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# Impact of Innovation Quality on the Growth Performance of Entrepreneurial Enterprises: The Role of Knowledge Capital

**Hanfang Chu [1,2], Hanxin Wang [1,2] and Zhaoyun Wang [3,*]**

[1] School of Management, Hebei GEO University, Shijiazhuang 050031, China
[2] Research Base for Scientific-Technological Innovation and Regional Economic Sustainable Development of Hebei Province, Hebei GEO University, Shijiazhuang 050031, China
[3] College of Business Administration, Capital University of Economics and Business, Beijing 100070, China
* Correspondence: wangzhaoyun621@163.com; Tel.: +86-157-3318-9107

**Abstract:** In the context of the continuous growth of the digital economy, the steady and sustainable development and growth of enterprises are increasingly dependent on the quality of innovation and knowledge capital. Based on the resource-based view and from the perspective of knowledge capital, this paper takes the knowledge capital index composed of human resource capital, innovation and R&D capability capital, innovation facility capital and relational capital as the intermediary variable and explores the mechanism of the influence of innovation quality on the growth performance of entrepreneurial enterprises from the enterprise level. Taking computer, communication and other electronic equipment manufacturing enterprises listed on GEM from 2017 to 2021 as the research object, this paper uses hierarchical regression and Bootstrap methods to explore the specific path of the impact of innovation quality on the growth performance of entrepreneurial enterprises and conducts an empirical analysis and robust analysis. This research shows that the innovative quality of entrepreneurial enterprises can significantly promote growth performance, and knowledge capital plays an intermediary role in it. The conclusion of this paper provides theoretical support for this kind of enterprise to improve the quality of innovation and make good use of knowledge capital and provides an empirical basis and reference for their sustainable and stable growth.

**Keywords:** innovation quality; knowledge capital; growth performance; sustainable development



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## 1. Introduction

With a new round of scientific and technological revolution unfolding, the knowledge economy and information technology are in the ascendant. In the context of the digital economy era, with the technological competition between countries constantly escalating, innovation being the accelerator of economic development and enterprises being the main body of a country's innovation system, constructing innovative enterprises is the core of an innovation-oriented country-building [1]. Technological innovation and knowledge resources have become one important substitute for factors of traditional production, contributing more to economic growth and influencing more on enterprises [1,2]. In the current environment, the updating of technology and knowledge is accelerating, the economic and social environment is also rapidly changing, and the market competition is becoming increasingly complex. In the future, the competition of enterprises is more about the competition of technology and knowledge. The purpose of the competition is to obtain comparative advantage. Based on the resource-based view and the theory of core competitive advantage, the competitive advantage between enterprises comes from their specific resources, which is reflected in the unique knowledge innovation consciousness of enterprises. The construction of core competitive advantage is crucial for the sustainable development of enterprises. On the one hand, in the context of high-quality development, one of the important ways for enterprises to achieve competitiveness is innovation [3]. Enterprises should not only carry out technological innovation continuously but also focus

on innovation quality [4]. Only by improving innovation quality can we stand out and achieve sustainable development. On the other hand, in the new economic environment, knowledge is the most valuable intangible asset of an enterprise and also the source of cultivating its core competitiveness. The construction and promotion of competitive advantages cannot be separated from the continuous optimization and integration of knowledge capital [5], which plays an important role in driving the stable and long-term development of enterprise performance. In the era of digital economy, market competition is becoming more and more fierce, and entrepreneurial enterprises are facing greater risks. It is a major problem for entrepreneurial enterprises to enhance their core competitiveness to adapt to the development of the times and find space for stable market development. Therefore, how can entrepreneurial enterprises remain invincible in a more complex and fiercely competitive environment? How to apply high-quality technological innovation to enhance enterprise growth? It is not only the focus of entrepreneurial enterprise management but also the topic that concerns scholars.

In retrospect, researchers took the high-tech industry or manufacturing industry as the research object and mostly discussed the relationship between technological innovation and enterprise performance or human capital and enterprise performance. Few scholars focused on entrepreneurial enterprises and studied the relationship between innovation quality and growth performance from the perspective of knowledge capital. The question discussed in this paper is whether the innovative quality of entrepreneurial enterprises will affect their growth performance and the role of knowledge capital in it, namely the questions are from the following aspects: Is it the case that the higher the innovation quality and the richer the knowledge capital, the better the growth performance correspondingly? Can innovation quality promote the accumulation of knowledge capital? Furthermore, can this accumulation promote the growth performance of the enterprise? The aim of the paper is to explore the influence relationship and the path of the three, which is conducive to bettering the innovation quality and optimizing the allocation of knowledge capital and then promoting the growth and development of enterprises. Based on this, this paper innovatively incorporates innovation quality and knowledge capital into a unified research framework and considers both tangible and intangible resources of enterprises, enriching relevant studies on enterprise growth performance. The conclusions of this paper are instructive for expanding the research perspective of knowledge capital, supplementing the research scope of growth performance and promoting the effective improvement of the growth performance of entrepreneurial enterprises.

## 2. Literature Review and Theoretical Hypothesis

### *2.1. Theoretical Basis and Literature Review*

As for the concept of entrepreneurial enterprises, many scholars at home and abroad have put forward their own views and opinions based on their own research. At present, it seems that the view of process elements has been recognized by more scholars. From the perspective of process elements, the concept of entrepreneurial enterprises is defined based on the establishment process, the years and its typical characteristics [6]. In this paper, the entrepreneurial enterprise is defined as an organization taking profit as its main purpose, constantly carrying out innovations, such as product marketing and looking for opportunities for sustainable development, and conducting empirical research on innovation quality and growth performance based on this theory.

Regarding the innovation behavior of enterprises and the growth of enterprises, the research and discussions carried out by domestic and foreign scholars are more from the perspective of innovation input and innovation output, and the conclusions reached are not consistent. Some scholars believe that the innovative behavior of enterprises will promote the growth and high-quality development of enterprises (Zhang Shuoxing, 2017 [7]; Wu Haoqiang and Hu Sumin, 2023 [8]). Some scholars hold the view that enterprise innovation has a restraining effect on growth (Alex Coada and Rekha Rao, 2010 [9]; Huo Xiaoping, 2019 [10]). In addition, studies by other scholars show that there is no relationship between

innovation and growth (Yang et al., 2013 [11]), but an inverted U-shaped relationship (Chen et al., 2022 [12]) or a parabolic relationship (Sheng et al., 2016 [13]). It can be seen that there is abundant research on this issue in the academic circle, but there is no unified understanding, which needs to be further studied and discussed. In addition, relevant studies focus more on the direct relationship between the two, but there is little literature on the in-depth analysis of the mechanism of influence between the two. In a word, the above literature provides an important theoretical reference and logical starting point for this study, but it fails to study the relationship between enterprise innovation and growth performance from the perspective of quality, nor does it explore other possible transmission paths.

According to the resource-based view, an enterprise is a collection of resources, and the tangible and intangible resources mastered by an enterprise are the important sources for its competitive advantages and long-term development. On the one hand, innovation is an important driving force for enterprise development. Different from the growth of innovation quantity, innovation quality reflects the breakthrough achievements in technological research and development [14], which can measure the level and development of technological innovation of enterprises and is closely related to the maintenance of competitive advantages, performance growth and sustainable development of enterprises [15]. On the other hand, knowledge resources are the most important and strategic for the development of enterprises. Due to their intangibles and imitations, they reflect the competitiveness and development potential of enterprises to some extent [16]. Based on the existing literature research and the above theoretical analysis, this paper attempts to explore the influence of innovation quality on the growth performance of entrepreneurial enterprises from the perspective of knowledge capital and clarify the path mechanism of innovation quality on the growth performance of entrepreneurial enterprises. In theory, it expands the research on enterprise innovation and growth and provides practical guidance for the vigorous development of entrepreneurial enterprises.

### *2.2. Proposal of Research Hypothesis*

According to the resource-based view, core competitiveness theory and knowledge-based theory, innovation quality and knowledge capital as the core of the enterprise played a decisive role in its future development. This paper tries to take an empirical test on the influencing relationships between innovation quality, knowledge capital and growth performance through sample data, providing theoretical enlightenment for the stable growth of entrepreneurial enterprises.

#### 2.2.1. Innovation Quality and Growth Performance

Previous scholars have mainly focused on the relationship between technological innovation and enterprise performance, and most of the conclusions are that there is a positive promoting relationship between them. Wu et al. (2016) [17] found that technological innovation has a positive role in promoting future financial performance in their research of using patent production to represent technological innovation, and with the strengthening of intellectual property protection law enforcement, the promotion will be greater. Using three types of patent authorization to the innovation quality, and the M/B ratio and Tobin's Q representing enterprise business performance, Liu et al. (2016) [18] analyzed the relationship between the innovative quality of the listed companies of the second-board market and enterprise business performance and found that the three types of patent authorization all have a positive impact on business performance, the invention patent effect being the most significant. Shan et al. (2023) conducted an empirical analysis of Chinese manufacturing industry data and found that innovation-driven can positively promote high-quality development of manufacturing [19].

Stable development and lasting growth are the problems facing many enterprises in China. According to the theory of core competitiveness, core competitiveness is the ability basis for enterprises to grow and develop in the fierce competition, which fun-

damentally depends on the high-quality innovation of enterprises. However, there is little present research on the impact mechanism of innovation quality on the growth performance of enterprises. Amirhosein et al. (2018) [20] promote the improvement of the innovation ability of enterprise organizations, thus enabling the performance of enterprises to grow. Chen et al. (2019) [21] show that the innovative quality of Chinese manufacturing enterprises can positively affect the growth and development of enterprises. Zhao et al. (2022) [22] empirically tested the promotion effect of innovation and opening on enterprise growth from the depth level. For entrepreneurial enterprises with stronger innovation motivation, the monopoly profits brought by their innovation activities will be obviously reflected in the business growth [10]. Therefore, this paper puts forward assumption H1: there is a significant positive relationship between innovation quality and the growth performance of entrepreneurial enterprises.

#### 2.2.2. Innovation Quality and Knowledge Capital

Technological innovation is conducive to enterprises' exploration and accumulation of knowledge [23]. Zhang et al. (2004) [24] maintained that knowledge capital could bring value proliferation to enterprise organizations, but it fundamentally needs technological innovation to commercialize and industrialize knowledge capital. Generally speaking, the higher the quality level of innovation activities, the more productive the high-quality, innovative results, and the knowledge capital will also increase accordingly. Zhang et al. (2015) [25] studied the relationship between open innovation and innovation performance through questionnaires and found that both inward- and outward-oriented open innovation had significant positive impacts on the ability of enterprises to acquire and use external knowledge. When enterprises carry out high-quality technological innovation activities, the amount of knowledge acquired will increase, the scarce knowledge resources will increase and the knowledge system of enterprises will be improved [22]. On this basis, this paper believes that the improvement of enterprise innovation quality will lead to the increase of knowledge capital and puts forward Hypothesis H2: there is a significant positive correlation between the innovation quality and knowledge capital of entrepreneurial enterprises.

#### 2.2.3. Knowledge Capital and Growth Performance

The knowledge base view points out that knowledge resource is an important source of competitive advantage. As the dominant source of enterprises' continuous competitive power, enterprises must continuously expand knowledge for a long time if they want to gain a foothold in the fierce and changeable market [26]. Penrose (1959) [27] maintains that the accumulation of enterprise knowledge is the essence of enterprise growth. When an enterprise is in uncertainty, knowledge accumulation determines the possibility of its future stable development (Alchian, 1950) [28]. Because knowledge is scarce and hard to be imitated, it determines the growth difference between enterprises to a certain extent. Yu et al. (2016) [29] conducted research on small- and medium-sized board-listed enterprises and found that knowledge capital has a significant role in improving the financial performance of enterprises. That is, the investment of knowledge capital will improve the financial performance of the enterprise and then promote better development of the enterprise. In the research of Chanal et al. (2016) [30] and Chen et al. (2020) [31], intellectual capital is divided into human capital, structural capital and relationship capital, and the influence of intellectual capital on bank performance and enterprise growth performance is respectively verified through empirical inspection. Bu et al. (2022) [32] pointed out that an enterprise, especially an innovative enterprise, must pay attention to the optimal allocation of the important tacit knowledge of structural capital if it wants to maintain long-term development. With the expansion of the breadth and depth of knowledge, enterprises' adaptability to the environment is also growing, which can help to build competitive advantages and bring opportunities for the growth and development of enterprises in the fierce market competition. Based on this, this paper proposes the third Hypothesis

H3: there is a significant positive correlation between knowledge capital and the growth performance of entrepreneurial enterprises.

#### 2.2.4. The Mediating Effect of Knowledge Capital

There are few studies on the effect of innovation quality on the growth performance of start-ups using knowledge capital as an intermediary variable. This paper holds that high-quality innovation output, on the one hand, will bring some tacit knowledge resources to enterprises; on the other hand, it will lead to the increase of innovation-related investment, the formation of new knowledge and the accumulation of more knowledge capital. By applying it to the business activities of enterprises, the core competitiveness of enterprises can be solidly established. It will not only bring a greater value of knowledge capital to the enterprise but also enhance the competitive advantage of the enterprise, which will ultimately promote the growth and development of the enterprise and have a positive promoting effect on the growth performance of the enterprise. Therefore, Hypothesis H4 is put forward: the innovative quality of entrepreneurial enterprises affects the growth performance of enterprises through the accumulation of knowledge capital. That is, knowledge capital plays an intermediary role in it.

Based on the above four assumptions, the theoretical model is made as shown in Figure 1 below.

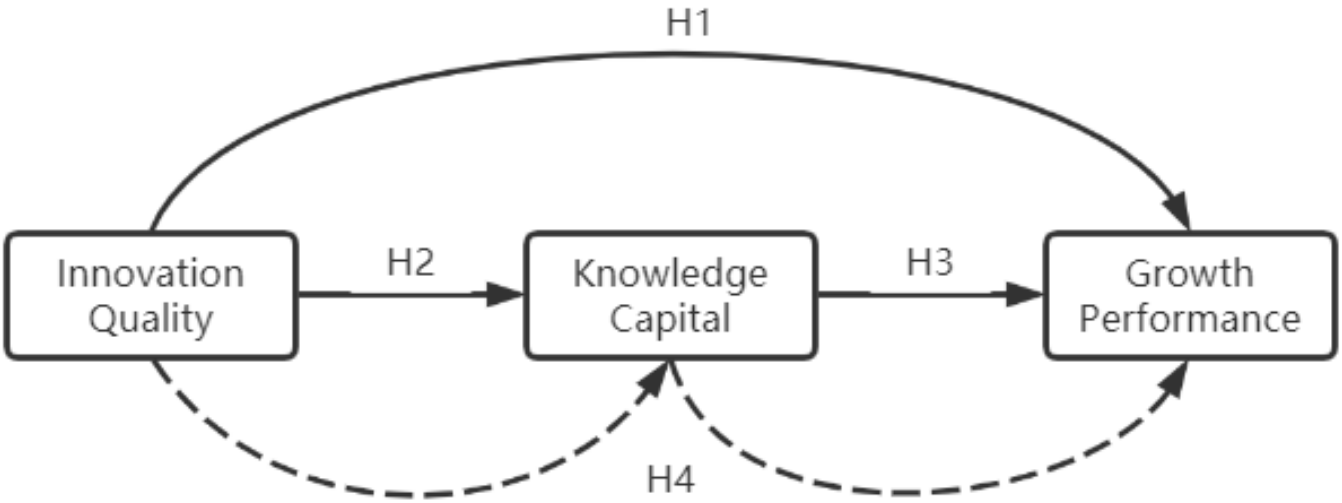


**Figure 1.** Theoretical model.

## 3. Construction and Calculation of the Knowledge Capital Index System

In order to empirically test the above hypothesis, this paper constructs the evaluation index system of knowledge capital and obtains the calculation formula of the knowledge capital index based on principal component analysis.

### *3.1. The Construction of the Evaluation Index System*

Galbrainth [33] first proposed the concept of knowledge capital in 1956, which is the capital related to knowledge activities. Since then, many scholars at home and abroad have carried out research on the constituent elements of knowledge capital. Different scholars have different divisions of knowledge capital, from monism to five-element theory and so on, but there is overlapping in the divisions, and the pluralistic theory of knowledge capital is now widely accepted. This paper is in favor of the four-element composition theory. Leibowitz (2000) [34] believed that from the perspective of knowledge value, knowledge capital includes human capital, innovation capital, structural capital and customer capital. Qiu et al. (2002) [35] explained the human capital, structural capital, technical capital and market capital in detail, and the knowledge capital constituted by the four parties was evaluated. According to Cheng et al. (2017) [36], knowledge capital is categorized into

the following four aspects: human capital, research and development capital, innovation facilities and technical capital. Hu et al. (2017) [37] constructed the index system of measuring and evaluating knowledge capital from the perspectives of human capital, relation capital and structural capital.

The construction of the evaluation index system of enterprise knowledge capital should rely on the industry characteristics and business philosophy, which should be classified, and the selection of the evaluation index should be quantified as much as possible [38]. On the basis of such research results as Qiu et al. (2002) [35], Cheng et al. (2017) [36] and Hu et al. (2017) [37], taking the research background and quantification into consideration, this article made some adjustments and supplements and divided knowledge capital into four dimensions: human resource capital, innovation and research and development capacity capital, innovation facility capital and relationship capital.

First of all, human resource capital is the most basic and core component of knowledge capital, and it is also a prerequisite for other elements to play their role. Human resource capital includes not only the ability, quality and work efficiency of employees who can create economic value for enterprises but also the investment in human capital [38]. Among them, the ability and quality of the employees are expressed by employee profitability, the salary ratio and total salaries of the first three executives to represent the investment in human capital [38] and the employee retention rate to further measure the efficiency of human capital [35,39].

Secondly, innovation and research ability capital reflect the level of enterprise innovation and investment ability. The innovation of enterprises includes both product/service innovation and process innovation, which is inseparable from the training of research and development innovation talents and the guarantee of the improvement of the enterprise's scientific and technology research and development ability. In addition, in the era of the knowledge economy, enterprises are required to take into account the reduction of management costs on the basis of increasing R&D investment. Therefore, this paper uses the R&D personnel investment [38], the proportion of R&D expenditure [38], R&D productivity and R&D intensity to describe.

Thirdly, the innovation facility capital provides efficiency support for the innovation activities of the enterprises. Advanced technology and facilities provide a guarantee for enterprises to respond quickly to the market. The advanced facilities of enterprises promote the circulation of information, knowledge sharing and transmission, and promote the liquidity of inventory and the efficient use of funds, which has a positive impact on the growth and development of enterprises. Therefore, this paper selects the current asset turnover rate, inventory turnover ratio [38] and management expense ratio to measure the innovation facility capital.

Finally, as far as micro-enterprises are concerned, relationship capital refers to the relationship between the enterprise and customers, suppliers and other interest groups and is also a reflection of the close connection between the enterprise and the outside world, which can be measured by some quantifiable indicators. This paper focuses on the relationship between enterprises, customers and suppliers and selects the customer concentration degree, supplier concentration degree, average accounts receivable turnover ratio [38] and sales expense ratio as these four indicators to measure the relationship capital.

In short, the four elements of knowledge capital are an independent, inseparable and interrelated whole, jointly realizing the appreciation of the knowledge capital of the enterprise [27]. The specific calculation formulas are shown in Table 1 below.

**Table 1.** Evaluation index system of knowledge capital.

| Measure Objective | First-Level Indicator | Second-Level Indicator | Calculation Formula |
|---|---|---|---|
| Knowledge capital (KC) | Human Resource Capital (HRC) | Salary–income ratio (sir) | Payroll payable/operating income |
| | | Staff profitability (sp) | Net profit/total number of staff members |
| | | Total salaries of the top three executives (ep) | Excluding the allowances |
| | | Staff retention rate (srr) | (1-number of retired staff)/total number of staff |
| | Innovation and Research Capital (IRC) | Research personnel input (rpi) | Number of research personnel/total number of staff |
| | | Research–expenditure ratio (rer) | Research input/management expenses |
| | | Research–productivity (rii) | Average operating profit in the past 2 years/average research and development Investment in the last 2 years |
| | | Research power (rp) | R&D investment/operating profit |
| | Innovative Facilities Capital (IFC) | Current asset turnover (cat) | Operating income/average occupied amount of current capital |
| | | Inventory turnover (ito) | Operating cost/average inventory occupied amount |
| | | Management expense ratio (mer) | Administrative expenses/operating income |
| | Relationship Capital (RC) | Customer concentration ratio (ccr) | The sales ratio of the top five customers to the total annual sales ratio |
| | | Supplier concentration ratio (scr) | The ratio of the purchase amount of the top five suppliers to the total annual purchase amount |
| | | Accounts receivable turnover (art) | Accounts receivable/average occupancy amount of operating revenue |
| | | Sales expense ratio (ser) | Sales expense/operating revenue |

### *3.2. Knowledge Capital Index Measurement Based on Principal Component Analysis*

#### 3.2.1. Principal Component Analysis

Many correlated indicators are covered in the index system, yet, the principal component analysis can simplify them into main components. Therefore, this paper selects the principal component analysis to calculate the knowledge capital index. Since the traditional principal component analysis method is generally applied to the cross-section data, this study first transforms the two-dimensional panel data into one-dimensional cross-section data. In this paper, each index is expanded in order of time and year. That is, the original f row v column panel is converted into the section of f × v row 1 column. On this basis, the principal component analysis is used, and then it is folded to obtain the final panel data.

#### 3.2.2. Knowledge Capital Index Measurement

1. Test the suitability for principal component analysis. Firstly, the KMO test and Bartlett test were conducted according to the four capital composition indicators. The test results showed that the KMO values of the four subjects were greater than 0.5, and the significance was less than 0.005, indicating that the four indexes of HRC, IRC, IFC and RC can be analyzed by principal component.
2. Extract principal components. The *p*-value can be selected by the cumulative contribution rate or characteristic value of the principal component. HRC group and RC group extracted two principal components whose characteristic value is greater than 1, and the IRC group and IFC group also extracted two principal components according to the principle of the cumulative contribution rate.

3. Calculate the principal components. The calculation formula of HRC index, IRC index, IFC index and RC index is obtained by weight calculation of each principal component. The negative value of the coefficient in the calculation result is due to the standardization of the principal component analysis. Details are shown in Table 2 below.

**Table 2.** Formulas of index calculation for HRC, IRC, IFC and RC.

| Order | Calculation Formula |
|---|---|
| Formula (1) | HRC = −0.143 ∗ sir + 0.465 ∗ sp + 0.205 ∗ ep + 0.729 ∗ srr |
| Formula (2) | IRC = 0.313 ∗ rii + 0.317 ∗ rpi + 0.066 ∗ rer + 0.304 ∗ rp |
| Formula (3) | IFC = 0.609 ∗ cat + 0.698 ∗ ito − 0.307 ∗ mer |
| Formula (4) | RC = 0.175 ∗ ccr + 0.498 ∗ ser + 0.514 ∗ scr − 0.187 ∗ art |

For the knowledge capital index, this paper uses the log of the sum of the HRC index, IRC index, IFC index and RC index to measure, i.e.,

$$KC = \ln(-0.143 * sir + 0.465 * sp + 0.205 * ep + 0.729 * srr + 0.313 * rii + 0.317 * rpi + 0.066 * rer + 0.304 * rp + 0.609 * cat + 0.698 * ito - 0.307 * mer + 0.175 * ccr + 0.498 * ser + 0.514 * scr - 0.187 * art). \quad (5)$$

## 4. Research Methods and Model Design

### *4.1. Sample Selection and Data Source*

The definition of entrepreneurial enterprises has been mentioned above, yet, the listed companies in GEM conform to the characteristics of entrepreneurial enterprises, and relevant information is complete. Given the need to ensure the consistency of statistical caliber, this paper chose the GEM companies between 2017–2021, namely, computer, communications and other electronic equipment manufacturing enterprises, as research samples, using the panel data analysis research. The financial data used come from the CSMAR database, and the number of authorized inventions of each enterprise during the observation period was obtained through the patent retrieval website of the State Intellectual Property Office. In order to ensure data consistency, reliability and integrity, the following sample data are excluded: enterprise samples marked with "ST", enterprise samples with missing data and enterprise samples with abnormal data. Finally, valid samples from 44 enterprises were obtained, with a total data number of 220.

### *4.2. About Variables*

#### 4.2.1. Explanatory Variables

Based on a quantifiable output perspective, patent licensing can reflect the direct results of innovation [40,41]. Therefore, in the measurement of innovation quality in empirical research, the patent number is the measure chosen by many scholars. Wu et al. (2016) [17] measured the technological innovation ability of the enterprise according to the patent stock applied for and obtained by the company. Compared with the other two types of patents, invention patents are more difficult to obtain and have a higher technical content, so they better reflect innovation ability and quality [42]. Chen et al. (2021) [43] used the number of invention patents to measure technological innovation ability. Yu et al. (2021) [44] used the invention patent authorization rate to represent the quality of innovation output. Based on this, this paper chooses to use the number of invention patent authorizations (IP) to represent the innovative quality of enterprises.

#### 4.2.2. Explained Variables

As the financial indicator parameters are relatively easy to obtain [45], thus, many scholars choose to use financial indicators (including sales revenue and assets) to measure enterprise growth performance. The operational definition of growth performance includes two aspects: growth in financial indicators and growth in profit potential (Zhang Jin, 2010) [46]. Wang Lei, Dang, et al. (2008) [47] used four variables, such as the growth

rate of total assets etc., in their measuring the growth performance of state-owned listed enterprises. Zhu et al. (2015) [48] held that the new enterprise performance includes financial performance and growth performance, the latter of which involves the growth rate of the enterprise's net income. As a resource that can generate income for the future, the enterprise assets can reflect the scale of the enterprise and then can be used as a measure of the growth performance of the enterprise. Based on this, this paper uses the Return on Assets (ROA) to measure the growth performance of enterprises and uses the Return on Equity as the replacement variable to test the stability.

#### 4.2.3. Mediator Variables and Control Variables

The intermediary variable KC (knowledge capital) is calculated by the above index formula of knowledge capital. Considering the influence of other factors on the growth performance of the enterprise, Ga (growth ability), Oc (ownership concentration), Lev (liability/asset ratio) and age (enterprise age) were selected as control variables. Among them, the proportion of the increase in operating profit and operating income represents the growing ability of the enterprise. It reflects the future development trend and the prospect of the enterprise to a certain extent. Generally speaking, the higher the relative stability of enterprises with high equity concentration, the stronger the ability to cope with external risks and threats; thus, to a certain degree, it is conducive to the steady growth and development of enterprises. The higher liability/asset ratio means its weaker solvency and the greater the operating risk, which is very unfavorable for the long-term development and stable growth of the enterprise. In terms of the age of enterprises, affected by the fluctuations of the life cycle, enterprises will have different characteristics and then different development trends in different stages. In short, these four aspects will have an impact on the growth of the enterprise to a certain extent. The variable selection and its calculation are shown in Table 3.

**Table 3.** Variable selection and its calculation.

| Variable Types | Variable Symbols | Variable Names | Calculation Specification |
|---|---|---|---|
| Explained variable | ROA | Return of assets | Net profit/average total assets |
| Explanatory variable | IP | Invention patents | Total number of inventions acquired by the company that year |
| Mediating variable | KC | Knowledge capital | The index formula of knowledge capital mentioned above (5) |
| Controlled variable | Ga | Growth ability | Operating profit increase/operating income |
| | Oc | Ownership concentration | The sum of the shareholding ratio of the top Three shareholders of the company |
| | Lev | Liability/asset ratio | Total liabilities/total assets |
| | Age | Enterprise age | The establishment date to the present date of the sample observation |

### *4.3. Regression Equation Model*

The F test, BP test and Hausman test on the panel data was made first, then combined with the test results, this paper selected the regression model. The following three regression models are established to test the influence relationship between innovation quality and growth performance, innovation quality and knowledge capital and knowledge capital and growth performance to verify the hypotheses H1, H2 and H3 proposed in this paper, respectively, as shown in Table 4 below. As stated, β0 is a random variable, which is the intercept of the regression equation; f is the observation unit, namely the 44 sample enterprises studied in this paper; t is the time sequence, namely 2017–2021; f,t represents the situation of enterprise f in year t; and ξf, is a random disturbance term.

**Table 4.** Model formula.

| Model Number | Model Formula |
| --- | --- |
| Model 1 | ROAf,t = β0 + β1 ∗ IPf,t + β2 ∗ Gaf,t + β3 ∗ Ocf,t + β4 ∗ Levf,t + β5 ∗ Agef,t + ξf,t |
| Model 2 | KCf,t = β0 + β1 ∗ IPf,t + β2 ∗ Gaf,t + β3 ∗ Ocf,t + β4 ∗ Levf,t + β5 ∗ Agef,t + ξf,t |
| Model 3 | ROAf,t = β0 + β1 ∗ KCf,t + β2 ∗ Gaf,t + β3 ∗ Ocf,t + β4 ∗ Levf,t + β5 ∗ Agef,t + ξf,t |

### *4.4. Mediation Effect Model*

The essence of testing for the existence of an intermediary effect is to test whether the path from the independent variable to the intermediary variable, then to the dependent variable, is significant all the time. By referring to the mediating effect test method concluded by Wen et al. (2004) [49] and on the basis of Models 1 and 2, Model 4 is constructed to verify the mediating role of knowledge capital. Model 4 is as follows:

$$ROAf,t = \beta0 + \beta1 * IPf,t + \beta2 * KCf,t + \beta3 * Gaf,t + \beta4 * Ocf,t + \beta5 * Levf,t + \beta6 * Agef,t + \xi f,t.$$

## 5. Empirical Analysis

### *5.1. Descriptive Statistics*

As can be seen from Table 5 below, the maximum number of invention patents granted by the sample enterprises is 162, while some enterprises have not obtained the invention patents. Some outlier samples have been deleted in this paper, but the gap between enterprises is still large, which also confirms the high quality and great difficulty of invention patents to some extent. The knowledge capital index of enterprises is not much different, floating on the average level of the industry, demonstrating that the sample enterprises are aware of the importance of knowledge capital. In terms of total asset net profit margin and growth ability, some enterprises show negative value, the situation is not good, and the overall gap is small. There is much difference in the ownership concentration of the sample enterprises, and the ownership concentration of some enterprises is much lower than the average value. A low level may have a negative impact on the stable growth of enterprises. The liability/asset ratio of the sample enterprise is relatively stable. On the basis of selecting some of the newer or older established companies, the lowest age in the sample enterprises is 6, and the highest is close to 30.

**Table 5.** Descriptive statistics.

| Variable | Cases | Minimum | Maximum | Average | Standard Deviation |
| --- | --- | --- | --- | --- | --- |
| IP | 220 | 0.000 | 162.000 | 12.250 | 20.310 |
| KC | 220 | 12.246 | 15.431 | 14.083 | 0.554 |
| ROA | 220 | −0.627 | 0.180 | 0.027 | 0.080 |
| Ga | 220 | −1.315 | 0.9442 | 0.119 | 0.270 |
| Oc | 220 | 5.651 | 68.038 | 40.988 | 13.045 |
| Lev | 220 | 0.028 | 0.832 | 0.316 | 0.172 |
| Age | 220 | 6.000 | 29.750 | 15.202 | 4.670 |

### *5.2. Correlation Analysis and the Regression Results*

In order to make a preliminary judgment on the correlation between the dependent and independent variables, a simple linear correlation analysis of Pearson was conducted before the regression analysis. From Table 6 below, the innovative quality of sample entrepreneurial enterprises has a positive and significant impact on growth performance, which is suitable for regression analysis. The correlation between innovation quality and knowledge capital, knowledge capital and growth performance is significant and positive, which will not be restated here. The model results from all passed the variance inflating factor test, showing that all VIF values are less than five, the independent variable setting is reasonable and there is no multicollinearity.

**Table 6.** Correlation analysis between innovation quality and growth performance.

| | IP | ROA | Ga | Oc | Lev | Age |
|---|---|---|---|---|---|---|
| IP | 1 | | | | | |
| ROA | 0.160 *<br>0.017 | 1 | | | | |
| Ga | 0.017<br>0.797 | 0.320 **<br>0.000 | 1 | | | |
| Oc | −0.074<br>0.272 | 0.180 **<br>0.008 | 0.039<br>0.565 | 1 | | |
| Lev | 0.159 *<br>0.018 | −0.065<br>0.340 | 0.165 *<br>0.014 | −0.021<br>0.760 | 1 | |
| Age | 0.097<br>0.152 | −0.023<br>0.732 | −0.201 **<br>0.003 | −0.163 *<br>0.016 | −0.194 **<br>0.004 | 1 |

Note: * At level 0.05, the correlation is significant. ** At 0.01, significant correlation.

This paper adopts two methods, namely, using enterprise virtual variable to control the personal effect and time trend variable to control the time effect. The results of regression analysis on Models 1–3 are shown in Table 7 below.

**Table 7.** Results of the regression analysis for Models 1–3.

| Variable | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | ROA | | KC | | ROA | |
| IP | 0.001 **<br>(3.381) | 0.001 **<br>(2.762) | 0.007 **<br>(3.191) | 0.005 **<br>(2.841) | | |
| KC | | | | | 0.061 **<br>(3.626) | 0.043 **<br>(3.765) |
| Ga | 0.075 **<br>(3.275) | 0.093 **<br>(4.170) | 0.098<br>(1.051) | 0.049<br>(0.356) | 0.069 **<br>(3.117) | 0.093 **<br>(4.114) |
| Oc | −0.001<br>(−0.691) | 0.001 **<br>(1.483) | −0.013<br>(−0.801) | −0.002<br>(−0.355) | −0.000<br>(−0.128) | 0.001<br>(1.433) |
| Lev | −0.280 *<br>(−2.386) | −0.056<br>(−1.441) | 0.028<br>(0.103) | 0.234<br>(0.676) | −0.282 *<br>(−2.601) | −0.056<br>(−1.287) |
| Age | −0.004<br>(−0.894) | 0.001<br>(0.411) | 0.073<br>(2.388) | −0.003<br>(−0.180) | −0.008 *<br>(−2.194) | 0.001<br>(0.660) |
| Intercept | 0.195<br>(1.873) | −0.032<br>(−0.796) | 13.411 **<br>(12.136) | 14.068 **<br>(41.458) | −0.629 *<br>(−2.572) | −0.634 **<br>(−3.980) |
| Personal effect | Yes | No | Yes | No | Yes | No |
| Time effect | No | Yes | No | Yes | No | Yes |
| R2 | 0.208 | 0.123 | 0.352 | 0.144 | 0.268 | 0.156 |
| N | 220 | 220 | 220 | 220 | 220 | 220 |
| F | 6.385 | 5.463 | 7.745 | 2.635 | 5.293 | 7.027 |
| *p* | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Note: * At level 0.05, the correlation is significant. ** At 0.01, significant correlation.

Model 1 reflects the regression results between the innovation quality and growth performance of the sample enterprises. The same results were obtained after controlling the personal effect and time effect. Both showed a significant correlation between innovation quality and growth performance below the level of 1%, and the regression coefficient was 0.001. It shows that the innovative quality of enterprises is indeed an important improving factor of growth performance. That is, the higher the innovation quality of entrepreneurial enterprises, the more conducive to the development and growth of enterprises, and then reflected in the improvement of their growth performance. Hypothesis H1 is proven. In terms of control variables, when only the personal effect is controlled, the growth ability is positively correlated with a significance level below 1%. That is, the higher the growth ability of the enterprise, the better the growth performance; the liability/asset ratio is

reduced by 0.280 units on average, indicating that the higher the ratio, the weaker the solvency and the more unfavorable to the growth and development of the enterprise. When controlling the time effect, the growth ability is also an important improving factor to the growth performance. The higher the ownership concentration of the enterprise, the more stable it is, and the company has a stronger ability to resist threats from some external markets, so it is conducive to the stable growth and future development of the enterprise.

The results of Model 2 show that after controlling the personal effect or time effect, the regression coefficient between the innovation quality and the knowledge capital reaches a significant level, which is 0.007 ** and 0.005 **, respectively, indicating that there is a significant positive influence between the innovation quality and the knowledge capital. That is, a higher innovative quality of entrepreneurial enterprises will promote the accumulation of knowledge capital, and Hypothesis H2 can be verified.

The test results of Model 3 are as follows: when the personal effect is controlled, the growth performance increases by 0.061 units as knowledge capital by 1 unit, indicating that the accumulation of knowledge capital is conducive to the sustainable growth of enterprises and plays an important role in promoting the growth and performance of enterprises, Hypothesis H3 passes the test. The growing ability of the enterprise plays a positive effect on the stable growth of the enterprise; on the contrary, the asset–liability ratio will inversely limit the positive trend of growth and development; in addition, the results show that age has a negative effect on the growth performance of the enterprise, which may be faced with the growing and maturing period when the enterprise will inevitably encounter some development bottlenecks and traps. When the time effect is controlled, the knowledge capital increase is still a significant positive promoting factor on the growth performance. In terms of control variables, the improvement of the growing ability of the enterprise promotes the continuous development and growth of the enterprise and then improves the growth performance.

### *5.3. Test of the Intermediary Role*

Through the above analysis, we have obtained that the regression coefficient a of the independent variable (IP) to the dependent variable (ROA) in Model 1 is significant, and the coefficient c of the independent variable (IP) to the mediation variable (KC) in Model 2 is significant; therefore, we only need to test the coefficient b of the mediation variable (KC) for the dependent variable (ROA) in Model 4 and the coefficient c′ of the independent variable (IP) for the dependent variable (ROA) in Model 4, the test results are shown in Table 8 below. We can see that when controlling the personal or time effects, coefficients b and c′ are both significant, and the number of a ∗ b and c′ and the significance of the independent variable (IP) to the dependent variable (ROA) decreased from 0.001 ** to 0.001 *. The robustness of the mediating effect was tested by the Bootstrap method. According to the Bootstrap mediation analysis, the test results showed a partial mediation effect and that the innovation quality of entrepreneurial enterprises has a direct effect on the positive promotion of growth performance. The other part is to promote growth performance through the intermediary variable of knowledge capital. By calculating the effect proportions of the two cases as 24.205% and 23.343%, respectively, Hypothesis H4 is proven. It further shows that there are two influencing paths from the innovation quality to the growth performance of entrepreneurial enterprises, one is direct, and the other is on the growth performance through knowledge capital.

**Table 8.** Test of the mediation effect.

| Way | c | A | b | a ∗ b | c′ | Personal Effect | Time Effect | Result |
|---|---|---|---|---|---|---|---|---|
| Innovation quality–knowledge capital–growth performance | 0.001 ** | 0.007 ** | 0.061 ** | 0.000 | 0.001 * | Control | Non-control | Partly intermediary |
| | 0.001 ** | 0.005 ** | 0.043 ** | 0.000 | 0.001 * | Non-control | Control | Partly intermediary |

Note: * At level 0.05, the correlation is significant. ** At 0.01, significant correlation.

### *5.4. Robustness Test Based on Alternative Variables*

Finally, this paper uses ROE (Return on Equity) as the measure of robustness test of the enterprise's growth performance. It can be seen from Tables 9 and 10 below that the test results are consistent with the original results, indicating that the empirical analysis results of this paper are stable and reliable.

**Table 9.** Results of the regression analysis of surrogate variables Models 1′ and 3′.

| Variable | Model 1′ | | Model 3′ | |
|---|---|---|---|---|
| | ROE | | ROE | |
| IP | 0.001 ** | 0.001 ** | | |
| | (3.473) | (2.822) | | |
| KC | | | 0.090 ** | 0.061 ** |
| | | | (3.272) | (3.712) |
| Ga | 0.118 ** | 0.155 ** | 0.108 ** | 0.155 ** |
| | (3.689) | (4.151) | (3.509) | (4.085) |
| Oc | −0.002 | 0.002 | −0.001 | 0.002 |
| | (−0.983) | (1.440) | (−0.519) | (1.411) |
| Lev | −0.372 | 0.006 | −0.375 * | 0.006 |
| | (−1.837) | (0.087) | (−1.979) | (0.084) |
| Age | −0.007 | 0.001 | −0.014 ** | 0.002 |
| | (−1.186) | (0.505) | (−2.553) | (0.775) |
| Intercept | 0.344 ** | −0.071 | −0.871 * | −0.935 ** |
| | (2.196) | (−1.142) | (−2.230) | (−4.237) |
| Personal effect | Yes | No | Yes | No |
| Time effect | No | Yes | No | Yes |
| R2 | 0.185 | 0.082 | 0.239 | 0.108 |
| N | 220 | 220 | 220 | 220 |
| F | 7.625 | 7.197 | 5.905 | 7.955 |
| *p* | 0.000 | 0.000 | 0.000 | 0.000 |

Note: * At level 0.05, the correlation is significant. ** At 0.01, significant correlation.

**Table 10.** Test of mediation effect for surrogate variables.

| Way | c | a | b | a * b | c′ | Personal Effect | Time Effect | Result |
|---|---|---|---|---|---|---|---|---|
| Innovation quality–knowledge capital–growth performance | 0.001 ** | 0.007 ** | 0.090 ** | 0.000 | 0.001 * | Control | Non-control | Partly intermediary |
| | 0.001 ** | 0.005 ** | 0.061 ** | 0.000 | 0.001 * | Non-control | Control | Partly intermediary |

Note: * At level 0.05, the correlation is significant. ** At 0.01, significant correlation.

## 6. Research Conclusions and Discussion

### *6.1. Main Results and Implications*

This paper first constructs the evaluation index system of knowledge capital from four aspects: human resource capital, innovation and R&D ability capital, innovation facility capital and relationship capital, which has a guiding influence for enterprises to use and develop knowledge capital. The knowledge capital index of the sample enterprises is measured by using the principal component analysis method. Enterprises should take the initiative to make a reasonable capital allocation to realize the value maximization of the enterprise.

Secondly, this paper conducted empirical research on the panel data of 44 GEM-listed enterprises from 2015 to 2019 to study the relationship between enterprise innovation quality, knowledge capital and growth performance. The influence path between the three is clarified, and the related research on enterprise growth performance is expanded. Specific research conclusions and enlightenments are as follows:

1. The innovation quality of entrepreneurial enterprises has a positive role in promoting the growth and performance of enterprises. This is consistent with the mainstream

conclusion of current relevant studies that technological innovation can improve enterprise performance, and the research conclusion of this paper further verifies the important role of innovation quality in the growth of enterprises. With the improvement of innovative quality, the growth and development of enterprises will be more optimistic, which is reflected in the growth performance. The government and relevant departments should implement the new development concept, encourage enterprises to carry out high-quality innovation activities and create a good environment for innovation. Enterprises must try constant innovations, give full play to the innovation subject, and make competitive and innovative advantages so as to provide corresponding products/services in the face of personalized and changeable market demand, and finally achieve innovation-driven economic development. Relatively speaking, entrepreneurial enterprises themselves pay much attention to innovation; meanwhile, they should control the innovation quality. By increasing the proportion of high-quality innovation output, they should increase competitiveness and occupy the market, which is conducive to the improvement of enterprise benefits and promote the long-term sustainable development of enterprises.

2. There is a positive relationship between the innovation quality and knowledge capital of entrepreneurial enterprises, which is reflected in the accumulation and growth of knowledge capital with the improvement of innovation quality. Existing studies point out that high-quality innovation activities increase knowledge acquisition to some extent, but this study further indicates that the growth of knowledge capital cannot be separated from the improvement of innovation quality. Therefore, from the present research conclusion, the quality of innovation covers the incremental information of knowledge capital, which can reflect the situation of knowledge capital to a certain extent. The improvement of the innovation quality output has won more market opportunities for enterprises and increased the investment in human capital, and the R&D productivity, current assets turnover and accounts receivable turnover will also be improved accordingly, thus increasing the accumulation of knowledge capital. In addition, enterprises should lay emphasis on the balanced development of knowledge capital components to achieve greater value and benefits.
3. There is also a significant positive correlation between the knowledge capital of entrepreneurial enterprises and their growth performance. The expansion and accumulation of enterprise knowledge capital create favorable conditions for the development and growth of enterprises and promote the growth of the strength and scale of the enterprise. In other words, corporate knowledge capital not only promotes the improvement of corporate financial performance but also facilitates the growth of corporate growth performance. Thus, the optimal and rational allocation of knowledge capital is the driving force of the long-term development of enterprises. Therefore, enterprise managers need to make reasonable knowledge capital investments considering their own resources, competitive ability and industry position, create a good internal environment of knowledge sharing, focus on the accumulation of knowledge capital and develop a capital management strategy conducive to the sustainable development of enterprise, so as to obtain a competitive position continuously. In addition, a reasonable and perfect knowledge capital management system is an important prerequisite to give full play to the role of knowledge capital, build a knowledge capital evaluation mechanism and evaluate the knowledge capital of enterprises comprehensively and reasonably based on the long-term development of enterprises.

Finally, this paper analyzes the mediating role of knowledge capital from a new perspective and expands the depth of research on the influencing mechanism between innovation quality and growth performance. The result is as follows: as a steady growth factor and an innovation quality variable, the knowledge capital of entrepreneurial enterprises plays an intermediary role between innovation quality and growth performance, and innovation quality affects growth performance through knowledge capital. Specifi-

cally, high innovation quality requires relevant innovation investment, which increases the accumulation of knowledge capital and produces more value of knowledge capital and promotes the income generation of the enterprise, which is then reflected in the growth of the enterprise. Therefore, entrepreneurial enterprises should pay attention to the following points in their future growth and development:

(1) Lay stress on the cultivation of talents, establish a reasonable salary mechanism and career development planning, strive to enhance staff's sense of identity, belonging and happiness, stop the outflow of talent and control the personnel flow.
(2) Reasonable R&D investment where the R&D personnel and development costs should take the management increase into consideration and make reasonable allocations.
(3) Introduce advanced technical facilities, promote the circulation and sharing of knowledge and enhance the working efficiency of employees.
(4) Maintain a good relationship with customers and suppliers. On the one hand, the growth and development of enterprises cannot be separated from customers' consumption of products/services. On the other hand, the close relationship with suppliers can broaden the channels for enterprises to obtain information, knowledge and resources. In short, entrepreneurial enterprises need to put more emphasis on knowledge capital and promote the value appreciation and sustainable development of enterprises.

### *6.2. Research Significance*

The conclusions of this paper are instructive for expanding the research perspective of knowledge capital, supplementing the research scope of growth performance and promoting the effective improvement of the growth performance of entrepreneurial enterprises. The possible theoretical contributions of the research design of this paper are as follows: (1) Starting from the perspective of knowledge capital and taking innovation quality as the main line, a theoretical model of the impact of innovation quality on growth performance will be constructed, which can provide new evidence and new ideas for theories on growth performance. Existing literature has not reached an agreement on the relationship between the two. However, through empirical research, this study found that innovation quality has a positive promoting effect on firm growth performance. (2) More importantly, knowledge capital plays a partial mediating role between innovation quality and growth performance. This finding can integrate the differences in the existing literature and clarify the driving role of knowledge capital as a core competitive factor in the growth performance of entrepreneurial enterprises. (3) This paper verifies the mediating effect of knowledge capital between innovation quality and growth performance so as to provide a reference for clarifying the cognition of the path mechanism from innovation quality to growth performance and promote further research. At the same time, in practice, the research results provide a reference for Chinese entrepreneurial enterprises to improve the quality of innovation and knowledge capital so as to obtain competitive advantages, a foothold in the competitive market and have an enlightening effect on entrepreneurial enterprises in the complex and changeable market and economic environment to cope with greater survival and development challenges and improve growth performance.

In view of this, entrepreneurial enterprises in the future development should not only focus on innovation quality but also pay attention to knowledge capital investment intensity and accumulation, encourage enterprises to improve the innovation quality to drive the knowledge capital growth, improve the positive role in the quality of innovation, make the enterprise occupy a place in the new market and achieve economic growth and finally win the enterprise growth performance.

### *6.3. Research Limitations and Prospects*

There are also some limitations in this paper. First of all, in the measurement of innovation quality, this paper adopts the number of authorized invention patents as the proxy variable. Although it reflects the innovation quality of the enterprise to a certain extent,

due to the complexity of innovation activities, it cannot fully reflect the innovation quality of the enterprise, which needs further discussion. Secondly, the growth performance improvement of enterprises is a very complex issue, and all enterprise studies ultimately point to the improvement of performance, one of which is innovation quality and knowledge capital. Subsequent studies can further find out the influence of other variables through research, literature review and other methods, and include more control variables so as to enrich the research framework and content of enterprise growth performance. Finally, this paper chooses computer, communication and other electronic equipment manufacturing enterprises listed on GEM as the research objects, and the universality of the research results is limited to a certain extent. In future research, we can continue to extend other types of enterprises for comparative analysis so as to draw more universal conclusions and also expand the coverage of the research to discuss from the perspective of the industry.

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