Research Article

Technological Innovation and Value Creation of Enterprise Innovation Ecosystem Based on System Dynamics Modeling

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1.Introduction

China’s R&D expenditures have grown at a high rate since 2017. The total amount has already ranked second in the world, with increasing investment in various innovative factors. However, the technological innovation of Chinese enterprises is largely still at an underdeveloped level. There are several fields of technology where China is at the front end of the value chain of technological innovation, but most are at the low end. If high R&D input is carried out but the efficiency of technological innovation is low, such high R&D input will not be transformed into a technological advantage for an enterprise. Therefore, it is of great significance to study the R&D investment in China in order to improve its technological innovation efficiency for creating enterprise values. Several scholars [1, 2] explore the growth mode of innovation by investigating the input and output rates of innovation but neglect the complexity of the innovation process and system. As a result, their research conclusions are not consistent.

Achieving sustainable economic growth and efficient use of materials and energy requires fundamental changes in the methods and services of production, distribution, and use. Penrose (1959) pointed out that the essential power of corporate growth stems from its internal and technological innovation, which is its internal driving force. Can technological innovation turn into corporate value? Competition of enterprises is reflected in the ability to create new products [3]. Technological innovation plays an intermediary role in the relationship between corporate social responsibility and corporate performance, and technological innovation has a positive effect on corporate performance [4]. Technological innovation integrates value creation, extends enterprise supply chain and industrial chain through achievement transformation, significantly improves supply chain efficiency, creates more enterprise and social value, and stimulates sustainable social and economic growth [5]. Therefore, it is of great significance for the value creation of an innovative ecosystem and the evolution of the
system to reconfigure the elements of technological innovation and to enhance enterprise innovation dynamics.

For technology investment and value creation, the internal R&D management intensity and behaviors of enterprises are the important factors causing the difference in innovation efficiency. The investment in technological innovation is inevitable, but what types of technological innovation can help companies create more value? What are the acquisition paths for enterprise value? What is the relationship between technological innovation and value creation in the innovation ecosystem? This article tries to answer these questions. Our contributions include the following. First, this research clarifies the relationship between technological innovation and value creation in the innovation ecosystem. Second, the research results point out the direction of technological innovation for enterprises and explore the theoretical basis for enterprises to realize sustainable development and create more value. In short, this research is of theoretical and practical significance in enhancing the efficiency of enterprise value creation in supply chains.

2. Literature Review

Enterprise innovation ecosystems are complex networks that take enterprises as the main body and universities, government, and financial institutions as system essential factor carriers. They integrate human, technology, information, capital, and other elements of innovation to achieve effective convergence of innovation factors, bring value creation to the networks, and achieve the sustainable development of the main body. The enterprise innovation ecosystem emphasizes the connection among the enterprise and other innovation entities, as well as the cooperation mechanism within an external environment, which jointly create value through the flow of matter, information, and energy in the system. The enterprise performs innovative behaviors based on collaborative dependence and symbiotic evolution.

Domestic and foreign scholars define the enterprise innovation ecosystem from network relationships, technical collaboration, and operational mechanisms of innovation subject. These studies show that the enterprise innovation ecosystem is dynamic and collaboratively dependent. Ander [6] believes that in order to meet customers’ requirements, enterprises need complementary collaboration to promote technological innovation with valuable products and services. It is inseparable from the relationship between technological innovation and enterprise value creation. Technological innovation provides a source of value for commerce through the combination of different knowledge elements [7]. The technical synergies of different innovation subjects avoid the single access to knowledge in technological innovation. From the perspectives of the main function and structure of enterprise innovation ecosystem, Xi [8] proposed that as a new organizational form, the enterprise innovation ecosystem emerges, which is a semi-close-layer quasi-market ecosystem based on the combination of market and bureaucratic administration. It is based on the same legal person with the platform enterprise as the core leadership of the inner and outer nested organizational structure with both external ecological cooperation and internal bureaucratic governance characteristics. Qi [9] found that the enterprise innovation ecosystem is based on the strategic logic of knowledge search, key point identification, cultivation of integration ability, and defensive blockade. On the basis of continuously integrating enterprise domain knowledge and architecture knowledge, it follows a three-stage evolutionary path based on “constructing initial vision as value creation and acquiring interactive ecosystem drift”.

Value creation is a process created by all innovative entities within the innovation ecosystem [10], providing users with products or services. Value creation not only optimizes the innovation process of a single company but also provides an overflow value for the innovation system. Tracing the path of value creation should consider value acquisition. Yan et al. [11] proposed the industrial innovation ecosystem with the leading enterprises as the core, since it has two stages of value creation and value acquisition. At present, the research on value creation focuses on the business ecosystem. Amit and Zott [12] believed that value creation originates from novelty, complementarity, efficiency, and locking of the ecosystem. Domestic scholars have studied the collaborative innovation of value creation. Xiang [13] proposed that collaborative innovation between research and practice lies in value creation. Hui [14] argues that the establishment of a vertical collaborative innovation alliance between upstream and downstream enterprises in the supply chain is a new trend in the industry. It is of great significance to carry out more extensive collaboration and effectively integrate the resources and capabilities of innovative alliance enterprises to improve the competitiveness of enterprises and even the whole supply chain and create enterprise value. From the perspective of value creation, Zhou and Qian [15] study the operation mode of the cooperative innovation of the industry, university, and research institute. Their results show that value creation is the core of the cooperative innovation operation of the whole industry, university, and research institute. From the openness of the innovation ecosystem, the value creation in the innovation model comes from knowledge, technology, users, and imitation [16]. This paper studies the collaborative value creation strategy of enterprises under the discontinuous innovation mode, and the results show that there is a threshold value for the intentional investment of technological innovation of large enterprises [17]. Although technological innovation is an important approach to enterprise value creation, there are also other ways of obtaining value. The differences in the behavioral model of collaborative innovation have important implications for value creation. As such, it is necessary to manage technological innovation systematically in order to achieve sustainable growth.

Based on the system dynamics of technological innovation, some scholars have studied the impact of collaborative R&D, standardization, and knowledge transfer on high-tech enterprises’ technological innovation networks [18]. Shao and Yu [19] believe that there is a positive
correlation between government support, cooperative innovation, and technical talents with technological innovation output. Bob and Rob [20] integrate the concept of innovation engine (a document that tracks emerging technological innovation systems) with the concept of transition path (a multilayered analytical framework) and used the system dynamic model to analyze the dynamic process of technological innovation systems in different transitional paths under different resource conditions. These studies have demonstrated that under different innovation factors and innovative behaviors, technological innovation has different effects on the innovation system; however, there is a lack of analysis on the combination of innovation factors and the impact of different sources of technological innovation. Therefore, this paper further studies the causality of enterprise value creation, technological innovation motivation, and value creation. It puts forward two paths of enterprise value creation. Moreover, it provides theoretical guidance and practical suggestions for technological innovation to promote the value creation of enterprise innovation ecosystems.

3. Value Creation of the Enterprise Innovation Ecosystem

According to existing research, many factors are brought together to promote the creation, flow, upgrade, and transformation of new technologies or new knowledge in the enterprise’s innovation network, ultimately improving the performance of technological innovation networks [21]. Generally speaking, value creation refers to a series of business activities and their structures that an enterprise produces and supplies to meet the needs of its target customers. Enterprise value creation in this research refers to the production of more personalized products through technological innovation to provide tailor-made services to meet customer needs and generate user utility. Value creation of innovation network depends on the cooperation between each main body innovation, but value acquisition depends on the complex interaction between customers and others who are involved in the collaboration of the enterprise [22]. From enterprise technology and knowledge sources, the main ways of value creation include enterprise technology innovation and external acquisition. From the behavioral model, technological innovation from the input of innovative factors is jointly created by the enterprise’s independent and cooperative innovation behaviors (See Figure 1).

From the perspective of knowledge sources, the approaches of enterprise value creation are divided into internal creation and external acquisition. Thus, Figure 1 is divided into the left and right sections. In the study of the relationship and influence between enterprise technology innovation and enterprise value creation, the interaction further divides Figure 1 into four quadrants. First, knowledge comes from outside, and the main body of technological innovation is the enterprise itself. In this case, enterprise realizes technological innovation and promotes enterprise value creation by purchasing technological innovation factors from outside. Second, the knowledge comes from outside, and the subject of technology innovation is the subject of joint research and development. In this case, the enterprise realizes the technology innovation through technical cooperation with the outside world. Third, knowledge comes from inside the enterprise, and the main body of technological innovation is the enterprise itself. In this case, the enterprise realizes value creation through independent technological innovation. Fourth, knowledge comes from inside the enterprise, and the subject of technological innovation is the subject of joint R&D. In this case, the enterprise can create value by digesting and absorbing the elements of technological innovation.

3.1. Source of Knowledge. The knowledge of an enterprise’s innovation ecosystem is generated by the continuous creation, diffusion, and absorption of innovative entities such as enterprises, universities, and research institutes within the system. An enterprise with intellectual property rights can ensure the core competitiveness in the market, which is a sufficient condition for the value of technological innovation in the future. R&D funds, scientific and technological talents, and other innovative elements are invested to ensure independent research and development in technological innovation [23]. Under the constraints of the heterogeneity of innovation resources, enterprises considering cost-utility provide a source of value-creating knowledge by direct purchases, the introduction of external technologies, or the learning of external knowledge and technologies.

3.2. Behavior Model. The resource elements of enterprises and other innovative entities are integrated into an ecosystem through collaborative innovation, and the overall value creation in the system is greater than the sum of individual value creation. An enterprise needs self-innovation as well as the technical synergies of value creation within the system [24]. The coordination and absorption of resources between innovative entities are the driving force for the overall evolution of the enterprise’s
innovation ecosystem and continuous value creation. Collaborative behaviors of enterprises include collaborative innovation with other enterprises, universities, and research institutes, as well as the digestion and absorption of mastering, applying, and imitating external technologies.

4. Model Construction

Based on system dynamics, the work used qualitative and quantitative research methods. In terms of the theoretical analysis of technological innovation and the value creation path of the enterprise’s innovation ecosystem, we first constructed the enterprise’s innovation ecosystem structure, as well as correlation analysis of its causality and dynamics to obtain the path of value creation [25]. Meanwhile, analog simulation was performed on the influencing factors of technological innovation and value creation.

Determination of the boundary of the enterprise innovation ecosystem is as follows. (1) The main body consists of enterprises, governments, universities, research institutes, and science and technology institutions. (2) The innovation factors are invested by enterprises, governments, universities, science and technology institutes, and the R&D personnel of enterprises, universities, and research institutes. (3) The innovation results include intellectual property rights, scientific and technological achievements, and new product sales revenue. The new product sales revenue is used as a measure of the ultimate value creation of the enterprise’s innovation ecosystem. (4) The innovation environment is driven by the intermediary role of science and technology institutions and the influence of the government on the intellectual property protection mechanisms. (5) The technology innovation behavior patterns include the independent innovation of enterprises, the cooperation innovation with the university, the research institute, and the internal digestion and absorption of external acquisition technologies. The value creation path was analyzed based on the above content of the boundary.

4.1. Causal Loop of System Power. Figure 2 shows the causality of the enterprise innovation ecosystem, which reflects the interaction among the input of innovation elements, technological innovation, and enterprise value creation. The core of the technology innovation module is the transformation and utilization of knowledge, promoting enterprise innovation ecosystem, sharing and reconstruction of knowledge and technology, and the value creation of the entire system. The sales revenue of new products in the value creation module is determined by the output of new products. The output of new products is related to the direct acquisition and digestion and absorption of external technologies in other technology source modules [26]. Furthermore, it is directly affected by the transformation of scientific and technological achievements. Scientific and technological achievements come from the technical cooperation of enterprises, the achievements of internal R&D personnel, and the transformation of patents. Direct acquisition and digestion and absorption of external technologies play a positive role in the independent innovation of enterprises. However, in enterprises with technology-based collaboration, the purchase, technology introduction, and digestion and absorption play a role in suppressing the technical cooperation of the enterprise’s innovation ecosystem. It has a negative impact on value creation [27, 28].

The causality of the system’s power contains 11 feedback loops:

(2) Government investment in science and technology-Technology service agencies-Technology transactions-External purchase, and introduction of technology-New product output-New product sales revenue
(3) Government investment in science and technology-Corporate science and technology funds-Corporate R&D input-R&D staff-Scientific achievements-New product output-New product sales revenue
(4) Corporate science and technology funds-corporate R&D inputs-technical cooperation-Patent applications-Scientific achievements-New product output-New product sales revenue
(5) Enterprise R&D input-Technical cooperation-Patent application-Scientific and technological achievements-Technological innovation
(6) Enterprise science and technology funds-External purchasing and technology introduction-New Product output-New product sales revenue
(7) Enterprise science and technology fund-Digestion and absorption of technology-Technical staff-Scientific and technological achievements-New product output-New product sales revenue
(8) Government investment in science and technology-Science and technology funds for universities and research institutes-R&D personnel-Patent applications-Scientific and technological achievements
(9) Government investment in science and technology-Science and technology funds for universities and research institutes-R&D personnel-Technical cooperation-(Patent applications)-Scientific and technological achievements
(10) Enterprise science and technology funds-Science and technology funds for universities and research Institutes-R&D staff-(Patent applications)-Scientific and technological achievements-New product output-New product sales revenue
(11) Government investment in science and technology-Government intellectual property protection-Patent applications-Scientific achievements-Technological innovation
It can be concluded that there are three main ways to obtain the value creation of enterprise innovation ecosystem: (1) factor input-technical innovation (autonomy/collaboration)-value creation; (2) external technology acquisition-value creation; (3) digestion and absorption-value creation. At the stage of technological innovation, the cooperation and exchange among enterprises or among enterprises, universities, and scientific research institutes have gradually increased. It becomes closer for the cooperation among production, teaching, and research, effectively utilizing the transfer of knowledge from universities and scientific research institutes to enterprises. Knowledge transfer makes knowledge accumulated in the enterprise innovation ecosystem. Enterprises improve technology innovation by increasing the utility of knowledge transformation to drive new product R&D. The government and the science and technology service agencies play an auxiliary role in promoting systemic motivation.

4.2. System Flow Graph. Based on the causality of enterprise innovation ecosystem dynamics, the other relevant variables of the flow graph are added to construct the flow graph of the enterprise innovation ecosystem (see Figure 3). The indexes of the number of patent applications and the sales revenue of new products are selected as the output of the model. Table 1 shows the variables. Stock $L$ is the state variable; flow $R$ is the rate variable; variable $A$ is the auxiliary variable; $C$ is the constant.

Technological innovation and value creation subsystems:

Subsystem of technological innovation: technological innovation is an important source of enterprise value creation, and it is the power source of extending product supply chain and improving enterprise value creation efficiency in the supply chain. The main method is the common combination of independent innovation of enterprises and collaborative innovation with other innovative entities. On one hand, the investment and accumulation of innovation funds and personnel are the process energy transformation of the enterprise’s independent innovation [29]. On the other hand, investments in cooperation among enterprises and external entities, as well as the R&D investment of universities and research institutes, have caused the flow of information and energy within the system. Technological cooperation is the choice of enterprises to utilize external complementary innovation resources under the open innovation paradigm, which can avoid the risk of independent technology development and help improve the benefits of technological innovation. Our study has selected the number of enterprise patent applications as a measure of technological innovation, which reflects the degree of intellectual property and technological innovation. R&D investment plays an intermediary role in the positive impact of patent administrative law enforcement on the number of patent applications [30]. Furthermore, it is affected by the utility of enterprise and external cooperation funds. The utility of R&D personnel is determined by the number of employees and the R&D input of enterprises, which is the measure for the effective use of knowledge transfer.

Value creation subsystem: technological innovation is the process and means of value creation, but transforming technological achievements into economic benefits is the ultimate goal of value creation. The most
Figure 3: Flow graph of enterprise innovation ecosystem dynamic.

Table 1: Variable declaration of the system flow graph.

<table>
<thead>
<tr>
<th>Label of variables</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>Government science and technology investment</td>
</tr>
<tr>
<td>C1</td>
<td>Rate of change in government science and technology investment</td>
</tr>
<tr>
<td>L2</td>
<td>Universities and research institutes' investment in R&amp;D personnel</td>
</tr>
<tr>
<td>C2</td>
<td>Rate of change in the R&amp;D personnel of universities and institutes</td>
</tr>
<tr>
<td>L3</td>
<td>Investment of the cooperation among universities and institutes</td>
</tr>
<tr>
<td>C3</td>
<td>Rate of change in the investment of external enterprise cooperation</td>
</tr>
<tr>
<td>L4</td>
<td>Expenditure of enterprise R&amp;D personnel</td>
</tr>
<tr>
<td>C4</td>
<td>Variation rate of R&amp;D personnel expenditure</td>
</tr>
<tr>
<td>L5</td>
<td>Number of R&amp;D personnel</td>
</tr>
<tr>
<td>C5</td>
<td>Rate of change in the number</td>
</tr>
<tr>
<td>L6</td>
<td>Enterprise R&amp;D investment</td>
</tr>
<tr>
<td>C6</td>
<td>Rate of change in R&amp;D investment</td>
</tr>
<tr>
<td>L7</td>
<td>Number of patent applications</td>
</tr>
<tr>
<td>R7</td>
<td>Rate of change in the number of patent applications</td>
</tr>
<tr>
<td>L8</td>
<td>Number of technology service agencies</td>
</tr>
<tr>
<td>C8</td>
<td>Rate of change in technology service agencies</td>
</tr>
<tr>
<td>L9</td>
<td>Expenditure for digestion and absorption</td>
</tr>
<tr>
<td>C9</td>
<td>Rate of change in digestion and absorption</td>
</tr>
<tr>
<td>L10</td>
<td>Sales revenue of new products</td>
</tr>
<tr>
<td>R10</td>
<td>Change in the sales revenue of new products</td>
</tr>
<tr>
<td>L11</td>
<td>Expenditure for technology purchase and introduction</td>
</tr>
<tr>
<td>C11</td>
<td>Rate of change in the expenditure of technology purchase and introduction</td>
</tr>
<tr>
<td>A1</td>
<td>Investment coefficient of government science and technology</td>
</tr>
<tr>
<td>A2</td>
<td>Outlay coefficient of R&amp;D personnel in universities and research institutes</td>
</tr>
<tr>
<td>A3</td>
<td>Investment coefficient of external enterprise cooperation</td>
</tr>
<tr>
<td>A4</td>
<td>Outlay coefficient of enterprise R&amp;D</td>
</tr>
<tr>
<td>A5</td>
<td>Change coefficient of R&amp;D personnel</td>
</tr>
<tr>
<td>A6</td>
<td>Coefficient of variation of enterprise R&amp;D investment</td>
</tr>
<tr>
<td>A7</td>
<td>Utility adjustment coefficient</td>
</tr>
</tbody>
</table>
important way to transform technological achievements into economic benefits is to extend the industrial chain and supply chain, extend the supply chain of enterprises through technological innovation, and realize the value creation of more enterprises. Therefore, new product revenue is regarded as an economic evaluation index of value creation. In view of the three value creation paths of the enterprise innovation ecosystem, the growth rate of new product revenue is mainly related to the intellectual property of technological innovation, the direct acquisition of external technology, and the absorption of technology [31]. The growth of sales revenue of new products is reflected in the coordinated development of supply chain enterprises and the change of system value creation.

5. Empirical Analysis

We used the statistical database of the DRCnet, combined with data sources such as China High Technology Industry Statistical Yearbook, China Science and Technology Statistical Yearbook, CNKI Express, and other relevant scientific and technological data from high-tech enterprise’s scientific and technological expenses, R&D investment, and operating conditions during 2008–2016. Using the system dynamics modeling software of Vensim PLE, we established the relationships among the variables in the model. Furthermore, the causes and degree of changes in output variables were analyzed, studying the paths that influence value creation in the system model. The model was verified by the fitness of the actual value and the analog value.

In the model design, suppose that the Initial Time = 2008, Final Time = 2016, and Time Step is 1. The simulation time unit is performed once per year by the integration method of Euler. Table 2 shows the simulation model test results.

Table 2 shows that the maximum error rate between the actual value and the analog value of the new product sales revenue and the number of patent applications in the high-tech industry enterprises is 3.79%, indicating a high degree of the fitting. The model is reasonable from the overall simulation and parameter settings, with further research basis.

5.1. Simulation Results of Technical Innovation

5.1.1. Talent Utility. Figure 4 shows that R&D talent has a positive impact on patent applications each year. By increasing the talent utility by 5 and 10%, respectively, it can be found that the number of patent applications has been significantly improved, with the increased talent utility over time. Therefore, talents are crucial to the input of the enterprise innovation ecosystem. Talent utility is not only used to attract and expand the number of R&D technicians but also increases funding for personnel and encourages exchanges and learning among R&D technicians, thus creating a relaxed atmosphere for innovation with a good information communication channel. At the same time, the conditional treatment of scientific research personnel should be improved, focusing on scientific research.

5.1.2. Utility of R&D Cooperation Fund. Figure 5 shows the positive impact of enterprise cooperation funds on universities and research institutes on patent applications. When the utility of R&D cooperation funds increases by 5% and 10%, respectively, the number of patent applications increases significantly. It can be seen that the utility of enterprise R&D cooperation funds has a greater impact on patented technology. Although R&D cooperation reduces the risk of technological innovation in favor of complementary advantages of resources, it has a weaker impact on patented technology than talent utility. Independent innovation is more critical for the technological innovation of high-tech enterprises [32, 33]. With the improved R&D cooperation utility, the number of patented technology applications has increased significantly until 2013. This is due to the fact that there are lags in cooperation innovation, which needs time to accumulate more resources for effective use. Enterprises, universities, and research institutes have a long period of cooperation in R&D, with uncertainties in future innovation. These factors should be considered by high-tech enterprises.

5.2. Value Creation

5.2.1. Utility of Patent Technology. The patent achievement, as a holding capital for technological innovation, is one of the sources of value creation for an enterprise. The utility of patented technology has a positive impact on the sales revenue of new products. However, the latter is not sensitive to changes in the parameters of patents. Patents are the periodical results of technological innovation. Nevertheless, it is more crucial to turn patents into technological achievements with applied value.
Table 2: Test of model output variables.

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales revenue of new products</th>
<th>Number of patent applications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual value (ten thousand yuan)</td>
<td>Analog value (ten thousand yuan)</td>
</tr>
<tr>
<td>2008</td>
<td>128794741</td>
<td>12963462</td>
</tr>
<tr>
<td>2009</td>
<td>125950003</td>
<td>127946750</td>
</tr>
<tr>
<td>2010</td>
<td>163647630</td>
<td>165649878</td>
</tr>
<tr>
<td>2011</td>
<td>203845208.9</td>
<td>210845341</td>
</tr>
<tr>
<td>2012</td>
<td>237653174</td>
<td>236143569</td>
</tr>
<tr>
<td>2013</td>
<td>290288371</td>
<td>298276943</td>
</tr>
<tr>
<td>2014</td>
<td>328451936.2</td>
<td>325451287</td>
</tr>
<tr>
<td>2015</td>
<td>381114794.3</td>
<td>387114854</td>
</tr>
<tr>
<td>2016</td>
<td>435592443.7</td>
<td>434211754</td>
</tr>
</tbody>
</table>

Figure 4: Influence of talent utility on patent applications.

Figure 5: Influence of R&D utility on the patent application.
The number of patent licenses has increased year by year, which is the result of technological innovation meeting the market demands. After the enterprise obtained the patented technology, the current market demand was not yet formed, or the patents are at a technical level and are not been utilized as storage resources of the enterprise innovation ecosystem [34]. On the other hand, the government’s intellectual property rights protection mechanism has an impact on the utility of patented technology, indicating that the protection of intellectual property rights is still insufficient. It results in patent technology having nonsignificant effect on the sales revenue of new products, thus failing to provide sufficient support for value creation (see Figure 6).

5.2.2. Utility of External Direct Acquisition. There is no significant positive relationship between technology (through direct external purchase and introduction) and sales revenue of new products. When the parameters increase by 5% and 10%, there is little increase in the new product’s sales revenue (see Figure 7). The technology directly acquired by the outsiders of the enterprise is not the core technology of the
original owner that may have been eliminated by other enter-
prises or core leading enterprises. Importers can no longer
occupy more new product markets, or there is no way to
effectively transform external technologies. If only relying on
external direct access to technology, high-tech enterprises do
not contribute much to their own value creation. The tech-
nology directly obtained from the outside by the enterprise is
faced with the problem that it is difficult to be directly
transformed into innovation. The dependence on the outside
cannot directly bring about obvious innovation benefits.

5.2.3. Utility of Digestion and Absorption. Figure 8 shows
that digestion and absorption have a positive effect on the
sales revenue of new products. When the utility of digestion
and absorption increases by 10%, the sales revenue of new
products will increase significantly, indicating that the di-
gestion and absorption of enterprises is an important path
for value creation. Digestion and absorption are affected by
the time period. From the figure, the utility of digestion and
absorption increases by 10% from 2008 to 2010. There is no
difference in the impact on the sales revenue of new

Figure 8: Utility of digestion and absorption on the sales revenue of new products.

Figure 9: Comparison of influencing factors on the sales revenue of new products.
products. The sustained digestion and absorption began in 2013, and the improvement in utility obviously shows a positive impact year by year. The digestion and absorption of enterprises reflect the mastery of technology and application expenditures, and the utility improvement of digestion and absorption initiates the competitiveness of value creation in high-tech enterprises. Enterprises transform external knowledge and technology into internal technologies through learning and copying, which is the key to the value creation of enterprises.

After utilities of technology purchase, digestion, and absorption increase by 5%, the impact difference of the three ways is not significant for the sales revenue of new products (see Figure 9). Their contributions to value creation are close to each other. In comparison, the utility of digestion and absorption has more positive effects on value creation, followed by the utility of patented technology and the utility of external direct acquisition. In summary, the value creation of the enterprise innovation ecosystem can be improved by correcting the key links and supplementing the missing links of technological utility in the path of value creation.

6. Conclusions and Prospects

Based on the process of technological innovation in the enterprise innovation ecosystem as well as the causality of system dynamics, this research established a dynamic model for the interactions among enterprises, governments, universities, and research institutes. This paper discusses the effect of technological innovation on value creation, the effect of technological innovation on enterprise value creation in the same supply chain, and the role of other technologies in value creation, which provides a basis for determining the best path of value creation [35]. Based on the simulations of the system model, the following conclusions are drawn. (1) Talent utility plays a positive role in technological innovation in the enterprise innovation ecosystem, exerted by multiple parties involved in innovation. It is vital for the investment of R&D personnel and the increased number of talents. (2) The simulation results show that the utility of the enterprise’s cooperative R&D investment has a less positive impact on technological innovation than that of talent utility with a lag. On the one hand, in high-tech industrial enterprises, universities and research institutes pay attention to forward-looking and breakthrough research. While it takes time to change the technological trajectory, independent R&D can better produce market-matched, patented technologies compared to cooperative R&D. On the other hand, the complex innovation ecosystem has been combined with multiple innovations, weakening the impact of R&D cooperation on technology innovation. However, R&D collaboration, especially among enterprises in the same supply chain, remains important in promoting value creation [36]. (3) The impact of technological innovation on value creation is not obvious when measured by the utility of patented technology. The reason is that the conversion of patented technology into applied technology forms a bridge between technological innovation and value creation. Even if technological innovation is strong, the lack of transformation cannot improve the economic value of enterprise innovation. (4) External acquisition of technology can fill the risks brought about by independent technological innovation, but it does not contribute much to value creation. (5) Digestion and absorption are the keys to the value creation of an enterprise, making up for the deficiency in the external acquisition of technology. It takes a certain period of time for digestion and absorption to function.

In summary, this article identifies the potential paths of value creation for the enterprise innovation ecosystem. The main path is innovation factor input-technical innovation-achievement transformation-value creation, complemented by the external acquisition of technology-digestion and absorption-value creation. In view of the above research findings, the following recommendations are proposed. (1) Enterprises should maintain moderate open innovation. High-tech enterprises need to rationally allocate scientific and technological funds as well as increase independent research and development investment, which ultimately transforms into actual innovation. At this stage and on the basis of independent innovation and their competitive advantages, enterprises shall strengthen cooperation with universities and research institutes and shall pay attention to the patented technological achievement protection. (2) Government and science and technology service organizations must serve not only the technical transactions between entities but also the mediating role of early technological innovation cooperation. They should focus on the transformation of patent technology results, by expanding the enterprise industrial chain and extending the supply chain, to promote the rapid transformation of the technological achievements of the main innovative market value. (3) The continuity of value creation should be maintained. With the strengthened digestion and absorption of technology, we should focus on the training of R&D personnel to accumulate external technology and knowledge and should stimulate the technological innovation and achievement transformation of R&D personnel.

Data Availability

The authors used the statistical database of the DRCnet, combined with data sources such as China High Technology Industry Statistical Yearbook, China Science and Technology Statistical Yearbook, CNKI Express, and other relevant scientific and technological data from high-tech enterprise’s scientific and technological expenses, R&D investment, and operating conditions during 2008–2016.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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