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*Evaluation of technology-based business proposals
by venture capital investors – example of healthcare sector*

Ocena propozycji biznesowych firm technologicznych przez inwestorów *venture capital*
– przykład sektora ochrony zdrowia

Key words: venture capital, technology, innovation, biotechnology, healthcare

Slowa kluczowe: *venture capital*, technologie, innowacje, biotechnologie, ochrona zdrowia

Introduction

In the last decade, technology-based firms and technology-based start-ups have received considerable attention from researchers. They are especially seen as offering a significant potential contribution in key areas of economic activity: innovation, new employment creation, export sales growth and regional development [Knockaert et al., 2010, pp. 357–371]. Recent studies indicate that technology-based start-ups that succeed in attracting venture capital (VC) tend to outperform those that do not in terms of time to market [Heirman and Clarysse, 2005, pp. 1–6], innovative activity [Petkova et al., 2014, pp. 422–448] and growth [Bertoni et al., 2011, pp. 1028–1043]. Access to VC is difficult for technology-based firms. Also often, venture capitalists (VCs) are willing to fund technology-based firms, but they have difficulty in identifying attractive and beneficial proposals [Wright et al., 2006, pp. 481–501].

For better understanding how VC can help to diffuse technological knowledge to the market place, it is explored in this paper how venture capital companies evaluate technological business proposals. The relations of these business proposals are

examined in the selection process adopted by venture capitalists. This study aims to answer the following research questions: *[1] Is it possible to identify different types of early-stage technology-based venture capital investors? [2] What are typical selection behaviours of venture capitalists invested in early-stage companies?*

The article provides an overview of the literature relating to VCs investments as a support for technology in first section. In the second one, the sample characteristics and methodology used is outlined. In the third section, results of research are presented. The paper ends with a conclusion and discussion. The method of collecting information based on clipping has been used, supported by telephone interviews technique.

1. Venture Capital investments as a support for technology – state of knowledge

Start-ups in the technology-based sector are key creators of innovations necessary to ensure the economic growth and development. Entrepreneurs often seek external financing in the form of VC funds to finance research and development, to provide an increase in production, purchase of production lines and to expand offers of services. In new knowledge-based enterprises there is a limited access to opportunities for external funding. The reason of such situation is the lack of asset-backed securities where intangible assets are dominating, and the value of innovation is difficult to estimate [Ben-Ari and Vonortas, 2007, pp. 475–488]. The results of research indicate that VC investments in technology companies have a positive impact on innovation activities [Allen and Hall, 2011, pp. 115–124]. The literature also confirms that VC investments stimulate the growth of new technology companies [Bertoni et al., 2010, pp. 1028–1043]. The effect of VC investment is reflected in the growth of economic values, especially in the increase of employment. The lack of financial resources at technology companies often results in their growth reduction and threatens their survival on the market. Despite the fact that VC funds help companies to overcome these barriers there are some supply obstacles [Walicka, 2013, p. 159–170]. The cost of accession of the VC fund may be too high, especially for young technology companies. The literature of the subject raises the issue that it is necessary to create incentive systems and eliminate barriers to financing these companies through a system of direct grants. Colombo and Grilli mention human capital and VC as the two main factors of success of technology companies [Colombo and Grilli, 2013, pp. 390–422]. Human capital in the form of skilled managers of technology companies is a factor encouraging VC companies to invest. European venture capital market has developed rapidly over the past 10 years, mainly thanks to public policy focused on the support of entrepreneurship and technology [Czemiel-Grzybowska, 2013, p.12; del-Palacio et al., 2012, pp. 283–301]. VC investments can develop and create innovativeness and entrepreneurship as prerequisites for fund assessment [Geronikolaou and Papachristou, 2012, pp. 454–459]. Modern economies depend on innovations, which improve their competitiveness and promote growth.

Therefore, it is a European challenge to improve the availability of capital funding at an early stage of the business in order to increase innovativeness [Pelly and Krämer-Eis, 2011, pp. 129–140]. The high risk funds play a role of intermediaries between investors, who make their capital available, and portfolio companies in which high risk capital investments are made. The presence of funds in the form of an intermediary has its justification in the specifics of the VC type investments characterized by a higher than average level of risk, and a greater degree of complexity than investments in stocks or bonds made directly by investors [Korzeb, 2010, pp. 143–156].

The financing by VC is often equated with SMEs and innovative businesses in classical approach to the subject. What is emphasized is the high risk associated with the investment, but first of all, the main aim of the investor which is to achieve a high rate of return.

Venture capital is defined as a professionally managed tool of capital invested in private companies at various stages of their development [Dimov et al., 2008, pp. 127–152]. VC firms actively participate in the decision making processes of the ventures they invest in by becoming members of the board of directors and assist management with advice and support [Waluszewski et al., 2009, pp. 86–123]. VC represents a specific type of governance that takes an active part in start-up companies' innovation processes.

In the discussions taken by researchers it is argued that without VC many entrepreneurs would have a problem to get the resources they need. VC allows to turn the promising ideas into a commercial success quickly. A VC firm provides three critical resources to a start-up enterprise. First, money expands the capacity to transform an idea or a new solution from individuals or a project into a company with established customer interfaces [Baeyens et al., 2006, pp. 28–46]. Start-ups usually need external fund-aids to grow, initiate product development, extend their specialized activities, invest in equipment, hire staff, and use outside partners for collaboration. Additionally, the VCs not only provide capital but also experience, in the form of **knowledge** and foresight about the risks and opportunities that entrepreneurs face. Baum and Silverman [2004, pp. 411–425] stress the importance of combining money and knowledge when financing technology-based enterprises. The VCs provides a network of **relationships** including financial, commercial or industrial contacts to help a new venture find suppliers and customers in various ways. Such network can help in knowledge and experience transfer between business partners and establish cooperation with new investors or banks. Being part of a network, VCs often help young firms who often face the „liability of newness” [Serrano-Cinca, Gutierrez-Nieto, 2013, pp. 4060–4070].

Venture Capital firms often use milestones to secure rapid results and to monitor themselves and the firms they have invested in [Narayansamy et al., 2012, pp. 49–63]. Making the emerging company's management accountable for attaining milestones within a set timescale they introduce stepwise financing through a stage of the process.

When a VC firm uses staged financing, the start-up must meet milestones before the VC invests more money [Chen et al., 2009, pp. 199–214]. The aim of this procedure is to reduce the risk of innovation processes and hinder opportunistic behavior from management in the portfolio firms [Domov et al., 2010, pp. 1248–1271]. In summary, the mechanisms of a VC firm reinforce its interest in compressing the innovation process of the start-ups it invests in.

2. Methodology

Accessing VC funds is problematical from both the demand and supply sides [Wright, 2006, pp. 481–501]. To help to solve this problem there is a need to examine the VCs selection processes. A dataset comprising 15 early-stage VC investors was used. This method has been successfully applied in studies on the venture capital investments in technology companies in the world [Bertoni et al., 2010, pp. 307–326]. The subject of research were VC companies established in Europe. All companies researched have established Head Office in Poland, all of them are investing in Poland and functioning on this market for at least three years. Analyzed companies provided commercial seed capital funds and venture capital funds or public-private seed capital funds and venture capital funds. Based on EVCA dataset and by clipping method, 82 companies that meet these conditions have been identified. After the initial verification, 48 active, early-stage technology-based VCs have been selected (58%). Clipping was based on analysis of information on the VCs by searching selected information on the Internet. The adopted methodology of the study comprised an analysis of the web pages content of the surveyed entities. Content analysis was focused on the investment directions of surveyed funds. In the studies conducted, Internet search engine has been used (Google). Parameters assigned to the audited entities, and the total evaluation have been recorded in the database specially created for this purpose. More rigorous analysis was conducted sampling of 15 top VCs who were selected by their reputation, number of technology-based portfolio companies, investing activity, and geographic diversity concerned on Poland. To ensure uniformity and to prevent hindsight bias, deals funded in the last 3 years were selected. CATI interviews were conducted on VCs managers at the beginning of 2014 year. An analysis was conducted to see whether any natural groups emerged from the interview data in order to understand the investing strategies for various technology-based firms. Table 1 gives details of responding VC companies.

Table 1. List of selected venture capital investors

VC investor description [N=15]			Alphabetical list of VC [N=15]
Code	Description [potential interest]	Focus [geography]	
A	Expansion capital and buy-outs Healthcare services	Central and Eastern Europe	
B	Early- and mid- stage research life sciences: biotechnology, pharmaceutical chemistry, informatics at life science, biology and medicine	Central and Eastern Europe	
C	Medical services, medical devices production, healthcare, pharmacy	Northern and Central Europe	
D	Food and food ingredient production, health, green biotech	Central and Eastern Europe	
E	Healthcare, medtech, life science	Central Europe	
F	Medical services, pharmacy	European Union, North America	
G	Medical services, medical devices production, healthcare, pharmacy	Europe, Mid East, Japan	
H	Biotechnology	Northern and Central Europe	
I	Green technology, medicine ICT	Europe	
J	Healthcare, pharmacy	Central and Eastern Europe	
K	Biotechnological engineering	Central and Eastern Europe	
L	Early- and late- stage Life science	Czech Republic, Poland, Slovakia	
M	Early- and late- stage Bioinformatics	Northern and Central Europe	
N	Food ingredients, green and white biotech	Europe	
O	Early- and late-stage Life science start-up	Central and Eastern Europe	

Source: own research.

Keeping in mind that each investment opportunity is distinct, each VCs was analyzed using six key investment criteria: Concept and Science, Management, Market, Intellectual Property, Valuation, and Geography. Table 2 outlines the metrics studied.

Table 2. Metrics of investment's evaluation for conjoint analysis

Metric	Description	Attribute	Levels
Concept and Science	How revolutionary the concept is. Change in paradigm of practicing medicine. Change in disease treatment.	(A) Uniqueness (B) Market acceptance	(1) Product is unique (2) Product is not unique (3) Product is accepted by the market (4) Product is not accepted by the market
Management	Team experience. Managing quality. What makes entrepreneur better than another.	(C) Team (D) Entrepreneur (E) Contact	(5) Non-complementary and no business experience (6) Complementary and business experience (7) Non-complementary and business experience (8) Leader: yes (9) Leader: no (10) Perseverance: yes (11) Perseverance: no (12) Contact with VC: good (13) Contact with VC: bad
Market	Target market size.	(F) Size (G) Growth	(14) It is a niche market (15) It is a mainstream market (16) The market is seemingly high growth (17) The market is low growth
Intellectual property	Composition of matter and method of use.	(H) Protection (I) General purpose	(18) Protection is possible (19) Protection is not possible (20) It is a general-purpose technology (21) It is not a general-purpose technology
Valuation	Financial forecast of company development.	(J) Time to break-even (K) Return on investment	(22) Expected time to break even is less than 1,5 years (23) Expected time to break even is more than 3 years (24) Expected time to break even is between 1,5 and 3 years (25) Expected return is less than 30% (26) Expected return is more than 50% (27) Expected return is between 30% and 50%
Geography	Typical investment destinations. Geography types and broadness.	(L) Geography	(28) The market is regional (29) The market is global

Source: own research based on: Boehm [2003] and Knockaert et al. [2010].

It is claimed that specifically for technology-based firms, there are nine characteristics with varying degrees of importance that need to be analyzed for understanding the complicated investment evaluation process [Boehm, 2003, pp. 78–83]. While Boehm outlined nine criteria, only eight were surveyed: Concept and Science, Management, Market, Competition, Intellectual Property, Valuation, and Geography. Type of Business was not included as limited to technology-based companies. Since each investment opportunity is different, an attempt was made to evaluate how each VC usually looks at these categories with respect to each other and then specifically with investments made by each firm.

3. Results

Conjoint analysis derived utility scores for each attribute of 15 investment managers. Utility scores measure how important each characteristic is to the respondent's overall preference. Importance scores were computed by taking the utility score for each attribute from Table 2. The model proved the internal validity of the data. Descriptive statistics for importance scores of each criterion are given in Table 3.

Table 3. Descriptive statistics of importance as the results of conjoint analysis [N=15]

<i>Importance</i>	<i>Mean</i>	<i>SD</i>
Team	11,75	6,17
Entrepreneur	12, 74	7, 82
Contact	7,71	7, 75
Product uniqueness	9,11	4,32
Market acceptance	6,52	5,33
Protection	7,76	6,55
General purpose technology	5,13	3,81
Market geography	5,25	3,86
Market size	4,29	3,24
Market growth	8,84	5,67
Time to break-even	7, 92	3,79
Return on investment	13,75	8,82

Source: own research.

The results show that the potential return on investment, and personality characteristics, such as the ability of the entrepreneur, and the characteristics of a team were the most important selection criteria. The size and geographical breadth of the

market, and technology as a general purpose have little impact on the VC's decision. The hierarchical analysis resulted in three different groups that were distinct from each other in a statistically significant way. The non-hierarchical algorithm was used to allocate characteristics to group defined as:

People investors [PI] – investors emphasized the human resources,

Financial investors [FI] – investors concerned on the financial data,

Technology investors [TI] – investors that stressed the technology characteristics as patentability.

The next stage of the analysis was calculating F-statistic of the variance analysis and the descriptive statistics for each group of investors. The six decision criteria which were significantly different at the 0,05 level for FI, TI and PI groups are shown in Table 4.

Table 4. Results from group analysis (selection profiles by means)¹

<i>Selection criterion</i>	<i>Financial Investors [N=5]</i>	<i>Technology Investors [N=6]</i>	<i>People Investors [N=4]</i>	<i>F[P]</i>
Team	11,76	8,32	14,81	7,3*** (0,001)
Entrepreneur	8,55	7,67	19,78	34,28**** (less than 0,001)
Contact with VC	4,35	11,2	7,09	5,44*** (0,008)
Product uniqueness	7,70	9,49	8,12	0,66 (0,524)
Market acceptance	5,95	5,84	7,64	0,98 (0,389)
Protection	6,13	12,21	6,26	12,22**** (less than 0,001)
General-purpose technology	4,95	6,13	4,03	1,87 (0,315)
Market geography	4,01	7,81	4,32	7,93*** (0,001)
Market size	4,03	5,2	3,99	0,75 (0,447)
Market growth	9,77	9,82	6,21	1,67 (0,230)
Time to break-even	7,79	6,45	8,64	1,11 (0, 321)
Return on investment	25,01	9,86	9,11	59,41**** (less than 0,001)

¹ The table reports the means of importance scores for each criterion. Importance scores are ranged between 0 and 100, where: 0 indicates no importance of criterion, 100 means that only that one criterion is important. Importance scores for all selection criteria for one respondent add up to 100.

Levels of significance: *0,10, **0,05, ***0,01, ****0,001; N=15

Source: own research.

The importance connected to the human resource variables: the team, entrepreneur, contact with the VCs was significantly different among the three groups. Also, the geographical location was significantly different and the importance assigned to the technology purposes characterized certain investors. Finally, the importance attached to the financial part of the deal such as ROI was significantly different. Group FI (5 VCs) emphasizes on the potential return set out in the business plan. The ROI criterion receives an importance score of 25 out of 100. That business plan without sufficient potential return will not be selected. The research shows that investors find the team skills and the market forecast important. FI mainly invest in teams with strong leaders focused on fast-growing markets. Adding the importance scores attached to the team, competence of the lead entrepreneur, market growth and potential return on investment, we obtain an importance score of 55/100. This means that FI make decision using a rational logic based on a limited set of 3 factors such as ROI, growth and team completeness. This group adds the least importance to the contact with the entrepreneur, market size and market geography. FI want to have complementary teams with good leadership, but do not bother about cooperation with the entrepreneur. It seems that IF are confident that a good team will generate the financial return, without bigger interference or coaching by VCs. Another group (6 VCs) was named technology investors. They perform rather balanced analysis of a business proposals than the FI and also consider more selection criteria. The criteria received by TI are rather in equal weight in the final decision. Only the degree to which the technology can be protected and the contact of the investment manager with the entrepreneur receive an importance score of more than 10 out of 100. This group emphasizes the uniqueness of the product, potential market growth and return on investment. The degree to which the technology can be protected and personal contact with the entrepreneur are the key factors differing TI from other groups of VCs. The last group of 4 VCs was named people investors. PI as the most important factors of selection consider human factors: capacities of the entrepreneur and the team quality. Financial criteria do not play crucial role. The contact with the entrepreneur is less important than for the technology investors. PI put the less attention on protection of technology. They also prefer the selection behaviour coming from the previous findings that shows that the quality of the entrepreneur is the most important selection criterion [Petkova et al., 2014, pp. 422–448].

Conclusion

The selection of early-stage technology-based firms by VC investors were analyzed as the output of conjoint analysis. It was found that the practice across VCs investors is heterogeneous. The 15 funds are distributed across the three groups: financial investors, people investors and technology investors. This extends the previous research by identifying a new group of investors who labeled technology investors.

These investors are focused on the extent to which the technology can be protected and the contact they have with the prime founder of the start-up. The previous studies have not identified this group of investors, which seems to be closely related to the emergence of spin-off activity at universities to stimulate technology entrepreneurship and invest in the pre-seed stage taking the technology out of the lab and building a management team [Druilhe, Garnsey, 2004, pp. 269–285]. Personal contact is then a very important element in order to be successful. If the founder is not interested in including entrepreneurs in the new management team, it will not be possible for the early-stage technology-based VC fund to raise new capital from people or financial investors. Technology and innovative entrepreneurs can benefit from a better knowledge of the selection behaviour of VCs. It is particularly interesting for them to know that not all VCs use the same investment selection strategy, and that some VCs care more about team characteristics, others emphasize technology characteristics, stress financial criteria. The findings indicate that early-stage technology-based VCs do not only invest in perfect deals, meaning that the business proposal has a well-established founding team, clear market vision and has secured its first customers, a strong proprietary position and good financial prospects. Rather, some VCs will invest in business proposals that either have a strong proprietary position, a complete team or excellent financial prospects. Entrepreneurs who have a strong protectable technology may for instance call upon the group of technology investors even before the technology is protected or a complete team is built. This group of investors invests in the very early seed stage of the company and has also raised a considerable amount of public funding for investment and they are usually not big funds.

This approach overcomes some difficulties in gaining access to the decision-making process adopted by VCs. However, further research could consider using the conjoint technique and a qualitative approach in which additional insights into VC selection behaviour are obtained. Also, there is a small size of the population of early-stage VCs in Europe and it is difficult to examine the differences between the country environments. Further qualitative research may be a way to explore individual country differences. This study was unable to link selection behaviour with investment outcomes or portfolio company growth [Frigo et al., 2005, pp. 8–61]. This research did not compare actual decisions to the outcomes of this study. Further research might usefully explore these issues.

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**Evaluation of technology-based business proposals by venture capital investors
– example of healthcare sector**

Venture capitalists (VCs) are willing to fund technology-based firms, but they have difficulty in identifying attractive and beneficial proposals. To understand well how VC can help to diffuse technological knowledge to the market place, it was explored in this paper how venture capital companies evaluate technological business proposals. The relations of these business proposals were examined in the selection process adopted by venture capitalists. The results show that the potential return on investment, personality characteristics, such as the ability of the entrepreneur and the characteristics of a team were the most important selection criteria.

**Ocena propozycji biznesowych firm technologicznych
przez inwestorów *venture capital* – przykład sektora ochrony zdrowia**

Inwestorzy *venture capital* (VC) są skłonni do finansowania przedsiębiorstw opartych na technologiach, ale często mają trudności z identyfikacją atrakcyjnych i korzystnych propozycji. W celu lepszego zrozumienia, jak inwestycje VC ułatwiają rozpowszechnianie wiedzy technologicznej na rynku, w niniejszym artykule zbadano kryteria oceny technologicznych propozycji biznesowych przez spółki podwyższzonego ryzyka.

Analizowano relacje propozycji biznesowych w kontekście selekcji dokonywanej przez inwestorów wysokiego ryzyka. Wyniki pokazują, że najważniejszymi kryteriami wyboru były potencjalny zwrot z inwestycji, cechy osobowości przedsiębiorcy oraz charakterystyka zespołu.