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Enigma of Relationship between Digital Economy and Intellectual Property Rights: Reflections on Innovation in Digital Economy Represented by Cloud Computing

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Abstract

INTRODUCTION: The development of the digital economy and intellectual property management represented by cloud computing has promoted the progress of China's modernization road. Cloud computing plays a vital role in various industries, and the control of intellectual property rights in the digital economy represented by cloud computing is closely connected with the high-quality development of China's digital economy, the construction of a robust intellectual property country, and the modernization of the national government. China's intellectual property management capability and digital economy management system are advanced, but practical difficulties still exist at home and abroad.
OBJECTIVES: To improve the development level of computer information technology such as cloud computing; to promote the integrated development of digital economy and intellectual property rights; to solve the protection problems in the practical application of intellectual property rights with information technology; and to promote the coordinated development of digital economy and intellectual property rights represented by cloud computing.
METHODS: Analyzes the role of intranet in protecting business information from the technical perspective of cloud computing; puts forward the hypothesis of the relationship between the digital economy and intellectual property rights by using literature research; and applies the empirical method to verify the use of patent data of state-owned enterprises and the total index of the regional digital economy.
RESULTS: The results of the study show that there is a significant positive correlation between the level of development of cloud computing, the Digital Economy, and the internal cloud computing network of the company, which meets the external conditions of the lack of capacity of the Digital Economy and strengthens the globalization of the cloud computing cooperation network.
CONCLUSION: Companies can manage the risk of data loss in the digital economy by adapting their internal cloud computing capabilities. After in-house processing and multiple reliability tests, the impact of the digital economy, represented by cloud computing, on supply chain innovation remains significant. In the post-financial crisis era, the effect of the digital economy on chain innovation is important because it is a cloud computing technology-intensive production chain with low dependence on external technologies. The digital economy has a threshold effect on innovation in the production chain. With the strengthening of intellectual property protection, the marginal impact of cloud computing and the digital economy on chain innovation increases significantly.

Keywords: digital economy, intellectual property, innovation, cloud computing

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1. Introduction

"Cloud computing and the digital economy" have become essential themes in China's economic development and are significant in driving change, growth, and innovation. The decentralized, virtual, and interconnected environment facilitates close cooperation and communication among knowledge creators on the one hand and increases the risk of accidental data leakage on the other. Therefore, protecting intellectual property is at the heart of cloud computing and the Digital Economy. Companies are the most active players in the cloud computing digital economy. Understanding a company is critical to its survival and maintaining a competitive advantage. More and more companies rely on information to create value and profits. However, most companies try to prevent the dissemination of information, especially in the context of the cloud computing digital economy. Firm-owned technologies can provide more opportunities by extending digital resources, increasing the flow of knowledge and information between different innovators, and lowering the threshold for other firms to access competent resources and transaction costs (Bingnan Guo, 2023). Ruoyu et al. point out that firms based on internal knowledge and other resources can use limited information resources by identifying network capacity and using different network connections to improve innovation. With the explosion of intelligent resources, companies must create more network connections to access more intelligent resources. The increased cloud and digital Economy resources have significantly impacted the organization's network structure. The company may accidentally disclose its data to several competitors or partners.

Researchers have long studied how companies can protect their smart innovations from theft (Bo Wang, 2022). Mr. Wu Chaoping points out that strengthening IPR protection is necessary to reduce firms' risk of disseminating knowledge. Improving national IPR protection systems can provide good incentives to ensure the sustainability of corporate innovation. However, legal protection only protects firms' ability to a minimal extent. Irvonen et al. argue that there are two main reasons for the loss of firms' knowledge: first, unnecessary data transfers and information possessed by competitors for external reasons—second, lack of security and privacy management mechanisms in companies.

Currently, most researchers focus only on external factors related to data leakage. They believe the network is the most essential way to access external information resources from the company, and cooperation with external companies increases the risk of knowledge loss. Therefore, network defense can provide additional power and reduce data loss due to competition. Thus, from a network perspective, these researchers have demonstrated that companies can protect their data by changing the structure and architecture of external networks (Boqiang Lin, 2022). However, Inkpen and others have argued that data breaches are inevitable because managerial and technical information is more critical in organizations of social media workers. Therefore, the role of intranets in explaining data protection deserves more attention. Companies have become the primary channel for searching for external information and accessing information resources from various sources. Changing the outer structure of the Business Capability Shield (BCS) network may make it difficult for firms to improve their innovative capabilities. Therefore, this paper examines the internal networks of firms to understand whether measures to change the internal structure of firms increase the barriers for other firms to search for intelligent resources and corruption to address the risk of data leakage in the cloud computing digital economy.

Table 1 Analysis of the types of industries combining Digital economy and intellectual property rights

Types of Digitized Industries	Industry and Sector	Specific breakdown of national economic sectors
Digital economy-industrial manufacturing	Manufacturing	Industrial equipment manufacturing, office equipment manufacturing, machinery and electrical appliance manufacturing, home and office furniture manufacturing, aerospace manufacturing, etc.
The digital economy technology industry	Computer industry	Infrastructure construction industry required by carriers, aerospace satellite equipment manufacturing industry, technology services home industry, etc.
Digital Economy - Factor concentration industry	Computer & Fintech industry (Ant et al., etc.)	Internet finance industry

"Digital China," "cloud computing, digital economy," and "digital trade" overlap with intellectual property rights (IPRs), the modernization and management of which is one of the critical aspects of China's modernization path. At the highest levels of the IP program, IP management is increasingly important as a source of national development strategy and a critical factor in international competitiveness, playing an increasingly important role in

promoting innovation, branding, and creativity. Adopting various policies and requirements to "standardize market order and expand transparency" sets the direction and specific requirements for prudent management of IPR in China's cloud computing and digital economy. Page 20. The report calls for enhanced protection of IPR management and a comprehensive innovation infrastructure support system (Cheng Zhang, 2022). Intellectual property management in cloud computing and digital economy is related to the development of China's modernization path, the high-quality development of China's cloud computing and digital economy, the construction of a strong IPR state, and the modernization of public administration. In building intellectual property rights, comprehensive management measures such as system building, institution building, market incentives, external support, and global participation are needed to clarify and gradually eliminate internal and external constraints. China will better utilize the dynamic and normative role of cloud computing and the digital economy to expand openness and compatibility.

The new era of intellectual property management in China's cloud computing and digital economy has entered a new stage of development, combining solid technological capabilities, cross-border, high migration, and foreign economic characteristics, bringing new interpretations and additions to China. For example, to protect a wide range of innovative technologies and digital rights in the cloud computing digital economy, China needs to do more to examine and manage intellectual property rights and examine assumptions about how and to what extent data and data are protected as intellectual property in the cloud computing, digital Economy (Zhao et al.; Y., 2022). For example, governments and quasi-public platforms effectively use the Internet, artificial intelligence, blockchain, and other technologies to regulate intellectual property access and effectively disaggregate the geographic character of intellectual property in digital commerce. For example, controlling and strengthening open-source intellectual property rights, promoting green governance, ensuring effective public intellectual property services, and effectively monitoring and coordinating national security issues in the cloud computing digital economy are also critical for complementary intellectual property management.

2. Literature review

Cloud computing and the digital economy can effectively mobilize resources from both domestic and foreign markets. Cross-border flows of IP-related goods would change over time as demand increased in the region. China's efforts to build a "digital China" and a "digital trade powerhouse" further increase the demand for cross-border flows of IP products. Therefore, IP management in the cloud computing digital economy must include internal and external aspects (Chuan Zhang, 2022). At the national level, through various digital financial organizations, China should actively use technology, law, governance, and other means to address IPR issues in new industries and co-manage new forms and models rationally and efficiently based on the full implementation of IPR protection. At the international level, the Author is actively responding to the crisis, for example, by using China's IPR issues to expand enforcement and the ongoing trade war "to promote international cooperation and competition in the field of intellectual property." "Promoting a fairer and more rational global intellectual property management system" to ensure national intellectual property security.

2.1 Domestic Research on Cloud Computing, Digital Economy, and Intellectual Property Development Dilemmas

Intellectual property management in the cloud computing digital economy is complex. The cloud computing digital economy includes digital industrialization, digital industry, digital governance, data value and other industries, governance and public services, and national and international economies(Da Huo, 2022). The content is broad and complex. Intellectual property and patents, standards, gaming, sporting events, online broadcasting, consumer interest in AI products, genetic engineering, trademark harmonization, intellectual property protection, industrial development, and cross-border trade, whether and to what extent this information is protected, which includes a wide range of regulatory measures in the area of intellectual property management and their broad application in legal, administrative, economic, technological, social and other areas. They also blur the boundaries of IPR infringement in the national cloud computing digital economy, broaden its scope, deepen its impact, complicate its typology, and hinder the provision of assistance.

In addition to cloud computing, the digital economy will create new forms of business such as e-commerce, video games, online offices, and telemedicine, as well as recent conversations about data, decision models, services and innovations, and business competition between digital platforms.' A unique situation has emerged in the 'gray area' of IP management, which does not lend itself to traditional concepts and approaches to IP management (Feng Dong, 2022). Identifying evidence and legal frameworks regarding competence and administrative authority is difficult, which will accelerate the revision of applicable laws. Ensuring the effective implementation of cloud computing and the Digital Economy, as well as providing innovation, fairness, and management of intellectual property rights, increases the difficulty of administration.

Technology, insecurity, and accidents are everywhere. 5G, blockchain, artificial intelligence and other new technologies and related themes of innovation and economic security, uncertainty caused by the global coronavirus of 2019, the standard status of human intelligence, and public health considerations affect and challenge the management of intellectual property rights in the cloud computing, digital economy. Only partial and unilateral powers have little or no impact. It promotes scientific and technological progress by improving institutional frameworks, harmonizing governance, and establishing country-led project management teams. The digital divide is deepening. The growth of cloud computing and the digital economy is widening this gap. Unique competitive advantages and legal monopolization of intellectual property rights further widen the gap between access to and use of such information and technologies, which may lead to abuse of IPR holders' rights, unfair competition, and monopolization of IPRs, deepening the digital divide in the cloud computing, digital economy. The interests of different positions are interrelated and must be addressed through technical, economic, legal, administrative, social, and other aspects. Harmonization takes work. Strengthening IP protection changes the scope and requirements of IP management. To find adaptive control, individuals must face the challenges of uncertainty, prepare for changes and accidents, and strengthen their ability to adapt to obstacles.

2.2 Foreign Studies on Cloud Computing, Digital Economy, and Intellectual Property Development Dilemma

International cooperation on intellectual property rights for cross-border transactions in cloud computing and the digital economy is difficult. Cross-border transactions in cloud computing and the digital economy involve multiple segments, including production, commercial services, payments, logistics, and various regulatory agencies. Cross-border contacts and cooperation include multilateral relationships between governments, market participants, and governments and market participants. In addition, cloud computing, digital economy, and intellectual property rights are new (Guangqin Li, 2023). In the cross-border context, collecting evidence is the main reason for the difficulty of protecting interregional rights. The persistence of different IPR regimes in other countries and regions, limited resources for cross-border IPR management, weak regulatory forces, and limited regulatory areas also complicate the practice of international governance.

International friction over intellectual property is uncertain. In recent years, there has been a trend towards globalization of the global political economy. Intellectual property rights are based on the recognition and protection of the rights of certain countries, enabling them to effectively create barriers to international trade, serve as a pretext for current global tensions, influence international economic and political realities, and tactically implement the international political strategies of certain countries. The United States has repeatedly used the "301 Special Investigation" and "Section 337" to pressure China. The U.S. government has used China's intellectual property rights to accelerate the accusations, and the U.S. has continued the trade war. The proportion of foreign IPR disputes between huge Chinese companies has increased dramatically (Jianda Wang, 2022). Implementing this international policy will inevitably increase global policy uncertainty and instability and prevent future prevention of IPR management in the cloud computing and digital economy as cross-border transactions continue to grow in the cloud computing and digital economy.

2.3 The Right Value Orientation of Cloud Computing, Digital Economy, and Intellectual Property Relationships

The healthy development and unimpeded mobility of China's cloud computing and digital economy must seek ways to modernize China, given the requirements for high-quality development of the cloud computing and digital economy, intellectual property rights building, and modernization of the national government (Jianda Wang, 2022). The new development concept of "innovation, coordination, environmental protection, openness, and sharing" combines economic, social, and ecological values. In building China's cloud computing and digital economy, the new IP management model can play a leading role in high value-addedness and help to adapt to the inherent requirements of China's modernization path. In addition, the five development concepts will help shape the specificity of intellectual property management in China's cloud computing and digital economy.

Intellectual property management in the cloud computing digital economy is itself a source and driver of innovation, not only through establishing systems and measures to encourage and protect many innovations but also through enhancing its social impact and sustainability. With the development of China's cloud computing and digital economy and the strengthening of IPR protection, IPR management in cloud computing and digital economy mainly focuses on the interests of IPR owners and patent protection. It opposes various traditional management models (Lianghu Wang, 2023)—for example, piracy and counterfeiting. It balances and harmonizes interests between respecting individual interests and maintaining fair order. This is reflected in the increasing emphasis on cloud computing and the Digital Economy, the encouragement of anti-monopoly and unfair competition measures in intellectual property, and the encouragement of market organizations of intellectual property owners to promote open source innovation. Realizing individual spiritual values and fundamental socialist values; paying more attention to intellectual property rights in the new

business models of cloud computing and the Digital Economy, the relationship between intellectual property owners and consumers, data protection and privacy, intellectual property protection and economic security, and public health; and focusing on shared prosperity and full respect for private intellectual property rights. China also needs to apply new development concepts at the international level to strengthen intelligent property management and international trade in cloud computing and the digital economy to avoid pretexts for international trade disputes.

3. Research questions and hypotheses

The growth of cloud computing and the digital economy has changed the cost of information flow, making it easier for companies to transmit and copy data. Some researchers have taken a network perspective to prevent business data theft. This paper focuses on internal collaboration and information networks and the general structure of the two internal networks. This structure describes not only the reality of ownership of people's social networks but also the dissemination of knowledge. The paper emphasizes two important features of small worlds: aggregation factors and temporary paths. The aggregation factor influences the knowledge richness of the network, and the intermediate course influences the tendency of participants to recognize new opportunities. Previous studies have only examined the role of structure (Lin Liang, 2023). Letters and telegrams; small world. gt; on information exchange and information flow, its role in data protection has yet to be fully recognized. Therefore, this section summarizes the impact of cloud computing and the digital economy on the internal networks of global small businesses from an internal network perspective.

3.1 Cloud Computing, Digital Economy Theory from the Perspective of Intra-Enterprise Defense

Cloud computing and the digital economy have increased openness, interaction, and uncertainty in the social environment. The use of digital technologies by many companies to reduce communication costs and improve the use of innovation networks also places greater demands on data integration and heterogeneity. Companies need to transform knowledge creation further and share it in innovation networks. The impact of cloud computing in the digital economy will strengthen the network effect between firms, enabling two-way integration of information within and between firms (Madinatou Y, 2022). The increasing number of communication channels contributes to the expected transfer of knowledge and its development and helps blur the information-sharing boundaries between companies. The use of the Internet and digital technology has made it easier for companies to access information through social media and for companies to access important information quickly. Other actors are also increasingly involved. These stakeholders benefit from stolen innovations that are too expensive for companies to protect their knowledge (Ming Yi, 2022). Patent inventors are in various social relationships through which companies transfer knowledge, influence access to resources, disseminate knowledge, and exchange ideas between organizations or individuals. Due to the dissemination of information created by cloud computing and the digital economy, companies inevitably transfer their knowledge to their competitors. The mini-global structure of intra-firm networks may complicate these social relationships, so other firms must try to interpret and imitate their complex behavior. Some researchers have found that over-centralization can impede knowledge transfer in relatively small collaborative networks, where network operators share information with only a few close partners and set common standards and trust in the cluster (Peng HUO, 2022). Outsiders cannot communicate information to one or more employees, hire valuable and innovative talent, and the company's expertise is difficult to understand and comprehend. As a result, companies in cloud computing, the digital economy developed regions, must rely on complex collaborations to maintain their key selling points and advantages. Based on the above analysis, this paper presents the following hypotheses:
Hypothesis 1: A company builds an internal collaborative network with small world leaders in a region with advanced cloud computing and digital economy.

3.2 Theories of Intellectual Property Protection

Unlike collaborative networks, knowledge-based networks are essential in highlighting critical connections between scientific and technological knowledge elements and helping inventors discover new ones. Thus, in a data network, two randomly selected data elements can be tightly connected through small-world properties with few connections. The small structure of information networks allows for in-depth exploration of business information in efficient web and digital applications(Su et al.; M. W., 2022). Competitors only need to capitalize on the importance of knowledge by integrating a small amount of information into an existing data network to gain access to a company's primary technical expertise and increase the likelihood of a merger or imitation (Pengyu Chen, 2022). Fragmented data may increase the cost of finding a replicator if the data elements in the network are not closely linked, making it difficult to understand and integrate information from different sources. As a result, small amounts of information obtained by other companies will not materially harm the company. When the level of cloud computing and the digital economy is high, companies may reduce the overall nature of their

information networks to hide the linkages between their core competencies, thus making it more difficult for simulators to explain their core competencies. Based on the above analysis, the following assumptions are made in this paper:

Hypothesis 2: In areas where cloud computing and the digital economy are highly developed, companies have created an internal information network representing only a tiny part of the world.

4. Research design and variable collection

4.1 Variable Design

Explained Variable: Cloud Computing, Digital Economy and Intellectual Property Relationship Puzzle. Innovation inputs and benefits in the production chain examine the innovation inputs and benefits of each product member of the production process. As production processes become more diverse and complex, the production of the final product is increasingly dependent on previously indirect inputs. Traditional approaches to measuring innovation investment and innovation activity from the perspective of the final product ignore the significant impact of indirect investment and do not reflect economic reality. The chain's innovation investment and performance have been calculated using the I/O model to address these shortcomings. For example, the I/O model can calculate the innovation shares of two sectors in the value chain and innovation performance. The order vector of medium innovation performance is P, and its components are Ri and Pi, which are calculated as follows:

$$R_i = \frac{rd_i}{x_j} + \beta 1 \ln dex_p + \delta_i \qquad (1)$$

Equation (1) illustrates how the inputs and outputs are calculated as including a random disturbance further improves the progress.

$$p_j = \frac{newprofit_j}{x_j} + \alpha \sum_{i=1} \sqrt{\chi^2 - 4} + \delta \qquad (2)$$

Where FEF is the domestic expenditure on R&D assets, NewProfitJ represents innovation profit. Since new products are the result and final form of innovation, this study uses the profit from recent product sales to measure innovation profit. Xj represents total production. The input matrix of the innovation chain (R, B) is the innovation input of the intermediate industry to the final product production process. The matrix element Rj x bij is the innovation input of industry chain i, which generates the middle industry j product end unit (Shuxing Chen, 2022). The equation shows the innovation input of each intermediate industry in the production of the first unit of the final product according to the direction of the columns. Accordingly, the matrix element Pj x bij represents the innovation profit of intermediate industry j, which is contained in each unit of the innovation profit of the final product of chain i. The matrix element Pj x bij represents the innovation profit of intermediate industry j, which is contained in each unit of the final product of chain i. The sum of the vectors represents the innovation profit of chain i. The equation is as follows:

$$innord = r_1 \times b_{1i} + r_2 \times b_{2i} \qquad (3)$$

Equation (3) explains well the relationship between cloud computing, the Digital Economy, intellectual property protection, and how profits are calculated.

$$innopf_i = p_1 \times b_{1i} + p_2 \times b_{2i} \qquad (4)$$

Explanatory variables: cloud computing, digital economy. This paper uses the cloud computing digital economy composite index as an explanatory variable. In measuring cloud computing, the digital economy currently needs to be revised. Many researchers have put forward the idea of creating an appropriate index system from different dimensions. Regarding data availability, this paper uses Zhao Tao's methodology for dealing with cloud computing digital economy variables. It measures the data using China's Inclusive Digital Finance Index, Internet penetration, suitable labor force, reasonable productivity, and cell phone penetration. The remaining four indicators are derived from the China Statistical Year. Internet penetration is calculated based on Internet connections per 100 users. A suitable labor force is the percentage of computer and software workers among urban workers. The results are derived by calculating the number of telecommunication services per inhabitant and the cell phone penetration rate per 100 users. Second, analyzing the essential components reduces the measurement of these standardized data to obtain a comprehensive indicator of the development of cloud computing, the Digital Economy, which is recorded as "Digit."

$$a_{ift} = \frac{x_{ift}}{x_{it}} + \beta_0 \qquad (5)$$

Including random variables in equation (5) is to model better the actual values that occur.

$$digr_{it} = \sum_f a_{ift} j \sum_j a_{ijt} \qquad (6)$$

Where the order is I, F, and J year, xift represents the consumption i in the production chain of cloud computing, digital economy, and the total value i in the production chain (Weilong Wang, 2022). If the direct consumption factor I of cloud computing, digital economy is the indirect consumption factor F of cloud computing, digital Economy, then DIGIT is the natural consumption factor I of all sectors of cloud computing, digital Economy, ALPHA IJT is the raw consumption factor I of the first intermediate chain of J I, and DIGIT is the direct dependence of the industry chain I on cloud computing, digital economy. This work uses the direct correlation

coefficient (DIG) to compare the regressions, and the direct wear coefficient (DIGD) is used for intensity testing.

Control variables. Based on the existing literature, the following variables were selected as control variables: the openness variable, expressed as the ratio of the export offer to the value of production and sales; the economic development of a country (state) is defined as the logarithm of the country's capital; and R&D personnel (contracts) is the number of R&D personnel, defined as the logarithm.

Table 2 Interpretation and statistical analysis of variables

Variable	Variable abbreviation	full name	sample size	Mean	standard deviation	minimum value	median
Variable - interpreted type	*innord*	Intra-industry and intra-sector investment	652	1426	5.362	0.635	1.548
	innopf	Profit within industries and sectors	652	0.352	0.482	0.415	2.141
Variable-Interpretation type	*digr*	Digital Economy	652	0.524	0.682	0.025	0.632
	scale	Analysis of the size of each type of enterprise	652	0.125	0.325	0.041	4.521
Variable - control type	*state*	National economic realities	652	3.681	0.141	5.41	10.364
	rder	Personnel expenditure as a percentage	652	9.325	0.232	0.632	9.642

4.2 Data Acquisition Process

The data matrices on total consumption, direct consumption, and direct dependence are taken from the OECD 2021 tables (Yanwei Lyu, 2022). The Tong and Fang Long methods can combine sales of new products and the number of R&D personnel for industrial enterprises above a specified size. Preliminary data on China's openness to foreign trade, output, and economic development are from Statistics Finland, China Statistical Year, and China Industrial Statistical Year.

4.3 Description of Basic Statistics

Descriptive statistics were performed using STATA 16.0, and correlations between variables were checked. See the statistical description in Table 2. According to the minor global criterion of two internal networks, different companies have smaller collaborative networks and more global networks of capabilities. The lowest value of the cloud computing and digital economy index is 0.4996, and the highest value is 8.1385, which indicates that the development of cloud computing and digital economy in different regions of China needs to be balanced. Second, the standard deviation of the R&D results is only different from the composite cloud computing digital economy index, which suggests that the R&D performance of the selected firms varies widely. The statistical characteristics of the main variables are given in this paper, indicating that the average input value of the innovation production line is 1.595, the standard deviation is 1.126, the maximum value is 6.219, and the minimum value is 0.198, which indicates that the innovation inputs in the industry chain have changed significantly during the test period. The mean benefit of innovation in the production line was 0.222, with a standard deviation of 0.176 and maximum and minimum values of 0.879. The difference between the mean and the average (0.162) is minimal, indicating no significant difference in the data distribution. The mean value of cloud computing and digital economy is 0.142, the maximum value is 2.371, and the minimum value is 0.003, indicating a massive difference in the level of development of cloud computing and digital economy between industrial chains. Foreign trade transparency, production scale, national economic development level, and R&D personnel level are all

reasonable, but there are also differences between samples.

5. The empirical process

Tests show a significant positive correlation between the small world trade network and the composite index of cloud computing and the Digital Economy, and there is a significant negative correlation between the small information network and cloud computing and the digital Economy (Yu Cheng, 2022). In addition, the small world of the two internal networks is somewhat correlated with other variables, suggesting that the independent and tax variables chosen in this study can explain the variables. Finally, the VIF values of the variables selected in this paper are less than 10, and the maximum VIF value is only 1.98, so there is no severe polygon problem in this model.

5.1 Relevance of Cloud Computing, Digital Economy and Intellectual Property Relationships

Stata 16.0 was used to perform correlation tests on descriptive statistics and variables. See the statistical descriptions in Table 3. According to the minor global criterion of the two internal networks, the cooperation network of different companies is small, and the competence network is global. The lowest value of the cloud computing and digital economy index is 0.4996, and the highest value is 8.1385, which indicates that the development of cloud computing and digital economy in different regions of China needs to be balanced. Second, the standard deviation of the R&D results is only different from the composite Cloud Computing, Digital Economy Index, which suggests that the R&D performance of the selected firms varies widely.

The test shows a significant positive correlation between the small world trade network and the composite index of cloud computing and digital economy and a significant negative correlation between the small information network and cloud computing and digital economy. In addition, the two internal networks of the small world are somewhat correlated with other variables, indicating that the independent and tax variables selected in this study can explain the variables. Finally, the VIF values of the variables chosen in this paper are less than 10, and the maximum VIF value is only 1.98, so there is no severe polygon problem in this model.

Table 3 Statistics of correlation test and baseline variables

Variable	Mean	Standard deviation	*ICN _ Q*	*IKN _ Q*	*Digit*
ICN _ C	0.521	0.057	1.635		
IKN _ Q	0.362	0.241	0.524***	0.987	
Digit	4.521	2.048	0.0381*	-0.048***	0.981
RD _ pro	6.358	1.628	-0.635***	-0.381***	0.041
Gro	0.426	0.354	0.004	0.001	0.028
Share	0.327	0.212	-0.236***	-0.081**	0.036
Siz	20.548	1.952	-0.362	0.085**	0.012
Age	3.216	0.854	-0.193***	0.051	-0.032***

5.2 Regression Analysis of the Relationship between Cloud Computing, Digital Economy and Intellectual Property Rights

The SUR model assumes that the distortions of each equation are correlated simultaneously. Therefore, before the regression analysis, the asynchronous correlation between the failure conditions of each equation was investigated, and the results indicated p = 0.023. Thus, at the 5% level, the researcher could abandon the initial assumption that the distortions of the equation conditions were independent. Therefore, comparing the SUR model with the equation can improve the efficiency of the assessment. The results of the regression analysis of the impact of cloud computing and digital economy on the types of innovative business risks are shown in Table 4. Model 1 analyzes the relationship between digitalization and the general characteristics of the Trade Cooperation Network (TCN). The results of the study show that the digital factor is positive and has reached a significant level, indicating that in regions with a high level of development of cloud computing and digital economy, companies are more willing to establish a minimal global internal cooperation network to improve the barriers to imitation and protect business know-how. Hypothesis 1 is confirmed. The results of model 2 show that there is a significant negative correlation between digitization and small business information networks, suggesting that

cloud computing digital economy should be considered in regions with high levels of cloud computing, digital economy development Hypothesis 2. The company builds an internal information network from a small world and prevents research and replication of its know-how by reducing the linkages between data elements.

Table 4 Statistical tests of the model

	ICN_Q1	IKN_Q2
Digit	0.051**	-0.043**
RD_pro	-0.045***	-0.049***
Gro	-0.032	0.058
Share	0.054**	-0.079**
Siz	0.004	0.069***
Age	-0.085***	-0.048
Sta	-0.0057	0.637

5.3 Endogeneity Regression Results

There is an opposite causal relationship between cloud computing, the Digital Economy, and supply chain innovation, as the higher the level of supply chain innovation, the higher the likelihood that industrial sectors will use advanced digital technologies. The innovation potential of the industrial chain can also positively impact the cloud computing digital economy. In this paper, the Author uses the methods of Qiuqiu Huang, Yongjie Yu, and Nancy to construct variable instruments. The instrumental variable for the current level of development of the cloud computing digital economy is the interaction between the scale of postal activity and the level of per capita development in the previous year. Cloud computing, the Digital Economy, is based on the Internet. The story of the Internet began with information and communication technologies. However, in the era of the cloud computing digital economy, it takes work to directly influence postal and telecommunication companies' production and productive activities. Although the development of cloud computing digital economy reflects individual characteristics, the instrumental variables for modern cloud computing digital economy are constructed to fulfill the requirement of selecting panel data variables based on the size of postal and telecommunication activities per capita. The results of the 2SLS regressions using the variable instruments are shown in Table 5.

Table 5 Discussion of results of inputs and benefits

	Corporate intellectual property investment cycle	Corporate intellectual property investment second cycle	Corporate Intellectual Property Benefits cycle	Corporate Intellectual Property Benefits second cycle
iv	1.654*** (0.524)		1.625*** (0.628)	
digr		1.524*** (0.524)		0.362*** (0.052)
Variable - control type	be	be	be	be
Variable - fixed type	be	be	be	be
Variable-effect type	be	be	be	be
$K-\Pr k\_LM$	5.817 (0.581)		5.258 (0.036)	
$K-\Pr k\_wald\_F$	30.254 (13.625)		29.364 (17.635)	
statistical value	506	506	506	506
The square of the statistical value R	0.684		0.963	

5.4 Cloud Computing, Digital Economy Robustness Analysis

To ensure the accuracy of the estimates, proxy estimation, proxy explanatory estimation of variables, and secondary yield production were used to validate the accuracy of the forecast. First, a change in the estimation methodology is needed. To reduce potential heterogeneity, autocorrelation, and co-correlation in the baseline regression model, the sampling should be reassessed using the full FGLS methodology, and the results should be reported in columns 1 and 4 of Table 6. It was found that the impact of cloud computing and the digital economy on innovation resources and the industry chain increased by 1%. 5% is a significant positive value corresponding to the original regression results. Second, the explanatory variables are replaced. Cloud computing digital economy is measured using the direct consumption coefficient (DIGD), and the regression estimates are

reported in columns 2 and 5 of Table 6. The results show that the estimated factor for the contribution of cloud computing digital economy to innovation and chain benefits increases to 1%, consistent with the results of the reference regression—third sampling. In 2017, cloud computing and digital economy were included in the central government report for the first time. In the same year, the 19th report began. World War II National Assembly is actively developing a cloud computing digital economy. As the release of policies related to the cloud computing digital economy may affect the study results, this paper overestimates the data from 2017 and 2018. Columns 3 and 6 of Table 6 show that the impact of Cloud Computing and the Digital Economy on the chain's innovation resources and revenues is still optimistic even though the multi-year national policies were not considered, confirming this study's findings.

Table 6 Robust analysis of cloud computing, digital economy, and intellectual property rights

	Corporate intellectual property investment			Corporate Intellectual Property Benefits		
	Tests of other models	Variable replacement	Basic test logic	Tests of other models	Variable replacement	Basic test logic
digr	0.514*** (0.814)		0.879*** (0.681)	0.047** (0.051)		0.639*** (0.083)
digd		6.841*** (0.748)			0.814*** (0.521)	
Variable - control type	be	be	be	be	be	be
Variable - fixed type	be	be	be	be	be	be
Variable-effect type	be	be	be	be	be	be
statistical value	506	506	506	506	506	506
The square of the statistical value R		0.958	0.482		0.985	0.365

5.5 Heterogeneity Analysis of Cloud Computing, Digital Economy

Since the financial crisis 2008, all countries have seen cloud computing Digital Economy as a critical driver of economic recovery and triggered explosive growth. Considering the different impacts of cloud computing digital Economy on supply chain innovation before and after the financial crisis, the whole sample is divided into two stages: 1995-2008 and 2009-2018. The regression results are as follows. The study shows that cloud computing and digital economy did not account for a significant share of innovation and innovation revenue in China's production chain between 1995 and 2008, while cloud computing and digital economy contributed significantly to innovation input and production chain revenue between 2009 and 2018. The impact of cloud computing and the digital economy on supply chain innovation will be significant before and after the financial crisis.

Regarding the distribution of industrial factor intensities in OECD countries, Table 7 shows that the impact of cloud computing and digital economy on returns to investment and innovation in technology-intensive chains is positive and passes the most relevant 1% test. In contrast, the impact of labor-intensive and capital-intensive chains on returns to investment and innovation does not pass the applicable test. The effect of cloud computing and digital economy on supply chain innovation depends on different demand factors in the supply chain.

Table 7 Heterogeneity analysis of cloud computing, digital economy, and intellectual property rights

	Corporate intellectual property investment			Corporate Intellectual Property Benefits		
	labour	capital	technology	labour	capital	technology
digr	0.632 (1.528)	-0.684 (0.485)	0.684*** (0.262)	0.036 (0.236)	-0.251 (0.635)	0.251*** (0.061)
Constant	-0.892 (0.584)	-5.621*** (0.985)	-6.628 (4.638)	-0.036 (0.018)	-0.842*** (0.638)	-2.621*** (0.258)
Variable - control type	be	be	be	be	be	be
Variable - fixed type	be	be	be	be	be	be
Variable-effect type	be	be	be	be	be	be

statistical value	241	241	362	241	241	362
The square of the statistical value R	0.984	0.915	0.963	0.948	0.968	0.975

In industrial chains with different degrees of technology dependence, different types of technology procurement may have other innovation impacts on cloud computing and the Digital Economy. To confirm this finding, the Wang and Zhang Yu method indicates the percentage of external technology in the total R&D cost. The samples with low dependence on external technology were grouped. When the external technology dependence was below the sample median, the models with high reliance on external technology were categorized according to the median of the total dependence on external technology during the test period. The impact of cloud computing and the digital economy on innovation investments and returns to innovation in the chain is particularly favorable for those distrusting external technologies. The effect of cloud computing and the digital economy on innovation in the production chain heavily dependent on external technology is insignificant.

6. Empirical discussion

Cloud computing and the digital economy are the driving forces of innovation in the new era and a significant force in promoting the revolutionary change of the industrial chain. It is very realistic to examine whether the cloud computing digital Economy can contribute to industry chain innovation, promote the high-quality development of the cloud computing digital Economy, and implement the innovation development strategy. Integrate cloud computing, digital economy, and industry chain innovation into a coherent analytical framework to construct an innovation decision-making model based on industry chain cloud computing digital Economy. Based on the OECD input-output table on the impact of cloud computing digital Economy on supply chain innovation, the following conclusions are drawn: first, cloud computing, digital economy as a whole has a significant positive impact on innovation inputs and supply chain benefits. The findings remain valid after a series of efficacy tests, such as endogenous treatment, alternative estimation, alternative explanatory variables, and sample regression. Secondly, the impact of cloud computing and digital economy on chain innovation is different. After the financial crisis, the result of cloud computing digital Economy on production chain innovation will be huge. As far as strength is concerned, cloud computing and the digital economy have significantly contributed to creating technology-intensive industry chains. In contrast, the innovation of labor-intensive and capital-intensive industries is small.

From the perspective of external technology dependence, industrial chains with low external technology dependence can benefit from innovative cloud computing and the digital economy. Third, the impact of cloud computing and the digital economy on the innovation of the production chain has a threshold effect. Threshold tests show that intellectual property protection as a threshold variable has one and two effects. The impact of cloud computing and the digital economy on supply chain innovation has shifted from negative to negative, and the marginal impact continues to increase as intellectual property protection is strengthened. Based on these findings, the authors make the following recommendations for action:

The first is accelerating the high-quality development of cloud computing and the digital economy and creating conditions for industrial chain innovation. Cloud computing and the digital economy are the main drivers of industry chain innovation and are expected to become a significant breakthrough in the future development of China's innovative countries. Today, China's cloud computing digital Economy is in a period of fierce competition and rapid growth. To achieve high-quality products, it is necessary to guide and regulate healthy and controllable development. Balance between "tolerance" and "control". Cloud computing and the Digital Economy have entered a critical stage where the old and the new are intertwined and in decline. Strengthen high-level governance and establish a coherent national regulatory framework that is dynamic, timely, and relevant and clarifies the rights and obligations of regulators, regulatory forums, and regulatory bodies. Establish a national monitoring and coordination mechanism for cloud computing and digital economy and improve the emergency management mechanism. Improve the justice system in the context of cloud computing and the Digital Economy.

Secondly, trust the industrial Internet and vigorously promote the digital transformation of the industrial chain. The digital transformation of the industrial chain is a global member of the cloud computing and digital economy industry chain innovation. Industrial Internet is an essential platform for production digitization and the primary carrier of industrial chain digitization. In the future, China's industrial Internet should combine general policy planning with the implementation of specific connections to promote the digital transformation of the industrial chain and strengthen support for the industrial Internet. Today, China's Industrial Internet is still in its infancy. Many industrial companies have yet to join the Industrial Internet, which limits the data and resources of existing Industrial Internet platforms and the integration of Industrial Internet platform resources. A special fund for financial and industrial development to provide special subsidies and support for enterprises that create and

connect to the Industrial Internet and improve digitalization; promote the integration of industry and education, lay the foundation for the development of Internet industry talents, and guide more skills to participate in the construction of the Internet industry.

Thirdly, the Author will strengthen the protection of intellectual property rights and promote the participation of critical issues in industrial chain innovation. China is committed to introducing advanced technologies and maintaining intellectual property protection. In the digital age, intellectual property protection is a more complex environment. There is an urgent need to combine legal and technical measures to promote the protection of intellectual property rights. An intelligent identification system based on blockchain, big data, and online tracking technology will be built to trace the source of infringement and counterfeiting, track real-time and online identification, and enhance accurate anti-infringement and counterfeiting. Third, different IPR policies will be developed, considering policy coherence and sectoral diversity. Differences between sectors determine different needs for innovation and protection of IPRs. Ignoring sectoral differences makes it difficult to maximize the role of IP protection in promoting innovation. Cloud computing and the digital economy have created many new business forms and models. With the development of new business forms and modes, such as e-commerce platform protection and management standards, the authors hope to actively explore the innovation of protection methods, strengthen IC design models, and maximize the role of the knowledge society in protection and innovation.

7. Conclusion

Cloud computing digital Economy not only unleashes the potential for economic growth but also creates new challenges for protecting business knowledge. Based on regional cloud computing, digital economy indices, and patent data from public research and development firms, the trend of firms adapting to intranet microcosms to address the risk of data loss in the cloud computing digital Economy is discussed from a cybernetic perspective. An empirical analysis of the relationship between cloud computing, digital economy, small-scale intranet cooperation, and information networks is also presented. The study results show that the cloud computing digital Economy has a significant positive impact on the small world of internal networks but a significant negative impact on the small world of internal networks, which is because the cloud computing digital Economy significantly reduces the cost of discovering, disseminating, copying, and reproducing information, increasing the competition of skills between companies and setting higher standards for protecting business information. In this context, companies increase the risk of data leakage when using data resources through network influence. However, small global collaborative networks and small global information networks provide companies with additional means of protecting intellectual property and preventing the transfer and copying of information. In other words, in the highly developed fields of cloud computing and the digital economy, companies may consider creating an increasingly global network of internal collaborations, complicating social relationships among inventors and difficulties for individuals or organizations to access and disseminate information. An internal network of primary data has been created to reduce the correlation between data elements and increase the cost of competitors' ability to learn, which prevents competitors from finding imitators within existing network relationships. This finding broadens the company's view that the network's internal structure can provide additional strength to protect the company's knowledge and prevent the transfer of the company's core data to competitors.

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