Economics of ChatGPT: a labor market view on the occupational impact of artificial intelligence

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Abstract

Purpose – The study investigates the influence of ChatGPT on the labor market dynamics, aiming to provide a structured understanding of the changes induced by generative AI technologies.

Design/methodology/approach – An analysis of existing literature serves as the foundation for understanding the impact, while the supply and demand model helps assess the effects of ChatGPT. A text-mining approach is utilized to analyze the International Standard Occupation Classification, identifying occupations most susceptible to disruption by ChatGPT.

Findings – The study reveals that 32.8% of occupations could be fully impacted by ChatGPT, while 36.5% might experience a partial impact and 30.7% are likely to remain unaffected.

Research limitations/implications – While this study offers insights into the potential influence of ChatGPT and other generative AI services on the labor market, it is essential to note that these findings represent potential implications rather than realized labor market effects. Further research is needed to track actual changes in employment patterns and job market dynamics where these AI services are widely adopted.

Originality/value – This paper contributes to the field by systematically categorizing the level of impact on different occupations, providing a nuanced perspective on the short- and long-term implications of ChatGPT and similar generative AI services on the labor market.

Keywords Large language models, Artificial intelligence, Automation, Labour saving technology, ChatGPT, Labour market, Generative AI, Occupational classification

Paper type Research paper

Introduction

ChatGPT, or Chat Generative Pre-Trained Transformer, is a chatbot developed by OpenAI. It was launched on November 30, 2022, and it soon drew attention for its comprehensive responses and precise answers to user prompts. Since its release, ChatGPT had quickly gathered 100 million monthly active users. It was quicker than TikTok and Instagram, which took 9 and 30 months to reach 100 million users who were actively using the app.

This public interest appears to be simply the tip of the iceberg. There have been reports of Microsoft, Google, Baidu, and other enterprises attempting to launch similar products. Microsoft is one of the leading investors in OpenAI, and Google's experimental conversational AI service, Bard, was recently introduced. ChatGPT, Bard, and other services like Jasperpy.a, coi, ELSA, DialoGPT, Chinchilla AI, and Replica are examples of Generative AI and Large Language Models that are popular now.

JEL Classification — O33, E24, J21, J24

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The ChatGPT and its impact on economies worldwide may be examined from various perspectives, and each of these perspectives has something important to offer. It should go without saying that the impact of these artificial intelligence-powered services on labor forces and the labor market is the most critical area of all. That is why there is a mass of literature in the field of labor economics on the topics of automation, robotics, technological changes, and other innovation related to the labor market.

Because ChatGPT and other AI-powered services may automate many tasks that human workers previously performed, their implementation can potentially cause significant disruption in specific market segments. ChatGPT is expected to have a significant impact on the labor market, as this may cause particular employment to become redundant while simultaneously resulting in the creation of other jobs. On the other hand, the transition phase may pose problems for workers who, to maintain their competitiveness in the labor market, may require further training or upgrading.

Recent research conducted by McKinsey aimed to model the potential effects of artificial intelligence in general on the global economy. Computer vision, natural language, virtual assistants, robotic process automation, and advanced machine learning are the five primary categories of artificial intelligence. According to their analysis, seventy percent of firms may have deployed at least one category of AI technology, and less than fifty percent may have fully integrated all five categories. By 2030, the potential impact of artificial intelligence on global economic activity may amount to around 13 trillion dollars. This potential impact would be the outcome of increased productivity and other channels associated with the deployment of AI.

On the other hand, several problems could slow down how quickly AI is adopted and used. For example, late adopters firms might fall behind in building capabilities and attracting talent. AI is also likely to have different effects on different companies, employees, and countries, which could make it harder to get the most out of it. It is possible that the effects of AI will not build up in a linear line but rather at different rates for different countries, firms, and employees. In general, artificial intelligence can contribute positively to global economic activity; yet, to maximize this potential, it is required to address the widening inequities that exist between countries, firms, and workers.

As mentioned earlier, the most important aspect of AI in the global economy is its relation with the labor market. The impact of artificial intelligence on employment and jobs is diverse and complex, with both positive and negative aspects. On the one hand, AI can automate numerous processes, resulting in employment losses in specific industries. On the other side, AI can potentially facilitate work and generate new roles. Many new occupations boosted by AI, such as digital assistant engineers, warehouse robot engineers, and AI marketing specialists, will likely arise soon. The influence of artificial intelligence on workers will rely on the race between automation and augmentation, which refers to the degree to which AI is employed to automate or augment tasks in various occupations.

According to (Autor, 2022), technological innovation's influence on the workplace is characterized by conflicting forces of automation and augmentation. Researchers and legislators should consequently focus on AI's potential for automation or augmentation and job redesign.

All in all, we must be careful about AI's unintended consequences. ChatGPT triggered a new wave of concern about incorporating AI into daily life. In a comprehensive view of the harm of artificial intelligence Acemoglu (2021) discusses the potential economic, political, and social costs of the current path of AI technologies. He argues that if AI continues to be deployed and remains unregulated, it may cause harm to competition, consumer privacy, and consumer choice, lead to excessive automation and inequality, push down wages, and damage political discourse.

He suggests that these costs are not inherent to the nature of AI but are related to how they are being used and developed. The best way to prevent these costs is to regulate AI and redirect AI research toward more positive outcomes. Acemoglu (2021) accepts that regulation

may be difficult and that the importance of these potential harms justifies having these conversations.

The purpose of this paper is to examine the impact of AI-related services, specifically ChatGPT, on different occupations in the labor market. The paper will begin with a brief literature review, analyzing some of the latest studies and their most significant findings. Using the supply and demand framework, I will then delve into a comprehensive evaluation of ChatGPT's effects on the labor market. This evaluation will examine the short-term and long-term consequences of this innovation on the labor market. Finally, I will present a model to see what major occupations are the most at-risk jobs due to AI-related services like ChatGPT. This paper aims to provide an in-depth understanding of the influence of AI-related services like ChatGPT on the labor market and the potential consequences that may arise from their implementation. It serves as a valuable resource for policymakers and corporations as they navigate the rapidly changing landscape of technological advancements and their impact on the workforce.

Literature review

The origin of labor-saving technologies (also known as LSTs) may be traced all the way back to the start of the Industrial Revolution. During the Industrial Revolution, production methods based on machines began to replace those that relied on human labor. This led to significant increases in both productivity and efficiency. The introduction of the steam engine and other mechanical improvements paved the way for implementing LSTs in various industries, including textiles, manufacturing, and agriculture. These breakthroughs led to higher economic growth and improved people's standard of living since they boosted productivity and reduced the labor required to manufacture new products (Staccioli & Virgillito, 2021a).

During the 20th century, LSTs continued to develop, and the introduction of electricity was a significant factor in their evolution. The expansion of computer and information technology in the latter half of the 20th century resulted in the widespread adoption of robots and automation across various business sectors, including the manufacturing and transportation sectors. Montobbio, Staccioli, Virgillito, and Vivarelli (2022) find that robots have had a labor-saving effect, but the size and direction of this effect vary depending on the specific industry, skill level, and country. Another research (Staccioli & Virgillito, 2021b) provides a historical overview of labor-saving technologies through patent analysis; this study documents the substitution of human functions by the latest wave of technological innovation.

Also, as a result of companies' ongoing efforts to boost their levels of productivity and competitiveness, LSTs are becoming more popular in economies worldwide. LSTs can increase productivity and generate new employment opportunities; nevertheless, they can replace workers in occupations requiring low skill levels.

It is possible to classify the effects of labor-saving technologies into two primary categories. Within each category, we can evaluate these technologies' impact on the supply and demand of labor. Because of different natures, we can divide LSTs into Automation or Robots and Artificial Intelligence (Figure 1).

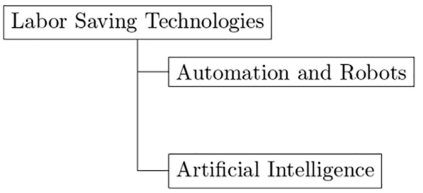

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Figure 1.
Two main category of labor-saving technologies

Automation, robots and labor market

The impact of automation on the labor market has been widely studied and debated in the labor economics literature. Some studies suggest that automation may lead to job displacement, particularly for workers in routine tasks. This displacement can result in unemployment, wage stagnation, and an increase in income inequality (Berg, Buffie, & Zanna, 2016). For example, Moll, Rachel, and Restrepo (2022) argue that introducing new technology can worsen inequality because the advantages accrue to highly trained labor and capital owners in the form of increased capital revenues. They establish a hypothesis linking technology to the distribution of income and wealth and utilize it to examine the implications of automation on inequality. This paper demonstrates that automation can increase inequality by increasing wealth returns and causing stagnating wages and income at the bottom of the distribution.

However, other studies argue that automation can also create new job opportunities, particularly in high-skilled jobs, and increase productivity and economic growth (Autor, 2015).

A recent study (Aghion, Antonin, Bunel, & Jaravel, 2022) discusses the effects of automation on employment, considering two contrasting views. The first view sees automation primarily destroying jobs, while the second view highlights the productivity effect of automation, which leads to increased demand for products and higher employment. The authors provide evidence supporting the second view in the case of France and show that the literature on automation and employment tends to support this view in a broad set of countries. The authors conclude that automation can actually be a positive force for employment by making firms more competitive and enabling them to win new markets.

Hassel, Özkiziltan, and Weil (2022) review the literature on the impact of automation on employment and wages, focusing on how it affects different skill groups differently. It covers literature from the past two decades in OECD countries. The study finds that high-skilled workers tend to benefit from automation with positive employment outcomes, while middle-skilled workers tend to have adverse outcomes. The effects on low-skilled workers are mixed. The results vary depending on the research design, with negative employment outcomes being found when identification strategies rely solely on occupational data.

Similarly Hirvonen, Stenhammar, and Tuhkuri (2022) present evidence of the effects of advanced technologies on employment. Their study focuses on a technology subsidy program in Finland and demonstrates that advanced technologies led to increases in employment and no change in skill composition. The authors used text analysis and machine learning methods to track firms and workers and measure specific technological changes. The findings are explained through a theoretical framework that contrasts two types of technological change: process vs. product. The results indicate that firms used new technologies to produce new types of output rather than replace workers, which contrasts with the idea that technologies necessarily replace workers or are skill-biased.

Overall, the literature suggests that the impact of automation on the labor market is complex and depends on various factors, such as the speed and extent of automation adoption, the types of jobs and industries affected, and the availability of re-skilling and upskilling opportunities for workers. For example Graetz and Michaels (2018) examine data from various countries and industries to understand how robots affect employment, wages, and the demand for skills. They find that the adoption of robots has had a significant impact on the labor market and that the effect has varied depending on the specific industry and country.

Artificial intelligence and labor market

Artificial intelligence (AI)'s influence on the job market is a topic that has received significant attention in labor economics and is the subject of ongoing debate. Some studies suggest that AI can lead to job displacement, particularly for workers in routine jobs, similar to the impact

of automation (Acemoglu, Autor, Hazell, & Restrepo, 2020). However, the speed and extent of AI adoption may be greater, leading to a faster and more widespread impact on the labor market.

On the other hand, other studies argue that AI can also create new job opportunities, particularly in high-skilled jobs, and increase productivity and overall economic growth. This is because AI can automate repetitive tasks, freeing up workers to focus on more complex and creative tasks. For example Acemoglu, Autor, Hazell, and Restrepo (2022) study the impact of artificial intelligence (AI) on labor markets. The authors used firm-level data on online vacancies in the US from 2010 to 2018. They found rapid growth in AI-related vacancies in firms that engage in tasks compatible with AI's current capabilities. These AI-exposed firms showed a reduction in hiring in non-AI positions and changes in the skill requirements of remaining postings. However, the aggregate impact of AI-labor substitution on employment and wage growth in exposed occupations and industries is currently too small to be detectable.

The authors found that there was a surge in AI activity, particularly after 2015, which companies drove with high exposure to AI. They also estimated consistent and robust changes in the skills demanded by these high-exposure firms. These changes suggest that some tasks performed by workers in these firms are no longer required while new skills are being introduced. Furthermore, AI-exposed firms reduced their non-AI and overall hiring.

Despite the evidence of the real effects of AI on firms exposed to the technology, the authors found no relationship between AI exposure and employment or wages at the occupation or industry level. The results suggest that while AI technologies are changing task and skill composition at exposed companies, any aggregate effects of AI are not yet detectable.

Similar to their research (Damioli, Van Roy, Vertesy, and Vivarelli, 2023) look at the impact of artificial intelligence (AI) technologies on job creation by focusing on developing these technologies as product innovations in upstream sectors. They use a global sample of over 3,500 companies that patented AI-related inventions from 2000-2016. Results from dynamic panel models show that AI patent families have a positive and significant impact on employment, indicating that AI product innovation has a labor-friendly nature.

In another interesting research Webb (2019) develops a new method for predicting the impacts of various technologies, including artificial intelligence (AI), on occupations. The method uses the overlap between job task descriptions and patent texts to measure the exposure of tasks to automation. The author applies the method to historical software and industrial robots cases and finds that occupations highly exposed to automation have seen declines in employment and wages. When applying the method to AI, the author finds that, unlike software and robots, AI is directed at high-skilled tasks and is likely to reduce wage inequality but not affect the top 1%. The author acknowledges that there is substantial uncertainty about the impacts of AI and that the results should be seen as a first step toward estimating the labor market impacts of AI. Factors such as labor supply, human capital investment, and indirect channels such as the creation of new products and the delivery of education will also have significant effects on the labor market.

Similarly Tolan *et al.* (2021), outline a framework for analyzing the impact of Artificial Intelligence (AI) on occupations. The framework maps 59 generic tasks from worker surveys to 14 cognitive abilities and then to a comprehensive list of 328 AI benchmarks, allowing for the identification of potential AI exposure for tasks where AI applications have not been created. Applying the framework to occupational databases shows which abilities are most likely affected by AI and ranks occupations according to AI exposure. The findings indicate that some jobs previously not thought to be affected by automation may now be more exposed to AI and that some abilities where AI research is intense are linked to tasks with limited labor input in advanced economies.

In country-specific research Genz and Schnabel (2021) study the impact of digitalization on the employment of individual workers using a linked employer-employee data set from Germany. It compares workers in establishments investing in digital technologies with similar employees in establishments that do not make such investments. The study finds that employment stability is lower in investing establishments, but most displaced workers easily find new jobs in other firms. It also highlights that the effects of digitalization on employment vary across skill groups, occupational tasks performed, and gender, with the most pronounced effects seen among low- and high-skilled workers, workers with non-routine tasks, and female workers. The results highlight the importance of addressing the digital divide among different groups of workers.

Also Genz, Gregory, Janser, Lehmer, and Matthes (2021), investigates the impact of firms' investment in new digital technologies, such as artificial intelligence, augmented reality and 3D printing, on workers. The study uses novel data from a firm's technology adoption survey and social security data to compare the outcomes of workers employed at technology adopters versus non-adopters. The results show that adopting digital technologies leads to improved employment stability, higher wage growth, and increased earnings, mainly for workers in service providers rather than manufacturers. IT-related expert jobs with non-routine analytical tasks benefit the most, with highly complex job requirements but not necessarily with more academic skills.

In a sector-related study (Dwivedi *et al.*, 2021), explores the potential impact of Artificial Intelligence on various industries, such as finance, healthcare, manufacturing, retail, supply chain, logistics and utilities. It gathers insights from leading experts to highlight the opportunities, challenges, and potential research agenda posed by the rapid development of AI. The research provides a valuable understanding of the impact of AI on the future of industries and society while recognizing the influence of society and industry on the pace and direction of AI development. The study emphasizes that AI has the same transformative potential as the Industrial Revolution and that new algorithmic machine learning and autonomous decision-making breakthroughs create new opportunities for innovation.

Furthermore, the political economy of AI and the labor market will be critical for policymakers to understand these technologies' potential benefits and challenges. For instance Gallego and Kurer (2022) discuss the impact of automation, digitalization, and artificial intelligence on the workplace and its implications for political behavior. The authors also explore the political implications of these technological advancements, arguing that they can lead to increased public support for right-wing parties and anti-immigrant sentiment as workers become more concerned about job security and wage reduction. On the other hand, the authors also suggest that these technological advancements can lead to greater support for left-wing parties as workers demand more support and protection in an increasingly uncertain and rapidly changing job market.

Another important aspect of technological change is its heterogeneous impact on the labor market. Cortes, Oliveira, and Salomons (2020) investigate the relationship between technological advancements and the gender wage gap. The authors analyze data from multiple countries and find that, in general, technological progress has not reduced the gender wage gap. They suggest that this may be due to factors such as gender-based occupational segregation and a persistent imbalance in the distribution of care work between men and women. The authors argue that technological advances alone are not enough to close the gender wage gap and that additional policies and interventions, such as increasing women's access to education and leadership roles, are needed to achieve gender equality in the workplace.

During the COVID-19 pandemic, AI significantly impacted the labor market. Many industries have adopted AI and automation due to the sudden shift to remote work (Zarifhonarvar, 2023). A recent paper (Carbonero & Scicchitano, 2021) explores the

relationship between Artificial Intelligence (AI) and the need for physical proximity in the workplace during the COVID-19 epidemic. The authors use a unique dataset to examine the advancements of AI at the occupational level, the required proximity in each job, and administrative employer-employee data on job flows. They find that AI and proximity have an inverse U-shape relationship at the sectoral level, with high advancements in AI being negatively associated with proximity. The results hold for both sectors that were closed due to lockdown measures and those that remained open. The authors argue that promoting digitization, apart from its expected productivity and competitiveness benefits, could also help preserve jobs and economic activities in high-contagion situations.

Finally Autor (2022) discusses the impact of technology on wages and wage inequality. The author presents four strands of thinking on this topic: the education race, the task-polarization model, the automation race, and the era of AI uncertainty. The author suggests that technological change creates winners and losers, but complementary institutional investments are needed to generate shared gains. The author highlights three domains for policy intervention: education and training, labor market institutions, and innovation policy. Improving the workforce's skills, revitalizing labor market institutions, and directly shaping innovation to complement the workforce's skills are all potential avenues for policy intervention. The author concludes by suggesting that policy reforms are necessary to align the benefits of technological innovation with shared prosperity.

Compared to the current state of the literature on economics of AI, this research makes an important contribution by focusing specifically on how AI could impact different occupations. While previous studies explored automation's general effect on jobs, this paper closely examines how generative AI may transform specific tasks within occupational categories. Concentrating on this approach provides nuanced insights into how large language models are reshaping skills and job requirements across professions. Unlike past research that generalized AI's impact on employment, this study offers a detailed analysis of how AI influences individual tasks within jobs. This targeted approach enables a precise understanding of labor market dynamics as AI rapidly evolves. It highlights the potential risks and opportunities for workers in different sectors.

Labor market and ChatGPT

In this section, I will go over a very general framework of the labor market to examine the short-term and long-term effects that generative AI services like ChatGPT will have on employment and wages. Understanding that this investigation will focus on the aggregate labor market is essential. If we take a specific job as an example, such as a taxi driver or a cook, those individuals will not be affected in any way by chatGPT. On the other hand, certain careers, such as those in customer service or copywriters, might have a considerable impact. Also, to better understand the direct influence of generative AI on the labor market, we need to distinguish between low-skilled and high-skilled jobs. Although automation and robotic technology have significantly impacted low-skilled jobs, generative AI seems more related to high-skilled jobs.

Short run impact

The short-term impact of ChatGPT and other generative AI services on the job market is unpredictable and might go either way. On the one hand, these services have the potential to automate specific processes, hence decreasing worker demand in particular fields. On the other hand, they could generate new employment opportunities in areas like AI development. In addition to this, they can boost the overall productivity of the workforce and raise wages. Nevertheless, as technology continues to advance, the net result will likely be a decline in the

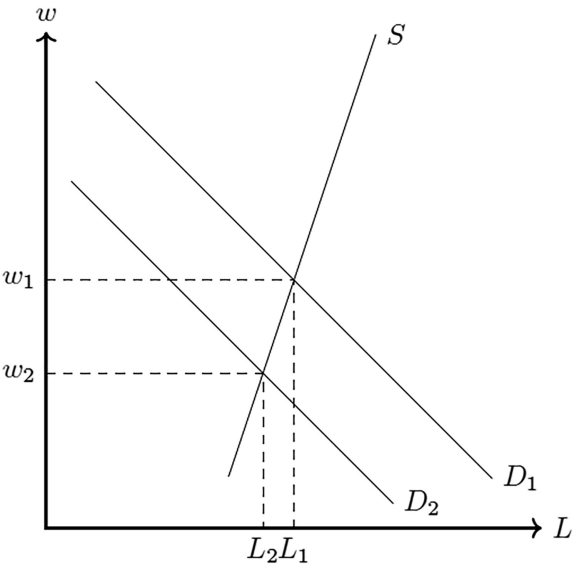
demand for labor for some jobs. The impact will also depend on the rate of technological adoption and the rate at which workers can acquire new skills. The short-term effects of AI on the labor market are expected to be nuanced and complicated.

It is also likely that there will be a temporary mismatch between the skills employees possess and the capabilities employers need, resulting in unemployment or underemployment in particular areas. However, as people gain new skills and the labor market adapts to AI-induced changes, the short-term impact on the labor market is anticipated to stabilize. As shown in Figure 2, we have an inelastic labor supply that cannot change much in the short run. This is because any form of reskilling for workers takes time.

Long run impact

The effect that ChatGPT and other forms of generative AI will have on the job market in the long term is difficult to predict and is mostly unknown. Nevertheless, we can think of two possible scenarios: One potential scenario is that the introduction of ChatGPT and other forms of generative AI services would result in an increase in the total number of job vacancies as well as an increase in the wage for those positions. This is because these services are predicted to positively influence productivity, which, in turn, is expected to result in economic growth and an increase in labor demand. Consequently, there will be a rise in both employment and wages, resulting in an environment that is more beneficial for employees.

The alternative scenario is that the increased level of automation that generative AI brings about will reduce the demand for human workers. For instance, chatbots may completely automate call centers that human agents previously ran. In this hypothetical situation, a decline in the demand for labor might lead to reduced employment rates as well as a decrease in wages for certain workers. This may be especially troublesome for workers in industries that are substantially touched by automation.



Source(s): Figure by the author

Figure 2.
Short run impact of ChatGPT on labor demand and labor supply

Impact of ChatGPT on major occupations

In this section, I will begin by introducing the two primary occupational classification systems. Following that, I will demonstrate a preliminary estimation of the jobs most likely to be impacted negatively by ChatGPT and generative AI based on the definition of each group and sub-group, as well as the tasks that are performed within those groups.

Major occupational categories

The International Standard Classification of Occupations (ISCO) and the Standard Occupational Classification System (SOC) are two systems for categorizing and describing different types of labor. The International Labour Organization (ILO) created ISCO, which is used internationally to compare and assess various occupations across nations and regions. It is organized into 10 major sections, each of which is further subdivided into subgroups and specialized occupations. The SOC, created and maintained by the Bureau of Labor Statistics in the United States Department of Labor, serves as a framework for organizing and collecting occupational data in the United States and is used to categorize and classify US jobs. I focus on the International Standard Classification of Occupations (ISCO) in this study.

For example, Figure 3 shows how the International Standard Classification of Occupations (ISCO) categorizes a sample occupation. Also, major groups and the number of sub-major groups, minor groups, and unit groups in the ISCO can be seen in Table 1.

Major Group	**5**	**Services and Sales Workers**
Sub-major Group	**51**	**Personal Services Workers**
Minor Group	511	Travel Attendants, Conductors and Guides
Unit Groups	5111	Travel Attendants and Travel Stewards
	5112	Transport Conductors
	5113	Travel Guides

Source(s): Figure by the International Labour Organization (ILO)

Figure 3.
Example of structure and composition of ISCO

Code	Major groups	Sub major	Minor	Unit groups	Skill level
1	Managers	4	11	31	3 and 4
2	Professionals	6	27	92	4
3	Technicians and associate professionals	5	20	84	3
4	Clerical support workers	4	8	29	2
5	Service and sales workers	4	13	40	2
6	Skilled agricultural, forestry and fishery workers	3	9	18	2
7	Craft and related trades workers	5	14	66	2
8	Plant and machine operators and assemblers	3	14	40	2
9	Elementary occupations	6	11	33	2
0	Armed forces occupations	3	3	3	1, 2 and 4
	Total number of groups	43	130	436	

Source(s): Table by the author

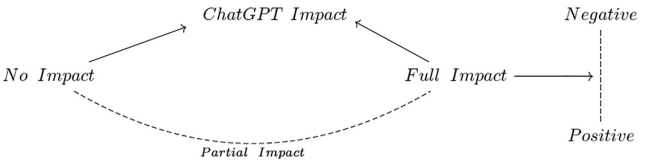
Table 1.
Number of groups at each level of ISCO

ChatGPT and its effects on occupations

In a first look, jobs such as coders, software developers, computer programmers, and data scientists are at risk of being displaced by AI. In addition to that, media jobs, including those in advertising, technical writing, journalism, and content creation, may also be affected by ChatGPT and similar forms of AI. Also, legal industry jobs such as paralegals and legal assistants are susceptible to AI-driven change, as they consume large amounts of information, synthesize what they learned, and make it digestible through a legal brief or opinion. Furthermore, ChatGPT may also significantly impact customer service representatives, teachers, those working in certain finance-related industries, and market research analysts. It can be argued that financial jobs that involve data analysis, such as market research analysts and personal financial advisors, may be impacted by AI. AI can analyze market trends, identify investment performance, and make investment forecasts based on data [1].

We can use occupational classifications to have a more systematic view of the jobs that ChatGPT can impact. If we look at ISCO and based on tasks and skill level, we can put them into three categories. According to Figure 4, ChatGPT and other generative AI services may not have any influence, full impact, or partial impact on various occupations. Both the full and partial impacts can have a negative or positive outcome. I have listed the potential impacts of ChatGPT on each major occupational category for both ISCO and SOC in Table 2.

In order to assess which jobs are more susceptible to being impacted by ChatGPT, I employed a text-mining approach. The reason this research utilizes text-mining techniques to examine how generative AI, like ChatGPT, is that the detailed description found in the ISCO can only be extracted by using this method. In recent years, textual analysis has become an invaluable methodology in economics research to extract meaningful data insights. By carefully analyzing the text descriptions of occupational roles and responsibilities, this study offers a precise lens into how AI could reshape the labor market. The key advantage of text as a data source is its ability to reveal intricate details about vulnerable job tasks and skills. Such



Source(s): Figure by the author

Figure 4.
A framework to see the Impact of ChatGPT on Labor Market

Major	Full impact	Partial impact	No impact
Professionals	95	22	9
Technicians and associate professionals	60	34	16
Managers	20	21	6
Clerical, service and sales workers	8	20	14
Craft and related trades workers	8	33	45
Plant and machine operators and assemblers	5	19	34
Skilled agricultural and trades workers	4	24	3
Services and sales workers	3	37	18
Armed forces occupations	0	0	10
Elementary occupations	0	16	35

Source(s): Table by the author

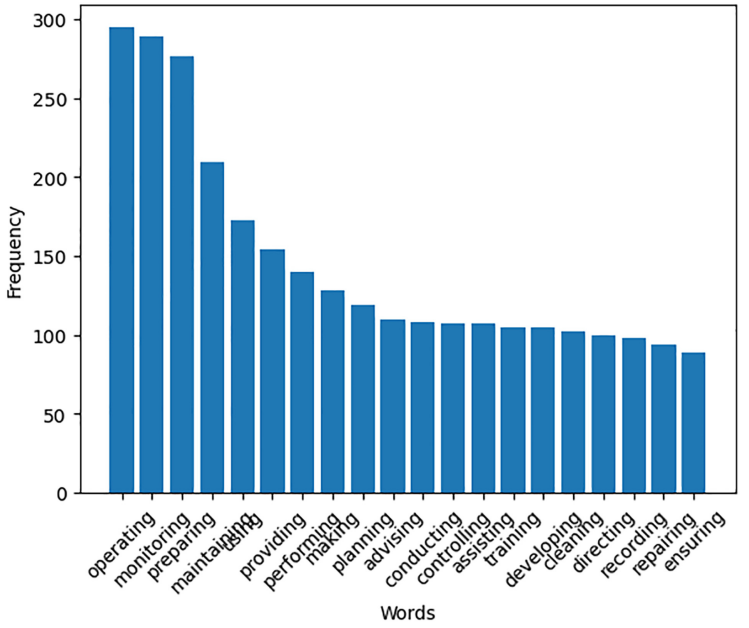
Table 2.
ISCO classification and ChatGPT impact (major label)

textual examination provides an empirical foundation for recognizing AI's transformative potential across job roles, skill demands, and broader employment trends. It demonstrates how text, traditionally confined to qualitative studies, now offers quantifiable insights into labor economics.

The methodology employed in this study centers on a keyword-driven analysis, which establishes a clear link between specific terms and the potential impact of AI on job categories. Keywords indicative of generative AI capabilities, like 'data processing' and summering,' were methodically mapped to corresponding tasks within the International Standard Classification of Occupations database. This mapping was important in determining the susceptibility of these tasks to AI-driven transformation, thus directly correlating the identified keywords to specific job functions.

Each job in the ISCO is defined by a task description. The following steps were taken: Firstly, I sorted all relevant keywords associated with performing the job, and the top 20 words can be seen in Figure 5. There are a total of 902 unique tasks. A tag cloud representation of these tasks can be seen in Figure 6. Secondly, I selected those tasks that are performed by generative AI and are most likely to be replaced by ChatGPT [2]. I then analyzed all jobs and sorted them based on these tasks. Finally, as some jobs in the ISCO have multiple tasks, I categorized them based on the number of tasks they used. Jobs that use more than 7 tasks were classified as having "Full Impact," those that used more than 3 but less than 7 were considered "Partial Impact," and those that used less than 3 were labeled as having "No Impact" [3].

Table 2 and Figure 7 shows the number of occupations in each major category of ISCO in three different categories of potential impact. It shows that in the "Professionals" category, 95 occupations are estimated to have a full impact from ChatGPT, 22 have a partial impact, and 9 have no impact. Similarly, for the "Technicians and Associate Professionals" category, 60 occupations are estimated to have a full impact, 34 have a partial impact, and 16 have no



Source(s): Figure by the author

Figure 5.
Top 20 verbs related to performing a job

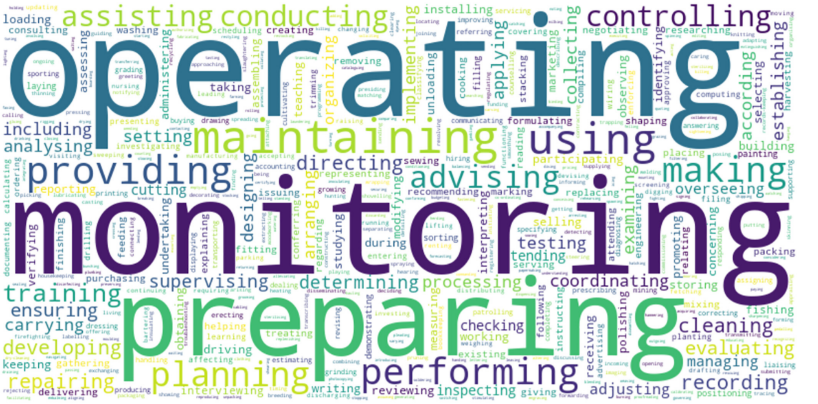


Figure 6.
Tag cloud of tasks in ISCO

Source(s): Figure by the author

impact. In the "Managers" category, 20 occupations are estimated to have a full impact, 21 are a partial impact, and 6 are estimated to have no impact.

In the "Clerical, Service, and Sales Workers" category, 8 occupations are estimated to have a full impact, 20 have a partial impact, and 14 have no impact. In the "Craft and Related Trades Workers" category, 8 occupations are estimated to have a full impact, 33 have a partial impact, and 45 have no impact. In the "Plant and Machine Operators and Assemblers" category, 5 occupations are estimated to have a full impact, 19 have a partial impact, and 34 have no impact.

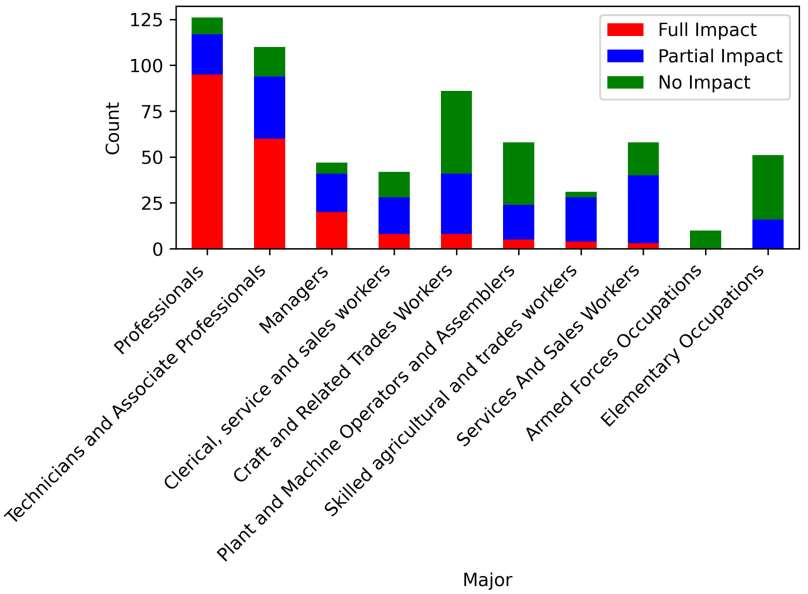
The Table also shows that in the "Skilled Agricultural and Trades Workers" category, 4 occupations are estimated to have a full impact, 24 are estimated to have a partial impact, and 3 are estimated to have no impact. In the "Services and Sales Workers" category, 3 of the occupations are estimated to have a full impact, 37 have a partial impact, and 18 have no impact. In the "Armed Forces Occupations" category, all the occupations are estimated to have no impact from ChatGPT. In the "Elementary Occupations" category, 0 of the occupations are estimated to have a full impact, 16 are estimated to have a partial impact, and 35 are estimated to have no impact.

For occupations with "Partial Impact," the tasks and skills associated with the job can be partially automated using AI services. However, certain tasks still require human judgment and creativity, making a full replacement of human workers unlikely. This can have both positive and negative impacts on the workforce, as some routine tasks can be automated, freeing up time for more complex and fulfilling tasks, but it can also lead to job loss for some workers.

For occupations with "Full Impact," the tasks and skills associated with the job can be fully automated using AI services. This can have significant implications for the workforce, leading to job loss for many workers. However, it can also improve efficiency and cost savings for businesses.

For occupations with "No Impact," the tasks and skills required are highly specialized and cannot be easily replicated by AI services, or the nature of the work requires physical skill and human interaction, making automation unlikely.

It is important to note that these impacts are potential and can vary depending on the specific application and implementation of AI services in each industry and workplace. We can see the potential impact of ChatGPT on different jobs depending on the tasks and skill level required for each occupation. Regardless of the impact, it is essential to note that the development of AI services like ChatGPT will change the job market.



Source(s): Figure by the author

Figure 7.
Different level of Impact for Major Categories in ISOC

Discussion

To further understand the influence of ChatGPT and other generative AI services on the labor market, additional research and analysis are required. Future research should focus on tracking the changes in employment patterns and the job market in locations where these services are widely adopted and utilized. Assessment of the possible effects of widespread AI adoption on employment and wages of workers could be another field of study. This may include a review of the labor market, changes in labor demand and specific job categories, and the distribution of income and earnings.

While this paper provides some insights into how generative AI like ChatGPT could impact the labor market, some limitations exist. The analysis is based on AI's current state, not future advancements. Also, the text mining approach enables quantitative analysis but may miss qualitative nuances of how AI could transform job tasks and roles. As highlighted in the paper, the labor market dynamics are complex and depend on various factors like the rate of AI adoption, the types of jobs and industries affected, and the availability of upskilling opportunities.

This study employs a straightforward and not very advanced text mining methodology chosen for its robustness in analyzing the International Standard Classification of Occupations database to understand how generative AI could impact various job tasks. The simplicity of this technique ensures the interpretability of results and applicability. The choice of the specific thresholds – 3 and 7 – was informed by a comprehensive analysis of the ISCO database. However, using this threshold, depending on the goal of the study, we can find a new set of jobs that are affected by generative AI. This division enables a more detailed categorization of tasks according to their varying degrees of susceptibility to AI disruption. While this initial methodology provides a clear yet nuanced analysis, future work could employ more advanced techniques as generative AI continues to evolve rapidly.

Additionally, it would be beneficial to examine the efficacy of upskilling and reskilling programs in response to shifting labor market demands, including their accessibility and success rates. In addition, studying the role of government policies and laws in shaping the acceptance and deployment of AI services would provide a complete picture of these services' effects on the labor market.

Finally, it would be interesting to examine the extent to which characteristics like education levels, race, and gender may lead to differences in the effects of generative AI on the job market. Understanding these differences could influence policy actions intended to mitigate the negative effects of artificial intelligence on the labor market and promote inclusive development for all workers.

Conclusion

Positive and negative consequences of Generative AI (like ChatGPT) on the job market are anticipated to be substantial. On the one hand, it is anticipated that they would lead to the displacement of workers, particularly those who do routine jobs. This displacement can lead to unemployment, declining wages, and a rise in income inequality. Conversely, AI, in general, may generate new employment possibilities, particularly in high-skilled occupations, and boost productivity and economic growth.

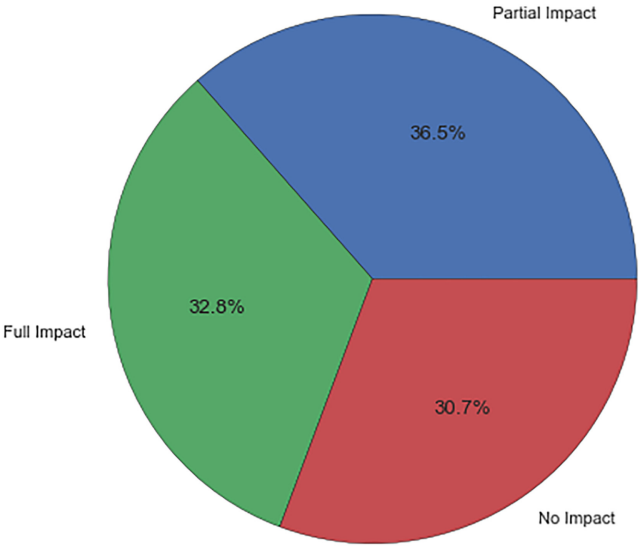
The Impact of AI on the labor market is directly tied to the mismatch in skills between the jobs being replaced and the employees who are losing their employment. This mismatch can lead to long-term unemployment for employees who cannot learn new skills to shift to other occupations. Opportunities for reskilling and upskilling can offset the harmful effects of AI on the job market.

The influence of AI on the labor market depends upon several economic and social factors, including the rate and scope of automation adoption, the types of employment and industries impacted, and the availability of reskilling and upskilling possibilities for employees. Some variables, such as the degree of economic growth, the structure of the local economy, and the availability of reskilling and upskilling possibilities, influence the impact of AI on the labor market.

Based on different tasks in the ISCO, this study found that AI technologies like ChatGPT may impact a significant portion of the workforce in the future. Specifically, it found that 32.8% of occupations may face a Full Impact, 36.5% may experience a Partial Impact, and 30.7% may have No Impact. This suggests that the labor market will likely experience significant changes as AI becomes more widely adopted (See Figure 8).

While incorporating AI technologies like ChatGPT can increase productivity and efficiency, it may also lead to job displacement and unemployment for some workers. For the 32.8% of occupations that face a Full Impact, the effects may be particularly pronounced and disruptive. On the other hand, for the 30.7% of occupations that have No Impact, these workers will likely be able to continue performing their jobs as they have in the past. The 36.5% of occupations that may experience a Partial Impact may fall somewhere in between, with some changes to their work processes and job responsibilities.

In conclusion, this study highlights the need for governments, businesses and workers to prepare for the impacts of AI on the labor market and take proactive steps to ensure that the benefits of AI are shared widely and that workers are able to transition to new roles as needed.



Source(s): Figure by the author

Figure 8.
Distribution of jobs based on keyword count

Notes

1. For example Cao, Jiang, Wang, and Yang (2021) explore the concept of combining the expertise of human stock analysts with the computational power of AI in stock analysis. The author suggests that a man + machine approach can lead to better results compared to either humans or AI alone.
2. These tasks include: preparing, providing, making, planning, advising, conducting, controlling, assisting, developing, evaluating, determining, processing, analyzing, testing, collecting, designing, examining, implementing, organizing, reporting, identifying, reviewing, interpreting, measuring, assessing, writing, marketing, researching, gathering, explaining, reading, investigating, advertising, calculating, documenting, accounting, estimating, answering, grading, correcting, completing, responding, classifying, revising, extracting, editing, proofreading, generating, counting, searching, summarizing, solving, debugging, coding, typing and data-processing.
3. There are some other ways to measure AI exposure of jobs. For example, the method proposed by Felten, Raj, and Seamans (2021); Felten, Raj, and Seamans (2019) use the ability to connect AI relationship with different occupations. In a recent empirical research Georgieff and Hyee (2021) employ their method to show links between AI and employment in a cross-country research.

References

Acemoglu, D. (2021), *Harms of AI*, National Bureau of Economic Research, Cambridge, Massachusetts.

Acemoglu, D., Autor, D., Hazell, J. and Restrepo, P. (2020), *AI and jobs: Evidence from online vacancies*, National Bureau of Economic Research, Cambridge, Massachusetts.

Acemoglu, D., Autor, D., Hazell, J., & Restrepo, P. (2022). Artificial intelligence and jobs: Evidence from online vacancies. *Journal of Labor Economics*, *40*(S1), S293–S340.

Aghion, P., Antonin, C., Bunel, S., & Jaravel, X. (2022). The effects of automation on labor demand: A survey of the recent literature. *Robots and AI* (pp. 15–39). Routledge.

Autor, D. H. (2015). Why are there still so many jobs? The history and future of workplace automation. *Journal of Economic Perspectives*, *29*(3), 3–30.

Autor, D. (2022), *The labor market impacts of technological change: From unbridled enthusiasm to qualified optimism to vast uncertainty*, National Bureau of Economic Research, Cambridge, Massachusetts.

Berg, A., Buffie, E. F., & Zanna, L. -F. (2016). Robots, growth, and inequality. *Finance & Development*, *53*(3), 10–13.

Cao, S., Jiang, W., Wang, J. L. and Yang, B. (2021), *From man vs. Machine to Man+ machine: The art and AI of stock analyses*, National Bureau of Economic Research, Cambridge, Massachusetts.

Carbonero, F., & Scicchitano, S. (2021). Labour and technology at the time of COVID-19. Can artificial intelligence mitigate the need for proximity?, *GLO Discussion Paper*.

Cortes, G. M., Oliveira, A., & Salomons, A. (2020). Do technological advances reduce the gender wage gap?. *Oxford Review of Economic Policy*, *36*(4), 903–924.

Damioli, G., Van Roy, V., Vertesy, D. and Vivarelli, M. (2023), "AI technologies and employment: micro evidence from the supply side", *Applied Economics Letters*, Vol. 30 No. 6, pp. 816-821.

Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T. and Williams, M. D. (2021), "Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy", *International Journal of Information Management*, Vol. 57, 101994.

Felten, E. W., Raj, M. and Seamans, R. (2019), *The occupational impact of artificial intelligence: Labor, skills, and polarization*, NYU Stern School of Business, New York.

Felten, E., Raj, M., & Seamans, R. (2021). Occupational, industry, and geographic exposure to artificial intelligence: A novel dataset and its potential uses. *Strategic Management Journal*, *42*(12), 2195–2217.

Gallego, A., & Kurer, T. (2022). Automation, digitalization, and artificial intelligence in the workplace: Implications for political behavior. *Annual Review of Political Science*, *25*, 463–484.

Genz, S. and Schnabel, C. (2021), "Digging into the digital divide: Workers' exposure to digitalization and its consequences for individual employment", *IZA Discussion Paper Series*, No. 14649.

Genz, S., Gregory, T., Janser, M., Lehmer, F., & Matthes, B. (2021). How do workers adjust when firms adopt new technologies?. *ZEW-Centre for European Economic Research Discussion Paper*, No. 21-073.

Georgieff, A., & Hyee, R. (2021). Artificial intelligence and employment: New cross-country evidence.

Graetz, G., & Michaels, G. (2018). Robots at work. *Review of Economics and Statistics*, *100*(5), 753–768.

Hassel, A., Özkiziltan, D., & Weil, K. (2022). Labor market effects of automation: A scoping.

Hirvonen, J., Stenhammar, A., & Tuhkuri, J. (2022). New evidence on the effect of technology on employment and skill demand, SSRN 4081625.

Moll, B., Rachel, L., & Restrepo, P. (2022). Uneven growth: Automation's impact on income and wealth inequality. *Econometrica*, *90*(6), 2645–2683.

Montobbio, F., Staccioli, J., Virgillito, M. E., & Vivarelli, M. (2022). Robots and the origin of their labour-saving impact. *Technological Forecasting and Social Change*, *174*, 121122.

Staccioli, J., & Virgillito, M. E. (2021a). Back to the past: The historical roots of labor-saving automation. *Eurasian Business Review*, *11*(1), 27–57.

Staccioli, J., & Virgillito, M. E. (2021b). The present, past, and future of labor-saving technologies. *Handbook of Labor, Human Resources and Population Economics* (pp. 1–16). Springer.

Tolan, S., Pesole, A., Martínez-Plumed, F., Fernández-Macías, E., Hernández-Orallo, J., & Gómez, E. (2021). Measuring the occupational impact of AI: Tasks, cognitive abilities and AI benchmarks. *Journal of Artificial Intelligence Research*, *71*, 191–236.

Webb, M. (2019). The impact of artificial intelligence on the labor market, SSRN 3482150.

Zarifhonarvar, A. (2023), "A Survey on the Impact of Covid-19 on the Labor Market", *The Journal of Social Sciences Research*, Vol. 9 No. 1, pp. 1-10.

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