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The Impact of Utility Model Patent Quality on Export Performance in China: A Moderated Mediation Effect Model

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Abstract: Utility model patent quality is vital for emerging countries to cultivate a strong domestic market and increase openness. Given China's high-quality development, this study incorporates enterprise utility model patent quality and export domestic value-added rate (DVAR) into a unified analysis framework to explore their relationship using authorized patent data and financial and customs data of Chinese industrial enterprises from 2002 to 2014. The utility model patent data used to support this study's findings were provided by the Incopat Patent Database, while the enterprise financial data and customs data were supplied by the RESSET Database. The empirical results show that: (i) utility model patent quality significantly contributes to enterprises' export DVAR; (ii) factor-intensive heterogeneous analysis indicates that the utility model patent quality of capital-intensive enterprises has a more significant promotion effect on DVAR; (iii) the price–cost markup and the relative price of intermediate goods are crucial domestic channels for utility model patent quality to promote DVAR; and (iv) market segmentation moderates the mediating role of the domestic intermediate relative price. Therefore, the government should further improve the utility model system, focus on increasing domestic market advantages, and develop industry-specific patent guidance policies. This study contributes to the literature by exploring the influence of utility model patent quality on enterprises' DVAR using an optimized utility model quality index, providing policy references for optimizing China's utility model patent system and upgrading the import gains of enterprises. However, this study has some limitations, and future research should strengthen the subdivision of utility model patents in different industries and explore the economic performance of the combination of inventions and utility models.

Keywords: utility model patent quality; domestic value-added rate in exports; price–cost markup; relative price of domestic intermediate goods; market segmentation; China

Citation: Ma, R.; Kong, X.; Wang, M.; Kong, X. The Impact of Utility Model Patent Quality on Export Performance in China: A Moderated Mediation Effect Model. *Sustainability* **2023**, *15*, 8181. https://doi.org/10.3390/su15108181

Academic Editor: Luigi Aldieri

Received: 16 February 2023
Revised: 12 May 2023
Accepted: 14 May 2023
Published: 17 May 2023

1. Introduction

The 2022 meeting of the Chinese Central Committee for Deepening Reform pointed out that "industrial chain security and competitiveness are the basis for building a new development pattern". This perspective implies that whole-industry innovation is crucial for effectively countering the competition of "high-end repatriation" and "low-end diversion" in China's global value chain, which features whole-industry category innovation. According to statistical data from the National Intellectual Property Administration of China, and in the context of reducing and canceling subsidies and fighting irregular applications, the number of utility model licenses in January 2022 had increased by 127,000 compared to January 2021, with a year-on-year growth rate of 71.9%. The countertrend rise in the number of utility models licensed indicates that incremental innovation is essential for China's innovation system in its development stage [1], and that utility model patents have generated an endogenous enterprise demand. An innovation strategy to increase the value chain is not limited to inventions in core areas, but also emphasizes the fundamental role of utility model innovation in moving up the value chain. Utility model patents are an inevitable requirement for promoting collaborative innovation throughout the chain, a critical guarantee to enhance the competitiveness of the domestic product supply chain, and an essential part of China's efforts to increase openness to the outside world.

The essence of the patent system is a social contract of "disclosure for protection", whereby the government provides a time-limited monopoly to inventors to incentivize them to innovate and publish their inventions. However, high costs and inventiveness standards disadvantage petty innovations in this system. The utility model patent system, created by the German Utility Model Act of 1891, focuses on rapidly protecting creations with substantial utility but is not limited to innovation. As such, more than 100 countries (and territories) now offer a "petty patent" system [2]. In the sharing economy model, the openness of innovative resources further increases the potential for free-riding [3]. Compared to invention patents, the utility model's lower creative examination requirements protect "small innovation" and effectively prevent competitors from free riding in the same market segment with a limited enterprise creation level [4]. However, utility models are only used for a formal examination of the application text, which allows for rapid commercialization in short-life cycle industries such as hardware, consumer electronics, and ICT [5]. In addition, the protection period of the utility model is short and patented technology enters the public domain early, thus effectively promoting technology diffusion and the technology catch-up of local enterprises [6]. Utility model patents are essential to developing countries, mainly due to the technological learning opportunities provided by such models [7]. Utility model patents also offer a foundation for in-depth innovation, improve the productivity of enterprises, and increase the number of chips in business negotiations. Japan's experience confirms that utility model patents are critical to shifting from backward to innovative countries [8].

However, a lack of substantive examination of patents has increased rights instability. China's patent funding policy has led to many low-quality non-market-oriented patents and to market rent-seeking, low market conversion rates, and patent litigation [9]. Therefore, scholars have questioned the utility models, arguing that utility model patents may create technological dependence on developed countries, while failing to provide a sustainable growth engine for high-income countries. They also contended that invention patents can have a crowding-out and substitution effect on utility model patents [10].

Research on patents and global value chains has been conducted at the macro and micro levels. At the macro level, the literature focuses on the "learning by doing" effect of import on indigenous innovation and the "value chain capture" effect [11]. The evolution of international trade patterns has shown that innovation plays a crucial role in promoting China's export of the domestic value-added rate (DVAR) based on the global innovation chain [12], green innovation [13], international innovation centers [14], and intelligent manufacturing [15]. An intellectual property protection environment is essential to guaranteeing the effectiveness of the patent mechanism. However, there is no consensus in the literature on the impact of intellectual property protection (IPR) intensity on trade gains [16]. For instance, Bulus et al. [17] point out that the optimal intensity of IPR depends on a country's economic development level. The above literature review shows that innovation and protection are essential in promoting China's position in the global value chain.

In the past, scholars have primarily focused on the impact of global value chain embedding on domestic innovation. Although some previous studies have explored the trade benefits of local enterprises' "reverse innovation" [18], the impact of invention quality on economic development has been the main focus, while utility model patents have often received negative evaluations. However, for China's actual level of innovation, protecting high-quality incremental innovation through utility model patents can help establish an orderly industrial gradient pattern. Therefore, this study focuses on the role of utility model patent quality in promoting value-added trade and emphasizes the crucial role of midstream industry chain innovation in shaping a high-quality development pattern. In the current context of intensified anti-globalization, the importance of innovation across the entire industry chain is further emphasized and the impact of utility models on the global value chain proves to be worthy of attention.

To address this research gap, this study explores whether the utility model generates institutional advantages in China. In doing so, it addresses the following question: can enterprises use the utility model to strengthen the advantages of the domestic market and reduce dependence on the global value chain to positively impact DVAR exports? Further, this study explores how domestic market segmentation affects the above mechanism. Therefore, its results provide meaningful implications for China to increase its openness to the outside world, with a substantial comparative advantage for the whole industrial chain, and support export competitive advantages as part of a new development stage.

This study contributes to the literature in the following ways. First, based on the theory of Kee and Tang [19], it incorporates the utility model patent quality and enterprise export DVAR into a unified analysis framework, while investigating the impact mechanism of utility model patent quality on enterprise export DVAR and providing new theoretical support for promoting the rise of Chinese enterprises in the global value chain. Second, it constructs a structural utility model patent quality index to measure the depth and width of enterprise utility model patents to reduce the error caused by the illusion of innovation in the quantitative index of utility models. Third, based on heterogeneity analysis, it examines the micro impact of utility models on enterprises' export DVAR from multiple dimensions, such as enterprise intensity and trade types. Finally, this study empirically tests the role of the enterprise addition rate and the relative price of domestic intermediate products in promoting enterprise export DVAR, and the mediating role of the domestic intermediate relative price is moderated by market segmentation.

2. Theoretical Framework and Hypotheses

In line with Kee and Tang (2016) [19], this study describes a firm's export DVAR as follows:

$$DVAR_{it} = 1 - \alpha_m \frac{1}{1+\left(p_t^F/p_t^D\right)^{\eta-1}} \frac{1}{markups_{it}}, \quad (1)$$

where $DVAR_{it}$ denotes the DVAR of exports in year i for firm t; α_{m} is the output elasticity of intermediate factors; η is the elasticity of substitution of domestic intermediate goods with foreign intermediate goods; p_t^F and p_t^D denote the prices of foreign and domestic intermediate goods, respectively; and $markups$ is the firm's cost-plus rate.

Deriving the markups and the relative prices of intermediate goods yields the following:

$$\frac{\partial DVAR_{it}}{\partial\left(p_t^F/p_t^D\right)} = \alpha_m \frac{1}{1+\left(p_t^F/p_t^D\right)^{\eta-1}} \frac{1}{markups_{it}{}^2} > 0, \quad (2)$$

$$\frac{\partial DVAR_{it}}{\partial\left(p_t^F/p_t^D\right)} = \alpha_m \frac{1}{markups_{it}} \frac{1}{\left[1+\left(p_t^F/p_t^D\right)^{\eta-1}\right]^2} (\eta-1)\left(p_t^F/p_t^D\right)^{\eta-2} > 0. \quad (3)$$

Equations (2) and (3) show that increasing the markup rate and the relative price of intermediate goods facilitates enterprises' export DVAR. Compared with invention patents, high-quality utility model patents are mostly used by local enterprises [8]. Therefore, the next subsection explores how utility model patent quality affects the export DVAR of enterprises by strengthening the domestic market (markups and relative price of intermediate goods).

2.1. Markup Channel

Markups reflect the extent to which the price of a product deviates from the marginal cost. Regarding the impact of markups on utility model patents quality and export DVAR, we conduct below a literature review from the "cost effect" and "market-share effect" perspectives.

On the one hand, the trickle-down effect of IPR protection suggests that lower licensing standards for utility models, which allow small innovations to be protected in line with the patents for inventions, incentivize technology followers to innovate. Therefore, the learning effect generated by local enterprises in the technological catch-up stage translates into patented technology, improving productivity. The literature has shown that high-quality utility model patents positively impact enterprises' productivity [20], and the higher the productivity of enterprises, the lower the marginal production cost of firms [21]. However, high-quality utility model patents also have a "market-share effect". Incremental innovation improves and marginally extends existing technologies, as described by the product life cycle theory. When disruptive innovation enters the market, a firm's innovation path for that product shifts to "incremental innovation". Utility models protect incremental innovations that can further extend the duration of the benefits of breakthrough innovation and improve the variety and quality of products in the industry [22].

At the same time, utility models make it easier for firms to obtain economic rents, which, mainly owing to the fast-track review system of utility models, quickly provide them with monopoly power by excluding others from marketing a new product when it enters the commercial stage, reducing the risk of product counterfeiting and increasing pricing power, and thus strengthening the "Schumpeter rent". In addition, previous studies have shown that a high-quality utility model layout effectively checks and balances competitors. Enterprises may form patent fences through utility models to improve the entry threshold of the industry and deal with competitors through patent cross-licensing [23]. By doing so, they maintain a competitive advantage. Hence, the utility model increases markups through the "market-share effect".

2.2. Domestic Intermediate Relative Price Channel

For brevity, this study collectively refers to the relative prices of domestic intermediates to imported intermediates as the relative prices of domestic intermediates. As previously mentioned, utility model patents are usually high in number. They cover many technologies, allowing companies to define new market types and segments. Therefore, the variety of intermediate goods available in the domestic market also increases [24], ultimately realizing the conversion of domestic intermediate goods to foreign intermediate goods. The short protection period of utility model patents accelerates the industry's spread of utility model technology. Further, it solidifies the incremental innovation of enterprises into the overall competitive advantage of the domestic industrial chain, narrowing the technological gap domestically and abroad and reducing the relative price of domestic intermediate products [25]. Hence, we propose the following hypotheses:

Hypothesis 1 (H1): *Utility model quality enhances the DVAR of a company's exports.*

Hypothesis 2 (H2): *Utility model quality increases a firm's export DVAR through the "markup" and the "relative price" channels.*

A wide gap is observed between technology absorption and the research and design (R&D) innovation capabilities of different industries. The impact of utility model patents on the export DVAR of various labor-intensive industries can be heterogeneous. Labor-intensive industries have fewer technology spillovers due to undertaking processing and assembly operations coupled with insufficient learning and absorptive capacity of enterprises. Hence, utility model innovation may not effectively promote the DVAR for the export of Chinese labor-intensive enterprises. However, the most significant bottleneck in the value chain upgrade of technology-intensive enterprises lies in the "stuck neck" of key core technologies. Although utility model patents may achieve technological accumulation through incremental innovation, they cannot directly break through technological bottlenecks and may easily lead to dependence on technology imports [26]. Therefore, the promotional effect of utility model patent innovations on technology-intensive enterprises is limited.

The innovation of enterprises in the process of catching up with technology shows a trend toward standardized production, incremental innovation, and subversive innovation [27]. Capital-intensive industries have evident innovation capabilities. However, compared with high-tech industries, their innovation activities focus on minor improvements in materials, functions, and quality and only concentrate on moving toward subversive innovation [28]. Therefore, labor input is not the leading factor in improving export DVAR in capital-intensive industries. Cumulative innovation is not only beneficial for capital-intensive enterprises to achieve eco-friendly production [29], but also a crucial avenue for upgrading their industrial structure, bridging the gap with technology-intensive enterprises and enhancing their export value-added capabilities. The majority of capital-intensive manufacturing industries integrate into the global value chain by exporting intermediate products and steadily moving towards the middle and high-end links [30]. This gradual ascent is a testament to the significance of cumulative innovation in enhancing the competitiveness of capital-intensive enterprises in the global market.

In addition, capital-intensive industries usually import technologies of suitably advanced levels that match domestic enterprises' technology absorption and digestion capabilities, achieving utility innovation [31]. Currently, 90% of the total output of China's capital-intensive industries is used for reproduction as an intermediate input [32]. The utility model patents in this industry may positively impact the export DVAR by affecting the domestic intermediate product channel through the "cost reduction effect" and "market-share effect". Hence, we posit the following hypothesis:

Hypothesis 3 (H3): *Utility model quality has a limited role in promoting DVAR for the exports of labor- and technology-intensive enterprises and plays a positive role in promoting DVAR for the exports of capital-intensive enterprises.*

Micro-firms may only be motivated to innovate when a sufficiently large scale of market demand enables them to translate their innovative R&D inputs into benefits from innovation activities. Therefore, the size of the local market demand is a key factor determining whether a firm's innovation investment and value-added activities can be realized. Given China's large market demand, the scale and capacity of the local market demand can stimulate domestic enterprises' independent innovation capability without resorting to external markets. However, although China's domestic market is vast and market-oriented, substantial market segmentation between provincial regions is observed.

The more varied the intermediate goods and the more unified the domestic market, the easier it is to obtain diversified intermediate goods for enterprises. Through this accumulation cycle, the advantages of the scale economy of enterprises are strengthened, the variety and quantity of intermediate goods being manufactured in the region are increased, and the domestic intermediate relative price is reduced. Most utility model patent enterprises' innovation achievements cannot support direct access to the international market [33]. Utility model innovation is a marginal innovation targeting demand, which mainly acts as a replacement for domestic intermediate good chains in the global value chain. However, market segmentation between regions has changed the revenue function of utility models in China, distorting enterprises' innovation behavior. This phenomenon also causes China's local market's overall demand scale space to be artificially fractured, forming a small-scale market space with market entry barriers and trade segregation borders [34]. Market segmentation restricts the free flow and reasonable allocation of products and factors in the country, resulting in the inefficient allocation of intermediate inputs and negatively affecting the value-added effect caused by the quality of utility models. Hence, we propose the following hypothesis:

Hypothesis 4 (H4): *Market segmentation moderates the mediating role of domestic intermediate relative prices. The higher the degree of regional market segmentation, the weaker the positive mediating effect of the domestic intermediate relative price on the relationship between utility model quality and firm export DVAR.*

The proposed theoretical model is illustrated in Figure 1.

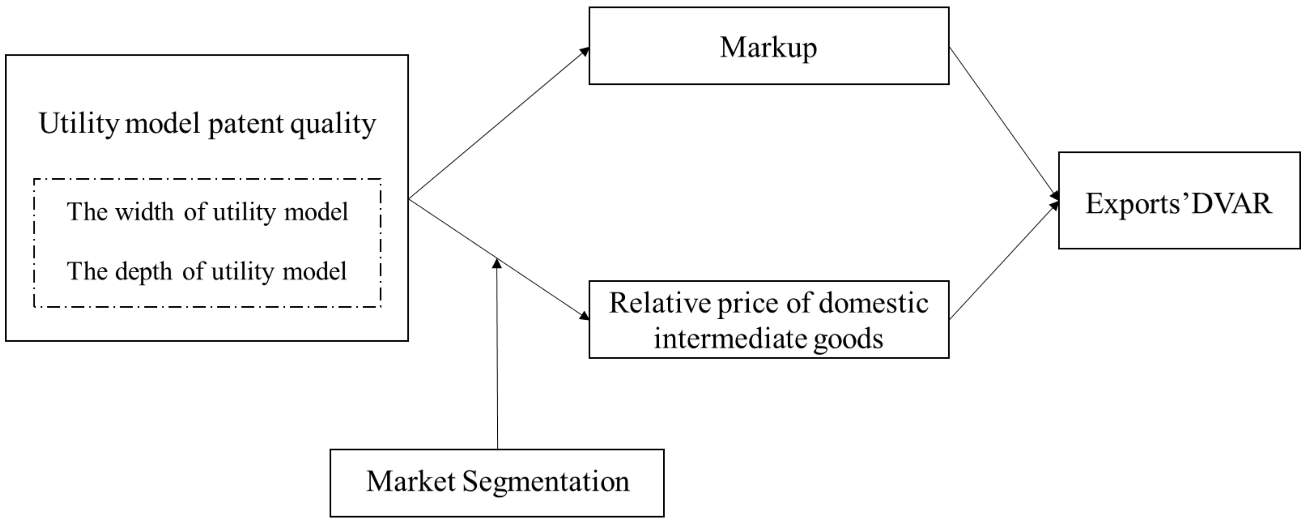

Figure 1. Theoretical framework.

3. Materials and Methods

3.1. Measurement Model

Obtaining high-quality utility model patents requires a high fixed-cost investment; hence, a study's sample may exhibit strong selection bias [35]. Following the literature, this study uses the following econometric model to examine the impact of the depth and width of utility models on export DVAR:

$$DVAR_{it} = \alpha_0 + \alpha_1 dep_{it-u} + \alpha_2 X + a_3 imr_{it-type} + \alpha_j + \alpha_t + \alpha_p + \varepsilon_{it}, \quad (4)$$

$$DVAR_{it} = \alpha_0 + \alpha_1 wid_{it-u} + \alpha_2 X + a_3 imr_{it-type} + \alpha_j + \alpha_t + \alpha_p + \varepsilon_{it}, \quad (5)$$

where $DVAR_{it}$ denotes the domestic value-added rate of firm exports in year i of firm t, dep_{it-u} is the depth of utility patents in year i of firm t, wid_{it-u} is the width of utility patents in year i of firm t, X is a control variable, and imr_{it-u} is the inverse Mills ratio of firm t in year i. In addition, α_0 is a constant term, while year α_t, industry α_j and region α_p denote fixed effects (to reduce potential endogeneity), and ε_{it} is the random error term.

3.2. Variables

3.2.1. Patent Quality of the Utility Model

To reduce the measurement error caused by the number of patents, this study uses the utility model width and depth to measure enterprise utility model patent quality, with utility model width indicating the degree of technological quality of the enterprise and utility model depth showing the complexity of the utility technology [36]. The International Patent Classification (IPC) is a standard for classifying patent documents according to the International Patent classification Agreement, which sets up categories for all fields of technology related to patents according to the hierarchy of "division-major category-minor category-major group-group". Usually, a patent involves several technical fields. It will feature several IPC classification numbers, among which the primary IPC classification number best reflects the technical field to which the patent information belongs. Based on the technical branch items (i.e., the number of IPC main classification numbers) and the number of patents involved in an enterprise's utility model patent, concerning the analysis tool of the State Intellectual Property Office's enterprise patent portfolio, this study defines the width of an enterprise's utility model patent as:

$$wid_{it-u} = ipc_{it-u}/\mathrm{IPC} \tag{6}$$

where wid_{it-u} denotes the width of the enterprise utility models, ipc_{itp-u} is the cumulative number of IPC main classification number categories covered by enterprise t's utility model patents up to year i, and *IPC* denotes the number of IPC main classification number categories in all technology fields. A higher wid_{it-u} value of the indicator implies that the enterprise's utility model patents cover more technology fields and have stronger control over peripheral patents.

The depth of the utility model patent is expressed as:

$$dep_{it-u} = \frac{patent_{it-u}}{ipc_{it-u}}, \tag{7}$$

where *dep* denotes the depth of the enterprise's utility models, $patent_{it-u}$ is the cumulative number of utility model patents granted by enterprise t up to year i, and ipc_{it-u} indicates the average number of patents under all IPC main classification numbers involved in the enterprise, namely, the average number of patents granted under the main technology branches. The greater the complexity of the technology, the more intensive the enterprise's R&D and the greater the technological complexity.

3.2.2. Domestic Value-Added Rates of Enterprise Exports

Drawing on Zhang et al. [37] and Kee and Tang [19], this study measures the DVAR of firms' exports from a micro perspective, considering the use of imported products [38], intermediary trade [39], and indirect imports of domestic intermediates [40]. We express the DVAR of a firm's exports as:

$$DVAR_{it} = \begin{cases} 1 - \frac{I^p_{itA} + \delta^p_{it}}{E^p_{it}} \ \text{Processingtrade} \\ 1 - \frac{E^o_{it}\left[I^o_{itA/bec}/\left(D^o_{it}+E^o_{it}\right)\right]+\delta^o_{it}}{E^o_{it}} \ \text{Generaltrade} \\ \omega^p_{it}\left(1 - \frac{I^p_{itA}+\delta}{E^p_{it}}\right) + \omega^o_{it}\left(1 - \frac{E^o_{it}\left[I^o_{itA/bec}/\left(D^o_{it}+E^o_{it}\right)\right]+\delta^o_{it}}{E^o_{it}}\right) \ \text{Mixedtrade} \end{cases} \tag{8}$$

where *DVAR* denotes the domestic value-added rate of a firm's exports; i and t indicate firms and years, respectively; and superscripts p and o denote the processing trade and general trade, respectively. In addition, ω^p_{it} and ω^o_{it} indicate the share of the two trade modes; i, E, and D are the import, export, and domestic sales behavior of enterprises, respectively; subscript *bec* denotes intermediate products under the BEC classification standard; I^p_{itA} indicates imports in processing trade; and $I^o_{itA/bec}$ denotes the imports of intermediate goods in general trade. Considering the case of enterprises purchasing overseas intermediate inputs from intermediate traders, this study expresses the import amount of processing trade and the import amount of intermediate goods in general trade as:

$$I^p_{itA} = \sum_k \frac{I^p_{itk}}{1 - m_{itk}} \text{ and } I^o_{itA/bec} = \sum_j \frac{I^o_{it/bec}}{1 - m_{itj}}, \tag{9}$$

where k and j denote the categories of products imported by enterprises through processing trade and the categories of intermediate products imported by enterprises through general trade, respectively. E_{it}^{o} and E_{it}^{p} represent the export value of processing trade and the export value of general trade of the enterprise, respectively, and δ indicates the extent of overseas imports in domestic intermediate inputs.

3.2.3. Control Variables

This study also includes the following control variables in the analysis:

Firm age, obtained by subtracting the number of years in the year of interest from the number of years in which the firm was established and adding one.

Firm size, obtained by deflating firm sales by the ex-factory price index for 1998 and taking the logarithm.

Liability ratio (Lev), measured by the ratio of total assets to total liabilities.

Profitability, obtained by taking the ratio of operating profit to sales.

Capital intensity, obtained by deflating fixed assets by the fixed asset investment price index for the base year 1998, dividing the deflated fixed assets by the number of employees, and taking the logarithm.

Internal financing restriction, expressed as the ratio of the difference between current assets and current liabilities to total fixed assets.

Financing restriction, measured by the ratio of interest expenses to fixed assets.

3.3. Data

The proposed econometric analysis requires three types of data. The first type is firm-level utility model patent data, used to calculate the depth and width of utility model patents. The second type is firm financial data, used to calculate firm-level variables such as firm size, firm age, and firm financing constraints. Finally, the third type is firm trade data, used to measure firm export DVAR.

The utility model patent data used to substantiate the findings in this study were obtained from the Incopat Patent Database. The enterprise financial data used to support the findings were supplied by the RESSET Database, and the Chinese customs data used to support the findings were also provided by the RESSET Database.

3.4. Descriptive Statistics

This article provides a correlation coefficient analysis of the explanatory, dependent, and control variables, and the results are presented in Table 1. According to the results of the Pearson correlation analysis, it can be determined that there is a positive relationship between the practical new type depth and width and DVAR, with correlation coefficients of 0.043 and 0.01, respectively. This provides preliminary support for H1, which suggests that both dimensions have a positive impact on DVAR.

Table 1. Correlation coefficient of main variables.

Variable	*DVAR*	dep_{it-u}	wid_{it-u}	Size	Lev	Profit	Capital	Interfinancing	Financing	Age
DVAR	1									
dep_{it-u}	0.043 ***	1								
wid_{it-u}	0.001	0.493 ***	1							
Size	−0.193 ***	0.218 ***	0.330 ***	1						
Lev	0.062 ***	−0.031 ***	−0.028 ***	−0.073 ***	1					
Profit	−0.046 ***	0.012 ***	0.006	0.088 ***	−0.144 ***	1				
Capital	−0.149 ***	0.021 ***	0.103 ***	0.408 ***	−0.205 ***	0.052 ***	1			
Interfinancing	−0.023 ***	0.067 ***	0.077 ***	0.078 ***	−0.455 ***	0.048 ***	0.014 ***	1		
Financing	0.060 ***	0.053 ***	0.057 ***	0.027 ***	0.271 ***	−0.062 ***	−0.236 ***	−0.161 ***	1	
age	−0.017 ***	0.110 ***	0.129 ***	0.243 ***	−0.050 ***	−0.024 ***	0.108 ***	0.041 ***	0.014 ***	1

Note: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The results were obtained using Stata 14.

4. Results

4.1. Baseline Regression

In Table 2, Models (1) and (2) reported the results of the benchmark regression involving utility model patent quality and export DVAR in the Heckman second stage. The estimates for both the utility model width and depth were positive and significant. This result indicated that the utility model patent quality substantially contributed to the DVAR of enterprises' exports, and the above tests initially confirm Hypothesis 1. This finding effectively reveals whether "utility models are useless".

Table 2. Baseline and estimations of main effects based on industrial intensity.

	M (1)	**M (2)**	**M (3)**	**M (4)**	**M (5)**	**M (6)**	**M (7)**	**M (8)**
Variable	**DVAR**	**DVAR**	**DVAR Labor**	**DVAR Capt**	**DVAR Tech**	**DVAR Labor**	**DVAR Capt**	**DVAR Tech**
dep_{it-u}	0.003 ***		0.001	0.002 **	0.003 ***			
	(4.217)		(0.215)	(2.255)	(2.968)			
wid_{it-u}		0.189 **				−0.023	0.297 **	0.078
		(2.548)				(−0.066)	(2.539)	(0.752)
Imr	0.066 ***	0.067 ***	0.163 ***	0.097 ***	0.076 ***	0.004	0.157 ***	0.061 **
	(4.538)	(4.681)	(3.074)	(3.147)	(3.782)	(0.039)	(3.307)	(2.488)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	50,548	50,548	3416	22,972	24,160	3405	22,974	24,163
r2	0.029	0.029	0.06	0.032	0.026	0.052	0.034	0.025

Note: M (1) refers to Model (1), and so on. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The results were obtained using Stata 14.

4.2. Regression Analysis Based on Industrial Intensity

To investigate the heterogeneous impact of utility model patent quality on the DVAR of enterprises' exports, this study conducted a group regression accounting for enterprises' factor intensity characteristics. Table 2 reports the results. Comparing Models (3)–(8), we found significant industry heterogeneity in the impact of utility model patent quality on the DVAR of enterprises' exports. Specifically, (i) in labor-intensive industries, utility models had no significant impact on enterprises' export DVAR. (ii) In capital-intensive industries, both the depth and width of utility model patent quality had a significant impact on export DVAR. In other words, both the technical coverage and technical complexity of utility models significantly contributed to enterprises' export DVAR. (iii) In technology-intensive industries, only the depth of utility models had a significant impact on enterprises' export DVAR, indicating that the technical complexity of utility models significantly promoted the DVAR of enterprises' exports. By contrast, the width of utility model coverage did not significantly impact the DVAR of enterprises' exports.

Various circumstances may affect these results. First, many local enterprises are capital-intensive, and the utility model system stimulates innovation in capital-intensive enterprises. Doing so, it enables domestic enterprises to make full use of utility models to build technological and market advantages in technology areas where inventions cannot be laid out and gain trade gains through a competitive domestic industrial chain supply market. Second, the mechanism through which utility models operate in technology-intensive industries is characterized by radical technological innovation through deep incremental innovation, with complex utility models contributing to the export DVAR through a spiral of upgrades [41]. In addition, high-technology enterprises usually adopt a combination of high-quality utility model patents with key core technologies. The higher the technical complexity of utility models and the stronger the compatibility with invention patents, the more significant the positive effect on the export DVAR of enterprises.

4.3. Heterogeneity Analysis Based on Firms' Trade Patterns and Productivity

Chinese firms vary in their trading patterns and productivity. Hence, this study further explores the impact of firm characteristics on core variables.

4.3.1. Regression Analysis Based on Firms' Trade Patterns

We calculated the ratio of total export value to annual export value for each exporting enterprise. Those with a ratio of 1 were defined as processing trade enterprises, while the rest were classified as general trade enterprises. We divided the sample enterprises into processing trade enterprises (Mach) and general trade enterprises (Normal) based on this classification. Models (1)–(4) in Table 3 show that the depth and width of utility model patent quality of general trade enterprises significantly affected the promotion of export DVAR. By contrast, the depth and width of utility model patent quality of processing trade enterprises had no significant effect on export DVAR.

Table 3. Regression results based on firms' trade patterns.

Variable	M (1)	M (2)	M (3)	M (4)	M (5)	M (6)	M (7)	M (8)
	Mach	Normal	Mach	Normal	High	Low	High	Low
dep_{it-u}	0.003	0.003 ***			0.004 ***	0.002 *		
	(1.295)	(4.630)			(3.830)	(1.679)		
wid_{it-u}			0.385	0.164 **			0.213 **	0.158
			(1.637)	(2.430)			(1.979)	(1.562)
imr	0.032	0.041 ***	0.014	0.045 ***	0.071 ***	0.044 **	0.074 ***	0.045 **
	(0.540)	(2.935)	(0.242)	(3.258)	(3.331)	(2.056)	(3.511)	(2.140)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	6740	43,808	6740	43,808	24,012	26,536	24,012	26,536
*r*2	0.106	0.018	0.106	0.018	0.035	0.024	0.035	0.024

Note: M (1) refers to Model (1), and so on. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The results were obtained using Stata 14.

On the one hand, processing trade enterprises only undertook a low-technology, product-assembly-type division of labor, and the spillover effect of technology introduction was not significant. Hence, utility model patent quality played a weaker role in raising the DVAR of exports for these enterprises. On the other hand, for general trade enterprises, the "trickle-down effect" of intellectual property protection and IPR protection provided incentives for technology leaders to technology followers. Hence, technology catching-up enterprises with stronger absorption capacity successfully crossed the technology threshold through utility model innovation, moving up the value chain through process upgrades to increase their export DVAR [42].

4.3.2. Regression Analysis Based on Firms' Productivity Levels

We used the LP method to measure enterprise productivity, and divided the sample enterprises into high- and low-productivity enterprises based on the median of their productivity levels. Models (5)–(8) in Table 3 show that utility model patent quality in the high-productivity group positively and significantly impacted the DVAR of enterprise exports. By contrast, in the low-productivity group, only the depth of utility models significantly affected the DVAR of enterprise exports. On the one hand, export expands the market scale of enterprises, incentivizing innovation for all exporting enterprises. On the other hand, entering the international market is accompanied by increased competition; the profits of exporting enterprises are constantly compressed, negatively affecting enterprise innovation. The increase in export demand from high-productivity enterprises strengthens the incentive for technological improvement, and the demand for high-quality patents increases, forming a utility model's virtuous circle, promoting the increase in export DVAR. However, low-productivity firms at the bottom of the global value chain are dominated by negative competitive effects. They therefore find it challenging to raise export DVAR through the utility model innovation channel. The negative competitive effects of low-productivity firms at the bottom of the global value chain dominate, making it challenging to increase export DVAR through the utility model innovation channel [43].

4.4. Robustness Tests

4.4.1. DVAR for Corporate Exports without Considering Indirect Imports

We calculated the DVAR of enterprise exports in the main regression based on Lv [44]. The DVAR of enterprises' exports was re-measured without considering enterprises' indirect imports. Models (1) and (2) in Table 3 show a significant positive effect of utility model patent quality on the DVAR of enterprises' exports.

4.4.2. Endogeneity Test

The Heckman two-stage model may overcome selection bias to some extent, but the econometric analysis may also suffer from endogeneity due to omitted variables and two-way causality. This study employed lagged explanatory variables and Lewbel's method [45] to address these issues.

As demonstrated by Models (3) and (4) in Table 4, the lagged explanatory variables continued to exert a significant positive influence on DVAR, which aligns with the findings of the baseline analysis.

Table 4. Robustness tests.

Variable	M (1)	M (2)	M (3)	M (4)	M (5)	M (6)
	DVAR	DVAR	DVAR	DVAR	DVAR	DVAR
dep_{it-u}	0.002 ***				0.003 ***	
	(2.578)				(3.838)	
wid_{it-u}		0.175 **				0.513 ***
		(2.346)				(5.007)
L. dep_{it-u}			0.002 ***			
			(3.024)			
imr dep_{it-u}			0.053 ***			
			(3.347)			
L. wid_{it-u}				0.172 **		
				(2.101)		
imr wid_{it-u}				0.052 ***		
				(3.328)		
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Kleibergen–Paap					1022.143	1018.307
rk LM statistic					[0.00]	[0.00]
Kleibergen–Paap					9655.677	6736.902
Wald rk F statistic					[16.38]	[16.38]
N	50,548	50,548			48,166	48,166
r2	0.030	0.030			0.028	0.027

Note: M (1) refers to Model (1), and so on. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The results were obtained using Stata 14.

Lewbel's [45] endogeneity method constructed an instrumental variable for the quality of utility model patents in each firm as the cube of the difference between the quality of the firm's utility model patents and the average quality of utility model patents across all firms. The model was estimated using the two-stage least squares (2SLS) method. The results in Table 4 indicate that the quality of corporate utility model patents significantly contributed to export DVAR in Models (5) and (6). The Kleibergen–Paap rk LM test and the Kleibergen–Paap Wald rk F test rejected the original hypothesis of underidentification and weak identification of instrumental variables, respectively. This finding suggests that even after accounting for possible endogeneity, utility model patent quality significantly contributed to firms' export DVAR, supporting the main conclusions of the study.

5. Moderated Mediation

5.1. Model Setting

To further explore the impact of utility model patent quality on the DVAR of enterprises' exports, based on the benchmark econometric model, this study introduced the enterprise markup rate (*markups*) and the relative price of domestic intermediate goods (p_t^F/p_t^D) as two mediating variables. It referred to Wen et al. [46] for calculating the mediating effect tests and examining the channels of influence of utility model patent quality on enterprises' export DVAR. The proposed mediating model reads as follows:

$$\begin{gathered} DVAR_{it} = \alpha_0 + \alpha_1 dep_{it} + \alpha_2 X + a_3 imr_{it} + \alpha_j + \alpha_t + \alpha_p + \varepsilon_{it} \\ markups_{it} = \beta_0 + \beta_1 dep_{it} + \beta_2 X + \beta_3 imr_{it} + \beta_j + \beta_t + \beta_p + \beta_{it} \\ DVAR_{it} = \alpha_0 + \alpha_1 dep_{it} + \alpha_2 X + a_3 imr_{it} + \alpha_4 markups_{it} + \alpha_j + \alpha_t + \alpha_p + \varepsilon_{it} \end{gathered} \tag{10}$$

$$\begin{gathered} DVAR_{it} = \alpha_0 + \alpha_1 wid_{it} + \alpha_2 X + a_3 imr_{it} + \alpha_j + \alpha_t + \alpha_p + \varepsilon_{it}, \\ p_t^F/p_t^D{}_{it} = \beta_0 + \beta_1 wid_{it} + \beta_2 X + \beta_3 imr_{it} + \beta_j + \beta_t + \beta_p + \beta_{it} \\ DVAR_{it} = \alpha_0 + \alpha_1 wid_{it} + \alpha_2 X + \alpha_3 imr_{it} + a_4 p_t^F/p_t^D{}_{it} + \alpha_j + \alpha_t + \alpha_p + \varepsilon_{it} \end{gathered} \tag{11}$$

Further, based on the intermediary model, we referred to the research of Wen et al. [47], who introduced market segmentation (MS) in the relative price channel of intermediate goods and constructed a moderated mediation effect model.

5.2. Mediating and Moderating Variables

5.2.1. Markups

This study's primary reference was De Loecker and Warzynski [48], which measures the firm's markups as:

$$markups = \rho(\vartheta)^{-1}, \tag{12}$$

where ϑ denotes the share of intermediate inputs in the firm's sales and ρ is the output elasticity of intermediate inputs.

5.2.2. Relative Prices of Domestic Intermediate Goods

Owing to the lack of relevant data on the relative prices of intermediate goods, this study refers to Gao et al. [49], who use the share of domestic intermediate goods as a proxy for the relative prices of domestic intermediate goods.

5.2.3. Moderating Variables

The moderating variable was MS, which refers to local protectionism, as local governments use administrative means to restrict the free flow of resources between regions. This study adopted the relative price method to measure the degree of regional MS, as in Gui et al. [50]. In the first step, the study areas were paired. We calculated the relative price difference of the eight consumer price indices in each area to obtain the relative price index of a specific category of goods between the two areas. In the second step, we eliminated the heterogeneity of commodities using the de-meaning method. In the third step, we calculated the variance of relative price fluctuations, and the obtained variance was taken as the group mean to obtain the MS index for each province.

5.3. Empirical Evidence of Mediation

The dep_{it-u} and wid_{it-u} coefficients in Models (1) and (3) in Table 5 are positive and significant, indicating that the depth and width of the utility model contributed positively to markups. The results of this study were built on Huang et al. [51]. Klette and Griliches [52] argued that the ultimate aim of R&D innovation is to obtain monopoly rents, setting a higher markup on marginal costs. Previous studies have shown that 60% of the utility models in Germany have been used commercially and are likely to yield economic rents. As local firms become capable of technological innovation and aware of patent protection, high-quality utility model patents with utility applications continue to create and enhance the value of new products, effectively reducing the risk of counterfeiting innovative products and providing legitimacy and durability to an increase in the firm's markup rate.

Table 5. Tests of mediation mechanisms for markups and relative prices.

Variable	M (1)	M (2)	M (3)	M (4)	M (5)	M (6)	M (7)	M (8)
	Markups	**DVAR**	**Markups**	**DVAR**	p_t^F / p_t^D	**DVAR**	p_t^F / p_t^D	**DVAR**
dep_{it-u}	0.001 ***	0.003 ***			0.001 **	0.002 ***		
	(4.590)	(4.139)			(2.425)	(3.633)		
wid_{it-u}			0.078 **	0.186 **			0.131 *	0.135 **
			(2.186)	(2.506)			(1.851)	(2.030)
markups		0.041 ***		0.042 ***				
		(3.467)		(3.547)				
p_t^F / p_t^D						0.410 ***		0.410 ***
						(31.585)		(31.595)
Control var	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	50,548	50,548	50,548	50,548	50,548	50,548	50,548	50,548
*r*2	0.422	0.030	0.422	0.030	0.059	0.155	0.059	0.154

Note: M (1) refers to Model (1), and so on. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The results were obtained using Stata 14.

The estimated coefficients on dep_{it-u} and wid_{it-u} in Models (5) and (7) of Table 5 are also positive and significant, indicating that utility model patent quality significantly reduced the relative prices of domestic intermediate goods. On the one hand, enterprises reduce the production cost of standardized products to a highly competitive level through the incremental improvement of utility model patent quality, thus reducing production costs. On the other hand, the positive effects of utility model patents on broadening the category of intermediate goods have gradually emerged, enhancing the ability of domestic firms to supply intermediate goods and, to a certain extent, achieve a shift from imported intermediate goods to domestic ones.

Models (2), (4), (6), and (8) in Table 5 report the regression results after adding markups and p_t^F / p_t^D to the main regression. The results show that the utility model patent quality was passed through the markup rate and domestic intermediate rate, and the relative price of the product increased the DVAR of the company's exports.

After adding markups to the main regression, the results showed that the utility model patent quality raised firms' export DVAR through markups and relative domestic intermediate prices. It should be noted that the core explanatory variable (dep_{it-u}) in Model (2) has the same estimated coefficient as in the main regression, implying that the indirect effect of utility models in raising firms' export DVAR was weaker.

5.4. Moderated Mediation Effect

Table 6 presents the empirical results of moderated mediation effects. Specifically, in Models (1)–(2) and Models (5)–(6), utility model quality was significantly positive, while in Model (3) and Model (7), the relative price of domestic intermediate goods was significantly positive. In contrast, in Model (4) and Model (8), the interaction effect between the relative price of domestic intermediate goods and market segmentation was significantly negative. Therefore, it can be inferred that the mediating role of the relative price of domestic intermediate goods was negatively moderated by market segmentation. As the degree of domestic market segmentation increased, the positive mediating effect of the relative price of domestic intermediate goods on utility model quality and DVAR became weaker. The moderated mediation effects were confirmed, and Hypothesis 4 was supported.

Table 6. Moderated mediation effect: market segmentation.

Variable	M (1)	M (2)	M (3)	M (4)	M (5)	M (6)	M (7)	M (8)
	DVAR	p_t^F/p_t^D	DVAR	DVAR	DVAR	p_t^F/p_t^D	DVAR	DVAR
dep_{it-u}	0.171 **	0.129 **	0.122 **	0.122 **				
	(2.465)	(2.050)	(1.968)	(1.975)				
wid_{it-u}					0.003 ***	0.002 ***	0.003 ***	0.003 ***
					(5.057)	(3.252)	(4.318)	(4.299)
p_t^F/p_t^D			0.380 ***	0.410 ***			0.380 ***	0.409 ***
			(27.138)	(23.989)			(27.115)	(23.967)
MS	−0.015 ***	−0.012 ***	−0.010 *	−0.017 ***	−0.015 ***	−0.013 ***	−0.010 **	−0.017 ***
	(−2.697)	(−3.134)	(−1.926)	(−3.161)	(−2.737)	(−3.162)	(−1.962)	(−3.188)
p_t^F/p_t^D * *MS*				−0.087 ***				−0.087 ***
				(−3.101)				(−3.085)
_cons	1.079 ***	−0.287 ***	1.188 ***	1.187 ***	1.082 ***	−0.286 ***	1.190 ***	1.189 ***
	(21.404)	(−7.844)	(22.900)	(22.843)	(21.522)	(−7.788)	(23.007)	(22.948)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	42,833	42,833	42,833	42,833	42,833	42,833	42,833	42,833
r2	0.018	0.065	0.125	0.125	0.019	0.065	0.125	0.126

Note: M (1) refers to MODEL (1), and so on. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The results were obtained using Stata 14.

6. Conclusions

This study demonstrates that utility model patent quality plays an essential role in improving the domestic competitiveness of local enterprises and maintaining the advantages of the entire industrial chain. The utility model patent quality is an effective localization measure to release endogenous growth power and upgrade the global value chain. This study merged enterprise utility model patent quality and export DVAR in the same analytical framework. It also explored their relationship using enterprise patent data, financial data of Chinese industrial enterprises, and customs data from 2002 to 2014.

The results may be summarized as follows. First, we found a significant promotion of enterprise utility model patent quality to export DVAR to be particularly prominent in the export DVAR of capital-intensive industries. Second, we showed that the utility model patent quality of normal trade enterprises and high-productivity enterprises played a significant role in promoting the export of DVAR by analyzing the heterogeneity of the trading patterns and firm productivity. Third, we found that enterprise markups and the relative price of intermediate goods are crucial domestic channels through which utility model patent quality boosts export DVAR. Finally, we provided evidence that the channel of "the domestic intermediate relative price" is moderated by MS.

Based on these conclusions, we make the following recommendations. (1) The Chinese government should optimize the use of utility models and strengthen the support mechanism for high-quality utility model patents to enhance global value chains. Utility models are not only found in technologically backward countries; for example, EU countries (except for the UK, Sweden, and Luxembourg) also provide legal protection for "utility patents". On the other hand, if the utility model patent system is abolished, many "small inventions" lose legal protection, with negative effects such as stagnation of innovation and weakening market competitiveness in low- and medium-tech industries. In the transition stage of China's high-quality economic development, utility models play a positive role in promoting the accumulation/improvement of innovation. Hence, the government should not equate low-quality patents with utility model patents, but should further enhance the quality of utility models by strengthening examination and supervision efforts to motivate DVAR enhancement for Chinese enterprises' exports. (2) The Chinese government should formulate a differentiated patent guidance policy in response to industry differences in China's innovation capacity. Incremental innovation remains an integral part of innovation output for low- and medium-tech sectors, such as capital-intensive sectors. The government should fund incremental innovation and layout utility models for low- and medium-tech intensive industries, helping utility models to improve the competitiveness of the relevant industries. (3) The Chinese government should also guide the commercialization of utility models by strengthening the domestic market advantage to enhance the export competitiveness of domestic intermediate goods. This study shows that utility models strengthen domestic intermediate goods' markup and relative price effects. By contrast, MS has a considerable negative impact on the domestic intermediate goods trading market. Therefore, the Chinese government should fully recognize the mutual promotion effect between utility models and domestic market advantages, formulate relevant policies to further clarify market trading barriers between provinces, and guide local enterprises' commercialization of utility models. Ultimately, these efforts should rely on utility model patents to enhance the profitability of enterprises in the middle domestic value chain and fully utilize the multi-level patent protection system to promote the synergistic enhancement of China's entire industry's DVAR.

This study has some limitations that offer future research directions. First, the empirical research was based on export enterprise data from all industries in China. However, as previously mentioned, the practical utility effect differs between different industries. In the future, more research should be conducted on capital-intensive industries such as chemicals, metals, and machinery, in order to optimize the application scenarios of utility model patents and provide impetus for Chinese enterprises to move the value chain from midstream to the high end. Second, this study employed a sample of Chinese industrial enterprises from 2002 to 2014. Despite the large sample size, the data may be considered somewhat outdated. To increase the timeliness and universality of our conclusions, we plan to use the latest data from the CSMAR and CNRDS databases in future studies. Additionally, we will crawl more comprehensive patent literature data to improve the measurement of patent quality and further enhance the depth of our study. Third, for high-end equipment manufacturing enterprises, cultivating high-quality invention patents driven by key core technologies is an important path to establish and consolidate China's comparative advantages in the international arena and promote the upgrading of China's industries towards the middle and high-end. Future research should further explore the issue of domestic value-added of invention patents for export.

Author Contributions: Conceptualization, R.M. and M.W.; methodology, X.K. (Xiaodan Kong); software, R.M.; formal analysis, M.W.; data curation, R.M. and X.K. (Xiaodan Kong); writing—original draft, R.M., X.K. (Xiaodan Kong) and X.K. (Xiangde Kong); supervision, M.W. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Major Project of the National Social Science Foundation of China: Research on the Strategy of Our Country's Participation in the Global Governance of Intellectual Property Rights under the New Situation (grant no. 21&ZD165).

Data Availability Statement: The proposed econometric analysis involved three types of data. The utility model patent data used to support the findings of this study were supplied by the Incopat Patent Database under license and cannot be made freely available. Requests for access to these data should be made to Ran Ma (email: mran@shu.edu.cn). The enterprise financial data used to support the findings of this study were supplied by RESSET Database under license and cannot be made freely available. Requests for access to these data should be made to Ran Ma (email: mran@shu.edu.cn). The Chinese customs data used to support the findings of this study were supplied by RESSET Database under license and cannot be made freely available. Requests for access to these data should be made to Ran Ma (email: mran@shu.edu.cn). The above data are available upon reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

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