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Original Research

Research on the Factors Influencing the Efficiency of Transactions between Supply and Requisitioning Parties in Green Economy Technology Transfer

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Abstract

Green technology innovation is an important guarantee for the realization of the "dual-carbon" goal, and it also plays an important role in promoting the development of the green economy. As societies evolve towards sustainable economic practices, the imperative to enhance the efficiency of green technology transfers has emerged as a pressing concern. This study delves into the dynamics between various elements, synthesizing the roles of technology intermediaries, trust, information sharing, and the transactional efficiency of both supply and requisitioning parties within the process of green technology transfer. Utilizing the Likert scale method for reliability and validity analysis, along with mediation effect verification, the research uncovers that technology intermediaries can foster a congenial trading atmosphere, facilitating the rapid establishment of trust between parties. Consequently, this atmosphere is more conducive to confidential transactions, significantly boosting the desire for information sharing among the participants in technology transfer. This study contributes to minimizing transaction costs and is of paramount importance in enhancing the transactional efficiency of green technology transfers between the transactional efficiency of both supply and requisitioning parties within the process of green technology transfer.

Keywords: green economy, green innovation, technology transfer, supply and requisitioning parties, efficiency

Introduction

Against the backdrop of drastic global climate shifts and escalating environmental issues, governments and corporations worldwide have acknowledged the significance of environmental preservation and sustainable development within the economic growth narrative, striving towards greener modalities of economic expansion. Evidently, the green economy is propelling industries towards higher-end, intelligent innovations, fostering the rapid emergence of new technologies in energy, materials, intelligence, and processes, thereby creating numerous new growth opportunities. Indeed, green technologies, with their unique environmentally friendly, energy-saving, and renewable features, have become a formidable force in driving global economic transformation and environmental conservation. The transfer of green technologies, as an efficacious

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mechanism, holds substantial importance in propelling the development of a green, low-carbon economy. Globally, the innovation of green technology has garnered widespread attention and proactive application, with numerous countries and regions enacting policies to support the research, development, and dissemination of green technologies, thereby advancing the growth of green industries. Likewise, corporations are recognizing the critical importance of green technology innovation in enhancing competitiveness and achieving sustainable development, thereby intensifying their investment in the research, development, and application of green technologies. By adopting eco-friendly, energy-efficient, low-carbon, and renewable concepts and technological approaches to transform and elevate traditional industries, this innovation process aims to harmonize economic, social, and environmental development. This innovative endeavor not only aids in improving resource utilization efficiency and reducing energy consumption and environmental pollution during production processes but also effectively stimulates the development of emerging industries, injecting green vitality into economic growth.

Certainly, as a complex and variable systemic project within the green economy, technology transfer requires the concerted efforts of all parties involved to realize its goals and value [1]. This involves intricate green technology innovation and knowledge systems, where verbal and written communication may prove insufficient for transferring technology to recipients, especially for highly confidential green technologies, where the transfer is even more challenging. Additionally, green technology transfer may encounter misunderstandings due to language and cultural differences, and high technological bottlenecks and information privacy concerns can diminish trust between partners, ultimately leading to unsuccessful technology transfers [2]. Characterized by information asymmetry, unpredictability, and reticence, market self-regulation cannot naturally and efficiently address such issues, significantly limiting the enhancement of interactive benefits between suppliers and recipients in the process of environmental technology transfer [3]. To address these issues, scholars have embarked on relevant inquiries [4]. Existing research indicates that trust can effectively improve communication between suppliers and recipients in the green economy, reducing the potential risks associated with green technology transfer and thereby boosting their confidence and the amount of information shared [5]. This, in turn, aids in the advancement [6] and value enhancement of green technologies [7]. However, there is substantial scope for exploration of how multidimensional elements affect the transactional efficiency of technology transfers between suppliers and recipients. Hence, the novelty of this study lies in its approach to examining the interplay between elements, integrating the relationships among technology intermediaries, trust, information sharing, and the transactional efficiency of both parties and employing the Likert scale method for reliability and validity analysis. This exploration uncovers how the transactional elements of green technology transfer between suppliers and recipients interact, impacting the enhancement of transactional efficiency in the green economy's technology transfer. This research outcome holds significant theoretical and practical guidance value for promoting the development of the green economy.

Theoretical Basis and Literature Review

Inquiry into the Agents of Technology Transfer

Presently, the main participants in the field of technology transfer encompass higher education institutions, research centers, corporations, and technological intermediaries, among others. Within these entities, universities and research institutions often serve as providers of scientific and technological advancements, while businesses frequently assume the roles of technology seekers and purchasers. This dynamic interchange of roles occurs regularly, especially during the technology transfer process [8]. Due to the inherent differences among these organizations and their varying influences on future expectations, the effectiveness of their actions when exchanging scientific outcomes as commodities is impacted by multiple factors [9]. These include, but are not limited to, the characteristics of the provider, the closeness of the relationship with the demand side (i.e., the buyer), and the quality and level of service from third-party service institutions [10]. Furthermore, through the interplay of these factors, a divergence between the actual outcomes of technology transfer and its anticipated goals may arise. Thus, a thorough examination of the entities involved in technology transfer is crucial for optimizing the process and enhancing efficiency.

(1) The impact of the characteristics of supply and requisitioning parties on technology transfer

Transfer Comprehensive studies suggest that the characteristics of both the technology supplier and the technology demander play a pivotal role in the success of technology transfer [11]. These characteristics are primarily reflected in their scientific capabilities and management structures. When scientific knowledge is considered a commercial resource rather than merely a product or service, the technological capabilities of the supplier emerge as a key factor in successful technology transfer. The "level of skill" encompasses not only how suppliers utilize scientific knowledge to create value (e.g., enhancing production efficiency) but also their ability to leverage these advantages to develop new products and services [12]. Concurrently, the learning pace of the technology demander is an important measure of the gap between the supply and requisitioning parties. A significant disparity in this aspect could decrease the likelihood of achieving technology transfer objectives; conversely, a smaller gap increases the probability of success [13].

Moreover, different types of institutions have varying expectations of technology transfer [14]. For instance, universities and research institutions often prioritize

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gaining prestige or advancing scientific progress over direct economic benefits. In contrast, businesses focus more on tangible benefits, and due to their different operational models compared to other types of institutions, they incur higher costs in completing technology transfers, thus increasing the complexity of the process [15]. Therefore, understanding and adapting to the characteristics of both the supplier and the demander are vital in the technology transfer process.

(2) The interrelationship of technology transfer

Technology transfer is a dynamic and ongoing process. According to dominant economic principles, the external manifestation of a green economy is influenced by individual economic activities [16]. Therefore, unveiling the technology transfer relationships among these micro-economic entities and establishing a balanced state becomes a key component of economic fundamentals and logic. Studies indicate that the interactions between technology transfer participants significantly affect transaction outcomes, primarily through trust levels, social distance, and social power.

Currently, discussions on trust relationships in green economy technology transfer are still at an early stage [17]. Trust is understood as a psychological state based on positive expectations of others and a willingness to undertake potential risks. This trust in the technology transfer process manifests as one party's optimistic expectations of the other [18]. Due to the complexity of technology and the asymmetry of information, establishing trust between technology transaction parties is challenging, potentially leading to increased transaction costs and even affecting the success rate of technology transfers [19]. Of course, capabilities and reputation, past cooperation experiences, integrity, a friendly demeanor, and a predisposition towards trust all contribute to enhancing trust. This helps both parties better understand and feel each other's trust, which can gradually deepen through cognitive and emotional levels [20]. Additionally, the closeness of the relationship is a key factor in measuring the power gap between the technology transfer parties, including organizational differences, technological similarities and differences, and cultural disparities [21]. The smaller the organizational distance, the greater the likelihood of successful technology transfer [22]. Significant differences in technology affect the consistency of the knowledge systems between the two parties. If they are too similar or too different, it may negatively impact learning outcomes [23]. At the same time, some scholars also point out that overly close relationships may lead to knowledge overlap, hindering the development of technology transfer, but can more effectively facilitate the transmission of hidden technological information, reducing the transaction risks of key technology transfers [24].

(3) The influence of technology intermediaries in technology transfer

In the process of technology transfer within a green economy, technology intermediaries play a crucial role. From a broad perspective, technology intermediaries are middlemen connecting technology demanders with service providers, using their knowledge, skills, experience, and information to facilitate the signing of technology agreements and support the entire process [25]. From a narrow perspective, technology intermediaries aim to achieve profit objectives by communicating with technology supply and requisitioning parties to promote technology transformation while ensuring the value and property rights of the technology remain unchanged. Common types of technology intermediaries include university technology transfer departments, technology transfer centers, and technology consulting firms [26]. Research shows that when technology intermediaries are involved, the transaction outcomes between supply and requisitioning parties in the development of a green economy are significantly better than those without intermediaries [27]. Essentially, the core function of technology intermediaries is to provide technology knowledge services to both sides and participate as an independent third party in the market division of labor. This helps break through information barriers in technology transfer, correct market failures, and reduce technology transfer costs [28].

By leveraging their professional expertise and renown to disseminate credible market information, technology intermediaries significantly narrow the gap in information, spatial differences, organizational barriers, and social network distances between buyers and sellers, thus enhancing the outcomes of technological exchanges [29]. Furthermore, the technological knowledge and practical experience of professional staff within technology intermediaries, the competency composition of their teams, and the reserves of their patent pools lay a foundational assurance for elevating the transactional efficiency of technology transfer [30]. Consequently, the effective incentive mechanisms, comprehensive contractual terms, and harmonious partnership relationships offered by technology intermediaries serve to boost the willingness and enthusiasm for technology transfer [31].

Factors Affecting the Object of the Transaction

The essence of technology as a pivotal element stems from its aggregation of myriad captureable and utilizable components. These encompass not only the physical phenomena of the optical domain but also extend to the non-physical, knowledge-based phenomena within management [32]. Conversely, technology transfer is the synthesis and integration of various elements, such as labor skills, strategic norms, tools, and scientific knowledge, under the guidance of specific goals, culminating in the construction of efficient systems [33]. For technology to be exchanged as a product and facilitate the transfer of rights, several conditions must be met: Firstly, the definition and exposition of technology must be clear and restrictive, achievable through texts, drawings, and technical specifications. This facilitates the identification of technology transfer as a transaction

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object with definite temporal and spatial limitations [34]. Secondly, the ownership and rights associated with the technology must be explicitly defined to ensure the transferability of rights and facilitate transactions [35]. Lastly, a demand arises when the technology possesses uniqueness and scarcity, and there is a significant gap in technological capabilities among users.

For the successful implementation of technology transfer, stringent standards for technology must be proposed, taking into account how factors such as technological instability, public utility characteristics, and maturity level affect the transaction process. The transfer of novel inventions and innovative technologies often involves an in-depth exploration of unknown fields, filled with uncertainties and unpredictabilities, primarily due to the unpredictable trajectory and outcome of technological development [36]. The technical uncertainties may lead to difficulties in clearly stipulating the responsibilities and rights of the parties involved in contract terms, potentially complicating the agreement process and affecting the success rate of technology transfer [37]. As a quasi-public good, the non-exclusivity and non-competitiveness of technology signify that its transfer can occur without precluding others from using it or diminishing their use, allowing for the possibility of free-riding. Given that producers cannot sufficiently profit from their developed technologies to offset production costs, a shortage in technology supply might occur. The maturity level of emerging technologies plays a significant role in the transfer process, with higher maturity levels correlating with greater probabilities of success [38]. Technological maturity, as a quantitative, standardized, and systematic tool, measures the maturity level of core technologies in scientific innovation projects, describing the development process from foundational theoretical exploration to practical application in complete systems [39]. Research indicates that the risk conditions faced at different developmental stages of new technology vary, and stakeholders in the technology transfer process should adopt appropriate action strategies based on the characteristics of technological maturity [40].

Research Hypotheses

The Influence of Trust on the Transaction Efficiency of Supply and Requisitioning Parties in the Process of Technology Transfer in the Green Economy

In the intricate dance of technology transfer, trust emerges as an indispensable beacon, especially amidst the swirling uncertainties and potential perils. It embodies a forward-looking optimism, spurring providers to brave the risks, buoyed by the belief that recipients will not exploit this opportunity for selfish gains. Once a robust foundation of trust is established, to manifest this conviction, they might allocate a proportionate share of proprietary resources, signaling their trust stance. This act, in essence, a form of self-imposed restraint, reserves heightened proprietary investment for those partners who genuinely harbor mutual trust. The depth of such investments mirrors the level of trust, allowing for a precise gauge of trust discrepancies through the comparison of investment intensities. Moreover, the infusion of proprietary assets serves as a barometer of commitment fulfillment, as the rental stakes in market share exert a binding effect, enhancing the credibility and stability of commitments. Higher proprietary investment signifies a heightened anticipation of future returns, a diminished propensity for betrayal, and a pronounced spirit of collaboration. This practice fortifies mutual trust between technology providers and recipients, fostering free information exchange and refining transaction processes.

At the green technology transfer's planning stage, trust plays a pivotal role, enabling technology recipients to appraise the technology's true worth at reduced costs while also lessening the economic burden on providers to showcase their technology. Consequently, both parties swiftly establish a basic transaction intent, smoothly transitioning to contract negotiations. In green economy technology transfer negotiations, mutual trust prompts both sides to commit more proprietary resources as proof of their aversion to opportunistic behaviors. This trust clarifies that, given the transaction's inherent uncertainty, the risk of contract renegotiation remains minimal. Hence, even without explicit contractual stipulations, opportunistic actions are unlikely. In such scenarios, agreements are swiftly reached and transaction accords signed, propelling the transaction into the execution phase. During the operational phase of technology transfer, the cooperative relationship, anchored in trust, heightens communication and collaboration, significantly reducing conflicts and inefficiencies. Faced with unforeseen outcomes spurred by uncertainties, both parties are inclined towards amicable negotiations to adjust or amend existing contracts, minimizing potential losses. Thus, trust's presence at every stage of technology transfer exerts a positive influence on transactions, effectively lowering transaction costs associated with the process.

The Influence of Technology Intermediary on the Trust of the Supply and Requisitioning Parties of Technology Transfer

The establishment of trust between the supply and requisitioning parties involved in technology transfer is an intricate, systemic endeavor that necessitates the consideration of multifarious factors. The technological competence of the recipient, their standing within the industry, and the history of prior collaborations all serve as pivotal elements in the trust-building process for the provider. However, the acquisition of this critical information often demands considerable temporal and financial investments on the part of the provider, which, to a certain extent, constrains the efficiency and ubiquity of technology transfer. To surmount this challenge,

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technology intermediaries have emerged as a vital component of the technology trade market. Representing a novel form of social division of labor, they fill the void in the technology transfer market through their specialized services such as market research, risk assessment, and contract management, aiding both parties in reducing transaction costs and enhancing transaction efficiency. Moreover, technology intermediaries play a crucial role in mitigating the issue of information asymmetry by providing suppliers with a more comprehensive set of data, thus facilitating a more accurate evaluation of the recipient's credibility and capability. Hence, they are indispensable in fostering trust between the parties involved in technology transfer, acting as a significant force in promoting the healthy development of the technology transfer market. Furthermore, in their commercial operations, technology intermediaries accumulate and sift through information about various parties involved in technology through diverse channels. With a potential transaction on the horizon, they showcase this information to the respective parties. Compared to supply and requisitioning parties, third-party service agencies hold a larger and higher-quality pool of information, primarily derived from their professional expertise and networks. Additionally, technology intermediaries can tailor suitable solutions based on the specific circumstances of a business, enabling smoother, more efficient operations, thereby saving time, conserving resources, and doubling the effectiveness of achieving goals. As competition intensifies, the collaborative experiences between information technology service intermediaries and information technology suppliers carry significant transmissibility. These shared experiences of collaboration hold considerable referential and instructional value, aiding in the establishment of trust relationships and facilitating the smooth progression of technology transfer.

The Influence of Technology Intermediaries on the Transaction Efficiency of Supply and Requisitioning Parties in the Process of Technology Transfer in the Green Economy

Within the transformative process of the green economy, technology brokers emerge as pivotal figures, significantly enhancing transactional efficacy between providers and recipients. As the domain of technological innovation becomes increasingly nuanced, this market orchestration model garners escalating regard and its influence is ever-expanding in the contemporary realm of technological transfer. Evidently, as autonomous market entities, these intermediaries mitigate the informational asymmetries inherent in the technological transition, addressing market-specific challenges to foster progress. Nonetheless, in the realm of green technology innovation, asymmetric information, propelled by imbalances and unpredictabilities, may precipitate adverse selection risks in direct transactions, where the market is inundated with valueless innovations, whereas superior technologies struggle to find appropriate counterparts. Herein, the introduction of technology brokers can, through their brand and expertise, disseminate credible market signals, enabling a discerning separation of high and low-quality technological goods, thus refining the conversion impact and elevating societal welfare. Indeed, these brokers play multifaceted roles, from enhancing transparency and trust to curbing excessive technological exploitation, managing risks, and promoting dissemination. Their primary objective is to streamline the collaborative search, reduce transactional uncertainties, and lower the costs associated with technological transfer. Crucially, in bridging the divide between buyers and sellers, they not only professionalize and order the process but also broaden informational exchange, deepen mutual trust, and ameliorate potential disagreements; they eliminate cognitive disparities, geographical divides, and barriers related to organizational scale and network resources. Consequently, technology brokers ensure fairness and transparency in green economy transactions, reduce trade risks, and deter speculative practices, thereby heightening the efficiency of green technological transfers.

The Influence of Information Sharing on the Transaction Efficiency of Supply and Requisitioning Parties in the Process of Technology Transfer in the Green Economy

In the crucible of green economic technology transfer, the sharing of information emerges as a pivotal linchpin, encompassing the dissemination of complete or partial knowledge about existing technologies by both providers and seekers to foster the efficacious utilization of information and the unlocking of its latent value. The landscape of green technology transfer is fraught with uncertainties, attributed to the nature of the technology itself and the behaviors of the participants. Yet, the exchange of knowledge between the demand and supply sides of green technology is heralded as a critical and indispensable mechanism for resource exchange. This interaction serves to fortify the bonds between them and mitigate communication barriers, while the scope and quality of information shared are paramount in determining the transaction costs. Broader and higher-quality information sharing accordingly reduces these costs, enhancing the interaction benefits between suppliers and recipients in the technology transfer phase of green technology. Providers, guarding their interests, often hesitate to divulge all pertinent information, wary of the technology becoming public domain and thus devaluing its worth, which could stymie the transfer process. The initial hurdle lies in verifying the authenticity of information, followed by considerable resource investment in information collection and filtration. This not only escalates the complexity of transactions but also incurs significant fixed costs. However, introducing technical intermediaries in the green economic technology transfer process can significantly alleviate the adverse effects of information asymmetry on transactions by leveraging their expertise in technical evaluation,

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networking, and advisory services to bridge the technical and informational gaps between parties. Furthermore, trust stimulates the exchange of information between technology providers and seekers. The genesis of green economic technology transfer lies in the technological divide between providers and seekers, with providers more inclined to share core aspects or techniques of the technology when confident in the seeker's ability to comprehend and apply the technology, significantly reducing the seeker's learning costs. Trust also enhances the technological expectations of both parties, fostering deeper information exchange and facilitating the realization of green economic benefits.

This study posits hypotheses regarding the influence of technical intermediaries, trust, information exchange, and transaction efficiency at both ends of the green technology transfer spectrum:

Hypothesis 1: The involvement of technical intermediaries significantly fosters trust between providers and seekers.

Hypothesis 2: In the green economic technology transfer process, a robust trust relationship significantly enhances transaction efficiency between providers and seekers.

Hypothesis 3: The involvement of technical intermediaries significantly improves transaction efficiency between providers and seekers during the green economic technology transfer process.

Hypothesis 4: The involvement of technical intermediaries significantly boosts the level of information exchange between providers and seekers.

Hypothesis 5: The level of information sharing significantly impacts the transaction efficiency between providers and seekers in the green economic technology transfer process.

Hypothesis 6: A positive trust relationship significantly influences information sharing between providers and seekers.

Research Design and Data Analysis

This study focuses on the roles of technological intermediaries, the cultivation of trust, the sharing and exchange of information, and the transfer of green economy technologies. It meticulously analyzes the exchange efficiency between the demand and supply sides in the green economy's technology transfer process (as the outcome variable), the function of technological intermediaries (as influencing factors), the relationships of trust (as influencing factors), and the behaviors of information sharing (as influencing factors), among other critical elements. Given the challenge of directly observing and evaluating these elements, the study, drawing upon an extensive review of relevant literature, expert opinions, and field research findings, crafts more than five question items for each element and employs the Likert scale method for their assessment to enhance the precision of evaluating these components.

Reliability Validity Analysis

Initially, the research meticulously and comprehensively planned each step of the survey plan through an amalgamation of literature review, field visits, and interpersonal communication, ensuring the efficiency and accuracy of practical operations. Building on international best practices and closely aligning with China's current state of technological exchanges, a pragmatic questionnaire was developed, with each question subject to thorough inquiry to gather data for subsequent processing. Finally, the study intends to employ statistical principles among other suitable methods for the conclusive quantitative validation experiments. Key indicators for assessing data reliability and validity include the use of Cronbach's alpha coefficient to test the authenticity of the results against objective realities. A coefficient beyond a certain threshold indicates the acceptability of the raw data. Moreover, the study applies the Spearman-Brown prophecy formula for understanding the interrelationships among questions, thereby clarifying the specific role of each. According to Table 1, the reliability indices for all measured parameters range from 0.762 to 0.814, and factor analysis reveals that each factor's load exceeds 0.5. The total variance contributions for the four measurements are 78.216%, 77.945%, 77.172%, and 78.341%, respectively, indicating high reliability and validity for all research variables.

Table 1. Reliability coefficients for each measurement indicator.

Measurement items	Cronbach's α	Cumulative variance contribution
Transaction efficiency	0.803	78.216%
Technical intermediary	0.762	77.945%
Trust	0.773	77.172%
Information sharing	0.814	78.341%

Table 2. Model fit analysis.

fitness index	Significance of the chi-square value	NC	RMSEA	GFI	AGFI	NFI	CFI
Modified index	0.164	1.261	0.032	0.947	0.928	0.954	0.977
Adaptation Standards	P>0.05	1-3	<0.05	>0.9	>0.9	>0.9	>0.9

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Model Fit Analysis

Upon refining the model, the sample data exhibited an admirable alignment with the anticipated model. Both the foundational and comprehensive fit indices met their respective evaluative standards, thereby affirming the acceptability of the theoretical model's hypothesized framework. Detailed parameter metrics are elucidated in Table 2.

Path Analysis and Hypothesis Testing

It is distinctly evident from Table 3 that the five standard regression paths manifest significant effects within the structural equation model. The range of estimated standard errors (S.E.) spans from 0.08 to 0.15; the critical ratios (C.R.) concur with the t-statistic values, all of which surpass the threshold of 1.96, indicating that the parameter estimates of this study have achieved a significance level of 0.05.

As depicted in Fig. 1, the factor loadings of all observed variables fluctuate between 0.68 and 0.88, signifying that the revised model boasts commendable fittingness—meaning these observed variables proficiently explicate the latent factors. Throughout the structural equation model, the significance levels of all standardized path regression coefficients remain consistent. Upon examining and analyzing the structural equation model, it becomes apparent that all standardized path regression coefficients are significant, thereby corroborating all theoretical hypotheses posited in this study.

Examination of Mediating Effects

This research necessitates the examination of three mediating paths, with the multi-step mediation effect "Technology Mediation—Trust—Information Sharing—Transaction Efficiency" being particularly pivotal. The procedure entails initiating the SPSS 24.0 software, selecting "Analysis"—"Regression"—"PROCESS," and sequentially inputting the independent variable "Technology Mediation," the mediating variables of "Trust" and "Information Sharing," and the dependent variable of "Transaction Efficiency." The Bootstrap sample size is set at 1000, with selections for the "Bias Corrected" non-parametric percentile method and the "95%" confidence interval.

The analysis reveals: (1) The presence of two mediating variables, Trust and Information Sharing, in sequence,

Table 3. Structural model significance check.

model assumption	pathway relationship	path factor	S.E.	C.R.	P	Verification results
Hypothesis 1	Technical intermediaries → trust	0.74			***	The result stands.
Hypothesis 2	Trust → Transactional efficiency	0.30			***	
Hypothesis 3	Technology intermediation → transaction efficiency	0.27			***	
Hypothesis 4	Technology brokering → information sharing	0.56			***	
Hypothesis 5	Information sharing → transaction efficiency	0.30			0.001	
Hypothesis 6	Trust → information sharing	0.41			***	

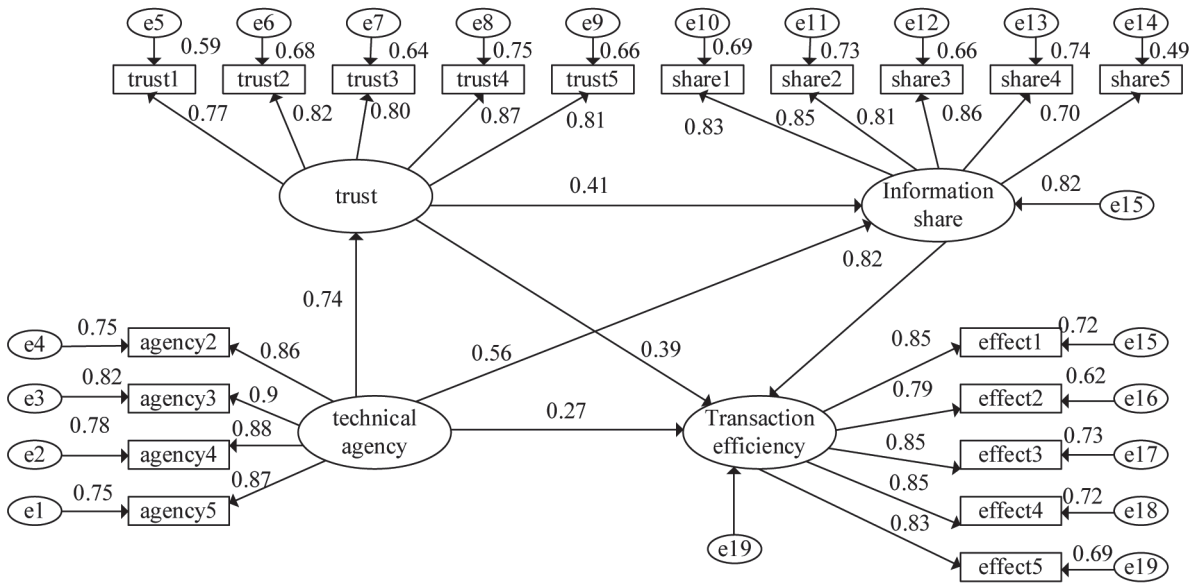

Fig. 1. Standardized model.

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Table 4. Intermediation effects.

	Effect	Se	LLCI	ULCI
overall effect	687	0.032	624	750
Total direct effect	0.249	0.044	0.162	335
Total indirect effect	438	0.048	354	542
Ind1: Technical intermediation - trust - ease of efficiency	229	0.041	0.148	0.312
Ind2: Technical intermediation - trust - information sharing - transaction efficiency	070	0.020	0.040	0.121
Ind3: Technology Intermediation -> Information Sharing -> Transaction Efficiency	140	0.038	0.075	0.232
(C1)	160	0.053	0.052	0.259
(C2)	089	0.067	-0.049	0.220
(C3)	-0.070	033	-0.156	-0.019

Note: C is a poor Ind1- Ind2 indirect effect; C2 is a poor Ind1- Ind3 indirect effect; and C3 is a poor Ind2- Ind3 indirect effect.

Table 5. Model stability test.

Model	ΔDF	ΔCMIN	P	ΔTLI
Factor loadings	15	6.410	972	-0.006
Structure path factor	6	4.720	580	-0.002
Structural model variance and covariance	1	191	662	0.000
Structural model residuals	3	0.220	974	-0.001
Measurement model residuals	19	56.365	0.000	0.002

hence three mediating paths exist: Ind1, Ind2, and Ind3; (2) The "Technology Mediation—Trust—Transaction Efficiency" path is significant (0.148, 0.312), indicating that technology mediation exerts a significant impact of 0.229 units on transaction efficiency through trust; the "Technology Mediation—Trust—Information Sharing—Transaction Efficiency" path is significant (0.040, 0.121), showing that technology mediation sequentially influences transaction efficiency through trust and information sharing by 0.070 units; the "Technology Mediation—Information Sharing—Transaction Efficiency" path is significant (0.075, 0.232), meaning that technology mediation impacts transaction efficiency by 0.140 units through information sharing. The cumulative indirect impact of the three mediating effects amounts to 0.438; (3) Controlling for the aforementioned mediating paths, the direct effect of technology mediation on transaction efficiency is 0.249, which is shown in Table 4.

Utilizing SPSS 24.0 software, the 343 samples were randomly divided into two groups: a validation sample, comprising 176 samples, and a calibration sample, consisting of 167 samples. Conducting Multiple-Group Analysis through AMOS 24 software, as depicted in Table 5, the study achieves the following outcomes: (1) The first row of Table 5 indicates that in the measurement model, 9 test items align perfectly with the hypothesis post subtracting 4 degrees of freedom, leaving 15 test items' factor loadings consistent with the original hypothesis, indicating no significant difference (p=0.972>0.05), thus the original hypothesis is accepted; (2) The second row shows that in the structural model, 6 structural path coefficients match the original hypothesis, suggesting no significant difference (p=0.580>0.05), thereby accepting the original hypothesis; (3) The third row reveals that in either the measurement or structural model, variances or covariances align with the original hypothesis, indicating no significant difference (p=0.662>0.05), thus the original hypothesis is accepted; (4) The fourth row elucidates that in the structural model, variances of residuals or error values of latent variables are in agreement with the original hypothesis, indicating no significant difference (p=0.974>0.05), thereby accepting the original hypothesis; (5) Despite the variance of error values of measuring variables in the measurement model showing a p-value less than 0.05, with ATLI<0.05, it holds significant practical implications, suggesting that residuals in the measurement model remain entirely consistent in practical application. Synthesizing these test results indicates that after random division into two groups, no significant differences were observed between them, thereby affirming the effectiveness and stability of the research model, i.e., the cross-validation results stand validated.

Conclusions and Implications

Main Conclusion

(1) The triumvirate of technological intermediation, trust, and information sharing plays an instrumental role

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in the success of business endeavors. Our empirical analysis reveals that these elements collectively foster a positive impact on the efficacy of technology transaction activities, with trust emerging as the most pronounced factor. Notably, a high degree of trust between parties not only facilitates deal closure but also enhances collaborative intent, proactiveness, and goodwill. Trust, even in the face of potential uncertainties, enables parties to adjust or refine contractual terms to mitigate risks, thereby reducing transaction costs and elevating the overall effectiveness of technology trade.

(2) Technological intermediaries significantly bolster trust levels and information exchange between parties engaged in technology transactions. As evidenced by standardized path coefficient estimates from structural equation modeling, the introduction of technological intermediaries expands communication channels between technology providers and seekers, thereby strengthening mutual trust and optimizing the overall trust environment. Furthermore, these intermediaries alleviate the adverse effects of information asymmetry on transactions, curtail speculative behaviors through their regulatory and market credit functions, and thus foster stable cooperative relationships conducive to the efficiency of technology transfer transactions within the green economy.

(3) Trust and information sharing incrementally modulate the relationship between technological intermediaries and the efficiency of technology transfer transactions. Our study delineates three pivotal pathways to enhance transaction efficiency: firstly, through bolstering trust between buyers and sellers; secondly, by facilitating information exchange among parties; and lastly, via the significant and positive impact of both trust and information sharing on transaction efficiency.

Research Implications and Limitations

This research offers invaluable insights for technology transfer within the green economy, highlighting the role of technological intermediaries in diversifying communication channels between parties and thereby fostering a harmonious transaction environment. Enhancing trust levels and establishing mutual trust relationships encourage parties to share "confidential" information, which significantly increases their desire for information exchange and effectively reduces transaction costs, ultimately leading to increased transaction benefits. Theoretically, enhancing the efficiency of technology transfer in the green economy is a complex process that requires support from institutional theories, multiple pathways, and synergistic actions to facilitate orderly technology knowledge transfer within and across nations, regions, industries, and technology systems.

Nonetheless, this study has its limitations, including the focus on trust and the need for extensive empirical data and case studies to support theoretical analysis. The diversity and complexity of green technologies, along with challenges in data collection, often limit research. Future studies could expand data and case sources, improve empirical validity and representativeness, and delve deeper into incentive mechanisms for technology transfer in the green economy to stimulate active participation and promote the widespread application and sustainable development of green technologies.

Main Recommendations

(1) Establishing a high-quality communication environment for green economy technology transfer necessitates proactive information sharing and dissemination among knowledge holders to integrate information into the final technological application. This will contribute to building an organization with a comprehensive technological capability network, closely linked to the development of a positive communication environment and a trust culture. A culture of trust guides organizational members to adhere to unified values and behavioral norms, facilitating an efficient communication environment that significantly enhances the efficiency of transfer transaction communication within the green economy.

(2) Enhancing trust levels between entities requires ensuring unobstructed green information communication channels to mitigate the adverse outcomes associated with communication barriers in technology transfer. Smooth information flow is the cornerstone of trust-building. Barriers to communication within or between entities can lead to the concealment or dissemination of false information, resulting in ineffective actions, trust crises, and a loss of confidence in cooperation. Establishing unobstructed communication channels in the technology transfer process involves seeking green technology innovation and breakthroughs in communication levels, methods, and environments.

(3) Developing and refining policies related to technology transfer to create a conducive policy system for technology transfer is crucial. Governments of entities involved in technology transfer transactions can establish comprehensive legal frameworks, clarify rights and obligations, and protect the legal rights of parties involved, thus providing a sound legal environment for technology transfer. Implementing tax incentives, such as reductions or exemptions in income tax and value-added tax for technology transfer, can reduce costs and stimulate the enthusiasm of enterprises and technology transfer institutions. Furthermore, guiding financial institutions to provide credit support for technology transfer, reducing financing costs, strengthening collaboration between enterprises and academic and research institutions, and promoting the integration of industry, education, and research will foster an environment conducive to technology transfer.

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Conflict of Interest

The authors declare no conflict of interest.

References

1. HOTTE K. How to Accelerate Green Technology Diffusion? Directed Technological Change in the Presence of Coevolving Absorptive Capacity. Energy Economics, (8), 5, **2020**.
2. KHOSLA R., SAGAR A., MATHUR A. Deploying low-carbon Technologies in Developing Countries: A View from India's Buildings Sector. Environmental Policy and Governance, **27** (2),149, **2017**.
3. WANG W.B., LIU F. Research on regional technology innovation and cross-regional technology transfer under the transition of low-carbon economy. Southeast Academic Research, (2), 68, **2016**.
4. ZENG M.B., LI L.J. Research on the Dislocation of Technology Transfer-Analysis Based on the Bilateral Perspective of Technology Transferors and Receivers. Management Review, **31** (11), 108, **2019**.
5. MA H.T. The theoretical construction and network simulation of intercity innovative relationships in knowledge flow space. Acta Geographica Sinica, **75** (4), 708, **2020**.
6. YU X., CHEN N., LI M. Q. Research on carbon emission characteristics and reduction pathways of low-carbon pilot cities in China. China Population, Resources and Environment, **3** (7), 1, **2020**.
7. TENG T.W., QU C.Y., HU S.L., ZENG G. Differentiation of Green Innovation Efficiency Patterns and Spatial Associationin the Yangtze River Delta Urban Agglomeration. Journal of East China Normal University (Humanities and Social Sciences), **51** (5), 107, **2019**.
8. XU Y., LIU Y., HE Y. Trans-regional technology transfer pattern and policy implications of Beijing universities and research institutes. Science Research Management, **38** (S1), 444, **2017**.
9. LV R.J., JIA Y.F., ZHANG Y.M. Efficiency Evaluation of Technology Transfer in Provinces of China: Based on Comparison of Universities and Enterprises. Science and Technology Management Research, **38** (12), 86, **2018**.
10. ZHONG X.M., PANG H.S., JIN Y.X., ZHENG Y.T. Research on the Service Model and Product Design of Intellectual Property Information for the Transfer and Transformation of Technical Achievements of universities. Library, (04), 84, **2023**.
11. ALI M., PARK K. The mediating role of an innovative culture in the relationship between absorptive capacity and technical and non-technical innovation. Journal of Business Research, **69** (5), 1669, **2016**.
12. YOUSSEF B.S., BRETON M., ZACCOUR G. Cooperating and non-cooperating firms in inventive and absorptive research. Journal of Optimization Theory and Applications, **157**, 229, **2013**.
13. SHANG Y.F., MI Z.F., ZHOU C., LIN L. Impact of intercity low-carbon technology transfer on carbon emission reduction in China: Based on the "dichotomy" of knowledge learning and technology learning. Resources Science, **45** (04), 827, **2023**.
14. SENO WULUNG R.B., TAKAHASHI K., MORIKAWA K. A model for selecting appropriate technology for incubator-university collaboration by considering the technology transfer mechanism. International Journal of Production Research, **56** (6), 2309, **2018**.
15. DANIEL A.D., ALVES L. University-industry technology transfer: the commercialization of university's patents. Knowledge Management Research & Practice, **18** (3), 276, **2020**.
16. ISHAK I., JAMALUDIN R., ABU N. H. Green technology concept and Implementation: a brief review of current development. Advanced Science Letters, **23** (9), 8558, **2017**.
17. TENG Y. Indigenous R&D, technology imports and energy consumption intensity: Evidence from industrial sectors in China. Energy Procedia, 16, 2019, **2012**.
18. MILANI S. Who innovates with whom and why? Evidence from international collaboration in energy patenting. Economics of Innovation and New Technology, **29** (4), 369, **2020**.
19. OU T.G., ZHOU L.L. Exploration on the Complexity of Technology Transfer. Chinese Journal of Systems Science, **24** (01), 29, **2016**.
20. HARDS M., YANG Y. Determinants of foreign ownership in international R&D joint ventures: Transaction costs and national culture. Journal of International Management, **13** (2), 110, **2007**.
21. YE J., YUAN Y.J., ZHANG R.J. Knowledge transfer in cross-border technology alliances under the perspective of cultural differences-based on system dynamics modeling and simulation. Studies in Science of Science, **30** (04), 557, **2012**.
22. LIU W., TAO Y., BI K. Capturing information on global knowledge flows from patent transfers: An empirical study using USPTO patents. Research Policy, **51** (5), 104509, **2022**.
23. ZHU X.Z., HU K. Study on the cultivation of technical transfer professionals from the perspective of the learning sciences. Scientific Management Research, **37** (01), 78, **2019**.
24. HOLAS T., SHIMIZU H. Intermediary functions and the market for innovation in Meiji and Taishō Japan. Business History Review, **87** (1), 121, **2013**.
25. RREAU M., VERDIER M. Cooperative and noncooperative R&D in two-sided markets. Review of Network Economics, **13** (2), 175, **2014**.
26. UYGHE A., KNOCKAERT M., WRIGHT M., PIVA E. Technology transfer offices as boundary spanners in the pre-spin-off process: The case of a hybrid model. Small Business Economics, **43**, 289, **2014**.
27. WANG X., LUO Y. Has technological innovation capability addressed environmental pollution from the dual perspective of FDI quantity and quality? Evidence from China. Journal of Cleaner Production, 258, 120941, **2020**.
28. BOZEMAN B. Technology transfer and public policy: a review of research and theory. Research policy, **29** (4-5), 627, **2000**.
29. VINCENT J.F., MANN D.L. Systematic technology transfer from biology to engineering. Philosophical Transactions of the Royal Society of London. Series A: Mathematical, Physical and Engineering Sciences, **360** (1791), 159, **2002**.
30. ZHANG H.F., LIU Z.Q. Research on the Cooperation and Exchange of Guangdong, Hong Kong and Macao Scientific and Technological Talents to Promote Technology Transfer and Transformation Under the Background of Globalization. Science and Technology Management Research, **41** (24), 94, **2021**.

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31. MAHONEY J.T., PANDIAN J.R. The resource-based view within the conversation of strategic management. Strategic Management Journal, **13** (5), 363, **1992**.
32. DEL GIUDICE M., SCUOTTO V., GARCIA-PEREZ A., PETRUZZELLI A.M. Shifting Wealth II in Chinese economy. The effect of the horizontal technology spillover for SMEs for international growth. Technological Forecasting and Social Change, **145**, 307, **2019**.
33. REZGUI Y. Review of information and the state of the art of knowledge management practices in the construction industry. The Knowledge Engineering Review, **16**(3), 241, **2001**.
34. MEYSMAN J., DE CLEYN S.H., BRAET J. Cash, community and coordination: The triple-C categorization of technology transfer office organizational philosophy. International Entrepreneurship and Management Journal, **15**, 815, **2019**.
35. GONZÁLEZ-PERNÍA J.L., KUECHLE G., PEÑA-LEGAZKUE I. An assessment of the determinants of university technology transfer. Economic Development Quarterly, **27** (1), 6, **2013**.
36. ZHENG Y., JUN A. Resource dependence and network relations: A test of venture capital investment termination in China. Journal of Management Studies, **55** (2), 295, **2018**.
37. SOHN S.Y., MOON T.H. Structural equation model for predicting technology commercialization success index (TCSI). Technological Forecasting and Social Change, **70** (9), 885, **2003**.
38. SINGHAI S., SINGH R., SARDANA H.K., MADHUKAR A. Analysis of factors influencing technology transfer: A structural equation modeling based approach. Sustainability, **13** (10), 5600, **2001**.
39. DECHENAUX E., THURSBY J., THURSBY M. Inventor moral hazard in university licensing: The role of contracts. Research Policy, **40** (1), 94, **2011**.
40. HO M.H.C., LIU J.S., LU W.M., HUANG C.C. A new perspective to explore the technology transfer efficiencies in US universities. The Journal of Technology Transfer, **39**, 247, **2014**.