

# Aggregation of Data Elements Empowers the Development of New Quality Productivity: A Quasi-Natural Experiment Based on National Big Data Pilot Zones

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**Abstract:** Developing new quality productivity (NQP) serves as the core driving force for high-quality economic development, and an inevitable choice for promoting industrial upgrading, boosting the construction of a modern industrial system, and achieving modernization. This study regards the establishment of national big data pilot zones (BDPZs) as a quasi-natural experiment for the aggregation of regional data elements. Taking China's provincial-level panel data from 2012 to 2022 as a sample, uses the difference-in-differences (DID) method to empirically analyze the influence of the aggregation of data elements on NQP. The research results show that: (1) The aggregation of data elements can significantly promote the improvement of NQP levels; (2) The mechanism analysis demonstrates that the aggregation of data elements promotes the improvement of the level of NQP through the aggregation of digital talents, environmental regulation, and green technological innovation; (3) Heterogeneity analysis indicates that the aggregation of data elements exerts significant positive effects on NQP in the eastern and western regions, while its impact is insignificant in the central region, presenting a differential distribution pattern of "Eastern region > Western region > Central region". This study provides policy implications for fully unleashing the effects of digital talent agglomeration, environmental regulation, and green technology innovation, strengthening the positive effect of data factor agglomeration on NQP, and boosting the construction of a modern industrial system.

**Keywords:** New quality productivity; Big data; Aggregation of data elements; Green technological innovation.

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## 1. Introduction

Productivity is the ultimate determinant of social development and the main criterion for social development, which ultimately depends on the degree of development of advanced productive forces. In September 2023, General Secretary first put forward the innovative concept of "new quality productivity" during his visit to China's Heilongjiang Province, pointing out that "integrating scientific and technological innovation resources, leading the development of strategic emerging industries and future industries, and accelerating the formation of new quality productivity". The proposal of the concept of "new quality productivity" has pointed out the forward direction for China's high-quality economic development and technological innovation, and has important theoretical significance and profound practical significance (Song, 2024)[1]. It also brings guiding significance for the deepening and expansion of Chinese-style modernization in the new era (Hu, 2023)[2]. In July 2024, the Third Plenary Session of the 20th Central Committee of the Communist Party of China once again put forward: "Promote the agglomeration of various advanced factors of production to develop new quality productivity." The core of new quality productivity is new elements. In the current era of rapid digital development, as a brand-new production factor, data has become the core driving force and leading power of economic and social development, and has profoundly changed the basic composition of social productivity in China. As a key national production factor, digital elements are integrated with other factors of production, leverage their data multiplier effects to promote multi-dimensional innovation,

enhance production efficiency, optimize resource allocation, advance industrial integration, spawns new labor materials, breeds new labor objects, and cultivates new labor force, which has become a new kinetic energy that promotes and leads economic and social development, thus promoting the formation of NQP.

Data elements aggregation is of great significance for enhancing the scale and diversity of data, improving data processing and analysis capabilities, promoting data openness, sharing, trading and collaboration, optimizing resource allocation (Liu et al., 2023)[3]. To fully leverage the aggregation effect of data elements, in February 2016, the Chinese government approved the construction of Guizhou Province as the first national big data pilot zone in China. To further facilitate the innovative development of big data and the circulation of data factors, in October of the same year, the Chinese government approved the advancement of national big data pilot zone construction in regions such as Beijing and Tianjin. The construction of national big data pilot zones places greater emphasis on data factors circulation, leads the flow of technology, materials, capital and talents with the flow of data, supports cross-regional public services, social governance and industrial transfer, promotes integrated regional development, provides a platform for data factor circulation and data resource sharing, effectively promotes the efficient agglomeration of data elements and the opening up of data resources, deeply explores the value of data elements, stimulates new data-driven momentum, effectively release the value of data elements, promotes the agglomeration of big data industries, and accelerates the cross-regional flow of knowledge and technology (Chang et al., 2023)[4].

Therefore, a question worthy of exploration is whether the aggregation of data elements (BDPZs) can promote NQP levels? What is its effect mechanism? This study will deeply analyze the influence mechanism and transmission path between the two, offering policy implications for fully unleashing the empowering role of data factors.

## 2. Literature Review

The proposal of NQP has become a frontier area for scholars, and the research mainly focuses on theoretical interpretation, the establishment of indicators and driving factors. Regarding the study on the theoretical aspects of NQP, Hong (2024) believes that the core of NQP is innovation, which is the replacement of traditional productivity by advanced productivity, which represents a qualitative leap in the level of productivity and promotes a more efficient, higher quality and more sustainable development model[5]. Some scholars analyze the three elements of NQP from the comparison of “new” and “old” based on Marxist productivity theory. They believe that NQP is new laborers, new means of labor, and new objects of labor (Sheng, 2024)[6], and the “newness” of NQP is the core of data elements and mainly characterized by the application of high technology (Feng and Lin, 2024)[7], which is mainly reflected in breakthrough innovation of the technological revolution, the innovative allocation of production factors, and the improvement of total factor productivity (Zhou and Xu, 2024)[8]. It is also reflected in new technologies, new industries, new energy, and the digital economy formed by the integrated development of these three aspects (Hong, 2024)[5]. The changes in the “quality” of NQP are reflected in promoting high-quality economic development (Du et al., 2023)[9], empowering the construction of a modern industrial system, and productivity that meets the requirements of high-quality development (Wang et al., 2024)[10], which can help stimulate the development potential of Chinese-style modernization (Zhang, 2024)[11].

Regarding the drivers of NQP, Zhang and Liu (2025) discovered that digital innovation can foster the development of firms’ NQP by facilitating industry-academia-research cooperation, increasing market concentration, and strengthening government innovation subsidies[12]. Li and Cai (2024) empirically analyzed the mechanism of science and technology financing on industrial NQP, and found that science and technology financing promotes the development of industrial NQP by improving regional innovation ability[13]. Ma et al. (2024) found that the ESG performance of enterprises promotes green innovation, thereby improving green NQP[14]. Yuan and Han (2024) found that artificial intelligence promotes the development of corporate NQP by improving corporate innovation capability, employee compensation, and labor investment efficiency[15]. Mao and Wang (2024) found that green finance can promote the level of NQP by promoting technological innovation and enhancing the environmental concern of the government and the public[16]. Xue and Chen (2025) believed that ESG performance can significantly contribute to the level of NQP of enterprises[17].

As a result, little literature has explored the relationship between data elements agglomeration and NQP. This study empirically analyzes the influence of data factor agglomeration on NQP using the DID method based on the data factors established in the National BDPZs as a quasi-natural experiment. The possible marginal contributions of

this study are as follows: ① NQP is a newly proposed term, there is a relative scarcity of the construction of the evaluation index system of NQP, the lack of corresponding measurement methods and index systems, and there is no unified standard on the measurement of indicators of NQP, this paper is based on the concepts and connotations of NQP, and guided by the new concept of development, to construct a comprehensive evaluation of NQP indicator system; ② This study will empirically study the effect of data factor aggregation on the development of NQP and explore its impact mechanism in depth, sort out the role of digital talent aggregation, environmental regulation, green technology innovation, on this basis, analyze the study on the effect of data factor aggregation on the development of NQP, provide scholars with experience in conducting quantitative research on NQP, enrich the empirical research on NQP, and deepen the field of economic research; ③ Investigate the impact of data element aggregation on NQP across regions, taking into account regional variability.

## 3. Research Hypothesis

### 3.1. The aggregation of data elements and NQP

The construction of the national BDPZs aims to leverage the strategic role of data resources, deeply tap the value of data elements, stimulate new data-driven momentum, promote data factors circulation, bring into play the agglomeration effect of data elements, and unleash the innovative vitality of data elements. Through increasing digital subsidies, improving digital infrastructure, enhancing digital capabilities, and optimizing the digital development environment, the national BDPZs can promote the progress of digital technology (Sun et al., 2023)[18], and drive the development of NQP (Lu, 2024)[19]. The construction of national BDPZs can effectively break down data resource barriers, alleviate the problem of asymmetric production factors, promote data factor circulation, sharing, openness, and efficient agglomeration. It can realize the more intelligent, efficient and secure circulation of elements, thereby enhancing the allocation efficiency of factor resources and driving the advancement of NQP towards a more intelligent, green and service-oriented direction, providing robust factor support for the advancement of NQP (Ren and Dou, 2024)[20]. Data elements give play to the multiplier effect of data elements, promote data elements integration with traditional production factors, and drive the innovation and upgrading of production tools. As a result, they give rise to new types of means of labor, nurture new types of objects of labor, and create new types of labor force. In turn, all these triggers the leap of productive forces and propel the formation and development of NQP (Zhang and Liu, 2024)[21]. Based on the above analysis, the following hypotheses are proposed:

Hypotheses 1: The aggregation of data elements has a significant impact on the improvement of NQP.

### 3.2. The mechanism of mediating effect

#### 3.2.1. The aggregation of digital talents

Innovative talents are not only the source of the development of NQP, but also a crucial force in promoting scientific and technological progress and realizing industrial innovation (Zhou and Ye, 2024)[22], while the insufficient supply of talents may hinder the development of NQP. The fundamental change in market demand has prompted workers

to continuously upgrade themselves and improve their skills by continuously deepening their professional skills and knowledge, thus raising the level of human capital in the whole region. The construction of national BDPZs promotes the agglomeration and development of the big data industry by optimizing infrastructure, implementing targeted policy incentives, and adopting industrial support strategies (Qiu and Zhou 2021)[23]. It attracts the settlement of high-tech enterprises and the inflow of high-tech talents, effectively promoting the aggregation of digital talents and meeting the urgent demand for digital talents within the pilot zones. The efficient development and utilization of data elements not only breaks through the inherent limitations of traditional resources such as knowledge and technology, and opens up new paths for innovation and development, but also optimizes the skill and knowledge structure of labor resources, thus promoting the improvement of labor productivity (Shi and Wang, 2024)[24]. At the same time, the information technology industry, which uses data as a production factor, which is in urgent need of digital talents, and the agglomeration of data factors breaks the geographical restriction, provides more innovative resources and opportunities for digital talents, favorably promotes the flow and allocation of talents, attracts the agglomeration of digital manpower, meets the urgent demand for talents in the pilot zones, and cultivates digital talents for the prosperous development of NQP (Zhang and Liu, 2024)[21]. Accordingly, the hypotheses 2 are proposed:

Hypotheses 2: The aggregation of data elements promotes the aggregation of digital talents, thereby driving the improvement of the level of NQP.

### 3.2.2. Environmental regulation

By virtue of its precision, real-time nature, and analyzability, data elements can effectively enhance the accuracy and transparency of environmental information, optimize the information exchange mechanism, and further boost the level of environmental governance. At the same time, the provide enterprises with optimized pathways for collecting, processing, and integrating environmental information, demolishing information dissemination barriers, enriching channels and modalities for environmental disclosure, and reducing associated disclosure costs. This thereby enhances the precision, relevance, and timeliness of disclosed environmental information (Zheng et al., 2024)[25]. At the same time, data elements can conduct real-time detection and analysis of the environment, ensure the proper handling of waste, prevent illegal dumping and improper handling. In this way, it helps the environmental protection department to promptly grasp the environmental quality situation and take corresponding environmental protection measures, thus fostering the development and improvement of the modern environmental governance system. Furthermore, it enhances the intensity of regional environmental regulation and improves its effectiveness, providing a solid institutional guarantee and continuous innovative impetus for the vigorous development of NQP.

Environmental regulation can effectively restrict the excessive expansion of high-energy-consuming and high-pollution industries, thereby reducing the pressure on the natural environment. At the same time, it encourages, supports and guides the vigorous advancement of eco-friendly, capital-intensive and technology-intensive industries. Such regulatory measures not only foster the optimization of resource allocation, drive the upgrading of industrial structure

and technological innovation (Wu et al., 2024)[26], but also reduce pollution emissions, boost the efficiency of urban green innovation (Wang et al., 2022)[27], and contribute to the advancement of total factor productivity (Cai and Zhou, 2017)[28], and further propel the development of NQP. Accordingly, the hypotheses 3 are put forward:

Hypotheses 3: Data elements aggregation enhances the intensity of regional environmental regulation, thereby promoting the improvement of NQP.

### 3.2.3. Green technological innovation

The BDPZs promotes the innovative application of big data, drives the opening and sharing of public data resources, and establishes and improves the mechanisms for data trading and circulation, achieves the effective aggregation of data elements within the pilot zones and gives play to the influence of the aggregation of data elements on green technological innovation (Liu et al., 2023)[3]. Data elements play an indispensable role in green technology innovation (Zhang and Li, 2024)[29], provide abundant information and data resources for the development and application of green technology, facilitate the process of R&D investment and technological progress of green products, contribute to the research and development and innovation of new ways of waste utilization, reduce external environmental pollution, and facilitate the advancement of green eco-efficiency (Liu, 2023)[30], contributing to the realization of sustainable development goals. At the same time, data elements promote cross-border cooperation and knowledge sharing, reduce the boundaries and barriers to innovation, and provide scientific decision-making support for technological innovation (Zhan et al., 2024)[31]. Through data analysis, the potential value and utilization approaches of waste can be revealed, and the development of new technologies and methods can be promoted, further driving the progress of green and low-carbon technologies. As a form of knowledge or information, data elements transform the coordination among production relations and elements. They accelerate the transformation of traditional industries, give rise to new industries such as big data, cloud computing and artificial intelligence, break down information silos and foster industrial linkages (Liu, 2023)[30], enhance the capacity and efficiency of resource allocation (Acemoglu and Restrepo, 2018)[32], stimulate industrial innovation (Zhang et al., 2018)[33], and drive the green technological innovation of enterprises (Ren et al., 2023)[34]. With the core goal of reducing energy consumption and emissions, green technological innovation accelerates the process of new industrialization, promotes the vigorous development of strategic emerging industries and future industries, and lays a solid foundation for the rapid development of NQP (Yang et al., 2024)[35]. So, the hypotheses 4 are put forward:

Hypotheses 4: Data elements aggregation drives the advancement of NQP by promoting green technological progress.

## 4. Model Construction and Variable Explanation

### 4.1. Model Construction

To deeply investigate the specific influence of data element aggregation on NQP, this research takes the pilot policy of national BDPZs as a quasi-natural experiment, and uses DID method to identify the causal relationship between the two. Based on Sun et al. (2023)[18], and Liu and Li (2025)[36],

this study constructs the following model:

$$NQP_{it} = \beta_0 + \beta_1 BDPZs_{it} + \alpha X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (1)$$

In the model, *i* and *t* represent provinces and years, respectively. NQP is the dependent variable, representing new quality productivity. BDPZs is the independent variable, representing the aggregation of data elements.  $X_{it}$  represents a set of control variables.  $\mu_i$  and  $\gamma_t$  represents the individual and time fixed effects respectively, and  $\varepsilon_{it}$  is the random error term.

## 4.2. Description of variables and data sources

### 4.2.1. Dependent variable

New Quality Productivity (NQP). General Secretary emphasized that “New Quality Productivity contains profound ecological ideas and represent an advanced form of productive forces that is in line with the new development concept.” Therefore, this paper takes the new development concept as a guide, constructs an evaluation index system of NQP from five dimensions of innovation, coordination, greenness, openness and sharing, and uses the entropy value method to measure NQP. The construction of specific indicators is shown in Table 1.

**Table 1.** Comprehensive Evaluation Index System of NQP

First level	Second level	Third Level	Measurement Method	Causality
Innovation	Innovative inputs	Science and technology expenditure intensity	Science and technology expenditure/general public budget expenditure	+
		R&D investment intensity	Expenditures on product development for high-tech industries	+
		Intensity of R&D Personnel Input	Full-time equivalent of R&D personnel in high-tech industries	+
	Innovation outputs	Scientific and technical outputs	Number of patent applications in high-tech industries	+
		Innovative outcomes	Technology market turnover/GDP	+
		Innovative products	Project development of new products for high-tech industries	+
		Innovative industries	Revenue from sales of new products in high-tech industries	+
Greenness	Resource consumption	Water consumption intensity	Per capita water consumption	-
	Green and environmentally friendly	Environmental protection efforts	Environmental protection expenditure/general public budget expenditure	+
		Reduce pollution	Pollution emission	Sulfur dioxide emission Emission of nitrogen oxides in waste gas
	Waste utilization		Comprehensive utilization amount/generation amount of industrial solid waste	+
	Waste treatment		The harmless treatment rate of domestic waste	+
Coordination	Industrial development	Growth of industry scale	Value added of primary industry/GDP	+
			Value added of secondary industry/GDP	+
			Value added of tertiary industry/ GDP	+
	Digital industrialization	Development of new industries	E-commerce sales/GDP	+
			Number of AI companies	+
Openness	Degree of openness	Foreign investment	Number of registered households of foreign-invested enterprises at the end of the year	+
			Total year-end investment of foreign-invested enterprises	+
	Foreign trade transactions	Export of products	Revenue from export sales of new products by industrial enterprises	+
Sharing	Infrastructure development	Internet penetration	Number of Internet broadband access ports	+
			Number of Internet broadband access subscribers	+
			Number of cell phone subscribers	+
	Digital development	Digital economy benefits	The scale of telecommunications services / GDP	+
			Software revenue / GDP	+

### 4.2.2. Independent variable

Data element agglomeration (BDPZs). In this study, the national big data pilot zone is used as a proxy variable for data element agglomeration. If a province (municipality) is designated as a pilot zone of the BDPZs in a certain year, the value of that province (municipality) in that year and thereafter is 1, otherwise it is 0.

### 4.2.3. Mediating variable

Digital talent agglomeration (ln(Labor)): Drawing on the approaches of Hou et al. (2023)[37], the logarithmic value of

urban employees in information transmission, computer services, and software industries is used to measure the regional digital talent agglomeration level; Environmental regulation (Er): referring to the approach of Liu and He (2021)[38], The completed investment in industrial pollution control/added value of secondary industry in each province was used as a proxy variable for regional environmental regulation; Green technological innovation (Pati): Drawing on the approach of Cui et al. (2023)[39], Measured using the number of patent applications for green inventions at the

provincial level.

#### 4.2.4. Control Variable

To reduce the possible effect of omitted variables on the estimation results, this study draws on the research of Wu et al. (2024)[40], Luo and Xiao (2024)[41], and selects a series of control variables to be added to the equation: ① Financial development level (Fin) is Measured by the sum of deposit and loan balances of financial institutions/GDP; ② Transportation level (Tin) is measured by the total regional freight volume; ③ International trade transactions (Ide) are measured by the total volume of import and export trade; ④ The entrepreneurial activity level (Infra) is measured by the number of innovative companies per 100 people; ⑤ Social consumer goods level (Con) is Measured using total retail

sales of consumer goods/GDP.

#### 4.2.5. Data sources

In view of the data availability, this study employs panel data from 28 Chinese provinces (municipalities) spanning 2012–2022 as the research sample to empirically analyze the effect of data factor agglomeration on NQP. The research data mainly come from the China Statistical Yearbook, China Science and Technology Statistical Yearbook, China Environmental Statistics Yearbook, China Energy Statistical Yearbook, China Industrial Statistical Yearbook, the statistical yearbooks of each province (region, municipality) and the National (Regional) Bureau of Statistics. The descriptive statistical results of each variable studied in this paper are shown in Table 2.

**Table 2.** Descriptive statistics

Variable	Observation	Mean	Standard deviation	Minimum	Maximum
NQP	308	0.1440	0.1020	0.0527	0.7595
BDPZs	308	0.2045	0.4040	0	1
ln(Labor)	308	2.0942	1.0576	-0.4614	4.6167
Pati	308	3519.5840	4645.6570	29	24072
Er	308	0.0024	0.0026	0.0000	0.0245
Tin	308	152732	100092.9000	13372	434298
Con	308	0.3999	0.0590	0.2190	0.6101
Fin	308	3.5190	1.1121	1.7844	7.6095
Infra	308	1.5186	0.9145	0.3212	5.6645
Ide	308	10593.5500	16020.9300	22.9552	83877.0400

## 5. Empirical Analysis

### 5.1. Baseline regression results

The regression results are presented in Table 3. As shown in Table 3, regardless of whether control variables, provincial and temporal fixed effects are included, the estimated coefficient of BDPZs is positive and significant at least at the 1% confidence level, this demonstrates that the agglomeration

of data elements represented by the construction of BDPZs promotes the improvement of the level of NQP. According to the estimation results in Column (4), after the establishment of the national BDPZs, the level of NQP within the pilot zone will significantly increase by 0.024, which fully demonstrates that the aggregation of data elements can significantly enhance the level of NQP, thus effectively verifying Hypothesis 1.

**Table 3.** Baseline regression results

Variable	NQP			
	(1)	(2)	(3)	(4)
BDPZs	0.0819*** (0.0136)	0.0218*** (0.0082)	0.0275*** (0.0053)	0.0240*** (0.0056)
Tin			0.0000*** (0.0000)	-0.0000 (0.0000)
Con			0.0182 (0.0346)	0.0241 (0.0305)
Fin			-0.0023 (0.0025)	-0.0132** (0.0058)
Infra			0.0148*** (0.0023)	0.0066** (0.0030)
Ide			0.0000*** (0.0000)	0.0000*** (0.0000)
Constant	0.1272*** (0.0062)	0.1866*** (0.0119)	0.0416** (0.0175)	0.0446 (0.0429)
time fixed effect	NO	Yes	NO	Yes
Individual fixed effect	NO	Yes	NO	Yes
R <sup>2</sup>	0.1054	0.9115	0.8949	0.9601
Adj.R <sup>2</sup>	0.1025	0.8990	0.8928	0.9536
N	308	308	308	308

Note: 1) Standard errors in parentheses; 2) \*\*\*, \*\*, and \* indicate significant at the 1%, 5%, and 10% levels, respectively. The following tables are the same.

## 5.2. Robustness test

### 5.2.1. Parallel trend test

When conducting a benchmark regression analysis using DID method, a necessary precondition is to pass the parallel trend test. That is, before the establishment of BDPZs, the experimental group and the control group have similar changing trends in NQP levels, so as to ensure the rationality of using the control group as the “counterfactual” control for the experimental group. In order to test the effectiveness of the benchmark regression results, this study draws on the research of Zhou et al. (2025)[42], Yan et al. (2024)[43] and constructs the following model:

$$NQP_{it} = \beta_0 + \alpha_1 pre\_3 + \alpha_2 pre\_2 + \alpha_3 pre\_1 + \alpha_4 current + \alpha_5 post\_1 + \alpha_6 post\_2 + \alpha_7 post\_3 + \alpha_8 post\_4 + \alpha_9 post\_5 + \alpha_{10} post\_6 + \beta_1 X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (2)$$

Among them,  $pre\_i$  and  $post\_i$  are a series of dummy variables. When it is the  $i$ -th year before (after) the experimental group becomes a pilot province, the values of  $pre\_i$  and  $post\_i$  are 1; In other cases, the values are 0. Based on the study of Sun et al. (2023)[18], this paper takes the first year of the study period (2012) as the reference period and plots the results of the parallel trend test of the pilot policy of BDPZs with 90% confidence interval, as presented in Figure 1. The estimated coefficient is close to 0 before the establishment of BDPZs, indicating that the NQP levels of the experimental group and the control group before the implementation of the policy maintain a relatively stable trend of change, and there is no significant difference, which indicates that this study satisfies the parallel trend hypothesis of the difference-in-differences method. Starting from the year when the national BDPZs was established (2016), the estimated coefficient is far from 0 and is positive, and all pass the significance level test of at least 10%, indicating the positive effect of the national BDPZs on NQP level, and there

is a trend of continuous enhancement over time, which shows that data elements aggregation based on the policy of the national BDPZs can facilitate the enhancement of the level of NQP.

### 5.2.2. Placebo test

To prevent omitted variables from interfering with the estimation results, this study draws on the research of Sun et al. (2023)[18], and Zhang et al. (2025)[44] to construct a placebo test to determine whether the impact of the national BDPZs on the level of NQP is caused by other random factors. The specific method is as follows: According to the pilot situation of the national BDPZs among the 28 provinces and municipalities, 6 provinces (municipalities) are randomly selected as the virtual experimental group, and the remaining regions serve as the control group. The treatment time remains 2016. By repeating the regression 1000 times, we can obtain 1000 estimated coefficients of the “pseudo” national BDPZs pilot variables, and then plot the distribution map of these estimated coefficients. As can be seen from Figure 2, the vertical dotted line in the figure represents the true regression coefficient value of the national BDPZs in Column 4 of the attached Table 3. The coefficient values of the randomly generated “pseudo” national BDPZs are distributed around the value of zero, and the regression coefficients show a normal distribution, all of which are smaller than the baseline regression results of 0.024. Most of the p-values are far from zero, and only a few fall within the 10% significance level (horizontal dotted line), demonstrating that the results obtained in this study are not accidental. It further proves that the agglomeration of data elements has a significant facilitating effect on NQP, suggesting that the role of the national BDPZs in NQP is relatively robust, and indicating that the agglomeration of data elements indeed facilitates the improvement of NQP levels.

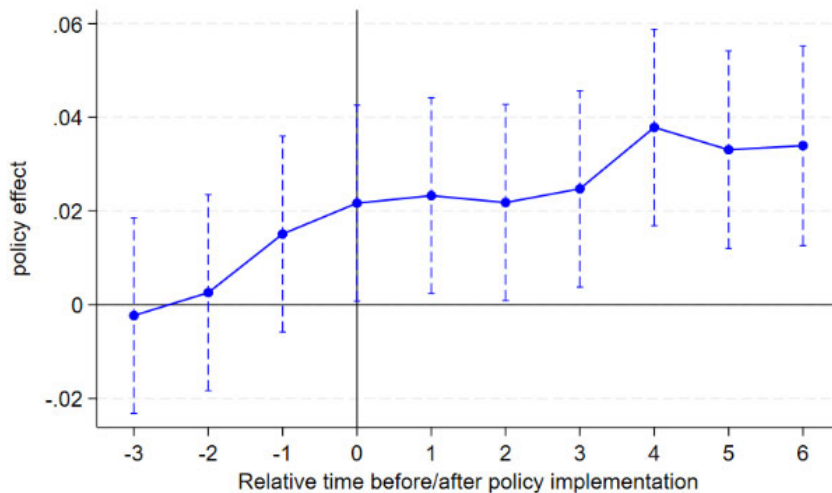


Figure 1. Parallel trend test

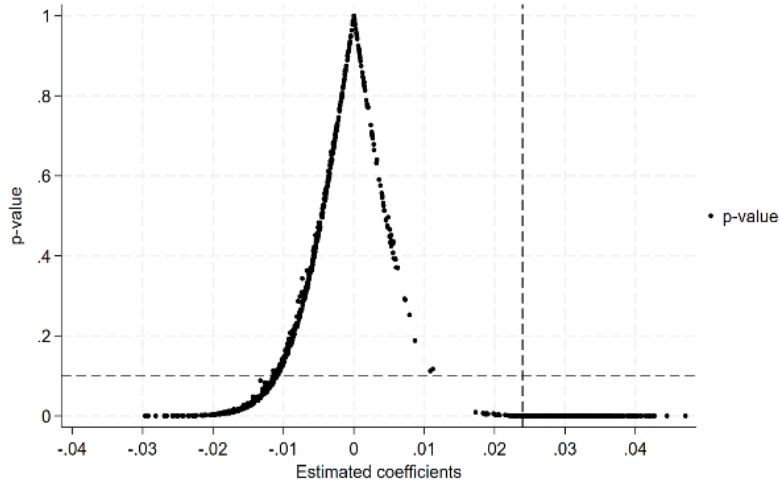


Figure 2. Placebo test

### 5.2.3. PSM-DID test

To eliminate the interference of different economic characteristics at the provincial level on the estimation results and reduce the estimation bias, the Propensity Score Matching-Difference in Differences (PSM-DID) method is used to re-estimate the benchmark regression model, so as to ensure the robustness of the conclusions of this study. We use the nearest neighbor matching and kernel matching methods, drawing on Yao et al. (2022)[45] and Wang et al. (2021)[46], the financial development level (Fin), transportation level (Tin), entrepreneurial activity level (Infra), and social consumer goods level (Con) are adopted as matching variables to ensure that a more reasonable comparison can be made between the experimental group and the control group. The regression results are illustrated in Table 4. Column (1) shows the estimation results of the nearest neighbor matching, the coefficient of BDPZs is 0.0173, which is slightly lower than the coefficient in Column (4) of Table 3. It is still positive at the 10% significance level, indicating that the aggregation of data elements can promote the improvement of NQP levels; Column (2) shows the estimation results of the kernel

matching. The coefficient of BDPZs is 0.024, which is significant at the 1% level. This conclusion is basically consistent with the estimation results of the benchmark regression in Column (4) of Table 3, indicating that the aggregation of data elements can facilitate the improvement of NQP levels, and once again verifying the robustness of the baseline regression results.

### 5.2.4. Exclude outliers

Considering the possible existence of extreme outliers in the sample, to ensure the robustness of the benchmark regression results and effectively prevent individual outliers or extreme outliers from interfering with the benchmark regression results, this study performs before and after 1% shrinkage tailing on all continuous variables in the sample. Then, Equation (1) is used to regress the processed data, and the regression results are illustrated in Column (3) of Table 4. The results illustrate that after excluding the influence of possible individual outliers or extreme outliers, the estimated coefficient of BDPZs is 0.0234, which is significant at the 1% confidence level, suggesting that the aggregation of data elements promotes the level of NQP.

Table 4. PSM-DID test

Variable	NQP	NQP	NQP
	Nearest neighbor matching PSM-DID(1)	Kernel matching PSM-DID(2)	Exclude outliers (3)
BDPZs	0.0173* (0.0099)	0.0236*** (0.0088)	0.0234*** (0.0053)
Constant	0.0302 (0.0590)	0.0281 (0.0487)	0.0687* (0.0409)
Control variables	Yes	Yes	Yes
time fixed effect	Yes	Yes	Yes
Individual fixed effect	Yes	Yes	Yes
R <sup>2</sup>	0.9356	0.9269	0.9613
Adj.R <sup>2</sup>	0.9188	0.9127	0.9550
N	199	253	308

### 5.3. Mechanism analysis

In this paper, regarding whether the promotion impact of data elements aggregation in the national BDPZs policy on NQP is transmitted through the aggregation of digital talents, environmental regulation, and green technological innovation, it is necessary to use the mediating effect model to conduct tests one by one. In this paper, the stepwise regression method

is adopted to conduct the mediating mechanism test and analyze the mechanism of the effect of the aggregation of data elements on NQP. Therefore, the following mediating effect model is constructed.

$$mediator_{it} = \theta_0 + \theta_1 BDPZs_{it} + \theta_2 X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (3)$$

$$NQP_{it} = \varphi_0 + \varphi_1 BDPZs_{it} + \varphi_2 Mediator + \varphi_3 X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (4)$$

Among them: Mediator represents the mediating variables, namely the regional digital talent aggregation, environmental regulation, and green technological innovation. Here,  $\beta_1$  reflects the influence effect of data element aggregation on NQP;  $\theta_1$  reflects the influence effect of data element aggregation on the mediating variable;  $\varphi_2$  reflects the influence effect of the mediating variable on NQP.

### 5.3.1. The mediating effect of the aggregation of digital talents

The regression results are presented in Table 5. Column (1) indicates that the estimated result of the pilot policy on the aggregation of digital talents is significantly positive, which indicates that the establishment of national BDPZs is

conducive to the aggregation of digital talents, proving that data elements aggregation has a significantly positive effect on the aggregation of digital talents. Column (2) illustrates that the estimated result of the aggregation of digital talents on the development level of NQP is significantly positive, which shows that the aggregation of digital talents can enhance NQP level, proving that the aggregation of data elements can significantly enhance NQP level. The above results indicate that the national BDPZs facilitates the enhancement of the level of NQP by attracting the aggregation of digital talents, which shows that the aggregation of data elements promotes the aggregation of digital talents and further enhances the level of NQP, thus effectively verifying Theoretical Hypothesis 2.

**Table 5.** Test of the Mediating Effect

Variable	ln(Labor)	NQP	Er	NQP	Pati	NQP
	(1)	(2)	(3)	(4)	(5)	(6)
BDPZs	0.2191*** (0.0394)	0.0159*** (0.0058)	0.0009** (0.0004)	0.0227*** (0.0057)	1686.9640*** (413.5628)	0.0121** (0.0050)
ln(Labor)		0.0368*** (0.0085)				
Er				1.4191* (0.7788)		
Pati						0.0000*** (0.0000)
Constant	3.4633*** (0.3001)	-0.0827 (0.0510)	-0.0098*** (0.0034)	0.0586 (0.0434)	10453.7800*** (3147.9110)	-0.0286 (0.0376)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Individual fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.9819	0.9628	0.6264	0.9606	0.8966	0.9706
Adj.R <sup>2</sup>	0.9789	0.9565	0.5656	0.9540	0.8798	0.9657
N	308	308	308	308	308	308

### 5.3.2. Test of the mediating effect of environmental regulation

The regression results are illustrated in Table 5. In Column (3), the impact of national BDPZs on environmental regulation is significant at the 5% level, this demonstrates that the aggregation of data elements can enhance the intensity of regional environmental regulation. Column (4) indicates that the coefficient of influence of environmental regulation on NQP is 1.4191, which is significant at the 10% level. This shows that the national BDPZs promotes the improvement of the level of NQP by increasing the intensity of regional environmental regulation. It is confirmed that the aggregation of data elements promotes the improvement of the level of NQP by increasing the intensity of regional environmental regulation, thus effectively verifying Theoretical Hypothesis 3.

### 5.3.3. The mediating effect of green technological innovation

The regression results are illustrated in Table 5. Column (5) reveals that the estimated result of the pilot policy on green technological innovation is positive and significant at the 1% level, indicating that the aggregation of data elements promotes the improvement of green technological innovation. Column (6) indicates that the estimated result of green

technological innovation on the development level of NQP is significantly positive, demonstrating that green technological innovation can facilitate NQP development. The above results indicate that the aggregation of data elements based on the national BDPZs policy facilitate the enhancement of NQP by enhancing green technological innovation, thus effectively verifying Theoretical Hypothesis 4.

## 5.4. Heterogeneity analysis

There are significant differences among different regions in terms of economic development scale, scientific and technological innovation levels, factor resource agglomeration degrees, industrial structures, resource endowments. These differences are very likely to affect the implementation effects of the pilot policy of BDPZs in different regions. Compared to the eastern region, the central and western regions have weaker capabilities in gathering innovative talents and technologies. This locational disadvantage is likely to limit the advancement of NQP in these regions. To analyze whether the heterogeneity of geographical location will lead to differences in the promoting effect of the aggregation of data elements on NQP of different regions, this paper divides the samples into the eastern region, the central region, and the western region, and respectively explores the impacts of the aggregation of data

elements based on the pilot policy of BDPZs on NQP in the eastern, central, and western regions. Columns (1), (2) and (3) of Table 6 present the estimated results of the regional grouping. The results illustrates that the data elements aggregation based on the policy of the national BDPZs can significantly foster the improvement of NQP levels in the eastern region, followed by the western region, while it is not significant in the central region. The reason for this is that the Eastern Region has advanced technology and a high level of digital infrastructure, which provides the basic conditions necessary for aggregating data elements. The digital infrastructure not only facilitates the aggregation of data elements but also drives the rapid development of the digital industry and contributes to the improvement of the level of NQP. Under the guidance of the national strategy of “Eastern Data Processing and Western Computing Capacity” and the dual promotion of the “Western Development” policy, the digital infrastructure in the western region has been

continuously improved, which has promoted the efficient flow and transaction of data elements and laid a solid foundation for the aggregation of data elements. At the same time, digital infrastructure is not only an important carrier for the transaction and flow of data elements, but also a driving force for the efficient aggregation of data elements. The aggregation of digital elements promotes the vigorous development of the digital industry, drives breakthroughs in technological innovation, and realizes the digital and intelligent transformation and upgrading of traditional industries, thus promoting the development of NQP. In contrast, the development of digital infrastructure in the central region is relatively weak, which restricts the effective aggregation and efficient utilization of data elements. Therefore, compared to the western region, the promoting effect of the aggregation of data elements on NQP in the central region is relatively weak.

**Table 6.** Test of Regional Heterogeneity

Variable	Eastern region	Central region	Western region
BDPZs	0.0566*** (0.0154)	0.0023 (0.0046)	0.0099** (0.0038)
Constant	0.1792* (0.0958)	0.0273 (0.0235)	0.0170 (0.0138)
Control variables	Yes	Yes	Yes
time fixed effect	Yes	Yes	Yes
Individual fixed effect	Yes	Yes	Yes
R <sup>2</sup>	0.9547	0.9835	0.9697
Adj.R <sup>2</sup>	0.9412	0.9756	0.9599
N	110	66	99

## 6. Conclusion and Recommendations

### 6.1. Conclusions

The research results show that: (1) The aggregation of data elements can effectively enhance new quality productivity; (2) The aggregation of data elements promotes the improvement of the level of NQP through the aggregation of digital talents, environmental regulation, and green technological innovation; (3) The promoting effect of the aggregation of data elements on NQP shows obvious differences due to regional characteristics, the aggregation of data elements exerts significant positive effects on NQP in the eastern and western regions, while its impact is insignificant in the central region

### 6.2. Policy Recommendations

We should increase investment in scientific and technological innovation, encourage in-depth cooperation among enterprises, universities and research institutions, and promote the integrated development of industry, academia, and research. At the same time, we should accelerate the transformation and application of scientific and technological achievements, making scientific and technological innovation a powerful engine for promoting the development of new quality productivity. We should promote the optimization and upgrading of the industrial structure. The optimization and upgrading of industrial structures are an important way for the development of NQP. We should accelerate the transformation and upgrading of traditional industries and promote the development of emerging industries and high-end manufacturing. The government should provide targeted support and guidance based on regional differences. For

regions with abundant resources but relatively backward technology, the government should focus on increasing support for technological innovation, through introducing advanced technologies, cultivating innovative enterprises, and building science and technology parks. These measures will facilitate technological upgrading and industrial transformation in regions, so as to fully leverage resource advantages and achieve efficient utilization and sustainable development.

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