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Factors Affecting Venture Funding of Healthcare AI Companies

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Abstract. Venture Capital (VC) funding raised by companies producing Artificial Intelligence (AI) or Machine Learning (ML) solutions is on the rise and a driver of technology development. In healthcare, VC funding is distributed unevenly and certain technologies have attracted significantly more funding than others have. We analyzed a database of 106 Healthcare AI companies collected from open online sources to understand factors affecting the VC funding of AI companies operating in different areas of healthcare. The results suggest that there is a significant connection between higher funding and having research organizations or pharmaceutical companies as the customer of the product or service. In addition, focusing on AI solutions that are applied to direct patient care delivery is associated with lower funding. We discuss the implications of our findings for public health technology funding institutions.

Keywords. Artificial Intelligence, Capital Funding, Technology

1. Introduction

As with other innovation systems, also AI technology environment in healthcare is highly driven by capital investment decisions [1]. Capital investment decisions affect the companies' research strategies, and VC investors might affect the target markets and development foci of the companies [1]. Also the decision on which companies are funded and which are ignored affects the developmental trends of the whole industry [2,3,4].

A recent descriptive analysis by Rock Health [5] stated that the venture capital (VC) funding of digital health companies applying AI/ML has grown in a similar way as the digital health VC funding overall. In the United States, 121 digital health companies leveraging AI/ML have raised a total of $2.7B with 206 deals from 2011 to 2017, which is slightly over 10% of all venture dollars invested in digital health during that period. The VC funding of AI Health companies has distributed unevenly and certain technologies have attracted significantly more funding than others. While companies with high R&D focus have been successful in gathering funding, companies with value propositions focusing on applying AI/ML to direct patient care delivery have been more modest in raising funding. It has been suggested that one of the reasons for the difference in funding amounts is that there are fewer risks in using AI to improve business functions instead of patient treatment [5].

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In this study, we aim to find initial evidence of the factors influencing VC funding of AI companies operating in different areas of healthcare. Based on the recognized preferences of VC investors in recent years, we chart out two hypotheses: **H1:** Companies the technology of which is used in direct patient care delivery receive less funding than other companies. **H2:** Companies the technology of which is mainly paid by research organizations and pharmaceutical companies or healthcare providers and insurers, receive more funding than mainly patient-paid technologies.

2. Data and Methods

There exists little standardized data on initial VC capital funding for AI/ML startups. Our database consists of funding information of 106 companies found from Crunchbase.com web portal. We selected those 1434 companies that had listed "Artificial Intelligence" as their technology category and raised more than 250 000 dollars funding. Out of these, 115 were healthcare companies. We left out multi-industry companies who had only narrow focus on healthcare. Remaining 106 companies were included in the analyses. In total, these companies had raised $1,4B in funding. The data were retrieved in June 2017 and June 2018. For companies that were in the datasets in both years, the 2017 data were used for better comparability between companies. We used data from 2017 for 39 companies and from 2018 for 67 companies.

The descriptive statistics are described in Table 1. Additional characteristics for each of the companies were gathered via online exploration on companies' web pages. We added information on whether the company's AI solution was used directly in patient care delivery, and whether it employed machine learning, machine vision or natural language processing technologies. We also added the population data of the companies' headquarter location.

Table 1. Descriptive statistics

Variable	Mean/Percentage	Std. Dev.
Log Total funding amount (MEUR)	1.40	1.61
Applying AI/ML to direct patient care delivery	66 %	0.48
Main Customer: Healthcare providers and insurers	70 %	0.46
Main Customer: Research organisations and pharmaceutical companies	21 %	0.41
Main Customer: Patient	9 %	0.29
Technology: Machine Learning	65 %	0.48
Technology: Machine Vision	22 %	0.41
Technology: Natural Language Processing	28 %	0.45
Continent: Europe & Israel	37 %	0.48
Continent: Northern America	56 %	0.50
Continent: Asia & Australia	8 %	0.27
Log Headquarters city population (Millions)	-0.33	2.05
Log Headquarters cluster population (Millions)	0.75	1.48
Log Headquarters country population (Millions)	4.77	1.43
Founding year (median)	2014	
Company Age	3.85	2.63

OLS multiple regression analysis was used to explore the associations between variables. As a **dependent variable**, we employed the amount of funding raised by the company, retrieved from Crunchbase.com database. We used two different sets of **independent variables:** For **H1**, we evaluated whether the company's technology was used in any phase of the treatment of the patient; coded as a dummy variable. For **H2**, we analyzed whether the main payer-customer of the AI solution was a) healthcare

provider or insurer, b) research organization or pharmaceutical company, or c) patient; coded as a categorical dummy variable.

As a **control variable**, we assessed some non-exclusive technology categories leveraged by companies [6]. We also controlled for the geographical location of the company headquarters, headquarter region's size, country size, and company age. Log transformations were performed on total funding amount and companies' HQ city and country populations due to the prominent right-skewed distribution of these variables. The log transformation remarkably reduced the skewness. Statistical analysis was performed using STATA 15.

3. Results

Initial descriptive analysis suggests support for both hypotheses. The companies applying AI/ML technologies to direct patient care delivery seem to raise less funding per company than those who were not (average funding $11.7M vs. $18.7M per company). Also, in accordance with Hypothesis 2, the companies whose main customer category is patients have raised less funding than companies having research organizations and pharmaceutical companies, or healthcare providers and insurers, as main customers ($1.9M vs. $15.2M and $15.4M, respectively).

Table 2. Regression of log of Total Funding Amount (MEUR) results.

Variable	Model 1	Model 2
Applying AI/ML to direct patient care delivery	-0.64*	
Main Customer: Patients (reference group)		-
Main Customer: Healthcare Providers and Insurers		0.6
Main Customer: Research Organizations and Pharmaceutical Companies		1.36**
Technology: Machine learning	0.38	0.26
Technology. Machine vision	0.7	0.44
Technology: NLP	0.36	0.31
Continent: Northern America (reference group)	-	-
Continent: Europe & Israel	0.48	0.51
Continent: Asia & Australia	1.53**	1.51**
Log Headquarters city population (Millions)	-0.15*	-0.15
Log Headquarters cluster population (Millions)	0.16	0.23*
Log Headquarters country population (Millions)	0.23*	0.2
Company Age	0.21***	0.2***
Constant	-0.74	-1.92
R-squared	0.189	0.214
N	106	106

***$p<0.01$; **$p<0.05$; *$p<0.1$.

The results from the OLS estimation are presented in Table 2. In Model 1, the independent variable of direct patient care delivery shows weakly significant but impactful decrease by the factor of -0.64 (p-value 0.078). This is indicative of companies with AI/ML applications used directly in patient care delivery receiving approximately 48% less funding than other companies. In Model 2, we compared the effect of having research institution or healthcare provider as the main customer to those companies having patients as the main customer. Model's factor for research organizations' and pharmaceutical companies' funding is 1.36 (p-value 0.02). The regression model explained the logarithm of total funding amount, meaning that the regression coefficients β_i can be interpreted as being associated with a change in the dependent variable of the factor of $e^{\beta i}$ indicating that the 1.36 factor of research organizations and pharmaceutical

companies is linked to a 290% increase in funding. The IVs and the control variables explain up to 21.4% of the variance in total funding amount raised. As a check for heteroscedasticity we inspected the distribution of residuals which was close to normal and not very skewed in the kernel density estimate, increasing model acceptability.

4. Discussion and Conclusions

The results give support to our Hypothesis 1 that employing AI solutions directly in patient care delivery is connected with a decrease in funding compared to other solutions. Funders are possibly more cautious for treatment technologies that require a high level of evidence of effectiveness [5]. Also H2 was supported, as the technologies mainly paid by research organizations and pharmaceutical companies received remarkably more funding than those paid by patients. In other words, AI technologies for which the main customer was patient raised significantly less funding than those targeted to research organizations. It could be that research institutions and pharmaceutical companies are more likely to purchase solutions involving high infrastructure investments.

The study has considerable limitations. Crunchbase.com is a US-based platform, and we detected some geographical bias within the dataset. Also due to the small number of companies in the data, longitudinal study design could not be employed. In the future, more robust panel settings should be used, including a wider set of control variables.

As VC investments are a key driver of innovation systems, it is possible that the uneven funding hinders the development of patient-focused health technologies. Furthermore, it should be considered whether public funding institutions ought to have patient-centered AI technologies as a specific target group. This is relevant for policymakers and public health officials defining the role of public technology funders in healthcare.

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