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# Vertical Network Relationships, Technological Capabilities, and Innovation Performance: The Moderating Role of Strategic Flexibility

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**Abstract:** Innovation is the key driver for companies to maintain sustainable growth. In an open innovation environment, leveraging network relationships is an effective way to obtain the resources required by an enterprise to improve its innovation performance. However, existing studies have not reached a consensus on whether network relationships are favorable to innovation activities. This study aims to fill this gap using resource-based theory and social network theory. It examines the paths through which and the conditions under which vertical network relationships affect innovation performance. The empirical results show that: (1) vertical network relationships have a significant positive effect on innovation performance; (2) strategic flexibility positively regulates vertical network relationships and innovation performance; and (3) technological capabilities have a significant positive effect on innovation performance and play a mediating role between vertical network relationships and innovation performance. This study reveals the intrinsic mechanism whereby network relationships affect innovation performance and provides new ideas for how companies can improve their innovation performance and thus achieve sustainable development.

**Keywords:** vertical networks; technological capabilities; strategic flexibility; innovation performance



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## 1. Introduction

With continuous changes in the external economic environment and increasingly fierce competition, China's economic development is going through a crucial period of replacing the old drivers of growth with new ones. To promote high-quality economic development, the key is to shift the growth engine from the factors of production to innovation. With technology and new product life cycles becoming shorter and shorter, firms need to continuously improve their innovation capabilities to achieve sustainable development. Open innovation poses new challenges for firms in developing countries. It is difficult for enterprises to satisfy their high-level innovation requirements by relying only on their own internal resources, and they must break through organizational boundaries and establish cooperative network relationships to obtain information and resources [1]. Effective use of network relationships is an important factor in enhancing technological innovation [2]. Due to the changing ways in which firms collaborate, research has begun to focus on the impact of different types of collaborative relationships on innovation. Vertical network relationships with suppliers and customers are an important source of innovation resources for companies [3]. Vertical networks are an important part of social networks. Vertical network relationships influence firms' strategic decisions and business activities. Therefore, how firms use vertical network relationships to influence their innovation activities and thus achieve sustainable development deserves in-depth study.

Existing studies mainly focus on the direct impact of network relationships on innovation performance. Some studies suggest that embedding network relationships has a

positive impact on innovation performance [4], while others suggest that the relationship is negative [5,6] or has an inverted U-shape [7]. It is evident that the results of studies on the impact of network relationships on innovation are inconsistent, which may be due to neglect of how the cooperation relationship between enterprises affects innovation performance; that is, the mechanism whereby network relationships affect innovation performance needs to be further explored. On the one hand, many existing studies have explored the direct impact of networks on innovation performance; in reality, this relationship may be indirect. It has been demonstrated that technological capabilities have an impact on innovation performance [8]. However, few studies have attempted to put network relationships, technological capabilities, and innovation performance together in the same framework, and whether technological capabilities can act as a mediating path for embedding relationships to affect innovation performance remains to be explored. Studying the relationship between the three has the potential to open the black box of the impact of network relationship embedding on innovation performance. On the other hand, the impact of network relationships on innovation performance may be influenced by other conditional factors. Because of the heterogeneity of the resources acquired through embedding external network relationships and due to firms' dependence on their original resources, firms may be reluctant to accept or utilize new resources [9]. To adapt to changes in the external environment, firms must develop dynamic capabilities that allow them to use new resources. Strategic flexibility is considered a dynamic capability, and firms with high levels of strategic flexibility reallocate and reuse resources in response to changes in the external environment [10], thereby reducing resource dependence and enabling them to absorb and utilize new external resources. Some studies have shown the positive effect of strategic flexibility on innovation performance [11]; however, whether strategic flexibility can moderate the effect of network relationships on innovation performance remains to be studied. With this in mind, this study constructs and validates a theoretical model of the network-resource-capability-performance relationship using resource-based theory and social network theory. We conducted a deep exploration of the impact of vertical network relationships on innovation performance by introducing technological capabilities as a mediating variable and strategic flexibility as a moderating variable.

It is meaningful for this study to take high-tech enterprises as its research object. In China, high-tech enterprises are restricted by many factors in their development processes, such as a lack of knowledge or technology, a shortage of innovative talents, and limited R&D investment and ability. It is difficult for enterprises to realize technological innovation by relying on their own resources alone. Therefore, high-tech enterprises need partners, such as suppliers or customers, to establish network relationships and obtain more information and resources. This study addresses the following questions: First, it explores whether and to what extent vertical network relationships have an impact on innovation performance. Second, it examines whether technological capabilities play a mediating role in the relationship between vertical network relationships and innovation performance. Finally, it investigates whether strategic flexibility plays a moderating role in the relationship between vertical network relationships and innovation performance. Theoretically, this paper explores the relationship paths between vertical network relationships, technological capabilities, and innovation performance, opens the black box of the three relationships from the perspective of social networks, and deepens our understanding of the situational factors affecting the impact of network relationships on innovation by verifying the moderating effect of strategic flexibility on the impact of vertical network relationships on innovation performance. This study provides new ideas about how high-tech companies can use network relationships to improve innovation performance and thus achieve sustainable growth.

## 2. Theoretical Analysis and Research Hypotheses

### *2.1. Vertical Network Relationships*

Network relationships are a type of social capital that enables enterprises to obtain certain competitive advantages [12]. The resource dependency view holds that it is impossible for firms to obtain all the resources they need by themselves and that firms need to obtain these resources by establishing interactive relationships with network partners to compensate for their own resource deficiencies [13]. Granovetter argued that relationships embedded in a network affect economic behavior [14], and this view has been accepted by many scholars. Tsai defined network relationships as the extent to which members are interconnected with each other in a network [15]; this interaction between members includes contacts and transactions [16,17]. Network relationships can be divided into vertical and horizontal networks [18]. "Vertical network relationships" refer to the relationships between firms and their suppliers and customers, whereas "horizontal network relationships" refer to the relationships between firms and universities, research institutions, governments, and financial and intermediary institutions. Vertical network partners can have more complementary resources and technologies for the focal firm because of the different types of industries to which they belong, whereas horizontal network partners generally belong to the same industry, and the resources and technologies acquired by the focal firm from them tend to have a high degree of redundancy [14]. Because different types of network relationships have heterogeneous resource endowments, there may also be differences in their impact on innovation. Further, building relationships with external suppliers and customers is one of a firm's main goals, and these relationships are one of the primary sources of information for the firm. This paper will look at vertical network relationships. Since different suppliers and customers have different knowledge systems, the degree to which the focal firm's relationships with suppliers and customers affect the firm's innovation performance will differ. We propose to study the relationships in a vertical network between the focal firm and its suppliers and customers separately. Extant studies have focused less on network relationship depth (network relationship quality) [19]; this paper focuses on the effect of vertical network relationship depth (network relationship quality) on innovation performance.

### *2.2. Vertical Relationship Networks and Innovation Performance*

Based on the resource-based view (RBV), the interrelationships between firms embedded in the network are called network resources, which are not easily imitated by competitors in the short term [20]. By effectively using network resources, companies can guarantee a competitive advantage for themselves and achieve sustainable development. Firms use network relationships to gain new knowledge and information, and strong relationships provide access to complex and invisible knowledge that can stimulate innovative activities and thus promote innovative performance [21]. Deciding to collaborate with different firms is an important strategic choice for firms, and firms tend to rely more on vertical relationships with suppliers and customers as resources in the innovation process [22]. Cooperation with suppliers provides access to relevant information and knowledge about the latest technologies [23], which in turn reduces risk in product development, improves the firm's adaptability to the market [24], and thus shortens the innovation cycle. Relationships with customers can identify potential customer needs and provide market information for developing business innovations. Building a trusting relationship with customers plays a very important role in a firm's innovation [25]. Strong relationships in the network are vital to the effective use of network relationship resources [26], and it is easy to form a common innovation goal with partners, which will create a synergistic effect and thus enhance innovation performance. Therefore, the following hypotheses are proposed:

**Hypothesis 1a (H1a).** *Relationships with suppliers in a vertical network have a positive impact on innovation performance.*

**Hypothesis 1b (H1b).** *Relationships with customers in a vertical network have a positive impact on innovation performance.*

### *2.3. Vertical Network Relationships and Technological Capabilities*

There is strong heterogeneity in technologies and resources among partners in vertical networks because they belong to different types of industries [27–29]. Firms can obtain heterogeneous knowledge from network-embedded relationships [30], and access to innovation resources for firms needs to come mainly from customers and suppliers [31–33]. Networking with customers and suppliers allows companies to access external information and knowledge from partners, which allows them to perceive more technological opportunities and better understand changing technological trends. On the one hand, trusting relationships with customers and suppliers can facilitate knowledge sharing and collaboration among partners, thus improving firms' technological capabilities. On the other hand, trust relationships facilitate the transfer of complex tacit knowledge and thus improve a firm's technological capabilities. Therefore, the following hypotheses are proposed:

**Hypothesis 2a (H2a).** *Relationships with suppliers in a vertical network have a positive impact on technological capabilities.*

**Hypothesis 2b (H2b).** *Relationships with customers in a vertical network have a positive impact on technological capabilities.*

### *2.4. Technological Capabilities and Innovation Performance*

Based on the resource-based view, technological capabilities reflect firms' ability to use various technological resources [34]. Technological capabilities are the ability to accumulate technical knowledge [35] and consist mainly of skills, experience, and knowledge [36].

The essence of technological capability is knowledge [37]. The accumulation of technological knowledge improves firms' ability to use new technologies for innovation [38], which allows them to identify new technological trends and engage in product innovation beyond current technologies. On the one hand, the accumulation of technical knowledge enhances the absorptive capacity of the firm, and a high level of technological capability helps firms make better use of available expertise [39]. On the other hand, firms with more technological capabilities can access more information and gain a greater advantage when combined with their existing knowledge bases. Some studies have shown that technological capabilities can facilitate developmental learning and promote incremental innovation [40]. Therefore, technological capabilities can contribute to innovation performance. Based on this, the following hypothesis is proposed:

**Hypothesis 3 (H3).** *Technological capabilities have a positive effect on innovation performance.*

### *2.5. The Mediating Role of Technological Capabilities*

The relationship with the supplier in the network relationship enables the company to gain critical knowledge and information about the technical aspects of the product [41]. The relationship with the customer reduces information asymmetry and allows access to the resources needed in response to dynamic changes in the external environment [42]. Core resources such as key technologies can only be acquired in vertical networks by enhancing the relationships between companies and their suppliers and customers in terms of communication, trust, communication, and information sharing. The more complementary knowledge possessed, the lower the transaction costs [43], which facilitates technology development capability [44,45]. Cooperation with enterprises is an important way to improve technological capabilities [46], which are accumulated from past experience and

reflect the ability to use various technological resources. Technological capabilities can provide firms with new ideas, allowing them to innovate and eventually transform these ideas into new products or services [47]. The improvement of technological capabilities enables firms to make better use of existing expertise [39] and facilitates the enhancement of absorptive capacity [48], thus enhancing innovation performance. Therefore, technological capabilities play a mediating role in the process whereby vertical network relationships affect innovation performance. Therefore, the following hypothesis is proposed:

**Hypothesis 4a (H4a).** *Technological capabilities mediate between relationships with suppliers and innovation performance.*

**Hypothesis 4b (H4b).** *Technological capabilities mediate between relationships with customers and innovation performance.*

### *2.6. The Moderating Role of Strategic Flexibility*

Strategic flexibility is a way for firms to gain a competitive advantage [49]. Based on the capability view, strategic flexibility is considered a dynamic capability. This dynamic capability enables the flexible use of resources and their reconfiguration [50], which allows the firm to overcome organizational inertia and adapt quickly to changes in the external environment by making adjustments to the firm. To obtain external network resources, firms must solve the problem of reliance on dedicated resources and the increased costs of resource reconstruction. The reliance on dedicated resources makes firms reluctant to establish relationships with suppliers and customers to obtain network resources, and only high strategic flexibility can break firms' reliance on their original dedicated resources and lower resource reconstruction costs [51], allowing the firm to establish cooperation with suppliers or customers in the vertical network to obtain external resources. For example, firms that are strategically flexible are more likely to obtain information regarding updates to raw materials through their relationships with suppliers, while they are more likely to obtain information about the latest products through their relationships with customers. That is, strategically flexible firms are more willing to strengthen partnerships with suppliers and customers that enhance innovation performance through the upstream and downstream market knowledge, manufacturing knowledge, etc. that they provide to the firm. In addition, firms with high strategic flexibility are more willing to build trust with their partners, and trust promotes knowledge sharing and collaboration among partners, thus improving the firm's innovation performance [52,53]. That is, strategic flexibility positively moderates the effect of vertical network relationships on innovation performance. Therefore, the following hypotheses are proposed:

**Hypothesis 5a (H5a).** *Strategic flexibility positively moderates the impact of relationships with suppliers on innovation performance.*

**Hypothesis 5b (H5b).** *Strategic flexibility positively moderates the impact of relationships with customers on innovation performance.*

The theoretical framework of this study is shown in Figure 1.

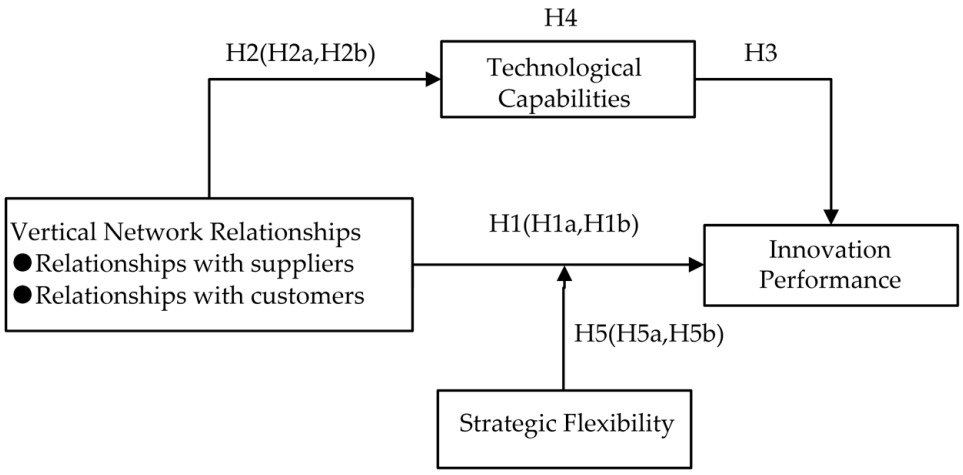


**Figure 1.** Theoretical framework.

## 3. Research Design

### *3.1. Sample and Data*

This paper takes high-tech enterprises as its research object. The data required for this study were obtained by means of a questionnaire survey, and an appropriate scale was formed by drawing on existing mature scales available in the literature that are relevant to the research needs of this paper. A total of 358 questionnaires were distributed, of which 280 were returned (a return rate of 78.2%). Out of these, 66 invalid questionnaires were excluded, leaving 214 valid questionnaires (a valid return rate of 76.43%). The industries studied include electronic and communication equipment manufacturing, medical equipment and instrumentation manufacturing, computer and office equipment manufacturing, and pharmaceutical manufacturing. The age of the enterprises studied is mainly 4–10 years, accounting for 70% of the total. In China, enterprises are either state-owned or non-state-owned in nature, with state-owned enterprises accounting for 51% of respondents and non-state-owned enterprises accounting for 49%. Enterprises with more than 100 employees accounted for 97% of the total. Large enterprises accounted for 28%, and SMEs accounted for 72%.

### *3.2. Variable Measurement*

The questionnaire design of this study was based on well-established scales commonly used in the literature. A 5-point Likert scale was used, with 1 standing for "strongly disagree" or "very low" and 5 standing for "strongly agree" or "very high".

#### 3.2.1. Dependent Variables

Drawing on Manu [54] and Hagedoorn and Gloodt [55], the research results used four question items to measure innovation performance. Each measurement item includes: (1) Companies have more patents; (2) Companies have a high number of new products; (3) The new products have a high sales-to-revenue ratio; and (4) The new products developed have high technological content.

#### 3.2.2. Independent Variables

Vertical network relationships include relationships with customers and suppliers. Vertical network relationships were measured using four items based on studies by McEvily and Marcus [56] and Nyaga and Whipple [57]. Four items were used to measure vertical network relationships with customers and suppliers, respectively. Each measurement item includes: (1) trust with suppliers (Customers); (2) communication with suppliers (customers); (3) sharing information with suppliers (customers); and (4) commitment to suppliers (customers).

#### 3.2.3. Mediating Variables

Following Day [58], J. Lee [59], and Song et al. [60], technological capabilities were measured using three question items. Each measurement item includes: (1) a great deal of investment in research and development; (2) the ability to develop new products; and (3) the ability to develop technology.

#### 3.2.4. Moderating Variables

Referring to Brozovic [61] and Sanchez [62], three items were used to measure strategic flexibility. The specific measurement items include: (1) facilitating the rapid discovery of new uses for existing resources; (2) facilitating the integration of resources to adapt to dynamic environmental changes; and (3) facilitating the rapid discovery of new uses for partner resources.

#### 3.2.5. Control Variables

In this study, industry, firm size, firm age, and firm nature will be used as control variables. Firm age and firm size are used as control variables because firm age and firm size have an effect on innovation performance [63,64]. According to the existing literature [17], firm age is measured by the time the firm was founded (1 = 3 years and below, 2 = 4–6 years, 3 = 7–10 years, 4 = 10 years or more). Firm size is measured by the number of employees (1 = fewer than 100 employees, 2 = 101–500 employees, 3 = 501–1000 employees, and 4 = more than 1000 employees). The impact of enterprise nature and industry on innovation may vary in China, so enterprise nature and industry type are used as control variables. The nature of the enterprises was divided into state-owned and non-state-owned enterprises (1 = state-owned enterprises, 2 = non-state-owned enterprises). Industry types include electronic and communication equipment manufacturing, medical equipment and instrument manufacturing, computer and office equipment manufacturing, and pharmaceutical manufacturing, which are represented by 1, 2, 3, and 4, respectively.

## 4. Results

### *4.1. Reliability and Validity Tests*

The reliability and validity tests are shown in Table 1. The reliability test is measured using the Cronbach's alpha coefficient, and the Cronbach's alpha values of all variables in this study are greater than 0.70, which indicates that the questionnaire has good reliability. The factor loading values are all greater than 0.60, indicating good convergent validity. The combined reliability (CR) of each variable is greater than 0.70, and the average variance of extraction (AVE) is greater than 0.50, indicating strong convergent validity among the variables. The $\chi^2$/df values of the model are all less than 3, the RMSEA is less than 0.08, and the values of CFI, GFI, and AGFI are all greater than 0.80. The indicators reached the ideal level, proving that the validity of the scale is very good.

**Table 1.** Reliability and validity tests.

| Variable | Items | Factor Loading | Ave | CR | Cronbach's Alpha |
|---|---|---|---|---|---|
| Vertical Relationship Network | Trust with suppliers | 0.849 | 0.696 | 0.902 | 0.891 |
| | Communicate with suppliers | 0.841 | | | |
| | Share information with suppliers | 0.801 | | | |
| | Commitment with suppliers | 0.846 | | | |
| | Trust with clients | 0.817 | 0.641 | 0.877 | 0.868 |
| | Communication with Customers | 0.832 | | | |
| | Share information with customers | 0.769 | | | |
| | Commitment with customers | 0.782 | | | |

**Table 1.** *Cont.*

| Variable | Items | Factor Loading | Ave | CR | Cronbach's Alpha |
|---|---|---|---|---|---|
| Technological Capabilities | A lot of investment in research and development | 0.600 | 0.500 | 0.742 | 0.869 |
| | Ability to develop new products | 0.747 | | | |
| | Ability to develop technology | 0.757 | | | |
| Strategic Flexibility | Facilitates the rapid discovery of new uses for existing resources | 0.751 | 0.575 | 0.802 | 0.788 |
| | Facilitate the integration of resources to adapt to dynamic environmental changes | 0.761 | | | |
| | Facilitate the rapid discovery of new uses for partner resources | 0.762 | | | |
| Innovation Performance | Companies have more patents | 0.838 | 0.652 | 0.882 | 0.728 |
| | High number of new products | 0.782 | | | |
| | New products have a high sales to revenue ratio | 0.863 | | | |
| | New products developed with high technological content | 0.741 | | | |
| Suitability index value | | $\chi^2/df = 1.397$; RMSEA = 0.047; GFI = 0.903; AGFI = 0.867; CFI = 0.979 | | | |

### 4.2. Descriptive Statistics and Correlation Analysis

The means, standard deviations, and correlation coefficients of the variables are presented in Table 2, from which it can be seen that there are significant correlations (Pearson coefficients) between the main variables.

**Table 2.** Means, S.D., correlation coefficients of variables.

| Variables | Mean | S.D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Firm age | 2.790 | 0.871 | 1 | | | | | | | | |
| 2. Firm size | 2.865 | 0.853 | 0.751 ** | 1 | | | | | | | |
| 3. Nature of enterprise | 1.491 | 0.501 | 0.033 | 0.090 | 1 | | | | | | |
| 4. Industry type | 2.154 | 1.070 | −0.046 | −0.018 | 0.173 | 1 | | | | | |
| 5. Relationship with suppliers | 3.349 | 0.788 | 0.015 | −0.090 | 0.031 | 0.051 | 1 | | | | |
| 6. Relationship with customers | 3.354 | 0.752 | −0.010 | −0.097 | −0.011 | 0.001 | 0.884 ** | 1 | | | |
| 7. Strategic Flexibility | 3.385 | 0.842 | 0.091 | 0.052 | −0.032 | 0.007 | −0.092 | −0.189 | 1 | | |
| 8. Technical capability | 3.163 | 0.630 | −0.004 | −0.051 | 0.003 | −0.038 | 0.783 ** | 0.794 ** | −0.080 | 1 | |
| 9. Innovation performance | 3.328 | 0.805 | 0.027 | −0.079 | −0.020 | −0.011 | 0.877 ** | 0.793 ** | 0.067 | 0.799 ** | 1 |

Notes: ** $p < 0.05$.

### 4.3. Direct Effect Analysis

As shown in Table 3, Models 1 and 7 use firm age, firm size, firm nature, and industry type as control variables. Models 2 and 3 show the effect of vertical network relationships on innovation performance. Model 2 shows that relationships with suppliers have a positive effect on innovation performance ($\beta = 0.879$, $p < 0.01$). Model 3 shows a positive effect of relationships with customers on innovation performance ($\beta = 0.788$, $p < 0.01$). The results indicate that vertical network relationships positively affect innovation performance. Hypotheses 1a and 1b are verified. Models 8 and 9 show the effect of vertical network relationships on technological capabilities. Model 8 shows a positive effect of relationships with suppliers on technological capabilities ($\beta = 0.800$, $p < 0.01$). Model 9 shows a positive effect of relationships with customers on technological capabilities ($\beta = 0.796$, $p < 0.01$). The results indicate that vertical network relationships positively affect technological capabilities, so Hypotheses 2a and 2b are verified. The results reveal that more network resources can be obtained by building good network relationships with

suppliers and customers. Model 4 shows that technological capabilities have a positive effect on innovation performance (β = 0.794, $p < 0.01$). Hypothesis 3 is verified.

**Table 3.** Main and mediating effects test.

| | Dependent Variable: Innovation Performance | | | | | Dependent Variable: Technological Capabilities | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Model 1** | **Model 2** | **Model 3** | **Model 4** | **Model 5** | **Model 6** | **Model 7** | **Model 8** | **Model 9** |
| Firm age | 0.196 *** | 0.082 | 0.024 | 0.135 * | 0.047 | 0.100 * | 0.077 | −0.04 | −0.08 |
| Firm size | −0.226 ** | −0.063 | −0.015 | 0.137 ** | −0.038 | −0.088 | −0.111 | 0.054 | 0.08 |
| Nature of enterprise | −0.005 | −0.007 | −0.038 | −0.019 | −0.034 | −0.014 | 0.017 | 0.016 | −0.012 |
| Industry type | −0.006 | −0.008 | −0.049 | 0.026 | −0.026 | 0.012 | −0.040 | −0.042 | −0.079 |
| Relationships with suppliers (RS) | | 0.879 *** | | | 0.651 *** | | | 0.800 *** | |
| Relationships with customers (RC) | | | 0.788 *** | | | 0.416 *** | | | 0.796 *** |
| Technical capability | | | | 0.794 *** | 0.287 *** | 0.465 *** | | | |
| $R^2$ | 0.023 | 0.774 | 0.632 | 0.649 | 0.805 | 0.711 | 0.007 | 0.633 | 0.623 |
| Adjusted $R^2$ | 0.004 | 0.769 | 0.623 | 0.640 | 0.800 | 0.703 | −0.012 | 0.624 | 0.614 |
| F value | 1.239 | 691.564 | 343.995 | 370.429 | 142.566 | 85.045 | 0.365 | 355.026 | 339.376 |

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

### *4.4. Mediating Effect of Technological Capabilities*

As can be seen from Table 3, Model 8 shows that relationships with suppliers have a positive impact on technological capabilities (β = 0.800, $p < 0.01$), Model 5 shows that technological capabilities have a positive effect on innovation performance (β = 0.287, $p < 0.01$), and Model 2 shows that relationships with suppliers have a significant positive effect on innovation performance (β = 0.879, $p < 0.01$). Technological capabilities mediate between relationships with suppliers and innovation performance; therefore, Hypothesis 4a is verified. Model 9 shows that relationships with customers have a positive impact on technological capabilities (β = 0.796, $p < 0.01$), and Model 6 shows that technological capabilities have a positive effect on innovation performance (β = 0.465, $p < 0.01$). Model 3 shows that relationships with customers have a significant positive effect on innovation performance (β = 0.788, $p < 0.01$). Thus, technological capabilities play a mediating role between relationships with customers and innovation performance, and Hypothesis 4b is verified. Based on the above tests, this paper further verifies the mediating effect using the bootstrap method. The results of a mediation test based on 5000 bootstrap samples are shown in Table 4. The results show that the indirect effects of the relationship with suppliers (β = 0.232, confidence interval [0.105, 0.369]) and the relationship with customers (β = 0.390, confidence interval [0.196, 0.556]) acting on innovation performance through technological capabilities are both significant. Thus, the results again verify the validity of Hypotheses 4a and 4b.

**Table 4.** Mediation effect test with the Bootstrap method.

| **Paths** | **Effect** | **Coefficient** | **Standard Error** | **95% Confidence Interval** | |
|---|---|---|---|---|---|
| | | | | **Lower Limit** | **Upper Limit** |
| RS®→Technicalcapability®→innovation performance | Total effect | 0.896 | 0.034 | 0.829 | 0.962 |
| | Direct effect | 0.664 | 0.050 | 0.564 | 0.763 |
| | Indirect effects | 0.232 | 0.068 | 0.105 | 0.369 |
| RC®→Technicalcapability®→innovation performance | Total effect | 0.849 | 0.045 | 0.760 | 0.937 |
| | Direct effect | 0.459 | 0.066 | 0.330 | 0.588 |
| | Indirect effects | 0.390 | 0.091 | 0.196 | 0.556 |

### *4.5. Moderating Effects*

As seen in Table 5, the regression results of Model 4 show that the interaction term of strategic flexibility and supplier relationship (β = 0.364, $p < 0.05$) is significantly and positively related to innovation performance. This result indicates that strategic flexibility can significantly and positively moderate the relationship between supplier relationships and innovation performance. Hypothesis 5a is verified. The interaction term of strategic flexibility with customer relationships (β = 0.424, $p < 0.10$) is significantly and positively related to innovation performance, as seen in Model 7. This result shows that strategic flexibility can significantly and positively moderate the relationship between customer relationships and innovation performance. Hypothesis 5b is verified. As shown in Figures 2 and 3, when strategic flexibility is high, both supplier relationships and customer relationships have a positive impact on innovation performance. However, when strategic flexibility is low, both supplier relationships and customer relationships also have a positive impact on innovation performance, but the degree of impact is smaller.

**Table 5.** Moderating effect test.

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 |
|---|---|---|---|---|---|---|---|
| Firm age | 0.196 *** | 0.024 | 0.003 | 0.018 | 0.082 | 0.049 | 0.063 |
| Firm size | −0.226 ** | −0.015 | −0.006 | −0.018 | −0.063 | −0.047 | −0.058 |
| Nature of enterprise | −0.005 | −0.038 | −0.033 | −0.032 | −0.007 | 0.001 | 0.001 |
| Industry type | −0.006 | −0.049 | −0.053 | −0.055 | −0.008 | −0.012 | −0.017 |
| Relationship with suppliers (RS) | | 0.879 *** | 0.894 *** | 0.599 *** | | | |
| Relationship with customers (RC) | | | | | 0.788 *** | 0.831 *** | 0.473 ** |
| Strategic Flexibility (SF) | | | 0.149 *** | −0.085 | | 0.223 *** | −0.073 |
| RS*SF | | | | 0.364 ** | | | |
| RC*SF | | | | | | | 0.424 * |
| $R^2$ | 0.023 | 0.774 | 0.796 | 0.800 | 0.632 | 0.679 | 0.684 |
| Adjusted $R^2$ | 0.004 | 0.769 | 0.790 | 0.793 | 0.623 | 0.670 | 0.674 |
| F value | 1.239 | 687.491 | 21.927 | 4.166 | 343.995 | 30.479 | 3.353 |

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

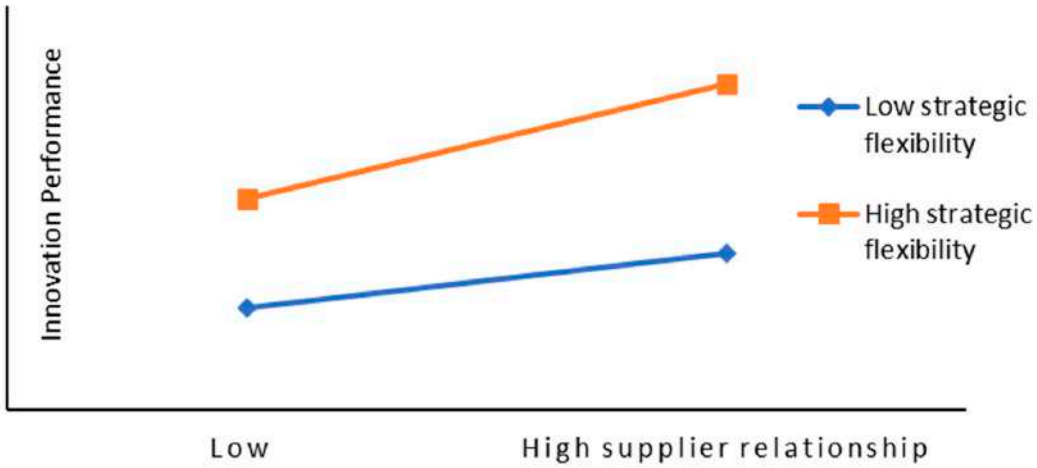


**Figure 2.** The moderating effect of strategic flexibility on the impact of vertical network relationships (with suppliers) on innovation performance.

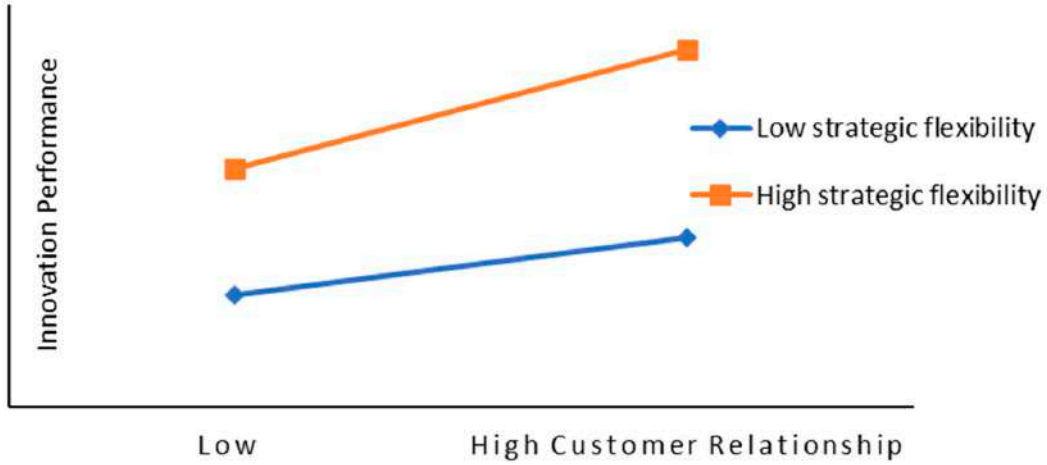


**Figure 3.** The moderating effect of strategic flexibility on the impact of vertical network relationships (with customers) on innovation performance.

## 5. Conclusions and Discussion

In this paper, we examine a framework involving vertical network relationships, technological capabilities, strategic flexibility, and innovation performance using a sample of high-tech firms. We explore the conditions under which and the paths through which vertical network relationships affect innovation performance by examining mediating capabilities. The results show that firms' vertical network relationships have a significant positive effect on innovation performance and that strategic flexibility positively moderates the effect of vertical network relationships on innovation performance. Technological capabilities positively affect innovation performance and mediate between vertical network relationships and innovation performance.

### *5.1. Theoretical Contributions*

First, the conclusions of existing studies regarding the relationship between network relationships and innovation performance are inconsistent. This study provides a theoretical basis for the positive impact of network relationships on innovation performance [4] and deepens the application of social network theory in the field of innovation [2].

Second, relatively few studies have examined the antecedent variables of technological capabilities from a social network perspective. Technological capabilities are not only generated through internal R&D but also rely on access to resources from external partners. The results of this paper show that embedding vertical network relationships helps firms obtain high-quality information and knowledge, thus improving their technological capabilities. The key ways of acquiring resources for technological capabilities are identified, and the antecedents of technological capabilities are deepened from a network embedding perspective.

Third, at present, there are few studies on the influence of network relationships on innovation performance. This paper verifies the mediating role of technological competence in the relationship between network relationships and innovation performance and deepens the explanation of the internal mechanism whereby technological competence promotes innovation performance in social networks. Therefore, by studying the influence path of network embeddedness on innovation performance, we open the black box of the relationship between network relationships and innovation performance and contribute to both social network theory and innovation theory.

Finally, by exploring the moderating effect of strategic flexibility on the influence of vertical network relationships on innovation performance, this paper provides a theoretical basis for understanding the influencing factors of vertical network relationships on innovation performance. Previous studies have confirmed that strategic flexibility has a positive impact on innovation performance, but whether strategic flexibility plays a moderating

role in the relationship between vertical network relationships and innovation has yet to be studied. This paper fills this research gap.

### *5.2. Management Insights*

This study provides important management insights for high-tech and related enterprises.

First, managers should be aware of the need to strengthen relationships with suppliers and customers in their vertical networks. Good relationships can play a positive role in the characteristics of social networks. To strengthen vertical network relationships, managers should regularly promote formal or informal communication and interaction with their companies' partners in the network. On the one hand, by strengthening partnerships between enterprises and suppliers, enterprises can obtain the latest information on raw materials, reduce production costs, and thus prepare for innovation. On the other hand, by building partnerships with customers, companies can gain an understanding of consumers' latest and differentiated needs, thus promoting innovation. To sum up, managers should be aware of the need to provide more innovation resources for innovation activities by strengthening vertical network relationships in order to improve innovation performance and achieve sustainable growth.

Second, enterprises need to improve their technological capabilities. By strengthening vertical network relationships, enterprises promote knowledge sharing among partners so that the implicit knowledge within the enterprise can be revealed, laying the foundation for the improvement of technological capabilities and thus promoting the realization of innovation.

Third, enterprises should improve their level of strategic flexibility. Managers should be aware that increasing strategic flexibility allows companies to adjust to changes in the external environment, prevents them from relying too much on internal resources, helps them capture external opportunities in a timely manner, and makes them more willing to cooperate with external partners. For example, managers can design flexible organizational structures to respond to changes in the external environment. Improving the use of heterogeneous types of external knowledge by increasing strategic flexibility leads to improved innovation performance and gives firms a competitive advantage.

Finally, policy makers should establish effective policies or systems to encourage high-tech enterprises to establish cooperative relationships. For example, through the establishment of a stable cooperation platform, it may be possible to enhance the relationships between high-tech enterprises and their partners and thus improve the enterprises' innovation performance.

## 6. Limitations and Further Research

First, this study mainly investigates the influence path of vertical network relationships on innovation performance, and the influence path of horizontal network relationships on innovation performance can be further considered in future studies. Second, there was no subdivision of technological capabilities in this paper, and dividing technological capabilities into technological absorption capability and technological innovation capability may allow for a more comprehensive understanding in future research. In addition, this paper uses cross-sectional data and does not consider the influence of vertical network relationships on innovation performance over time—future research should consider using time series data.

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