

# Commercial Adoption of AI in the Healthcare Sector: An Exploratory Analysis of S&P500 Companies

Tomasz MUCHA<sup>a,1</sup>, Olli HALMINEN<sup>a</sup>, Henni TENHUNEN<sup>a</sup> and Timo SEPPÄLÄ<sup>a,b</sup>

<sup>a</sup>*Department of Industrial Engineering and Management, Aalto University, Espoo, Finland*

<sup>b</sup>*Research Institute of the Finnish Economy, ETLA, Helsinki, Finland*

**Abstract.** The use of Artificial Intelligence (AI) technologies within the healthcare sector is growing. However, there are differences in the speed of commercial adoption of AI across sub-sectors. We employ a dataset including news mentions and executive communications of all S&P500 Health Care Index companies to explore these differences. Pharmaceutical and medicine manufacturing companies had the earliest AI-linked news presence, yet they appeared to be among the slowest commercial implementers of AI. Ambulatory health care services and hospitals, as well as insurance carriers, received media coverage later, but were the quickest to take AI into commercial use. From the theory perspective our results indicate that the classical innovation diffusion theory might not fully explain these differences.

**Keywords.** Artificial Intelligence, Technology Transfer, Health Technology

## 1. Introduction

Artificial intelligence (AI) technologies are expected to significantly impact or even transform healthcare provision. Value of goods and services produced by 12 developed economies in the healthcare sector alone is estimated to exceed baseline growth by USD 400 billion in 2035 thanks to the use of AI [1]. However, such value creation and capture can take place only when the technology is translated into action [2]. To understand this transition, information technology (IT) diffusion and assimilation has been one of the central areas of investigation in healthcare informatics [3], information systems [4], and innovation literature [5]. Due to the increasing applications of AI in healthcare, there is a need for studies exploring the status of commercial adoption of AI within that sector.

This paper reports results from an exploratory analysis focusing on the adoption and commercial use of AI technologies by large healthcare companies. We investigate AI and machine learning (ML) related keyword appearances in two contexts for the sample of 62 healthcare sector companies, which were constituents of S&P500 index as of May 2019. The first context is news and media items that relate to the sample companies and include AI or ML keywords. The second context is earnings calls and other investor presentations of the sample companies, where top executives make statements regarding commercial applications of AI and ML technologies.

---

<sup>1</sup> Corresponding Author: Tomasz Mucha, Aalto University, Finland; E-mail: tomasz.mucha@aalto.fi

## 2. Data and Methods

Sample of companies selected for this study consisted of S&P500 Health Care Index constituents included in the index as of May 2019. These companies represent some of the largest healthcare companies in the world and are thoroughly covered by news and media, as well as financial analysts. Consequently, there is a large body of publicly available information regarding these companies, which makes a research design leveraging content analysis a feasible approach. The sample companies were divided into six sub-sectors based on their NAICS codes (manufacturing companies were further divided into two subgroups). Following [6], we do not intend to provide explicit definition of AI, but rather rely on implicit definitions embedded in the examples covered in the analyzed content. Nevertheless, our work was guided by an inclusive definition as follows, “Artificial Intelligence . . . is intended to make computers do things, that when done by people, are described as having indicated intelligence” [7].

For each company, we collected data from two sources. News and media items were collected from ProQuest ABI/INFORM Collection using the following search query: (*"artificial intelligence" OR "machine learning"*) AND *stype.exact("Magazines" OR "Trade Journals" OR "Newspapers" OR "Reports" OR "Blogs, Podcasts, & Websites" OR "Wire Feeds")* AND *la.exact("English")*. Transcripts of management presentations were retrieved from Thomson Reuters Eikon database. The types of items searched included not only transcripts of quarterly earnings calls, but also other conferences, media events, financial analyst days and investor events. The case insensitive search query used for that database was: *"artificial intelligence" OR "machine learning"*. The time period covered in this exploratory analysis was 1 January 2004 – 10 May 2019.

Preliminary qualitative analysis focused on the transcripts of management presentations. For each company, the transcripts were analyzed by two researchers to determine whether a commercial application of AI technologies has been mentioned. The definition of commercial application was either (1) reference to a current commercial use of AI or ML technologies (as part of customer offering or internal processes, which are “business as usual”), or (2) commercial launch or implementation utilizing AI or ML technologies in the near future (specific details provided).

The subsequent exploratory analysis had two objectives: (1) to establish the current status of AI use by healthcare sector companies and (2) to inspect the pattern of diffusion of the technology over time with the intention of identifying aspects requiring scrutiny.

## 3. Results

Nearly all companies (91.9%) included in the sample have been mentioned in news and media in the context of AI, and 43.5% of companies have mentioned commercial use of AI technologies during their investor presentations given by top executives (Table 1).

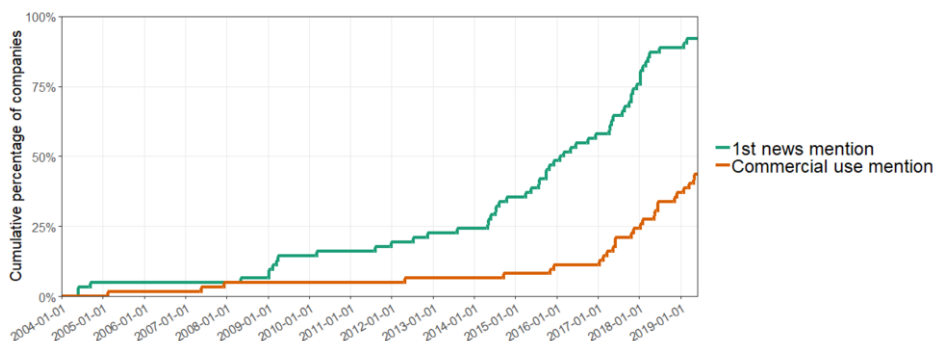
It appears that news and media coverage in relation to AI and healthcare companies increased sharply starting from 2015. Major increase in number of companies mentioning commercial use of AI during their investor presentations started in 2017. Figure 1 provides more detail on the cumulative percentage of companies covered in news and media items related to AI, as well as those mentioning commercial use of AI.

First mentions of AI in news and media items covering healthcare companies, in many cases, have been far ahead of the recent wave of AI technology implementation by the companies. This is particularly the case for manufacturing companies (sub-sectors 1

and 2). Figure 2 illustrates the publication timings of news and media items. 98% of the items were published during the last four years.

**Table 1.** Summary statistics for news and media items mentioning sample companies and AI technologies, and top executive investor presentations mentioning AI technologies.

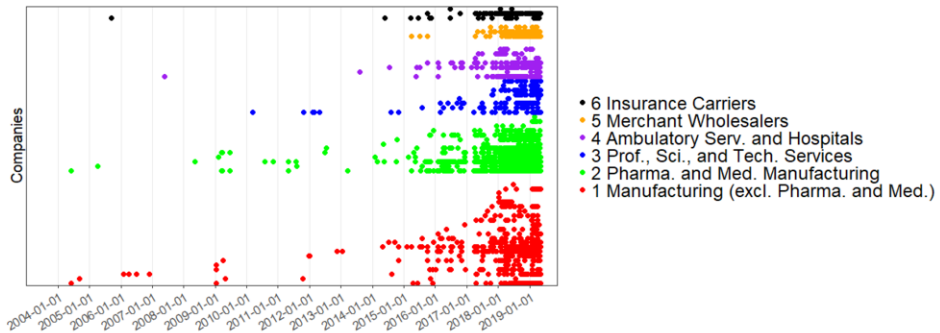
Sub-sector	News and media items			Top executive presentations		
	Count	Mean count per company	Mean date of 1st mention of AI/ML	Count	Mean date of 1st commercial use mention	Share (ratio) of companies with commercial use
<b>1. Manufacturing (excl. Pharmaceutical and Medicine)</b>	721	28.8	2014-11-11	81	2018-08-17	48.0% (12/25)
<b>2. Pharmaceutical and Medicine</b>	1 661	127.8	2013-04-02	14	2019-11-12	15.4% (2/13)
<b>3. Professional, Scientific, and Technical Services</b>	254	31.8	2016-05-04	28	2018-11-27	37.5% (3/8)
<b>4. Ambulatory Health Care Services and Hospitals</b>	327	36.3	2016-12-19	18	2017-10-21	66.7% (6/9)
<b>5. Merchant Wholesalers</b>	148	37.0	2017-09-02	4	2019-11-17	25.0% (1/4)
<b>6. Insurance Carriers</b>	214	71.3	2015-07-16	23	2013-07-09	100.0% (3/3)
<b>Total</b>	<b>3 325</b>	<b>53.6</b>	<b>2015-03-27</b>	<b>168</b>	<b>2018-08-21</b>	<b>43.5% (27/62)</b>



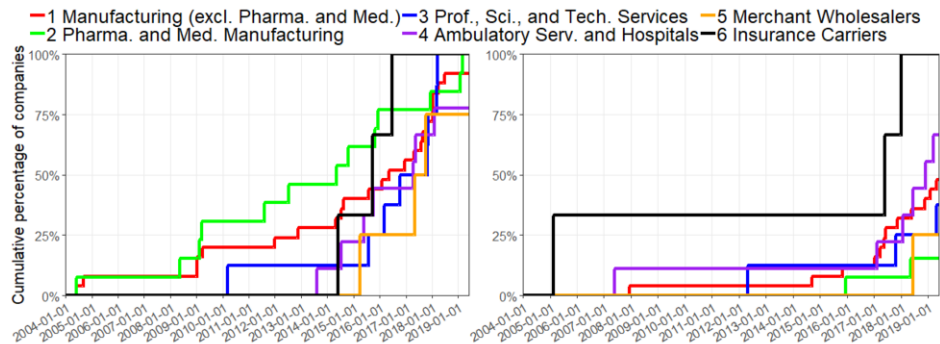
**Figure 1.** Comparison of cumulative percentage of companies mentioned in AI related news and media items with cumulative percentage of companies mentioning commercial use of AI in executive presentations.

A sub-sector level comparison of cumulative percentage of companies mentioned in news and media in relation to AI, and those whose top executives mention commercial use of AI reveals stark differences. Manufacturing (1 and 2) and Professional, scientific and technical services (3) companies started appearing in news and media items in a relatively even manner over time. The remaining sub-sectors started receiving news and media coverage much later, yet they caught up or even exceeded early-comers. See Figure 3 (left). This pattern is nearly reversed when mentions of commercial uses of AI are considered. See Figure 3 (right). Insurance carriers (6) and Ambulatory health care services and hospitals (4), which received news and media attention later, were not only the first ones to mention commercial uses of AI, but these sub-sectors present also the highest rate of disclosure regarding commercial use of AI. Contrary to the news and

media coverage, Pharmaceutical and medicine manufacturing (2) companies appear to have the lowest rate of commercial utilization of AI.



**Figure 2.** Timing of AI related news and media mentions of healthcare companies. Each row in the chart represents a single company.



**Figure 3.** Left: Cumulative percentage of companies mentioned in AI related news by sub-sector. Right: Cumulative percentage of companies with commercial AI mentions in executive presentations by sub-sector.

#### 4. Discussion and Conclusions

Companies from pharmaceutical and medicine manufacturing subsector had the longest and most prominent news and media presence, yet they were among the slowest commercial implementers of AI. Ambulatory health care services and hospitals, as well as insurance carriers received news and media coverage much later, although more rapidly, and were the quickest to take AI technologies into commercial use. Larger media coverage might be a result of pharmaceutical companies having typically a long product developmental timescale, resulting in relatively larger overall fixed costs and possibly also driving larger marketing budgets, thus leading to increased press coverage. AI solutions developed for pharmaceutical companies are also found to attract more venture capital funding than other healthcare-related AI solutions [8].

Classical diffusion of innovations theory (DOI) [5] predicts that new technologies, such as AI, do not spread evenly across the whole population. Instead, a typical cumulative adoption curve takes an “S-shape”— the sample companies taken as a single group appears to follow such pattern (Figure 1). However, sub-sector level analysis and

comparison of news and media coverage (approximating diffusion of information and awareness) with mentions of commercial uses of AI by top executives (approximating diffusion of commercial adoption) indicate that DOI might not fully explain the sub-sector level differences. Disparity between these two diffusion patterns indicates that factors beyond those recognized by DOI might be at play, which is a phenomenon requiring further investigation. From media perspective, the solutions for e.g. insurance carriers might be seen as having less public impact potential than pharmaceutical products [9]. Furthermore, organizational characteristics such as IT intensity and absorptive capacity or use case of AI, such as those illustrated by quotes in Table 2, might explain AI adoption rates [4]. In our future research we intend to further investigate factors driving AI adoption by healthcare companies.

**Table 2.** Quotes illustrating organizational characteristics and use cases, which might impact AI adoption.

Sub-sector	Quote
<b>1. Manufacturing (excl. Pharmaceutical and Medicine)</b>	“Tempus combines Illumina’s sequencing with machine learning to provide physicians a comprehensive report that highlights key findings to support clinical decision-making.”
<b>2. Pharmaceutical and Medicine Manufacturing</b>	“[...] many different kinds of data sciences we had to bring together. So add to this list graph theory, non-linear machine learning, lot of combinatorial methods, and I’m even going to show you how we’ve used elements of cryptography in some of the analysis...”
<b>3. Professional, Scientific, and Technical Services</b>	“[W]e will leverage [...] machine learning, human genetics and functional genomics to create disease models for NASH and discover relevant drug targets...”
<b>4. Ambulatory Health Care Services and Hospitals</b>	“We use real-time machine learning. We know the demand patterns that are coming into our patient service centers, so we can make real-time staffing decisions and we can take some of the staffing decisions out of the hands of the supervisors and tell them exactly what they’re going to need at that facility next Tuesday at 9:00 in the morning.”
<b>5. Merchant Wholesalers</b>	“[W]e’re basically using machine learning, artificial intelligence to do online claims adjudication, which will make us so much more efficient and so much more scalable...”
<b>6. Insurance Carriers</b>	“[W]e process about 2 billion claims a year, about \$0.5 trillion in medical spend and we transmit about \$130 billion in funds electronically every year and we do so to about 1 million care providers across the country. [...] all of that represents data and [...] increasingly, we’re applying machine learning...”

## References

- [1] E. Plastino, M. Purdy, Game changing value from artificial intelligence: Eight strategies, *Strategy Leadersh.* 46 (2018), 16–22.
- [2] Microsoft CEO: AI can change the trajectory of healthcare if properly used, *Digit. Health.* (2018). <https://www.digitalhealth.net/2018/11/microsoft-ceo-ai-healthcare/> (accessed January 4, 2020).
- [3] R.J. Holden, B.T. Karsh, The technology acceptance model: its past and its future in health care, *J. Biomed. Inform.* 43 (2010), 159–172.
- [4] R.G. Fichman, The diffusion and assimilation of information technology innovations, *Fram. Domains IT Manag. Proj. Future Past.* 105127 (2000), 105–128.
- [5] E.M. Rogers, *Diffusion of innovations*, Simon and Schuster, 2010.
- [6] J.K.-U. Brock, F. Von Wangenheim, Demystifying AI: What Digital Transformation Leaders Can Teach You about Realistic Artificial Intelligence, *Calif. Manage. Rev.* 61 (2019), 110–134.
- [7] R.A. Brooks, *Intelligence without reason*, Massachusetts Institute of Technology, 1991.
- [8] O. Halminen, H. Tenhunen, A. Heliste, T. Seppälä, Factors Affecting Venture Funding of Healthcare AI Companies, *Stud. Health Technol. Inform.* 262 (2019), 268–271.
- [9] K. Viswanath, K.D. Blake, H.I. Meissner, N.G. Saiontz, C. Mull, C.S. Freeman, B. Hesse, R.T. Croyle, Occupational practices and the making of health news: A national survey of US health and medical science journalists, *J. Health Commun.* 13 (2008), 759–777.