

Article

Role of Servitization, Digitalization, and Innovation Performance in Manufacturing Enterprises

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Abstract: The structure of the manufacturing industry has forced manufacturing companies to understand the importance of digitalization and servitization transformation, in terms of production and R&D. In this study, we examine the relationship between servitization, digitization, and enterprise innovation performance through the lens of dynamic capabilities within enterprises. We also discuss the impact of the transformation servitization strategy on business innovation, and the mechanisms by which it impacts business innovation performance. The study's findings indicate that servitization significantly contributes to innovation performance, and digitalization acts as a mediating mechanism between the proposed relationships. Thus, this article argues for the integration and growth of servitization and digitization.

Keywords: servitization; digitalization; dynamic capabilities; enterprise innovation performance; PSM-DID



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1. Introduction

Under the leadership of national strategies such as Industry 4.0 and smart manufacturing, and on the theoretical foundation of the deep integration of information technology within the manufacturing and productive service industries, transformation has become an unavoidable choice for manufacturing firms to successfully acquire competitive advantages [1]. Currently, manufacturing firms are undergoing change and development along the lines of digitization and servitization. Recently, studies have revealed that advanced manufacturing enterprises are actively innovating the manufacturing industry's production mode through the use of information technology such as the Internet, big data, and artificial intelligence, comprehensively improving product design, manufacturing, and management [2]. Moreover, these enterprises have begun to improve their environmental performance [3–5].

In the digital economy, servitization and digitization have become the primary tools for businesses to gain a competitive edge. Companies that rely on digital servitization can frequently maintain a favorable position in the face of fierce market competition [6,7]. The transformation of manufacturing enterprises to digital services has become an effective strategy for enterprises to achieve a favorable market position and increase value creation. This phenomenon triggered our research into the impact of digital servitization transformation on manufacturing enterprises. Currently, the issue of digital service transformation in manufacturing enterprises is of practical importance; however, from a theoretical standpoint, relevant research on digital service transformation in manufacturing enterprises is still insufficient, particularly in terms of empirical testing and research on the transformation mechanism of digital service transformation. In this study, the authors focused on the perspective of firms' innovation behavior and examined the effects of transformation on manufacturing firms' innovations and the mechanism by which it occurs. This can be

summarized as follows. First: does a firm's transformation into a service business affect its innovation performance? Second: what role does digitalization play in the relationship between servitization and innovation performance, and how is this relationship affected by the degree of digitalization? Third: are there any other enterprise characteristics that affect the performance of servitization, digitization, and innovation, and, if so, how? The paper's primary contributions are as follows: first, an empirical examination of the impact of manufacturing enterprises' adoption of a servitization transformation strategy on their innovation performance; and second, a quantification of manufacturing enterprises' levels of servitization and digitalization, and an examination of how the integration of digitalization and servitization affects the innovation performance of manufacturing enterprises.

2. Literature Review

2.1. Servitization and Digitalization

In today's fiercely competitive domestic and international manufacturing markets, the shift from a "product economy" to a "service economy" has become the primary means of increasing competitiveness [8], and the manufacturing operation paradigm is undergoing noticeable changes. For example, Xerox offers a pay-per-copy service for its office printers; HP has implemented "information services," and Michelin has implemented an "after-sales service," a series of service transformations that have demonstrated remarkable effectiveness. Following GE's restructuring, service-related revenue accounted for more than 80% of total revenue. Hangyang Group transitioned from selling air separation equipment to becoming a gas service provider, and gas service has since become the enterprise's primary source of revenue. Manufacturing enterprises are more closely connected to services and digital technologies. On the one hand, green manufacturing, intelligent manufacturing, virtual manufacturing, and other new manufacturing methods have emerged and spread rapidly; on the other hand, the traditional divisions between manufacturing and service industries have accelerated their demise, and the integration of manufacturing and service development has become increasingly prominent [3]. In this context, manufacturing enterprises are confronted with two disruptive changes. First, there is the need to meet consumer expectations and for businesses to combine high-quality products and services by refocusing their strategies away from providing essential products and toward providing value-added "product+service" solutions, a process known as "servitization" [9]. Second, there is the increasing availability and connoisseurship of data [10]. According to Vandermerwe and Rada [11], servitization can be understood in two ways: as a process of servitization of manufacturing, or servitization of manufacturing organizations. The former reflects the overall manufacturing trend, and the latter emphasizes the strategic initiative of manufacturing organizations. According to Baines et al. [8], it is a strategy for developing unique and sustainable value-added capabilities compared to competitors. Bandinelli and Gamberi [12] argue that manufacturing enterprises can leverage servitization to achieve profitability and economic stability, and growth. For digitalization, most early perspectives were technological, viewing digital transformation as the application of digital technology to business processes such as manufacturing operations, and the definition of digital transformation was centered on digital technology [13]. With the increasing integration of digital technologies into the real economy, scholars have begun to view digitalization through the lens of organizational change, referring to the enhancement of enterprises' use of market information and the timely application of advanced digital technologies to optimize or change existing production and service processes as a process of digital transformation [14]. In general, servitization and digitalization are the primary directions of manufacturing enterprise transformation. Regardless of the direction, the primary objective of enterprises is to increase competitiveness, create value, and generate economic benefits.

Given the profound impact that both servitization and digitalization have on business competition, it is necessary to pay closer attention to their interaction. It has been noted that the application of digital technologies can accelerate servitization by enabling the pro-

vision of complex and innovative services [15]. Digital technologies drive and benefit from servitization, and leveraging them allows businesses to mitigate the challenges and risks associated with servitization while successfully reaping the benefits [16]. This pattern emphasizes value creation through digital technologies, including the Internet of Things, big data, and cloud computing [17]. The development and provision of services with technical support improve an enterprise's competitive advantage [18]; the dematerialization of physical goods with the assistance of ICT capabilities enhance an enterprise's performance [19]. While servitization and digital technologies originated in distinct fields of study, scholars have observed a convergence of the two, resulting in the concept of "digital servitization" [20]. Kohtamäki et al. [21] define digital servitization as "the transition to intelligent product-service software systems that generate and capture value through monitoring, control, optimization, and self-management." According to this view, enterprises must use a combination of products, services, and software to derive value from digital services. Dreyer et al. [22] define digital services as a personalized, dynamic, digital, high-quality service solution provided by an enterprise focusing on perceptibility and connectivity, as a combination of physical products and digital value-added services. These definitions recognize the importance of digital technology in enhancing the strategic and operational effectiveness of servitization. Moreover, the combination of digitalization and servitization results in a synergistic "digital + service" model for manufacturing enterprises, which realizes value-added solutions in all aspects of the manufacturing process.

2.2. *The Role of Transformation Concerning Enterprise Innovation*

While the transformation of manufacturing enterprises toward servitization and digitalization increases their competitiveness, it also raises a critical question: how will it affect manufacturing enterprises' innovation behavior? In terms of the servitization dimension, scholars have examined the type of product-service systems offered by manufacturing enterprises, the path toward increasing servitization, and the allocation of resources and capabilities necessary to achieve this value-added solution [23–25], as well as the relationship between manufacturing enterprise services and the environment. According to Eggert et al. [26], the impact of services on the performance of engineering firms varies according to the type of service and whether the firm previously possessed product innovation capabilities. Chester Goduscheit and Faullant [27] investigated how new services can be used to spark three distinct types of innovation: service concept innovation, customer experience innovation, and service process innovation. In terms of servitization, advanced services provided by businesses, such as research and development, are centered on the process of collaborative research with customers, enabling the continuous improvement of products and services through close interaction with customers to meet their needs [28]. In terms of business models, servitization enlarges the enterprise's boundaries. Businesses become more sensitive to the external environment due to this process, which enables manufacturers to continuously adapt and design new business models that are more compatible with the dynamic external environment [29,30].

Scholars have increasingly focused on the relationship between digital transformation and innovation management [31], arguing that digital technologies have had a significant impact on today's competitive business environment [32], most notably by altering the way firms and consumers interact and exchange value [33], as well as by changing the innovation capabilities and the nature of innovation activities [34]. Because the widespread adoption of digital technologies can significantly improve product and service performance in a variety of ways, digital transformation has the potential to influence various stages of the innovation process in complex and causally ambiguous ways [35,36]. According to Ardito et al. [37], digitalization directly affects product and process innovation performance; Lee [38] argues that firms benefit from the use of ERP, product management, and other systems. Ferreira et al. [30] demonstrate a strong correlation between process digitization and firm innovation using a sample of 938 firms. The more businesses that adapt to ongoing digital transformation, the more they can innovate and establish sustainable

competitive advantages. Appio et al. [39] demonstrate the myriad ways in which digital transformation and innovation are interconnected at the micro, meso, and macro levels. The rapid advancement of digital technology continues to create new opportunities and challenges for innovators.

Some scholars have focused on the interaction effect of servitization and digitalization. The “digital” aspect of servitization is becoming increasingly apparent, and digital technology has the potential to boost product and service innovation significantly. In digital servitization, enterprises place a premium on the integration and coordination of the front and back ends; they conduct data analyses via platforms to align the front end (sales) with the back end (manufacturing), increase organizational efficiency through the adjustment of organizational structures and processes (Kohtamäki et al.) [40], stimulate organizational dynamics, and maintain a positive work environment [5]. As a result, the following hypotheses are proposed:

Hypothesis 1 (H1). *The transformation of enterprise servitization has a positive impact on the innovation performance of enterprises.*

Hypothesis 2 (H2). *Digitalization can enhance enterprise innovation performance by mediating the effect of servitization on innovation performance.*

Despite the lack of a clear understanding of which corporate initiatives are more effective at integrating new digital service capabilities into traditional manufacturing firms, the mechanisms by which servitization and digital transformation affect a firm’s innovation performance are complex, especially when other factors influencing a firm’s innovation performance are taken into account. According to some scholars, this process requires effective resource mobilization within the firm or collaboration with other organizations in the system [27]. Scholars (e.g., Theoharakis et al. [41]) discovered the beneficial effect of a firm’s operational capabilities on servitization and performance, where operational capabilities primarily include internal management and external relationship capabilities; Kohtamäki et al. [42] emphasized the beneficial moderating role of network capabilities (network management capabilities, network integration capabilities, and network learning capabilities). Increasingly, scholars believe that the inconsistent effect of servitization and digitization on the enterprise’s role is because the transformation process of digital servitization is influenced by a variety of factors, including organizational and resource capabilities and the external environment [43]. While the foci of most scholars’ perspectives are on one aspect of the firm’s capabilities, such capabilities are frequently not static, necessitating the development of specific capabilities that constantly adjust their strategies in light of the firm’s environment, e.g., the dynamic capabilities vision.

A company is a collection of assets and capabilities, some of which are unique and difficult to replicate. According to Teece et al. [44], dynamic capabilities can be analyzed and decomposed into three dynamic capability dimensions: coordination and integration capabilities, learning abilities, and organizational reconfiguration capabilities. In the coordination and integration capability dimension, examined from the perspective of resource elements, the focus is on maximizing the value of irreplaceable, scarce, and difficult-to-replicate resources and using them to improve the current manufacturing processes and procedures. Tian et al. [45] highlighted the importance of coordination and value cocreation across multiple participants, whereas, Lockett and Wright [46] claimed that managers should focus on training and hiring employees with a broad base of business skills, as demonstrated by Groysberg and Lee [47].

On the one hand, learning capabilities enable managers to respond rapidly to environmental and technological changes [48]. A robust learning capability enables firms to acquire new skills and resources, integrate them into their internal capabilities, produce innovative products, develop new product markets, reduce R&D costs, and improve innovation performance [49]. On the other hand, organizations with a strong capacity for learning place a premium on cultivating the innovation capacity of radical employ-

ees to build the necessary strength for innovative development. If an organization has a strong organizational restructuring capability, it can adapt its organizational strategy and development model to the external market and policy environment. Additionally, it is more receptive to organizational and technological innovation. While it is clear that dynamic capabilities and enterprise innovation are related, the extent to which dynamic capabilities affect enterprise innovation remains unknown. It is unclear what role dynamic capabilities play in manufacturing enterprises in the processes of servitization and digital transformation and the effect they have on innovation performance. As a result, this paper proposes the following hypotheses:

Hypothesis 3a (H3a). *Enterprise coordination and integration capabilities play a moderating role in the relationship between servitization, digitalization, and enterprise innovation performance, and the moderating effect is positive.*

Hypothesis 3b (H3b). *Learning capability plays a moderating role in the relationship between servitization, digitalization, and enterprise innovation performance, and the moderating effect is positive.*

Hypothesis 3c (H3c). *Organizational restructuring capability plays a moderating role in the relationship between servitization, digitalization, and enterprise innovation performance, and the moderating role is positive.*

In conclusion, the research model constructed in this paper is shown in Figure 1.

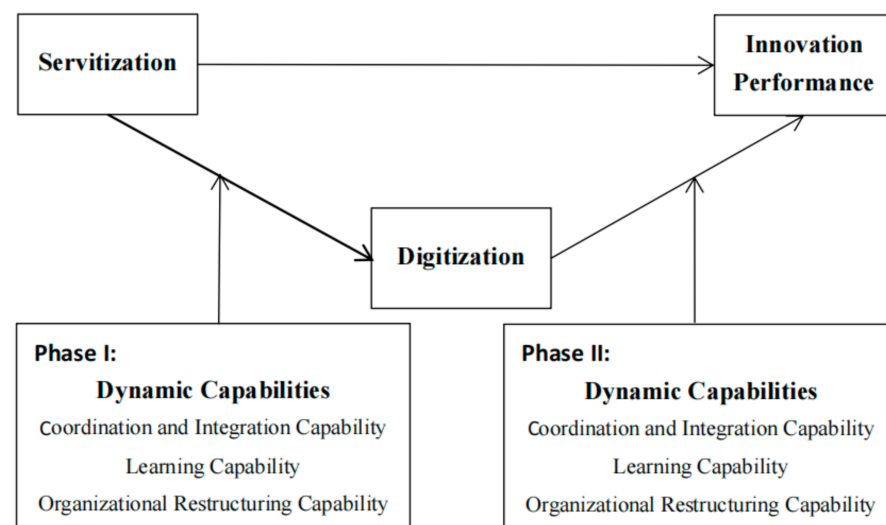


Figure 1. Research model.

3. Research Design

3.1. Methodology

The purpose of this paper is to investigate the impact of servitization strategy on the innovation performance of manufacturing firms and how the innovation performance of firms changes before and after the implementation of servitization. Therefore, in this paper, we construct a “counterfactual” via propensity score matching (PSM) and then estimate it by the double-difference method (DID) with matched samples. First, a propensity score matching method was used to select a control group compared to the treatment group (enterprises that have undergone service transformation) from enterprises that have not undergone service transformation, year by year. The basic idea is to construct a group (control group) of enterprises that have not transformed, similar to the main characteristics of the enterprises that have undergone service transformation (treatment group) prior to

transformation. The enterprises in the treatment group and the control group are matched such that, after matching, the paired enterprises in the two sample groups differ only in whether they have undergone a transformation and are otherwise the same or similar. Thus, the matched control group can be an approximate substitute for the treatment group of “counterfactual.” Based on matched data, double differencing is used to test the effect of a firm’s servitization strategy on the firm’s innovation performance because by taking the difference between the results of cross-sectional units before and after the implementation of the strategy, the double differencing method can exclude the effects caused by individual fixed effects and environmental effects. In other words, by comparing the difference in the effect of an event on the experimental group and the control group, other factors that interfere with causality or omitted variables can be overcome and thus better identify the causal relationship.

3.1.1. Baseline Model

To explore the relationship between servitization transformation strategies and enterprise innovation performance, the baseline model of this paper is set as follows:

$$IP = \beta_0 + aST_i + \gamma X_i + \varepsilon_i \quad (1)$$

IP is the innovation performance of the firm of interest in this paper; ST_i is the explanatory variable service transformation strategy adoption; X_i is the control variables such as firm size and gearing ratio, and ε_i is the random error term.

3.1.2. PSM-DID

The propensity score matching process involves matching the treatment and control groups together according to a specific matching approach and identifying the differences between the two groups by comparing them in the following model:

$$P_i(x) = P_r(d_i = 1|x_i) = f[h(x_i)] \quad (2)$$

This matching process requires that the probability p -values of the treatment and control groups are as close as possible. The matching variables satisfy the principle of balance between the treatment and control groups. This paper uses the most common matching ratio of “1:1 nearest neighbor” for matching.

Based on the propensity score matching results, a binary dummy variable ST_i is set, with “ $ST_i = 1$ ” for the study sample belonging to the treatment group, and “ $ST_i = 0$ ” for the study sample belonging to the control group after matching. Second, the time dummy variable $Time_t$ is set to 0 before and 1 after the manufacturing enterprise starts its service business, and the performance of manufacturing enterprise i is assumed to be P_{it} at time t . The variables ΔP_i^1 and ΔP_i^0 represent the difference between the performance of the treatment and control group enterprises in the two experimental periods under investigation, respectively. Based on the double-difference method, the changes in the performance of manufacturing enterprises after they start their service business are expressed as follows.

$$\tau = E(\tau_i | ST_i = 1) = E(\Delta P_i^1 | ST_i = 1) - E(\Delta P_i^0 | ST_i = 1) \quad (3)$$

In this case, $E(\Delta P_i^0 | ST_i = 1)$ is the “counterfactual” of a service-oriented manufacturing firm in the absence of a service business, which can be used as a proxy for the change in firm performance of the control group before and after the test period obtained by matching the propensity scores, i.e., $E(\Delta P_i^0 | ST_i = 1) = E(\Delta P_i^0 | ST_i = 0)$, so that:

$$\tau = E(\tau_i | ST_i = 1) = E(\Delta P_i^1 | ST_i = 1) - E(\Delta P_i^0 | ST_i = 0) \quad (4)$$

3.1.3. Mediation Effect Test

Based on the purpose of testing whether the servitization transformation of enterprises affects their innovation performance by promoting or inhibiting the level of digital transformation, the following mediation test model is set up in this paper, where ST_level and DT_level denote the level of servitization transformation and the level of digital transformation of enterprises:

$$IP = \beta_1 + a_1ST_level + \gamma X_i + \varepsilon_i \quad (5)$$

$$DT = \beta_2 + a_2ST_level + \gamma X_i + \varepsilon_i \quad (6)$$

$$IP = \beta_3 + a_3ST_level + b_1DT_level + \gamma X_i + \varepsilon_i \quad (7)$$

3.1.4. Moderating Effect Test

To test the influence of dynamic capability on digital servitization and innovation performance, this paper adds the interaction term between dynamic capability and servitization, and the interaction term between dynamic capability and digitalization, based on Equation (1), to test not only whether dynamic capability plays a moderating role, but also to analyze at which stage dynamic capability plays a role, to explore the mechanism of dynamic capability influencing digital servitization and the innovation performance of enterprises. The specific model is set as follows:

$$IP = \beta_1 + a_1ST_level + \gamma X_i + \varepsilon_i \quad (8)$$

$$DT_level = \beta_4 + a_4ST_level + C_1DC_i + a_3ST_level*DC_i + \gamma X_i + \varepsilon_i \quad (9)$$

$$IP = \beta_5 + a_5ST_level + b_2DT_level + \mu DT_level*DC_i + C_2DC_i + \gamma X_i + \varepsilon_i \quad (10)$$

DC_i ($i = 1, 2, 3$) denotes dynamic capability, and the three dimensions of dynamic capability measured in this paper are coordination and integration capability, learning capability, and organizational reconfiguration capability.

4. Data Collection

The sample selected in this paper is from manufacturing enterprises listed on the main board of the Shanghai Stock Exchange of China, and the time range is from 2015 to 2019. To ensure that the sample case studies remain continuous and available during the examination period, sample enterprises that went out of business, went bankrupt or underwent major asset restructuring during the study period are excluded, and enterprises with incomplete data missing during the examination period of the sample are excluded. In addition, the selected manufacturing enterprises' main business scope, primary product name and type, and other financial information are screened, and the enterprises whose primary business includes service business such as maintenance, installation, consulting, and distribution are treated as the treatment group, and other enterprises are classified as the control group. Finally, 1894 observations of 532 listed enterprises were obtained as the full sample; the experimental group contained 717 observations, and the control group included 1177 observations, which were matched year by year using the propensity score matching method, and the data processing was carried out by Stata15.0 software in the obtained PSM sample.

4.1. Variable Measurements

4.1.1. Dependent Variable

Corporate innovation performance is the dependent variable in this paper. Historically, indicators such as new product sales revenue, new product output, and patent applications are used to assess innovation performance; however, new product sales revenue and output must be more accurately reflected after products are commercialized and generate benefits, and corporate-level data are more difficult to obtain. As a result, this paper uses the actual

number of patent applications, which is more deterministic and quantifiable, to assess an enterprise's innovation performance.

4.1.2. Independent Variable

The paper's independent variable is the degree to which manufacturing enterprises are servitized. First, enterprises engaged in service business were screened based on information about their primary business, including installation and maintenance services, processing services, logistics and transportation, consulting services, financial services, and design services. Second, enterprises' annual reports were consulted to determine the composition of business income, and the ratio of service business income to main business income (in percent) was calculated for metrics. This two-step operation aimed to determine whether an enterprise had a servitization strategy and then to quantify the extent of servitization; thus, this paper established specific indicators of servitization for manufacturing enterprises based on these two steps of judgment: first, there was the dummy variable ST_i , which indicated whether a manufacturing enterprise engaged in servitization transactions; and second, there was the dummy variable ST_i , which indicated whether a manufacturing enterprise engaged in servitization transactions. " $ST_i = 0$ " denotes manufacturing enterprises that did not transform their products into services, referred to as non-service manufacturing enterprises. Third, there was the service level of manufacturing enterprises (ST level), which was expressed as the ratio of service business income to manufacturing enterprise's main business income.

4.1.3. Other Variables

The mediating variable in this paper is the degree of enterprise digitization, which Saunders [50] defines as the proportion of digital technology and digital tool-related assets (e.g., software, platforms, systems, information technology, etc.) in the breakdown of intangible assets in the enterprise's total assets, with a larger indicator indicating a greater degree of digitization.

As mentioned previously, this paper measures dynamic capabilities using the dynamic capabilities perspective and the Teece et al. [44] dynamic capabilities dimensions. These dimensions are as follows: coordination and integration capabilities, learning capabilities, and organizational reconfiguration capabilities. In this paper, the total asset turnover ratio is used to quantify the coordination and integration capability dimension. The learning capability dimension, which primarily relates to the educational aspects of employees, is expressed using the percentage of employees with a bachelor's degree or higher. The organizational restructuring capability dimension is reflected by the asset compensation rate.

Additionally, some scholars have examined the impact of their business characteristics on firms, arguing that firm size can influence strategic firm behavior, with larger firms more likely to pursue servitization strategies [51,52]. Additionally, it was discovered that gearing acts as a moderator, negatively affecting the relationship between servitization and performance. As a result, this article includes firm asset size and gearing as control variables.

5. Empirical Analysis

5.1. Testing the Relationship between Servitization and Enterprise Innovation Performance

5.1.1. Descriptive Statistics

The sample data were matched year by year to exclude samples that did not meet the parallel trend assumption, and the results are shown in Table 1. The t-value of the matched samples was less than 2, implying that there was no significant difference between the control group and the treatment group in other variables after matching, so the parallel trend assumption was satisfied and the matching results were reliable.

Table 1. Propensity score matching results.

	Matching Stage	Treated	Control	Difference	t Statistics	Samples That Do Not Satisfy Parallel Trend Assumptions
2015	Unmatched	340.98	191	149.98	1.14	17
	Matched	340.98	803.92	−462.93	−1.63	
2016	Unmatched	437.05	220.89	216.16	1.87	16
	Matched	447.21	269.98	177.23	1	
2017	Unmatched	505.67	163.94	341.73	3.38	6
	Matched	508.96	303.99	204.97	1.4	
2018	Unmatched	574.99	280.75	294.25	2.24	3
	Matched	574.99	306.13	268.87	1.75	
2019	Unmatched	656.72	384.70	272.02	2.11	10
	Matched	602.53	606.59	−4.06	−0.02	

5.1.2. Baseline Regression Results

The link between the adoption of the servitization transformation strategy and the firm's innovation performance can be analyzed by the results in Table 2. The finding that manufacturing firms undergoing servitization transformation have positive impact on firm innovation performance at 5% and 1% significance levels tentatively verifies Hypothesis 1 of this paper: firm servitization transformation positively impacts firm innovation performance. In other words, implementing a service-oriented transformation strategy in manufacturing firms is better for innovation performance, so firms should actively develop service-oriented strategies and carry out service-oriented transformation if they try to seek the development of innovation direction. At the same time, the data in Table 3 show that the learning ability and the asset size of enterprises have a positive effect on the innovation performance of enterprises at a significant level of 1%, which indicates that manufacturing enterprises cannot develop innovation without the support of learning ability on the one hand. The strong learning ability of enterprises and employees can quickly and effectively acquire information and absorb new knowledge, which is important for developing new products and new product markets and improving the innovation performance of enterprises. On the other hand, enterprises with more significant assets have advantages in innovation development. They can increase their investment in R&D activities by virtue of their financial strength, hire experts and excellent talents to form teams, and conduct innovative research, which will likewise promote the innovation performance of enterprises.

In summary, the data in Table 2 tentatively verify that the adoption of a service-oriented transformation strategy has a positive contribution to corporate innovation performance, which is also positively influenced by elements such as corporate learning ability and asset size.

5.1.3. Robustness Test

For the sake of robustness, a placebo test is conducted in this paper to see whether the “dummy” policy still has a significant impact on firms' innovation performance by artificially advancing or delaying the implementation of the servitization strategy by one year. Supposing that there is a significant impact of the “dummy” policy, this means that the impact on innovation performance is likely due to other factors, not the servitization strategy studied in this paper. According to the results in Table 3, whether to adopt a servitization strategy one period earlier or later does not have a significant effect on the innovation performance of enterprises, which indicates that the research on the positive effect of servitization transformation on the innovation performance of enterprises is valid, and the innovation performance of enterprises is affected by the servitization strategy.

Table 2. Baseline regression results.

	(1)	(2)
	Innovation Performance	Innovation Performance
Servitization	1.030 ** (2.48)	1.150 *** (2.80)
Learning capacity		1.006 *** (3.30)
Coordination and integration capacity		−0.434 (−0.99)
Organizational restructuring capacity		−0.644 (−0.65)
Asset–liability ratio		−1.471 (−1.63)
Asset size		0.755 *** (3.07)
Constants	8.209 *** (13.81)	−9.025 (−1.53)
Firm FE	Yes	Yes
Year FE	Yes	Yes
N	1842	1842
Pseudo R2	0.896	0.903

t statistics in parentheses, ** $p < 0.05$, *** $p < 0.01$.

Table 3. Placebo test results.

	(1)	(2)
	Innovation Performance	Innovation Performance
Servitization_pre1	0.280 (1.13)	
Servitization_post1		0.197 (1.37)
Learning capacity	1.300 ** (2.25)	1.320 *** (3.14)
Coordination and integration capacity	0.165 (0.85)	0.181 (1.64)
Organizational restructuring capacity	−0.0690 (−0.05)	−0.153 (−0.14)
Asset–liability ratio	−0.0113 (−0.02)	0.00299 (0.01)
Asset size	0.495 *** (6.40)	0.496 *** (8.69)
Constants	−6.558 *** (−4.17)	−6.509 *** (−5.60)
Firm FE	Yes	Yes
Year FE	Yes	Yes
N	1842	1842
Pseudo R2	0.365	0.362

t statistics in parentheses, ** $p < 0.05$, *** $p < 0.01$.

At this point, this paper has explored the correlation between the servitization transformation strategy and the innovation performance of enterprises, initially verified the Hypothesis 1 of this paper, and completed the analysis of the importance of servitization transformation for manufacturing enterprises. However, this process only answers the question of whether to adopt a servitization transformation strategy on enterprise perfor-

mance, but the specific degree of servitization and the mechanism of how servitization affects innovation performance are not yet resolved.

5.2. Analysis of the Mechanism of the Role of Servitization in Affecting the Innovation Performance of Enterprises

5.2.1. A Test of the Mediating Effect of Digitization

To test Hypothesis 2, the mediating effect of digital transformation is tested in this paper, and according to Equations (5)–(7) in the model design, the results are obtained as shown in Table 4.

Table 4. Results of mediation effect test.

	(1)	(2)	(3)	(4)
	Innovation Performance	Innovation Performance	Digitization	Innovation Performance
Servitization level	0.0253 *** (21.86)	0.0447 ** (2.20)	45.97 *** (3.16)	0.0654 *** (2.82)
Digitization level				0.0143 ** (2.42)
Learning capacity		−1.028 *** (−3.61)	1228.2 *** (2.83)	−0.470 (−1.41)
Coordination and integration capacity		−0.619 (−1.49)	−30.13 (−0.11)	−0.0935 (−0.22)
Organizational restructuring capacity		0.406 (0.35)	1490.8 * (1.86)	−0.944 (−0.65)
Asset–liability ratio		−1.091 (−1.29)	397.0 (0.83)	−1.546 (−1.61)
Asset size		0.584 ** (2.23)	−157.2 (−1.00)	1.352 *** (6.80)
Constants	8.902 *** (1460.84)	−4.280 (−0.68)	2966.1 (0.76)	−23.18 *** (−5.06)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1842	1842	1842	1842
Pseudo R2	0.886	0.892	0.024	0.883

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Columns (1) and (2) are the main effects tests of the model, which aim to test whether the level of servitization significantly improves innovation performance or not. It can be seen that at significance levels of 1% and 5%, the level of servitization can effectively improve the innovation performance of enterprises, and combined with the previous paper's adoption of servitization transformation strategy on the promotion of enterprise innovation performance, Hypothesis 1 of this paper is fully verified, and enterprise servitization transformation does have a positive impact on enterprise innovation performance.

Column (3) shows that at the significance level of 1%, the level of servitization can significantly promote the development of the digital transformation of enterprises, while the learning ability and organizational restructuring ability also play a positive role in promotion. In the process of servitization transformation, enterprises tend to introduce new intelligent devices or technologies to reshape the enterprise service process with new generation digital technologies such as the Internet of things, big data and artificial intelligence to improve their value-added process and provide more complete market packages or products or services that satisfy customers. Therefore, manufacturing enterprises increase their attention to digitalization in the process of servitization transformation. Column (4) indicates that the levels of servitization and digitization are positively associated with firm innovation performance at a 1% significance level. The size of firm assets also positively affects firm innovation performance. Combining the data in the three columns (2)–(4),

the level of servitization significantly increases the level of digitization, and digitization also significantly increases the firm innovation performance. This suggests that the degree of servitization alone has the effect of improving corporate innovation performance. On the other hand, it can also improve corporate innovation performance by increasing the degree of digitization. The mediating effect of digitization is verified and Hypothesis 2 of this paper holds. It can be seen that the servitization has formed a new combination of digital value-added services under the role of digitalization, using the collaborative work of product services and digital software to drive innovation in production, R&D, marketing, and logistics, etc. At the same time, the use of the platform for data analysis, continuous adjustment, and design to meet the needs of consumers, causes an integration, producing a new model of “digital + service” synergy, resulting in higher innovation performance in digital services, which is important for the innovative development of enterprises.

5.2.2. A Test of the Moderating Effect of Dynamic Capacity

Based on the previous findings, which verify that digitization plays a mediating role in servitization and firm innovation performance, this paper addresses the question of what role dynamic capabilities play in the relationship between servitization and the impact of innovation performance. According to the research design model, (8)–(10), this paper explores the moderating role of dynamic capabilities in two stages. It examines the role of dynamic capabilities between servitization and digitization and the role of dynamic capabilities between digitization and firm innovation performance, respectively, the results for which are shown in Tables 5 and 6.

Table 5. Moderating effects test I.

	(1)	(2)	(3)	(4)
	Digitization	Digitization	Digitization	Digitization
Servitization level	25.41 *	19.51 *	55.84 ***	40.95 *
	(1.93)	(1.76)	(3.52)	(1.92)
Servitization × Learning capacity	137.2 ***			279.9 ***
	(3.30)			(4.91)
Servitization × Coordination and integration capacity		−13.97		−13.03
		(−1.01)		(−0.74)
Servitization × Organizational restructuring capacity			−262.3	97.05 ***
			(−1.56)	(4.07)
Learning capacity	190.3	460.5 **	1252.7 ***	−62.26
	(0.92)	(2.43)	(2.89)	(−0.29)
Coordination and integration capacity	−120.9	−79.51	−5.100	−59.55
	(−1.16)	(−0.70)	(−0.02)	(−0.50)
Organizational restructuring capacity	591.1	298.0	1977.0 **	32.05
	(1.08)	(0.55)	(2.30)	(0.06)
Asset–liability ratio	425.5 *	360.4	391.0	334.7
	(1.82)	(1.54)	(0.82)	(1.43)
Asset size	−81.88 **	−78.96 **	−149.8	−82.35 **
	(−2.44)	(−2.35)	(−0.95)	(−2.47)
Constants	1614.7 **	1490.5 **	2748.3	1697.3 **
	(2.30)	(2.12)	(0.71)	(2.42)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	1842	1842	1842	1842
Pseudo R2	0.001	0.001	0.025	0.001

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6. Moderating effects test II.

	(1)	(2)	(3)
	Innovation Performance	Digitization	Innovation Performance
Servitization level	0.0447 ** (2.20)	40.95 * (1.92)	0.0426 ** (2.13)
Digitization level			0.0474 *** (2.73)
Servitization × Learning capacity		279.9 *** (4.91)	
Servitization × Coordination and integration capacity		−13.03 (−0.74)	
Servitization × Organizational restructuring capacity		97.05 *** (4.07)	
Digitization × Learning capacity			−0.0529 (−2.42)
Digitization × Coordination and integration capacity			0.0372 *** (3.07)
Digitization × Organizational restructuring capacity			0.116 (2.02)
Learning capacity	−1.028 *** (−3.61)	−62.26 (−0.29)	−0.783 *** (−2.75)
Coordination and integration capacity	−0.619 (−1.49)	−59.55 (−0.50)	−0.456 (−1.22)
Organizational restructuring capacity	0.406 (0.35)	32.05 (0.06)	−0.232 (−0.22)
Asset–liability ratio	−1.091 (−1.29)	334.7 (1.43)	−1.008 (−1.27)
Asset size	0.584 ** (2.23)	−82.35 ** (−2.47)	0.604 ** (2.47)
Constants	−4.280 (−0.68)	1697.3 ** (2.42)	−4.964 (−0.85)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	1842	1842	1842
pseudo R2	0.892	0.001	0.893

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

After verifying that the level of servitization improves the firm's innovation performance by increasing the level of digitization, Table 5 (1)–(4) further analyze what factors affect the enhancement effect of the level of servitization on the level of digitization. The results show that the level of servitization, the interaction term between servitization and learning capabilities, and the interaction term between servitization and organizational reconfiguration capabilities positively contribute to the digitalization level of the firm at 10%, 1%, and 1% significance levels, respectively. In other words, manufacturing firms can promote digital transformation through servitization and learning capabilities, and organizational reconfiguration capabilities significantly and positively moderate this process. Furthermore, a comparison of these datasets in columns (1), (3), and (4) in Table 5 shows that examining organizational reconfiguration capabilities in isolation underestimates their

influential role in the relationship between servitization and digitization, and this underestimation is due to the neglect of the influence of variables, such as learning capabilities on the relationship between servitization and digitization; therefore, the interaction between the moderating variables should be considered in an integrated manner.

The moderating effect of the second stage can be illustrated in the column (3) of Table 6. Among the three interaction terms of digitalization and dynamic capabilities, only the digitalization and coordination and integration capabilities have positive effects on firms' innovation performances, while the other two interaction terms have insignificant effects on firms' innovation performances, indicating that there is a significant moderating effect of coordination and integration capabilities between digitalization and innovation performance in this stage.

In summary, Hypotheses 3a, 3b, and 3c of this paper are tested, and the moderation of dynamic capabilities on firms' innovation performances plays a role in two stages, respectively, with learning and organizational restructuring capabilities focusing on the first stage, and synergy and integration capabilities focusing on the second stage.

6. Conclusions and Discussion

6.1. Conclusions

Servitization and the digital transformation of manufacturing enterprises are critical components of the digital economy's development strategy. In this article, we combine the internal dynamic capabilities of enterprises and the transformations of servitization and digitalization into a single model to investigate the mechanism by which they affect an enterprise's innovation performance. The findings indicate that: (1) servitization plays a significant role in promoting enterprise innovation performance; (2) servitization can improve enterprise innovation performance by influencing an enterprise's digitalization level. In other words, there is a significant mediating effect of the digitalization level on servitization and innovation performance, and the integration development of digital technologies plays a significant role in promoting enterprise innovation performance. (3) Dynamic capabilities act as a moderator in the relationship between servitization, digitization, and the performance of enterprises in terms of innovation. Specifically, learning capabilities and organizational restructuring capabilities can help mitigate the driving effect of servitization on digitization and thus help improve enterprise innovation performance, while coordination and integration capabilities can help reduce the impact of digitization on enterprise innovation performance and help significantly improve enterprise innovation performance.

6.2. Discussion

The existing research effectively confirms the significance of digital and service-oriented transformation in improving enterprise competitiveness from transformation trends, value creation processes, organization structure, and business model innovation [8,27,29,40]. Most of the research methods discuss the impact of digitalization on the innovation of manufacturing enterprises and the impact of servitization on the innovation of manufacturing enterprises through regression analysis. However, the joint effect and integration development between digitalization and servitization are not explored in-depth, and the role of the internal dynamic capabilities of enterprises in this influence mechanism is ignored. Accordingly, this paper uses the PSM-DID research methodology to put digitalization, servitization, and dynamic capabilities in the same model to discuss their impact mechanisms on the innovation performance of enterprises. The major contributions of this paper include demonstrating that the converging effects of digitization and servitization can drive enterprise innovation, while confirming that both servitization and digitization have a beneficial impact on enterprise innovation. Additionally, different dynamic capabilities possessed by enterprises themselves also influence the impact of digitalization and servitization on enterprise innovation. Thus, the role of dynamic capabilities cannot be ignored when exploring the issue of enterprise innovation.

According to the main findings of this paper, enterprise innovation is critical to manufacturing enterprises' production activities and cannot be overlooked. Thus, it is critical to consider the impact of factors such as servitization, digitalization, and dynamic capabilities on an enterprise's innovation performance. The servitization and digital transformation of manufacturing enterprises have become the primary means for enterprises to increase their competitiveness and occupy a favorable market position. Therefore, this research focuses on promoting the development of innovation performance, and this paper makes the following policy recommendations.

First: consolidate and improve the process of enterprise servitization and digitalization. Enterprises undergoing servitization transformation exhibit characteristics of expanding business scope, which results in the rapid adoption of personalized customization and flexible manufacturing in manufacturing enterprises, while productive services and service-oriented production enable enterprises to be more innovative in their research, development and manufacturing processes. At the same time, manufacturing enterprises should also consider the following.

Second: accelerate service and digital development integration. The combination of digitalization and servitization results in a synergistic model of "digital + service" for manufacturing enterprises, achieving a $1 + 1 > 2$ value-added solution. Additionally, this process fosters enterprise innovation and development. In comparison to adding services to traditional manufacturing, traditional manufacturing enterprises' digital services focus on business model innovation and R&D activities. For example, Qingdao Red Leader Group established a new industrial system centered on "customization" through the data-driven establishment of intelligent factories and an industry chain collaboration platform, addressing global consumers' online customization needs. In this process, innovation is no longer an internal matter but a collaborative effort between multiple participants that reduces marginal costs and adds new capabilities to manufacturing enterprises' traditional products.

Third: the effective utilization of dynamic enterprise capabilities to catalyze innovation. Enterprises must be capable of coordinating and integrating resources and restructuring their organizational structures. From an enterprise management perspective, an enterprise's dynamic capability is a response to its management capability. When an enterprise has strong coordination, integration capabilities and organizational restructuring capabilities, all stakeholders can contribute to the process of innovative products, progressive development, and management transactions, thereby increasing enterprise value while meeting customer needs. Without enterprise and employee learning and creation, enterprises and employees cannot develop innovatively. When businesses foster a more conducive environment for learning and research and their employees possess a strong learning capacity, it becomes easier for them to engage in innovative behaviors. As a result, manufacturing firms should strengthen their own dynamic capabilities in order to boost their innovation performance.

In the manufacturing industry's future development, the greater integration of various service and digital concepts will become the predominant trend. Engineering technology will advance by integrating manufacturing processes, information technology, new materials, new technology, advanced management, and other qualitative revolutionary changes to achieve innovative development. However, carrying out the servitization and digital transformation of manufacturing enterprises, integrating servitization and digitalization, and the impact of transformation on enterprises, are still the polar opposite of the research and focus on upgrading and developing manufacturing enterprises, and thus deserve more detailed and in-depth discussions.

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