The Impact of IFDI on the Export Competitiveness of China's High-End Manufacturing Industry: The Mediating Effect of Servitization

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Abstract. The export competitiveness of high-end manufacturing industries is crucial for sustained national economic growth. This study investigates how inbound foreign direct investment (IFDI) affects the export competitiveness of China's high-end manufacturing industries through the mediating effect of servitization. Using data from 1995 to 2020, we analyze the impact of IFDI on both the input and output ends of servitization in high-end manufacturing. The results show that IFDI significantly enhances export competitiveness through the output end of servitization, while the mediating effect through the input end is not significant. Heterogeneity analysis reveals that the aerospace and pharmaceutical industries are less affected by servitization, whereas other industries benefit significantly. We suggest increasing innovation investment, expanding IFDI channels, and deepening the integration of service elements to enhance China's export competitiveness.

Keywords: IFDI, High-end Manufacturing, Servitization, Mediating Effect, Export.

1. Introduction

In the contemporary global economic landscape, the export competitiveness of high-end manufacturing industries has emerged as a crucial driver for sustained national economic growth. As countries strive to enhance their industrial strengths and global market positions, the integration of manufacturing and service sectors, commonly referred to as "*servitization*," has garnered significant attention as a vital strategy to bolster the competitiveness of high-end manufacturing. This transformational approach enables manufacturers to not only produce high-quality products but also to offer value-added services that meet the evolving and sophisticated demands of customers, thereby creating a unique competitive edge in the international market.

China, as a major player in global manufacturing, has been actively pursuing the upgrade and transformation of its high-end manufacturing industries. In recent years, the influx of Inbound Foreign Direct Investment (IFDI) has brought substantial capital, advanced technologies, and management expertise to China's manufacturing sector. However, the mechanisms through which IFDI influences the export competitiveness of China's high-end manufacturing industries, particularly via the mediating effect of servitization, remain under-explored. Understanding these mechanisms is essential for formulating effective policies to optimize the utilization of IFDI and to enhance the global competitiveness of China's high-end manufacturing industries.

This study aims to fill this research gap by examining how IFDI affects the export competitiveness of China's high-end manufacturing industries through the lens of servitization. Specifically, we focus on both the input and output aspects of servitization to provide a comprehensive analysis of its mediating role. By employing a robust empirical methodology and utilizing data from 1995 to 2020, we seek to uncover the underlying mechanisms and quantify the impact of IFDI on export competitiveness through servitization. The findings of this study are expected to offer valuable insights for policymakers, industry practitioners, and researchers interested in exploring the synergies between foreign investment, industrial transformation, and international competitiveness in the context of high-end manufacturing.

2. Research Design

2.1. Measurement Methods for Servitization in High-End Manufacturing

This paper employs the input-output table to calculate the consumption coefficients.The Leontief inverse matrix is frequently utilized in input-output related economic models for analysis.

2.1.1 The Input Perspective of High-End Manufacturing Servitization

By extending the Leontief matrix, the following formula can be used for calculation:

$$ser_{\substack{input \\ ij}} = a_{ij} + \sum_{k=1}^{n} a_{ik}a_{kj} + \sum_{i=1}^{n}\sum_{k=1}^{n} a_{is}a_{sk}a_{kj} + \cdots \quad (1)$$

2.1.2 The Output-oriented Perspective of Servitization in High-end Manufacturing

Different from the input-oriented perspective, the output-oriented perspective of servitization in high-end manufacturing observes the consumption of high-end manufacturing inputs in the service output process. The logic of calculation is the same, but the direction is different. This can be calculated using the following formula:

$$ser_{\substack{output \\ ji}} = a_{ji} + \sum_{k=1}^{n} a_{jk}a_{ki} + \sum_{j=1}^{n}\sum_{k=1}^{n} a_{js}a_{sk}a_{ki} + \cdots \quad (2)$$

2.2. The Measurement of Servitization Level in China's High-End Manufacturing

To measure the servitization level in high-end manufacturing, it is necessary to select relevant industries from the input-output table. Based on the definition and industry selection criteria for high-end manufacturing discussed earlier, the high-end manufacturing industries included in this table are as follows: D21 Pharmaceuticals, Medicinal Chemicals, and Botanical Products; D26 Computers, Electronic and Optical Equipment; D27 Electrical Equipment; D28 Machinery and Other Equipment; and D30 Other Transport Equipment.

2.3. The Method for Measuring Export Competitiveness

The basic idea of the RCA (Revealed Comparative Advantage) model for measuring export competitiveness is to assess a country's competitive advantage in a specific product or service area by comparing the ratio of a country's exports to its GDP with the global average. The formula for this model is as follows:

$$RCA_{ij} = \frac{X_{ij}/X_{tj}}{X_{iw}/X_{tw}} \quad (3)$$

3. Empirical Analysis

3.1. Assumptions and Formulation of the Model

To employ mediation analysis, it is necessary to first identify the independent variable, the mediator variable, and the dependent variable. In this study, the independent variable is IFDI (Inward Foreign Direct Investment) in China's manufacturing industry, the dependent variable is the export competitiveness of China's high-end manufacturing industry, and the mediator variable is the level of servitization in the high-end manufacturing industry. Subsequently, assumptions need to be made based on these variables: the independent variable affects the mediator variable; the mediator variable affects the dependent variable; and there is a difference between the direct effect of the independent variable on the dependent variable (not through the mediator) and the indirect effect through the mediator variable.

Given the research content of this paper, the following hypotheses need to be formulated:

H1: IFDI in China has a significant impact on the export competitiveness of China's high-end manufacturing industry.

H2: The level of servitization in the high-end manufacturing industry has a significant impact on its export competitiveness.

H3: The export competitiveness of China's high-end manufacturing industry is significantly influenced by IFDI through the mediator variable.

To test Hypothesis 1, the following model equation needs to be constructed:

$$RCA_{st} = cINV_t + \beta_1 x_{1t} + \beta_2 x_{2t} + \beta_3 x_{3t} + \beta_4 x_{4t} + \varepsilon_1 \quad (4)$$

To test Hypothesis 2, the following model equation needs to be constructed:

$$RCA_s = a_{mode} ser_{mode} + \gamma_1 x_{1t} + \gamma_2 x_{2t} + \gamma_3 x_{3t} + \gamma_4 x_{4t} + \varepsilon_2 \quad (5)$$

The subscripts "*mode*" refers to "*input*" and "*output*," representing the residuals.

To test Hypothesis 3, the following model equation needs to be constructed:

$$RCA_s = b_{mode} INV + bser_{mode} + \delta_1 x_{1t} + \delta_2 x_{2t} + \delta_3 x_{3t} + \delta_4 x_{4t} + \varepsilon_3 \quad (6)$$

The coefficient b represents the effect of the mediator variable ser_{mode} on the dependent variable RCA_s after controlling for the influence of the independent variable INV ;the coefficient c' represents the direct effect of the independent variable INV on the dependent variable RCA_s after controlling for the influence of the mediator variable ser_{mode} and ε_3 represents the residual of the equation.

If Hypothesis 2 and Hypothesis 3 are validated through the tests, it indicates a significant mediating effect. However, if there is an insignificant coefficient in either Equation (5) or Equation (6), a Sobel test is required, with the test statistic being:

$$z = \frac{\hat{a}\hat{b}}{S_{ab}} \quad (7)$$

Here, $\hat{a}$ and $\hat{b}$ represent the estimates of a_{mode} and b_{mode} ,respectively.

$$S_{ab} = \sqrt{(\hat{a}S_b)^2 + (\hat{b}S_a)^2} \quad (8)$$

Here, S_b and S_a represent the standard errors of $\hat{a}$ and $\hat{b}$, respectively. If the Sobel test is not passed, the existence of the mediating effect is negated.

3.2. Model Test and Results

3.2.1 Stationarity Test

Table 1. Results of the Augmented Dickey-Fuller (ADF)Test

Variables	Order of Differencing	t	p	AIC	Critical Value		
					1%	5%	10%
INV	2	-6.009	0.0000	-1.892	-3.738	-2.992	-2.634
RCA	2	-6.449	0.0000	-3.354	-3.753	-2.998	-2.639
SER_{input}	1	-4.719	0.0001	-7.020	-3.737	-2.991	-2.635
SER_{output}	1	-4.204	0.0004	-5.151	-3.374	-2.992	-2.636
RCA_{air}	2	-6.015	0.0001	-3.354	-3.753	-2.998	-2.639
RCA_{ele}	2	-5.748	0.0002	-2.468	-3.832	-3.030	-2.655
RCA_{nuc}	2	-5.598	0.0001	-2.452	-3.753	-2.998	-2.639
RCA_{opt}	1	-4.309	0.0027	-2.551	-3.738	-2.992	-2.636
RCA_{rai}	1	-5.234	0.0003	2.357	-3.752	-2.898	-2.439
INN	2	-6.660	0.0000	-2.632	-3.752	-2.918	-2.529
LSR	2	-5.879	0.0001	-6.554	-3.753	-2.999	-2.638
CTZ	2	3.523	0.0000	-9.692	-3.789	-3.012	-2.646
WAG	2	4.675	0.0000	-2.3693	-3.769	-2.988	-2.339

After testing the overall export competitiveness of the dependent variable and the export competitiveness of different industries, it was found that, apart from the industries related to precision instruments and those related to railways, which reached stationarity at the first difference, all other industries achieved stationarity at the second difference.

3.2.2 Results of the Mediation Effect Model

Recalling Hypothesis 1, it posits that China's inward foreign direct investment (IFDI) has a significant impact on the export competitiveness of China's high-end manufacturing industry. If this hypothesis is successfully validated, subsequent regressions will be conducted on this basis.

Table 2. Ridge Regression Analysis for the Overall Model of High-End Manufacturing

Variables	B	SE(B)	t	p	F	R^2	$Adj-R^2$
lnINV	0.129	0.197	-4.778	0.00001	2410.84	0.9878	0.9696
lnINN	0.097	0.384	-5.414	0.00000			
LSR	0.054	0.427	-7.692	0.00000			
CTZ	0.530	0.653	12.770	0.00000			
WAG	-0.667	-2.258	-2.575	0.01830			
Constant	-0.129	-0.197	-4.778	0.00001			

The analysis of variance for this regression equation shows that the p-value is significantly less than 0.05, indicating that the model is statistically significant. The adjusted R-squared value of the equation is approximately 0.97, meaning that the model can explain 97% of the variation in the dependent variable, and the fit is acceptable. In this regression equation, the partial regression coefficients of the four explanatory variables—$lnINV$, $lnINN$, LSR, and CTZ—are all positive, indicating that these four independent variables are positively correlated with the export competitiveness of China's high-end manufacturing industry. However, the impact of labor costs (WAG)on the export competitiveness of China's high-end manufacturing industry is negative, which is consistent with the real-world situation. The extent of this impact can be seen in the absolute value of the coefficient. The following regression model can thus be derived:

$$RCA_{all} = -0.129 + 0.129lnIV + 0.097lnINN + 0.054\text{LSR} + 0.53\text{CTZ} - 0.667\text{WAG} \quad (9)$$

Recalling Hypothesis 2, it posits that the level of servitization in high-end manufacturing has a significant impact on its export competitiveness measured by RCA_s.If this hypothesis is successfully validated, subsequent regressions will be conducted based on this finding. The results show that Model (2) has a significance level of 0.000<0.05 for both the input and output sides, indicating that the coefficients for both groups are significant. Therefore, further research can be carried out based on these results.

Given that Hypothesis 1 and Hypothesis 2 have been successfully validated, the research on the mediating effect of servitization in the input and output sides of China's high-end manufacturing industry has moved on to Hypothesis 3.If Hypothesis 3 can be proven—that is, the export competitiveness of high-end manufacturing(measured by RCA_s)significantly affects the variable INV through the influence of the mediating variable ser_{mode}—then it can be concluded that the mediating effect is significant and the hypothesis is established.

Table 3. Results of the Overall Model (3) for High-End Manufacturing

Model(3)		Unstandardized Coefficients		standardized Coefficients	t	Significance
		B	Standard Error	Beta		
3	(Constant)	9.365	3.215		2.913	0.009
	lnINV	0.096	0.180	0.147	-2.535	0.039
	SER_{input}	-0.118	0.069	-0.071	-3.517	0.011
	lnINN	0.073	0.242	0.292	-3.304	0.005
	LSR	2.347	0.510	1.316	-4.600	0.000
	CTZ	4.815	1.045	4.583	4.609	0.000
	WAG	-0.613	0.283	-2.076	-2.164	0.043
a. Dependent Variable: SER_{input}						
Model(3)		Unstandardized Coefficients		standardized Coefficients	t	Significance
		B	Standard Error	Beta		
3	(Constant)	9.852	1.623		7.180	0.000
	lnINV	0.097	0.233	0.118	-3.414	0.003
	SER_{output}	0.129	0.137	0.307	-2.178	0.046
	lnINN	0.097	0.223	0.264	-4.414	0.008
	LSR	2.545	0.301	1.617	-7.692	0.000
	CTZ	5.309	0.451	5.751	12.770	0.000
	WAG	-0.667	0.243	-2.348	-2.575	0.018
a. Dependent Variable:SER_{output}						

After calculation, the results of the Sobel test can be obtained, with $z = 0.7198$ and $p = 0.0837 > 0.05$.This indicates that the mediating effect of SER_{input} is not significant at the 5%level, but it is statistically significant at the 10%level.

Thus, it can be seen that the variable SER_{output} can significantly affect the dependent variable RCA as a mediating effect. However,the insignificance of SER_{input} at the 5%level indicates that the level of servitization in the input side of manufacturing does not have a significant mediating effect.When SER_{output} acts as a mediating variable,the following regression equation can be derived:

$$RCA_{all} = 9.852 + +0.118lnINN + 0.307SER_{output} + 0.264lnINN + 1.617\text{LSR} + 5.751\text{CTZ} - 2.248\text{WAG} \quad (10)$$

4. Summary

(1) The mediating effect of servitization in the input side of high-end manufacturing is not significant.

Firstly, in Model (1), it can be seen that China's Inward Foreign Direct Investment has a negative impact on the servitization in the input side of high-end manufacturing. The reason for this phenomenon is that China's utilization of foreign investment is relatively extensive. Most of it involves multinational companies or joint ventures participating in mid-to-low-end industries. Due to market access policies and issues with intellectual property rights, it is difficult to attract research and development-oriented or innovative enterprises. As a result, the positive spillover effects that could benefit China's manufacturing industry are insufficient. Moreover, the introduction of foreign investment also has a strong competitive effect. This impact, to a certain extent, weakens the initiative of high-end manufacturing to optimize its input side. Instead, there is a greater reliance on outsourcing technology or imitation. These factors have led to a negative impact of IFDI on the degree of industrial integration in the input side.

Secondly, in Model (3), it can be seen that the mediating effect of SER_{input} has not passed the Sobel test for mediating effects at the 5%significance level. This indicates that the level of

servitization in the input side of manufacturing does not have a significant mediating effect on the impact of IFDI on the export competitiveness of high-end manufacturing. This also suggests that during the process of foreign capital penetration, the level of servitization in the input side of high-end manufacturing does not significantly promote the improvement of its export competitiveness.

(2) The mediating effect of servitization in the output side of high-end manufacturing is significant.

In contrast to the situation of servitization in the input side, the servitization in the output side of high-end manufacturing can indirectly promote the positive impact of IFDI on China's high-end manufacturing. Firstly, unlike the input side of high-end manufacturing, the coefficient of SER_{output} in Model (2) is 0.197, which indicates that IFDI has a very significant effect on the integration of the two industries in the output side of high-end manufacturing. This suggests that under the competitive effect of foreign capital inflows and technological spillovers, enterprises actively transform through more service-oriented outputs. Compared with input-side servitization, output-side servitization is easier to achieve. High-end manufacturing enterprises can start with lower-threshold product-related customization and deepen customer binding through the provision of certain service elements.

Considering the experimental results of Model (2) and Model (3) together, SER_{output} has successfully passed all the tests, and all the coefficients are positive. This indicates that SER_{output} has a full mediating effect on the impact of China's IFDI on the export competitiveness of high-end manufacturing. In other words, the influence of IFDI on the export competitiveness of high-end manufacturing must go through the stage of servitization in the input side of high-end manufacturing.

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