Title: Emerging AI Entrepreneurship Ecosystems in Europe: Are they geographically unbounded?

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Extended Abstract

1. Introduction

Artificial intelligence (AI) is widely recognized as a general-purpose technology with the potential to transform businesses, economies, and societies. Despite its growing significance, empirical evidence on the actual adoption of AI by firms remains limited (see, e.g., McElheran et al., 2024), which can be attributed to the fact that AI represents a new digital technology, which is difficult to define and to measure (Hannigan et al., 2022). Evidence on the regional distribution of AI adoption is even more scarce, which is further complicated by the challenge of finding a comparable measure of AI adoption across different regions. AI is still in a relatively early stage of its geographic diffusion, and AI's future path will likely depend on its early geographic dispersion (McElheran et al., 2024). Thus, this paper's primary objective is to shed light on the early geographic distribution of AI startups and established AI-adopting firms in the EU that will likely affect its future diffusion.

This study aims to provide novel empirical evidence on the regional distribution of AI adoption by firms in European regions and to identify the "hotspots" of AI-driven companies. To this end, a novel source of web-scraped data of economically active companies in the EU (the webAI database) is used to identify AI-driven firms (Kinne & Axenbeck, 2020). A key advantage of this data source is that it makes it possible to identify firms for which AI plays a central role in their organizational identity (Dahlke et al., 2024), thus offering a narrow and focused definition of firm-level AI adoption. Moreover, the measure of AI-driven firms is comparable across regions, making this dataset well-suited for the objectives of this paper. Given that AI represents a relatively new digital technology that creates new opportunities for digital entrepreneurship (Chalmers et al., 2021; Giuggioli and Pellegrini, 2023), it is the goal of the paper to also map the regional distribution of AI startups, using the same definition of AI adoption and focusing on firms that are five years old or younger.

Moreover, this paper investigates the role of regional characteristics in explaining the regional variation in the level of AI-driven firms and AI startups. Literature on digital affordances suggests that the dependence of business ventures on regional clusters as sources of business opportunities has decreased, since these opportunities can now be accessed far beyond regional clusters (Autio et al., 2018). Likewise, a growing body of research on digital entrepreneurship ecosystems suggests that digital transformation, fueled by AI, has altered the traditional view on entrepreneurship ecosystems, in which entrepreneurs were dependent on local, geographically bounded resources (Audretsch et al., 2024). In contrast, digital entrepreneurship ecosystems are

geographically unbounded and they are characterized by new elements, such as digital infrastructure or digital users. In addition, digital entrepreneurship ecosystems may rely less on such local factors as cultural amenities or professional services (Sussan and Acs, 2017; Fossen, McLemore, & Sorgner, 2024). Thus, this paper contributes to these literatures by empirically investigating the role of a rich set of regional characteristics (at a NUTS2 level), including regional demographics, regional economic performance, regional digital economy, regional digital and physical infrastructure, to provide evidence on a potentially different role of geography for AI-driven businesses.

2. Data and Methods

Data

The study utilizes web-scraped data from the webAI database, which includes information on economically active AI companies in the EU (Kinne & Axenbeck, 2020). The webAI database is constructed using a firm database that includes basic firm characteristics and website addresses (URLs) that are used to webscrape firm-relevant data. The web-scraped data is then used to construct various innovation indicators, such as AI intensity scores, which are merged back into the firm database.

To identify AI adopters, a keyword search using a carefully selected list of keywords related to different forms and applications of AI was conducted. The final selection of AI keywords was based on the OECD definitions of AI, the expertise of independent subject matter experts, and the frequency of keywords in a sample of websites of validated AI adopters. Paragraphs on the websites where AI keywords were mentioned were analyzed to determine how the company reports on AI. Companies' AI know-how was mapped to a firm-level AI Intensity Score, with the sample of AI adopters restricted to those companies with a high or very high AI intensity score.

In addition, regional data from Eurostat's regional statistics available at the NUTS2 level are employed. The study constructs a wide set of variables using data from 2019-2023 to capture factors that may affect the general level of economic dynamism in a region. These include measures of regional demographic characteristics, regional economic performance, regional stock of knowledge, regional digital economy, and digital and physical infrastructure.

Empirical Strategy

The dependent variable is represented as counts of AI adopters in each NUTS2 region. A negative binomial regression with robust standard errors is estimated, as it is a frequently used tool for modeling count dependent variables, particularly over-dispersed ones. Additionally, OLS regressions with robust standard errors are estimated when the dependent variable is the AI adoption rate or the share of AI startups in all AI adopters.

3. Preliminary results

Empirical analysis reveals that AI adopters are not evenly distributed across European regions. NUTS2 regions with the highest absolute number of AI adopters include Ile de France (Paris metropolitan area), Lombardy (Milan), and Upper Bavaria (Munich). In contrast, several Greek and Portuguese NUTS2 regions, mainly islands, and Eastern European regions, such as Bulgaria and Romania, are among the lowest ranked in terms of the number of AI adopters. AI adopters are more likely to be based in densely populated regions, which tend to be big cities.

A different picture emerges when looking at the share of AI startups in all AI-adopting firms. New AI clusters are emerging in Eastern European regions of Poland and Baltic countries, as well as in Southern European regions of Portugal, Spain, and Italy. Relatively high shares of AI startups are also observed in Northern regions of Sweden. This pattern, along with the still relatively low absolute number of AI adopters, hints toward emerging AI entrepreneurship ecosystems in these regions.

The number of AI adopters is significantly and positively correlated with population density, regional economic performance (GDP per capita and TFP level), regional stock of knowledge, digital economy, and digital infrastructure. There is also a strong positive correlation between physical infrastructure and the number of AI adopters. In contrast, the share of AI startups in all AI adopters has fewer significant correlations with regional characteristics, with a positive correlation only with the share of researchers in total employment and measures of digital economy and digital infrastructure.

Negative binomial regressions reveal several key findings. The median population age is significantly and negatively related to the number of AI adopters, indicating that aging regions have a lower probability of AI adopters. Regional GDP per capita and relative TFP levels are positively related to AI adopters. A greater regional stock of knowledge, measured by the share of employment in high-tech sectors, increases the number of AI adopters. Local demand for digital products and services, as measured by the share of digital shoppers, is positively related to AI adopters. Regions with weaker digital infrastructure tend to have fewer AI adopters.

Separate models for AI startups and established AI adopters reveal differences. Population density is negatively related to the number of AI startups but not to established AI adopters. Established companies seem to adopt AI to increase productivity, while this effect is not observed for AI startups. Digital infrastructure is more important for established AI adopters than for AI startups.

4. Discussion and Conclusions

The diffusion of AI firms in the geographic space has recently taken off, and the current regional distribution of AI-adopting firms is likely to determine its future development path. This paper provides novel empirical evidence and insights into the geography of AI adoption by firms in

Europe. AI adoption is still a niche phenomenon, with only 0.26 percent of firms in Europe possessing substantial AI know-how and communicating about it on their websites. AI adopters are more likely to be concentrated in densely populated urban regions, exacerbating regional digital divides.

AI adopters are more likely to be in regions with younger populations, significant stocks of knowledge, and the presence of digital users. Regions with greater counts of AI adopters also tend to be more productive. The share of AI startups in all AI adopters is higher in regions with lower relative TFP levels, suggesting that AI startups may be a different type of company compared to established AI adopters.

AI startups account for about half of all AI adopters in Europe. Studying emerging AI entrepreneurship ecosystems is crucial, as they may determine future regional patterns of AI knowledge diffusion and have significant effects on regional economic and societal outcomes. Many regional characteristics that are usually considered important determinants of entrepreneurship turned out not to be relevant for AI entrepreneurship in this study. Future research should therefore investigate the emergence and locational decisions of AI startups in more detail.

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