

A Study on the Impact of Industrial Robot Development on the Economy

– A Case Study of China

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Abstract: The impact of industrial robot development on the economy has long been a subject of keen interest. This research aims to explore the role of industrial robots in the Chinese economy and the factors influencing their impact. This is achieved through an analysis of the scale of the industrial robot market, its applications, the localization process, and its effects on employment and production efficiency. In the course of this study, we review the rapid growth of the Chinese manufacturing sector and the increasing adoption of industrial robots. With technological advancements, industrial robots have achieved significant milestones in fields such as automobile manufacturing and electronics production. Subsequently, this paper delves into the repercussions of industrial robots on the Chinese economy. Data indicates that the widespread use of industrial robots has significantly enhanced production efficiency, lowered production costs, and improved product quality. Furthermore, the paper scrutinizes the progress of domestication in the industrial robot sector, highlighting China's positive strides in enhancing its capacity for independent research and development, as well as manufacturing. Consequently, the rapid development of industrial robots has exerted a multifaceted impact on the Chinese economy, fostering both production efficiency and industrial upgrading, while also giving rise to a series of employment and societal issues. In the future, China should continue to intensify its efforts in technological innovation and talent development to better address the challenges and opportunities arising from the development of industrial robots, thereby promoting sustained and healthy economic growth.

Keywords: industrial robots, economic development, industrialization, factory efficiency

1. Introduction

1.1. Background

Industrial robots are multi-joint manipulators or robots with multiple degrees of freedom designed for use in industrial settings. They can autonomously perform tasks while being guided by human instructions. The initial purpose of developing robots was to assist people in relieving heavy or repetitive labor and to replace humans in hazardous environments. Industrial robots have achieved

labor savings, gradual increases in production efficiency, higher part quality, a safer working environment, and an overall improvement in the competitiveness of enterprises. It can be said that industrial robots have driven a new wave of development in manufacturing and the economy, accelerating economic growth in China.

1.2. Related Research

In recent years, the application of industrial robots has become increasingly mature, drawing the attention of many scholars. Wu [1] and others have studied the specific capacity improvement of Chinese industrial robots in factories, using Overall Equipment Effectiveness (OEE) and Overall Total Efficiency (OTE) to calculate equipment efficiency. Wang [2] and colleagues have explored feasible system structures, utilizing new technologies to enhance the openness of control systems. Zhou [3] and others have researched how the development of the cold chain industry contributes to economic growth. The cold chain industry has become a new distribution system, with the total capacity of domestic cold storage facilities surpassing 195 million cubic meters in 2021, and a fleet of over 320,000 cold chain vehicles. The greatest beneficiaries of the cold chain industry's growth are the catering and medical sectors, both of which have immediate needs and represent significant drivers of economic development. Gao [4] has investigated the impact of Chinese industrial robots on the automotive industry.

On the other hand, the efficiency of using industrial robots has significantly promoted global economic development. Yang [5] has studied global economic growth and, drawing from data from the International Federation of Robotics, suggests that China needs to transition toward the direction of replacing manual labor with industrial robots in an appropriate manner to ensure manufacturing efficiency, economic stimulation, and keeping pace with the times. Sun [6] has studied the era of the robot economy and believes that robots can enhance society's economy and people's quality of life from various perspectives.

Simultaneously, the use of industrial robots has also driven the development of the Chinese robot market and the socio-economic landscape. Sun [7] and others have researched the domestic industrial robot market and found that competition is intensifying. China's manufacturing industry faces significant challenges in aligning with international standards and participating in international division of labor. Accelerating research, development, and production of industrial robot technology is a primary avenue for seizing this historic opportunity. Relying on its own advantages, improving independent innovation, and seeking development pathways are essential. Yang [8] and colleagues have studied the impact of industrial robot use on China's economic growth and concluded that total factor productivity is the primary factor influencing economic growth. Zhao [9] and others have studied the impact of "robots replacing humans" and found that the use of industrial robots did not lead to a reduction in overall market employment but instead resulted in job reallocation. The use of urban industrial robots increased local labor hours, with a relatively small impact on overall wage growth. Wang [10] and colleagues have researched China's industrial robot development strategy and proposed the need for more localization and popularization of robots in the future.

1.3. Objective

This article aims to investigate the economic impact of developments in industrial robotics. The second chapter provides an overview of the market size, applications, and domestic substitution trends of industrial robots in China. The third chapter delves into how China's industrial robot industry enhances factory efficiency, leading to the scissors effect and influencing the entire industrial robot industry chain. Lastly, the fourth chapter examines the future prospects of localizing industrial robot production in China and its potential effects on the country's capital market.

2. Current State of Industrial Robot Development in China

2.1. Market Size

The Chinese industrial robot market is rapidly expanding at a remarkable pace. As one of the largest industrial robot markets globally, China possesses immense market potential. In recent years, the shipment volume of industrial robots in China has been consistently increasing. According to data from the International Federation of Robotics (IFR), in 2022, China's industrial robot shipments reached 268,000 units, marking a 15% year-on-year growth. This trend underscores the continuous rise in demand for automation technology in China's manufacturing sector. Nevertheless, China's per capita robot density remains relatively low, significantly below the levels seen in developed nations. However, as China's manufacturing undergoes transformation and upgrading, coupled with advancements in automation, it is anticipated that per capita robot density will gradually increase.

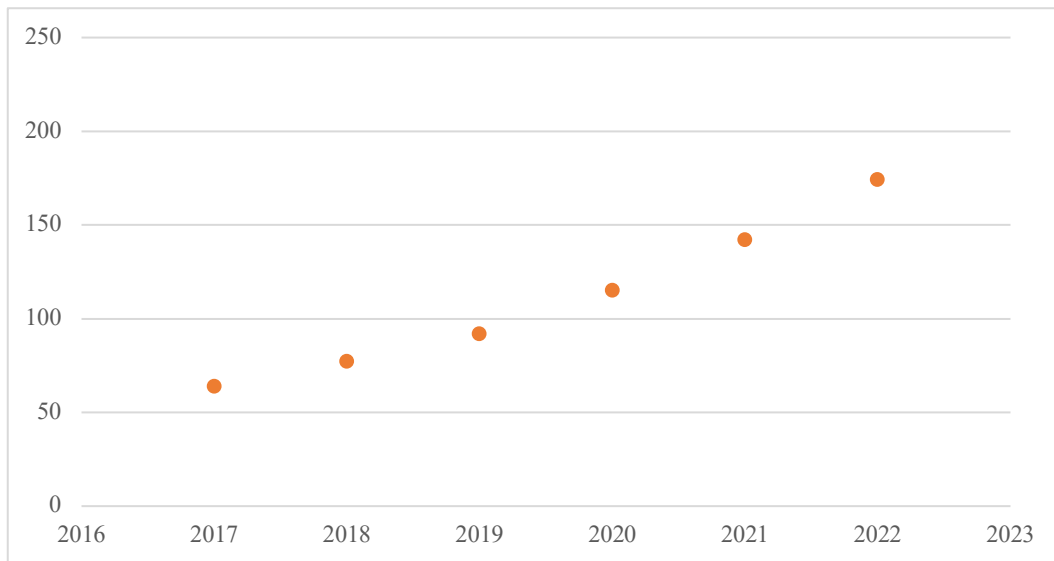


Figure 1: Forecasted Trend of the Chinese Robot Market Size from 2017 to 2023 (One hundred million U.S. dollars).

2.2. Application Landscape

The application of industrial robots in various industries in China continues to expand, playing a pivotal role in industry development and the enhancement of production efficiency. Below are the applications of industrial robots in several key industries in China, accompanied by relevant data:

Automotive Manufacturing: The automotive manufacturing sector has consistently been one of the primary application areas for industrial robots in China. According to data from the International Federation of Robotics (IFR), in 2022, the installation of industrial robots in China's automotive manufacturing industry reached 62,000 units. Industrial robots in automotive manufacturing undertake tasks such as welding, assembly, painting, and material handling. They contribute to increased production efficiency, reduced labor costs, and improved product quality and consistency.

Electrical and Electronic Equipment Manufacturing: China's electrical and electronic equipment manufacturing industry widely employs industrial robots. According to IFR data, in 2022, the installation of industrial robots in China's electrical and electronic equipment manufacturing industry reached 88,000 units. Industrial robots in this sector are involved in assembly, testing, packaging, and logistics, leading to increased production efficiency, reduced labor costs, and meeting the growing market demands.

Metal Processing Industry: Industrial robots find extensive applications in China's metal processing industry. According to IFR data, in 2022, the installation of industrial robots in China's metal processing industry reached 34,000 units. Industrial robots possess advantages of high precision and repeatability in metal processing, enhancing production efficiency and product quality. They are utilized in processes such as cutting, milling, grinding, and welding, helping companies reduce production costs, increase production capacity, and adapt to the rapid changes in personalized and customized demands.

Logistics and Warehousing Industry: With the flourishing development of e-commerce, the demand for industrial robots in the logistics and warehousing industry continues to grow. According to IFR data, in 2022, the sales and installation of industrial robots in China's logistics and warehousing industry reached 29,000 units. Industrial robots in this sector are primarily used for material handling, sorting, and packaging. Their automation and intelligence enhance efficiency and accuracy in logistics and warehousing operations, reducing the need for human resources and accommodating high-speed, large-scale logistics operations.

In addition to the mentioned industries, industrial robots also have widespread applications in the food and beverage manufacturing, medical equipment manufacturing, and chemical industries. With continuous technological advancements and cost reductions, the application scope of industrial robots is expected to further expand. The widespread use of industrial robots in China drives industry upgrades and transformations, enhances production efficiency and product quality, and raises the level of automation and intelligence in manufacturing. The introduction of industrial robots promotes the competitiveness of China's manufacturing industry. As China's manufacturing sector continues to develop and innovate technologically, the application of industrial robots in various industries will deepen, providing robust support for the sustainable development of China's manufacturing industry.

2.3. Domestic Substitution

In recent years, China has made significant progress in increasing the domestic substitution rate of industrial robots. According to data from the International Federation of Robotics (IFR) as of 2022, the domestic substitution rate in the Chinese industrial robot market has exceeded 50%. This signifies that over half of the industrial robots in the Chinese market are now produced by domestic Chinese enterprises, demonstrating the achievements in domestic substitution of industrial robots in China.

The Chinese government has actively promoted the domestic substitution of industrial robots. It has formulated a series of supportive policies, including financial support, tax incentives, and subsidies, to encourage enterprises to increase their investment in the research and development and production of industrial robots. The implementation of these policies has provided a favorable environment for Chinese enterprises, fostering technological innovation, industrial upgrading, and advancing the process of domestic substitution of industrial robots.

Domestic Chinese enterprises in the field of industrial robots have also achieved significant progress. Some Chinese companies have continuously improved the technological capabilities and product quality of industrial robots through independent research and innovation. They actively engage in international technological exchanges and cooperation to enhance the competitiveness of domestically produced industrial robots. These enterprises have successfully launched a range of high-performance, high-precision industrial robot products through continuous improvement and innovation.

The increase in the domestic substitution rate of industrial robots has had a positive impact on China's manufacturing industry. Firstly, it has reduced reliance on imported robots, thereby lowering external technological and market risks. Secondly, domestic substitution has driven technological innovation and industrial upgrading, promoting the development of the Chinese industrial robot industry. Additionally, domestically produced robots are relatively more cost-competitive, reducing

procurement costs for enterprises and promoting the widespread adoption and application of industrial robots in the Chinese market.

3. Impact on the Economy

3.1. Enhanced Efficiency

The impact of Chinese industrial robots on the economy is multifaceted, and one significant aspect is the remarkable enhancement of production efficiency. The introduction of industrial robots has achieved "robots replacing humans," replacing a portion of labor-intensive and highly repetitive manual work, thereby reducing labor costs and addressing labor shortages. The high precision and speed of industrial robots make production processes more precise and efficient, significantly boosting production efficiency. Moreover, industrial robots work continuously in 24/7 conditions without the need for rest or holidays, enabling unmanned operations and further elevating production efficiency.

Furthermore, the precision of industrial robots is a crucial aspect of their economic impact. In many manufacturing processes, high precision and stability are critical, and industrial robots enable fine-grained processing and production, ensuring product quality consistency and a high standard. This helps reduce product defect rates and quality issues, enhancing product competitiveness and promoting sustained business growth.

In addition, the application of industrial robots has given rise to new production models, such as "lights-out factories" and "lighthouse factories." A lights-out factory refers to a facility that achieves unmanned operations using automated equipment and robots, with no manual intervention required throughout the entire production process. This model significantly saves on labor costs and enhances production efficiency. A lighthouse factory, on the other hand, refers to a centralized industrial robot production base that achieves unified management and coordinated operation of multiple production lines through intelligent scheduling and control. This further optimizes production processes and enhances resource utilization efficiency.

In summary, Chinese industrial robots play a pivotal role in enhancing efficiency. Through the implementation of "robots replacing humans," high-precision processing, and the introduction of new production models, they have significantly improved production efficiency. This is of paramount significance for the upgrading and transformation of China's manufacturing industry, as it enhances economic efficiency and competitiveness.

3.2. Scissor Effect

The impact of Chinese industrial robots on the economy may, in certain circumstances, give rise to a scissor effect, where labor decreases while wages increase. This is due to the widespread adoption of industrial robots, which achieves "robots replacing humans" and replaces some labor-intensive and highly repetitive manual work. For every 1% increase in the penetration rate of industrial robots, labor demand in enterprises decreases by 0.18%. As industrial robots become more prevalent across various industries, there may be a reduction in the demand for traditional labor, leading to some workers losing employment opportunities.

According to data from the International Federation of Robotics (IFR), in 2022, China's industrial robot sales reached 268,000 units, making it the largest industrial robot market globally. With the widespread use of industrial robots in manufacturing, labor demand may gradually decrease. This effect may be especially pronounced on production lines with high repetition and labor-intensive tasks, where the introduction of robots could lead to reduced labor requirements.

However, it's important to note that the scissor effect is not the sole impact, and the situation may vary across different industries and regions. As industrial robots become more common and

technology advances, they will also bring new employment opportunities and sources of economic growth, such as emerging professions like robot maintenance and program development.

When promoting the application of industrial robots, attention should be paid to issues related to the retraining and reemployment of workers to mitigate the negative impacts of the scissor effect. Additionally, strengthening technological innovation and industrial upgrading, as well as fostering highly skilled talents to meet the demands of the era of smart manufacturing, will help achieve the organic integration of robots and artificial intelligence technology with human resources, maximizing the positive impact of industrial robots on the economy.

3.3. Robots Are a Vital Indicator of Manufacturing Advancement

The impact of Chinese industrial robots on the economy can be seen as a gem in the crown of manufacturing. They are not only the epitome of advanced manufacturing but also a driving force for the development of the entire industrial sector. Industrial robots play a crucial role in improving production efficiency, optimizing industrial structure, promoting industrial upgrading, and fostering innovative development.

The industrial robot industry can be viewed through the lens of the industrial chain. Upstream, there are core components production such as reducers, servo systems, and control systems. In the middle, there is the production of industrial robot bodies. Downstream, there is the integration of industrial robot systems based on specific requirements of end industries. These systems are mainly used for processes or functions such as welding, assembly, inspection, handling, and painting. Industrial applications are primarily in sectors like automotive and electronics, where there is a high demand for automation and intelligence.

The development of industrial robots has driven the development of the entire industrial chain. The complete industrial system of manufacturing, research and development, sales, and services of industrial robots has created new opportunities for related enterprises. The rise of the industrial robot industry has also given birth to a multitude of supporting industries, such as sensors, intelligent control systems, artificial intelligence technologies, and more. This has further fueled technological innovation and expanded the industrial chain.

In summary, Chinese industrial robots play a pivotal role in advanced manufacturing. Their widespread application and rapid development not only enhance production efficiency and reduce costs but also drive the development of the entire industrial sector. With continuous technological advancement and the expansion of industrial robot applications, they will continue to lead the manufacturing industry towards intelligence and digital transformation, contributing more momentum and vitality to the sustainable development of the Chinese economy.

4. Outlook

4.1. Domestic Substitution

The future outlook for Chinese industrial robots is optimistic regarding the trend of domestic substitution. With continuous technological advancements and the support of national policies, China has made significant progress in independent research and innovation in the field of industrial robots. Specific data indicates that as of 2022, the domestication rate of the Chinese industrial robot market has reached 35%.

In the future, domestic substitution will continue to be emphasized and receive further support. The Chinese government has implemented a series of policy measures in the development of the industrial robot industry. These measures include increased funding support for research and development, tax incentives, and subsidies to encourage enterprises to enhance their efforts in

independent innovation and technological upgrades. These policies will provide a more favorable environment for the development of domestic robots.

At the same time, Chinese industrial robot manufacturing companies are continually striving in the areas of technology research and development and innovation. Some domestic enterprises, such as Ester, have already developed the capability for independent research and production of industrial robots. Through continuous technological innovation and ongoing investments, they are consistently improving the performance and functionality of industrial robots. These companies not only meet domestic market demands but also expand their development prospects in international markets.

The promotion of domestic substitution will bring multiple benefits. Firstly, domestic robots have relatively lower costs, which help reduce procurement expenses for enterprises and enhance their competitiveness. Secondly, domestic substitution reduces dependence on imported robots, lowers risks related to external technology and markets, and strengthens China's ability to control and manage the industrial robot industry.

In conclusion, the future outlook for Chinese industrial robots is positive regarding the development trend of domestic substitution. Government policy support and the efforts of enterprises will further drive progress in the domestication of industrial robots in China, injecting new momentum into the upgrading and transformation of the Chinese manufacturing industry and the sustainable development of the economy.

4.2. Capital Market (EASTON)

The outlook for the Chinese industrial robot industry in the future appears quite optimistic, especially in terms of the capital market. EASTON, as one of China's leading industrial robot enterprises, holds immense development potential.

With the upgrading and transformation of China's manufacturing industry, the demand for industrial robots continues to rise. According to market research agencies, the Chinese industrial robot market reached a size of approximately \$17.4 billion in 2022, making it the largest industrial robot market globally. EASTON, as a domestic industry leader, holds a significant position in this market.

EASTON continuously invests in research and development and innovation, consistently launching high-performance, high-precision industrial robot products to meet the evolving market demands. Its technological prowess and product quality have been recognized, providing strong support for capturing more market share both domestically and internationally.

As the industrial robot market thrives, EASTON has garnered significant attention in the capital market. Investors have confidence in EASTON's future development prospects, resulting in a continuous increase in its stock price and market value. On the stock market, EASTON's stock price has shown robust performance, with its market value steadily climbing, attracting more attention and enthusiasm from investors.

In the future, with the continuous advancement of industrial robot technology and the ongoing expansion of the market, EASTON is poised to further solidify its leading position in the Chinese industrial robot industry and expand into international markets. The capital market will continue to monitor and support EASTON's development, providing more financing and growth opportunities to facilitate its sustained growth and expansion in the Chinese industrial robot industry.

5. Conclusion

This article, using China as an example, has examined the impact of the development of industrial robots on the economy. Through an analysis of the market size of industrial robots, their applications, the process of localization, and their effects on employment and production efficiency, the paper draws the following conclusions:

The widespread application of industrial robots significantly enhances production efficiency and reduces manufacturing costs. Robots can accomplish complex tasks in a short amount of time, reducing the demand for human labor and accelerating the production process. Furthermore, the introduction of industrial robots promotes industrial upgrading and technological innovation. China has made significant progress in the independent research and manufacturing of industrial robots, meeting not only domestic market demands but also gaining a share in international markets.

In addition, the application of industrial robots has, to some extent, led to a decrease in labor demand, potentially resulting in the scissor effect, where labor decreases while wages rise. This necessitates that both the government and businesses, while promoting the application of robots, pay attention to the retraining and reemployment of workers.

In the future, China should further strengthen technological innovation and talent development to drive the sustainable development of industrial robots. This can be achieved through the formulation of more favorable policies to encourage enterprises to increase research and development investments and promote independent innovation, thereby accelerating the process of industrial robot localization. Simultaneously, there is a need to focus on talent development by nurturing high-skilled individuals who can adapt to the demands of the era of intelligent manufacturing, ensuring the organic integration of industrial robots with the workforce.

Looking ahead, industrial robots will continue to play a positive role in the Chinese economy, driving the upgrading and transformation of the manufacturing industry and assisting China in transitioning towards an innovation-driven development path.

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