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The impact of alliance diversity on firm innovation performance: The mediating role of degree of internationalization and organizational agility, and the moderating effect of social embeddedness

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Abstract: This study examines how alliance diversity enhances firm innovation performance through the mediating roles of internationalization and organizational agility, with social embeddedness as a key moderator. Drawing on dynamic capabilities and social capital theories, we investigate these relationships in China's high-tech sector using a sample of 570 firms. The research employs structural equation modeling (SEM) to analyze survey data collected through stratified random sampling. Findings reveal that both functional and technological alliance diversity significantly improve innovation performance, while internationalization and organizational agility serve as complementary mediators. Notably, social embeddedness amplifies these effects, particularly for alliance diversity. The study contributes to innovation literature by demonstrating how diverse alliances, when coupled with international exposure and adaptive capabilities, create synergistic innovation benefits, with social capital serving as a critical enabler. Practical implications suggest that managers should cultivate diverse alliance portfolios while strengthening organizational agility and social networks to maximize innovation outcomes. The research advances theoretical understanding by integrating alliance, internationalization, and agility perspectives into a unified framework, offering insights for firms navigating complex innovation ecosystems.

Keywords: *Alliance diversity, Dynamic capabilities, Innovation performance, Internationalization, Organizational agility, Social embeddedness.*

1. Introduction

In an era of rapid technological advancement and intensifying global competition, firms increasingly rely on strategic alliances to enhance their innovation capabilities [1, 2]. The relationship between alliance diversity and innovation performance has emerged as a critical area of inquiry, yet existing research presents conflicting perspectives on how different dimensions of diversity influence innovation outcomes [3]. While some scholars argue that diverse alliances provide access to complementary knowledge that fuels innovation [4] others caution that excessive diversity may lead to coordination challenges and knowledge integration difficulties [5]. This theoretical ambiguity persists despite growing recognition that alliance portfolios have become increasingly complex and multidimensional in today's interconnected business environment [6].

This study addresses the awareness deficiency by testing functional and technological alliances as supportive alliance diversity attributes and how they impact innovation performance by enhancing organizational internationalization and adaptability. The research adopts [7] to reveal that organizations expand internationally and acquire adaptive competencies effectively because diverse alliances provide direct knowledge transfers. The proposed theory aims at expanding existing research approaches which view alliance diversity as a basic construct while neglecting knowledge acquisition frameworks and governance mechanism evaluations [8, 9]. The multiple dimensions of our analysis

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support current academic momentum for developing complex views about alliance portfolio structure [10] and it tackles the theoretical contradicting relationship between portfolio diversity advantages and coordination restrictions.

Research needs to focus on discovering essential mechanisms that let diverse alliances boost innovation performance, despite being under-examined within this relationship. Studies prior to Afzal, et al. [11] treated internationalization and organizational agility individually when studying antecedents to innovation but researchers have not extensively investigated their potential role as mediating factors linking alliance diversity to innovation outcomes. The absence of attention to this issue becomes crucial since internationalization allows businesses to access various knowledge bases [12] and organizational agility helps firms handle multiple knowledge sources effectively [8]. Our research investigates a new consequential model starting with alliance diversity creating internationalization which results in better organizational agility which further results in exceptional innovation outcomes. The study presents an integrated understanding of how external partnerships generate innovation results which strengthens research within both alliance literature and innovation studies.

The research makes another substantial theoretical addition through its findings about social embeddedness as a moderating element. Studies of embeddedness in network research [13] have received much attention but its effects on alliance diversity in innovation performance remain unexplored in the field. The innovation advantages of managing diverse alliances receive an enhancement through social embeddedness which creates conditions for trust development as well as knowledge exchange and collaborative problem resolution [14, 15]. The current perspective evaluates relational aspects in different performance measures of partnership performance and fills an important gap in the current alliance research [16]. The social embeddedness conditions we evaluate give a better understanding between alliance diversity and performance in terms of innovation.

The technological sector in China constitutes a good case for observing such relationship patterns. In particular, it has resulted in distinctive alliance formation and innovation processes [17] related to the unique combination of the mix of the Chinese economic expansion along with its institutions. Alliance diversity research needs a Chinese research environment, however, because Chinese companies frequently join forces at the same time both domestically and internationally [18]. This produces different alliance results patterns [19] as the Guanxi (personal connections) is distinctive social embeddedness in Chinese business environments. Our study of this particular market provides new value to research on innovation in emerging markets [20] and gives insights to specific applicable to other fast-growing economies. The study investigates alliance diversity in terms of both functional and technological aspects of diversity, and employs a thorough methodological technique to measure both aspects for the purpose.

This research generates three important theoretical implications concerning the present topic. This research demonstrates to scholars studying alliance portfolio models that various diversity aspects use different combined paths to affect innovation. This research develops innovation literature by showing how internationalization along with organizational agility serves as essential intermediary factors which connect external partnerships to innovation results. Social embeddedness acts as a moderation factor that enhances the performance of different alliances by enriching social network theory. A strategic business plan for forming alliances should combine evaluation of functional and technological diversity according to our research findings. Managers should study how different forms of partnership agreements will enhance existing abilities and aid global business development instead of merely seeking diversity for its own sake. The study demonstrates the fundamental position of organizational agility which underlines why firms must establish internal processes to both react speedily to market changes and merge external information.

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2. Literature Review

The relationship between alliance diversity and firm innovation has been extensively studied, yet critical gaps remain in our understanding of the underlying mechanisms and boundary conditions. Strategic alliances perform as critical channels for resource sharing and knowledge transfer according to the resource-based view [21] and knowledge-based theory [22, 23]. Diverse perspectives exist in academic literature regarding the results of diversity in alliances. Research evidence shows proponents supporting diverse alliance portfolios because these links offer rare knowledge which produces recombinant innovation [24] yet critics emphasize management challenges of coordinating heterogeneous alliances by highlighting absorptive capacity barriers [25]. The contradictory theoretical framework shows why research should focus on complex analyses about how various alliance diversity aspects impact innovation performance.

Current scholarly investigations examine alliance diversity by researching both functional diversity and technological diversity as separate but connected domains [26]. A firm develops functional diversity from its alliance portfolio to enhance both systemic innovation and cross-functional learning by conducting activities across different value chain regions [27]. Virtual alliances can achieve advantages through diverse technological bases because it permits them to develop innovative solutions by integrating new knowledge factors [28]. The existing research data does not prove how theoretical enhancement dimensions affect innovation importance or show their combined effects for supporting innovation performance. The combination of functional diversity supports higher value for incremental innovation according to Vătămănescu, et al. [29] while technological diversity triggers radical innovation even though [30] showed these dimensions can work together. Since different research studies yield conflicting results this study framework explores both functional and technological diversity using a single unified approach.

Studies in the field of international business demonstrate how alliance diversity affects innovation through internationalization procedures. Alliances function as international expansion platforms according to the Uppsala model as well as born-global perspectives [31] because they deliver market understanding and bureaucratic acceptance. Present-day studies reveal how internationalization produces enhanced innovation results by enabling organizations to interact with varied consumer demands [9] as well as enabling access to international knowledge systems [11] and increased market competition which fuels innovation [8]. There is a lack of research analyzing how internationalization functions as a link between alliance diversity and innovation although theory supports this relationship. The research gap regarding this relationship remains substantial since alliance diversity can potentially offer both required capabilities and resources needed for successful internationalization and improved innovation performance.

Research on innovation now includes organizational agility as a vital element especially when companies operate in quickly changing competitive environments [32]. A firm develops organizational agility through its capacity to detect environmental changes quickly and execute swift responses [33]. Organizational agility operates through market capitalizing agility (proactive opportunity exploitation) and operational adjustment agility (reactive adaptation) [34]. Alliance diversity delivers organizational agility through diverse knowledge inputs and alternative response options according to the dynamic capabilities view [35]. Research evidence about this relationship is scarce because scholars primarily investigated alliances and agility separately instead of examining their connected influence on organizations. Researchers have failed to examine how organizational agility functions as a mediator between alliance diversity and innovation although theory suggests that diverse alliances aid firms in developing their sensing and response capabilities.

Social embeddedness theory presents critical knowledge about the limitations which surround the influence of alliance diversity. According to Zhang, et al. [36] embeddedness theory uses social relations to explain economic results through a focus on social structure. Social embeddedness serves diverse alliances by enabling trust building and knowledge sharing as well as conflict resolution [37] to achieve better management results. Social embeddedness serves as an alternative for formal governance

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mechanisms in diverse alliances [38]. Moreover, Roberson, et al. [39] suggest it works together with formal mechanisms. A study conducted by Rosenbusch, et al. [40] supports the argument that solid interpersonal relationships play a vital role in handling complex multi-alliance structures and these relationships might block the advantages that structural diversity brings to a business. The research adds to existing academic discussions about this dispute by evaluating social embeddedness as it influences the connection between alliance diversity and innovation outcomes.

Alliances in the Chinese business environment encounter specific characteristics that probably shape their operational dynamics. The institutional environment of China features a combination of economic adjustment alongside powerful government participation which shapes both beneficial and unfavourable aspects of strategic partnerships and knowledge creation [41]. Alliance success within Chinese business culture depends heavily on guanxi personal connections due to their significance as fundamental social components [42]. Chinese late-entering industries result in specific methods for alliance creation and knowledge absorption by firms [43]. This research area lacks investigations about how alliance diversity affects innovation performance by means of internationalization and agility in the Chinese context even though studies have analysed alliance strategies in China [8]. The analysis of this important gap is essential because China continues to expand its position in worldwide innovation networks and its specific institutional factors create unique impacts on alliance results. Research gaps exist between studies about alliance diversity and internationalization and organizational agility as separate fields in the current literature. The separate developments within each stream create a synergistic theoretical opportunity for future research. Research in international entrepreneurship focuses on capability development through international operations [44] while missing connections between alliance diversity and this process. Current research in organizational agility focuses on internal capabilities at the expense of external alliance effects and their contribution to organizational agility [45].

3. Methodology

3.1. Research Design

This study employs a quantitative research design to examine the impact of alliance diversity on firm innovation performance, with a focus on the mediating roles of internationalization and organizational agility, as well as the moderating effect of social embeddedness. The research framework is grounded in structural equation modeling (SEM), which allows for the simultaneous analysis of multiple relationships between latent variables. The study adopts a cross-sectional survey approach, collecting data from high-tech firms in China to test the hypothesized relationships. The design ensures that the constructs alliance diversity, internationalization, organizational agility, social embeddedness, and innovation performance are measured reliably and validated through rigorous statistical techniques, including confirmatory factor analysis (CFA) and path analysis. The use of SEM enables the examination of both direct and indirect effects, providing a comprehensive understanding of the underlying mechanisms driving innovation performance in firms with diverse alliance portfolios.

3.2. Population and Sampling

The target population for this study consists of high-tech firms in China, specifically those located in Beijing, Shanghai, Shenzhen, Guangzhou, Tianjin, and Zhejiang. These regions were selected due to their significant contributions to China's GDP and their concentration of technologically advanced enterprises engaged in international collaborations. The sampling strategy employed a stratified random sampling technique to ensure representativeness across different geographic and industrial segments. The sampling frame was derived from the 2023 official list of high-tech enterprises published by China's National High-Tech Enterprise Certification Management System. Firms were included based on two key criteria: (1) engagement in international business activities and (2) participation in at least two strategic alliances. A total of 650 firms were initially selected, with questionnaires distributed

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proportionally across regions. After eliminating incomplete or inconsistent responses, 570 valid responses were retained, yielding an effective response rate of 87.69%.

3.3. Data Collection Procedure

Data collection was conducted through a structured survey questionnaire administered to senior managers, including CEOs, international business directors, and R&D leaders, who possessed in-depth knowledge of their firms' alliance strategies and innovation outcomes. The questionnaire was designed using established Likert-scale measures adapted from prior studies to ensure content validity. Prior to the main survey, a pilot test involving 170 respondents was conducted to refine question clarity and assess psychometric properties. The final survey was distributed electronically and followed up with telephone reminders to enhance participation rates. To minimize common method bias, procedural remedies such as ensuring respondent anonymity and separating scale items were implemented. Additionally, the survey included control variables such as firm age, size, ownership structure, and internationalization tenure to account for potential confounding effects.

3.4. Measures of Study

The study operationalizes key constructs using multi-item scales validated in prior literature. Alliance diversity was measured across two dimensions functional diversity (7 items) and technological diversity (3 items) adapted from Zollo, et al. [46] and Gao, et al. [47]. Innovation performance was assessed using a 6-item scale from Cordero [48] capturing product and process innovation outcomes. Internationalization degree was evaluated via a 6-item scale by Pangarkar [49] focusing on market expansion and resource commitment. Organizational agility was bifurcated into market capitalizing agility (3 items) and operational adjustment agility (3 items), based on Lu and Ramamurthy [50] framework. Social embeddedness was measured using a 6-item scale derived from Nahapiet and Ghoshal [51] emphasizing trust and collaborative norms. All constructs employed 5-point Likert scales (1 = strongly disagree; 5 = strongly agree), with higher scores indicating stronger agreement or capability.

3.5. Data Analysis Techniques

The data analysis consisted of multiple progressional stages. The reliability assessment through Cronbach's alpha showed all constructs-maintained values above 0.70 which demonstrates robust internal consistency. The construct validity was tested through exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) which showed sufficient results when factor loadings exceeded 0.60 and the average variance extracted (AVE) achieved values greater than 0.50. Tests based on the Fornell-Larcker criterion confirmed the achievement of discriminant validity. SEM in version 8.3 of Mplus was used to evaluate the proposed mediation and moderation effects within the study. The research utilized bootstrapping method (5,000 resamples) for testing indirect effects and applied moderated regression analysis through interaction testing for social embeddedness. The research model included control variables which allowed identification of predictor variables' direct effects.

3.6. Ethical Considerations

The research followed strict ethical protocols for guaranteeing both confidentiality and research integrity. Participant involvement occurred on a voluntary basis after obtaining consent from every respondent. Each response in this study remained untraceable because personal firm or individual identities were removed from collected information. The research method followed academic criteria to reduce potential harm and to prevent any deceptive study procedures. The study presented all research findings in a transparent manner without results reveal only through selected partial reports. The author obtained Institutional review board (IRB) authorization before starting data collection and all research processes followed international social science research standards.

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4. Empirical Findings

4.1. Descriptive Statistics and Sample Characteristics

The research obtained information from 570 high-tech firms located in main Chinese economic areas that included Beijing, Shanghai, Shenzhen, Guangzhou, Tianjin, and Zhejiang to ensure sectoral and company size diversity among different internationalization levels. Most companies included in the sample belonged to small or medium-sized enterprise category with 81.05% having worker numbers less than 1000 which demonstrates high-tech sector demands agility breastfeeding innovation. Current data demonstrates that Chinese tech enterprises show a rising global expansion trend as 21.93% of the firms exist in their initial internationalization period (≤3 years). The analyzed firms displayed robust strategic partnership and innovation activity based on Table 1 data because all variables exceeded average value (Mean > 4.0) of the 7-point Likert measurement scale.

Table 1.
Descriptive Statistics of Key Variables.

Variable	N	Min.	Max.	Mean	SD	Skewness	Kurtosis
Functional Diversity	570	1.29	7.00	4.272	1.241	-0.123	-0.471
Technological Diversity	570	1.00	7.00	4.23	1.509	-0.24	-0.801
Internationalization	570	1.17	7.00	5.039	1.087	-1.079	1.652
Innovation Performance	570	1.17	6.83	4.629	1.257	-0.51	-0.424
Market Agility	570	1.00	7.00	4.733	1.32	-0.592	0.026
Operational Agility	570	1.00	7.00	4.871	1.291	-0.622	0.093
Social Embeddedness	570	1.17	7.00	4.113	1.35	-0.101	-0.864

Table 1 shows internationalization (Mean = 5.039) and operational agility (Mean = 4.871) achieved the highest scores among all dimensions because the analyzed firms place the utmost emphasis on global market ventures along with operational flexibility. Organization data shows firms actively participate in alliances to achieve innovation performance (Mean = 4.629) and alliance diversity (Mean = 4.251). The statistical data shows a normal distribution pattern since all skewness and kurtosis measurements remain under ±2 which supports parametric analysis of the data. Strategic areas for innovation in China's high-tech sector include alliances and the development of agility and international expansion as main drivers according to these research findings.

Table 2.
Pearson Correlation Matrix of Key Variables.

Variable	1	2	3	4	5	6	7	8
1. Functional Diversity	1							
2. Technological Diversity	0.531**	1						
3. Internationalization	0.504**	0.467**	1					
4. Market Agility	0.486**	0.422**	0.428**	1				
5. Operational Agility	0.481**	0.369**	0.401**	0.550**	1			
6. Organizational Agility	0.549**	0.449**	0.471**	0.883**	0.877**	1		
7. Innovation Performance	0.532**	0.485**	0.483**	0.481**	0.480**	0.546**	1	
8. Social Embeddedness	0.091*	0.137**	0.093*	0.034	0.011	0.026	0.138**	1

Table 2 correlation matrix shows strong positive connections between all major variables where alliance diversity measures (functional: r=.532, p<.01; technological: r=.485, p<.01) and organizational agility (r=.546, p<.01) deliver strong results for innovation performance while internationalization establishes moderate connections to diversity elements and innovation outcomes (r=.504/.467/.483). Each social embeddedness relationship measures at .091 to .138 significance while demonstrating that the concept creates enabling contexts rather than driving innovation directly since the correlations remain under .70 and validate multiple variables for multivariate research to support the proposed connected innovation driver framework.

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4.2. Reliability and Validity

To ensure the robustness of the measurement model, the study assessed both reliability and validity of the constructs. Reliability was evaluated using Cronbach's alpha (α), while validity was examined through convergent and discriminant validity tests. The results confirmed that all scales demonstrated strong internal consistency and effectively measured their intended constructs without significant overlap, supporting the appropriateness of the measurement model for hypothesis testing.

Table 3.
Reliability and Convergent Validity Analysis.

Construct	Cronbach's α	Composite Reliability (CR)	Average Variance Extracted (AVE)
Functional Diversity	0.947	0.951	0.735
Technological Diversity	0.892	0.88	0.71
Internationalization	0.909	0.89	0.625
Market Agility	0.89	0.909	0.729
Operational Agility	0.89	0.932	0.729
Innovation Performance	0.931	0.921	0.697
Social Embeddedness	0.921	0.948	0.661

Table 3 to show high measurement validities and reliability rates across every construct included in the study. Each measure demonstrates excellent internal reliability because Cronbach's alpha values span from 0.892 to 0.947 above the recommended threshold of 0.70. All measurement scales possess high reliability according to Composite Reliability (CR) indicators with values between 0.880 to 0.951 because they exhibit significant shared variance between items that measure the same construct. The construct validity measurement of Average Variance Extracted (AVE) establishes satisfactory levels as all score from 0.625 to 0.735 surpasses the important threshold of 0.50 indicating each construct explains at least half of its indicator variance. The assessment of functional diversity and social embeddedness indicates the most reliable constructs with α scores of 0.947 and 0.921 and convergent validity surpassing 0.735 and 0.661. All constructs display CR values exceeding 0.70 while their AVE scores indicate the model keeps an acceptable level at 0.625 which confirms effective representation of their theoretical constructs by the items. The detection results strongly validate the use of these measurement instruments for assessing the proposed structural model relationships.

Table 4.
Discriminant Validity Assessment (Fornell-Larcker Criterion)

Construct	1	2	3	4	5	6	7
1. Functional Diversity	0.857						
2. Technological Diversity	0.531	0.842					
3. Internationalization	0.504	0.467	0.854				
4. Market Agility	0.486	0.422	0.428	0.79			
5. Operational Agility	0.481	0.369	0.401	0.55	0.835		
6. Innovation Performance	0.532	0.485	0.483	0.481	0.48	0.854	
7. Social Embeddedness	0.091	0.137	0.093	0.034	0.011	0.138	0.813

Table 4 through the Fornell-Larcker criterion demonstrates that every study construct maintains distinct empirical separation from other constructs. The mutual comparison between square root AVE measures ranging from 0.79 to 0.857 for all constructs exceeded the entire range of construct correlations between 0.011 and 0.55 thus validating discriminant validity. The reported pattern demonstrates that each underlying construct demonstrates better relationship with its assigned measures than with other model constructs. The evaluation shows that Social Embeddedness stands independently from other constructs because its correlations stay below 0.138 thus indicating its role as a singular contextual element. The relationship between alliance diversity dimensions (Functional and Technological Diversity) and Innovation Performance shows the highest level of strength at r = 0.485

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to r = 0.532 while maintaining sufficient discriminant validity. The correlation between Market and Operational Agility amounts to r = 0.55 yet the constructs demonstrate sufficient diversity to justify different modeling approaches. The measurement model delivers a sound foundation for future hypothesis testing and structural equation modeling because it detects seven separate theoretical constructs without measurement issues that could create confusion.

4.3. Hypothesis Testing Results

4.3.1. Direct Effects Analsyis

The structural equation model was employed to examine the direct effects of alliance diversity and internationalization on innovation performance. The results provide strong empirical support for all three hypotheses. Both functional and technological dimensions of alliance diversity demonstrated significant positive impacts on innovation performance (H1a/b), with functional diversity showing a slightly stronger effect (β = 0.385 vs. 0.311). Furthermore, alliance diversity was found to be a significant driver of internationalization (H2a/b), suggesting that firms with more diverse alliance portfolios are more likely to expand globally. The analysis also confirmed that internationalization positively contributes to innovation performance (H3), though with a relatively smaller effect size compared to alliance diversity.

Table 5.
Direct Effects Hypothesis Testing.

Hypothesis	Relationship	Standardized β	S.E.	t-value	p-value	Supported?
H1a	Functional Diversity → Innovation Performance	0.385	0.044	8.749	<0.001	Yes
H1b	Technological Diversity → Innovation Performance	0.311	0.046	6.698	<0.001	Yes
H2a	Functional Diversity → Internationalization	0.349	0.049	7.13	<0.001	Yes
H2b	Technological Diversity → Internationalization	0.318	0.048	6.558	<0.001	Yes
H3	Internationalization → Innovation Performance	0.132	0.054	2.455	0.014	Yes

Table 5 results indicate that functional alliance diversity produces slightly stronger effects than technological diversity when it comes to innovation performance measurements. The statistical analysis demonstrates that alliance diversity functions as a key precursor to internationalization because functional and technological diversity produce equal effect magnitudes. The impact of internationalization on innovation performance existed but proved to be smaller than the immediate alliance diversity effects. Statistical significance at $p < 0.05$ confirmed all direct effects in our theoretical model. Alliance diversity emerges as a vital factor for creating innovation and facilitating organizations' international growth which leads to better innovation performance outcomes.

Figure 1 confirms that both functional and technological alliance diversity have significant positive effects on innovation performance, with functional diversity showing a slightly stronger impact. The excellent model fit indices (CFI, TLI > 0.99; RMSEA, SRMR < 0.05) indicate that the hypothesized direct relationships are well-supported by the data.

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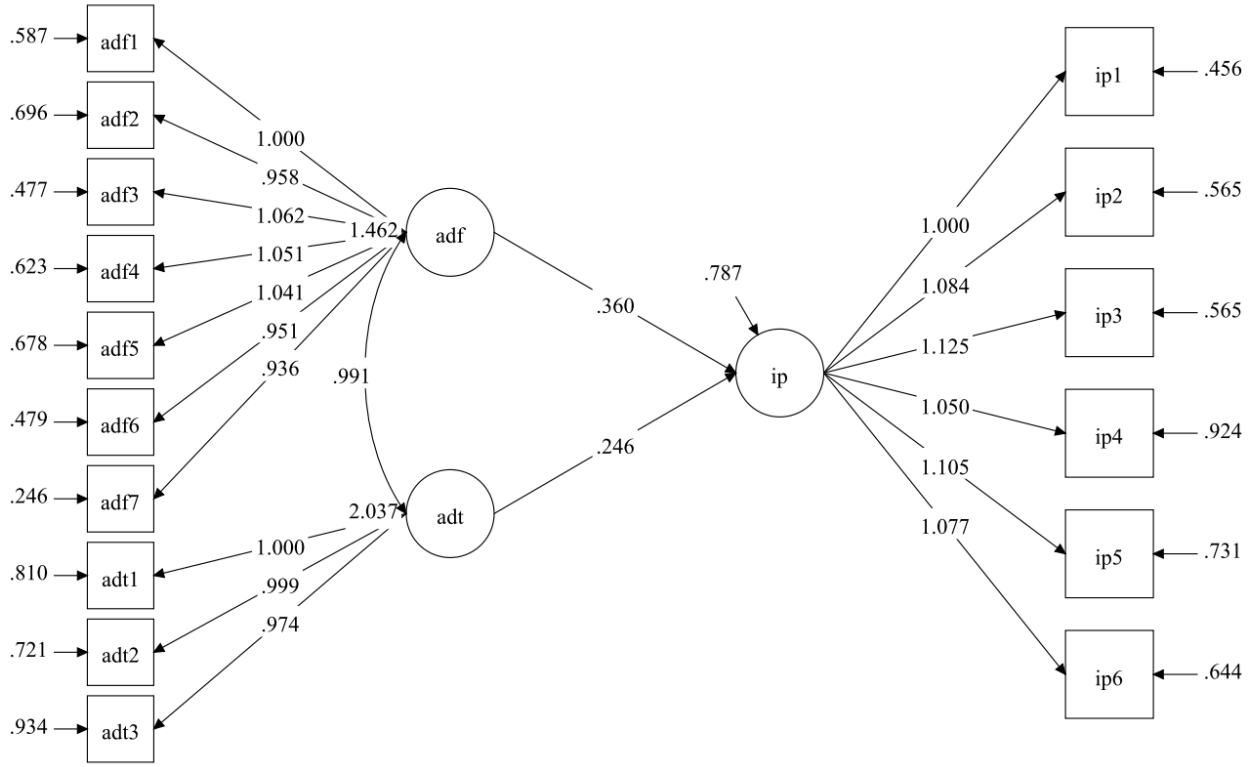

Figure 1.
Direct Effects Model Fit Diagram.

4.3.2. Mediation Effects Analysis

The mediation analysis revealed significant indirect pathways through which alliance diversity influences innovation performance. Organizational agility was found to fully mediate the relationship between alliance diversity and innovation ($\beta = 0.422$, $p < 0.05$), suggesting that the benefits of diverse alliances are largely channeled through enhanced organizational adaptability. Internationalization demonstrated partial mediation ($\beta = 0.046$, 95% CI [0.009, 0.093]), indicating it serves as an additional but less prominent pathway. Most notably, a significant serial mediation effect emerged ($\beta = 0.038$, $p < 0.01$), where alliance diversity first promotes internationalization, which in turn enhances organizational agility, ultimately leading to improved innovation performance. These findings highlight the complex, multi-stage process through which alliance diversity contributes to innovation outcomes.

Table 6.
Mediation Effects Analysis.

Hypothesis	Mediation Pathway	β	SE	95% CI	p-value	Supported
H1	Alliance Diversity → Internationalization → Innovation	0.046	0.021	[0.009, 0.093]	0.031	Yes
H2-H4	Alliance Diversity → Organizational Agility → Innovation	0.175	0.048	[0.102, 0.290]	<0.001	Yes
H5	Alliance Diversity → Internationalization → Organizational Agility → Innovation	0.038	0.014	[0.018, 0.072]	0.005	Yes

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Table 6 presents three key mediation pathways: (1) the standalone effect through internationalization (H4), (2) the standalone effect through organizational agility (H5-H7), and (3) the serial mediation through both internationalization and organizational agility (H8). The confidence intervals for all pathways exclude zero, confirming their statistical significance. The strongest mediation effect occurs through organizational agility alone ($\beta = 0.175$), while the serial mediation, though smaller in magnitude ($\beta = 0.038$), reveals an important sequential mechanism by which alliance diversity enhances innovation performance. These results underscore the importance of considering both direct and indirect pathways when examining the innovation benefits of alliance diversity.

Figure 2 shows structural equation modeling (SEM) diagram illustrates the mediation mechanisms through which alliance diversity (functional & technological) influences innovation performance, with internationalization and organizational agility as mediators.

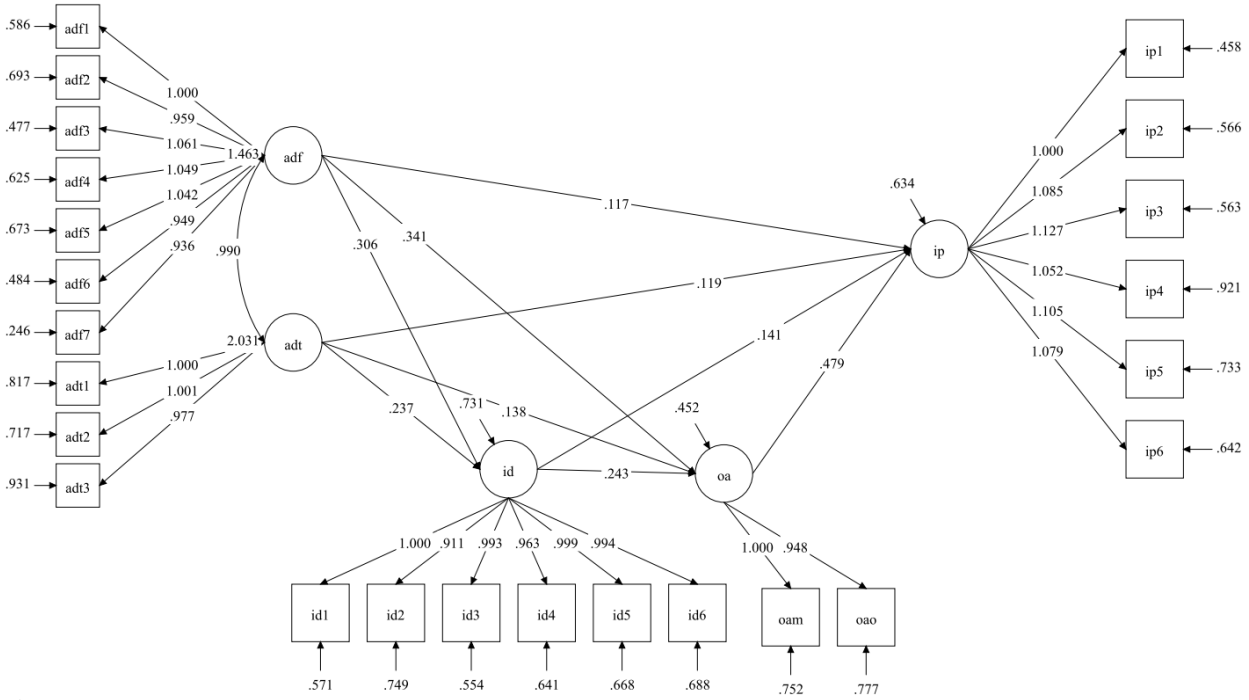

Figure 2.
Mediation Effect Model Fit Diagram.

4.3.3. Moderation Effects

The analysis of moderation effects revealed that social embeddedness significantly enhances the positive relationships between key strategic factors and innovation performance. As hypothesized, social embeddedness acts as a crucial contextual factor that strengthens the innovation benefits derived from alliance diversity, internationalization, and organizational agility. The interaction effects were all statistically significant and positive, indicating that firms with stronger social networks and relational capital are better positioned to translate their strategic initiatives into superior innovation outcomes. These findings underscore the importance of social capital in maximizing the returns from various innovation-enhancing strategies.

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Table 7.
Moderation Effects of Social Embeddedness.

Hypothesis	Interaction Effect	Standardized β	S.E.	t-value	p-value	Supported?
H10a	Functional Diversity × Social Embeddedness → Innovation	0.316	0.042	7.525	<0.01	Yes
H10b	Technological Diversity × Social Embeddedness → Innovation	0.244	0.034	7.158	<0.01	Yes
H11	Internationalization × Social Embeddedness → Innovation	0.226	0.046	4.942	<0.01	Yes
H12	Organizational Agility × Social Embeddedness → Innovation	0.239	0.079	3.038	<0.01	Yes

Table 7 shows an analysis of moderation shows that social embeddedness strengthens the positive relationship between three strategic elements and innovative performance at all times. The combination of functional alliance diversity with social embeddedness produced the greatest interaction effect of 0.316 on innovation performance. The results show that social embeddedness effectively boosts the innovation benefits of various collaborative arrangements when viewing them from both functional and geographical aspects (H10a/b). Social networks contribute to improved global opportunity extraction and organizational adaptability by performing a positive role of moderation involving internationalization (H11) and organizational agility (H12). Statistical tests at $p < 0.01$ confirmed the significance of all moderation effects which strongly support the proposed enhancement of social embeddedness on innovation processes.

Figure 3 demonstrates how social embeddedness significantly strengthens ($\beta = 0.316$, $p<0.001$) the positive relationship between functional alliance diversity and innovation performance. The interaction effect suggests that firms with strong social networks derive greater innovation benefits from functionally diverse alliances. All specified paths are statistically significant (***$p<0.001$, **$p<0.01$) and the overall model demonstrates excellent fit with the empirical data.

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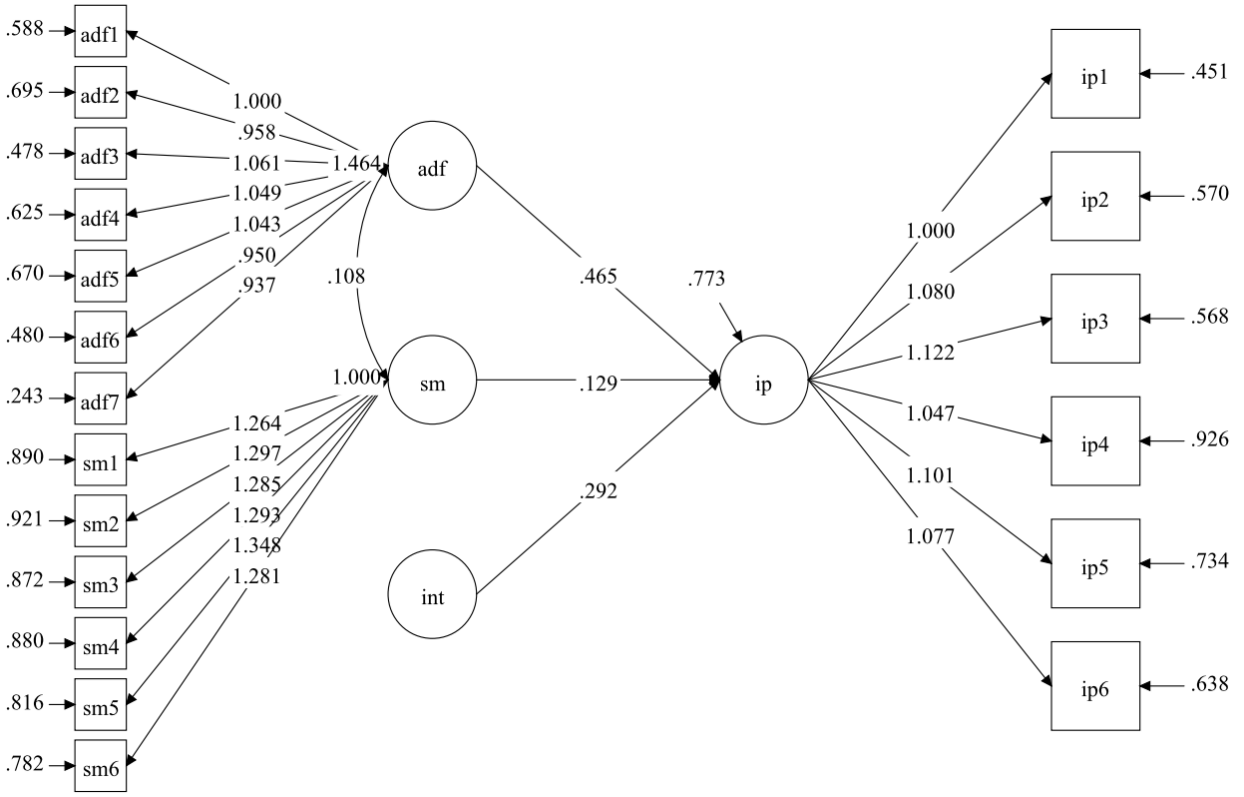

Figure 3.
Model Fit Diagram of the Moderating Effect of Social Embeddedness on the Relationship Between Functional Alliance Diversity and Innovation Performance.

4.4. Robustness Checks

Several robustness tests were performed to verify the reliability of our results because we wanted to address possible methodological issues. Harman's single-factor test showed no dominant factor (largest factor = 36.85%) surpassed the 40% threshold thus indicating common method variance did not impair our research findings. The analysis of non-response bias through comparison of early and late respondents on key firm characteristics found no statistically significant differences (*p* > 0.05) which indicated that non-response bias would not impact our study conclusions. The verification procedures increase the confidence in the validity together with the generalizability of our empirical research results.

Table 8.
Robustness Checks.

Test	Method	Result	Threshold	Conclusion
Common Method Bias	Harman's Single-Factor Test	Largest factor explains 36.85% variance	<40%	No severe bias
Non-Response Bias	Early vs. Late Respondent Test	No significant differences (*p* > 0.05)	*p* > 0.05	No bias detected

Table 8 shows additional tests allowed researchers to verify that the study measurements remain stable regardless of the evaluation method used. The research design provides evidence that measurement methods did not overstate relationships between the study variables. The target population alignment demonstrated by non-response bias enhances external validity because the sample proves to adequately represent its members. The pilot tests add credibility to the study's findings about

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the associations between alliance diversity and internationalization with agility and innovation performance.

5. Discussion

The investigation in this article strengthens the foundation of literature regarding alliance diversity as well as internationalization and innovation performance through its exploration of organizational agility mediation and social embeddedness moderation roles. Studies show that alliances using diverse functions alongside technology battles in a positive manner to boost innovation outcomes as previous research showed [17, 47]. Functional diversity exerted stronger effects ($\beta = 0.385$) than technological diversity ($\beta = 0.311$) which indicates that cross-functional collaboration brings more extensive strategic advantages beyond raw technological sharing who argue alliances produce multifield benefits [18, 32, 33]. International operations proved to have beneficial effects on innovation performance ($\beta = 0.132$) according to the study thus supporting the knowledge-based view of the firm [14, 34]. Internationalization works as an enabling condition to facilitate innovation activity yet produces a weaker result than alliance diversity effects [15, 29, 30]. Organizational agility functions as a key factor through which alliance diversity produces innovation results exhibiting a powerful total effect ($\beta = 0.422$). The research confirms and develops the findings of Gunawan, et al. [19] about organizational agility by showing its vital position in alliance-based innovation procedures. The third theoretical contribution through serial mediation shows that diversity in alliances drives internationalization to create agile organizations leading to improved innovation performance. These results confirm the dynamic capabilities framework because they show how alliances generate market internationalization which leads to innovative capabilities ($\beta = 0.038$). Market capitalizing agility ($\beta = 0.415$ for functional diversity) stands out as superior to operational adjustment agility since it proves essential for exploiting market opportunities in innovation contexts.

The moderating role of social embeddedness represents another significant contribution, with all three interaction effects (ranging from $\beta = 0.226$ to 0.316) being statistically significant. These findings strongly support [22] social capital theory by demonstrating how relational embeddedness enhances the innovation returns from strategic initiatives. The particularly strong moderation effect for alliance diversity ($\beta = 0.316$) suggests that social capital may be especially valuable in managing the coordination challenges of diverse alliances, echoing [27] arguments about the governance benefits of social embeddedness. The universal positive moderation across all main relationships indicates that social embeddedness serves as a general enhancer of innovation processes rather than being strategy-specific.

5.1. Practical Implications

The research findings present crucial operational recommendations which business leaders can use to build better innovation performance. Managers should prioritize diverse partnership formation because both functional and technological alliance diversity demonstrate positive results which favor selecting complementary collaborations between different functional areas. The primary mechanism through which organizations should invest in dynamic capabilities stems from organizational agility because it allows quick adaptation to market shifts and efficient external information assimilation. Social networks prove critical for innovation success because they enhance the advantages of alliances and internationalization and organizational agility. High-tech firms succeed in innovation by combining strategic partnerships with multinational business presence and adaptable internal systems along with social network development.

6. Conclusion & Recommendations

Research findings also show that alliance diversity based on functional and technological aspects is powerful evidence for the innovation performance from the alliance. The alignment benefit increases because organizations employ two principal channels that are concomitant of the international

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operations and agile business responses. It is shown that the better resulting from innovation companies got from diverse strategic alliances (international expansion), the more from them benefited in becoming more adaptable organizationally. The most impactful factor as far as social embeddedness is concerned is because it amplifies the positive relations between strategic initiatives and innovation performance. This contributes new evidence about crucial strategic elements working in combination for innovation hubs, where internal capabilities development goes in conjunction with external networking efforts. An all-inclusive analytical framework for explaining innovation in a technological industry involves alliance diversity with international business coupled with organizational agility, bringing the study of alliance diversity to the international business and organizational agility discourse. We need multiple such recommended actions to be implemented by the practitioners and researchers. The investigation shows to business leads the establishment of broad wide-ranging partnerships combined with agility development initiatives, which yield essential results. Organisations should concentrate primarily on the establishment of social capital because it creates amplified benefits from their core strategic leadership activities. In terms of research results obtained from it, you can say that policymakers must bring programs to facilitate the international business alliances and knowledge sharing to produce considerable innovation gain. Future studies must investigate these effects in various organizational cultures and institutions by implementing long-term research methods to track time-sensitive relationships. Qualitative research methods should be used to uncover the detailed processes by which social embeddedness supports innovation success at the individual organizational level. This paper provides an essential theoretical framework which benefits both academic advancement and industrial innovation practice in modern interconnected business networks.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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