ISSN 2616-5902 Vol. 6, Issue 12: 1-13, DOI: 10.25236/AJBM.2024.061201

China's Manufacturing OFDI & Independent and Controllable Industrial Chain: Based on the Perspective of "Technology Seeking"

Chen Xuemeng[1,a,*], Ma Guangqi[1,b]

[1]*School of Economics & Management, Shaanxi University of Science and Technology, Xi'an, China*
[a]*bs210711001@sust.edu.cn*, [b]*maguangqi@sust.edu.cn*
[*]*Corresponding author*

Abstract: *At the core of enhancing China's industrial and supply chain independence lies the addressing of "bottleneck" issues. Technology-seeking "outward forward direct investment" (OFDI) exhibits significant reverse technology spillovers, strengthening key core technology advancement. This study uses panel data from China's manufacturing industry (2016-2021) to explore the correlation between technology-seeking OFDI and industrial chain self-control. Based on the latecomer's advantage framework, the mechanisms of this OFDI are analyzed under different technological progress paths: technology introduction, tracking and imitation, and independent innovation. The results indicate that technology-seeking OFDI positively impacts industrial chain autonomy. All three paths contribute, with independent innovation being the most effective. However, OFDI's promotion of autonomous innovation requires further enhancement. To maximize technology-seeking potential, selecting appropriate technological progress paths based on factor endowments is crucial. This is needed to efficiently drive manufacturing technology and innovation, thereby accelerating the enhancement of independent and controllable industrial chain capacity.*

Keywords: *China's manufacturing OFDI; Independent and controllable industrial chain; Technology import; Imitative innovation; Independent innovation*

1. Introduction

The current global economic landscape is divided and volatile, with economic globalization facing setbacks. Escalating trade frictions are strongly impacting China's industrial chain, increasing instability and uncertainty in the industrial development environment. Many Chinese manufacturing enterprises have traditionally relied on foreign technology and industries, which in turn causes a "hoop effect" that affects upstream and downstream industries, as well as national economic security [1]. As China enters a high-quality development stage under a new development paradigm, strengthening the independent and controllable capabilities of the industrial chain and supply chain is crucial for enhancing China's international economic and trade governance rights. Building an autonomous and controllable modern industrial system is a national strategy; the aim is to ensure sustainable development, international competitiveness, resilience to risks, and flexibility for multiple substitutions [2]. To enhance China's industrial chain and supply chain autonomy, future efforts should focus on technological breakthroughs and innovation drives to seize industry control and the development initiative [3]. As innovation globalization intensifies, to bolster internal innovation gaps, companies increasingly invest in overseas R&D or technology M&A [4]. Specifically, China's outward OFDI flow reached $178.82 billion in 2021, representing 10.6% of the global outward FDI flow that year. Among these, the outward investment by manufacturing enterprises stood out, with a flow of $26.87 billion, accounting for 15% of the total flow. Simultaneously, its stock reached $263.26 billion, accounting for 9.5% of the total stock [5]. Also, OFDI's reverse technology spillover effect is significant [6], but OFDI's impact in terms of enhancing China's industrial chain's autonomous controllable ability is the focus of this paper.

China's manufacturing industry has achieved rapid development, largely due to the industry's latecomer advantage. This advantage enables China to learn from global manufacturing experiences, avoid detours, and achieve leapfrog progress. Through introduction, digestion, absorption, and re-innovation, China's manufacturing industry has rapidly improved both its technology and productivity, forming a unique development model. This process has fully leveraged China's latecomer

ISSN 2616-5902 Vol. 6, Issue 12: 1-13, DOI: 10.25236/AJBM.2024.061201

advantage, laying a solid foundation for the country's manufacturing rise. From reliance on foreign technical support in the 1950s to self-reliance and independent innovation systems in later periods, China has continuously built re-innovation and design capabilities through technology introduction and local application. Under the innovation-driven strategy, Chinese industry has achieved a unique technological catch-up, yet China's manufacturing industry's current innovation mode remains heavily reliant on imitative innovation, with primary innovation remaining weak [7-8]. As China's technological gap with advanced countries narrows, the long-relied-upon strategy of technology introduction and imitation is facing limitations, which in turn are weakening the intrinsic motivation for independent innovation in the manufacturing industry. The path of imitating advanced technologies for catch-up faces challenges. For long-term development, the continued reliance on imitation is unsustainable. In the competitive international environment, China's manufacturing industry urgently needs a new technological innovation path to enhance independent innovation capability and achieve sustainable development. At the critical stage of building a modern industrial system, China faces both opportunities and challenges. How should China's manufacturing industry choose an appropriate technological path based on the country's factor endowments? How can China improve technological capability and strengthen core technology research by optimizing innovation resource allocation to promote technological and innovation advancements? Strengthening the independent and controllable capability of China's manufacturing industry chain for high-quality development is urgent. This paper explores the impact of "technology-seeking" outward foreign direct investment (OFDI) on the autonomous controllability of the industrial chain and the associated differences in technological introduction, tracking and imitation, and independent innovation paths. Detailed analysis of "technology-seeking" OFDI under these paths aims to reveal the mechanisms, effects, and potential problems, thereby providing valuable references for enhancing China's manufacturing industry chain's independent controllability.

2. Literature review

The existing literature relevant to this study is comprised of three aspects. Firstly, research on the autonomy and controllability of industrial chains is scarce. Related studies primarily focus on theoretical logic and practical paths for building an independent and controllable modern industrial system [1]. Secondly, a comprehensive index system for evaluating industrial chain modernization may be developed to assess autonomy and controllability. The related studies encompass technology R&D, manufacturing, marketing, and after-sales service, reflecting the chain's autonomy at various stages, fields, and market environments [9]. Lastly, limited empirical studies have explored the influencing factors and internal mechanisms of industrial chain autonomy and controllability from the perspective of digital transformation [10-11]. These studies explore how digital transformation factors (IT application, data utilization, intelligent manufacturing, and digital service platforms) impact industrial chain autonomy. They analyze factor interactions and mechanisms that enhance chain autonomy and control [12]. Scholars have noted that weak autonomy stems from a lack of key technologies and high import dependence. Autonomy and controllability regulate industrial network synergies. Research on OFDI focuses on OFDI's positive effects on exports [13], green spillovers [14], economic growth [15], and reverse technology spillovers [16]. Enterprises via OFDI can, through technological spillovers and market feedback, establish stable sales channels, expand overseas market share, and enhance product competitiveness and export capacity. In practice, OFDI fosters economic ties and cooperation, creating export opportunities and market space for home country enterprises. In manufacturing OFDI research, scholars have identified five main investment types: resource development, technology seeking, market expansion, cost control, and spatial layout. Studies have exploring the opportunities and challenges of these investment types for industrial chain modernization [17]. Specifically, resource development investment secures resources and supply. Technology-seeking investment fosters absorption and innovation. Market expansion investment boosts competitiveness. Cost-control investment reduces costs and improves efficiency, while spatial layout investment optimizes resource allocation. These investments face challenges including sustainability, technology barriers, market restrictions, cost pressures, and complexity. Research has shown that technological innovation and introduction impact economic growth transformation, being influenced by technology dependence, opportunity costs, and reverse spillover [18]. Adopting independent R&D-led technological progress fosters long-term national development by emphasizing domestic collaborative innovation for technological control and sustainability. In contrast, technology importation, while temporarily bridging gaps, may lead to long-term dependence, thereby weakening independent innovation, widening gaps, and hindering sustained economic development [19]. As the world's largest developing country, China must recognize the significance of independent R&D and take steps to implement policy incentives and institutional

ISSN 2616-5902 Vol. 6, Issue 12: 1-13, DOI: 10.25236/AJBM.2024.061201

safeguards to transition from technology importation. Measures include but are not limited to increasing research investment, optimizing the innovation environment, cultivating top talents, and fostering industry-academia-research integration [9]. These initiatives can stimulate enterprise and research institution innovation, accelerate technology transfer, and support China's sustained, high-quality economic development.

Within the framework of technological innovation, Schumpeter (1991) classified activities into independent, imitative, and cooperative innovation [20]. Tang (2014) argued that technological innovation and introduction, influenced by factors like dependency, opportunity cost, and reverse spillover, differently affect economic growth mode transformation [21]. Independent R&D fosters long-term development, while the introduction of technology may initially reduce technological disparity but can eventually lead to long-term dependence and disparity widening. Foreign ownership positively influences enterprise innovation, accelerating innovation activities with controlled foreign investment. Ai (2015) found significant spatial effects of technological progress modes on China's environmental performance [22]. Li (2022) discovered that environmental regulations drive different technology input modes, impacting total factor energy efficiency [23]. Wu (2023) believed that green innovation is more sensitive than green imitation to financial factors in enterprise R&D [24]. As independent innovation rises, technology introduction's impact on green economy efficiency shifts positively via "transfer, absorption, diffusion, and re-innovation." Advancements enhance energy efficiency, accelerating development. The transfer of FDI-induced technology boosts recipient innovation, mitigating risks and costs. Song (2022) found that government subsidies often fund low-risk imitative projects due to rent-seeking, limited R&D, and review criteria [25]. Government intervention in business innovation should be minimized. Yu (2018) developed a model that showed that technology input and self-innovation impact innovation quantity and quality. Technology introduction and independent innovation complement each other and independently drive significant innovation output, with independent innovation exhibiting a threshold effect [26]. China is transitioning from emphasizing innovation quantity to balancing quantity and quality. To sustain advancement, creating incentives for transitioning from technology introduction to independent R&D is crucial. A literature review shows that the limited studies on modern industrial system construction lack mechanism testing. Studies have suggested that technology-seeking OFDI enhances chain autonomy, but systematic verification of OFDI’s impact and the differences in mechanisms under various paths is lacking.

This paper uses 2016-2021 China manufacturing OFDI data to quantify industrial chain autonomy indicators and empirically analyzes their relationships. The main contributions are as follows: (1)

This study expands research on China's manufacturing OFDI's domestic economic effects, exploring the impacts on industrial and supply chain autonomy from technology-seeking OFDI. (2)The positive effect of OFDI in terms of enhancing industrial chain controllability is empirically confirmed, complementing existing literature. (3) This study also clarifies OFDI's influence mechanism on industrial chain controllability through independent innovation, technology acquisition, and tracking/imitation, based on technological innovation modes and latecomer advantage theory. The findings offer new empirical evidence and policy insights for industrial chain autonomy.

3. Theoretical analysis and research hypotheses

3.1. OFDI & independent and controllable industrial chain

Independent control of China’s industrial chain entails high local dominance in production, low dependence on external regions, and resilience against "broken chain" risks under economic uncertainty. Currently, rising trade protectionism and anti-globalization trends are disrupting global production networks, compromising industrial chain stability [3]. When upstream-downstream connectivity is severed, local enterprise production sustainability is challenged, impacting the local industrial chain and hindering the chain’s development. An analysis of modern industrial systems shows that autonomy and controllability require possession of key, controllable technologies in pivotal industries [1]. Technology condenses material elements and highlights soft elements' value. Advanced manufacturing involves highly intensive knowledge and technology and is characterized by large investment, long cycles, and high risks, all of which contribute to its scarcity. Mastering advanced technology determines a country’s/enterprise's position in the global industrial chain, and advanced technology secures higher added value and influence. The autonomous mastery of key technologies addresses industrial chain bottlenecks, enhances resilience and adaptability, and boosts a country's international

ISSN 2616-5902 Vol. 6, Issue 12: 1-13, DOI: 10.25236/AJBM.2024.061201

standing and voice [27].

For latecomers, industrial technological progress is reliant on self-investment, global resource learning, and innovation. Introduction, digestion, absorption, and re-innovation are low-cost, low-risk paths for catch-up. Currently, FDI transfers high-quality resources to China, enhances domestic innovation, encourages enterprise innovation via "reverse technology spillover," and utilizes overseas markets. In addition, FDI connects domestic and international cycles, preventing enterprises from shifting from real to virtual and addressing overcapacity[28]. In the eclectic paradigm of international production [29], the theory posits that firms derive competitive advantages from ownership-specific advantages, internalization advantages, and location-specific advantages. The purposes of OFDI mainly include advanced technology, efficient management mode, cutting-edge theoretical knowledge, higher production efficiency and economies of scale, market share, and the natural resources or energy of the invested countries and regions. Specifically, OFDI can be categorized into four types: technology-oriented, efficiency-driven, market-seeking, and resource-seeking. The aim of technology-seeking OFDI is to acquire advanced technology, management, and knowledge from invested regions; this belongs to Dunning's third stage of OFDI, a turning point. These investments occur in developed regions through spillovers or M&As. Thus, "technology seeking" may significantly impact industrial chain autonomy. China's manufacturing investments in developed nations help to swiftly acquire advanced technologies via R&D, M& As, etc., fostering the mastery and upgrading of pivotal technologies. Consequently, this paper advances the following hypothesis:

H1: Technology-seeking OFDI is conducive to improving the independent and controllable ability of China's manufacturing industry chain.

3.2. OFDI, technical progress & independent and controllable industrial chain

The top-down flow of production technology along the industrial chain is a crucial channel for productivity improvement. Technological progress enhances resource allocation efficiency, broadens profit margins, promotes product and labor division, advances high-end production, and improves existing products. Thus, to some extent, technological progress breaks low-end production constraints [30]. Acknowledging the pathway-dependent impact of technological process is crucial. Latecomer countries can make advances through independent innovation, technology introduction, and imitation, aligning with factor endowment structures. Selecting the right mode is vital for absorption and advancement, enhancing efficiency, and productivity. Late-mover advantage theory highlights late-developers' leveraging of early-developer technologies. Under openness, backward countries can access global resources via M& As, alliances, cooperation, and FDI, enabling rapid development and entry. Initially, imports alleviate shortages and are cost-effective and time-efficient. Spillovers provide a higher research starting point, swiftly narrowing gaps. However, late-developers often neglect basic research, leading to high dependence on key equipment and strategic control provided by developed countries. Tracking imitation enables the grasping of principles through digestion, absorption, and reverse learning, thereby improving and imitating innovations while mitigating risks. Late-mover advantage showcases diversity and plasticity in technology choices. However, developing countries often focus on technology introduction, neglecting imitation and secondary innovation, falling into the technology trap.

On a macro level, independent innovation involves a country or region exploring technological frontiers, overcoming technical difficulties, creating independent intellectual property technologies, and commercializing those technologies. This manifests in enterprises' endogenous technological capability evolution. Strengthening independent innovation to enhance manufacturing competitiveness is pivotal for China's innovation-driven development strategy. This poses a significant challenge as China transitions from high-speed growth to high-quality development [4]. In the long-term perspective, the investment or output associated with independent innovation can genuinely achieve advancements in industrial technology, elevate productivity, and yield substantial benefits. This will effectively foster the development of the manufacturing industry [31]. Local enterprises that lack independent innovation ability struggle to lead the way in technological innovation. Excessive dependence on technology transfer hinders open innovation benefits and international competitiveness. Most Chinese industries, in nascent product development stages, follow foreign pathways, with weak independent technical capabilities. These industries continue to rely on mature, end-of-life technologies. This results in a "strong production, weak innovation" gap. Independent innovation demands long-term investment, a solid foundation, and resources, without which, enterprises may fail to immediately boost productivity and may potentially face reduced ROI due to inadequate outcomes. This situation poses challenges to the manufacturing industry's development trajectory.

ISSN 2616-5902 Vol. 6, Issue 12: 1-13, DOI: 10.25236/AJBM.2024.061201

Thus, in the process of industrial development, latecomer countries are faced with complex technological progress decisions. Only by adopting a technological path that matches their factor endowments, makes full use of their latecomer advantages, relies on more independent development of core technologies, and digests, absorbs and re-innovates after technology introduction, can latecomer countries quickly realize technological progress and economic catch-up, rebuild a competitive advantage and better participate in international competition. Consequently, this paper advances the following hypothesis:

H2: There are different influence paths in the process of technology-seeking OFDI improving the autonomous controllable ability of China's industrial chain, including technology introduction, tracking and imitation, and independent innovation.

4. Research design

4.1. Model setting

This study opts to establish a panel data model to empirically examine the relationship between China's OFDI in the manufacturing sector and the autonomous controllability of the industrial chain. The benchmark regression model is formulated as follows:

$$\boldsymbol{Indecon_{it}}=\alpha_0+\alpha_1\boldsymbol{OFDI_{it}}+\sum_j\alpha_j\boldsymbol{X_{jit}}+\varepsilon_{it} \tag{1}$$

Where, subscripts i and t represent industry and year, respectively; j represents the number of control variables; Indeconit represents the independent controllable level of the manufacturing industry chain i in year t, and εrit is a random disturbance term. This paper focuses on the coefficient α1 corresponding to OFDIit. If the coefficient is significantly positive (or negative), this indicates that a significant relationship exists between China's manufacturing OFDI and the independent controllable ability of the industrial chain.

4.2. Variable selection and measurement

4.2.1. Explained variable

In this paper, $Indecon_{it}$ refers to the degree of dependence of the production activities of the main body of the local industrial chain on other countries and regions, or the degree of influence and control by external supply. For China's manufacturing industry, a decrease in the use of imported products from other countries and regions can reflect the ability of the industrial chain to master core technologies. With reference to the ideas of Chen (2022), this paper measures $Indecon_{it}$ by calculating the proportion of import supply consumed by industrial sectors in the production process, and the specific calculation method is as follows:

$$\boldsymbol{Indecon_{it}}=1-[\boldsymbol{Input\_im_{it}}/(\boldsymbol{Input\_im_{it}}+\boldsymbol{Output_{it}})] \tag{2}$$

Where, $input\_im_{it}$ represents the import consumption of manufacturing industry chain i in year t, and $output_{it}$ represents the total output of manufacturing industry chain i in year t. When $Indecon_{it}$ is large, this means that the normal operation consumption of the industrial chain mainly depends on the supply of the domestic market, and the industrial chain has a high level of autonomous controllable ability. On the contrary, when $Indecon_{it}$ is small, this indicates that the independent controllable ability of the industrial chain is low.

4.2.2. Explaining variable

China's manufacturing OFDI constitutes an economic activity wherein domestic manufacturing enterprises, acting as investors, assume control over the operations and management of foreign enterprises as a primary objective. To accurately capture the current year's manufacturing industry chain's OFDI activities, this study selects the magnitude of OFDI as the explanatory variable. The calculation of this variable utilizes the index of manufacturing OFDI flows. The relevant data were sourced from the Statistical Bulletin of China's Outbound Direct Investment, spanning the years 2016 to 2021.

4.2.3. Control variables

(1) Industry scale (*S*): Manufacturing industries possess distinct organizational structures, and their operational and developmental trajectories are inevitably influenced by their respective scales.

ISSN 2616-5902 Vol. 6, Issue 12: 1-13, DOI: 10.25236/AJBM.2024.061201

Typically, on the one hand, large-scale industries exhibit comparative advantages in terms of capital and personnel resources. On the other hand, small-scale industries demonstrate greater operational flexibility. To represent the average size of the industry, the ratio of total industry assets to the number of enterprises is employed. (2) Digital transformation (*D*): The advancement of the digital economy presents a pivotal opportunity for enhancing the autonomy and controllability of the industrial chain. The level of digital input, derived from an input-output table, serves as a metric to quantify the direct reliance of the manufacturing industry chain on the digital economy sector. (3) Ownership structure (*O*): Variations in ownership structures lead to differences in governance mechanisms, incentive frameworks, and personnel motivation. This ultimately manifests in disparities in output efficiency and influences the progression of innovation activities. The ownership structure is characterized by the aggregate assets of various industries and the proportion of assets attributed to state-owned enterprises. (4) Foreign direct investment in the host country market exhibits a "technology lock-in effect," which can potentially impact the technological advancement of the host country. In this study, this effect is quantified by the ratio of total assets held by foreign investors and businesspeople from Hong Kong, Macao, and Taiwan in each industry to the overall industry assets. (5) Human capital (*H*): Improving the human capital level has also become an important force to break through key core technologies. Technical personnel have strong learning and absorption ability and high professional and technical ability. Scientific and technological achievements created by R&D personnel change the industry's production mode.

4.3. Sample selection and data explanation

This study examines the influence of "technology-seeking" OFDI on the autonomous and controllable capacity of industrial chains. Eighteen industrial chain segments within China's manufacturing industry are utilized as research samples, spanning the period from 2016 to 2021. The primary data sources for computing each variable index include China's OFDI Statistical Bulletin, China's Input-Output Tables, China's Science and Technology Statistics Yearbook, and China's Industrial Statistics Yearbook. The data processing in this study should be explained as follows: (1) For the problems of different industrial classification standards in various statistical yearbooks, the sample is uniformly classified into 18 manufacturing industry chains, according to the standard of Industry Classification of National Economy (GB/4754-2017) and the input-output Table (interpretation and code of sector classification). The corresponding relationship is shown in Table 1. (2) To address the issue of missing data for certain years in China's input-output tables, an interpolation method is employed to fill in the gaps for these discontinuous years. (3) A consistent adjustment is made to the statistical scope, focusing on industrial enterprises above a designated size. (4) To mitigate the influence of data volatility and heteroscedasticity on the empirical estimation results, natural logarithms of the dependent variable and all independent variables are included in the model. The descriptive statistical properties of each variable after applying the logarithmic transformation are presented in Table 2.

Table 1: The classifications of China's manufacturing industry chain and the corresponding relationship with the classification of national economic industries and input-output product sectors

Number	Industrial chain name	National economy industry classification code	Input-output table product department code
1	Food industry chain	C13	13012, 13013, 13014, 13015, 13016, 13017, 13018
		C14	14019, 14020, 14021, 14022
		C15	15023, 15024, 15025
2	Textile and garment industry chain	C17	17027, 17028, 17029, 17030, 17031
		C18	18032
3	Leather products and furniture industry chain	C19	19033,19034
		C21	21036
4	Paper and paper products industry chain	C22	22037
5	Oil/coal and other fuel processing industry chain	C25	25041, 25042
6	Chemical product industry chain	C26	26043, 26044,

ISSN 2616-5902 Vol. 6, Issue 12: 1-13, DOI: 10.25236/AJBM.2024.061201

			26045, 26046, 26047, 26048, 26049
		C28	28051
7	Pharmaceutical manufacturing industry chain	C27	27050
8	Rubber and plastic products industry chain	C29	29052, 29053
9	Non-metallic mineral products industry chain	C30	30056, 30057, 30058, 30059, 30060
10	Metal smelting and calender processing industry chain	C31	31061, 31062, 31063
		C32	32064, 32065
11	Metal products industry chain	C33	33066
12	General equipment industry chain	C34	34067, 34068, 34069, 34070, 34071, 34072
13	Special equipment industry chain	C35	35073, 35074, 35075, 35076
14	Automobile manufacturing industry chain	C36	36077, 36078
15	Other transport equipment industry chain	C37	37079, 37080, 37081
16	Electrical machinery and equipment manufacturing	C38	38082, 38083, 38084, 38085, 38086, 38087
17	Computer/communications and other electronic equipment manufacturing	C39	39088, 39089, 39090, 39091, 39092, 39093
18	Instrument industry chain	C40	40094

The results indicate that the minimum and maximum values of the industrial chain autonomy controllable level are -0.347 and -0.0013, respectively, with a median of -0.0091. The overall sample values are relatively low, suggesting limited autonomous controllable ability within China's manufacturing industry's industrial chains. Furthermore, the standard deviation of 0.0071 suggests a lack of significant extreme values. The values of the other variables lie within a normal range and exhibit some variability, aligning with the research requirements.

Table 2: Descriptive statistics of variables

Variable type	Variable symbol	Variable name	*Obs*	*Med*	*Sta*	*Min*	*Max*
Variable being explained	***Indecon***	Independent and controllable industrial chain	94	-0.091	0.071	-0.374	-0.013
Explained variable	***OFDI***	Outward foreign direct investment	94	2.345	0.943	0.182	4.736
Control variables	***S***	Industry scale	94	0.953	0.741	-0.166	2.913
	D	Digital transformation	94	-3.015	1.444	-6.938	1.249
	O	Ownership structure	94	-1.561	0.429	-2.464	-0.706
	F	Foreign direct investment	94	-1.835	0.864	-4.361	-0.389
	H	Human capital	94	12.215	0.661	9.386	13.421

5. Empirical results and analysis

5.1. Baseline regression result

Table 3 presents a comprehensive analysis of the benchmark regression outcomes that investigate the impact of OFDI on the autonomous controllability of the industrial chain. In particular, Entry (1) within this table meticulously details the regression results obtained after accounting for both time-fixed effects and individual-fixed effects, without the incorporation of any additional control

ISSN 2616-5902 Vol. 6, Issue 12: 1-13, DOI: 10.25236/AJBM.2024.061201

variables. The statistical analysis reveals that the estimated coefficient for OFDI attains statistical significance at the 5% level, thereby providing preliminary evidence of the positive influence of OFDI on the autonomous controllability of the industrial chain. Furthermore, Columns (2) through (5) of Table 3 showcase the results derived from two-way fixed-effects regression models, in which control variables are systematically introduced in a step-by-step manner. A rigorous examination of these results reveals that the sign of the estimated coefficient for OFDI remains consistent throughout, while OFDI's statistical significance is notably strengthened. This consistent pattern indicates that OFDI maintains a significant and positive effect on the autonomous controllability of the industrial chain, even when various control factors are taken into consideration.

From an economic standpoint, the analysis further elucidates that a 1% increase in OFDI is positively correlated with a 2.6% enhancement in the independent controllability of the industrial chain. This economic relationship underscores the substantial impact that OFDI can exert on the autonomy and control capabilities of the industrial chain. These findings emphasize that OFDI's influence on the autonomous controllability of the industrial chain not only holds statistical significance but also possesses meaningful economic implications. Additionally, the results suggest that a higher level of OFDI corresponds to a more pronounced and substantial improvement in the independent and controllable ability of the industrial chain. This positive correlation between OFDI and the enhancement of industrial chain controllability further reinforces the notion that OFDI is a pivotal factor in fostering the autonomy and resilience of industrial structures. Consequently, the results presented in Table 3 validate Hypothesis H1 by confirming that OFDI does indeed exert a significant and beneficial effect on the autonomous controllability of the industrial chain.

Table 3: Foreign direct investment affects the benchmark regression results of industrial chain autonomy and control.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
OFDI	0.020** (0.008)	0.022*** (0.007)	0.023*** (0.007)	0.029*** (0.006)	0.032*** (0.006)	0.026*** (0.005)
S		-0.028*** (0.007)	-0.027*** (0.007)	-0.035*** (0.006)	-0.024*** (0.008)	-0.023*** (0.007)
D			0.013*** (0.007)	0.020*** (0.005)	0.019*** (0.005)	0.020*** (0.005)
O				-0.037*** (0.006)	-0.040*** (0.006)	-0.049*** (0.005)
F					-0.015*** (0.009)	-0.022*** (0.008)
H						0.026*** (0.005)
Cons	-0.137*** (0.019)	-0.142*** (0.018)	-0.145*** (0.017)	-0.160*** (0.014)	-0.165*** (0.015)	-0.152*** (0.013)
Obs	94	94	94	94	94	94
R^2	0.069	0.228	0.258	0.500	0.516	0.630

In terms of the control variables included in the analysis, the estimated coefficients associated with the digital economy and human capital both exhibit significant positive values at the 1% level, which is consistent with our initial expectations. The advancement in the level of industrial digitalization has the potential to exert a profound impact on achieving key technological breakthroughs. Specifically, digital transformation fosters enhanced information sharing, thereby improving the industry's production flexibility and augmenting the collaborative research and development capabilities of the industrial and supply chains. By harnessing initiative and creativity, human capital serves as the primary source of technological innovation. Furthermore, human capital is entrusted with the crucial task of technological innovation, transformation, and diffusion. Human capital also plays a pivotal role in overcoming key core technologies and elevating the independent and controllable ability of the industrial chain. In contrast, the estimated coefficients of industrial scale, ownership structure, and foreign direct investment (FDI) all demonstrate significant negative values at the 1% level. This finding indicates that a higher degree of industrial chain autonomy and controllability is observed for industrial chains characterized by a low proportion of small-scale enterprises, state-owned enterprises, and foreign-invested enterprises. This outcome highlights the significant flexibility advantage possessed by small-scale industries. Conversely, due to the constraints imposed by their system operation and management levels, state-owned enterprises may impede the efficiency of technological advancements. Additionally, the substantial influx and formidable purchasing power of FDI has the potential to trap

ISSN 2616-5902 Vol. 6, Issue 12: 1-13, DOI: 10.25236/AJBM.2024.061201

associated supporting enterprises within low value-added processing links. Consequently, this scenario may hinder domestic enterprises from acquiring high-end and core technologies, ultimately leading to a decline in the autonomous controllable level of the industrial chain. These findings provide valuable insights into the multifaceted factors that influence the autonomy and controllability of industrial chains in contemporary economic landscapes.

5.2. Robustness test

In order to bolster the reliability and robustness of the obtained empirical results, a rigorous validation process was conducted utilizing both the variable substitution method and the subsample regression method. This aim of this comprehensive approach is to ensure the consistency and generalizability of the findings. The two sub-samples were entered into the model test, respectively. The results of this subsample analysis, presented in Table 4, offer a nuanced understanding of how the model's predictions vary across different types of manufacturing industries.

Firstly, the variable substitution method was implemented. Specifically, the independent controllable level of the industrial chain within the manufacturing industry was recalculated using an alternative metric. This metric was derived by computing the direct proportion of import supply to the total output value of the focal industrial sectors. This recalculated variable was then substituted for the original dependent variable and reintroduced into the regression model. This step was crucial to assessing the sensitivity of the model to variations in the dependent variable's operationalization, thereby providing a robust check on the model's validity. Secondly, the subsample regression method was applied. To further scrutinize the model's performance across different segments of the manufacturing industry, the 18 manufacturing industry chain samples were meticulously categorized into two distinct sub-groups: labor-intensive industries and capital-intensive industries. These classifications were based on the relative proportion of labor and capital inputs in each industry, reflecting their underlying economic structures and production processes. Subsequently, these two sub-samples were independently introduced into the regression model for testing.

Table 4: OFDI affects the robustness test results of industrial chain autonomy and control.

Variable	Alternate dependent variable	Subsample regression	
	(1)	(2)	(3)
OFDI	0.040*** (0.008)	0.004*** (0.003)	0.026*** (0.006)
Controls	Yes	Yes	Yes
Cons	-0.201*** (0.021)	-0.048*** (0.008)	-0.198*** (0.013)
Obs	94	58	36
R^2	0.589	0.720	0.926

Column (1) in Table 4 presents the regression outcomes derived from the application of the alternative variable method. Specifically, the estimated coefficient of OFDI is reported as 0.04, which is statistically significant at the 1% level. This finding aligns with the results obtained from the benchmark regression analysis, thereby suggesting that the benchmark regression results exhibit a relatively high degree of robustness. The consistency between these two sets of results reinforces the reliability of the underlying economic relationships being investigated. Columns (2) and (3) of Table 4 display the regression results for the two distinct sub-samples, namely the labor-intensive industries and capital-intensive industries, respectively. Within these sub-samples, the estimated coefficient of OFDI remains significantly positive. This persistence of a positive and statistically significant coefficient across both sub-samples further reinforces the research conclusion presented in this paper. The finding indicates that the positive impact of OFDI on the dependent variable, as identified in the benchmark regression, is not confined to a specific industry type but is evident across both labor-intensive and capital-intensive manufacturing sectors.

6. Further analysis: the mechanism of different technological progress paths

The aforementioned empirical findings clearly demonstrate that OFDI plays a pivotal role in significantly enhancing the autonomous and controllable ability of China’s industrial chain. This finding prompts a deeper inquiry into the nuanced impact of technology-seeking OFDI on the autonomous controllable ability of the industrial chain, particularly when considered under the context of various technological progress pathways. To fully comprehend how these factors influence the

ISSN 2616-5902 Vol. 6, Issue 12: 1-13, DOI: 10.25236/AJBM.2024.061201

autonomy and control within the industrial chain, the intricate interplay between technology-seeking OFDI and technological progress pathways necessitates a more granular analysis.

In order to gain a deeper understanding of this phenomenon, this paper endeavors to further explore the underlying mechanisms through which OFDI exerts its influence on the autonomous controllable ability of the industrial chain. To achieve this, a rigorous and structured analytical framework is essential. Therefore, this paper proposes to construct a theoretical model, which aims to elucidate the specific pathways through which technology-seeking OFDI can impact the autonomous controllable ability of the industrial chain. Simultaneously, the diversity of technological progress pathways is also taken into account.

$$T_{it}=\beta_0+\beta_1 OFDI_{it}+\sum_j \beta_j X_{jit}+\varepsilon_{it} \quad (3)$$

$$Indecon_{it}=\theta_0+\theta_1 OFDI_{it}+\theta_2 T_{it}+\sum_j \theta_j X_{jit}+\varepsilon_{it} \quad (4)$$

In this paper, the current technological progress (***T***) pathway of China's manufacturing industry is meticulously subdivided into three distinct categories: technology introduction (***TF***), tracking and imitation (***TR***), and independent innovation (***RD***). The categorization aims to provide a nuanced understanding of the various strategies employed by the focal industry in advancing its technological capabilities.

Independent innovation (***RD***) is quantified by assessing the intensity of investment in research and development (R&D). Within the realm of R&D activities, fund investment constitutes a vital component, serving as the cornerstone for conducting R&D projects, as well as capital construction. Through R&D fund investment, the industry is able to undertake R&D activities, which in turn support the development of independent innovation endeavors. This investment not only provides the necessary financial backing but also ensures the successful transformation of scientific and technological achievements into practical applications. In this context, the internal expenditure of R&D funds is utilized as a proxy for the investment intensity of independent innovation, thereby reflecting the industry's commitment and efforts towards enhancing the industry’s independent innovation capabilities. Regarding technology introduction and imitation innovation, the "China Science and Technology Statistical Yearbook" offers detailed statistics on the industrial regulations pertaining to the technology acquisition and technology transformation expenditures of industrial enterprises. These statistics encompass four key components: 1) introduction of technology expenditure, 2) purchase of domestic technology expenditure, 3) digestion and absorption expenditure, and 4) technology transformation expenditure. The first two components serve as indicators of the industry's expenditure on importing technology from external sources; the latter two components measure the extent to which companies invest in copying and adapting external technologies. Consequently, in this paper, external technology acquisition by industrial enterprises is employed as a metric for technology introduction (***TF***), while technology imitation transformation expenditure is utilized to quantify imitation innovation (***TR***). This approach allows for a comprehensive assessment of the industry's engagement in both technology acquisition and adaptation processes.

Table 5: The results of the test on the mechanism of OFDI affecting the independent and controllable industrial chain

Variable	Independent innovation		Technology introduction		Tracking and imitation	
	(1)	(2)	(3)	(4)	(5)	(6)
	RD	*Indecon*	*TF*	*Indecon*	*TR*	*Indecon*
OFDI	0.087* (0.048)	0.035*** (0.002)	0.283*** (0.089)	0.036*** (0.005)	0.278*** (0.045)	0.039*** (0.006)
RD		0.099*** (0.005)				
TF				0.033*** (0.005)		
TR						0.046*** (0.012)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Cons	15.375*** (0.121)	1.371*** (0.076)	11.344*** (0.222)	0.217*** (0.062)	13.277*** (0.113)	0.452*** (0.155)
Obs	94	94	94	94	94	94
R^2	0.724	0.935	0.785	0.741	0.858	0.686

Table 5 presents a comprehensive compilation of the test results pertaining to various technological

ISSN 2616-5902 Vol. 6, Issue 12: 1-13, DOI: 10.25236/AJBM.2024.061201

progress paths. Specifically, Columns (1), (3), and (5) contain the regression outcomes derived from Equation (3). Upon examining these results, it becomes evident that the estimated coefficients associated with OFDI exhibit significant positive values at a statistical significance level of at least 10%. This observation underscores the notion that, within the context under investigation, OFDI exerts a notable enhancement effect on technological progress. Among the three distinct pathways of technological progress – independent innovation, technology introduction, and tracking and imitation – it is discernible that the statistical significance of independent innovation is relatively weak. Conversely, both technology introduction and tracking and imitation demonstrate robust significance levels of 1%. This finding suggests that the promotional impact of OFDI on independent innovation has yet to be fully realized and indicates potential areas for further advancement. From an economic standpoint, a meticulous analysis reveals that, for every 1% increment in OFDI, independent innovation experiences an augmentation of approximately 8.7%. In contrast, technology introduction experiences a more substantial increase of 28.3%, with tracking and imitation seeing a comparable rise of 27.8%. These findings indicate that the "technology-seeking" objective of OFDI has been successfully achieved, thereby contributing to an overall enhancement in the technical sophistication of China’s manufacturing industry. This analysis not only highlights the differential impacts of OFDI across various technological progress pathways but also underscores the potential for further optimization and enhancement in the realm of independent innovation.

Columns (2), (4), and (6) of the presented data set detail the regression outcomes obtained from Equation (4). When both OFDI and technological progress are concurrently incorporated into the regression model, the estimated coefficient of OFDI maintains a statistically significant positive value at the 1% level. The estimated coefficient of technological progress similarly exhibits a significant positive value at the 1% level. This dual significance underscores the positive influence that technological progress exerts on the independent controllable ability of the industrial chain. In summarizing these findings, what becomes apparent is that technological progress serves as a partial intermediary in the process through which OFDI impacts the independent controllable ability of the industrial chain. This observation indicates that OFDI is instrumental in fostering technological progress, which in turn enhances the independent controllable ability of the industrial chain. Among the three pathways of technological progress – independent innovation, technological advancement, and tracking and imitation – each plays a partial intermediary role. Specifically, independent innovation contributes the largest intermediary effect, accounting for 9.9% of the total impact. Meanwhile, technological advancement and tracking and imitation contribute intermediary effects of 3.3% and 4.6%, respectively. These test results robustly validate the proposition that technological progress constitutes a pivotal avenue through which OFDI can improve the independent controllable ability of the industrial chain. Consequently, Hypothesis H2, which posits a relationship between OFDI, technological progress, and the enhancement of industrial chain control, is confirmed. This analysis not only contributes to the understanding of the mechanisms underlying OFDI's impact on industrial chain control but also highlights the critical role of technological progress in facilitating this process.

7. Conclusion

Foreign direct investment (FDI) that is motivated by the objective of "technology seeking" represents a pivotal pathway for China to follow to bolster the independent and controllable ability of the country’s industrial chain. This paper delves into the intricate internal logic and transmission mechanisms through which outward foreign direct investment (OFDI) influences the independent controllable ability of the industrial chain. Utilizing a panel model encompassing China's manufacturing industry chain, from 2016 to 2021, this study empirically examines both the overall effect and the underlying mechanisms of OFDI on the independent controllable ability of China’s industrial chain. The findings drawn from this rigorous analysis are as follows:

(1) On a holistic level, OFDI demonstrates a marked capacity to enhance the autonomy and controllability of China’s industrial chain. This conclusion remains robust, even after conducting a series of robustness tests, thereby reinforcing the significance of OFDI in this context.

(2) The results of the mechanism test further elucidate that OFDI exerts not only a direct effect but also a pronounced indirect effect on augmenting the autonomous controllable ability of China’s industrial chain. The indirect effect is mediated through the improvement of technological levels, indicating that OFDI fosters technological advancements which, in turn, bolster both the independence and control of the industrial chain.

(3) Among the three finely delineated pathways of technological progress – independent innovation, technological enhancement, and technological adaptation – independent innovation emerges as the most significant intermediary factor. However, one noteworthy finding is that the promotional effect of OFDI on independent innovation, while present, is not sufficiently robust.

In anticipation of future increasingly complex and challenging international and domestic scenarios, China must harness its inherent advantages and progressively strengthen the independent and controllable ability of both its industrial and supply chains. This strategic imperative underscores the need for continued investment in technological innovation and the refinement of OFDI strategies to maximize their positive impacts on the domestic industrial landscape.

References

[1] BAI Xuejie, Song Pei, Ai Yang, Li Lin. China build independent control logic and practice the theory of modern industry system path [J]. Journal of economists, 2022 (6): 48-57.
[2] Li Feng, Cao Xiaolei, Chen Simeng. The impact of Sino-US trade friction on China's manufacturing supply chain and its countermeasures [J]. Economist, 2019(9):104-112.
[3] Fu Baozong. The blocking points and breakpoints that need to be solved to enhance the independent controllable ability of industrial chain and supply chain [J]. Economic aspect, 2022 (3): 46 + 39-137.
[4] He Yobing, Han Qiumin, Zeng Yi. Independent innovation for the influence of China's manufacturing industry international competitiveness [J]. Journal of scientific research management, 2019, 40 (07) : 33-46.
[5] Ministry of Commerce of the People's Republic of China, National Bureau of Statistics, State Administration of Foreign Exchange. Statistical Bulletin of China's Outward Direct Investment in 2021 [M]. Beijing: China Business Press, 2022.
[6] Piao Yingai, Yu Hong, Zhou Xinhong. Reverse technology spillover effect of China's OFDI and its influencing factors: A study from the perspective of absorptive capacity [J]. Economic fabric, 2022, 33 (5): 6 45 to 55.
[7] He Jun, Tao Siyu. Innovation system and technology synergy evolution: China's industrial technological progress in 70 [J]. Journal of economic aspect, 2019 (10): 64-73.
[8] Gong Gang, Huang Chunyuan, Zhang Qiancheng, Chen Weitao, Zhao Liangliang. From technology introduction to Independent research and development: on China's economic growth mode in the new stage [J]. Journal of Economics, 2013(05):16-26.
[9] Zheng Jianghuai, Dai Wei, Ran Zheng. The way to improve the development level of industrial chain modernization during the 14th Five-Year Plan period: A case study of Jiangsu Province [J]. Modern Management Science, 2021(01):4-15.
[10] Chen Yao, Wang Baozhu. Smooth circulation of national Economy with the development of digital Economy: from the perspective of spatial comparison [J]. Economist, 2022 (6): 58-67.
[11] Chen Xiaodong, Yang Xiaoxia. Does digital transformation improve the ability of industrial chain autonomy and control? [J]. Journal of economic management, 2022, 44 (08): 23-39.
[12] Huang Taiyan, Pian Fei. Manufacturing OFDI effect on the added value of exports [J]. China industrial economy, 2016 (7): 91-108.
[14] Sha Wenbing. Foreign direct investment, reverse technology spillover and domestic innovation capacity: An empirical study based on China's provincial panel data [J]. The world economy research, 2012 (03): 69-74 + 89.
[15] Janice, Shen Chen. China's foreign direct investment in manufacturing industrial upgrading effect research [J]. Journal of international trade issues, 2016 (8): 143-153.
[16] Kong Qunxi, Wang Ziqi, CAI Meng. Does foreign direct Investment improve the quality of China's economic growth [J]. Finance and Trade Economics, 2019, 40(05):96-111.
[17] Liu Jiajun, Li Xiaohua. Chinese manufacturing foreign direct investment's influence on the modernization of the industrial chain and deal with [J]. Journal of economic aspect, 2021 (12) : 58-66.
[18] Tang Wei-bing, Fu Yuan-hai, Wang Zhan-xiang. Technological innovation, technology introduction and the transformation of economic growth mode [J]. Economic Research Journal, 2014, 49(07): 31-43. (in Chinese)
[19] Kim C S, Inkpen A C. Cross-border R&D alliances, absorptive capacity and technology learning [J]. Journal of International Management, 2005, 11 (3): 313-329.
[20] Schumpeter, J., 1991. Theory of Economic Development. The Commercial Press.
[21] Tang, W.B., Fu, Y.H., Wang, Z.X., 2014. Technological innovation, technology introduction and the transformation of economic growth mode. Economic Research Journal, 49(07):31-43.

ISSN 2616-5902 Vol. 6, Issue 12: 1-13, DOI: 10.25236/AJBM.2024.061201

[22] Ai, H.S., Deng, Z.G., Yang, X.J., 2014. The effect estimation and channel testing of the technological progress on China's regional environmental performance. Ecological Indicators, Volume 51201, Pages 67-78.

[23] Li, S.S., Miao, X., Feng, E.H., Liu, Y.Q., Tang, Y.H., 2022. Technology import modes, environmental regulation types and total factor energy efficiency. Energy Sources, Part B: Economics, Planning, and Policy, oracle.

[24] Wu, R.H., 2023. Innovation or imitation? The impacts of financial factors on green and general research and development. International Review of Economics &Finance, Volume 88202, Pages 1068-1086.

[25] Song, F., Zhao, C., 2022. Why do Chinese enterprises make imitative innovation? - An empirical explanation -based on government subsidies. The Front. Psychol. 802703.

[26] Yu, L.P., Li, H.Y., Wang, Z.G., Duan, Y.L., 2018. Technology imports and self-innovation in the context of innovation quality. International Journal of Production Economics, Volume 9, 214201 Pages 44-52.

[27] Lin Shanlang. China's solution to global industrial chain restructuring [J]. Beijing: People's Forum · Academic Frontiers, 2022, (7): 41-53.

[28] Xie Zhong, Lu Wenling. Does foreign direct investment restrain manufacturing enterprises from "moving from real to virtual"? -- The moderating effect of home country intellectual property protection [J]. Journal of Investment Research, 2022,41(10):62-77.

[29] Dunning J H, Lundan S M. Multinational Enterprises and the Global Economy[M]. Edward Elgar Publishing, 2008.

[30] Zhao Jingrui, Sun Hui, Hao Xiao. Domestic industrial technology progress and product quality in the industry trade differences [J]. Journal of international business (journal of foreign economic and trade university), 2022 (02): 33-49.

[31] Ji Liangyu. Technology innovation path and intensive development of China's manufacturing industry [J]. Journal of shanxi university of finance and economics, 2017, 33 (6) 6:51-63.