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Service-oriented Transformation in Manufacturing and The Deepening of Corporate Value Chains

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Abstract: This paper examines the challenges and opportunities faced by China's manufacturing industry in the context of global value chain division and technological revolution. It explores the impact of manufacturing servitization on enterprise value chain advancement, aiming to address how this transformation affects climbing the enterprise value chain. Drawing on data from Chinese industrial enterprises between 2003 and 2013, this study employs micro-level empirical analysis using a two-way fixed effect regression model and 2SLS instrumental variable method to establish a causal relationship between manufacturing servitization and enterprise value chain advancement. The findings reveal that manufacturing servitization has a significant positive impact on climbing the enterprise value chain, particularly for technology-intensive, capital-intensive, and resource-intensive enterprises. By providing empirical evidence and policy implications for China's manufacturing industry transformation and upgrading efforts, this research enriches existing literature on both manufacturing servitization and value chain advancement.

Keywords: Efficiency of business, Enterprise value chain climbing, Servitization of manufacturing.

1. Introduction

The global economic landscape is in a state of perpetual flux, and at its epicenter, China stands as a formidable force shaping the course of the manufacturing industry. This meteoric rise in industrial output was not merely a domestic feat; it played a substantial role, contributing nearly one-third of the world's manufacturing capacity. However, beneath this facade of dominance lies a multifaceted reality—a paradox that demands our scrutiny. As Xu[1] observed, China's manufacturing industry predominantly occupies a downstream position compared to its global counterparts, emphasizing the degree of servitization of manufacturing.

Recent years have ushered in a convergence of internal and external pressures that China must adroitly navigate. On one hand, the relentless ascent of factor costs is beginning to cast a discernible shadow on China's export trade. An increasing number of manufacturing producers are now favoring Southeast Asian countries such as Vietnam[2] Consequently, the once-unchallenged appeal of "Made in China" is gradually losing its luster, as succinctly noted by Wang & Guo[3] in 2020. On the other hand, an epochal technological revolution is sweeping across industries, triggering a global shift towards intelligence-driven manufacturing. Developed nations are now embracing industrialization strategies aimed at reinvigorating their manufacturing sectors and, in the process, redefining the contours of the global division of labor[4]. This dual challenge—escalating costs and the relentless march of global industrialization strategies—has placed a weighty mantle on China's manufacturing industry, compelling it to reinvent itself and transform[5]. A midst these compelling circumstances, it becomes imperative for China to strategically harness its inherent strengths, seize extant development opportunities, and embark on a nuanced exploration of how intelligence-driven technologies are reshaping the trajectory of the manufacturing value chain. This endeavor is not only consonant with the overarching paradigm shift underway in China's manufacturing sector but also holds profound implications for comprehending the intricate driving mechanisms that underpin this transformation. Indeed, it is a pursuit marked by both theoretical and practical significance, with repercussions that reverberate across industries and geographies[6]. Most of the existing studies believe that manufacturing servitization has a positive effect on enterprise performance[7] export value added[8] and factor endowment[9].

The term "service-oriented manufacturing" or "manufacturing servitization" encapsulates a new manufacturing paradigm—a fusion of manufacturing and services[10]. It signifies not just integration but a profound amalgamation of advanced manufacturing and the modern service industry. This dynamic integration involves manufacturing enterprises transcending the confines of traditional production boundaries by incorporating more service elements or embarking on a journey of expansion into the service sector.

Numerous empirical studies underscore the transformative potential of manufacturing servitization across various facets of enterprise performance. From enhancing enterprise performance metrics to boosting export value-added and optimizing factor endowment, manufacturing servitization has left an indelible mark. At its core, manufacturing servitization entails the strategic infusion of service components into a manufacturer's core product offerings. This augmentation may manifest as services spanning maintenance, consulting, training, or customization. The outcome is profound: an enterprise's ability to ascend the value chain is considerably fortified as value-added activities are bolstered and the pursuit of higher profits is expedited. This enhancement is engineered through improved factor productivity, an outcome attributed to the infusion of service inputs that enhance production processes, elevate product quality, catalyze innovation, and facilitate product differentiation.

However, the scope and influence of manufacturing servitization extend beyond the realm of improved productivity. This transformative phenomenon exerts its influence on the very structure and governance of global

value chains (GVCs). These GVCs represent intricate and interconnected networks that span multiple countries, orchestrating a product's journey from conceptualization to end-use. Servitization, in its manifold forms, empowers manufacturing firms to forge closer, more collaborative bonds with both customers and suppliers. It equips them with the leverage to wield greater control and exercise increased bargaining power over the entire spectrum of value chain activities.

The imperative of understanding the intricate mechanisms and the extensive ramifications of servitization on value chain elevation cannot be emphasized enough. It is an exigent necessity for the sustained competitiveness and long-term viability of manufacturing enterprises in an ever more interconnected global marketplace. This research, positioned at the nexus of transformation and evolution, endeavors to illuminate these intricate dynamics and their profound implications. It embarks on an academic odyssey into the core of China's manufacturing renaissance. In this quest, it offers valuable insights that resonate far beyond academia, reaching the desks of policymakers, the boardrooms of industry titans, and the minds of stakeholders. It extends an invitation to all to join in charting a course toward a future characterized by innovation, adaptability, and unwavering resilience. In this unfolding narrative of China's manufacturing evolution, we find not only a story of economic prowess but a tale of adaptability, innovation, and strategic foresight that holds valuable lessons for industries and nations around the world.

2. Literature Review and Theoretical Hypotheses

2.1. Research on the Economic Effects of Manufacturing Services

At present, the research on the economic effect of manufacturing servitization mainly focuses on three aspects: First, as for the impact of manufacturing servitization on enterprise productivity and technological innovation, most scholars agree that there is a positive relationship between the two. Certainly, here's an alternative sentence for that part: For instance, scholars like Crozet & Milet[11] contend that the connection between manufacturing servitization and enhanced productivity and technological innovation can be attributed to the integration of technical and human capital into productive services, thereby fostering improvements in production efficiency driven by technology spillover effects. Breinlich et al.[12] discovered that service-oriented manufacturing enterprises exhibited a significant increase in green productivity levels compared to others. Additionally, improvements in input service quality were found to positively influence enterprise innovation activities through technology absorption[13]. However, it's worth noting that dissenting voices, like Benedettini et al.[14], have contested these findings, suggesting that servitization may not universally drive productivity improvements.

Second, regarding the impact of manufacturing servitization on value addition and value chain upgrading, Crozet & Milet posit that it can significantly augment a manufacturing enterprise's value-added capabilities and enhance the domestic value-added rate in exports. Yet, an alternative viewpoint introduces the concept of a non-linear, U-shaped curve relationship. Lastly, the effects of manufacturing servitization on enterprise exports represent another intriguing sub-argument. In terms of value chain upgrading, Liu et al.[15] noted that servitization of the manufacturing industry significantly elevated China's manufacturing sector's position within the global value chain. However, the study conducted by Xu et al. posits that the relationship between the serviceability of the manufacturing industry and the domestic value-added rate of enterprises' exports is not a straightforward linear correlation but rather follows a distinctive U-shaped curve pattern[16].

Third, Turning to the impact of manufacturing servitization on enterprise exports, Qian et al.[17] uncovered an intriguing U-shaped relationship with China's manufacturing servitization. Meanwhile, an analysis conducted by Liu & Wang[18] shed light on the connection between the servitization of the manufacturing industry and the "binary margin" of enterprise exports. Their findings indicated that manufacturing servitization not only increased the likelihood of enterprises exporting but also broadened the variety and market reach of their exported products. Furthermore, Yuan et al.[19] discerned that the service-oriented manufacturing industry played a significant role in enhancing the quality of enterprises' export products.

2.2. Literature Review on Value Chain Climbing in Manufacturing

Within the realm of global manufacturing, the expansion and development of value chains are contingent upon several influential factors[20]. A comprehensive analysis of pertinent research studies reveals a multifaceted landscape where various elements converge to propel the growth of global value chains. Foremost among these factors is the pervasive impact of digitalization[21]. Jing & Yuan[22] assert that digitalization has emerged as a potent force driving the evolution of value chains. It transcends conventional boundaries by not only reducing trade costs and enhancing transaction efficiency but also by empowering producers, reshaping trade methods, and intensifying communication among key stakeholders, including producers, consumers, and government entities. In turn, these transformations have led to a reconfiguration of international trade patterns. This realignment underscores the centrality of technology in molding the global manufacturing landscape. Moreover, research conducted by Xu & Xia[23] underscores the pivotal role played by a nation's digital capabilities in determining its position within the global value chain and its influence over the governance of this intricate network. This underscores the profound implications of technology in reshaping the global manufacturing terrain. Beyond digitalization, artificial intelligence emerges as another instrumental factor in this transformation. Furthermore, Lu et al.[24] provide a comprehensive examination of AI's impact on firm participation within value chains, dissecting its influence from both cost-related perspectives and its contribution to firm productivity. Their findings underscore the far-reaching implications of AI in shaping the evolution of value chains.

Nevertheless, it is essential to recognize that the expansion of global value chains is not solely reliant on technological advancements[25]. A deeper exploration reveals that the integration and extension of domestic value chains constitute a fundamental driving force in this context. Liu & Zhang[26] posit that the interconnection of the eastern region with the global value chain forms the basis for an extended domestic production network. The construction of domestic value chains, with local enterprises at their core, facilitates a

positive interaction between regional economies and contributes to the upward trajectory of the global value chain. Yuan et al.[27] reinforce this perspective, demonstrating that the extension of domestic value chains can significantly boost the export value of manufacturing. Importantly, the degree of interregional correlation emerges as a critical determinant in shaping the integration of domestic value chains, highlighting the nuanced nature of this process.

Extending this argument further, Gu et al.[28] elucidate how domestic value chains can become integrated with the global value chain through various pathways, such as land-to-inland and land-to-coastal connections. These intricate interlink ages exemplify the diverse strategies that can be employed to infuse added value into the global manufacturing network. Moreover, when considering the regional context, Liu & Xia[29] employ a comprehensive world input-output model, which includes China's provinces, to reveal distinct patterns of value chain embedding. Coastal provinces predominantly tend to be ensconced within the global value chain, whereas inland regions primarily find their niche within the domestic value chain. This research underscores the manifold regional disparities in the benefits accrued and the degree of value chain integration, emphasizing the localized nuances that shape the trajectory of global value chain development.

In summation, the growth of global value chains in manufacturing is an intricate and multifaceted process driven by an amalgamation of factors, as delineated within this sub-argument. Digitalization and technological advancements like AI have ushered in transformative changes, while the integration and extension of domestic value chains constitute fundamental pillars that underpin this evolution. Recognizing the interplay of these factors is essential for comprehending the dynamic and ever-evolving landscape of global manufacturing value chains.

2.3. Impact of Value Chain Input Factors on Manufacturing Firms

In their examination of factors driving growth in the industrial sector, Brandt et al.[30] underscore the increasing influence of market forces, expanded market entry, and intense competition as pivotal drivers behind the rising capabilities and productivity.

In line with this, Bai et al.[31], employing the Heckscher-Ohlin framework, provide empirical validation for their theoretical predictions concerning the impact of minimum wage on firms' selection and exit. They emphasize that a 10% hike in the minimum wage, equivalent to a yearly increase of 500 Chinese Yuan, results in a significant 4.4% boost in firm total factor productivity (TFP), accompanied by a corresponding rise in the likelihood of firms exiting the market.

In a related context, Yuan delves into the impact of upstreamness on wages, revealing a positive correlation with reduced firms' management costs. She posits that a 1% increase in a firm's position in the value chain corresponds to a 0.17% rise in the firm's average wage level. Additionally, the position of firms in the global value chain, considering capital intensity, emerges as a significant factor in promoting wage levels, highlighting the connection between upstreamness and cost management. Pahl & Timmer[32] discovered that their measurement framework, as presented in their study, fails to differentiate between these scenarios. This observation paves the way for intriguing opportunities for additional research. There is a pressing requirement for a more in-depth characterization of various activities within Global Value Chains (GVCs), such as research and development , manufacturing, and marketing activities. These activities differ significantly in terms of their factor demands and the potential for knowledge spillovers. Further investigation into these distinctions could yield valuable insights.

Lastly, Wang & Guo shed light on how the rise in labor prices and other factor price increases challenge China's historically advantageous labor-intensive and resource-intensive manufacturing industries. They illustrate that monthly wages in China's southeastern coastal regions range from approximately $500 to $600, in contrast to $300 in Indonesia, $250 in Vietnam, and $200 in Cambodia. Furthermore, Wang[33] underscores the strategies employed by developed economies, such as Europe and the United States, to attract manufacturing back, emphasizing the complex interplay of labor, land, logistics, electricity, tax, financing, and overall business environment costs in this context.

In a separate study, Ge & Xie[34] argue that the coefficient on the core explanatory variable is significantly negative for firms located in cities with talent admission policies. They also demonstrate that talent admission policies reduce the share of imported intermediates in firms' intermediate inputs, confirming that the allocation of intermediates is an important channel through which talent admission policies affect firms' exported domestic value added. Zhu & Fan[35] characterize China's outward migration of manufacturing industries by highlighting several key features. They note that the migrated industries are predominantly labor-intensive and pollution-intensive, such as textiles and wood products. Some of these industries also involve technology-intensive components, with the transfer of technology-intensive industries to China. For instance, the "Computer, Electronic and Optical Products Manufacturing Industry" saw a notable increase in production in China from 2009 to 2014, reflecting its technology-intensive nature. In this sector, the proportion of high-skilled workers is significantly higher compared to other manufacturing industries.

Collectively, these studies provide valuable insights into the multifaceted factors shaping the industrial landscape, offering policymakers and stakeholders a comprehensive understanding of the challenges and opportunities in the global industrial environment.

2.4. Comprehensive Research Regression of Manufacturing Servitization and Enterprise Value Chain Climbing

In the realm of academic inquiry, manufacturing servitization has become a subject of increasing interest. This phenomenon entails the integration of services into the core offerings of manufacturing firms and carries significant implications for global value chain upgrading. Scholars have largely focused their efforts on exploring these implications from two distinct vantage points: the macro-industry level and the enterprise level.

At the macro-industry level, a subset of studies has sought to establish indicators capable of measuring the extent of manufacturing servitization and its consequential effects on value chain upgrading[36-38]. This branch of research is instrumental in providing a broader perspective on the interplay between manufacturing servitization and global

value chains. The majority of existing literature in this field primarily centers its attention on examining how manufacturing servitization impacts the improvement of global value chains. This examination primarily adopts a perspective that revolves around the development of producer services and the integration of enterprise services[39,40]. Research pertaining to producer services has predominantly focused on the infusion of these services into the manufacturing process and the extent to which producer services are accessible. In the realm of research related to the integration of producer services, certain studies have established measurement criteria for evaluating manufacturing servitization and the subsequent enhancement of value chains at the macro-industry level. These studies then proceed to conduct comprehensive analyses based on these established criteria[41].

Li & Zong[42] delved into the intricate relationship between manufacturing servitization, service trade openness, and business cycle linkage. Their study unveiled a positive association between manufacturing servitization and service trade openness, further emphasizing the interconnectedness of these elements. These insights underscore the need for a comprehensive understanding of service openness in the context of manufacturing servitization.Shifting our focus to the enterprise level, a significant portion of the literature has sought to examine how manufacturing servitization influences the export performance of individual firms. Researchers have utilized various metrics, such as export value-added rate, export product quality, and product complexity, as proxies for assessing the global value chain status of enterprises. These studies provide valuable insights into the micro-level implications of manufacturing servitization[43] .

However, despite the significant progress made in analyzing manufacturing servitization's impact on global value chains from both macro-industry and enterprise-level perspectives, several critical shortcomings persist in the existing literature. Firstly, a substantial portion of the research relies heavily on domestic data, primarily sourced from China's input-output tables and industrial enterprise databases. This heavy reliance on China as a primary case study limits the generalizability of findings to other global contexts. Therefore, there is a pressing need for research that incorporates international perspectives to provide a more comprehensive understanding of the phenomenon's global implications.

Secondly, as the development of the global value chain becomes increasingly fragmented and characterized by "block-based" structures, there is a growing recognition that a country's manufacturing industry is deeply integrated into regional value chains. Consequently, there is a gap in our understanding of how the development of regional value chains may influence the upgrading of industries on a global scale. Future research should explore these regional dynamics to capture a more holistic view of the effects of manufacturing servitization.

Lastly, while the existing literature has made strides in analyzing the impact of service input in the manufacturing industry, many studies have provided relatively simplistic analyses. To gain a more nuanced understanding of this aspect, future research should explore the intricate relationships between service inputs, manufacturing servitization, and value chain dynamics. By delving deeper into these complexities, scholars can contribute to a more comprehensive comprehension of the multifaceted nature of manufacturing servitization.

2.5. Hypothesis of Research

The transformation of the manufacturing industry towards servitization has far-reaching implications for the global value chain. Simultaneously, enhancing the domestic value chain and ensuring the efficient circulation of the domestic market plays a pivotal role in elevating the level of manufacturing servitization. This paradigm shift underscores the importance of services as they facilitate the integration of advanced production factors, expanding the value chain from an internal to an external industry level. This enhancement in total factor productivity consequently boosts enterprises' competitiveness, propelling the manufacturing industry towards higher value-added segments within the global value chain.

Recent research highlights a notable U-shaped relationship between the degree of global value chain integration and the level of manufacturing servitization, with technological innovation acting as a crucial intermediary channel. Manufacturing servitization significantly impacts enterprises' positions in the global value chain through two primary mechanisms: advancing technological innovation and managing production costs efficiently.The integration of the domestic value chain capitalizes on the immense internal demand, enabling enterprises to harness the "local market effect." This, in turn, incentivizes enterprises to allocate more resources to critical areas such as product research and development and service-related production processes. China's eastern coastal regions, following years of reform and openness, have become epicenters for high-end equipment manufacturing industries and producer service sectors. However, a significant challenge persists as foreign service integration outpaces domestic service integration, posing a substantial bottleneck to the development of China's manufacturing sector.

Hence, nurturing and strengthening the domestic value chain, alongside promoting its seamless integration, takes on paramount importance. Leveraging the unified domestic market's advantages holds the potential to fuel the servitization transformation of the manufacturing industry, contributing significantly to its high-end and intelligent upgrade.

Building on this analysis, we propose hypothesis for empirical testing: The enhancement of manufacturing servitization among Chinese enterprises positively correlates with the promotion of the export value chain of Chinese manufacturing firms.

3. Methodology: Modeling and Data Description

3.1. Model Assumption

In order to examine the relationship between the serviceization of the manufacturing industry and the deepening of the export value chain of enterprises, combining the database of China's industrial enterprises, the database of China's industrial enterprises' pollution emission and the data of the world's input-output table, this paper establishes the following econometric model:

$$Y_{it} = \alpha + \beta_1 X_{it} + \beta_2 C + \mu_i + \nu_t + \varepsilon_{it}. \quad (1)$$

where i represents the firm, t represents the year, α

represents the constant term, u_i, v_t responds to individual fixed effects and time fixed effects, ε_{it} is the random perturbation term, Y_{it} is the level of enterprise value chain of each firm in each year, and X_{it} is the level of manufacturing servitization of each firm in each year. C denotes a series of control variables, including enterprise age, enterprise productivity level, capital intensity, enterprise debt ratio, enterprise ownership form, which are enterprise-level control variables, and industry-level control variables, such as total industry size and the degree of industry competition.

3.2. Description of Variables

3.2.1. Explanatory Variable

Firms climb global value chains (Y). Kee & Tang[44] pointed out that the export domestic value added rate of enterprises can be used to assess the "upgrading to the high end of the value chain" of emerging market countries, therefore, this paper draws on the idea of Kee & Tang, and combines the database of China's industrial enterprises with the database of China's Customs to measure the enterprise's domestic value added rate of exporting (DVAR), which is measured by the following formula:

$$DVAR_{ft}=\begin{cases}1-\frac{PM_{f,adj}^{P}}{PY_{f}^{P}}-\frac{\delta_{f}^{F}}{EXP_{f}^{P}}, & \text{shipment=P(Processing trade)}\\ 1-\frac{IMP_{f,adj}^{O}+\delta_{f}^{F}}{PY_{f}^{O}}, & \text{shipment=O(General trade)}\\ \gamma_{P}\times\left(1-\frac{PM_{f,adj}^{P}}{PY_{f}^{P}}-\frac{\delta_{f}^{F}}{EXP_{f}^{P}}\right)+\gamma_{O}\times\left(1-\frac{IMP_{f,adj}^{O}+\delta_{f}^{F}}{PY_{f}^{O}}\right), & \text{shipment=M(Mixed trade)}\end{cases} \quad (2)$$

Where γ_P and γ_O represent the proportion of the export value of the processing trade and general trade parts in the total exports of mixed trade enterprises respectively; $PM_{f,adj}^{P}$ and $IMP_{f,adj}^{O}$ represent the adjusted actual imports of intermediates in processing trade and general trade enterprises respectively; δ_f^F represents the value of domestic intermediates from foreign sources; PY and EXP represent the total output value of the enterprise, total exports and total exports of the enterprise respectively. The larger this indicator is, the higher the trade profit an enterprise can get in the process of global value chain division of labor cooperation, and the higher the added value of products from export.

3.2.2. Core Explanatory Variables

Manufacturing servitization(X). In this paper, with reference to Liu Bin et al., the full consumption coefficient of each industry is used to measure the level of manufacturing servitization, which is calculated as follows:

$$X_{jt}=\alpha_{jt}+\sum_{M=1}^{n}\alpha_{km}\,\alpha_{kj}+\sum_{s=1}^{n}\sum_{M=1}^{n}\alpha_{ks}\alpha_{km}\,\alpha_{kj}+u_i+\cdots \quad (3)$$

X_{jt} is the level of servitization of sector j. The first term on the right-hand side of the equal sign, α_{jt}, is the direct consumption of sector k by sector j. The second term, $\sum_{M=1}^{n}\alpha_{km}\,\alpha_{kj}$, is the first round of indirect consumption, and so on, with the nth term, n+1, being the nth round of indirect consumption.

3.2.3. Control Variable

In addition to the core explanatory variables, the following variables are selected as control variables in this paper in order to avoid endogeneity problems caused by omitted variables.

The control variables at the enterprise level comprise: Enterprise Age (lnage), calculated by taking the logarithm of the difference between the current year and the year the enterprise was established, plus one. Enterprise Productivity Level (lnprod), represented as the logarithm of the ratio of actual industrial output value to the number of employees. Capital Intensity (lnkl), measured as the logarithm of the ratio of the net value of actual fixed assets to the number of employees. Debt-to-Equity Ratio (lnalration), assessed as the logarithm of the proportion of total debt to total assets for the enterprise. Ownership Structure of the Enterprise (soe, foreign), identified using indicators for registered types in the database.

At the industry level, the control variables consist of: Industry Size (lnindscale), obtained by summing up the logarithms of enterprise-level actual total output at the industry level. Degree of Industry Competition (lnhhi), which represents the Herfindahl-Hirschman Index at the industry level.

3.3. Data Sources

This article primarily draws from three data sources: firstly, it mainly utilizes data from the China Customs Trade Database and the China Industrial Enterprise Trade Database of manufacturing enterprises spanning from 2003 to 2013. Following the approach outlined by Tian & Yu[45], the two databases were matched using information such as the Chinese company name, postal code, and the last seven digits of the enterprise's telephone number, in order to calculate the Firm-Level Export Diversification (DVAR). When calculating DVAR, two main considerations were taken into account: (1) considering the issue of intermediate goods, this study matched HS product codes of each year to BEC codes to identify the import value of intermediate goods for general trade enterprises; (2) considering the problem of trade agents, companies containing terms such as "import-export" and "trade" in their names were recognized as trade agents. After excluding the import share of trade agents, adjustments were made to the actual import value of the enterprises. Secondly, the enterprise production indicators used primarily come from the China Industrial Enterprise Database, excluding non-manufacturing samples. Following the methods outlined by Brandt et al., this study addressed issues such as sample matching confusion, abnormal indicator sizes, measurement errors, etc., in that database. Finally, the 2016 version of the 2000-2014 World Input-Output Database (WIOD) was used. Matching the aforementioned databases, the final enterprise sample from 2000 to 2013 was obtained as the subject of study.

3.4. Multicollinearity Test

To assess the reasonableness of the selected control variables and avoid issues of spurious regression due to multicollinearity, this study conducted VIF (Variance Inflation Factor) tests on the chosen data. The results are as follows: The VIF test indicates that among the control variables, the strongest multicollinearity exists in the variable "lnindscale," with a VIF value of 1.91, significantly lower than 10. Hence, it can be inferred that the explanatory variables in this study do not exhibit severe multicollinearity issues, validating their suitability for regression analysis.

Table 1. Results of the multicollinearity test

Variable	VIF	1/VIF
lnindscale	1.94	0.516227
lnhhi	1.90	0.526998
lnkl	1.29	0.776427
lnprod	1.28	0.780419
soe	1.08	0.922792
ser	1.08	0.923759
lnage	1.07	0.937152
lnalratio	1.05	0.955715
foreign	1.02	0.983033
Mean VIF	1.30	

4. Empirical Analysis

4.1. Return to Baseline

The estimation was performed using a fixed effects model. Assuming some correlation in the random disturbances within the same enterprise but not across different enterprises, the clustering was done at the enterprise level, as presented in Table 1. In the first column, results are shown including only the core variables and fixed effects. It is evident that the service transformation in manufacturing significantly enhances the increase in a firm's domestic value-added rate at a significance level of 1%. Subsequently, in the second column, controlling for all enterprise and provincial-level variables, the results indicate that the impact coefficient of manufacturing service transformation on Firm-Level Export Diversification (DVAR) remains significantly positive. On average, for every unit increase in the manufacturing service transformation index, there is an approximately 0.058 unit increase in the firm's domestic value-added rate.

Manufacturing service transformation alters the mechanism driving the manufacturing value chain. It not only reduces production costs but also enhances operational efficiency, streamlining production and management processes, thereby aiding manufacturing enterprises' integration into the global value chain.

Furthermore, this study employed two methods to conduct robustness checks. First, considering the issue of truncated data, as the domestic value-added rate ranges from 0 to 1, using Ordinary Least Squares (OLS) estimation directly might lead to biased results. Hence, a Tobit model for censored dependent variables was utilized to ensure robustness (see the results in the third column of Table 1). Using different methods for model estimation did not affect the core variable—manufacturing service transformation's role in promoting the domestic value-added rate in manufacturing.

Secondly, concerning the selection of the sample interval, although the baseline regression window was set from 2003 to 2013, various significant events impacting trade occurred during the sample period, such as the 2008 global financial crisis. To test whether the choice of the sample timeframe affected the identification results, similar to Tang et al.[46], sub-samples were generated at random intervals of one year for regression analysis. Results in the fourth column of Table 2 indicate that manufacturing service transformation still significantly promotes an increase in the domestic value-added rate in manufacturing at a significance level of 1%.

In summary, the results of the benchmark regression show that the relationship between manufacturing servitization and firm value chain deepening is positively correlated. The basic conclusion of this paper holds.

Table 2. Benchmark regression results on the impact of manufacturing servitization on firms' export value chain deepening

	(1) Y	(2) Y	(3) Y	(4) Y
X	0.058**	0.058**	0.025***	0.062*
	(2.38)	(2.33)	(3.70)	(1.93)
lnage		-0.005***	-0.001**	-0.001
		(-3.07)	(-2.57)	(-0.35)
lnprod		0.004***	-0.001***	-0.000
		(5.48)	(-3.42)	(-0.26)
lnkl		-0.006***	0.002***	-0.005***
		(-11.08)	(6.83)	(-5.72)
lnalratio		0.009***	0.013***	0.002
		(4.42)	(11.55)	(0.55)
soe		0.009	-0.007**	0.017*
		(1.21)	(-2.26)	(1.84)
foreign		-0.003	-0.032***	0.010*
		(-0.76)	(-30.99)	(1.68)
lnindscale		0.002	0.004***	0.002
		(1.55)	(7.64)	(0.84)
lnhhi		-0.001	-0.003***	-0.003**
		(-0.85)	(-7.18)	(-2.38)
_cons	0.842***	0.802***	0.748***	0.825***
	(83.55)	(28.71)	(79.89)	(24.65)
N	311639	309030	309030	174138
F	882.085	508.076	855.020	289.931
r2	0.046	0.046		0.049
individual fixed effect	YES	YES	YES	YES
time fixed effect	YES	YES	YES	YES
control variable	NO	YES	YES	YES

Note: Standard errors for robustness are in parentheses, *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively, Same as below.

4.2. Heterogeneity Test

This paper utilizes the OECD's industry classification, which categorizes industries based on technological intensity, for a nuanced analysis. Industries are grouped into four distinct sectors: high-tech, medium-high-tech, medium-low-tech, and low-tech. Each sector exhibits unique input structures, respectively characterized as technology-intensive, capital-intensive, resource-intensive, and labor-intensive. This classification forms the foundation for our regression analysis, aimed at identifying industry-specific heterogeneities.

The results, detailed in Table 3, begin with column (1) highlighting the impact of manufacturing servitization on technology-intensive firms. Here, a positive correlation with firm value chain deepening is evident, significant at the 1% level. In capital-intensive sectors, the regression coefficient stands at 0.132, maintaining significance at the 1% level. Notably, the influence of manufacturing servitization on export value chain deepening is most pronounced in capital-intensive industries, with a significant regression outcome of 0.179 at the 5% level. However, the impact in labor-intensive sectors differs markedly. The regression coefficient here is a non-significant 0.019, suggesting that manufacturing servitization has a limited effect on value chain deepening within these industries.

In summary, the results of the heterogeneity test show that there is heterogeneity in the relationship between manufacturing servitization and enterprise value chain deepening, which is more obvious in technology-intensive, capital-intensive, and resource-intensive firms, while the effect is not very effective in labor-intensive firms, which is a component that should be taken into account in the promotion of transformation of manufacturing servitization in the enterprise.

Table 3. The Heterogeneous Impact of Manufacturing Service Transformation on the Deepening of Enterprise Export Value Chains

	(1)	(2)	(3)	(4)
	technologically intensive	capital-intensive	resource-intensive	labor-intensive
	Y	Y	Y	Y
X	0.132***	0.179**	0.142*	0.019
	(3.20)	(2.35)	(1.92)	(0.24)
N	180308	51837	51831	51829
F	295.506	58.951	65.024	53.260
r2	0.046	0.044	0.044	0.041
individual fixed effect	YES	YES	YES	YES
time fixed effect	YES	YES	YES	YES
control variable	YES	YES	YES	YES

5. Conclusion

Utilizing data sourced from the China Customs Trade Database and China Industrial Enterprise Trade Database spanning the decade from 2003 to 2013, this research paper undertakes an empirical examination of the influence exerted by manufacturing servitization on the global value chain position of China's manufacturing sector. The comprehensive regression analysis conducted in this study reveals a noteworthy trend: the adoption of servitization within China's manufacturing industry substantially enhances its standing within the global value chain.

Further dissecting the data through heterogeneity analysis, it becomes apparent that technology-intensive, capital-intensive, and resource-intensive industries stand to gain the most from embracing manufacturing servitization. In contrast, labor-intensive enterprises exhibit limited discernible effects in their ascent up the global value chain as a result of servitization transformation.

The aforementioned findings highlight the potential for a nation to bolster its manufacturing industry's global competitiveness by embracing manufacturing servitization. Consequently, it can propel the said manufacturing sector to ascend within the global value chain. In light of these insights, this paper offers the following recommendations:

First and foremost, we must emphasize the pivotal role that manufacturing servitization plays in the transformation and advancement of the manufacturing industry. By strategically implementing manufacturing servitization, we can expedite the enhancement of our domestic manufacturing sector's competitiveness. This, in turn, will enable the manufacturing industry to break free from the "low-end lock" that has constrained it within the global value chain. Consequently, we can bolster our control and influence within the global industrial chain, transitioning from a passive position within the global value chain to actively spearheading the formation of a regional value chain with ourselves at the helm.

China's manufacturing industry has historically found itself situated in the middle and lower echelons of the global value chain, characterized by limited added value and minimal influence in the upstream segments of the industrial chain, such as high-end capital goods and precision components. Manufacturing servitization fosters improved organizational efficiency and innovation capabilities by seamlessly integrating services with manufacturing processes. This holistic approach enhances the overall competitiveness of the manufacturing sector and elevates its standing within the global value chain.

Second, we advocate for an elevated level of openness within the service sector. Empirical analysis, as highlighted in this study, underscores the pivotal role played by advanced service components in enhancing manufacturing competitiveness. In an era of economic globalization, the strategic importation of high-level R&D, consulting, design, and other services from developed nations and regions can effectively bridge the gap caused by domestic deficiencies in advanced factors.

Drawing from global experience, industries boasting a high

degree of globalization in production and manufacturing invariably exhibit a parallel globalization of their associated productive services. Currently, global producer services account for over 80% of worldwide service trade, presenting abundant opportunities for China to nurture its producer service trade and integrate advanced service industries. This proactive approach holds significant promise in advancing China's manufacturing industry's international competitiveness and fostering a favorable environment for growth..

Third, we will be deeply integrated into regional value chains and actively expand regional multilateral economic and trade cooperation. With the rise of anti-globalization and trade protectionism, global value chains have become "block-based." Since the COVID-19 pandemic, for the consideration of the security of the industrial chain, countries have accelerated the reflow of the industrial chain to their own countries and the layout of the regional network in their own countries, which has further promoted the "blockization" of the global value chain. A country's deep participation in regional value chains, on the one hand, can more effectively improve the efficiency of division of labor and collaboration among industries, and on the other hand, can reduce policy and security risks. In the next step, China should take the opportunity of CPTPP to realize the coordinated development of the industrial chain, value chain and innovation chain and enhance the position and competitiveness in the global value chain.

References

[1] Xu, L-F., (2014). On the Development of Servitization of China's Manufacturing Industries.On Economic Problems(12),79-84. doi:10.16011/j.cnki.jjwt.2014.12.014.

[2] Wei, H., & Li, C. (2014). The Basic Situation of Rising Labor Costs in China's Manufacturing Industry and Strat-egies for Coping with Them. Intertrade(03), 10-15. doi:10.14114/j.cnki.itrade.2014.03.002.

[3] Wang, X-H., &Guo X. (2020). Analysis on Industrial Chain Shift and Industrial Competitiveness after COVID-19 Pandemic—Take the Integrated Circuit Industry Chain as an Example.intertrade(11),18-27.doi:10.14114/j.cnki.itrade.2020.11.004.

[4] Sun, Z.,& Hou, Y-L.(2019).How Does Industrial Intelligence Reshape the Employment Structure of Chinese Labor Force. China Industrial Economics. (05),61-79. doi:10.19581/j.cnki.ciejournal.2019.05.004.

[5] Zhu, S-J., Tan, X-J., & Li, D. (2022). An Empirical Stu-dy for the Impact of Intelligence on Manufacturing Indus-try Global Value Chain Upgrading from the Perspective of Labor Demand. Journal of International Trade (05), 51-68. doi:10.13510/j.cnki.jit.2022.05.005.

[6] Eaton, J., & Kortum, S. (2002). Technology, Geography, and Trade. Econometrica, 70(5), 1741-1779. https://doi.org/10.1111/1468-0262.00352

[7] Xiao, T. (2018). Can Chinese Manufacturing Get Performance Dividend through Servitization. Finance & Trade Economics(03),138-153. doi:10.19795/j.cnki.cn11-1166/f.2018.03.011.

[8] Xu, H-L., Cheng, L-H., & Sun, T-Y. (2017).The Effect of the Input Servitization of Manufacturing on Upgrading Export Domestic Value Added of Enterprises—Empirical Evidence from Chinese Micro-enterprise.China Industrial Economics(10),62-80. doi:10.19581/j.cnki.ciejournal.2017.10.005.

[9] Su, H., Zheng, L.,& Mou, Y-F. (2017).Factor Endowmentand Industrial Upgrading of China's Manufacturing Industry—Analysis based on WIOD and China's Industrial Enterprises Database (IED).Journal of Management World(04),70-79. doi:10.19744/j.cnki.11-1235/f.2017.04.007.

[10] Huang, Q., & Lou, B. (2022). Service-oriented Manufact-uring. In Understanding China's Manufacturing Industry (pp. 147–166). Springer. https://doi.org/10.1007/978-981-19-2527-6_9

[11] Crozet, M., & Milet, E. (2017). Should everybody be in services? The effect of servitization on manufacturing firm performance. Journal of Economics & Management Strategy, 26(4), 820–841. https://doi.org/10.1111/jems.12211

[12] Breinlich, H., Soderbery, A., & Wright, G. C. (2018). From Selling Goods to Selling Services: Firm Responses to Trade Liberalization. American Economic Journal. Economic Policy, 10(4), 79–108. https://doi.org/10.1257/pol.20150116

[13] Liu, B., & Pan, T. (2020). Research on the Impact of Artificial Intelligence on Manufacturing Value Chain Specialization. Journal of Quantitative & Technological Economics(10),24-44. doi:10.13653/j.cnki.jqte.2020.10.002.

[14] Benedettini, O., Swink, M., & Neely, A. (2017). Examining the influence of service additions on manufacturing firms' bankruptcy likelihood. Industrial Marketing Management, 60, 112–125. https://doi.org/10.1016/j.indmarman.2016.04.011

[15] Liu, B., Wei, Q., Lu, Y-L., & Zhu, K-F. (2016). Servitization of Manufacturing and Value Chain Upgrading. Economic Research Journal (03) ,151-162.

[16] Wright, G. C. (1976). Linear Models for Evaluating Conditional Relationships. American Journal of Political Science, 20(2), 349–373. https://doi.org/10.2307/2110649

[17] Qian, X-F., Wang, S., & He, J. (2020).Servitization of Manufacturing and China's Exports -- Entering the Service Dividend Era. Research on Financial and Economic Issues(05),111-120. doi:10.19654/j.cnki.cjwtyj.2020.05.013.

[18] Liu, B.,& Wang, N-J. (2016).Input Servitization of Manufacturing and Dual Margins of Firms' Export ——An Empirical Study Based on the Data of Chinese Micro-enterprise. China Industrial Economics(09),59-74. doi:10.19581/j.cnki.ciejournal.2016.09.004.

[19] Yuan, Y. (2020). the location of firms in embedded global value chains How affects wage levels, China Circulation Economy(30),127-130. doi:10.16834/j.cnki.issn1009-5292.2020.30.041.(2020, p129)

[20] Autor, D., & Acemoglu, D. (2010). Skills, Tasks and Technologies: Implications for Employment and Earnings. NBER Working Paper Series, 16082-. https://doi.org/10.3386/w16082

[21] Acemoglu, D., & Restrepo, P. (2020). Robots and Jobs: Evidence from US Labor Markets. The Journal of Political Economy, 128(6), 2188–2244. https://doi.org/10.1086/705716

[22] Jing, L., & Yuan, P-H. (2019). New Trends in Global Value Chain Changes and China's Countermeasures. Journal of Management World(11),72-79. doi:10.19744/j.cnki.11-1235/f.2019.0148.

[23] Xu, J-H., & Xia, J-C. (2020). The Development of Digital Trade from the Perspective of Global Value Chain：Strategic Positioning and China's Path. Reform(05),58-67.

[24] Lu, Y., Gu, W., & Bao, Q. (2020). Artificial Intelligence and Chinese Enterprises' Participate in Global Value Chains. China Industrial Economics(05),80-98. doi:10.19581/j.cnki.ciejournal.2020.05.016.

[25] Cole, M. A., & Elliott, R. J. R. (2003). Do Environmental Regulations Influence Trade Patterns? Testing Old and New

Trade Theories. World Economy, 26(8), 1163–1186. https://doi.org/10.1111/1467-9701.00567

[26] Liu, Z-B., & Zhang, S-J . (2008).Regional Disparity and Rectification Analysis in China:Based on GVC and NVC's Perspective. Academic Monthly(05),49-55. doi:10.19862/j.cnki.xsyk.2008.05.008.

[27] Yuan, K-H., Peng, S-J., & Chen, H-W. (2019). The Facts and Explanations of the Domestic Value Chain Driving the Export Value of China's Manufacturing Industry. Economist(09),93-103. doi:10.16158/j.cnki.51-1312/f.2019.09.010.

[28] Gu, F-J., Sha, X-J., & Zhang, W-F. (2022).National Value Chain Connecting Global Value Chains: A Study on the Acquisition Path of China's Provincial Value Added in Export. China Soft Science. (03),164-172+182.

[29] Liu, P., & Xia, Y. (2021). China's Provinces' Value-added Export and Embedding in Value Chains —From the Perspective of Global Value Chain and National Value Chain. Journal of International Trade(05),109-126. doi:10.13510/j.cnki.jit.2021.05.008.

[30] Brandt, L., Van Biesebroeck, J., & Zhang, Y. (2012). Creative accounting or creative destruction? Firm-level productivity growth in Chinese manufacturing. Journal of Development Economics, 97(2), 339-351. https://doi.org/10.1016/j.jdeveco.2011.02.002

[31] Bai, X., Chatterjee, A., Krishna, K., & Ma, H. (2021). Trade and minimum wages in general equilibrium: Theory and evidence. Journal of International Economics, 133, 103535-. https://doi.org/10.1016/j.jinteco.2021.103535

[32] Pahl, S., & Timmer, M. P. (2020). Do Global Value Chains Enhance Economic Upgrading? A Long View. Journal of Development Studies, 56(9), 1683-1705. https://doi-org-s.elink.xjtlu.edu.cn:443/10.1080/00220388.2019.1702159

[33] Wang, X-H.(2017) The key to reshaping the new competitive advantage of the manufacturing industry lies in improving the capability of independent innovation. Globalization, 2017 (11) : 32－38+133－134

[34] Ge, X-T., &Xie, J-G. (2023). Can Talent Introduction Break the "Low－end Locking" of Global Value Chain: Evidence From Export DVAR of China's Manufacturing Enterprises. International Economics and Trade Research (03),19-35. doi:10.13687/j.cnki.gjjmts.2023.03.004.

[35] Zhu, K-P., & Fan, S-D. (2019). A Study on Employment Effects of China's Manufacturing Shifts: Based on Inter-country Input-output Model. Chinese Journal of Population Science(01),33-46+126-127.

[36] Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation? Technological Forecasting & Social Change, 114(January), 254–280. https://doi.org/10.1016/j.techfore.2016.08.019

[37] Graetz, G. and Michaels, G. (2015) 'Robots at work: the impact on productivity and jobs', CentrePiece - The magazine for economic performance [Preprint]. Available at: https://ideas.repec.org//p/cep/cepcnp/447.html

[38] Graetz, G., & Michaels, G. (2018). Robots at Work. The Review of Economics and Statistics, 100(5), 753–768. https://doi.org/10.1162/rest_a_00754

[39] Grossman, Gene M., & Esteban Rossi-Hansberg. 2008. "Trading Tasks: A Simple Theory of Offshoring." American Economic Review 98 (5): 1978-97.DOI: 10.1257/aer.98.5.1978

[40] FORT, T. C. (2017). Technology and Production Fragmentation: Domestic versus Foreign Sourcing. The Review of Economic Studies, 84(2 (299)), 650–687. https://doi.org/10.1093/restud/rdw057

[41] Goos, M., Manning, A., & Salomons, A. (2014). Explaining job polarization: routine-biased technological change and offshoring. The American Economic Review, 104(8), 2509–2526. https://doi.org/10.1257/aer.104.8.2509

[42] Li, G-Q., & Zong, Z-G. (2021). Input Servitization of Manufacturing，Service Trade Openness and Business Cycle Comovement: A Perspective of Global Value Chain. World Economy Studies(10),69-86+135. doi:10.13516/j.cnki.wes.2021.10.006.

[43] Vom Lehn, C. (2020). Labor market polarization, the decline of routine work, and technological change: A quantitative analysis. Journal of Monetary Economics, 110, 62–80. https://doi.org/10.1016/j.jmoneco.2019.01.004.

[44] Kee, H. L., & Tang, H. (2016). Domestic Value Added in Exports: Theory and Firm Evidence from China. The American Economic Review, 106(6), 1402–1436. https://doi.org/10.1257/aer.20131687

[45] Tian, W., & Yu, M-j. (2013). Firms' export intensity and trade liberalization of imported intermediate goods: an empirical study from Chinese firms. Journal of Management World (01),28-44. doi:10.19744/j.cnki.11-1235/f.2013.01.004.

[46] Tang, Y-H ., Yu, F., Lin, F-Q.,& Zhang, M-T. (2019). China's High-speed railway, Trade Cost and Firm Export. Economic Research Journal (07),158-173.