

Asymmetric Effects of OFDI Supply Chain Spillovers in an Open Economy: An Empirical Study on the Upstream and Downstream Transmission Mechanisms of Digital Technological Innovation in Local Enterprises

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Abstract

Against the backdrop of the digital economy and high-level opening-up, this study uses A-share listed companies (2007–2024) to explore OFDI supply chain spillovers' impact on domestic enterprises' digital technology innovation via the two-way fixed-effects model and related tests. Results show significant bidirectional heterogeneous effects: downstream customers' OFDI promotes innovation through knowledge spillovers (mediated by technology imports, etc.), while upstream suppliers' OFDI inhibits it via knowledge monopolization (mediated by patent barriers, etc.), validating spillover asymmetry. Robustness tests confirm reliability. This study offers theoretical/practical references for enterprises, governments, and industrial chains, and points out limitations in samples, variable measurement, and mechanism exploration, guiding future research.

Keywords

OFDI Supply Chain Spillovers; Domestic Enterprises; Digital Technology Innovation; Heterogeneous Impact; Mediating Mechanism; Two-way Fixed-effects Model.

1. Introduction

Against the backdrop of the deepening new round of global scientific and technological revolution and industrial transformation, digital technological innovation has become the core engine driving high-quality economic development, as well as a strategic high ground for countries to enhance their international competitiveness. China attaches great importance to the digital technological innovation of enterprises and the coordinated development of industrial and supply chains. The *14th Five-Year Plan for Digital Economy Development* issued by the State Council clearly stipulates that enterprises' digital technological innovation should not only improve their own operational efficiency but also optimize the coordination efficiency with upstream and downstream partners in the industrial chain. Similarly, the *Special Action Plan for Digital Empowerment of Small and Medium-Sized Enterprises (2025–2027)* also takes promoting the chain-wide transformation of industrial chains and driving the collaborative digitalization of upstream and downstream supply chains as its core objectives. The construction of digital industrial chains effectively integrates resources across all links, encourages enterprises to break through their own resource constraints and conduct in-depth collaborative innovation with upstream and downstream firms, laying a foundation for knowledge and technology spillovers at the supply chain level. Meanwhile, with the continuous advancement of China's high-level opening-up, outward foreign direct investment (OFDI) has become an important channel for domestic enterprises to integrate into global industrial chains and access advanced international technologies and market information. Its spillover effects

generated through supply chain networks are becoming a key factor affecting the digital technological innovation of domestic enterprises. In this context, exploring the impact of OFDI supply chain spillovers on the digital technological innovation of domestic enterprises carries important practical research value.

Existing literature predominantly focuses on the macroeconomic growth effects or single-dimensional technological spillovers of outward foreign direct investment (OFDI), while neglecting its heterogeneous impacts on digital technological innovation in domestic firms from the perspective of upstream and downstream supply chain collaboration [1]. Therefore, investigating digital technological innovation in focal firms based on upstream supplier ties and downstream customer ties not only aligns with national strategic planning but also addresses gaps in existing research and enhances the explanatory power and universality of the theory [2]. From the perspectives of customers and suppliers, this paper uses a sample of listed firms during 2007–2024 to systematically investigate the effects and transmission mechanisms of OFDI supply chain spillovers on digital technological innovation in domestic enterprises. By clarifying the heterogeneous impacts of OFDI by upstream and downstream supply chain partners on digital technological innovation in domestic firms, this study provides theoretical support and practical evidence for enterprise innovation decision-making and government policy formulation, thus promoting the coordinated advancement of national strategic objectives and the construction of Digital China.

First, a novel research perspective. Existing studies are predominantly confined to a domestic context, focusing mainly on the mechanisms of industrial chain (supply chain) linkages and peer effects on firms' digital technological innovation. This paper innovatively extends the research scope to the field of international investment, focusing on how knowledge spillovers generated by outward foreign direct investment (OFDI) of upstream and downstream supply chain firms drive digital technological innovation in domestic firms. It thus provides a new perspective for evaluating the technological innovation performance of domestic firms against the backdrop of China's high-level opening-up.

Second, a original research framework. In contrast to existing studies that mostly adopt a single perspective to analyze the impact of the industrial chain (supply chain) on firms' digital technological innovation, this study innovatively constructs a two-way interactive analytical paradigm. By systematically decomposing the diverse spillover mechanisms exhibited by upstream suppliers and downstream customers in the process of OFDI, this paper deeply explores the heterogeneous characteristics of their influence paths on digital technological innovation in domestic enterprises.

2. Literature Review

2.1. Literature on OFDI Supply Chain Spillovers

Early studies on outward foreign direct investment (OFDI) primarily focused on investment motives and location choice, such as traditional theories including the theory of monopolistic advantage, internalization theory, and the eclectic paradigm of international production, which explain why firms engage in OFDI. With the deepening integration of the global industrial chains, scholars have begun to explore the impacts of OFDI at the supply chain level. OFDI supply chain spillovers refer to the dissemination and diffusion of knowledge, technology, management experience and other factors among related enterprises through upstream and downstream supply chain linkages in the process of firms' OFDI activities. Supply chain spillovers constitute an important mechanism for the upgrading of China's supply chains and industrial advancement, and play a critical role in promoting the transformation of China's industries toward a more efficient, modernized, and intelligent supply chain model [3]. To address industrial relocation and safeguard national industrial security, a key measure is to

strengthen control over the supply chains that underpin industrial development and build China into a strong supply chain power. Such a competitive supply chain can be continuously upgraded through participation in international market competition-specifically, by extending China's supply chain system overseas and realizing supply chain spillovers [3].

2.2. Literature on Digital Technological Innovation of Enterprises

Digital technological innovation refers to the process of developing new products, transforming organizational models, improving production processes, and innovating business models based on underlying digital technologies such as artificial intelligence, big data, cloud computing, and blockchain [4]. Digital technological innovation has become the driving force behind the development of the digital economy and an important pillar for achieving high-quality economic development [5]. It is not only a critical path for Chinese listed firms to realize transformation and upgrading and enhance core competitiveness, but also a solid shield for building corporate resilience and resisting uncertain risks [6]. Enterprises should attach importance to the role of digital transformation in enhancing innovation value, follow the trend of the digital economy, seize the dividend released by the digital economy, and actively carry out digital transformation [7].

2.3. Literature on OFDI Supply Chain Spillovers and Corporate Digital Technological Innovation

With the continuous deepening of global value chain division, the supply chain network has become an important channel for technology diffusion and knowledge spillovers [8]. Existing studies have formed a certain consensus on the impact of upstream and downstream supply chain interactions on enterprise innovation. Some scholars point out that there is a significant linkage effect between upstream and downstream of the industrial chain in the process of digital transformation, and this transmission mechanism is mostly manifested as a downstream customer-driven type. The digital transformation of focal enterprises is not passive imitation, but active learning and strategic adaptation based on collaborative needs and competitive pressures [9]. On this basis, further studies find that the digital transformation of customer enterprises can produce obvious spillover effects through business connection, standard transmission and resource sharing, effectively improving the innovation capability and innovation performance of upstream suppliers [10].

2.4. Literature Review Summary

Existing studies are mostly limited to a domestic perspective, focusing on the mechanisms of industrial chain (supply chain) linkages and peer effects on corporate digital technological innovation [11]. This study innovatively extends the research scope to the field of international investment, focusing on how knowledge spillovers generated by outward foreign direct investment (OFDI) of upstream and downstream supply chain enterprises drive digital technological innovation in domestic firms, providing a new perspective for evaluating firms' technological innovation efficiency under the high-level opening-up strategy. Furthermore, most extant literature examines the industrial chain (supply chain) linkage effects on corporate digital technological innovation from a single dimension [1]. This study constructs a two-way interactive analytical framework to systematically investigate the heterogeneous spillover mechanisms of upstream suppliers and downstream customers in the process of OFDI. It empirically reveals the divergent transmission paths of their impacts on digital technological innovation of domestic enterprises, which carries important implications for optimizing supply chain resource allocation in an open economy.

3. Theoretical Mechanism and Research Hypotheses

3.1. Concept Definition

3.1.1. OFDI Supply Chain Spillovers

OFDI supply chain spillovers referred to in this paper denote the effects in which upstream and downstream affiliated enterprises in the supply chain diffuse and transmit resources such as digital technologies, management experience, and market demand information acquired overseas to local focal firms through vertical supply chain linkages in the process of outward foreign direct investment (OFDI). It is a concrete manifestation of reverse knowledge spillovers of OFDI in the supply chain network, and presents differentiated spillover directions and action logics due to the different roles of upstream and downstream entities.

3.1.2. Corporate Digital Technological Innovation

Innovative activities carried out by enterprises around production processes, organizational models, products and services, supported by underlying digital technologies including artificial intelligence, big data, cloud computing, and blockchain. This paper measures it from two dimensions: the number of applied invention patents for digital technologies and the frequency of digital keywords in corporate annual reports, covering both substantive technological R&D achievements and practical explorations of enterprise digital transformation.

3.2. Theoretical Mechanism Analysis and Research Hypotheses

Mechanism 1: Incentive Effect of Digital Technological Innovation Driven by Customer Demand

Knowledge Spillover Effect: Downstream OFDI customers promote the digital transformation of upstream suppliers through digital demand transmission and knowledge sharing. Relying on international market experience, multinational enterprises output real-time data and digital management experience to suppliers, forming a supply chain knowledge diffusion effect [12].

Demonstration and Competition Effect: The high-level demand of OFDI customers for digital, intelligent and customized products forces suppliers to carry out digital process transformation, thereby stimulating digital technological innovation of local enterprises.

Peer Effect Driver: After downstream customer enterprises conduct OFDI, their overseas digital practice information spreads in the supply chain network, prompting suppliers to achieve supply chain collaboration through digital transformation [9].

H1: OFDI of downstream customer enterprises promotes digital technological innovation of local enterprises, that is, OFDI supply chain spillovers from downstream present an incentive effect on digital technological innovation driven by customer demand.

Mechanism 2: Restriction Effect of Digital Technological Innovation under the Dominant Position of Suppliers

Knowledge Monopoly Effect: After acquiring advanced digital technologies through OFDI, upstream suppliers tend to build a knowledge monopoly system to maintain their competitive advantages, thereby inhibiting digital technological innovation of local enterprises.

Technology Lock-in Effect: After upstream suppliers conduct OFDI, they may enhance the dependence of local enterprises on upstream technologies based on their own technological advantages, and further generate a technology lock-in effect [13].

Talent Loss Differentiation: Upstream enterprises establish overseas R&D centers or acquire high-tech enterprises through OFDI, providing more competitive salaries and scientific research environments, leading to the loss of core R&D personnel of local enterprises.

H2: OFDI of upstream suppliers exerts a certain inhibitory effect on corporate digital technological innovation, that is, OFDI supply chain spillovers from upstream present a restriction effect on digital technological innovation under the dominant position of suppliers.

Mechanism 3: Mediating Mechanism of OFDI Supply Chain Spillovers Affecting Local Enterprises' Digital Technological Innovation

The heterogeneous impacts of OFDI supply chain spillovers from upstream and downstream on local enterprises' digital technological innovation are not realized through direct paths, but form an indirect action logic through specific mediating variables relying on the transmission of knowledge, resources and factors in the supply chain network.

Combined with the aforementioned theoretical mechanism and existing research results, this paper selectively selects the number of technology introductions, the frequency of patent citations in the same industry, and the participation in industrial technology standards as mediating variables for the positive incentive effect of downstream customer OFDI. It selects the intensity of patent barriers of upstream suppliers, technological substitution elasticity, and R&D personnel turnover rate as mediating variables for the negative restriction effect of upstream supplier OFDI, to systematically analyze the transmission paths of each mediating variable.

H3: The number of technology introductions, the frequency of patent citations in the same industry, and the participation in industrial technology standards play mediating roles in the positive relationship between downstream customer OFDI and digital technological innovation of local firms.

H4: The intensity of patent barriers of upstream suppliers, technological substitution elasticity, and R&D personnel turnover rate play mediating roles in the negative relationship between upstream supplier OFDI and digital technological innovation of local firms.

4. Research Design

Based on the theoretical mechanism and research hypothesis mentioned above, this part clarifies the selection scope and data source of research samples, defines the definition and measurement methods of core variables, constructs a benchmark regression model and a mediating effect test model suitable for the research topic, and explains the core methods of subsequent empirical analysis, so as to provide rigorous empirical design support for testing the impact effect and action path of OFDI supply chain spillover on the digital technology innovation of local enterprises.

4.1. Sample Selection and Data Sources

4.1.1. Sample Selection

This paper takes A-share listed companies as the research object and selects the annual data from 2007 to 2024 as the initial sample. In order to ensure the reliability of the research conclusions, the initial samples are screened with reference to existing academic practices, including: excluding financial industry companies, ST/*ST and delisted companies, samples with missing or abnormal core variable data, and abnormal samples with an asset-liability ratio of more than 100%. After the above screening, 12,860 valid observations were finally obtained, covering 1,523 listed companies, forming non-balanced panel data and providing solid support for subsequent empirical analysis.

4.1.2. Data Sources

The core data required for this empirical study are all from authoritative databases and public channels: the financial and corporate governance, and outward foreign direct investment (OFDI) data of listed companies come from China Stock Market & Accounting Research Database (CSMAR) and Wind Information Database (Wind); Macroeconomic data are taken from the official website of the National Bureau of Statistics and the Wind database to control the impact at the macro level; The data related to digital technology innovation comes from the CSMAR patent database, among which the frequency of keywords such as "big data" and "cloud

computing" in the annual report is downloaded through China Securities Information Network (CNINFO), combined with manual collation and Python text mining. The mediating variable data is partly from the CSMAR database, and some are manually verified through listed companies and industry statistical reports. All data are cross-checked to ensure that they are true, complete, and consistent, ensuring the credibility of the research conclusions.

4.1.3. Data Processing

In order to improve the robustness of econometric model estimation, all continuous variables are standardized: the missing samples of the core variables are directly eliminated, and the missing values of the control variables are filled by the median. The extreme values are corrected by 1% quantile winsorize treatment to avoid distorting the regression results of extreme observations. The core purpose of the above processing is to improve the quality of data, ensure the robustness of empirical conclusions, and lay a good foundation for subsequent inspection and analysis.

4.2. Definition and Measurement of Variables

4.2.1. Dependent Variable: Corporate Digital Technology Innovation (*Digitalit*)

Drawing upon the measurement methodology of Bao Qun and Liao Sainan [14], a dual-dimensional indicator is employed to assess corporate digital technology innovation levels. The primary indicator serves for benchmark regression, while the substitute indicator is adopted for robustness testing:

(i) Primary Indicator: Number of digital technology invention patent applications

Referencing the Correspondence Table Between Core Digital Economy Industries and International Patent Classification issued by the China National Intellectual Property Administration, we match digital technologies with corresponding IPC patent classification codes, and screen out the number of digital technology-related invention patents applied for by enterprises in the current year. Invention patents are selected over utility model patents or design patents because they better reflect an enterprise's substantive digital technology innovation capabilities.

(ii) Robustness Alternative Indicator: Keyword frequency in annual reports

We select core digital technology keywords such as "big data, cloud computing, artificial intelligence, blockchain, smart manufacturing, industrial internet, digital twin, Internet of Things", and count the total frequency of these keywords in the company's annual report. This indicator reflects the enterprise's strategic emphasis, practical willingness, and actual investment level in digital transformation and digital technology innovation, serving as an effective supplement to the primary indicator.

4.2.2. Core Explanatory Variables: Outward Foreign Direct Investment (OFDI) by Upstream and Downstream Enterprises in the Supply Chain ($OFDI_{down,it}$, $OFDI_{up,it}$)

The core explanatory variable $OFDI_{down,it}$ is a dummy variable, which equals 1 if the downstream customer enterprises of firm i conduct OFDI in year t , and 0 otherwise. Similarly, $OFDI_{up,it}$ equals 1 if the upstream supplier enterprises of firm i conduct OFDI in year t , and 0 otherwise.

4.2.3. Mediating Variables ($M_{k,it}$)

$M_{k,it}$ denotes six mediating variables, namely the quantity of technology imports, the number of patent citations by peer enterprises, the degree of industry participation in technical standards, the intensity of patent barriers of upstream suppliers, the elasticity of technological substitution, and the turnover rate of R&D personnel.

4.2.4. Control Variables

To mitigate the interference of firm-specific characteristics on corporate digital technology innovation, we select firm-level control variables with reference to existing mainstream literature. Their specific definitions and measurement approaches are detailed as follows:

Table 1. Definition and Measurement of Firm-Level Control Variables

| Control variable symbol | Control Variable Name | Measurement Method |
|-------------------------|--|--|
| Size _{it} | Enterprise Scale | Natural logarithm of the enterprise's total assets at year-end t |
| Age _{it} | Company Age | The duration of the enterprise's existence from its establishment to year t |
| ROA _{it} | Return on Assets | The ratio of a company's net profit in year t to its average total assets reflects the company's profitability. |
| Lev _{it} | Asset-liability ratio | The ratio of total liabilities to total assets at the end of year t reflects the company's financial leverage. |
| Top1 _{it} | Largest Shareholder's Shareholding Ratio | The proportion of shares held by the largest shareholder at the end of year t relative to the total number of shares reflects the concentration of equity ownership. |
| RD _{it} | R&D intensity | The ratio of a company's R&D expenditure to its operating revenue in year t reflects the foundation of its innovation investment. |

4.3. Model Specification

4.3.1. Benchmark Regression Model

To test Hypotheses H1 and H2, which state that OFDI by downstream customers and upstream suppliers exerts heterogeneous effects on the digital technology innovation of domestic firms, this paper constructs a two-way fixed-effects panel data model, which is formulated as follows:

$$Digital_{it} = \beta_0 + \beta_1 OFDI_{down,it} + \beta_2 OFDI_{up,it} + \gamma X_{it} + \lambda_i + \mu_t + \varepsilon_{it} \tag{1}$$

In Equation (1), *Digital_{it}* denotes the digital technology innovation capability of domestic enterprise *i* in year *t*. Following the approach of Bao Qun and Liao Sainan (2023), two measurement indicators are employed to assess the level of corporate digital technology innovation (Digital): first, the number of digital technology-related invention patent applications filed by the enterprise in the current year; second, the frequency of keywords such as "big data", "cloud computing", and "intelligent manufacturing" in the enterprise's annual report. The core independent variable *OFDI_{down,it}* is a dummy variable, which equals 1 if the downstream customer enterprises of firm *i* conducted OFDI in year *t*, and 0 otherwise. Similarly, *OFDI_{up,it}* equals 1 if the upstream supplier enterprises of firm *i* conducted OFDI in year *t*, and 0 otherwise. *X_{it}* denotes the control variables, *λ_i* represents the firm-fixed effect, and *μ_t* indicates the year-fixed effect. *ε_{it}* is the random error term. This model is employed to examine the impact of OFDI supply chain spillovers on the digital innovation of domestic enterprises.

4.3.2. Mediated Effect Model

The stepwise regression method is employed to test the mediating path of the mechanism model, which is conducted in two stages:

$$M_{k,it} = \theta_1 + \theta_1 OFDI_{down,it} + \theta_2 OFDI_{up,it} + \gamma X_{it} + \lambda_i + \mu_t + \varepsilon_{it} \tag{2}$$

$$Y_{it} = \alpha_2 + \beta_1' OFDI_{down,it} + \beta_2' OFDI_{up,it} + \phi M_{k,it} + \gamma X_{it} + \lambda_i + \mu_t + \varepsilon_{it} \quad (3)$$

Specifically, in Equation (2), we examine the effects of the core independent variables $OFDI_{down,it}$ and $OFDI_{up,it}$ on the mediating variable $M_{k,it}$ represents the volume of technology imports, the number of patent citations by peer enterprises, the degree of industry participation in technical standards, the intensity of patent barriers of upstream suppliers, the elasticity of technological substitution, and the turnover rate of R&D personnel. In Equation (3), we test the impact of the mediating variable $M_{k,it}$ on the dependent variable $Digital_{it}$, while controlling for the core independent variables.

5. Empirical Findings and Analysis

This section is based on panel data of A-share listed companies from 2007 to 2024. Through benchmark regression, mechanism testing, and robustness checks, it empirically analyzes the impact and transmission channels of OFDI supply chain spillovers on the digital technology innovation of domestic enterprises, thereby validating the three proposed mechanisms outlined earlier.

5.1. Benchmark Regression Results

Using corporate digital technology innovation as the dependent variable, we conduct a benchmark regression analysis by incorporating core explanatory variables and control variables, while controlling for firm-fixed and year-fixed effects. The results confirm the heterogeneous effects of OFDI by upstream and downstream enterprises in the supply chain on the digital technology innovation of domestic enterprises:

The coefficient of OFDI by downstream customer enterprises ($OFDI_{down,it}$) is significantly positive, indicating that OFDI by downstream customers exerts a significant promotional effect on the digital technology innovation of domestic enterprises, which confirms the incentive effect of digital technology innovation driven by customer demand.

The coefficient of OFDI by upstream supplier enterprises ($OFDI_{up,it}$) is significantly negative, indicating that OFDI by upstream suppliers has a significant inhibitory effect on the digital technology innovation of domestic enterprises, which is consistent with the constraint effect on digital technology innovation under the dominant position of suppliers.

5.2. Mechanism Verification Results

The stepwise regression method is employed to test the mediating effect, so as to verify the transmission pathways of the two major mechanisms. The results are as follows:

Customer-Demand-Driven Innovation Incentive Mechanism: OFDI by downstream customers promotes the quantity of technology imports, increases the number of patent citations by peer enterprises, and improves the degree of industry participation in technical standards of domestic enterprises, thereby realizing the transmission of knowledge spillovers, demonstration competition, and peer group effects, and further promoting the digital technology innovation of domestic enterprises with a significant mediating effect.

Innovation Constraint Mechanism under Suppliers' Dominant Position: OFDI by upstream suppliers strengthens the intensity of patent barriers, raises the elasticity of technological substitution, and increases the turnover rate of R&D personnel of domestic enterprises, forming the transmission of knowledge monopolization, technological lock-in, and talent loss, and further inhibiting the digital technology innovation of domestic enterprises with a significant mediating effect.

5.3. Robustness Test Results

To validate the reliability of the research conclusions, we re-conducted regression tests using the frequency of digital keywords in annual reports as a robust alternative indicator for corporate digital technology innovation. The results show that both the sign and significance level of the coefficients of the core explanatory variables are consistent with those of the benchmark regression. This indicates that the conclusion regarding the differentiated impact of OFDI supply chain spillovers on local firms' digital technology innovation is robust and remains unchanged despite alterations in the measurement approach of the dependent variable.

6. Research Findings and Policy Recommendations

6.1. Research Findings

OFDI supply chain spillovers exert a significant bidirectional heterogeneous impact on the digital technology innovation of domestic enterprises. OFDI by downstream customer enterprises significantly promotes the digital technology innovation of domestic enterprises, while OFDI by upstream supplier enterprises exerts a significant inhibitory effect, which validates the asymmetry of OFDI spillover effects from a supply chain perspective. Specifically, OFDI by downstream customer enterprises relies on knowledge spillovers, demonstration competition, and peer group effects to drive domestic enterprises to increase the quantity of technology imports, raise the number of patent citations, and improve the degree of industry participation in technical standards. It empowers the digital technology innovation of domestic enterprises from multiple dimensions and realizes the transmission of the customer-demand-driven innovation incentive effect. In contrast, OFDI by upstream supplier enterprises weakens the innovation motivation and capability of domestic enterprises through three core pathways—knowledge monopolization, technological lock-in, and talent loss-by restricting technology supply, fostering innovation capability, and reserving talents, thereby forming the innovation constraint effect under the dominant position of suppliers. Meanwhile, mediating variables such as the quantity of technology imports and the intensity of patent barriers play a significant role. This indicates that OFDI by upstream and downstream enterprises in the supply chain does not directly affect the digital technology innovation of domestic enterprises, but exerts an impact through intermediary links such as industrial chain resource transmission, technological interaction, and talent mobility, which confirms the crucial bridging role of supply chain collaboration in corporate digital technology innovation.

6.2. Policy Recommendations

6.2.1. Enterprise Level

Align with Supply Chain Spillovers to Enhance Digital Innovation Capability Enterprises should actively leverage the positive knowledge spillovers from OFDI by downstream customers, align with overseas digital and intelligent demand to optimize R&D directions, increase investment in digital technology R&D, and improve patent transformation efficiency, so as to promote the deep integration of digital technology with production and management. Meanwhile, they should break technological dependence on single upstream suppliers, build a diversified cooperation system, strengthen the construction of core R&D teams and talent incentives, and enhance the autonomy of digital innovation by increasing independent R&D investment to overcome technological lock-in. Furthermore, enterprises should lead or participate in supply chain innovation alliances to promote digital technology sharing and collaboration, and utilize technologies such as text mining and big data to extract innovation-related information, providing support for innovation decision-making.

6.2.2. Government Level

Optimize Policy Guidance to Foster a Sound Innovation Ecosystem The government should introduce differentiated supporting policies, increase subsidies and tax incentives for downstream OFDI enterprises to encourage the transfer of technology and experience, strengthen anti-monopoly regulation on upstream monopolistic enterprises to promote technology sharing, and optimize financing support for innovative enterprises to reduce R&D costs. It is necessary to improve the system for introducing and cultivating digital talents, build talent exchange platforms to attract high-end digital professionals, promote university-enterprise cooperation to cultivate interdisciplinary talents, and stabilize R&D teams by improving incentive mechanisms. In addition, the government should construct a digital supply chain ecosystem, establish international technology cooperation platforms, improve digital infrastructure, formulate technical standard systems, regulate technology transmission and sharing, and enhance the overall innovation efficiency of the supply chain.

6.2.3. Industrial Chain Level

Strengthen Synergistic Linkage to Overcome Innovation Constraints At the industrial chain level, efforts should be made to promote the digital upgrading of the supply chain, jointly build digital platforms to realize supply-demand matching and technology sharing, give play to the bridging role of industry associations, and organize enterprises to carry out technical exchanges and joint R&D to improve the overall innovation capacity of the industrial chain. It is important to optimize the allocation of supply chain resources, guide resources to tilt toward digital innovation, support the digital transformation of small and medium-sized enterprises, and encourage qualified enterprises to conduct digital-intensive OFDI, so as to form a virtuous cycle of “overseas layout – technology spillovers – collaborative innovation”. Meanwhile, a sound risk prevention and control mechanism should be established to monitor risks such as technological monopoly and talent loss caused by upstream OFDI, deploy alternative technologies and suppliers in advance, improve the technology early warning system, and safeguard the innovation security of the industrial chain.

6.3. Research Limitations

This paper conducts theoretical and empirical analyses on the impact of OFDI supply chain spillovers on the digital technology innovation of domestic enterprises. While certain research conclusions have been obtained, there are still several limitations, which are specifically reflected in the following three aspects:

6.3.1. Sample Selection Limitations

This study exclusively utilizes listed companies from 2007 to 2024 as research samples, excluding data from small and medium-sized enterprises (SMEs) and unlisted firms. SMEs constitute vital entities in digital economic development, and supply chain collaborative behaviors are equally prevalent among unlisted enterprises. The sample limitations reduce the generalizability of research conclusions, failing to comprehensively reflect the actual circumstances of enterprises of varying scales and listing statuses.

6.3.2. Insufficient Precision in Variable Measurement

The core explanatory variable-OFDI by upstream and downstream enterprises-is measured using dummy variables (0-1), which only reflects the binary state of “whether OFDI is conducted” and fails to consider heterogeneous characteristics such as investment scale, location, and industry of OFDI. The measurement of mediating variables such as elasticity of technological substitution and turnover rate of R&D personnel partially relies on textual assignment from annual reports, resulting in a certain gap in objectivity and precision compared with objective quantitative indicators.

6.3.3. In-depth Exploration of Influence Mechanisms is Needed

While this study validates core mediating mechanisms like knowledge spillovers and knowledge monopolies, it fails to deeply explore the heterogeneous transmission characteristics of these mechanisms under different scenarios. It also neglects macro-level moderating variables such as regional digital development levels and industry competition intensity. Consequently, the study insufficiently examines the boundary conditions under which OFDI supply chain spillovers influence the digital technology innovation of domestic enterprises, and fails to reveal the evolving patterns of their relationship in different external environments in a more detailed manner.

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