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Evaluating the Impact of "Made in China 2025" on High-Tech Industrial Transformation: A Multi-Criteria Analysis of Investment, Innovation, and Global Competitiveness

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Abstract: This study conducts a comprehensive evaluation of «Made in China 2025» initiative, a strategic industrial policy aimed at transitioning China from a low-cost manufacturing hub to a global leader in high-tech industries. Utilizing multi-criteria decision analysis tools, including the TOPSIS method and SWOT analysis, the research assesses program effectiveness across key sectors such as robotics, new energy vehicles, aerospace, and information technologies. Data from the World Bank and China's National Bureau of Statistics (2010–2025) reveal significant progress: investments in priority sectors tripled to $1.15 trillion, with robotics (19.8% CAGR) and green technologies (20.2% CAGR) emerging as top performers. Domestic market share surged from 50.1% to 78.4%, while global leadership solidified in solar panels (47.5%) and railway equipment (37.2%). Return on investment (ROI) improved post-2015, peaking in robotics (160.6%) and IT (144.1%). However, challenges persist, including dependency on foreign semiconductors, regional disparities, and geopolitical tensions with the U.S. and EU. Despite these obstacles, the program has driven structural economic shifts, emphasizing innovation over export-led growth. The findings highlight China's progress in reducing technological reliance and fostering high-value industries, though sustained policy adjustments are needed to address overcapacity and intellectual property gaps. This study underscores the program's role in reshaping China's economic model and positioning it as a challenger for global technological leadership.

1 INTRODUCTION

Over the past seven decades China's transformation stands as a unique example of evolution from an agrarian economy to a global manufacturing leader. Following the initiation of economic reforms in 1978, the country adopted a strategy of accelerated economic growth, primarily based on international trade and attracting foreign investment, while placing less emphasis on developing its own scientific and technological capabilities (Brandt & Rawski, 2008; Zhu, 2021).

This approach allowed China to successfully integrate into global production by effectively leveraging competitive advantages such as affordable labour and strategic geographic proximity to large Asian markets (Lardy, 2004; Li, 2013). However, it led to the formation of an export-oriented economic model with significant reliance on the technological expertise of developed countries and the production capacities of multinational corporations (Tan & Conran, 2022).

This specialization, which secured China's status as the «global factory», simultaneously constrained the country's ability to develop critical technologies, such as microelectronics and the production of high-tech components (Ernst, 2007; Zhang et al., 2024).

As the population's prosperity grew and production costs correspondingly increased, the traditional economic growth model began to show signs of exhausting its potential, evident in the slowdown of economic development (Zhao & Ruet, 2021). This fostered the search for new growth drivers, including diversifying production specialization, shifting from an investment-driven to

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an innovation-driven model, and large-scale technological retraining of the workforce. Implementing these objectives required active government support and the creation of an effective system to incentivize innovative development (Beckley, 2023).

The «Made in China 2025» (MIC 2025) initiative, launched in 2015, represents a comprehensive strategy aimed at transforming the Chinese economy from the «world's factory» into a leader in high-tech production (Brühl, 2024). The relevance of this study is supported by a range of specific facts and trends in the global economy.

According to World Bank data, China's share of global GDP increased from 4.5% in 2000 to 17.4% in 2021, reflecting the country's growing influence on global economic processes. The «Made in China 2025» initiative plays a pivotal role in further strengthening China's position in the global economy. In 2019, China surpassed the United States for the first time in the number of international patent applications filed, highlighting significant progress in the country's innovative development (Fasi, 2022). China has already become a global leader in fields such as electric vehicle manufacturing and solar panel production, achievements directly linked to the implementation of the MIC 2025 program.

Furthermore, the relevance of the study is underscored by rising geopolitical tensions and intensifying competition between China and Western countries in the high-tech sector (Lee, 2024). For instance, in 2019, the United States imposed restrictions on technology exports to China, which significantly impacted the program's implementation and necessitated strategic adaptations by Chinese leadership (Sykes, 2021). These developments underscore the need for a thorough analysis of the "Made in China 2025" program's effectiveness and its impact on key sectors of the Chinese economy.

Regarding the status of the MIC 2025 program, it should be noted that over 86% of the 260 objectives outlined in the program document have already been achieved (Atkinson & Atkinson, 2024).

Particular attention should be paid to the fact that the targets set for robotics, agricultural machinery, biopharmaceuticals, and marine equipment have already been achieved as of 2025. However, the «Made in China 2025» program faces challenges due to the low level of completion in the «new materials» sector, which has emerged as a critical issue in recent years (Löchel & Jablonski, 2025).

The purpose of the article is to conduct a multi-criteria assessment of the effectiveness of the «Made in China 2025» program in key sectors of the Chinese economy and to determine its impact on the country's competitiveness on a global scale.

2 METHODS

The research is based on Economic-mathematical modelling method TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) (Chaube et al., 2024) to rank industries based on five criteria:

- CAGR (Compound Annual Growth Rate) of investments
- CAGR (Compound Annual Growth Rate) of production output
- Return on investment (ROI)
- Domestic and international market share.

SWOT analysis was used to assess the program's strengths and weaknesses.

Reports from the World Bank, China's National Bureau of Statistics were primary data sources for the research.

3 RESULTS

The development of innovative sectors opens prospects for qualitative diversification of China's economy. The historically rooted orientation toward manufacturing and exporting goods with relatively low added value can be overcome by advancing high-tech industries and fostering an innovative service sector. This transition will not only ensure quantitative growth in exports but also significantly enhance their qualitative characteristics, strengthening the country's position in the global economic system and boosting its competitiveness in international markets (Chen et al., 2024).

Under the MIC 2025 strategy, the country's leadership has prioritized sectors aimed at securing technological leadership and driving economic growth. These sectors include advanced information technologies, robotics systems, aerospace industry, modern shipbuilding and railway equipment manufacturing, green transportation, energy equipment, agricultural machinery, innovative materials, and medical technologies. By focusing on these strategic areas, China aims to redefine its role in global value chains and set its status as a technological powerhouse.

3.1 Dynamics of Investments and Production

To conduct an objective multi-criteria assessment of the MIC 2025 program effectiveness, a

comprehensive analysis of the development dynamics of key industries before and after the program's implementation is essential. Comparing the periods of 2010–2015 (pre-program) and 2015–2025 (post-program launch) will help identify the program's impact on transforming the sectoral structure of the Chinese economy and evaluate the extent to which its objectives have been achieved.

The first phase of the analysis focuses on investment trends in the strategic sectors prioritized under the MIC 2025 initiative. This involves examining the Compound Annual Growth Rate (CAGR) of investments in target industries such as robotics, aerospace, green energy, and advanced materials, as well as the sectoral allocation of funds, including public versus private investments and foreign direct investment (FDI) inflows. Additionally, the correlation between investment growth and production output, such as return on investment (ROI) and capacity utilization, is analyzed.

Key aspects of the analysis include a comparative assessment of investment trends to determine whether post-2015 investment growth in priority sectors like semiconductors, artificial intelligence, and electric vehicles significantly outpaced pre-2015 levels, as projected by the program. Production output dynamics are measured through changes in the CAGR of industrial output, export volumes, and value-added contributions of high-tech sectors (Table 1). The analysis also identifies structural transformations, such as the decline of low-value-added manufacturing and the rise of advanced industries like renewable energy equipment and biotechnology.

Table 1: CAGR rates of investments in target industries.

Industry	2010	2015	2020	2025 (forecast)	CAGR 2015, %	CAGR 2025, %
New Information Technology	42.7	87.3	157	284.8	0.15	0.13
Robotics	5.8	12.5	29.4	58.7	0.17	0.17
Aviation and Aerospace	18.3	34.2	52.8	89.7	0.13	0.10
Ocean Engineering Equipment	7.6	13.1	21.4	38.5	0.12	0.11
Railway Equipment	14.2	25.7	39.6	61.4	0.13	0.09
Energy-Saving Technologies and New Energy Vehicles	21.5	48.6	102	195.2	0.18	0.15
Energy Equipment	31.4	57.8	89.5	134.6	0.13	0.09
New Materials	23.9	42.1	72.6	117.9	0.12	0.11
Medical Equipment and Biopharmaceuticals	16.8	38.4	75.2	134.8	0.18	0.13
Agricultural Machinery	8.2	14.9	23.7	35.8	0.13	0.09
Total	190	374	664	1151.4	1.43	1.17

Source: compiled by the authors based on China's National Bureau of Statistics reports

Notes:

- Values are in USD billion unless stated otherwise.
- CAGR (Compound Annual Growth Rate) is expressed as a decimal (e.g., 0.15 = 15% annual growth).
- The total CAGR sums (1.43% and 1.17%) reflect aggregated growth across all sectors but do not represent a weighted average.

Between 2015 and 2025, investments in key industries tripled, increasing from 374.6 billion USD to 1.15 trillion USD. Following the launch of the MIC 2025 program, all strategic sectors saw substantial growth in investment. The highest compound annual growth rates (CAGR) during the 2015–2025 period were recorded in robotics (16.7%), energy-saving technologies and new energy vehicles (14.9%), medical equipment and biopharmaceuticals (13.4%), and new information technologies (12.6%) These figures underscore the program's emphasis on prioritizing these sectors, aligning with China's strategic goals to advance technological innovation and strengthen its global economic position. The targeted growth in these areas highlights their critical role in driving the nation's transition toward high-tech industrial leadership.

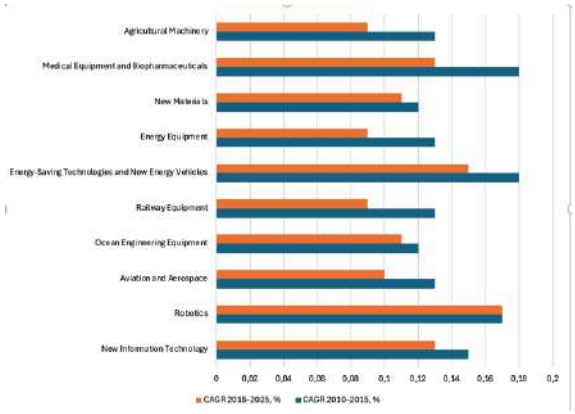

Figure 1: CAGR of production of the MIC 2025 program.
Source: compiled by the authors based on China's National Bureau of Statistics reports

Energy-saving technologies and new energy vehicles (CAGR 20.2%), robotics (CAGR 19.8%), medical equipment and biopharmaceuticals (CAGR 15.5%), and new information technologies (CAGR 15.4%) demonstrate the highest production growth rates during the implementation of the program (Figure 1). This growth aligns with the priorities of China's investment policy, which emphasizes high-tech and innovative sectors. To assess the effectiveness of investments, the authors calculated the return on investment (ROI), defined as the ratio of the increase in production volume to the volume of investments over the corresponding period (Table 2).

Table 2: Return on investment in target industries.

Industry	Return on Investment (ROI) 2010–2015 (%)	Return on Investment (ROI) 2015–2025 (%)
New Information Technology	10.00	20.45
Robotics	6.67	18.98
Aviation and Aerospace	4.51	7.44
Ocean Engineering Equipment	6.39	9.05
Railway Equipment	6.86	8.55
Energy-Saving Technologies and New Energy Vehicles	7.27	20.24
Energy Equipment	7.60	9.51
New Materials	6.67	9.87
Medical Equipment and Biopharmaceuticals	9.68	17.81
Agricultural Machinery	7.27	9.83
Average	7.29	13.17

Source: compiled by the authors based on China's National Bureau of Statistics reports

During the implementation of the MIC 2025 program, there has been a significant increase in the return on investment (ROI) across all industries compared to the 2010–2015 period. The average ROI rose from 7,29 to 13,17, indicating the high effectiveness of the program's targeted investments. The greatest increases in ROI were observed in the following sectors: energy-saving technologies and new energy vehicles, robotics, new information technologies, and medical equipment and biopharmaceuticals. Such a significant improvement in investment efficiency can be attributed to the following factors:

- Synergistic effects from a comprehensive approach to developing the entire innovation ecosystem, including education, R&D, and industrial production.
- Achievement of a critical mass of investments, enabling the overcoming of initial entry barriers in high-tech industries.
- Successful localization of previously imported technologies and transition to indigenous innovation.
- Network effects arising from the development of interconnected industries, creating additional incentives for growth.
- Increasing economies of scale in production driven by rising domestic demand and export opportunities.

3.2 Market Share

Another crucial metric for assessing the program's effectiveness is the change in the market share of Chinese products in both domestic and international markets. This indicator reflects the competitiveness of China's industries under the MIC 2025 initiative, highlighting progress in displacing foreign imports domestically and expanding export capabilities globally. Tracking these shifts helps evaluate the program's success in reducing technological dependence and establishing China as a leader in high-value manufacturing (Table 3).

Table 3: Change in the market share of Chinese products in both domestic and international markets.

Industry	2010	2015	2020	2025 (forecast)	2010- 2010–	2010-2025, %
New Information Technology	32.1	45.6	62.3	78.5	13.5	32.9
Robotics	18.5	28.4	46.2	68.7	9.9	40.3
Aviation and Aerospace	25.7	36.8	49.5	63.2	11.1	26.4
Ocean Engineering Equipment	42.3	53.7	68.2	79.4	11.4	25.7
Railway Equipment	72.6	85.3	93.7	97.8	12.7	12.5
Energy Equipment	28.4	47.2	69.3	85.1	18.8	37.9
New Materials	52.6	64.3	74.8	85.9	11.7	21.6
Medical Equipment and Biopharmaceuticals	31.5	42.6	54.8	71.3	11.1	28.7
Agricultural Machinery	24.3	37.8	52.3	69.4	13.5	31.6

Source: compiled by the authors based on China's National Bureau of Statistics reports

The most notable advancements were seen in robotics (40.3%), energy-saving technologies and new energy vehicles (37.9%), and new information technologies (32.9%). Domestically, the share of Chinese products surged from 50.1% to 78.4%, with exceptional growth in robotics (+40.3%) and electric vehicles (+37.9%).

On the global stage, China achieved a 16.4% increase in market share, cementing its dominance in solar panel production (47.5% global share) and railway equipment manufacturing (37.2% global share). These outcomes underscore the program's effectiveness in bolstering China's industrial competitiveness, reducing dependency on foreign technologies, and advancing high-value sectors essential for long-term economic resilience.

3.3 Ranking Industries Using TOPSIS

To comprehensively evaluate the effectiveness of the MIC 2025 program, the TOPSIS method (Technique for Order of Preference by Similarity to Ideal

Solution) was applied. This multi-criteria decision analysis tool ranks industries based on their proximity to an ideal solution across the following performance indicators:

1. CAGR of Investments (2015–2025)
2. CAGR of Production Output (2015–2025)
3. Return on Investment (ROI) (2015–2025)
4. Domestic Market Share Growth (2015–2025)
5. International Market Share Growth (2015–2025)

The results of the TOPSIS analysis are summarized in Table 4.

Table 4: Comprehensive Effectiveness Index of the «Made in China 2025» Program in Key Industries (TOPSIS Method).

Industry	Composite Index	Rank
Energy-Saving Technologies and New Energy Vehicles	0.91	1
Robotics	0.67	2
Medical Equipment and Biopharmaceuticals	0.53	3
New Information Technologies	0.51	4
Ocean engineering equipment	0.37	5
New Materials	0.35	6
Agricultural Machinery	0.33	7
Railway Equipment	0.28	8
Power Equipment	0.27	9
Aviation and aerospace Industry	0.26	10

Source: compiled by the authors

The results of the multi-criteria evaluation using the TOPSIS method demonstrate significant differentiation in the effectiveness of the MIC 2025 program across various industries. The highest composite index (0.91) was achieved by the sector of energy-saving technologies and new energy vehicles, indicating its proximity to the ideal solution across all evaluated criteria. This result reflects China's large-scale investments in the development of electric vehicles, energy storage systems, and green energy technologies, aligning with both global environmental trends and the country's strategic energy security goals.

Robotics ranks second with a notable margin (0.67), confirming the priority given to automation and digitalization of production processes. The significant attention to this industry is driven by the need to offset rising labor costs and enhance productivity amid demographic shifts.

Medical equipment and biopharmaceuticals, as well as new information technologies, occupy the third and fourth positions with indices of 0.53 and 0.51 respectively. Their high rankings are attributed not only to substantial investments but also to their success in increasing market share domestically and internationally, which speaks to the effectiveness of the program in these areas.

The aviation and aerospace industry, despite its strategic importance for national security, ranks last (0.26). This may be due to the longer investment payback cycles and the technological complexity involved in establishing a fully independent aerospace industry.

This distribution reflects the actual priorities of the Chinese government, which has focused its efforts on developing new high-tech industries capable of ensuring technological independence and securing China's global leadership in the near future.

Despite the differences in implementation effectiveness across sectors, it is important to note that all the evaluated industries demonstrate positive development trends and an increasing share of Chinese products in both domestic and international markets. This indicates the overall success of the MIC 2025 strategy in achieving its goals of technological modernization and enhancing the competitiveness of China's manufacturing sector.

4 DISCUSSIONS

The primary strength of the «Made in China 2025» program lies in its combination of robust state support and clear strategic direction. The Chinese government has allocated massive investments (over $1.1 trillion from 2015 to 2025) to priority industries, creating favourable conditions for their accelerated development. A comprehensive approach integrating industrial advancement, scientific research, and education enables systematic progress in technological modernization.

Key weaknesses include uneven regional and sectoral development, persistent reliance on imported critical components and technologies (particularly in semiconductors and advanced materials), and a shortage of skilled personnel in certain high-tech sectors. These challenges hinder the program's full potential.

Opportunities arise from China's potential to expand its global market share in high-tech products and strengthen its position in global value chains. Developing domestic technologies could reduce import dependency and position China to establish

new international standards in emerging technological fields.

Major threats include escalating trade restrictions and technological sanctions from the U.S. and EU, intensifying global competition, and risks of overproduction and excess capacity in certain industries, which could undermine the program's economic efficiency. Addressing these challenges will require adaptive policies and sustained innovation to balance growth with sustainability.

5 CONCLUSIONS

The program represents a large-scale industrial modernization project aimed at positioning China as a leading technological power. Its core objective is to strengthen the global competitiveness of Chinese products through innovation, production robotization, and the advancement of high-tech industries.

The analysis reveals significant progress toward achieving the program's goals. Notable successes include breakthroughs in robotics, artificial intelligence systems, electric vehicle manufacturing, and renewable energy equipment. Chinese companies have demonstrated remarkable achievements in adopting and deploying cutting-edge technologies, solidifying their international standing.

However, the program faces major challenges. Escalating geopolitical tensions and intensifying technological rivalry with Western powers, particularly the United States, pose significant hurdles. Restrictions on access to advanced technologies and foreign markets threaten to slow the implementation of planned reforms.

The program is fundamentally transforming China's economic model, shifting away from a reliance on low-cost exports and foreign investment toward an innovation-driven development strategy. This new approach prioritizes domestic technological innovation and the production of high-value-added goods, enhancing economic resilience and China's role in global supply chains.

The study identifies key implementation challenges, including insufficient intellectual property protection (which stifles innovation), regional resource disparities, and risks of overproduction in certain industries, potentially undermining financial stability.

Despite these issues, the overall assessment of «Made in China 2025» remains positive. The strategy has successfully stimulated technological advancement, improved product quality, and accelerated innovation in critical sectors. This progress lays the foundation for sustainable long-term growth and reinforces China's expanding influence in the global economy. The program exemplifies China's ambition to transition from a manufacturing giant to a global innovation leader, reshaping economic paradigms in the process.

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