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Working Paper

AI Adoption Among German Firms

CESifo Working Paper, No. 11459

Provided in Cooperation with:
Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

Suggested Citation: Licht, Thomas; Wohlrabe, Klaus (2024) : AI Adoption Among German Firms, CESifo Working Paper, No. 11459, CESifo GmbH, Munich

This Version is available at:
https://hdl.handle.net/10419/308355

CESifo WORKING PAPERS

11459
2024

November 2024

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CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp
An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
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AI Adoption Among German Firms

Abstract

This paper examines the adoption of Artificial Intelligence (AI) among German firms, leveraging firm-level data from the ifo Business Survey. We analyze the diffusion of AI across sectors and firm sizes, showing a significant increase in AI usage from 2023 to 2024, particularly in manufacturing and services. The survey data allows us to explore not only sectoral patterns of adoption but also the drivers and barriers that firms face, including firm-specific characteristics and industry dynamics. Additionally, we investigate the role of managerial traits, such as risk tolerance and patience, in shaping AI adoption decisions. Finally, we assess the potential productivity impacts of AI at the firm level, with a focus on the expected long-term benefits of AI for different sectors of the German economy. Our findings contribute to the growing body of research on AI adoption by providing new evidence from a non-US context, offering valuable insights for both academia and politics.

JEL-Codes: M150, O300, C830, L200.

Keywords: artificial intelligence, AI, ifo business survey, productivity.

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November 2, 2024

1 Introduction

Artificial Intelligence (AI) is poised to significantly reshape business operations, firm strategies, and overall economic growth. While prior literature has documented the substantial influence of digital technologies such as cloud computing, data analytics, and advanced automation tools on firm-level productivity and economic outcomes (e.g., Brynjolfsson and Hitt 1996; Bresnahan et al. 2002), research on the diffusion and impact of AI remains relatively limited. AI has been characterized as a transformative General-Purpose Technology (GPT) (Brynjolfsson et al., 2019; Trajtenberg, 2018), yet understanding its adoption and effects, particularly in non-US contexts, is still an emerging field.

Despite its promising potential, evidence suggests that AI adoption has been slow and concentrated among a few large firms and sectors, primarily in the United States (McElheran et al., 2024). The European landscape, however, deserves more focus, with existing studies mainly focusing on cross-country comparisons without delving into country-specific factors that might influence adoption patterns (Czarnitzki et al., 2023; Hoffreumon et al., 2024). This paper addresses this gap by providing a detailed examination of AI adoption in the German context, leveraging unique firm-level survey data from the ifo Business Survey.

Our study makes three key contributions to the literature. First, we extend the analysis of AI adoption to Germany, a leading European economy with distinctive institutional settings, firm structures, and innovation policies. Unlike other European countries, Germany's strong industrial base and emphasis on manufacturing provide a unique environment for studying AI adoption across a diverse set of industries, including those that are traditionally less technology-intensive. This context allows us to investigate whether established theories of technology diffusion, which predominantly rely on US-based data, hold in a different institutional setting.

Second, we focus on the role of managerial characteristics, specifically risk and time preferences, in shaping AI adoption decisions. While existing studies often emphasize firm-level determinants such as size or sector (McElheran et al., 2024; Czarnitzki et al., 2023), we provide new evidence on how heterogeneity in managerial preferences influences firms' likelihood to adopt AI. This micro-level analysis contributes to the literature by

highlighting the importance of individual decision-makers in driving technology adoption, which is especially relevant for small and medium-sized enterprises (SMEs) that dominate the German economy.

Third, we assess the potential productivity implications of AI adoption at the firm level, drawing on theoretical frameworks of technology diffusion and economic growth (Brynjolfsson and Hitt, 1996; Bresnahan, 2024). We go beyond documenting adoption patterns by linking them to firms' productivity expectations and future growth potential, thereby contributing to a more comprehensive understanding of AI's economic impact. Our findings reveal a significant positive relationship between managerial risk tolerance and patience and the likelihood of adopting AI, suggesting that these preferences play a critical role in shaping firms' technology adoption paths under uncertainty.

In the following sections, we discuss the data and methodology used in our study, present descriptive statistics on AI adoption across German firms, and provide regression results to quantify the relationship between managerial preferences and AI use. We conclude with a discussion of the implications of our findings for policy and practice, emphasizing the need for targeted support to mitigate potential disparities in AI adoption and fully leverage the economic benefits of AI technology.

2 Data and descriptive results

2.1 The ifo business survey

The if business survey has run since December 1949 and its basic concept has remained relatively unchanged since then. It mainly rests on qualitative questions (mostly three-likert scale). Each month, approximately 9,000 companies across Germany participate in the survey, yielding a sample that is broadly representative of the German economy, albeit with a slight over-representation of larger firms (Hiersemenzel et al., 2022). The survey, initially launched in 1949 for the manufacturing sector, has been progressively expanded to include retailing (1950), wholesaling (1951), construction (1956), and, more recently, the service sector in 2005. The harmonization of survey questions across all sectors allows for comprehensive analyses of the overall economy, as detailed by Sauer

et al. (2023).

Recent surveys from 2019 and 2023 reveal that more than 90% of respondents occupy senior management roles, including positions such as owners, CEOs, or department heads (Sauer and Wohlrabe, 2019; Hennrich et al., 2023). This contributes significantly to the credibility and reliability of the collected data. The ifo survey encompasses a broad spectrum of firm activities, gathering information on current business conditions (status quo), past developments (ex post), as well as future plans and expectations (ex ante). Particular focus is placed on core variables such as production levels, pricing strategies, and employment figures. Beyond these essential questions, the survey also incorporates supplementary inquiries related to contemporary economic issues or firm-specific details pertinent to ongoing research projects (Demmelhuber et al., 2023). At the heart of the survey are two fundamental questions: the assessment of the current business situation and expectations for the next six months. These questions form the foundation of the widely recognized ifo Business Climate Index (Sauer and Wohlrabe, 2018). The excellent forecasting power of the ifo surveys is reviewed in Lehmann (2023).

In June 2023 and 2024, companies were asked about their use of Artificial Intelligence (AI) in the monthly ifo Business Survey. The survey did not specify the types of AI applications in detail. It only asked whether AI is already being used in the company, whether its use is planned, whether it is being discussed, or whether it has no relevance at all. In 2023 6,332 companies provided an answer, in 2024 6,095.

2.2 Baseline results for 2024

Table 1 provides a comparison of AI adoption among German firms between 2023 and 2024. In June 2023, 13.3% of companies nationwide reported using AI (Schaller et al., 2023). This figure more than doubled within a year, with 27% of companies indicating that they use AI in 2024. This significant increase is observed across all sectors. As in the previous year, the manufacturing industry was a key driver of this growth, where nearly one-third of companies (31%; 2023: 17.3%) reported using AI. The increase in AI usage in manufacturing can be attributed to the industry's emphasis on automation, predictive maintenance, and process optimization, which align well with AI applications.

Additionally, the share of manufacturing companies where AI had no relevance decreased notably from 31.1% in 2023 to only 13.1% in 2024, indicating a growing recognition of AI's potential benefits in this sector.

AI adoption was less frequent in the trade, services, and construction sectors. In the services sector, AI usage increased from 12.2% in 2023 to 27.7% in 2024, demonstrating the sector's growing interest in leveraging AI for customer service, market analysis, and operational efficiency. The trade sector also showed a marked rise in AI adoption, with usage growing from 10.5% in 2023 to 22% in 2024. However, a considerable proportion of companies in trade (29.8%) and construction (41.8%) still indicated that AI has no relevance for them. In the construction industry, where AI usage remains the lowest, the share of companies using AI doubled from 7.1% in 2023 to 11.6% in 2024. This modest increase may reflect the challenges that construction companies face in integrating AI into their workflows, which are often complex and less amenable to automation.

Despite these variations, the overall trend suggests that the discussion and planning for AI adoption have become more prevalent in all sectors. The share of companies that are currently discussing AI's potential dropped slightly overall, from 36.7% in 2023 to 34.3% in 2024, likely because many of these companies have moved forward to the planning or implementation stages. Notably, the proportion of companies that have planned AI adoption increased from 9.2% in 2023 to 17.5% in 2024, indicating a growing readiness among firms to invest in AI technologies.

This increased adoption aligns with the findings of Czarnitzki et al. (2023), who emphasize that AI adoption is associated with significant productivity improvements at the firm level, although the impact varies across industries. In sectors like manufacturing and services, where routine tasks are more prevalent, AI can automate processes, leading to efficiency gains and productivity enhancements. In contrast, industries like construction and trade, which are often characterized by less routine and more manual tasks, face challenges in realizing the same level of productivity gains through AI.

Overall, the data suggest that AI is gaining importance in the German economy, and companies across various sectors are increasingly exploring its potential. While the rate of adoption and the perceived benefits of AI differ among sectors, a general trend toward

recognizing AI's strategic value is evident. As AI technologies continue to evolve, it will be important for companies to invest in complementary assets, such as employee training and organizational changes, to fully harness AI's productivity-enhancing capabilities.

Table 1: AI Adoption by Sector in 2023 and 2024

	Overall	Manufacturing	Services	Trade	Construction
2023					
In use	13.3	17.3	12.2	10.5	7.1
Planned	9.2	12.9	7.2	8.8	7.9
Discussed	36.7	38.7	38.4	31.1	25.3
No relevance	40.8	31.1	42.2	49.6	59.7
2024					
In use	27.0	31.0	27.7	22.0	11.6
Planned	17.5	20.1	16.5	15.5	17.0
Discussed	34.3	35.7	34.5	32.7	29.7
No relevance	21.2	13.1	21.4	29.8	41.8

2.3 Comparison across branches and size classes

There are significant differences in the use of AI in the individual industries within the sectors. Overall, however, it can be stated that the use and plans for future use have increased across all sectors. This increase was particularly evident in the textile industry, for example, and in the areas of consultancy, legal/tax advice and auditing. Here, the proportion of AI users has risen by up to 37.9 percentage points in the last twelve months. With growth rates of less than 5 percentage points, growth was lowest in transport/pipeline services and metal production.

A closer look at the absolute usage figures for the individual sectors reveals that the frontrunners are the service providers (see Figure 1). Companies in the advertising and market research sector, service providers in the information technology sector and information services in particular stand out with AI usage rates of 72.3%, 61.7% and 60.2% respectively. Transport/pipeline services and gastronomy bring up the rear in

the service sector. Here, only 11.8% and 16.4% respectively use AI. Although the usage rates in the manufacturing industry are on average higher than those of service providers, values between 60% and 70% cannot be found. At 52.7%, motor vehicle manufacturers are clearly ahead in the manufacturing sector. AI is also used intensively by manufacturers of data processing equipment, clothing and pharmaceutical products. Overall, it can be seen that the proportion of companies in the manufacturing sector in which AI plays no role at all is very small. In almost 90% of companies, the introduction of AI is at least being discussed, if not concrete steps are planned or an AI application is already being used.

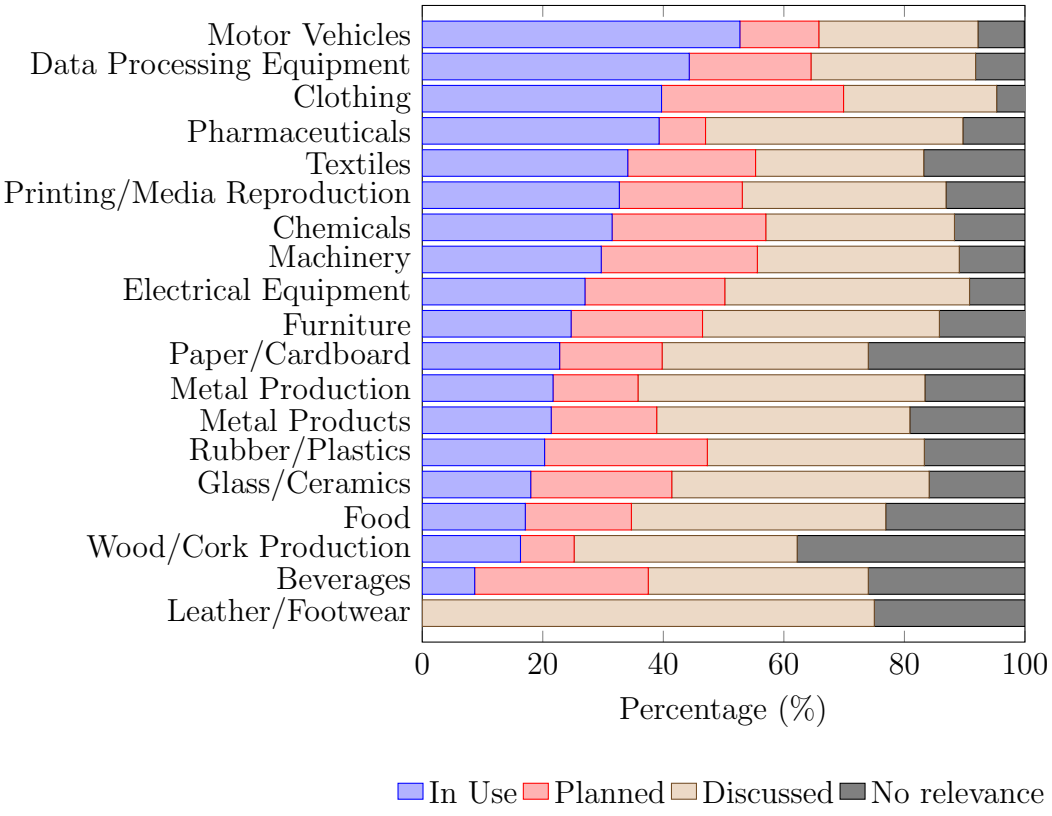

Figure 1: Introduction of AI in the various manufacturing industries in 2024

As Table 2 suggests the difference in AI adoption is not only evident at sector level but also at firm size level. Large companies are significantly ahead in AI adoption, particularly in industries like manufacturing and services, while SMEs are slower to implement these technologies and often view AI as less relevant to their operations.

Among large companies, 34.3% have already adopted AI, with the manufacturing sector leading at 44.1%. This indicates that larger firms, especially those in more technology-

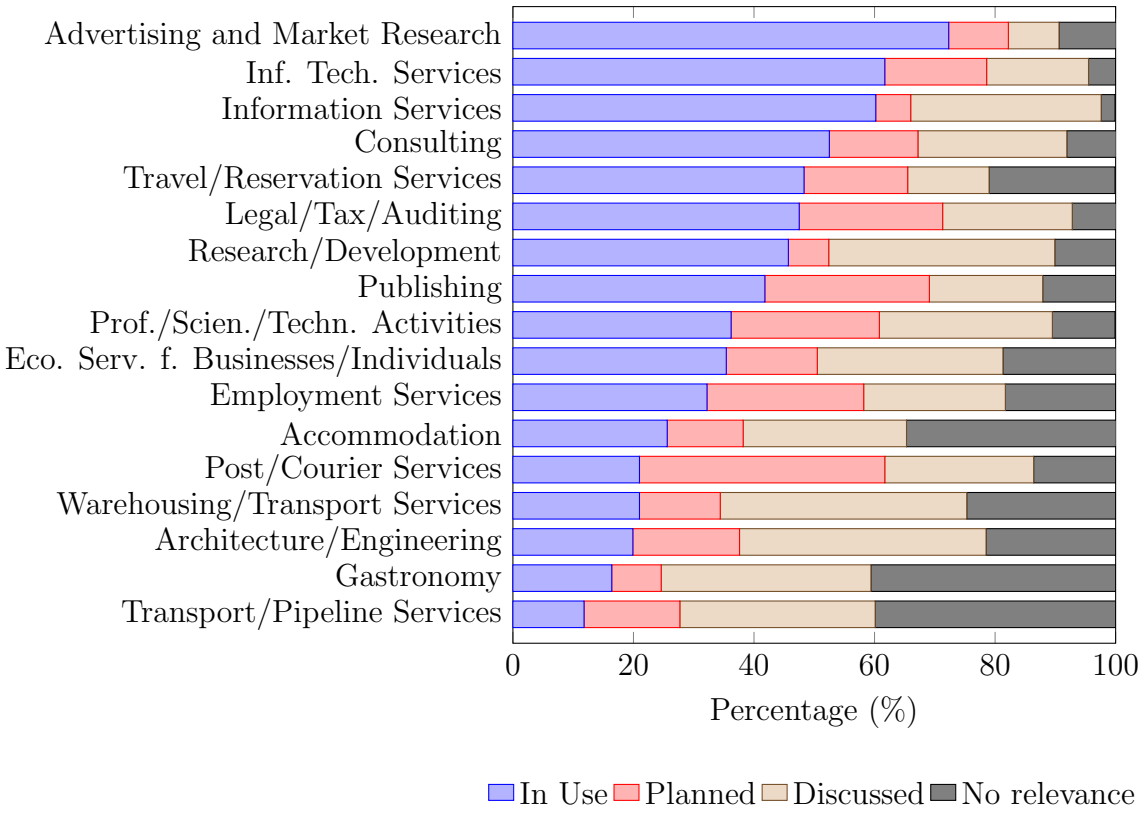

Figure 2: Introduction of AI in the various services in 2024

intensive sectors, have the resources and infrastructure to integrate AI into their processes more rapidly. By contrast, SMEs show much lower levels of current AI usage, with only 21.6% of firms reporting AI implementation. The gap is especially wide in the construction sector, where 24.5% of large firms have adopted AI compared to just 5.8% of SMEs. Even in trade and services, where AI use is generally higher, large firms are outpacing their smaller counterparts.

Planned AI adoption also follows this trend, with 23% of large companies planning to adopt AI in the near future, compared to 16.8% of SMEs. As in the AI usage, this gap is even more pronounced in construction: while 34.1% of large companies have concrete plans to implement AI, only 9.3% of SMEs do. Similarly, in manufacturing, 24.9% of large companies are preparing to adopt AI, compared to 19.1% of SMEs. This discrepancy suggests that larger firms are more forward-looking when it comes to integrating AI into their operations, likely because they have more access to financial resources, talent, and technology infrastructure.

AI discussions (our indicator of future potential adoption) are taking place in both

large companies and SMEs, but again, large firms are ahead. More than 32% of large companies across all sectors are engaged in discussions about AI, with a particular emphasis on services and trade. SMEs are also having these discussions, especially in manufacturing, where 41.4% are actively exploring AI options.

A much higher proportion of SMEs, particularly in construction and trade, report no interest in AI. In construction, for example, 54.7% of SMEs view AI as irrelevant, compared to only 12.8% of large firms. This highlights a challenge for smaller companies, which may lack the resources or expertise to see how AI can be applied to their specific business needs. Even in sectors like trade, where AI could bring significant benefits, 38.1% of SMEs consider AI irrelevant, compared to just 13.5% of large companies. This difference suggests that larger firms are more aware of AI's potential advantages, or they may simply have more capacity to experiment with new technologies.

Considering the previously mentioned obstacles SMEs face, AI adoption among self-employed explains itself. It is significantly lower compared to both SMEs and large companies. Only 14.4% have implemented AI, with most of this concentrated in the services sector (23.2%). Planned adoption is similarly modest, with just 9.4% overall, and almost no planned AI adoption in construction and trade. Discussions about AI are occurring among 28.8% of the self-employed, particularly in manufacturing, but a substantial majority consider AI irrelevant to their operations. Notably, 47.4% of self-employed individuals in manufacturing and 75.7% in construction report no interest in AI.

Overall, the data shows a clear divide between firm sizes in terms of AI adoption. Large companies are not only more advanced in terms of current AI usage but also have more concrete plans and active discussions about future adoption. In contrast, SMEs, while increasingly considering AI, are slower to implement it. This slower pace can be attributed to a combination of limited financial resources, a lack of AI-related expertise, and uncertainty about the relevance of AI to their operations. These arguments apply all the more to the self-employed.

Table 2: AI Adoption by Firm Size

	Overall	Manufacturing	Services	Trade	Construction
Overall					
In use	27.0	31.0	27.7	22.0	11.6
Planned	17.5	20.1	16.5	15.5	17.0
Discussed	34.3	35.7	34.5	32.7	29.7
No relevance	21.2	13.1	21.4	29.8	41.8
Self-employed					
In use	14.4	3.4	23.2	12.2	2.9
Planned	9.4	9.5	10.7	6.9	2.9
Discussed	28.8	33.7	27.8	26.0	18.6
No relevance	47.4	53.4	38.3	55.0	75.7
SME					
In use	21.6	19.5	25.7	18.0	5.8
Planned	16.8	19.1	17.4	12.7	9.3
Discussed	33.7	41.4	29.9	31.2	30.2
No relevance	27.9	20.1	27.0	38.1	54.7
Large companies					
In use	34.3	44.1	30.3	29.8	24.5
Planned	23.0	24.9	20.8	21.2	34.1
Discussed	32.8	28.0	35.7	35.4	28.6
No relevance	9.9	2.9	13.1	13.5	12.8

Notes: SME - Industry: < 500 employees, Services: < 10 Million € Revenue, Construction: < 200 employees, Trade: < 25 Million € Revenue.

2.4 Comparison to other studies

How do these survey results compare across countries? Table 3 gives an answer. For the USA, the figures and the development of AI usage are not yet clear. McElheran et al. (2024) find a usage rate of almost 6% among 850,000 companies surveyed in the USA. If the size of the companies is taken into account, this figure rises to 18%. However, the

figures relate to 2018. In a recent survey (February 2024), Bonney et al. (2024) also only document values of around 5% for the USA. However, the degree of use among larger companies is also increasing there. This would imply that there has been no fundamental increase in the use of AI. Eurostat (2024) provides results for the European countries for the year 2023. The EU average was 8% of companies with at least 10 employees. At 11.6%, the figures for Germany were not far off our results Schaller et al. (2023) for 2023. The highest usage rates were found for Denmark (15.2%), Finland (15.1%) and Luxembourg (14.4%). Spain, France and Italy are in the midfield with AI usage of 9.2%, 5.9% and 5.0%.

Table 3: AI Adoption by Country and Year

Study	Country	No. of obs.	Adoption rate (%)	Year
McElheran et al. (2024)	US	850,000	5.8; 18.2 (weighted)	2018
Bonney et al. (2024)	US	164,500	5.4	2024
Eurostat (2024)	EU	n.a.	7.6; 8.0	2021, 2023
ifo Business Survey	DE	6,332; 6,095	13.3; 27.0	2023; 2024
Czarnitzki et al. (2023)	DE	5,852	7.0	2019

2.5 Development at the firm level

In the previous subsection, we presented aggregated percentages on AI adoption among German firms, illustrating the growing importance of AI across various sectors. However, these figures do not reflect the dynamic progression of firms transitioning between different stages of AI adoption. To gain a deeper understanding of these dynamics, we now focus on firm-level transitions between different AI adoption states from 2023 to 2024.

Table 4 provides a detailed view of these transitions, showing how firms moved between categories such as "In use", "Planned", "Discussed", and "No relevance". We also report the number of firms for which no response was provided in 2024. Specifically, 1,187 firms provided a response in 2023 but not in 2024, and 1,423 firms responded in 2024 but not in 2023.

Among firms that were already using AI in 2023, 56.7% continued to do so in 2024, indicating a strong retention rate among early adopters. However, 25.4% of these firms did not provide a response in 2024, and 9.6% shifted to the "Planned" category, suggesting some re-evaluation or adjustment in their AI implementation strategies.

Firms that had planned to adopt AI in 2023 showed notable progress, with 34.9% transitioning to active AI use in 2024. This finding indicates that many firms are moving beyond the planning stage to actual implementation. Nonetheless, 28.3% of firms remained in the planning stage, reflecting the challenges in moving from planning to execution.

For firms that were only discussing AI in 2023, 17.1% moved into the "In use" category, while another 17.1% advanced to the planning stage. This trend highlights the gradual shift from exploratory discussions to more concrete adoption efforts.

Lastly, firms that considered AI as "No relevance" in 2023 also showed some movement: 38.8% remained disengaged from AI in 2024, but 25.2% began discussing AI, and 5.4% moved to the planning stage. This suggests that even among initially hesitant firms, AI is starting to gain traction as a strategic consideration.

Table 4: Transition Matrix of AI Adoption in 2024 conditional on usage in 2023

2023 ↓ 2024 →	In use	Planned	Discussed	No relevance	No answer		N
In use	56.7%	9.6%	6.5%	1.8%	25.4%	100%	737
Planned	34.9%	28.3%	12.5%	2.4%	22.0%	100%	505
Discussed	17.1%	17.1%	34.6%	6.9%	24.4%	100%	1835
No relevance	4.7%	5.4%	25.2%	38.8%	25.9%	100%	2615
No answer	25.2%	15.3%	33.9%	25.6%	–	100%	1187
N	1329	851	1806	1470	1423		6879

2.6 Impact on productivity

In the ifo Business Surveys, companies were asked about the overall economic productivity potential of AI as well as the productivity potential of AI for their respective companies

over the next five years. This is relevant for two reasons. Firstly, companies will only use AI if they expect corresponding productivity increases. Secondly, aggregating company-specific productivity expectations offers a way to estimate the overall economic growth opportunities of AI for the coming years.

Specifically, companies were first asked whether they expect any positive effects of AI on productivity at all. The overwhelming majority of companies expect positive productivity effects from AI, both for their own company (70%) and for the overall economy (84%), as shown in Table 5. Companies that expect positive productivity effects from AI were also asked to estimate the extent of the expected productivity increases over the next five years. The question was framed as an interval, which allowed the companies to express their uncertainty regarding these expectations. Companies that expect positive productivity effects estimate the cumulative productivity gains over the next five years for their company to be between an average of 8% and 16%, and for the overall economic potential to be between 9% and 20%. The wide range in both cases reflects the uncertainty among companies about the possible productivity increases. There are significant differences between industries. The highest expected effects are in the service and trade sectors, followed by the manufacturing industry. In the construction industry, the expected productivity increases are the lowest. This aligns with the low proportion of companies using AI in the construction industry.

A consistent pattern across all industries is that the overall economic expectations are higher than the company-specific expectations. Since the ifo Business Surveys are approximately representative of the German economy (Hiersemenzel et al., 2022), this clear difference between the average company-specific and overall economic expectations is surprising at first glance. This could be due to overly optimistic overall economic expectations resulting from the AI hype, which may not ultimately be realized at the company level. Another reason could be an expected reallocation toward sectors that anticipate higher productivity gains from AI. In order to better assess the cause, in-depth analyses and further assessments of companies over time are required.

Czarnitzki et al. (2023) further supports the notion that the impact of AI on productivity is nuanced and varies significantly depending on firm-specific characteristics such

as size, industry, and the firm's existing technological infrastructure. Their study, which employs a firm-level analysis, finds that while AI adoption is associated with increased productivity, the magnitude of this effect is heterogeneous across firms. They highlight that firms in sectors with a higher intensity of routine tasks tend to benefit more from AI adoption, as AI technologies often replace or augment routine work, leading to efficiency gains. Additionally, the study emphasizes the importance of complementary investments, such as organizational changes and employee training, in realizing the full productivity potential of AI. These findings align with the observed industry differences in the ifo survey, suggesting that the sectors where firms expect higher productivity gains (e.g., services and trade) are likely those where AI can most effectively complement human labor and existing processes.

What macroeconomic implications can be derived from the company-specific expectations, and how do these estimates compare to the literature? If one multiplies the mean of the probability interval by the proportion of companies expecting positive productivity effects, an average expected overall economic productivity growth of 12% is obtained for the next five years based on overall economic expectations, and 8% based on company-specific expectations. The "bottom-up" estimate of 8% is likely a more realistic estimate, as it is based on the average expected productivity gains of companies, about which the survey participants have better knowledge. It should first be noted that the average expected 8% would also mean significant productivity increases that exceed the growth rates of recent years. Acemoglu (2024) estimates the productivity growth due to AI in the next 10 years at only 0.7%. This rather pessimistic forecast is partly due to the fact that the analysis only takes into account the cost-reducing automation effects of AI. Other scenarios, which also consider the realization of Artificial General Intelligence (AGI), arrive at triple-digit growth rates over the next 10 years. Sachs (2023), on the other hand, forecasts productivity growth of 1.5% per year for the USA due to AI. This is very similar to the average expectations of companies in the ifo survey. Whether the expected productivity increases will actually be achieved in the coming years remains to be seen.

Table 5: Expected Productivity Potential

	Expected Overall Economic Productivity Potential				
	Overall	Manufacturing	Services	Trade	Construction
No Increase (%)	16.4	15.5	11.8	22.8	44.1
Increase (%)	83.6	84.5	88.2	77.2	55.9
Increase between X and Y %					
X (%)	9.2	7.8	10.2	9.1	8.2
Y (%)	19.6	17.3	20.9	23.0	14.8
Average (%)	14.4	12.6	15.6	16.1	11.5
Average Overall (%)	12.0	10.6	13.7	12.4	6.4
	Expected Company-Specific Productivity Potential				
	Overall	Manufacturing	Services	Trade	Construction
No Increase (%)	30.0	25.5	26.4	40.7	58.6
Increase (%)	70.0	74.5	73.6	59.3	41.4
Increase between X and Y %					
X (%)	7.5	6.4	8.6	7.3	5.3
Y (%)	15.5	13.7	17.3	15.5	10.7
Average (%)	11.5	10.1	13.0	11.4	8.0
Average Overall (%)	8.1	7.5	9.5	6.8	3.3

3 Correlates with firm and managers characteristics

3.1 Current State of the firm

Is the AI usage determined by the current state of business of a firm or the economic outlook? In order to answer this question we utilize the two main sentiment questions: assessment of the current business situation and the business expectations for the next six months. These two questions form the basis of the famous ifo Business Climate Index. It allows us to approximate the economic outlook and the present condition of firms, and thus, examine whether firms' decisions to adopt AI are influenced by their perception of their own business environment.

Regarding the business situation, the respondents are asked to answer if they assess their current situation as 'good', 'satisfactory', or 'poor'. With respect to the business expectations, they are asked if they expect the business situation to 'become better', 'stay the same', or 'get worse'. We approximate the current state of the firm and the general outlook by taking the average over the first six months of 2024 of both variables. In the following analysis we leave out the construction sector as many firms provide several answers for different crafts and no general assessment for the whole firm is available.

In Figure 3 we show the percentages of AI usage conditional on the three states for the current situation and expectations. Firms reporting a "good" business situation show higher AI adoption rates compared to those in "satisfactory" or "poor" conditions. Similarly, firms that expect an improvement in their business situation are more likely to be adopting or planning to adopt AI, compared to those that expect no change or a deterioration.

These patterns suggest that firms in a stronger economic situation, with a more optimistic outlook, may be more likely to invest in advanced technologies such as AI. In contrast, firms that are struggling or facing uncertain future conditions might be more risk-averse and less willing to commit resources to AI adoption. This aligns with prior research indicating that firms' current performance and outlook significantly influence their readiness to adopt new technologies (Brynjolfsson and Hitt, 2000; Aral et al., 2012; Bresnahan et al., 2002; Thompson and Heron, 2006; Geroski, 2000).

3.2 The relation to managers risk and time preferences

The relationship between managers' risk and time preferences and their firms' likelihood of adopting AI technologies is explored in this section. Risk and time preferences are fundamental elements in models of economic decision-making, influencing decisions made under uncertainty as well as the discounting of future income. Heterogeneity in risk preferences has been shown to explain variations in financial decisions, entrepreneurial activity, labor market outcomes, and health behavior (Dohmen et al., 2011; Bonin et al., 2007). Similarly, heterogeneity in time preferences has been linked to differences in financial decision-making and educational choices (Falk et al., 2018; Golsteyn et al., 2014).

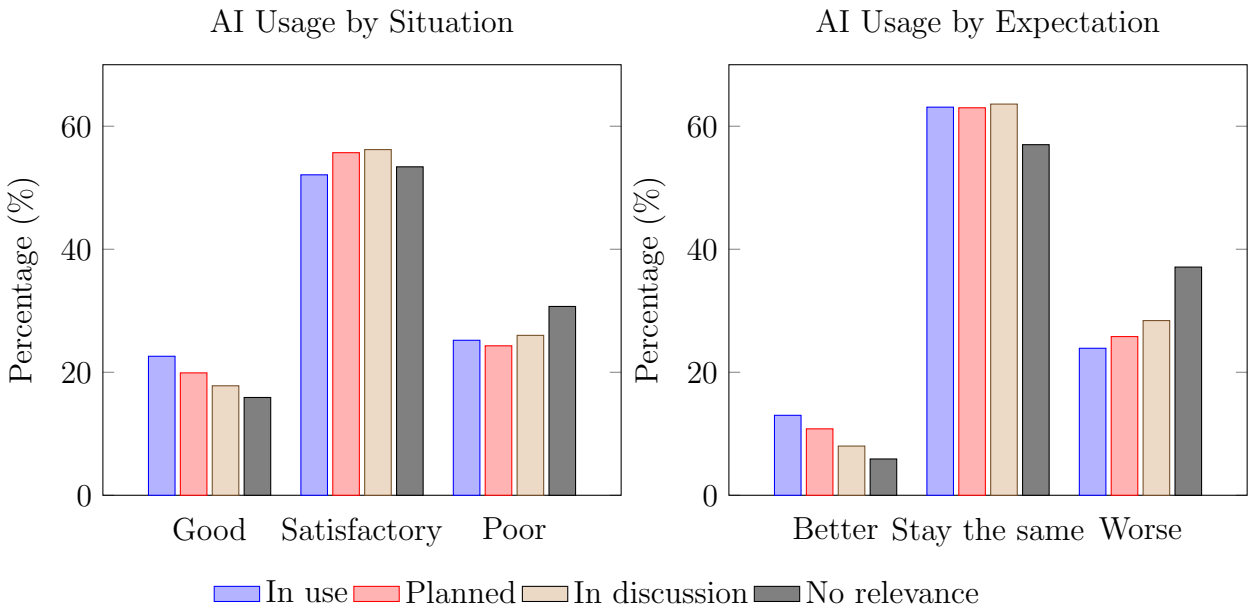

Figure 3: AI Usage by Situation and Expectation

Such heterogeneity in preferences also has broader macroeconomic implications (Falk et al., 2018; Sunde et al., 2022).

To investigate whether these preferences also influence firms' adoption of AI, we leverage data from Baarck et al. (2024), who measured risk and time preferences of respondents in the ifo Business Survey using experimentally validated survey questions developed by Falk et al. (2023). The elicitation of preferences took place in the March and August 2022 survey waves. Respondents were asked the following questions:

- **Risk Tolerance**: Are you a person who is generally willing to take risks, or do you try to avoid taking risks? (scale 0-10).
- **Patience**: Are you a person who is generally willing to give up something today in order to benefit from it in the future? (scale 0-10).

The data contain 5,952 responses for risk preferences and 5,764 responses for patience. We run a linear probability model of the following form:

$$AI_i = \beta_1 risk_i + \beta_2 patience_i + \beta_3 size_s + \beta_4 industry_b + \varepsilon_i \quad (1)$$

where AI_i is a dummy variable equal to one if a firm has already adopted AI in 2023 or 2024. We control for size and industry fixed effects.

The regression results documented in Table 6 show a significant positive relationship between both risk tolerance and patience and the probability of AI adoption. The coefficients can be interpreted as percentage point changes in the probability of AI adoption. For AI adoption in 2024, a one-unit increase in risk tolerance is associated with a 2.4 percentage point increase in the probability of adopting AI, while a one-unit increase in patience corresponds to a 2.0 percentage point increase. Notably, the effects remain robust whether risk tolerance and patience are included individually or simultaneously in the regressions, indicating that these two preferences independently contribute to firms' decisions to adopt AI.

When considering the pooled data for 2023 and 2024, the coefficients decrease slightly to 1.6 percentage points for risk tolerance and 1.4 percentage points for patience, suggesting that while these preferences are critical drivers of AI adoption, their impact may be slightly weaker when viewed over multiple years. The results imply that firms with managers who are more risk-tolerant and patient are better positioned to invest in new technologies like AI, which often involve significant upfront costs and uncertain returns.

While these findings highlight the importance of managerial preferences in shaping firms' technology adoption decisions, it is important to note that the results represent correlations rather than causal evidence. The observed relationships may be influenced by unobserved factors, such as specific firm-level characteristics or external economic conditions, that could simultaneously affect both managerial preferences and AI adoption. Thus, the findings should be interpreted with caution as suggestive evidence rather than definitive proof of a causal link. Nevertheless, the inclusion of both risk tolerance and patience in the regression models does not substantially alter the results, suggesting that these preferences have independent and complementary effects. This is consistent with prior research, which emphasizes the role of heterogeneity in preferences in explaining firm behavior (Dohmen et al., 2011; Bonin et al., 2007; Falk et al., 2018; Sunde et al., 2022).

Table 6: Influence of Risk and Patience on AI adoption

	Data 2024			Data 2023 and 2024		
	(1)	(2)	(3)	(4)	(5)	(6)
Risk	0.024***		0.019***	0.016***		0.014***
	(0.003)		(0.004)	(0.002)		(0.002)
Patience		0.020***	0.016***		0.014***	0.011***
		(0.003)	(0.003)		(0.001)	(0.002)
Branch FE	Yes	Yes	Yes	Yes	Yes	Yes
Size FE	Yes	Yes	Yes	Yes	Yes	Yes
N	3864	3945	3351	9555	9556	7862

4 Concluding Remarks

The adoption of Artificial Intelligence (AI) among German has accelerated significantly from 2023 to 2024, reflecting a growing recognition of AI's potential to enhance and drive productivity and innovation. Our analysis of firm-level data reveals that, though spreading AI adoption, it remains highly concentrated in larger companies and in the manufacturing and services sector. Small and medium-sized companies (SMEs), as well as firms in the trade and construction sector, lag behind in AI implementation. Reasons being limited resources and perceived irrelevance.

Managerial characteristics, particularly risk tolerance and patience, play a crucial role in determining AI adoption. Our findings suggest that firms led by managers with a higher willingness to take risks and a forward-looking mindset are more likely to adopt AI technologies. This highlights the importance of not only firm-level resources but also the personal attributes of decision-makers in shaping technology adoption paths.

In terms of productivity, the majority of firms expect AI to generate significant gains over the next five years, particularly in the service and manufacturing sectors. However, there is considerable uncertainty regarding the magnitude of these benefits, and the realization of AI's full potential will likely depend on complementary investments in skills, infrastructure, and organizational changes.

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