towards a deeper understanding of the importance of the individual decision-factors in the decision-making process of venture capitalists.

Conclusion

To understand venture capitalists' decision-making process is crucial to ensure that more start-ups in the life science industry receive funds and ultimately succeed in bringing new drugs and treatments to the market. The understanding of that decision-making process however remains undifferentiated up to today, nevertheless, due to discussed factors that make the venture capital industry heterogeneous and do not allow broad generalisations, several researchers call for a use of more qualitative, in-depth studies to understand the venture capital industry more thoroughly (Knockaert et al., 2010a, Shepherd and Zacharakis, 2002). In the same vain, this paper reviewed relevant literature on venture capitalists' decision-making for start-up firms and concludes that three factors of a business proposal put forward by start-up firms are of importance to venture capitalists in their decision-making process, but still each individual venture capitalist's decision-making process and the specific context of the decision made will play into the final decision and hence a need for further research particularly in Europe becomes apparent.

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