LUISS

Master's Degree in Policies and Governance in Europe
Major in Economic Governance and Market Regulation

Course of Industrial Policy in Europe

AI Empowerment for Small and Medium-Sized Enterprises: The Case of EU Digital Innovation Hubs

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Academic Year 2023/2024

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INTRODUCTION

The present research explores the intricate relationship between Artificial Intelligence (AI) and Small and Medium-Sized Enterprises (SMEs) within the European landscape.

In light of the pervasive influence of AI and the burgeoning relevance of SMEs in Europe's economic landscape, this thesis investigates the underlying factors driving the convergence of these two entities. The aim is to answer the research question: "Why did the EU adopt EU Digital Innovation Hubs (EDIH) to facilitate AI Adoption in Small and Medium-Sized Enterprises, and are they fit for purpose?"

Based on the principle of subsidiarity, the Member States and the European Commission have shared responsibility for supporting SMEs. According to Article 173 of the TFEU, this EU policy aims to "ensure that the conditions necessary for the competitiveness of the Union's industry exist". As a result, initiatives to improve the business and boost productivity have been introduced. While the Commission supports SMEs through regulations, funding, awareness campaigns and exchange of best practices, Member States are involved in implementing SME policies (European Court of Auditors, 2022).

Firstly, the dynamics of SMEs within the European framework will be scrutinised, comparing the EU's position to that of other countries. The case of Italy will be analysed to lay the foundations and knowledge that will be useful for the questionnaire submitted to the Italian referents of the instrument, as part of the last chapter.

Secondly, the present work examines the transformative potential of AI in enhancing business operations, reviews the literature on AI adoption by SMEs, and identifies the main challenges for SMEs to adopt AI technologies. Central to this investigation is a more analytical question concerning the rationale behind the EU's adoption of specific policies. Indeed, this research aims not to provide a descriptive analysis of all measures but to focus on a single measure, analysing the European approach, the reasons behind it, and its robustness, as well as identifying bottlenecks. If the goal is to narrow the scope to the EU's strategy for facilitating convergence between SMEs and AI, and the robustness of the EDIH measure, it is unnecessary to retrace the history of European measures introduced in this area until now.

While the literature on AI is extensive, research on its implementation in SMEs primarily focuses on challenges and benefits. These may be the reasons why the EU decided to facilitate the interaction between SMEs and AI, shaping its strategy. Yet, there is a gap in the

literature regarding the specific reasons behind the EU's chosen approach over another. This thesis aims to fill this gap.

The final chapter will delve into the EDIH initiative undertaken by European institutions to facilitate the integration of AI into SMEs' operations. Although this tool is not solely focused on AI, the latter remains a significant area of interest within the broader digital transition strategy introduced by the European Commission. Building on the theories presented in the previous chapter, the reasons behind the EU's decision to introduce this tool to facilitate convergence between SMEs and AI will be explored. Then the survey conducted among the Italian EDIH representatives will help to assess the effectiveness of this strategy and identify bottlenecks that require further work.

In essence, this thesis endeavours to unravel the complexities surrounding the convergence of AI and SMEs within the European context, shedding light on the underlying drivers, challenges, and policy interventions shaping this symbiotic relationship.

1 SMEs IN THE EUROPEAN CONTEXT

To comprehend the intricate interplay between AI and SMEs, it is imperative to contextualise within the broader European framework. This section will provide an overview of the European SMEs landscape, by defining the concept and highlighting their contributions to the economy and their level of innovation and competitiveness.

1.1 Overview of the European SMEs Landscape

1.1.1 Definition of SMEs

As regards the origins of the definition of SMEs, the term was initially understood, particularly in Germany, as synonymous with the term "Mittelstand", which refers to enterprises with less than 500 employees and large family-run enterprises. Afterwards, the EU definition took place. As a result, German Mittelstand companies with 250 to 499 employees are excluded from the EU's SME category, even though they maintain the typical SME-like structure of unified ownership and management, usually with strong regional links. Therefore, now the Bonn Institute of Mittelstand Research distinguishes between larger family businesses and quantitatively defined SMEs. The unity of ownership and management affects the strategic decision-making processes which are handled within a family rather than within the managers employed. However, this aspect is not taken into account in the EU definition of SMEs, nor in the resulting economic policy (Röhl, 2017).

The creation of the single market has made it necessary to introduce a common definition and measures for SMEs in order to avoid anti-competitive behaviour. Although for Member States the use of the definition is voluntary, the Commission encourages its broad application (European Commission, 2005).

The current definition of Small and Medium-Sized Enterprises at the European level is provided in the Recommendation 2003/361/EC. This document replaced the Recommendation 96/280/ EC as from 1 January 2005, to harmonise European legislation and adapt it to the contemporary developments in the field.

> "An enterprise is considered to be any entity engaged in an economic activity, irrespective of its legal form. This includes, in particular, self-employed persons and family businesses engaged in craft or other activities, and partnerships or associations regularly engaged in an economic activity" (European Commission, 2003, art. 1).

To provide greater specificity to the definition, one basis to consider, as indicated by the Commission, is the 'staff headcount criterion'. However, it is also necessary to account for financial aspects. These include not only turnover but also aim to capture the true size, performance, and competitive position of a business compared to others. From a financial perspective, turnover alone is insufficient. Therefore, it should be supplemented by the total balance sheet, which indicates the total wealth of a business.

SMEs are businesses characterised by having fewer than 250 employees, along with either an annual turnover below EUR 50 million or a balance sheet total not over EUR 43 million. Enterprises could also be micro and small. On the one hand, micro-enterprises are defined as those employing fewer than 10 employees and having an annual turnover or balance sheet total not over EUR 2 million. On the other hand, small enterprises are characterised by having fewer than 50 employees and an annual turnover or balance sheet total not over EUR 10 million (European Commission, 2003).

Considering staff numbers and financial weight, it is possible to identify three different types of enterprises: 'autonomous', 'partner enterprises', and 'linked enterprises'. The differentiation is based on the relationship between the enterprises. The first ones may be entirely independent or with less than 25% of partnerships with other enterprises. Secondly, they can be called 'partner enterprises' if the number of partnerships is 25% or more, with a maximum of 50%. Lastly, enterprises are considered linked if one holds the majority of voting rights, can "appoint or remove a majority of the members of the administrative, management or supervisory body of another enterprise" (art. 3.3), has a contract allowing dominant influence, or can control the majority of voting rights through an agreement. If multiple individuals jointly own enterprises that operate in the same or adjacent markets, these enterprises are also considered linked (Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, European Commission, 2015).

1.1.2 Contribution of SMEs to the European Economy

Having established a comprehensive understanding of the definition of SMEs within the EU framework, the present paragraph will explore the contributions these entities make to the European economy.

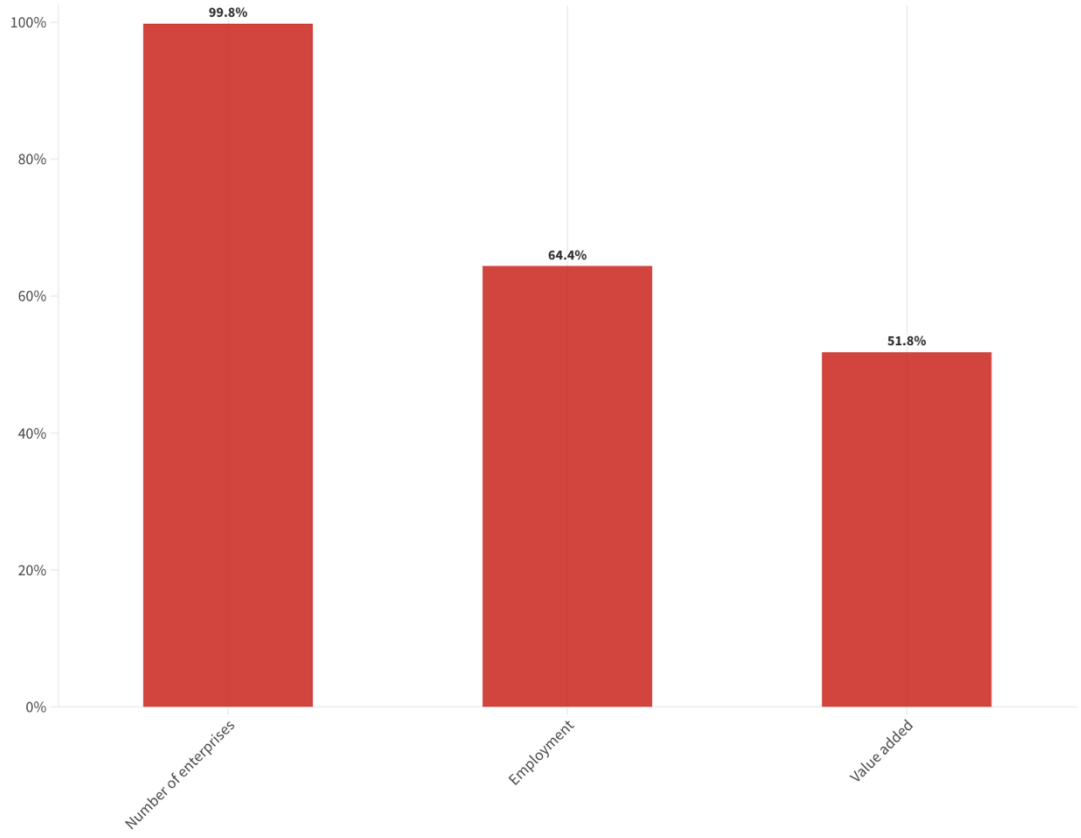
In the EU, enterprise policy is heavily influenced by SMEs. In the European Commission's vision, they are seen as essential tools for promoting economic growth, innovation, generating jobs, and enhancing social integration within the EU (Matt & Rauch, 2020).

SMEs comprise more than 99% of the EU business landscape (Graph 1) being recognised as the cornerstone of the EU-27 economy. Indeed, in 2022 almost 24.3 million SMEs were operating in the EU Member States. The number of employees reached 84.9 million people. Moreover, SMEs accounted for two-thirds of non-financial business sector (NFBS) employment and over half of NFBS value added.

It is worth noticing that most of these were micro-SMEs. The latter contributed 36% to the SMEs value added and 46% of SMEs employment within the NFBS in 2022. Regarding employment, micro-enterprises presented a higher share compared to small SMEs (30%), followed by medium-sized SMEs (24%). As regards the value added, there are no relevant differences among the three size classes, with a share of around 30% (Di Bella et al., 2023).

Graph 1. Share of EU SMEs in the number of enterprises, employment and value added of NFBS, 2022 (%)

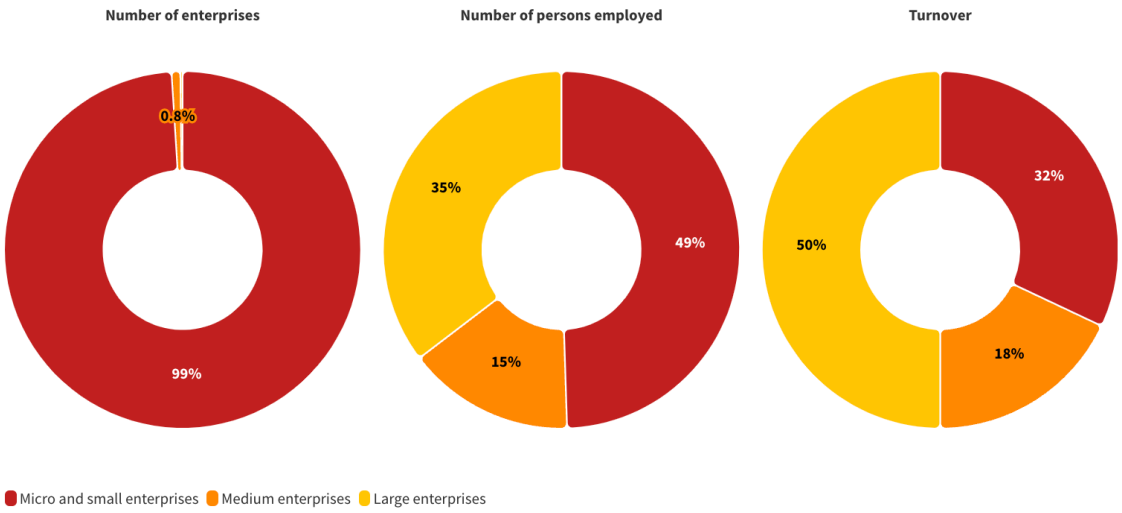
Author's own elaboration. Source: Di Bella et al., 2023



Another interesting aspect is the comparison between SMEs and larger enterprises (Graph 2). Indeed, there is a huge difference in annual turnover. The latter constitute 0.2% of the total number of enterprises, employ over a third of the labour force, and generate 50% of the net turnover, arriving at €19.2 trillion.

Graph 2. Distribution of business economy by size class, 2022 (%)

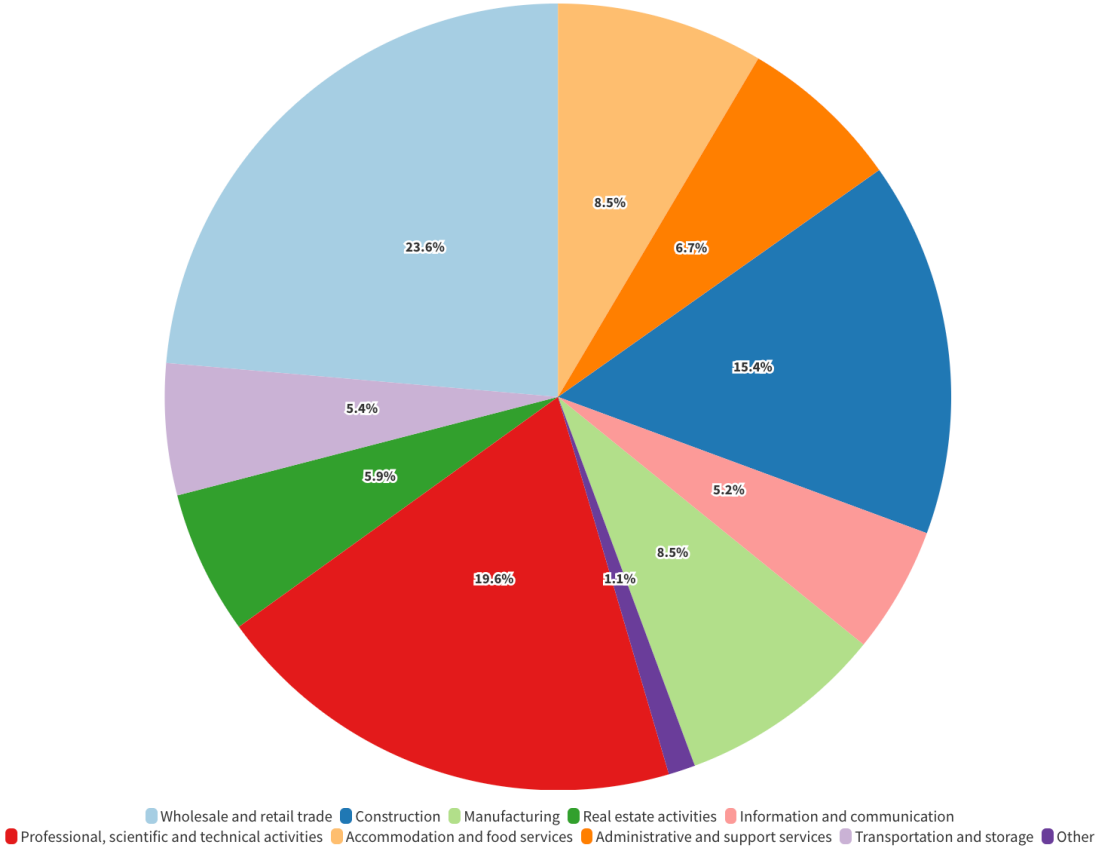
Author's own elaboration. Source: Eurostat, 2023



Looking at the distribution of EU SMEs among NFBS industries, a concentration in few specific sectors emerges. More specifically, SMEs made up 24% of all Member States in wholesale and retail trade, followed by professional, scientific and technical activities, and construction (Graph 3).

Graph 3. Distribution of EU SMEs by NFBS industry, 2022 (%)

Author's own elaboration. Source: Di Bella et al., 2023

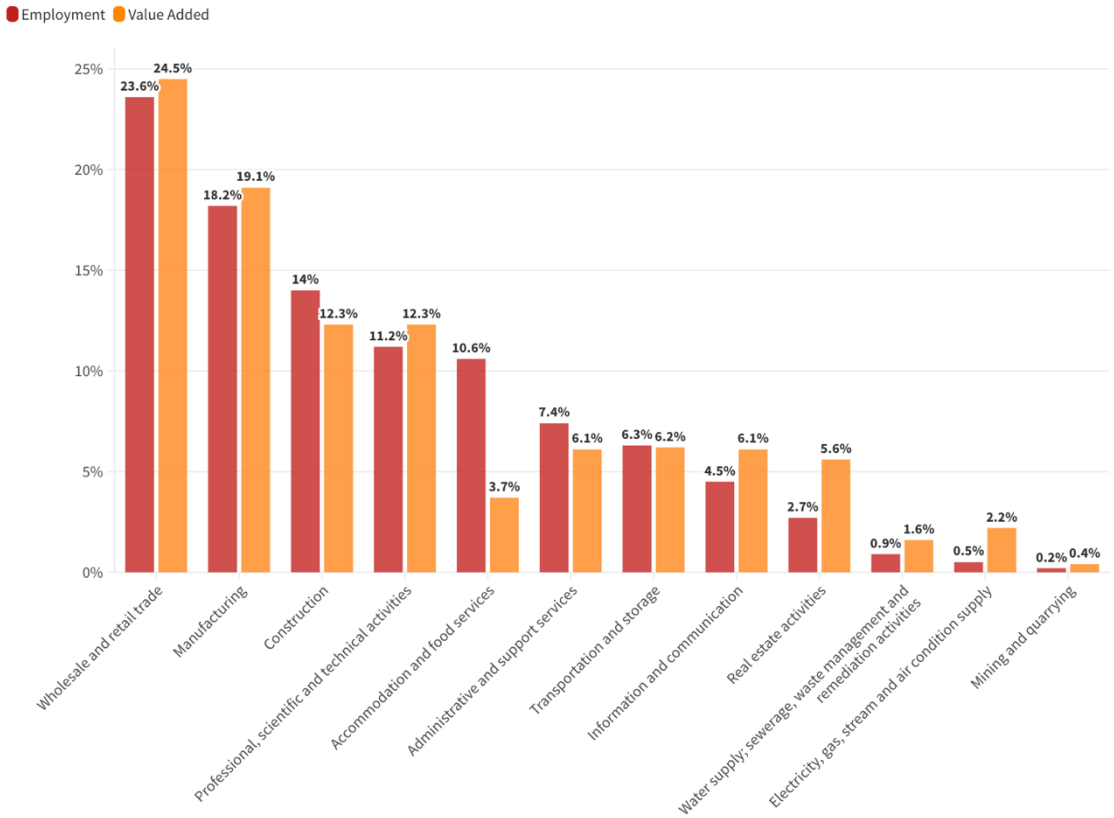


Furthermore, in 2022 the distributions of the number of SMEs' employment and value added were quite similar (Graph 4). However, two industries stood out: manufacturing and professional, scientific and technical activities. The first one, despite comprising only 8.5% of all SMEs, contributed significantly to employment and value-added, with shares of 18% and 19%, respectively. This trend has been consistent over the years but is slowly decreasing.

In contrast, the second industry has seen steady growth. Moreover, although 20% of SMEs were operating in this sector, they contributed by just 11% to employment and 12% to value added.

Graph 4. Distribution of EU SMEs employment and value added by industry, 2022 (%)

Author's own elaboration. Source: Di Bella et al., 2023



As regards SMEs growth, a study from Sage (2023) shows a +4.2% year-on-year increase in real terms profitability in the first quarter of 2023 and a modest +0.2% economic growth. Nevertheless, many businesses are facing significant challenges related to an unpredictable and volatile economy. The main barriers to growth include reduced consumer spending, cash flow management, and rising wage costs. This underscores the necessity of measures that help SMEs to develop. To this end, technological innovation is an essential tool, in line with the European vision of a green and competitive future. However, the European Commission itself recognises that EU SMEs are lagging behind with regard to business targets, particularly related to AI. Indeed, it will be difficult to meet European targets by 2030 without increased investments and additional incentives. According to the abovementioned research, if these SMEs increase their adoption rates, the EU could gain €628 billion in economic growth annually.

The mentioned strategy is the so-called Digital Decade. Among the main targets:

- *Business transformation*: the goal is to have 75% of businesses adopting advanced technologies, including AI. Additionally, over 90% of SMEs are expected to reach at least a basic level of digital intensity;
- *Skills*: the objective is to have a minimum of 80% of the population with basic digital skills and to hire 20 million ICT specialists;
- *Government*: the goal is to guarantee online availability of indispensable public services and to build direct contact between privates (businesses, citizens) and public authorities through digital services;
- *Infrastructure*: achieve gigabit connectivity for all citizens and increase the EU's global semiconductor market share twofold.

Recently, the Covid-19 pandemic has disrupted the situation. Among the problems SMEs face are the recruitment of new staff and the rapid increase in prices. In 2022, new obstacles emerged, linked to rising inflation rates, along with energy and raw material costs, and the end of the pandemic's financial support measures. Moreover, the Ukrainian war still affects these enterprises today, through import restrictions and disruption of supply chains (Di Bella et al., 2023). However, looking at the period after the financial and economic crisis, SMEs have significantly contributed to the recovery. A crucial aspect was export. The European Commission identified many factors which helped boost SMEs' exports: being part of a group, being older and with a higher turnover, having growth expectations, being involved in the manufacturing sector, selling to different businesses or organisations, and being innovative (Alessandrini et al., 2019). As Matt & Rauch (2020) argue, the previous crisis demonstrated that SMEs, with their flexibility, entrepreneurial spirit, and innovation capabilities, are more resilient than large and multinational enterprises.

1.1.3 Innovation and Competitiveness of European SMEs

While the economic contributions of SMEs are substantial, their role extends beyond mere economic metrics. A deeper examination of their innovation capacity and competitiveness reveals further dimensions of their impact.

The EU is navigating accelerated technological advancements, a volatile geopolitical situation, inflation, a continuing energy crisis, and heightened global competition. Given these challenges, it has pledged to achieve ambitious sustainability and digitalisation goals in the coming years, while fully respecting European values. Realising these objectives hinges on advanced support for Europe's 25 million SMEs, which constitute two-thirds of all private sector employment. Although over 80% of SMEs recognise digitalisation as pivotal to their future growth, significant gaps still remain in tech adoption (Sage, 2023).

SMEs are highly diverse, varying in business models, size, age, and entrepreneur profiles, and they leverage a rich talent pool. They span from liberal professions and microenterprises in the service sector to mid-sized industrial companies, encompassing traditional crafts as well as high-tech start-ups. They are pivotal to the EU's transitions towards a sustainable and digital economy and play a critical role in Europe's competitiveness, prosperity, economic and technological sovereignty, and resilience to external shocks. Therefore, they are central to achieving the EU's industrial strategy. Undoubtedly, SMEs offer innovative solutions to tackle climate change, resource efficiency, and social cohesion, encouraging innovation across European regions (European Commission, 2020).

The term innovation[1] refers to introducing something new to change a system. In the 1995 Green Paper, the European Commission further defined it as:

> "the renewal and enlargement of the range of products and services and the associated markets; the establishment of new methods of production, supply and distribution; the introduction of changes in management, work organisation, and the working conditions and skills of the workforce" (European Commission, 1996, p. 9).

Research, development and use of new technologies may be perceived as the main drivers of innovation. Other factors such as organisational efforts and human resources are relevant.

Here comes the so-called "European paradox". Despite the EU Member States being ahead in terms of scientific performance compared to the competitors, already thirty years

[1] Two types of innovation may be distinguished: (1) product innovation, which involves launching a new or significantly improved good or service, and (2) process innovation, which refers to the implementation, the distribution method, or the support activity for goods or services (Eurostat, n.d.).

ago the Commission was concerned about the decline in technological and commercial performance in high-tech sectors, such as electronics and information technology (IT). A significant weakness for Europe is its inability to effectively transform technological research and expertise into innovations and competitive advantages. This highlights the strategic necessity of converting scientific and technological potential into practical innovations.

To better comprehend these dynamics within the EU context, some data will be analysed. Looking at the following map (Figure 1. Regional performance groups), European regions have been categorised into four groups based on the Regional Innovation Index:

1. *Innovation Leaders*: regions (36) performance exceeding 125% of the EU average;
2. *Strong Innovators*: regions (70) performance between 100% and 125% of the EU average;
3. *Moderate Innovators*: regions (69) performance between 70% and 100% of the EU average;
4. *Emerging Innovators*: regions (64) performance under 70% of the EU average.

Figure 1. Regional performance groups, 2023

Source: Hollanders & Es-Sadki, 2023

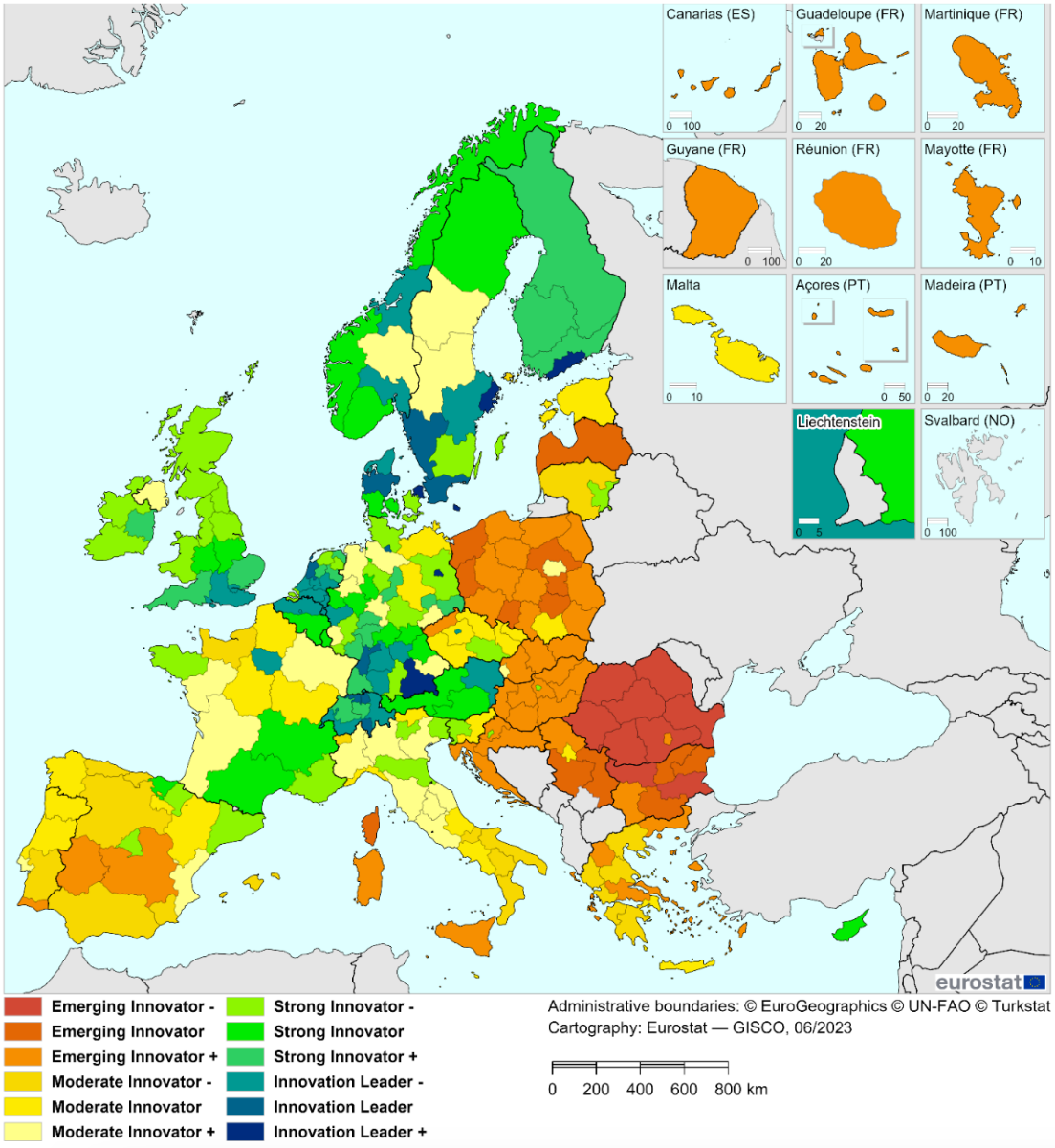
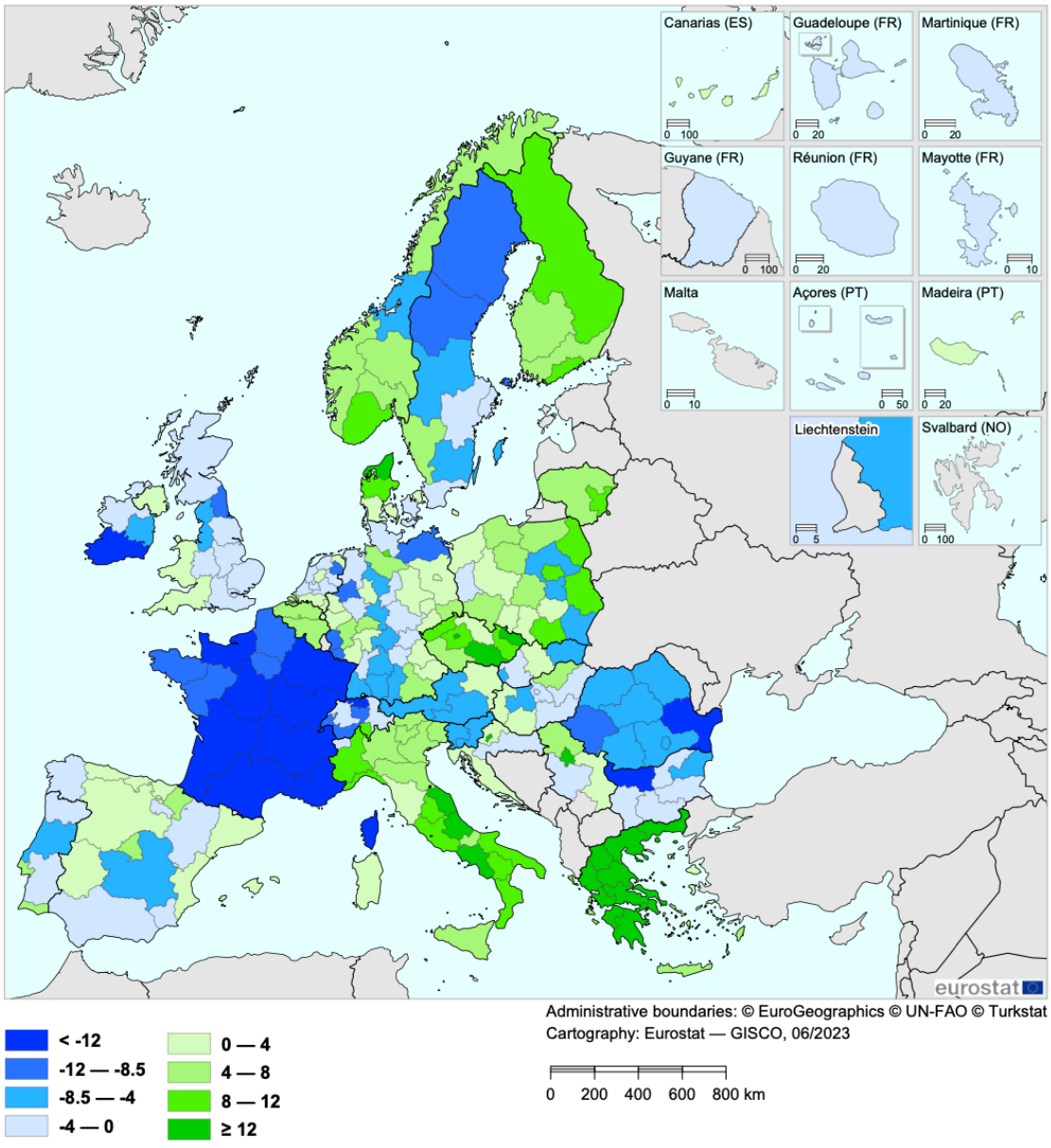


Figure 2. Innovation performance change, 2016-2023

Source: Hollanders & Es-Sadki, 2023

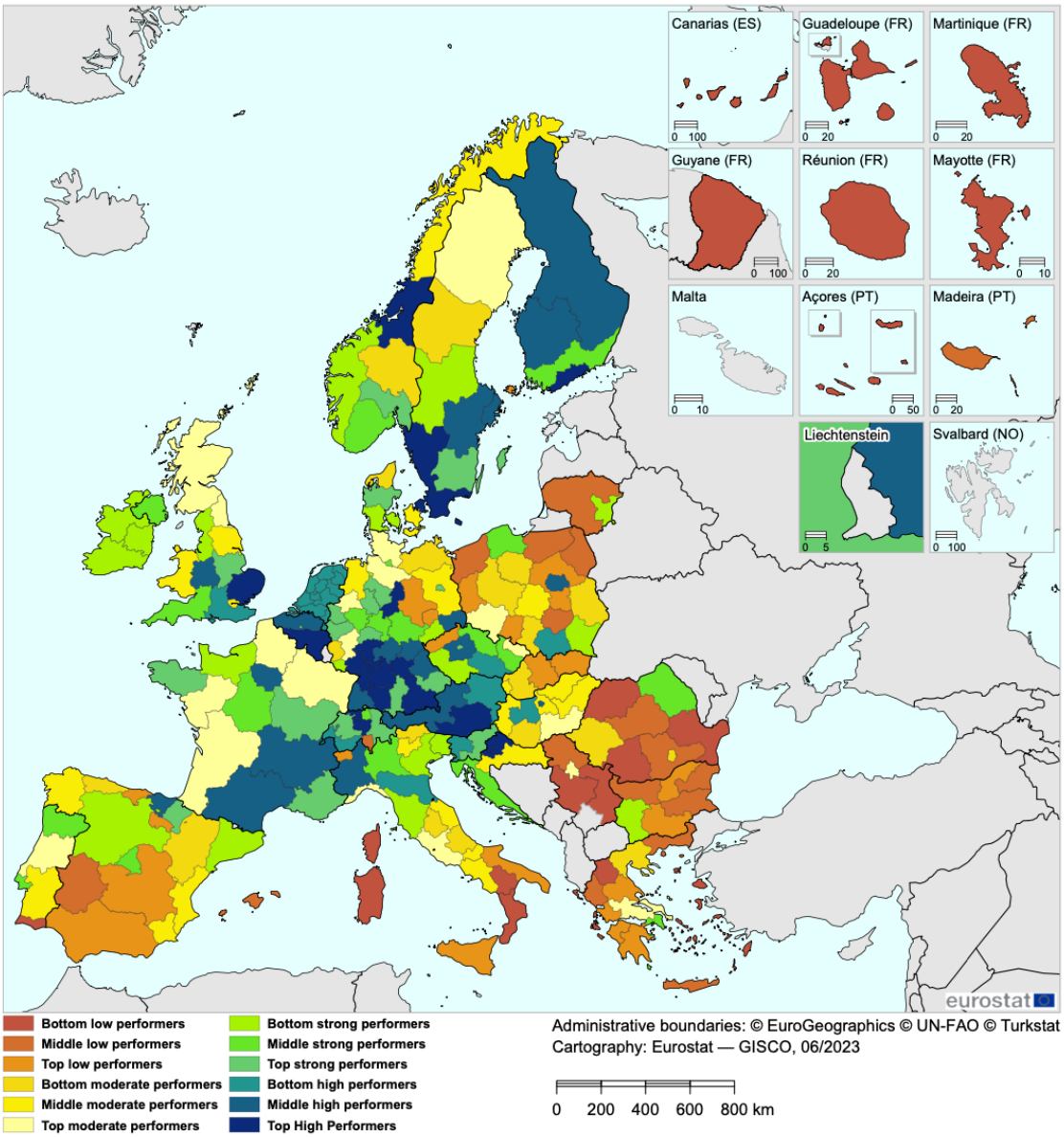


From 2016 to 2023, the EU's performance improved by 8.5 percentage points. Compared to the EU average, more than half of the Moderate Innovators and Emerging Innovators saw an increase in performance and fewer than half of the Innovation Leaders and Strong

Innovators. On the one hand, the performance increased in all regions in Belgium, Czechia, Greece, and Lithuania, and all except one in Italy, Croatia, Denmark, Finland, Norway, and Serbia. On the other hand, it decreased in all regions in France, Ireland, Bulgaria, Romania and Slovenia, and all except one in Austria, Slovakia, Sweden, and Switzerland.

Figure 3. Expenditure in R&D in the business sector as a percentage of GDP, 2023

Source: Hollanders & Es-Sadki, 2023

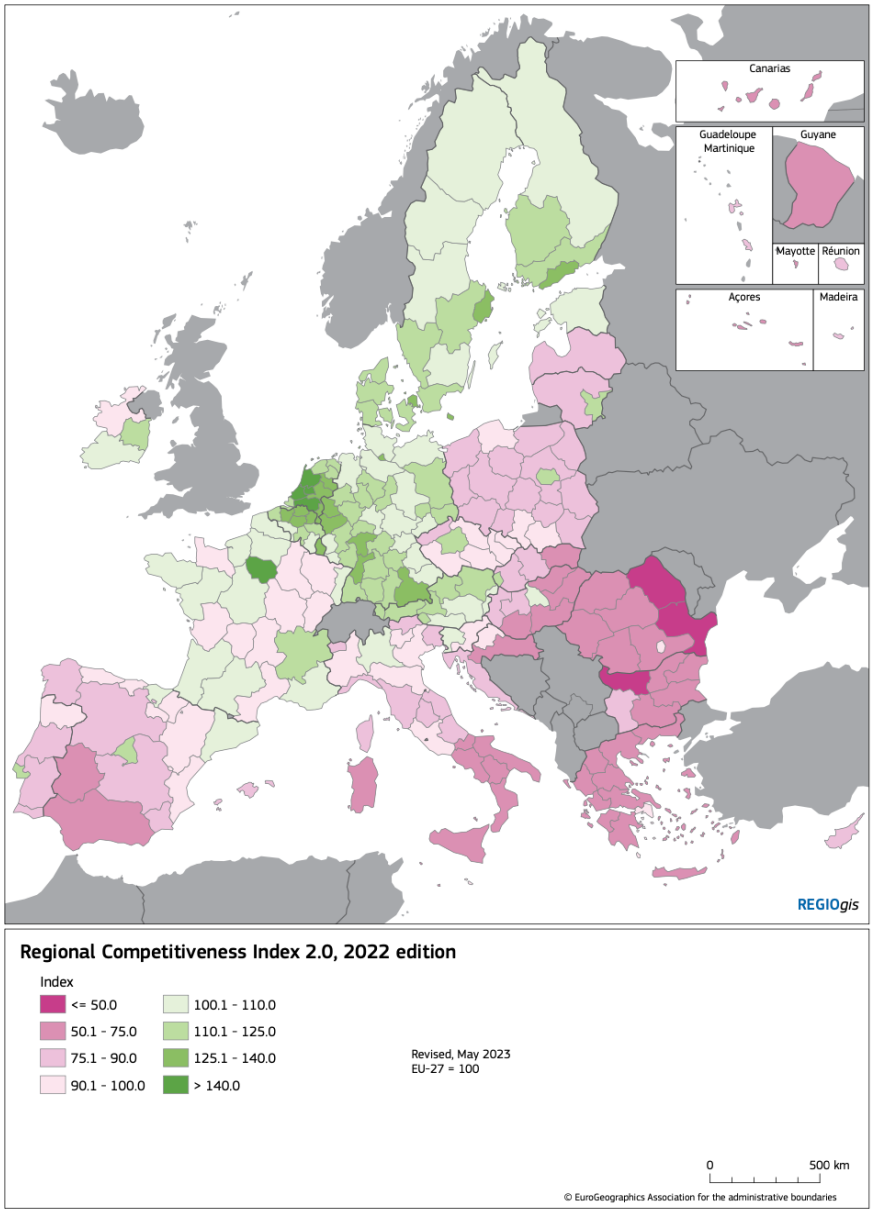


In the EU, 15 countries constitute the 40 best-performing regions. Germany and Croatia are the two countries with the best-performing ones. Overall, 49 regions exceed the EU

average performance, while 190 fall below it. In Austria and Slovenia, all regions perform above the EU average. Conversely, all regions in Bulgaria, Greece, Ireland, Lithuania, the Netherlands, Portugal, Romania and Slovakia are under the EU average (Hollanders & Es-Sadki, 2023).

Figure 4. Regional Competitiveness Index, 2022

Source: European Commission. Directorate General for Regional and Urban Policy, 2023

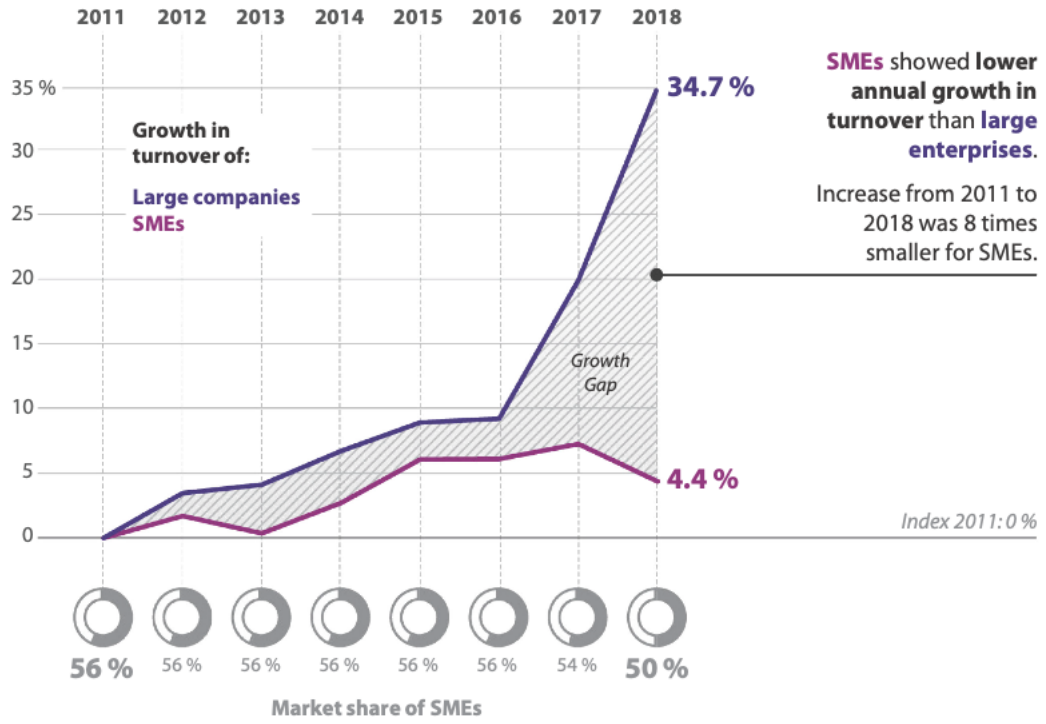


The pattern illustrated in the Regional Competitiveness Index (RCI) is extremely diverse among EU regions (Figure 4). While regions in Austria, Benelux, Germany and the Nordic nations score above the EU average, most eastern regions – excluding major capitals – tend to perform below average. Southern EU Member States show below-average scores, with exceptions including Cataluña, Madrid, and País Vasco, Lombardia, and Lisboa. Ireland and France reveal mixed performance across their regions.

The 2022 RCI presents a polycentric distribution: a stronger performance is observed in regions with major urban centres. These areas benefit from agglomeration economies, enhanced connectivity, and increased amounts of human capital. Albeit capitals are typically recognised as the most competitive within regions, such as France, Spain and Portugal, this pattern does not hold in Italy, Germany and the Netherlands. For instance, Lombardy, with Milan, is the top-performing region in Italy. Nevertheless, concentration within capitals may lead to adverse effects, such as straining resources. On a regional level, the top-performing areas are found in the Netherlands and France, whereas Romania, Greece and Bulgaria lag behind (European Commission. Directorate General for Regional and Urban Policy, 2023).

Graph 5. Comparison of growth in turnover, SMEs vs large enterprises, 2011-2018

Source: European Court of Auditors, 2022



Comparing SMEs to large enterprises, the graph above indicates a remarkable decline in the competitiveness of SMEs across the EU between 2011 and 2018. The turnover growth for SMEs was eight times lower than that of large enterprises, resulting in a substantial loss of market share for SMEs.

Additionally, large enterprises created almost all new jobs during this period, leading to a decrease in SMEs' share of total employment from 67% to 63%. As previously mentioned, SMEs are highly susceptible to economic crises but have demonstrated a particular ability to recover. Undoubtedly, they contribute significantly with many jobs for less experienced individuals, less educated and lower-income workforce. However, the financial crisis led to substantial job losses, especially in the countries most affected by the sovereign debt crisis (Poufinas et al., 2018).

Regarding the value added, it increased by 11% for large enterprises but remained stuck for SMEs. Thus, SMEs accounted for 52% of the value added in 2018, down from 58% in 2011 (European Court of Auditors, 2022).

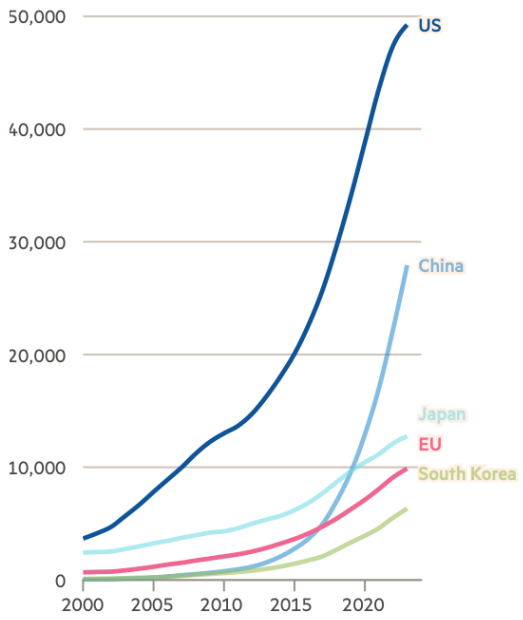
A relevant part of the literature on SMEs focuses on the factors that determine their competitiveness and success. Among these, the primary indicator of a company's competitiveness is productivity. Other indicators are mainly related to the company's capabilities in research, development and innovation (RD&I) (European Court of Auditors, 2022). However, these will not be further analysed as it goes beyond the aim of the present research. SMEs around the world are grappling with growing competitive pressures, which are further exacerbated by uneven access to cutting-edge technologies and scientific resources (Poufinas et al., 2018).

1.2 Falling Behind: The EU's Struggle in the Global Race

To better understand the European position in the global landscape, it is necessary to compare its performance with other major economies.

Graph 6. Innovation gap, US, China, Japan, EU, South Korea, 2000-2020

Number of top-tier patents in advanced digital technologies. Source: Borrett et al., 2024



The graph above shows how far the EU lags behind State powers such as the United States (US) and China. This is even more evident regarding AI innovation and adoption, at the general level of enterprises and not only for SMEs. For instance, the German multinational Siemens had to rely on the American Microsoft for the development of its chatbots.

Especially following the COVID-19 pandemic and the Ukrainian war, the EU's economic under-performance has become a major concern of policymakers, as the gap with the US increased. The US economy has demonstrated remarkable resilience to these shocks, with the GDP rising by 8.7% compared to pre-pandemic levels. By contrast, the Eurozone GDP has recovered to 3.4% above pre-Covid levels.

Isabel Schnabel, an executive at the European Central Bank (ECB), highlights that the Eurozone has lagged behind the US in terms of productivity. Since the mid-1990s, the Eurozone has lost approximately 20% of productivity relative to the US. This discrepancy is attributed to the Eurozone's failure to fully harness the benefits of digital technology. Interestingly, the necessary technological knowledge exists across countries, but only a small share of firms within each country efficiently utilises it. Additionally, many European companies face constraints due to their size and regulatory environment, preventing them from fully exploiting new technologies (European Investment Bank, 2021). With the recent introduction of the AI Act, emerges the risk of creating the opposite effect of a secure and competitive digital market, through strict privacy laws and data security that have increased the costs and complexity for the development of AI and slow progress in key areas, as European companies face high compliance costs and administrative difficulties. In contrast, US and Chinese companies benefit from more flexible regulations that promote faster technological growth and global competitiveness. This regulatory gap makes it more difficult for European companies to compete globally, widening the divide in respect of technological progress and innovation (Maglio, 2024). Therefore, in the global race to lead in cutting-edge technologies like AI, the EU struggles for dominance. Despite Europe's impressive scientific capabilities, there's a notable underinvestment in these technologies in comparison with other leading regions (European Investment Bank, 2021). Compared to the US, where they have grown by more than 8% since the end of 2019 and continued to increase, the Eurozone's performance remains weak, still 4% below pre-pandemic levels. Paolo Gentiloni, the EU's Economy Commissioner, emphasised the need to sustain adequate investment levels, drawing in private capital, and backing our needs through public investments. Conversely, the US is

renowned for its business-friendly and active entrepreneurial ecosystem, directing investments toward high-growth sectors, notably information technology (IT).

> "The potential gains from AI represent a substantial key driver and opportunity for Europe to have the economic power to tackle some of its toughest problems" (Borrett et al., 2024, p. 11).

This disparity raises concerns about Europe's ability to effectively translate scientific achievements into tangible economic success. The US and China dominate the share of global investments in AI and blockchain technologies: they collectively account for over 80% of the €25 billion annual investment in these areas, leaving the EU behind with just a 7% share, equivalent to approximately €1.75 billion. Europe's venture capital landscape does offer some support, particularly in financing early-stage AI and blockchain startups, which receive about 10% of total venture capital investments in the EU – twice the percentage seen in the US. However, the issue arises in the later stages of funding, where Europe seems to struggle, hindering the growth and expansion of SMEs operating in these sectors (European Investment Bank, 2021). Regarding Italy, since 2019 investments in AI have grown consistently, reaching nearly $200 million (approximately €178 million). However, in 2023 there has been a noticeable decline (Aspen Institute Italia – Osservatorio Permanente sull'Adozione e l'Integrazione della Intelligenza Artificiale, 2024).

Considerable financing is therefore needed to compete globally. To transform innovative ideas into marketable products and achieve global business success, improving and connecting high-tech ecosystems across Europe is necessary. Several programmes have been introduced by the European Commission to advance AI technologies, including Horizon 2020 with €1.5 billion allocated to AI from 2018-2020, and the Digital Europe Programme, which allocated €2.5 billion for AI investments between 2021-2027.

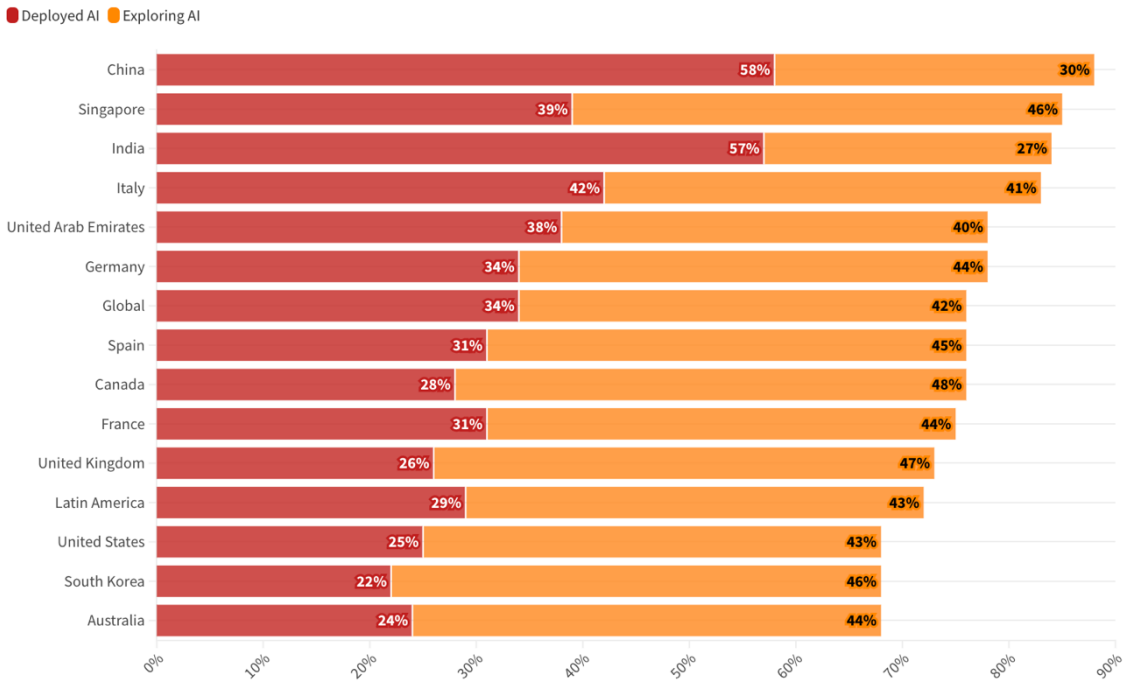
AI emerges as a critical instrument for statecraft, power projection, and economic prowess and this produces far-reaching sociopolitical implications, influencing the dynamics of global political power. Indeed, the rivalry with the US and China, each aiming to establish dominance in AI capabilities and set global standards, impacts the EU's economic goals, military strength, and international influence. The US uses its tech giants and research institutions to maintain a competitive edge, while China takes advantage of state-supported initiatives and extensive data resources.

Hence, the EU must understand how to deal with the dominance of the United States and China both in terms of strategic autonomy, technological sovereignty and economic

security, in order to avoid relying on other countries and undermining its position in the global landscape of AI (Csernatoni, 2024).

Graph 7. AI adoption rates in businesses worldwide, 2022

Author's own elaboration. Source: Mitra & Dey, 2023



The scale and scope of AI adoption within SMEs change from country to country. Regarding AI integration, countries such as the US, China and Germany are leaders. This is because of strong technological ecosystems, government backing, and skilled people. Regarding AI adoption, at the global level, larger companies are more likely to adopt AI. Moreover, in the information technology sector, companies in China and India are at the forefront.

The IBM Global AI Adoption Index 2022 (Graph 7) recognises China as the leading country in AI adoption, mostly in the automotive industry. In terms of AI adoption intensity, both in deployment and exploration, China and Singapore excel, followed closely by India and Italy (Mitra & Dey, 2023).

The EU's goal is to have 75% of companies adopt AI by 2030. Currently, only 8% of businesses are using AI, with substantial differences among Member States (ANSA, 2024).

Europe lacks its own leading companies in AI. The 'European Data Strategy' highlights that a few extra-European Big Tech firms control the majority of the data worldwide, while European SMEs do not have internal databases and have limited access to external ones – hampering the creation of unified datasets. The EU, unlike the US and China, presents a fragmented digital market, characterised by insufficient collaboration among private companies, institutions and other stakeholders. This has consequences for the entire AI value chain.

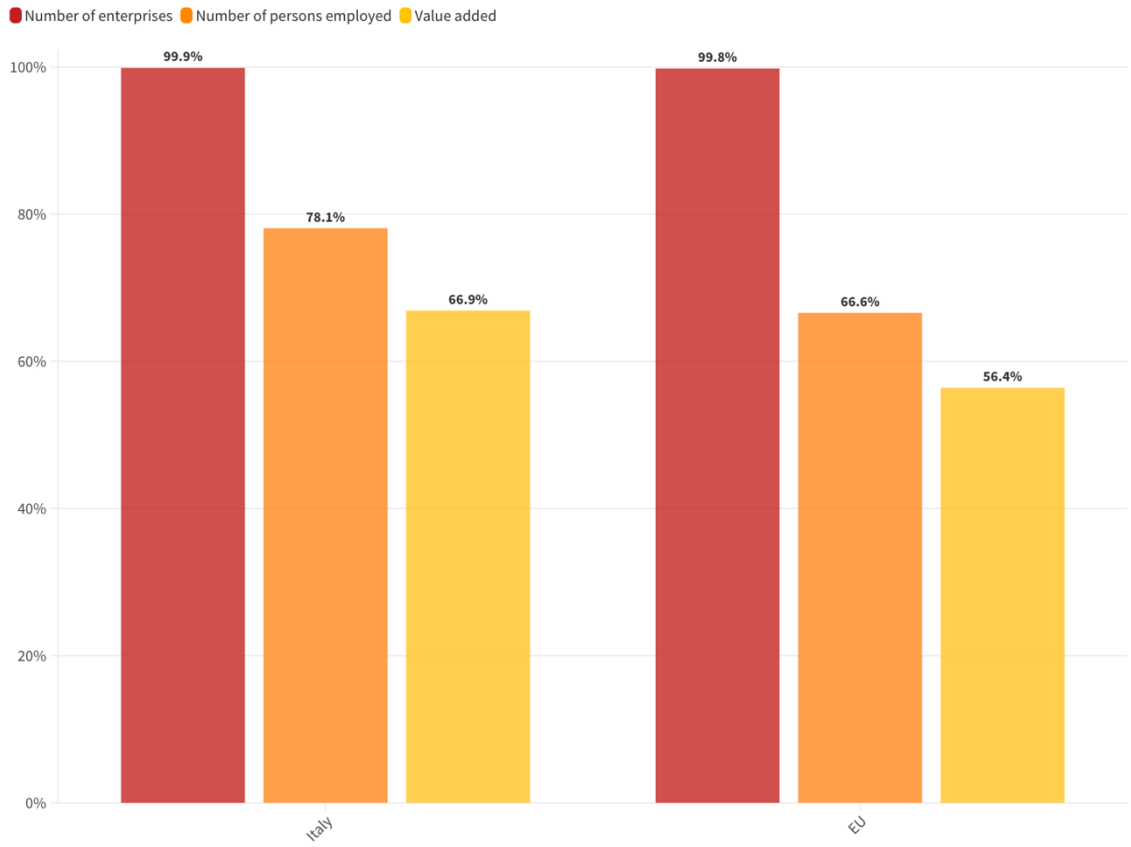
Regarding competitiveness, skilled human capital is pivotal and, as a consequence, talent shortage acts as a primary obstacle to AI adoption. The EU is unable to attract and maintain talent, and the phenomenon of brain drain is considerably growing. More and more researchers, because of better salaries, flexible contracts and prestigious positions migrate to the US. Additionally, the transition rate from academic excellence to commercial and entrepreneurial ventures in the EU is low. In 2022, 54% of AI model creators were American, compared to only 3% of Germans, the leaders in Europe. Moreover, only 12% of European company founders have a PhD, while in the US 30% and just one-third of Europe's top AI talent operate in the industry (Bianchini & Ancona, 2023).

1.3 The Italian Framework

Given the aim of this research, although the regional data provide a broad overview, it is essential to delve into country-specific patterns with the Italian case.

Graph 8. Comparison of number of enterprises, number of persons employed, value-added, Italy vs EU, 2018

Author's own elaboration. Source: Mitra & Dey, 2023

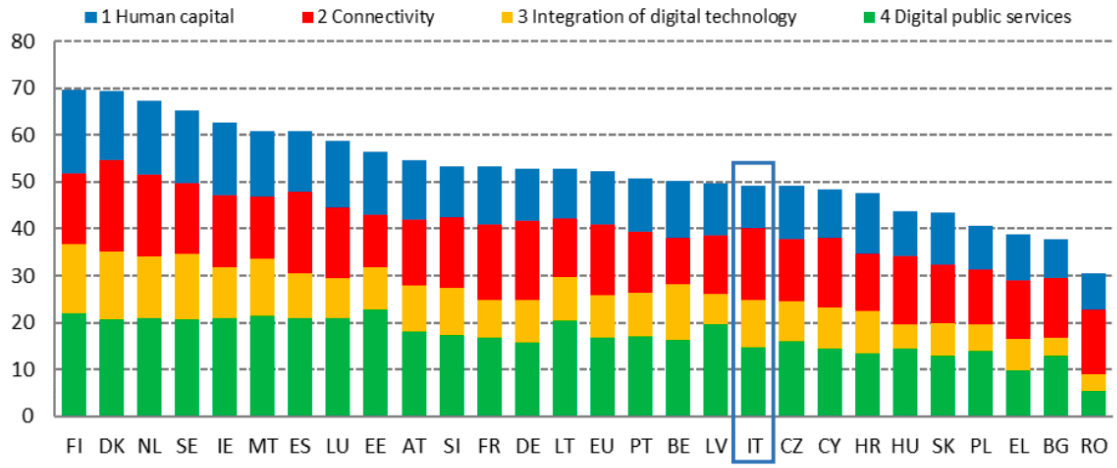


The bar chart above shows that SMEs in 2018 were extensively spread in both Italy (99.9%) and the EU (99.8%). Looking at the data on employment and value-added, in both figures Italy surpasses the EU average. This highlights the substantial role of SMEs in the Italian economy compared to the whole EU.

According to a study by The European House Ambrosetti, the expansion of AI in Italy could result in an additional annual added value of €312 billion (Aspen Institute Italia – Osservatorio Permanente sull'Adozione e l'Integrazione della Intelligenza Artificiale, 2024).

Graph 9. Digital Economy and Society Index (DESI), 2022

Source: European Commission, 2022



From 2014, the European Commission launched the Digital Economy and Society Index (DESI) to monitor the progress of the EU Member States in the field of digital over five years. The Index includes many indicators including human capital, connectivity, integration of digital technology and digital public services.

In 2022, Italy was ranked 18th out of the EU Member States. This suggests a slower pace in the digital transformation process compared to other European countries. Nevertheless, Italy has been making significant strides in digital transformation. This topic has gained political importance, led to the creation of the Ministry for digital affairs, and the adoption of strategies and the implementation of several policies. Concerning SMEs, 60% of them have reached a basic level of digital intensity, above the EU average of 55%. Despite that being in line with the goals of the Digital Decade regarding business transformation, the adoption of critical technologies such as Big Data and AI remains relatively low (European Commission, 2022).

Regarding the relationship between SMEs and AI in Italy, a recent article from Il Sole 24 ORE highlights that 47.6% of companies are interested in AI, with an additional 29.1% showing a high level of interest. However, 70.3% of SMEs have expressed no initiative. The primary reason for this low adoption is there is mostly a lack of knowledge of new AI applications.

Furthermore, more than 25% of the companies feel they do not require AI, and merely 10% have identified cost as an issue. In the coming three years, 27.6% of SMEs are planning to invest in AI technologies, while 24.4% remain uncertain, and 37.4% are undecided.

The study is also concerned with the impact. On the positive side, approximately 40% of respondents are confident AI will reduce workers' workloads by automating repetitive tasks, and about one-third anticipate an overall improvement in working conditions. Nevertheless, among the risks associated, there could be confusion among older people and those with less digital skills, loss of expertise and the possibility of AI making incorrect or biased choices. On the negative side, only a small fraction of enterprises expects a reduction in staff. The other opinions are two-fold: those who foresee employment levels to stay the same, and those who predict a rise in employment (Prioschi & Pizzin, 2024).

According to another research, the value of the AI market in Italy is significantly growing, and arrived at 760 million euros in 2023, with an increase of 52% compared to the previous year. Here, one of the major issues that arises is heterogeneity. Indeed, only a few small companies represent examples of excellence, and most SMEs almost entirely lack the use of AI (Econopoly, 2024a). In Italy, only 5% of companies with 10 or more employees use AI technologies, whereas the EU average is 8% (Econopoly, 2024b). Furthermore, a critical challenge is the absence of technology infrastructure (Econopoly, 2024c).

The Istituto nazionale di statistica (Istat, 2023) has developed the Digital Intensity Index (DII), which considers different features such as the use of AI, the purchase of cloud computing services, the value of online sales, and the number of related employees, among others. The percentage of SMEs in 2023 with more than half of employees having internet access to work remains at 46.8%, approximately the same as in 2022.

This reflects, compared to 2019, the growth in SMEs' employees using internet-connected devices (55.7%). A noteworthy finding from the Institute's Report, relevant to the present research, is that AI technologies are mainly used by companies that have already implemented basic technologies, and therefore are highly digitalised.

Another widely discussed topic in the Italian context is the territorial divide. Indeed, there is a great heterogeneity between the North and the South of the country: companies with a low level of digitalization are predominantly located in the South.

Lastly, the sectors with the highest use of AI technologies include IT, telecommunications, film, video, and TV production, as well as music and sound recording. Interestingly, in terms of the intensity of AI use, some of them combine the adoption of multiple AI

technologies. Among companies leveraging AI, the most used technologies include automating processes with software robots, text extraction from documents, and transcribing spoken language through speech recognition. Large companies prefer using machine learning for data analysis. Moreover, AI is frequently used in production processes for tasks such as predictive maintenance and quality control, in marketing and sales for customer support and personalized promotions, in cybersecurity, and in research and development for data analysis and product development (Istat, 2023).

2 THE RELATIONSHIP BETWEEN AI AND SMES

The previous chapter proved valuable in identifying the main characteristics of SMEs and their economic importance, resilience, and flexibility. However, several challenges faced by SMEs also emerged, including digital and technological lag, sectoral concentration, competitive pressures from larger enterprises, talent and skills shortages, underinvestment, and regional disparities. These impact their ability to adopt AI, which will be further explored.

The discussion will start with a definition of AI, followed by an examination of its benefits for SMEs and the theories that explain AI adoption within these businesses. Next, a review of the existing literature will highlight the challenges SMEs encounter when adopting this technology. Finally, the literature on policy learning and cluster policies will be explored to better understand the reasons behind the implementation of policies designed to facilitate the adoption of new technologies.

This approach will equip us with the tools needed to answer the research question of the present thesis, which will be further examined through the case of EDIHs.

2.1 AI Impact on SMEs

The current body of research exhibits a noticeable gap in addressing the adoption of emerging technologies – particularly AI – within the context of SMEs. Hansen and Bøgh (2021; in Meier, 2023) note a scarcity of publications explicitly discussing AI within SMEs, despite the preponderance of discussions on adoption challenges and barriers related to other technologies like Big Data and Information Technology (Kim et al., 2019; Ghobakhloo et al., 2012; Molinillo & Japutra, 2017; Wymer & Regan, 2011; in Meier, 2023).

2.1.1 Definition of AI

There is no universally accepted definition of AI. Nevertheless, several definitions illustrate its main aspects.

In 2019, the OECD conceptualised an AI system as:

> "one that is based on a machine which, for explicit or implicit purposes, deduces, from the inputs it receives, how to generate outputs such as predictions, content, recommendations or decisions that can influence physical or virtual environments. Different AI systems vary in their levels of autonomy and adaptability once deployed" (Bianchini & Ancona, 2023, p. 1).

This definition, however, overlooks other crucial aspects. Kate Crawford, co-founder of the University of New York's AI Now Institute, argues that AI is neither truly artificial nor intelligent. Indeed, AI involves "natural resources, fuels, human labour, data, infrastructure and classifications" (p. 1), reflecting its relationship with economic, political and technical dynamics. Yet, Luciano Floridi, founder of the Digital Ethics Center of Yale University, stresses that artefacts lack any autonomous consciousness. Rather, they perform tasks through computing power and statistical inferences (Bianchini & Ancona, 2023).

The European Commission proposed the following definition:

> "Artificial intelligence (AI) refers to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals" (Independent High-Level Expert Group on Artificial Intelligence, 2018, p. 1).

Here, the Independent High-Level Expert Group on Artificial Intelligence (2018) deduces from this that AI involves rationality, meaning it can select the optimal action to meet a specific goal based on certain criteria and available resources. An AI system achieves rationality by using sensors to perceive its environment, collecting and analysing data, reasoning based on the resulting information, determining and executing the best action. AI may work using symbolic rules or numeric models. Moreover, these systems incorporate multiple approaches and techniques, including machine learning, machine reasoning and robotics (Independent High-Level Expert Group on Artificial Intelligence, 2018).

2.1.2 The Potential of AI for Business Enhancement

Makridakis (2017) compares the industrial, the digital and the AI revolution. While the Industrial Revolution increased living standards, the digital revolution offered more satisfying office jobs, and the AI revolution is expected to further enhance productivity and wealth. Here, four scenarios have been identified:

- *The optimists*: accelerate the memory capacity and knowledge of humans.
- *The pessimists*: machines will take over decision-making, leaving humans unable to make their own choices, which will result in a lack of motivation to work.
- *The pragmatists*: AI technologies can be managed through "OpenAI" and proper regulation. They assert that focusing research on intelligence augmentation can help prevent or reduce the potential risks associated with AI.
- *The doubters*: human intelligence and skills cannot be replicated by formal rules. One of the main proponents of this view, Dreyfus, strongly criticises Herbert A. Simon who claimed that "a computer would be the world chess champion within ten years" (p. 52). Dreyfus argues that these predictions were based on false assumptions since human intelligence does not work like a computer. Other doubters believe that even with advanced algorithms, computers will never replicate human creativity, strategic thinking and risk-taking, and therefore human superiority will prevail over intelligent machines.

The digital revolution led to a decline in large industrial firms, similar to how AI technologies are expected to impact society today. AI is anticipated to profoundly impact how businesses operate, sell products and services, and manage their operations, thereby affecting employment patterns. While the Industrial Revolution boosted productivity by replacing handwork with machines and increasing living standards, the digital revolution further increased productivity by automating repetitive mental tasks. The AI revolution goal is to "substitute, supplement and amplify practically all tasks currently performed by humans" (p. 55), which will boost productivity but, some argue, may increase unemployment. It is undeniable that automated roles will require new skills, necessitating talented employees who can leverage AI effectively. According to a McKinsey study, data-related tasks and predictable physical work are more susceptible to these dynamics than activities requiring managing others and applying expertise. Critics argue that although automation might not increase overall unemployment, but could lead to job polarization, with growth in low and high-end jobs but a decline in middle-range positions, exacerbating social inequality. Nevertheless, new opportunities will arise in AI-related fields. Proponents see this as a way to free people from routine work, while critics worry about economic stagnation and lower incomes. Others argue that fears of AI risks, such as loss of decision-making power or worsening social inequalities are temporary.

Undoubtedly, this new reality sparks diverse, sometimes discordant opinions. Nonetheless, much of the literature emphasizes the numerous benefits that SMEs can gain from AI.

SMEs face common challenges, such as intense competition and administrative burdens, which AI-driven solutions can help address (European Economic and Social Committee. et al., 2021). Given the current advanced state of AI, it has emerged as an innovative and cost-effective solution to support business actors (Pamungkas et al., 2023). The integration of AI marks a revolutionary shift in technological evolution. Systems can now operate quasi-autonomously, with machines communicating among themselves, controlling each other without human intervention, and adapting their behaviours to changing environments. This leads to continuous improvements in system performance (Cefis et al., 2023).

As transversal technologies, AI and blockchain have the potential to disrupt various sectors significantly. They are expected to play pivotal roles in Europe's green and digital transitions and in bolstering its technological sovereignty (European Investment Bank, 2021). AI's contributions to digitalization and automation also help reduce carbon footprints (Lahtinen & Humala, 2023). AI can enable early pattern detection, automate the generation of machine-readable legal and compliance documents, and provide automated language and speech recognition (European Investment Bank, 2021). AI enhances the performance of SMEs by tracking user activities, providing recommendations, boosting trade activities, and automating business processes (Govori & Sejdija, 2023). This leads to more reliable, unbiased processes, becoming more accurate over time as it processes more data (European Investment Bank, 2021).

Additionally, AI has a pervasive impact across industries, fostering the development of other technologies with high positive externalities. Its applications include automating tasks, face recognition, natural language processing, data analytics, and decision-making, all of which enhance information management and predictive capacity. The most significant benefits for enterprises arise from automating a broader range of tasks and enhancing prediction capabilities. AI-enabled automation allows for the execution of non-routine tasks, improving productivity and reducing human and economic costs associated with repetitive or dangerous tasks (OECD, 2021).

AI's continuous availability and fatigue-free operation provide substantial advantages in cost and resource savings, particularly for SMEs. AI applications such as customer churn prediction, budget control, sentiment analysis, financial risk prediction, sales forecasting, and personalised recommendation systems demonstrate their potential to drive partial business

growth through technological advancements (Pamungkas et al., 2023). AI solutions enable SMEs to enhance their competitiveness by streamlining business processes, supporting growth, improving customer interactions, and facilitating the green transition through digitalisation. These solutions offer strategic value enabling SMEs to create new jobs, increase turnover, and explore international market channels (Lahtinen & Humala, 2023).

Finally, while large corporations often lead in AI adoption, SMEs can also benefit from integrating AI by competing more effectively with larger firms (Watney & Auer, 2021).

2.2 Theories Behind AI Adoption in SMEs

The discourse surrounding AI adoption in SMEs centres on two prominent theories.

2.2.1 Resource Dependency Theory

The *Resource Dependency Theory* was introduced by Pfeffer and Salancik (Fernandez de Arroyabe *et al.*, 2024) in 1978 through the publication of *The External Control of Organizations: A Resource Dependence Perspective*. It examines how organisations rely on external resources for survival and success, creating strategic dependencies with entities like suppliers, customers, and regulatory bodies.

> "to understand the behavior of an organization you must understand the context of that behavior—that is, the ecology of the organization." (Hillman et al., 2009, p. 1404).

In SMEs' contexts, this theory explores how these businesses depend on both external factors, such as access to financial resources and technological support, and internal factors, such as skills and capabilities, and organisational culture, for their development.

The literature highlights the critical role of a supportive ecosystem in fostering innovation within organisations. Effective internal management and innovation are essential for SMEs to minimise their dependency on external factors. By developing internal capabilities and investing in human capital, SMEs can reduce their reliance on external resources.

As for AI integration, a supportive business environment is pivotal. This includes financial support, opportunities for collaboration, a skilled workforce, and robust infrastructure. Business support should prioritise training, workshops, and educational initiatives to enable employees to effectively use AI tools. Additionally, SMEs require strong IT infrastructure,

including reliable internet, data storage, and cybersecurity, to implement AI successfully. Technical support is also vital in providing SMEs with the foundation needed to run AI applications. This comprehensive approach not only speeds up AI adoption but also enhances SMEs' agility, competitiveness, and readiness for the digital future.

2.2.2 Dynamic Capabilities Theory

The *Dynamic Capabilities Theory*, as proposed by Eisenhardt and Martin (2000) and Teece (2014), focuses on a firm's ability to adapt to changing environments through dynamic and flexible capabilities. These capabilities involve efficiently utilising resources to achieve specific outcomes or objectives, with learning and innovation playing pivotal roles. Dynamic capabilities allow firms to modify their operations to meet evolving market demands, emphasising the importance of integrating and reconfiguring capabilities to remain competitive (Fernandez de Arroyabe et al., 2024).

According to the present theory, possessing digital and innovation capabilities significantly drives AI adoption in companies. Digital capabilities involve the ability of an organisation to effectively use digital technologies, including infrastructure, skills, and data management, to achieve strategic goals and maintain competitiveness. Conversely, innovation capabilities focus on the ability to generate and implement new ideas, processes, products or services.

Digital capabilities of SMEs facilitate AI adoption, as companies do not necessitate conspicuous investments to access new technologies. This is also because employees and managers who already have knowledge gain a better understanding of the opportunities and limitations of AI. Conversely, companies with strong innovation capabilities are better positioned to successfully implement AI technologies. Innovative capabilities include developing new products and improving already existing ones. While innovation capabilities are crucial for creative adaptation, expertise and alignment of AI with company goals, digital capabilities play a role in the technical integration of AI.

This literature highlights the biggest role of internal capabilities rather than external environmental support in influencing the successful adoption of AI.

2.3 Obstacles Faced by SMEs in Adopting AI Technologies

Part of the literature explores the opportunities and challenges associated with integrating AI solutions within SMEs. On the one hand, companies that integrate AI solutions tend to experience enhanced productivity and efficiency (European Investment Bank, 2021). On the other hand, research highlights the financial burden of AI implementation on SMEs (Mitra & Dey, 2023). The lack of financial resources, particularly cash flow issues, directly impacts their ability to invest in technology. This financial strain results in reduced confidence in technology and lower levels of investment.

SMEs also express concerns about the security of their data and customer privacy, and regulatory uncertainty further complicates their adoption of new technologies, as SMEs are often unsure about the compliance requirements (Sage, 2023). In this regard, the recently entered into force-AI Act marks a significant step forward to have uniform regulations across all EU member states. Moreover, companies must comply with the General Data Protection Regulation (GDPR), a framework that has positioned the EU as a leading digital regulator, with other countries following its footsteps (Wallraff et al., 2023). Although these regulations safeguard customers and their personal data, sometimes the strict standards for data exchange hinder the rapid adoption of AI (European Economic and Social Committee. et al., 2021).

The lack of individuals with the necessary technological, technical, and business skills is another huge challenge, exacerbated by the competition for talent from larger companies offering higher salaries. In terms of knowledge, the challenge is twofold: a deficit in skilled personnel and a widespread lack of comprehension regarding AI implementation and its potential uses (Oldemeyer et al., 2024). Hence, the lack of awareness about the full range of benefits that AI can offer is a barrier (Sage, 2023). Indeed, managers need to have at least a basic grasp of AI, including the technologies available, the solutions it offers, and what it can achieve (European Economic and Social Committee. et al., 2021). Compared to other technologies, AI is perceived as more complex due to its IT-intensive nature, the prerequisites of high-quality data, and the challenges of transferring or customising AI solutions from one company to another. This complexity is further heightened by the highly technical nature of most AI case studies, which are difficult to comprehend for managers without IT expertise (Oldemeyer et al., 2024). Nevertheless, the overall digital maturity of the organisation emerged among the most cited barriers for SMEs. Concerning this, organisational problems must be taken into account. Large companies lead in this respect because of their economies

of scale and ability to drive such processes (European Economic and Social Committee. et al., 2021).

The human resources is another aspect worth considering. The integration of AI poses challenges related to the requirement of advanced technical expertise, which is usually out of the reach of these small enterprises. Therefore, many SMEs decide to keep the status quo (Govori & Sejdija, 2023). A number of leaders do not see the need for change, especially if their business is already performing well (Oldemeyer et al., 2024). Other SMEs often rely on external experts to gain know-how. Nevertheless, this is not enough as they also require this knowledge in their daily activities. Also, recruiting new staff with sufficient AI skills is costly and makes it difficult to compete with larger companies (European Economic and Social Committee. et al., 2021).

Another issue is the availability of vast amounts of data needed to train algorithms. SMEs often struggle with this, due to their limited data resources. A possible solution may be relying on external data sources which need to be accessible and of high quality – but this is not always the case. Nonetheless, in addition to large volumes of data, effective data management is pivotal. This includes the collection, integration, harmonisation, tagging, and classification of data, all of which depend heavily on existing data infrastructures and legacy systems. For small companies, the costs associated with these processes can be burdensome. Yet, small firms steeped in family and tradition-bound practices tend to be more rigid and less forward-looking, further complicating their ability to embrace AI (European Economic and Social Committee. et al., 2021; Oldemeyer et al., 2024). Accordingly, a fragmented EU market makes it more difficult to compete with players such as the US and China, as Europe presents local and asymmetric ecosystems (European Economic and Social Committee. et al., 2021).

Finally, Bauer, van Dinther and Kiefer (2020), suggest that external assistance is often necessary for SMEs. They advocate for political and governmental support in funding such research collaborations. Nevertheless, the substantial investments and mobilisation of resources necessary to embark on the digital journey and gain a competitive edge appear to be more easily available to larger enterprises (Meier, 2023). However, SMEs are agile in adapting to change, suggesting a potential for swift AI adoption (OECD, 2021).

2.4 Hypotheses Regarding the Origin of Innovation Policies

Over the past decades, the development of innovation theory has undergone a significant transformation, shifting from a linear process of discovery to a non-linear process of learning (Mytelka & Smith, 2002; Nauwelaers & Wintjes, 2008).

Mytelka and Smith (2002) argue that learning happens within specific institutional contexts shaped by regulations, laws and political cultures. This systemic perspective is relevant to understanding how SMEs react to the obstacles of AI adoption.

Innovation policy, once primarily concerned with industrial, science, and technology policies, has evolved into a broader, more integrated approach. Schumpeter distinguished between invention – introducing new ideas – and innovation – meaning the practical application of these ideas. This distinction is related to SMEs as they transition from recognising the potential of AI to effectively integrating it into their operations.

In an ideal scenario with perfect information and communication, policymakers could easily select and adopt the most effective policies for fostering innovation within SMEs. Nevertheless, the reality is far more complex. Innovation, particularly in the context of AI, is a relatively young policy field, which lacks widely shared models. This uncertainty makes policy learning a heuristic and learning-by-doing process, often driven by history, stakeholder pressures, and emerging opportunities rather than by evaluation and evidence (Edler & Fagerberg, 2017). Furthermore, the challenges SMEs face in adopting AI, mentioned in the previous section, reflect the broader uncertainties in innovation policy. Yet, over the years, policy increasingly started addressing these specific needs, reflecting the growing recognition of tailored support for SMEs to overcome these obstacles. The European Commission's *Green Paper on Innovation* in 1995 was instrumental in spreading the idea that innovation is pivotal for enhancing competitiveness, which has led to an expansion of policy instruments that help support SMEs in this regard. This involved practitioners, analysts and evaluators, the definition of specific objectives and the diffusion of best practices (Nauwelaers & Wintjes, 2008). For SMEs, this could mean stronger support systems to facilitate the integration of AI technologies.

Usually, AI and SMEs-related policies focus on the dissemination of multiple technologies. Three different types of policies are identified in this respect: those focused exclusively on SMEs and entrepreneurs, those aimed at different actors to promote agglomeration and

collaboration (e.g. cluster policies), and those targeting enterprises of all sizes, although they focus mainly on SMEs (OECD, 2021).

Another part of the literature to be analysed is the one on cluster policies, since EDIHs may be perceived as related to that, both because they aim to facilitate the adoption of AI tools in public sector organisations and SMEs and as a networking tool. These instruments are not generally explicitly part of cluster policy; however, they can be recognised as relevant actors in the cluster environment or driving forces for their establishment.

> "Cluster policies –traditionally used to foster innovation and growth in a specific geographic area– are receiving new impulse in the digital era, with the creation of digital research and innovation hubs. Their objective is promoting partnerships for research and innovation between regional actors in a specific manufacturing sector or technology area, to enhance their competitiveness at the national and international levels and ensure science-industry knowledge transfer" (Planes-Satorra & Paunov, 2019, p. 33).

The literature agrees that clustering and networking processes are essential to make SMEs more competitive and for their growth. The definition of Porter is the most widespread: "A geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities" (Nauwelaers & Wintjes, 2008, p. 246). Four features of clusters emerge: geographical concentration, specialisation, presence of enterprises together with other institutions (research centres, regulatory institutions, public bodies, intermediaries, financial institutions, etc.), and interrelations between actors.

On the one hand, the traditional approach towards the benefits of clusters stresses that several companies come together to achieve the scale needed to compete in enlarged markets. This is how, by creating a network while maintaining the flexibility typical of their small size, companies can respond to the needs of global markets. On the other hand, following a modern vision, clusters act as a means of opening up the minds of business managers, and learning platforms, broadening opportunities and facilitating access to sources of knowledge and strategic information (Nauwelaers & Wintjes, 2008).

3 EU INITIATIVES TO SUPPORT AI ADOPTION BY SMES: THE CASE OF EU DIGITAL INNOVATION HUBS (EDIH)

In the following sections, the previously discussed literature will be utilised to analyse the EU Digital Innovation Hubs (EDIH). This thesis aims to understand why the EU introduced these hubs to facilitate AI adoption in SMEs and to evaluate their effectiveness in achieving this goal. Therefore, the financial aspects of these instruments will not be covered, as they fall outside the scope of this research. Instead, the analysis will begin by explaining the role and function of EDIHs, followed by the rationale behind the EU strategy. Additional insights will be gained through direct interviews with representatives of the hubs in Italy. The findings will be discussed in the final section on the robustness of the instrument in promoting AI adoption – an objective that, while not the sole purpose of the EDIHs, becomes the central focus of this thesis.

3.1 Understanding EDIHs: Role and Function

The EU Digital Innovation Hubs (EDIH), introduced in 2021 through the Digital Europe Programme, are either a single entity or a coordinated group of entities with complementary expertise, operating on a not-for-profit basis (Regulation (EU) 2021/694, 2021). They aim to drive the digital transformation of the European economy over the next decade while achieving European digital sovereignty through the dissemination of key technological capabilities. The Programme contributes to the broader objectives of the Digital Services Act (DSA) and the Digital Markets Act (DMA). These regulations focus on creating a safer digital space that protects the fundamental rights of all digital service users and fosters a level playing field to enhance innovation, growth, and competitiveness.

The Programme aims to achieve its objectives through a network of European Digital Innovation Hubs that provide access to technology testing and support for digital

transformation to private and public sector organisations (PSOs) across the EU, including governments at the national, regional, or local levels.

One of the key areas recognised in the Digital Europe is AI. Based on the European Commission's guidance, at least one centre in each country should deal with AI – with a different focus. Moreover, SMEs are among the primary targets of the initiatives. Indeed, EDIHs are integral to EU policies, especially in supporting industrial and SME sectors through the twin transitions – green and digital. These hubs are designed to be close to local companies, communicating in their language. Additionally, they should align with national priorities and existing assets, chosen through an open and competitive process.

EDIHs will play a crucial role "in networking with other hubs, sharing best practices and specialist knowledge, in bringing companies into contact with other companies of their value chain, and in seeking synergies with innovators and early adopters" (p. 9). These hubs will thereby act as multipliers promoting the usage of any digital capacity.

To evaluate the performance of the EDIHs, several indicators will be used, including the number of businesses and public sector entities served, the amount of additional investments triggered, the number of collaborations with other EDIHs and stakeholders at the European level, the rise in digital maturity of organisations, and the market maturity and the market creation potential of innovations (European Commission, 2021).

EDIHs propose a variety of services, including:

- *Test before invest:* this may include services such as awareness raising, digital maturity assessment, demonstration actions, visioning for digital transformation, fostering integration, adaptation and customisation of various technologies, testing and experimentation, and knowledge and technology transfer;
- *Skills and training:* comprises advertising, training, boot-camps, traineeships, and supporting job placements;
- *Support to find investments:* EDIHs assist organisations in accessing financial institutions and investors, utilising InvestEU and other financing mechanisms;
- *Innovation ecosystem and networking*: EDIHs act as brokers, connecting companies within their value chains, and with innovators or early clients for testing solutions. They network with other EDIHs when local partners are not available and conduct constant technology search to map innovation ecosystems and understand priorities and potentials. In this regard, systematic relationships with regional

authorities, clusters, associations, business development agencies, incubators and accelerators are needed.

The AI-on-demand platform will be one of the knowledge transfer mechanisms to provide access to AI algorithms and public data sets. The role of EDIHs in this will be to help SMEs experience this platform, identify relevant data sets and algorithms and carry out security audits.

Additionally, diverse horizontal support activities are planned, including:

- *Guidance for hubs:* developing reusable support tools, and sharing best practices;
- *Train the trainer:* EDIHs will receive training and will, in turn, train others through workshops and training materials;
- *Community building:* organising events among groups of EDIHs, also outside the European DIH network;
- *Matchmaking:* facilitating matchmaking events to connect hubs with specific competencies;
- *Impact assessment:* analysing indicators and KPIs, setting targets, creating new knowledge for benchmarking and policy recommendations.

Moreover, these hubs will be regularly monitored by the European Commission with the assistance of external experts.

Lastly, the expected knowledge spill-overs between advanced and less advanced countries through the EDIH network will help reduce the digital divide and drive cross-country convergence, benefitting all sides (European Commission, 2019).

3.1.1 Factors Influencing EU Strategy

Different factors play a role in determining the EU strategy to introduce EDIHs. Following the literature illustrated in the previous chapter, the discussion is divided into three main topics: policy learning and cluster policies, an understanding of the obstacles for SMEs to adopt AI, and finally the EDIHs will be analysed through the theoretical lenses of the *Resource Dependency Theory*.

Policy learning and cluster policies

Policy learning involves the process by which governments and policymakers draw lessons from past experiences and adapt policies to achieve their goals (Radaelli & Dunlop, 2013). In this regard, the EDIHs represent a nuanced manifestation of policy learning. EU has already experimented with digital innovation policies through Smart Specialisation Strategies (S3) and Europe 2020 Strategy by introducing the Digital Innovation Hubs (DIHs). Smart Specialisation Strategies contributed to identifying regional strengths and, by using a bottom-up approach, smart specialisation involves local governments, academic institutions, businesses, and civil society to collaboratively develop and execute long-term growth strategies within their regional innovation ecosystem (European Commission, Joint Research Centre, 2020). Along the same lines, EDIHs are not top-down initiatives imposed by the EU as they are created with input from regional and national authorities, industry stakeholders, and civil society. This collaborative approach to governance could be seen as the recognition that successful digital transformation requires the involvement of all relevant stakeholders to respond to local needs and conditions.

Policy learning is an ongoing process, and the EU introduced mechanisms to evaluate the effectiveness of EDIHs such as the Digital Maturity Assessment (DMA) tool developed by the Joint Research Centre of the European Commission, which evaluates the degree of digital maturity of a company through a questionnaire to facilitate EDIH to identify specific digital requirements and provide more customised interventions. By May 2024, there have been over 4,700 assessments conducted for SMEs and PSOs with the DMA tool (European Digital Innovation Hubs Network, n.d.). This is in line with the view of Nauwelaers and Wintjes (2008) which state that while at the beginning policy learning was mostly driven by history, stakeholder pressures, and opportunities rather than by evaluation and evidence (Edler & Fagerberg, 2017), now evaluations are involved in the process. However, it is difficult to find an impact assessment by the Commission in this regard.

EDIHs may also be linked to cluster policies. Cluster policies aim to enhance the competitiveness of certain sectors within specific geographic areas by fostering collaboration among businesses, research centres, and other stakeholders. Similarly, EDIHs are regionally anchored and help companies adopt advanced digital technologies that are essential for maintaining competitiveness. A key component of cluster policies is also the creation of an innovation ecosystem where stakeholders share knowledge, resources, and technology to drive

competitiveness and innovation. By facilitating knowledge exchange and offering digital infrastructure and services, EDIHs help companies innovate, thereby supporting the broader innovation ecosystem envisioned by cluster policies.

Challenges for SMEs in Adopting AI

The establishment of EDIHs within the Digital Europe Programme reflects an adaptation to new challenges and opportunities in the European digital landscape. This adaptation led to a more focused emphasis on specific aspects such as the integration of key technologies such as AI support for SMEs, and the need to bridge digital divides between regions. Thus, it has been recognised the need for a more tailored approach. Moreover, the EU has recognised that innovation does not occur in isolation but is rather the product of interactions within and across regions. By fostering collaboration and connectivity among EDIHs, the EU seeks to create a more integrated and cohesive innovation ecosystem that can leverage the strengths of different regions while addressing their specific needs and challenges, and ensuring that these hubs are part of a broader, interconnected European network – the European Digital Innovation Hubs Network. The latter consists of 228 EDIHs, catalogued on the official website. Additionally, 18 new EDIHs from Albania, Montenegro, North Macedonia, Serbia, Türkiye, Ukraine, and Kosovo have been invited to sign the Grant Agreement to join the network (European Commission, 2024). The EU understood that regional disparities in digital maturity can exacerbate economic inequalities and hinder the overall competitiveness of the European economy. The EDIH framework is designed to ensure that all regions, including less developed ones, have access to the resources and support needed to participate in the digital economy.

The awareness process started with the European Commission, which recognised the crucial role of SMEs in the European economy, as well as the substantial barriers to growth (Watney & Auer, 2021). Furthermore, past economic crises highlighted the resilience of SMEs and their potential for innovation and flexibility (Alessandrini et al., 2019; European Investment Bank, 2021). The competitiveness with the US and China in AI also underscored the need for effective policy tools and has put the EU in a hurry to do so.

Resource Dependency Theory

Considering the theories discussed in the second chapter, one might argue that the phenomenon of EDIHs may be interpreted through the lens of *Resource Dependency Theory*, rather than *Dynamic Capabilities Theory*. EDIHs reflect the dependencies that SMEs have on external resources by providing them with access to technical assistance systems. The EU understands the necessity to reduce the barriers SMEs face by offering access to AI technologies, training, technical support, and networking opportunities through EDIHs. This tries to support SMEs to overcome their dependency on scarce or costly resources, such as advanced technical expertise and digital infrastructure, thereby enabling them to innovate and remain competitive. This approach aligns with the *Resource Dependency Theory*, as it demonstrates an understanding of how external support can be structured to reduce dependency and enhance organisational capabilities.

Whether this achieved awareness translated into results will be clarified in the last paragraph of this study, enhanced by the interviews with Italian representatives of the instrument.

3.1.2 Interviews with Italian Stakeholders

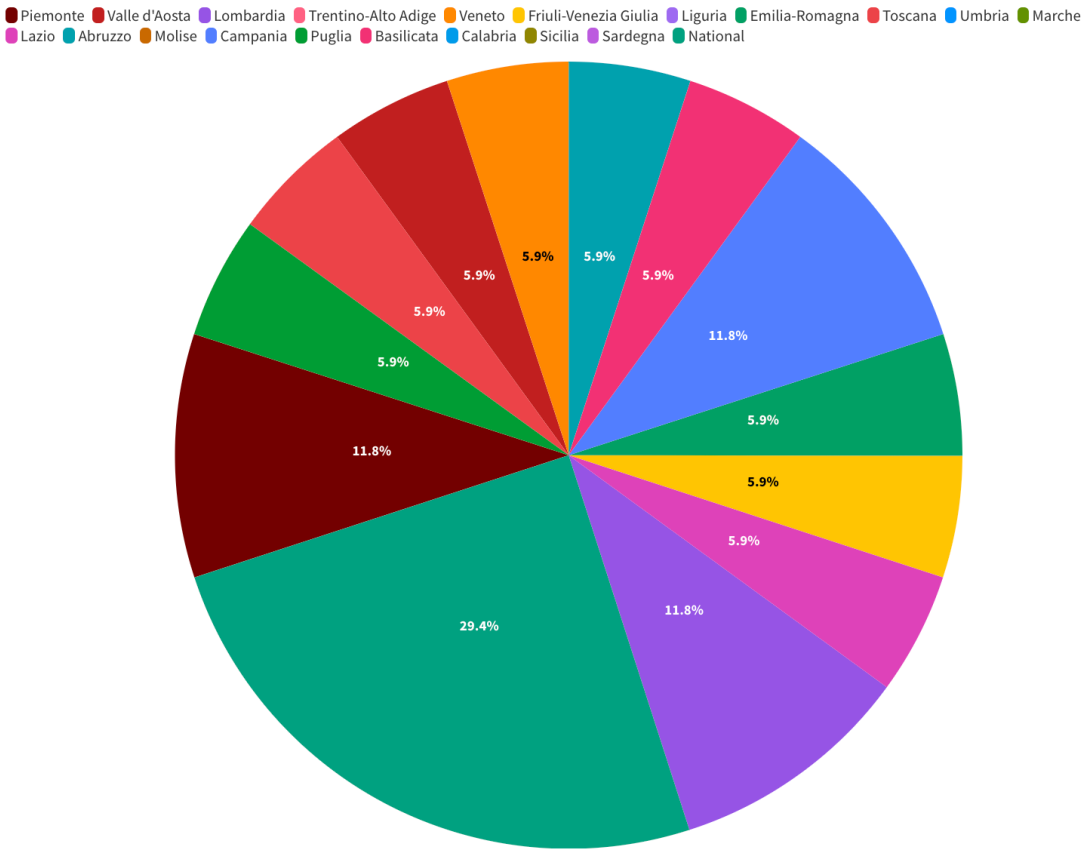
According to the EDIH catalogue of the European Digital Innovation Hubs Network, at the beginning of September 2024, 36 EDIHs were active in the Italian country. Out of the 36 EDIHs targeted in this survey, 17 representatives provided valid responses to the questionnaire, resulting in a response rate of 47.2%. While this is nearly half of the surveyed sample, it is necessary to take into account the limitations in terms of data representativeness and statistical robustness. A response rate below 50% may indicate that the findings could be influenced by non-response bias, where the perspectives of the non-respondents might differ significantly from those who participated.

That said, this response rate still provides valuable insights into the functioning and strategic approaches of EDIHs in Italy. The data can be considered a meaningful preliminary step in understanding the dynamics of these hubs, However, the results should be interpreted with caution, and further data collection could help enhance the robustness and generalisability of the findings.

The EDIHs can operate either nationally or within specific geographical regions. Of the total respondents, 29.4% indicated that they operate on a national level. This is followed by the Lombardy and Piedmont regions, both in northern Italy, where 11.8% of the EDIHs are active in each.

Graph 10. EDIHs geographical distribution, Italy, 2024

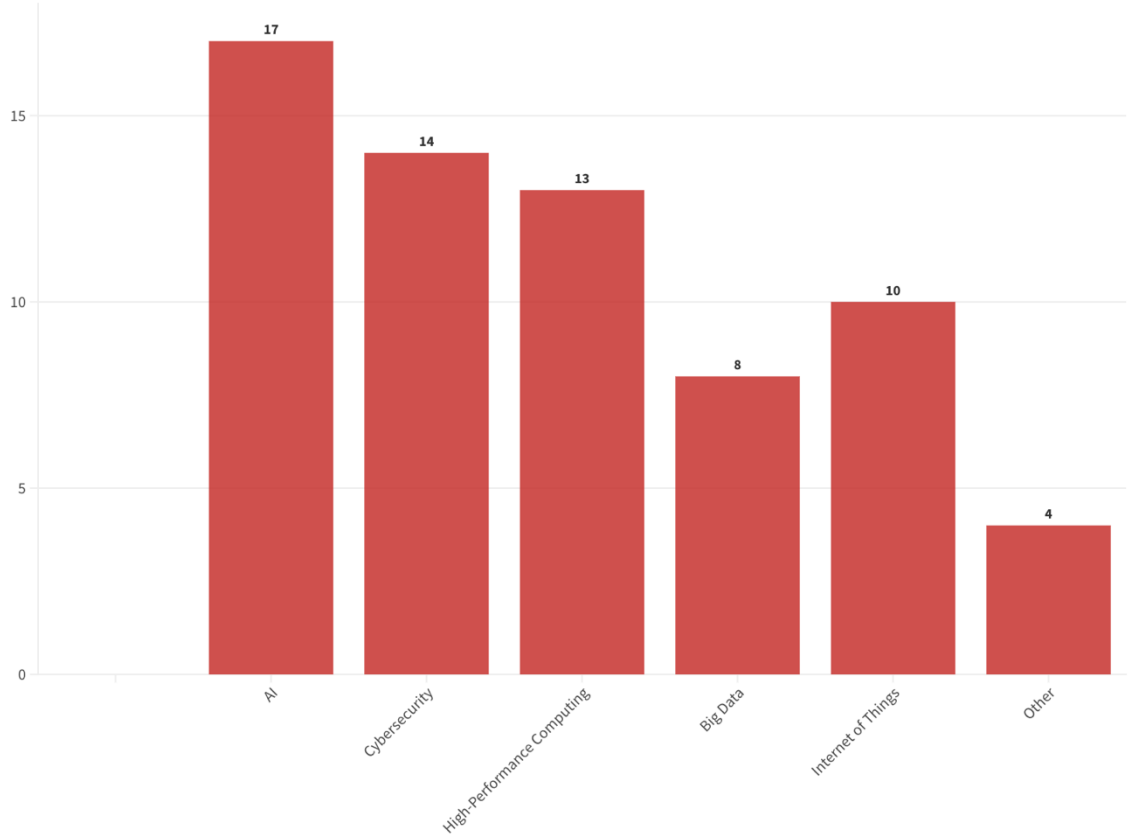
Author's own elaboration.



Interestingly, as shown in the table below, all respondents reported focusing primarily on AI, followed by Cybersecurity (14 responses) and High-Performance Computing (13 responses). This data suggests that AI is a core technological domain for the majority of these hubs, while other areas like Big Data are less central to their work.

Graph 11. Main technologies of interest per EDIH, 2024

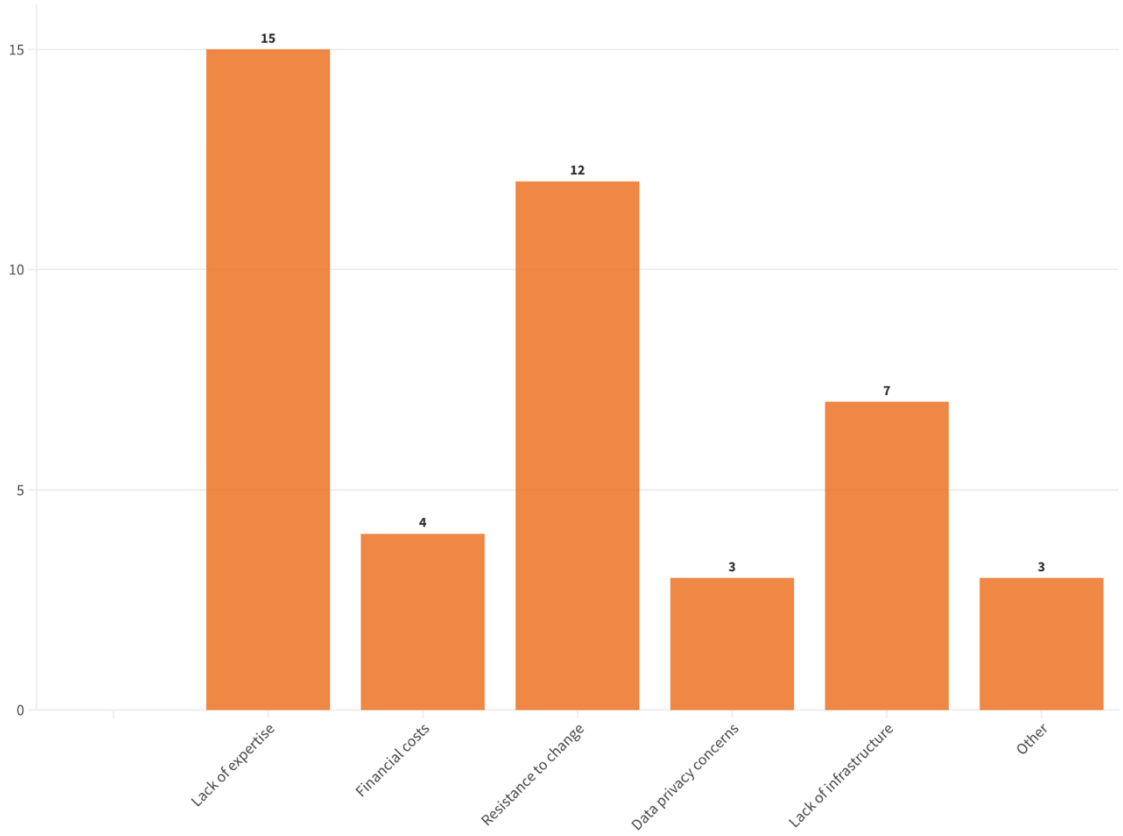
Author's own elaboration.



The questionnaire then asked respondents to identify the main obstacles they face, allowing up to three selections. The most frequently cited obstacle was a lack of skills, reported by 15 respondents. This was followed by resistance to change (12 responses) and lack of infrastructure (7 responses). Notably, data privacy concerns were seen as the least significant issue, highlighting that technical and human challenges are perceived as more pressing than regulatory concerns at this stage.

Graph 12. Primary barriers in AI adoption in SMEs, 2024

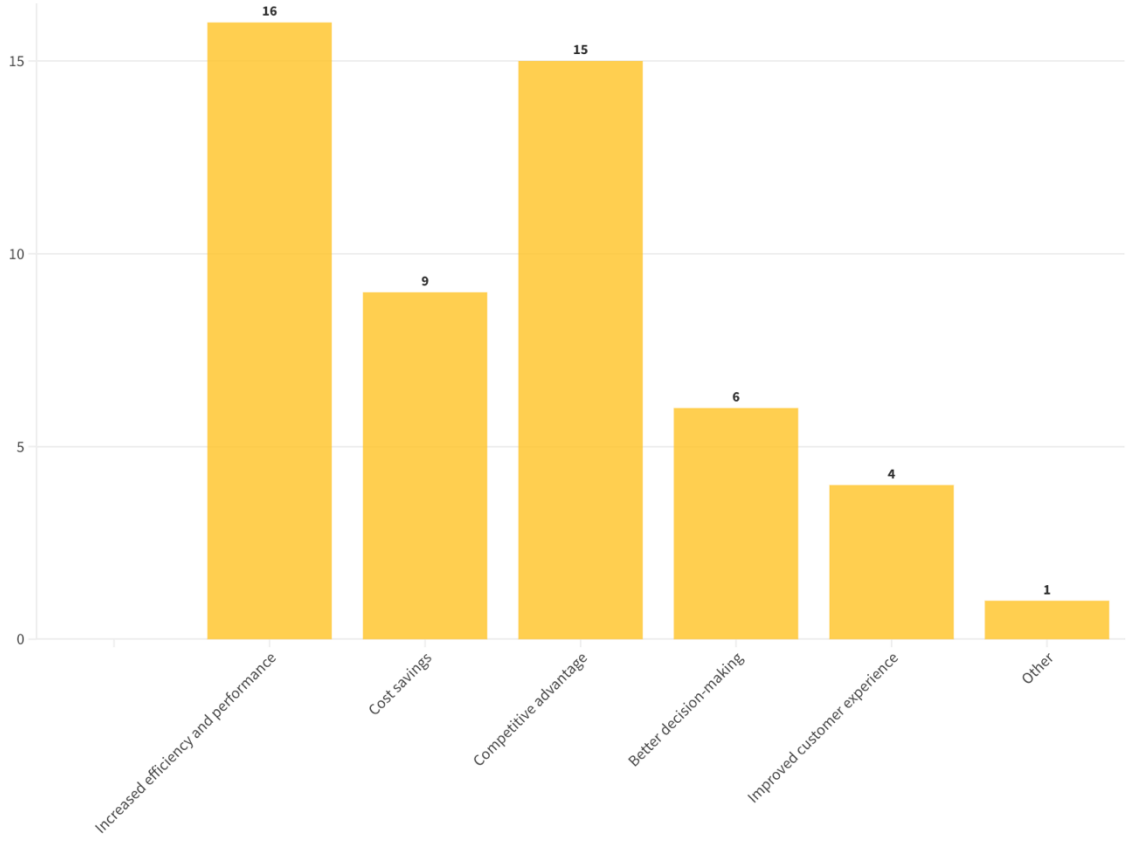
Author's own elaboration.



When it comes to the perceived benefits of their work, respondents overwhelmingly pointed to improved efficiency and performance (16 responses) and competitive advantage (15 responses). Improving customer experience was the least cited benefit, suggesting that these hubs are more focused on internal organisational improvements rather than customer-facing innovation.

Graph 13. Benefits of AI adoption in SMEs, 2024

Author's own elaboration.



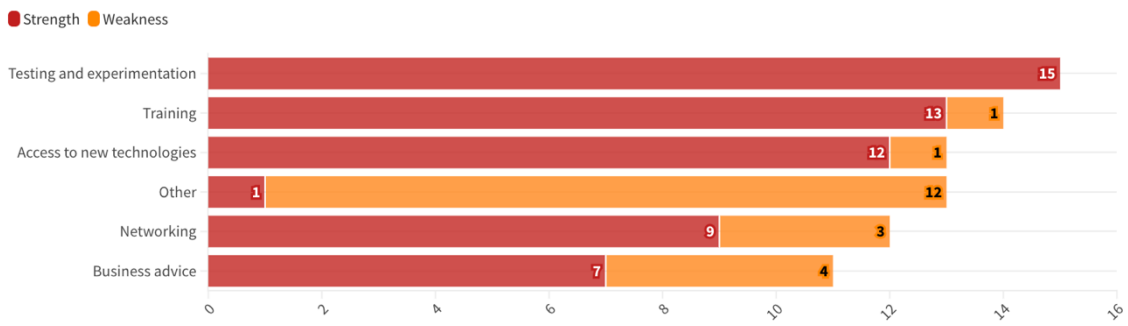
Respondents were also asked to evaluate the strengths and weaknesses of their EDIH in facilitating AI adoption, choosing from options such as training, business consulting, access to new technologies, testing and experimentation, networking, and others.

Among the strengths, the top three were testing and experimentation (15 responses), training (13 responses), and access to new technologies (12 responses), indicating a strong focus on enabling practical applications and knowledge dissemination. Business consulting, however, was not perceived as a key strength.

Regarding weaknesses, business consulting (4 responses) and networking (3 responses) were cited as areas needing improvement. Nevertheless, it is worth noticing that the majority of respondents (12) have chosen the option "other", implying that there are additional, unlisted challenges that need to be addressed. This suggests there may be unique contextual barriers faced by individual hubs that go beyond the standard categories.

Graph 14. Perceived strengths and weaknesses in facilitating AI adoption, per Italian EDIH, 2024

Author's own elaboration.



In the final open-ended question, respondents were asked how they plan to address the previously identified weaknesses and meet the identified needs. Key responses included:

- Leveraging industry associations to better engage SMEs;
- Hiring more technical staff with vertical expertise;
- Collaborating with consortium partners to identify new strategies for improvement;
- Consolidating and strengthening project partnerships to overcome weaknesses;
- Addressing the challenge of helping SMEs understand the real benefits provided by EDIHs;
- Expanding the network of companies engaged in the digitalisation journey through the EDIH;
- Enhancing training offerings and improving communication to raise awareness on these topics;

- Collaborating closely with regional service providers to make support more effective for small businesses;
- Increasing participation in digital channels and regional initiatives;
- Streamlining administrative procedures to make it easier for companies to access EDIH services;
- Organising awareness events to promote EDIH services and increase innovation readiness in businesses;
- Structuring the organisation to become more responsive and proactive in addressing the needs of companies;
- Expanding the staff to enhance service capacity.

3.2 Robustness of the European Solution

Building upon the European narrative and the Italian case, this section will critically evaluate whether EDIHs fit for purpose. The advantages and disadvantages of the EU's approach towards fostering AI adoption among SMEs will be further explored.

The data collected provide valuable insights and may serve as a basis for future policies to support their growth and effectiveness. Collaboration, capacity building and better communication emerge as central strategies for overcoming current challenges for AI adoption in Italian SMEs. Many respondents highlighted the need for greater awareness to better serve SMEs and adapt to the specific needs of digital transformation. The results suggest that there are context-specific challenges which are not fully covered by standard categories, making a more targeted approach necessary. Nonetheless, the responses to the open question indicate that while there is awareness of the main challenges, there is also a strong commitment towards strategic partnerships, staff expansion and better communication.

Advantages

Italian EDIHs operate not only at a national level but are also regionally distributed, ensuring that hubs are accessible to businesses in different parts of the country. Another advantage is the focus on networking and ecosystem-building activities enabled by EDIHs.

By acting as brokers, EDIHs help Italian SMEs connect with other businesses, research institutions, and public sector entities, both within their value chains and beyond. These connections not only foster collaboration but also enable SMEs to gain access to a broader innovation ecosystem. This approach reflects a learning process where the EU has moved beyond innovation models that focused mainly on funding research to embrace a more comprehensive view of innovation, including technology transfer, skill development, and the creation of favourable environments for digital transformation.

Additionally, the interconnected nature of the hubs helps create a unified digital ecosystem, reducing the risk of failures and ecnouraging cross-border synergies. The focus on integration can possibly ensure that the benefits of digital transformation are more widely distributed, contributing to regional development and social cohesion – key objectives of the EU's broader policy agenda.

Disadvantages

The advantages are highlighted by the fact that EDIHs, being also active at the regional level, can assure a more tailored approach. Nevertheless, this does not automatically translate into successful and closer alignment of EDIHs with local and regional needs. Accordingly, Italian representatives reported that there is still little knowledge about these tools, highlighting the need for more networking among companies which make use of them. To address this, outreach campaigns and improvements in EDIH training programmes are necessary. In this respect, the need for the availability of highly qualified technical staff is a critical point, as well as an increase in the number of employees. This aligns with the observations made in section 2.3, although only focusing on SMEs. EDIHs, created to fill the gap between AI and SMEs, face challenges in helping businesses without the required vertical expertise.

Cultural resistance to digital transformation also presents a significant disadvantage. This resistance is compounded by a lack of explicit understanding of the benefits that AI can bring, making it difficult for EDIHs to persuade more conservative businesses to take the first steps toward digital transformation.

Networking, while recognised as a key strength of the EDIH initiative, is another area that could be further strengthened. Despite their role as brokers, some hubs in Italy have reported difficulties in creating effective networks that connect SMEs with key players in the AI and digital technology sectors.

Evaluating the effectiveness of EDIHs in the context of AI is complex. While performance indicators like the number of businesses served and digital maturity improvements provide some insight, they may not fully capture the depth of transformation or the long-term impact on competitiveness. Overcoming the digital skills gap, cultural resistance to change, and regional disparities will be critical in ensuring that the initiative reaches its full potential and helps Italian SMEs succeed in the digital age. A more tailored approach would help reduce dependencies from other countries.

CONCLUSION

Drawing insights from the preceding analysis, this section will offer concluding remarks on the relationship between AI and SMEs in Europe.

The introductory chapter emphasised the crucial role of SMEs as the backbone of the EU economy, highlighting their economic significance, resilience to crises, and flexibility compared to large enterprises. As the EU sets ambitious targets for the future, particularly under the Digital Decade strategy, the digital transformation of SMEs has become a central focus. In the era of technological advancements, the digitalisation of SMEs is not just an opportunity but a necessity.

Despite recognising the importance of digitalisation for growth, many SMEs still face substantial challenges in adopting AI. This gap in adoption brings to the forefront two themes: innovation and competitiveness. One of Europe's major weaknesses lies in its difficulty in converting scientific research into marketable innovations and competitive advantages. Nowadays, SMEs face heightened competitive pressures, exacerbated by uneven access to cutting-edge technologies. Particularly, the EU is lagging behind global leaders like the US and China, especially in AI adoption. Although Europe has considerable scientific expertise, underinvestment in these critical technologies has hindered its progress compared to other leading regions. Former ECB President Mario Draghi noted in his report on European competitiveness (2024), "Europe needs to make it easier for inventors to become investors" (p. 29).

The Italian case is emblematic. With 99.9% of its businesses classified as SMEs, they play a pivotal role in the country's economy. However, Italy ranks 18th out of 27 EU member states in the DESI. AI technologies are predominantly adopted by companies that have already implemented basic digital technologies, leaving less digitally advanced SMEs behind. While Italy aligns with the goals of the Digital Decade in terms of business transformation, the adoption of AI and Big Data remains relatively low. Many SMEs lack sufficient interest in AI, primarily due to limited knowledge of its applications. Additionally, there is skepticism regarding AI's potential risks, particularly concerning biased or erroneous decision-making.

In the second chapter, although the literature addressing the adoption of AI is limited, existing research underscores the significant benefits AI can offer to SMEs in terms of addressing common challenges such as intense competition and administrative burdens. However, several barriers persist, including the overall digital maturity of SMEs, financial

constraints, data privacy concerns, regulatory complexities, skill shortages, and the inherent complexity of AI solutions.

To address these challenges, the EU introduced the EDIHs as part of its strategy to facilitate the digital transformation of SMEs. The rationale behind this is related to three different factors: policy learning and cluster policies, the barriers SMEs face in adopting AI, and the *Resource Dependency Theory*. Previous strategies revealed the need for a more localised and tailored approach to address the distinct challenges faced by SMEs in different regions. Additionally, EDIHs, linked to cluster policies, serve as regionally rooted tools that enable businesses to adopt advanced digital technologies, foster knowledge exchange, and provide essential digital infrastructure to drive innovation.

The barriers illustrated by the literature highlight the need for a more tailored and collaborative approach to overcome the specific challenges SMEs face. Through the lens of *Resource Dependency Theory*, the EU also recognises the necessity of offering SMEs access to AI technologies, training, technical support, and networking opportunities via EDIHs. This understanding is reflected in the feedback provided by EDIH representatives in Italy, where a lack of expertise and resistance to change were identified as critical obstacles to AI adoption. Furthermore, the data collected suggests that many challenges are context-specific. A more targeted approach is essential to address the peculiarities of SMEs in different regions. Nevertheless, the answers also revealed that while awareness of these challenges exists, there is a strong commitment to overcoming these obstacles through strategic partnerships, expanded expertise, and improved communication. The EDIHs represent a potentially vital tool in reducing the barriers to AI adoption and enabling SMEs to remain competitive in an increasingly digitalised global economy.

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