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# Has China's New Infrastructure Promoted Sustainable Economic Development? Evidence Based on Information Infrastructure and Entrepreneurship

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**Abstract:** Entrepreneurship has always been regarded as an important economic activity that promotes sustainable economic development, enlivens markets and social transactions, and cultivates entrepreneurial spirit. As a unique concept in China's economic development, new infrastructure has been widely disseminated and practiced and has also contributed to urban development and sustainable economic growth. However, there is little research by scholars on whether there is a causal relationship between the two, that is, whether new infrastructure will affect the level of regional entrepreneurship in sustainable economic development. This article used panel data from 267 cities in China between 2011 and 2017 to examine the impact of new infrastructure on regional entrepreneurial activities. Research has found that the construction of new infrastructure, especially information infrastructure, significantly promotes regional entrepreneurship. This study explored mechanisms such as human capital agglomeration and alleviating financing constraints. This study also found that the impact of new infrastructure on entrepreneurship varies based on the urban administrative level and region, with a more significant impact on central cities and central and western regions. This study will help researchers discover and understand the role of new infrastructure in regional entrepreneurship while promoting sustainable economic development.

**Keywords:** new infrastructure; sustainability; economic development; entrepreneurship

## 1. Introduction

It is well known that infrastructure construction is one of the conventional means by which countries promote economic recovery and sustainable economic development. In the wake of economic challenges precipitated by the COVID-19 pandemic, nations worldwide have deployed infrastructure development as a key policy tool to stimulate economic activity. The State Council of China has also formulated a response strategy for moderately advanced infrastructure investment. In 2023, the National Development and Reform Commission of China also proposed to moderately advance infrastructure investment to promote the stable recovery of the Chinese economy. According to the current situation of China's industrial development, the construction of new infrastructure represented by the information network industry is one of the most active industries in China's current economic development process, and it is also an important source of support for achieving economic momentum transformation and high-quality development. The rapid development of new infrastructure has long made significant contributions to promoting sustainable economic development in China.

In recent years, economic connections between Chinese cities and other cities around the world have been increasingly strengthened (Derudder et al., 2022) [1], and the economic strength of enterprises has also improved (Raźniak et al., 2021) [2]. Chinese cities have shown enormous economic potential on a global scale (Raźniak et al., 2017) [3]. This enormous economic potential is closely related to China's implementation of new infrastructure policies.

New infrastructure is a unique concept of economic development in China; it mainly refers to the construction of new infrastructure based on information networks, it is driven by technological innovation, and it aims to achieve economic digital transformation, intelligent upgrading, and integrated innovation. At the same time, it emphasizes the widespread application and driving role of information technology in the economy and society. The fields covered by new infrastructure mainly include ICT infrastructure, artificial intelligence, industrial Internet, new energy vehicle charging piles, urban rail transit, big data centers, etc. This paradigm diverges from traditional infrastructure ventures, such as the construction of roads, railways, airports, ports, and bridges, encapsulating a broader spectrum of infrastructure-related activities and exhibiting pronounced characteristics including low carbon emissions, environmental protection, sustainability, and a digital economy.

The goal of new infrastructure is to promote high-quality and sustainable economic development, accelerate industrial transformation and upgrading, and promote the continuous optimization of economic structure. Since its inception by the Chinese government in early 2020, the concept has crystallized into an integral component of China's economic progression strategy. After the COVID-19 pandemic, China's economy fell into a downturn as the unemployment rate climbed and the entrepreneurship level urgently needed to be restored. It is necessary to specifically assess the promotion effect of new infrastructure construction on China's urban entrepreneurship so as to provide empirical evidence for the targeted development of new infrastructure construction and provide policy guidance for the sustainable development of the regional economy, especially for the macro policies of incentive and the recovery of the regional entrepreneurship level. In addition, it also provides a new research perspective on the impact of new infrastructure on regional economic sustainable development in academia. This study primarily employs the lens of information infrastructure development to scrutinize and appraise the influence of China's new infrastructure on regional entrepreneurship. The significance of this research lies in providing guidance for policy formulation; by specifically evaluating the promoting effect of new infrastructure construction, especially information infrastructure construction, on urban entrepreneurship, the research results provide important policy guidance for macro policies regarding regional economic sustainable development. This study not only enriches the theoretical research on the relationship between new infrastructure construction and regional entrepreneurship, but it also provides empirical evidence to support the realization of the Chinese government's policy goals of "mass entrepreneurship and innovation" and activating the market economy.

Existing research has preliminarily revealed the potential positive role of new infrastructure, especially information infrastructure, in promoting regional entrepreneurship (Audretsch et al., 2015; McCoy et al., 2018) [4,5]. This article aims to explore the impact of China's new infrastructure construction on the regional entrepreneurship level and its mechanism and heterogeneity through a comprehensive analysis. This article uses panel data from 267 cities in China from 2011 to 2017 to examine the impact of new infrastructure construction on regional entrepreneurship levels through direct impact and heterogeneity, and it explores possible mechanisms such as human capital agglomeration and alleviating financing constraints. The contributions of this study are threefold: Firstly, it diverges from previous inquiries as it does not limit its scope to the impact of new infrastructure on urban employment or innovation levels, nor does it confine itself to entrepreneurial effects within a specific region or the aftermath of quasi-natural experiments. Instead, it zeroes in on the nationwide implications of new infrastructure development on regional entrepreneurial vigor. Secondly, this study enriches the theoretical research based on the relationship between new infrastructure construction and sustainable economic development. Thirdly, it furnishes empirical substantiation for the sustainable advancement of new infrastructure, particularly informational infrastructure, thereby undergirding the policy aspirations of widespread entrepreneurship and innovation as championed by the Chinese government, vitalizing China's market economy. This study elucidates how new

infrastructure can elevate regional entrepreneurship, offering a novel and viable trajectory for regional economic enhancement and the perpetual intensification of economic activities.

The remainder of this paper is organized as follows: Section 2 reviews relevant studies in the literature on similar topics. Section 3 delineates the empirical framework and data exposition, explicating the measurement models and data selection criteria. Section 4 discusses the empirical findings and analytical procedures, emphasizing the basic regression outcomes, the treatment of endogeneity concerns, robustness checks, and heterogeneity analyses. Section 5 delves into the mechanisms through which new infrastructure fosters regional entrepreneurship. Finally, Section 6 offers concluding remarks regarding this study.

## 2. Literature Review

### 2.1. Impact of New Infrastructure on Entrepreneurship

The significant promoting effect of sustainable infrastructure on economic growth has been demonstrated by scholars in previous research (Mahmood et al., 2024) [6]. When studying the construction of the China–Pakistan Economic Corridor (CPEC), scholars found that the project provides more employment opportunities for local residents (Mahmood et al., 2020) [7]. Since then, the COVID-19 pandemic has seriously delayed the construction of the China–Pakistan Economic Corridor (CPEC), which has had an impact on the stability and sustainable development of the regional economy (Mahmood et al., 2023) [8]. Although few researchers have studied the impact of new infrastructure on the regional entrepreneurship level using urban level data across China, there is a basic consensus in academia on the promoting effect of new infrastructure, especially information infrastructure, on entrepreneurship. Audretsch et al. (2015) [4], utilizing county-level data in Germany from 2001 to 2015, explored the nexus between infrastructure and entrepreneurship. Their findings underscore that regions endowed with robust infrastructure and widespread broadband access are hotbeds for entrepreneurial activity. McCoy et al. (2018) [5] also corroborated the positive correlation between broadband coverage and the propensity for business ventures within a locale. Furthermore, Li et al. (2022) [9] evidenced that information infrastructure amplifies the beneficial effects of digital inclusive finance on household entrepreneurship.

In a similar vein, Meng et al. (2022) [10] observed that information infrastructure development bolsters overall entrepreneurial endeavors in a region. Focusing on the Yangtze River Economic Belt, Zhang and Bai (2023) [11] discerned that all forms of "new infrastructure," including information, integrated, and innovation infrastructure, significantly propel entrepreneurial activity, with "information infrastructure" having the most pronounced effect. Wen and Zhang (2023) [12] examined the "Broadband China" pilot city initiative, finding that this new infrastructure significantly escalated the emergence of startups in those cities. Additionally, Yang (2024) [13] posited that digital infrastructure serves as a catalyst for innovation and entrepreneurship.

A systematic review of the extant literature delineated several mechanisms through which new infrastructure, particularly in the realms of information and integrated development, augments entrepreneurial activity. Primarily, it diminishes the costs and lowers the barriers to entry for startups. Furthermore, the digitization inherent in new infrastructure markedly enhances the efficiency of the production and distribution processes, thus facilitating market engagement and reducing operational costs for nascent firms. Innovation infrastructure, another pillar of new infrastructure, aids entrepreneurs in acquiring and processing information, thereby elevating the efficacy of technological innovation and abbreviating the R&D timeline for novel products. From a macroeconomic perspective, new infrastructure contributes to optimal resource allocation, engenders industrial agglomeration effects, and fosters a strategic enterprise distribution, collectively nurturing the entrepreneurial ecosystem.

The concept of new infrastructure in this study specifically refers to the information infrastructure construction part of the extensive new infrastructure introduced in the introduction, such as 5G networks, the Internet of Things, data centers, and cloud computing

platforms, which can provide high-speed and high-capacity data transmission and processing capabilities and support the development of the digital economy. In addition, regional entrepreneurial activities typically refer to entrepreneurial activities that occur within specific geographical regions, including the establishment, early development, and growth of new enterprises. These activities typically involve individuals or teams identifying business opportunities, mobilizing resources, and establishing and operating new businesses. The regional entrepreneurial activities referred to in this study mainly refer to the activities of private shareholders establishing new companies within a specific city.

*2.2. New Infrastructure Promotes Regional Entrepreneurship by Reducing Costs and Increasing Efficiency*

The caliber of public services is indicative of the infrastructure's capacity to fulfill the essential needs pertinent to the well-being, sustenance, and progression of citizens. An imperative role of new infrastructure is to elevate the standard of urban public services. This enhancement either imposes resource constraints or proffers robust support for the production and operational activities of regional enterprises, subsequently exerting a considerable influence on investment location decisions (Li, 2019) [14]. Consequently, the efficacy of public services bears significance on regional venture capital dynamics. Public infrastructure services, by virtue of their multiplier effect, propel market demand for associated commodities and services (Wang et al., 2014) [15], thereby improving the overall carrying capacity of the environment, and more entrepreneurial opportunities emerge (Aldrich and Ruef, 2006) [16]. As infrastructure often represents a quasi-public good characterized by positive externalities, it has the potential to curtail transaction and production expenses (Zhang and Song, 2013) [17] and catalyze private investment, thus fostering entrepreneurial activities.

*2.3. New Infrastructure Promotes Regional Entrepreneurship by Gathering Talents*

Entrepreneurial talent, characterized by a high level of human capital, is often mobile and migratory, seeking to identify and exploit entrepreneurial opportunities that cities present. These individuals aim to improve resource allocation and maximize their net benefits, as conceptualized by Schultz (1961) and Sjaastad (1962) [18,19]. The locational decisions of entrepreneurial talents are profoundly influenced by the quantity and quality of non-tradable urban public services. Hence, the levels of public infrastructure and social welfare offerings significantly determine the migratory patterns of these individuals.

New infrastructure, an integral component of the public service framework, exerts a considerable force on entrepreneurial talents. The presence of advanced new infrastructure in a city can facilitate the immediate local release and sharing of entrepreneurial activities, propel the diffusion of technological innovations, and expedite the assimilation of new technologies. This environment is conducive to attracting further entrepreneurial talent from beyond regional borders (Kerr et al., 2014) [20].

By drawing on the resource dependence theory, DePrijcker et al. (2019) [21] suggest that entrepreneurs evaluate the availability of entrepreneurial resources across regions to secure the venture capital necessary for business development. Digital infrastructure, such as high-speed internet connectivity, cloud computing, and big data centers, elevate urban informatization levels, providing critical technical support for entrepreneurs in product research, development, and business expansion. Swift data transmission and efficient online services enhance the information reception and feedback processes, enabling entrepreneurs to conduct research, testing, and marketing with heightened efficiency (Salanova et al., 2004) [22].

Moreover, the advent of new infrastructure spawns a multitude of novel entrepreneurial opportunities. The expansion of broadband networks, the burgeoning prevalence of 5G, and the Internet of Things, along with the surge in broadband users, generate increased demand for related applications, services, and solutions. This creates a vast potential market and customer base for entrepreneurs engaged in such endeavors. Additionally, investors typically exhibit a preference for projects located in cities with robust new infrastructure, as

this symbolizes market maturity and potential business value. An influx of capital into these cities naturally attracts entrepreneurial talent, drawn by improved access to financing.

Lastly, the digitization of public services, such as smart transportation and online education, which are components of new infrastructure, enhances the appeal for entrepreneurs to initiate and conduct business activities in the locale, thereby contributing to a vibrant entrepreneurial ecosystem.

*2.4. New Infrastructure Alleviates Entrepreneurs' Financing Constraints and Promotes Entrepreneurship through Digital Finance*

Financial constraints are well-documented impediments to entrepreneurial activity, with the extant literature substantiating the negative impact of credit limitations on entrepreneurship (Zeng and Wen, 2021; Karaivanov, 2012) [23,24]. In the context of China's economic landscape, the rapid ascent of digital finance—powered by broadband, the Internet, big data, and cloud computing—has been noteworthy (Guo et al., 2020) [25]. Digital finance, particularly as it extends services to previously underserved groups, has been pivotal in advancing the agenda of inclusive finance (Li, 2015; Zhang et al., 2019) [26,27].

The integration of digital finance within the ambit of new infrastructure is contingent on the development of informational infrastructure, such as the Internet and big data platforms. At the regional echelon, concerted efforts to foster a balanced development of new infrastructure across China have been observed, with preferential policies directed towards the less developed central and western provinces. Such initiatives present an opportunity for the amalgamation of the traditional financial sector with emergent technologies in these regions, thus broadening the reach of financial services and diminishing the costs associated with service delivery coordination.

It is posited that as new infrastructure continues to evolve and improve, digital finance will likely broaden its service ambit and depth of utilization. This expansion is anticipated to alleviate financial credit constraints for entrepreneurs, democratize entrepreneurial opportunities, and, consequently, stimulate entrepreneurial activities.

Hence, this study posits the following two hypotheses for empirical validation:

**H1:** *The construction of new infrastructure catalyzes regional entrepreneurship.*

**H2:** *New infrastructure fosters regional entrepreneurship by diminishing costs and enhancing efficiency, by attracting talents, and by alleviating financial constraints.*

### 3. Data and Methods

*3.1. Model Setting*

In order to investigate the impact of new infrastructure on regional entrepreneurship, we set the basic regression model as follows:

$$Startup_{i,t} = \beta_0 + \beta_1 NI_{i,t} + \gamma X_{i,t} + \phi_i + \lambda_t + \varepsilon_{i,t} \tag{1}$$

where $Startup_{i,t}$ is the carbon emission intensity of city $i$ in year $t$. $NI_{i,t}$ measures the new infrastructure level of city $i$ in year $t$. $X_{i,t}$ is a set of control variables. $\phi_i$ and $\lambda_t$ represent city fixed effects and time fixed effects. $\varepsilon_{i,t}$ is the error term. The coefficient $\beta_1$ is a basic statistic that captures the net effect of information infrastructure on regional entrepreneurship. The significantly positive $\beta_1$ indicates that the level of regional venture capital has been significantly promoted due to the improvement and promotion of information infrastructure, which effectively plays the role of the unit GDP in influencing regional economic development under the background of digital economy. Otherwise, if $\beta_1$ is significantly negative, it indicates that the construction of information infrastructure inhibits local venture capital. However, if $\beta_1$ is not significant, the impact of information infrastructure on the level of regional entrepreneurship is negligible.

### 3.2. Variables

The selection of variables is mainly based on the needs of the research question, and past studies in the literature are used as the main reference. The selection of dependent and independent variables conforms to the basic principles of economics and regional development research, aiming to ensure scientific, accurate, and reliable research results.

### 3.2.1. Independent Variables

Referring to the research of Pan (2020) [28], the investment in fixed assets of information transmission, software, and information technology services is used as the measurement index. Referring to previous studies in the literature, this study uses four indicators to measure and determine the quality and level of a city's information infrastructure. These indicators include the Internet penetration rate (number of people using the Internet per 100 people), computer services and software employees (share of urban computer services and software employees), total telecommunications services per capita, and mobile phone penetration rate (number of mobile phone users per 100 people). The foundational data for these indicators are sourced from the China City Statistical Yearbook. To synthesize these variables into a composite measure, Principal Component Analysis (PCA) is employed. PCA facilitates the standardization of and dimensional reduction in the aforementioned variables, yielding a comprehensive index of information infrastructure, denoted as the NI index.

The selection of independent variables follows correlation, that is, the independent variables are related to the factors expected to affect the dependent variable in the following research hypothesis: the construction of new infrastructure, especially information infrastructure, is believed to provide better information and communication technology support, reduce entrepreneurial costs, improve entrepreneurial efficiency, and potentially promote regional entrepreneurial activities. The selection of independent variables also follows the scientificity and rationality of the measurement method, as it can reflect the actual situation of the research object. The construction level of new infrastructure is comprehensively measured by multiple indicators such as the Internet penetration rate, the proportion of computer service and software practitioners, the total number of telecommunications services per capita, and the mobile phone penetration rate, which can comprehensively reflect the construction level of information infrastructure. At the same time, the selection of independent variables also follows representativeness and comprehensiveness. The selection of new infrastructure should comprehensively reflect the various characteristics of new infrastructure, such as the informatization and digitalization levels. By integrating these indicators, it is possible to more comprehensively reflect the level of new infrastructure construction in a city.

### 3.2.2. Dependent Variable

In evaluating the entrepreneurial landscape, it is pivotal to acknowledge the distinct characteristics and entry barriers associated with different types of enterprises. State-owned and foreign-funded enterprises typically enter markets with substantial national or corporate group backing and robust financial support. Such attributes set them apart from entrepreneurial ventures in the traditional milieu, which are often characterized by their nimbleness and resource constraints.

In alignment with the methodologies adopted in the scholarly works of Rui et al. (2008), Li et al. (2012), Chang and Zhang (2015), and Ming (2016) [29–32], this study adopts the number of registered private enterprises as a proxy for gauging the intensity of regional entrepreneurship. This metric is chosen to reflect the grassroots level of entrepreneurial initiative, uninfluenced by the substantial capital and support that larger state-owned and foreign-funded entities typically enjoy.

The data pertaining to the registration of private enterprises, indicative of startup activities, is procured from the annual China Statistical Yearbook. This source provides a reliable and consistent basis for measuring the entrepreneurial vigor within various regions, thus allowing for a nuanced analysis of the entrepreneurial dynamics at play.

The selection of dependent variables follows the principles of representativeness, data availability, and accuracy. Firstly, the dependent variable should fully represent the level and activity of regional entrepreneurship. This article uses the number of registered private enterprises as an indicator to measure the level of regional entrepreneurship because the number of newly established private enterprises can intuitively reflect the frequency of entrepreneurial activities and the friendliness of the entrepreneurial environment in a region. Secondly, it needs to be ensured that the selected dependent variable can be obtained from existing data sources to ensure the feasibility of the study. The data on the number of registered private enterprises can generally be obtained from national or local statistical yearbooks, which have high accessibility. Finally, the selection of the dependent variable should accurately reflect the testing objectives of the research hypothesis. The number of registered private enterprises is directly related to entrepreneurial behavior and is a direct and accurate indicator for measuring the level of entrepreneurship.

### 3.2.3. Control Variables

In order to account for external factors that may influence regional entrepreneurship, this study incorporates a series of control variables. These variables are integral in providing a comprehensive analysis by controlling for additional determinants that could affect the outcome variable outside of the new infrastructure investment.

Foreign Direct Investment (FDI): This is quantified as the ratio of the actual foreign investment inflow to the regional Gross Domestic Product (GDP). The actual foreign investment data are converted using the median exchange rate of the Chinese RMB to USD for the respective year under consideration. Human Capital (edu): The human capital level within a region is operationalized as the percentage of individuals with at least a high school education relative to the urban population. This metric serves as a proxy for the educational attainment and potential skill level of the workforce. Fixed Asset Investment (invest): This is represented as the share of total urban fixed asset investment in the region's GDP; this variable reflects the intensity of investment in long-term physical assets within urban areas. Regional Employment Level (employ): This is assessed through the employment rate within the city, providing an indication of the overall employment health and labor market dynamics of the region. Urbanization Rate (urban): This is measured as the proportion of the jurisdictional city population to the total city population; this variable captures the rate and scale of urbanization, which can influence entrepreneurial opportunities and activities. Each of these control variables was chosen based on their potential to influence the entrepreneurial environment, and their inclusion ensures a more rigorous and nuanced understanding of the variables driving regional entrepreneurial activity.

### 3.2.4. Data Sources

Because the statistical caliber of some data has changed after 2017 and some variable data have not been released yet, the long-term existence of COVID-19 in China after 2019 has led to the delay of new infrastructure activities and the almost complete stagnation of entrepreneurial activities. In order to study reliability, this paper finally selects panel data from 2011 to 2017 for analysis. Although the data used in the article may not be the latest, the theoretical verification, trend revelation, mechanism analysis, and long-term policy impact assessment provided by this study have important practical significance and lasting value for understanding and analyzing the impact of new infrastructure on China's economic development and regional entrepreneurship.

Since this paper examines the impact of information infrastructure construction on regional entrepreneurship, the data on infrastructure construction and fixed asset investment involved are from a wide range of sources. These sources include the China Statistical Yearbook, the China City Statistical Yearbook, the China Fixed Asset Investment Statistical Yearbook, as well as various databases and platforms such as the EPS data platform, the China Stock Market & Accounting Research (CSMAR) database, and the Chinese Research Data Service Platform (CNRDS), amongst others.

To ensure the comparability of data across different scales and to mitigate the effects of outliers or extreme values, standardization techniques were applied to the variables. Additionally, a winsorization process was implemented to address any undue influence from extreme data points on the research outcomes. The descriptive statistics for the variables under consideration are systematically presented in Table 1, providing an overview of the data's distribution and central tendencies.

**Table 1.** Variables and descriptive statistics.

| Variables | Variable Symbols | 50th Percentile | Min. | Max. | Standard Deviation |
|---|---|---|---|---|---|
| Regional entrepreneurship level | Startup | 33,633 | 1243 | 904,403 | 72,977.07 |
| New infrastructure level | NI | −0.2500 | −1.5400 | 14.6200 | 1.0000 |
| Foreign direct investment | FDI | 0.0100 | 0.0002 | 0.1900 | 0.0200 |
| Human capital level | edu | 134.3000 | 2.0900 | 1270.5000 | 233.5567 |
| Fixed asset investment | invest | 0.7600 | 0.0900 | 2.2000 | 0.2900 |
| Regional employment level | employ | 51.8800 | 15.3900 | 90.0600 | 13.3052 |
| Urbanization rate | urban | 0.3000 | 0.0500 | 1.0000 | 0.2400 |

## 4. Results

### 4.1. Basic Regression Results

To account for regional macroeconomic disparities and the effects of time-invariant factors, this study employs a two-way fixed-effects model for the empirical assessment of the relationship between new infrastructure development and regional entrepreneurship. This methodology allows for a robust examination by controlling for unobservable variables that are constant over time within a given entity but vary across entities, and those that are constant across entities but vary over time.

Table 2 presents the foundational regression results. Specifically, column (3) consolidates the outcomes after the inclusion of control variables and fixed effects. The regression analysis yields a statistically significant positive coefficient for the NI variable at the 1% level, underscoring the pivotal role of new infrastructure in fostering regional entrepreneurship. This positive association corroborates the hypothesis that well-developed information infrastructure, reflecting advanced information and digital technologies, enhances the regional entrepreneurial milieu. It achieves this by not only escalating the levels of entrepreneurial investment but also by streamlining entrepreneurial efficiency and diminishing the costs associated with entrepreneurial ventures.

**Table 2.** Basic model: effect of NI on startup.

| Variables | Startup | Startup | Startup |
|---|---|---|---|
| | **(1)** | **(2)** | **(3)** |
| NI | 12,340.69 *** | 13,577.1 *** | 10,964.58 ** |
| | (3708.315) | (4240.11) | (5606.449) |
| Controls | N | Y | Y |
| Year FE | N | N | Y |
| City FE | N | N | Y |
| Cons | 47,562.41 *** | 5809.72 | −31,402.41 |
| | (2781.744) | (9784.019) | (21,851.59) |
| Observations | 1637 | 1086 | 1086 |
| Adjusted R-squared | 0.2334 | 0.2928 | 0.8842 |

*t*-statistics based on standard errors clustered at city level are reported beneath each coefficient estimate. Significance levels are indicated by **, and *** for 5%, and 1%, respectively.

### 4.2. Heterogeneity Analysis

By building upon the comprehensive sample analysis, existing research has substantiated the significant contributory effect of new infrastructure on the enhancement of regional

entrepreneurship. To ensure the robustness of these findings and to shed light on the potential moderating factors, this study extends its examination by delineating the influence of new infrastructure based on various demarcations such as the urban administrative level, geographical location, and urban scale.

Such a comparative analysis not only addresses potential omissions or biases inherent in the full sample assessment but also furnishes a granular perspective on how different urban environments may variably leverage new infrastructure for entrepreneurial growth. This nuanced exploration is critical for tailoring policy recommendations that are sensitive to the unique dynamics of each urban context.

### 4.2.1. Heterogeneity at the Urban Administrative Level

The level of element agglomeration, as well as the extent of technological innovation and development, is known to differ across cities with varying administrative statuses. These disparities are likely to result in divergent externalities associated with new infrastructure. Drawing upon the analytical framework of Zhou et al. (2021) [33], this study differentiates between central cities—defined as municipalities directly under the central government, provincial capitals, and sub-provincial level cities—and peripheral cities, which include all other urban areas. This classification is utilized to investigate the heterogeneity in the effects of new infrastructure on regional entrepreneurship.

The empirical results, as delineated in columns (1) and (2) of Table 3, reveal that a unit change in the level of new infrastructure induces a more pronounced alteration in the entrepreneurial levels of central cities compared to those of peripheral cities. This finding suggests that new infrastructure exerts a more substantial impact on entrepreneurship in central cities. The underlying mechanism for this discrepancy is principally attributed to the national policy directives that have been specifically designed to steer new infrastructure development in central urban areas. Such policy measures offer robust support for the advancement of new infrastructure, thereby broadening the scope and avenues through which new infrastructure can facilitate entrepreneurial activities.

**Table 3.** Heterogeneity analysis.

| Variables | Key City (1) | Peripheral Cities (2) | Eastern (3) | Midwest (4) |
|---|---|---|---|---|
| NI | 15,549.53 *** | 9203.64 *** | 14,220.33 *** | 10,030.21 *** |
| | (1224.60) | (781.23) | (659.20) | (658.33) |
| Controls | Y | Y | Y | Y |
| Year FE | Y | Y | Y | Y |
| City FE | Y | Y | Y | Y |
| Cons | 5387.56 *** | 625.09 *** | 828.78 ** | 1065.21 *** |
| | (767.51) | (143.22) | (400.29) | (322.10) |
| Observations | 248 | 838 | 504 | 582 |
| Adjusted R-squared | 0.67 | 0.70 | 0.66 | 0.57 |

When Controls is marked as YES, this indicates that the control variables are controlled. The *t*-statistics based on the standard errors clustered at the city level are reported beneath each coefficient estimate. The significance levels are indicated by **, and *** for 5%, and 1%, respectively.

### 4.2.2. Heterogeneity of Geographical Location

The interplay between digital new infrastructure and regional entrepreneurship within China's diverse urban landscape is subject to spatial heterogeneity, influenced by regional disparities in resource allocation and economic foundations. To probe into the regional variances of new infrastructure's impact on entrepreneurship, this study bifurcates the sample cities into eastern and central–western regions in accordance with the demarcation criteria set by the National Bureau of Statistics and performs regression analyses to test the variations.

Table 3 consolidates the findings from these analyses, revealing marked regional heterogeneity in the efficacy of new infrastructure on entrepreneurial activity. Both the eastern and central–western regions exhibit a positive correlation between new infrastructure and

regional entrepreneurship, with both passing the 1% threshold for statistical significance. The regression coefficients suggest that new infrastructure acts as an effective catalyst for enhancing the level of regional entrepreneurship, with the degree of impact being more pronounced in the central and western regions than in the eastern regions.

This observed disparity may be attributed to the more significant strides made by the central and western regions in developing their information infrastructure. Such advancements have likely mitigated previously existing impediments to regional entrepreneurship, thereby amplifying the transformative effects of new infrastructure in these areas.

### 4.3. Robustness Test and Endogeneity Discussion

To fortify the robustness of the foundational model, this study undertakes a series of additional analyses. These were meticulously designed to address potential concerns regarding the initial findings and to solidify the interpretive power of the model. Firstly, the dependent variable is reconstructed. By employing the lagged values of the dependent variable, this study introduces a temporal dimension that accounts for delayed effects and potential dynamic relationships. Secondly, a rigorous process for the exclusion of outliers is implemented. By removing extreme observations from the dataset, the analysis minimizes the risk of skewed results that could potentially distort the true relationship between variables. Lastly, this study addresses potential endogeneity issues by employing instrumental variable techniques. This approach mitigates the bias that might arise from omitted variable bias, measurement errors, or simultaneous causality, providing a more accurate estimation of the causal impact of new infrastructure on regional entrepreneurship.

#### 4.3.1. Reconstruction of Dependent Variable

In alignment with the methodologies of Rui et al. (2008), Li et al. (2012), Chang and Zhang (2015), and Ming (2016) [29–32], this study operationalizes regional startup activity through the prism of private enterprise registrations within a given area. Recognizing that the raw count of registered enterprises may deviate from a normal distribution, the natural logarithm of the number of registered enterprises, denoted as (lnnum), is utilized for analytical normalization. Moreover, this study expands its measurement of regional entrepreneurship by incorporating two alternative metrics: the net increase in enterprise registrations and the growth rate of enterprise registrations. These measures provide additional dimensions to the assessment of entrepreneurial activity.

Subsequent retesting with model (1) has demonstrated that the regression coefficients for new infrastructure remain significantly positive irrespective of the iterations in the dependent variable. These findings not only reaffirm Hypothesis 1, but also bolster the benchmark regression outcomes that were previously discussed. The detailed results can be observed in columns (1), (2), and (3) of Table 4, thereby substantiating the robustness of the initial conclusions.

**Table 4.** Robustness test.

| Variables | Lnnum (1) | Increment (2) | Rate (3) | L. Startup (4) | 1% (5) | 5% (6) |
|---|---|---|---|---|---|---|
| NI | 0.0510 * | 126.54 *** | 32.45 *** | 6456.327 *** | 8891.90 * | 6647.90 ** |
|  | (0.0295) | (11.33) | (2.06) | (613.758) | (5006.77) | (3180.21) |
| Controls | Y | Y | Y | Y | Y | Y |
| Year FE | Y | Y | Y | Y | Y | Y |
| City FE | Y | Y | Y | Y | Y | Y |
| Cons | 8.665 *** | 625.09 *** | 443.21 ** | 344.55 *** | 326.55 ** | 289.45 *** |
|  | (0.133) | (123.28) | (206.42) | (102.12) | (148.26) | (98.95) |
| Observations | 1086 | 1086 | 1086 | 1086 | 1086 | 1086 |
| Adjusted R-squared | 0.96 | 0.72 | 0.67 | 0.66 | 0.74 | 0.85 |

When Controls is marked as YES, it indicates that the control variables are controlled. The *t*-statistics based on the standard errors clustered at the city level are reported beneath each coefficient estimate. The significance levels are indicated by *, **, and *** for 10%, 5%, and 1%, respectively.

### 4.3.2. One-Period Lag of Dependent Variable

In the acknowledgment of the temporal delay inherent in the impact of new infrastructure on regional entrepreneurial activities, this analysis incorporates a time lag in the dependent variable to capture the prospective influence. This approach utilizes the lagged number of private enterprise registrations (L. startup) as an indicator of entrepreneurial activity in the subsequent period. A new estimation equation is constructed with the L. startup serving as the dependent variable on the left side of the equation. This model aims to elucidate the longitudinal effects of new infrastructure investment on entrepreneurship.

The regression results indicate that the coefficients for new infrastructure are significantly positive at the 1% level, suggesting that the influence of new infrastructure on entrepreneurship manifests in a subsequent period rather than instantaneously. This finding is in concordance with Hypothesis 1 and aligns with the benchmark regression results presented earlier in this chapter, as detailed in column (4) of Table 4. The results lend credence to the proposition that the developmental impacts of new infrastructure on regional entrepreneurship are not immediate but unfold over time.

### 4.3.3. Elimination of Outliers

In an effort to refine the data quality and mitigate the impact of anomalies, this study applies a truncation method to the dependent, explanatory, and control variables. By implementing both upper and lower truncation at the 1% and 5% thresholds, the analysis seeks to curtail the distortive effects of outliers and reduce data volatility.

The regression outcomes post-truncation, as delineated in columns (5) and (6) of Table 4, reveal that the coefficient for the core explanatory variable—excess losses—registers at 8891.90, attaining statistical significance at the 10% level. Moreover, the coefficient for the core explanatory variable of excess loss, documented in column (6) of Table 5, is 6647.90 and is significant at the 1% level. These results underscore the assertion that the establishment of new infrastructure exerts a notably robust and stable impetus on regional entrepreneurship.

**Table 5.** Instrument variables test.

| Variables | 1st Stage (1) | 2nd Stage (2) |
|---|---|---|
| NI | | 8654.54 *** |
| | | (1001.23) |
| L.NI | 4310.21 *** | |
| | (1022.21) | |
| Durbin–Wu–Hausman | | 35.43 |
| Andersoncanon. corr. LM statistic | | 132.21 |
| Cragg–Donald Wald F | | 106.10 |
| Controls | Y | Y |
| Year FE | Y | Y |
| City FE | Y | Y |
| Cons | 458.65 *** | 775.49 *** |
| | (62.33) | (177.55) |
| Observations | 1086 | 1086 |
| Adjusted R-squared | 0.76 | 0.65 |

When Controls is marked as YES, this indicates that the control variables are controlled. The *t*-statistics based on the standard errors clustered at the city level are reported beneath each coefficient estimate. The significance levels are indicated by *** for 1%, respectively.

Such findings corroborate the earlier benchmark regression results, suggesting that the positive influence of new infrastructure on regional entrepreneurial endeavors remains intact even after the adjustment for data outliers.

4.3.4. Instrumental Variable Regression

The preceding regression analyses potentially grapple with endogeneity issues, where unobservable factors—such as institutional and cultural dimensions that elude quantification—may influence regional entrepreneurship. Such factors could lead to omitted variable bias and inaccurately estimated coefficients. Furthermore, regions with an underdeveloped entrepreneurial climate may not attract the requisite talent in the technology and information sectors, which could impede the advancement of new infrastructure.

To mitigate these concerns, this study employs the one-period lag of the core independent variable as an instrumental variable (IV). This technique is commonly utilized to reduce the endogeneity bias stemming from omitted variables and the problem of reverse causality. New infrastructure construction exhibits inherent dynamic continuity, with the development of information infrastructure in the preceding period establishing a foundation for subsequent construction. Moreover, prior investment in infrastructure potentially influences the current level of regional entrepreneurship by shaping the ongoing development of new infrastructure.

This study applies the two-stage least squares (2SLS) method for re-estimating the model, using the lagged new infrastructure (NI) as the IV. The 2SLS regression results, displayed in Table 5, reveal that the IV's estimated coefficient in the first-stage regression (column 1) is 4310.21, significant at the 1% level, confirming the foundational role of early-stage infrastructure development. In the second-stage regression (column 5), the estimated coefficient for new infrastructure (NI) stands at 8654.54, also significant at the 1% level, which suggests that the entrepreneurial uplift from information infrastructure remains robust.

Additionally, the IV diagnostics indicate no presence of identification issues or weak instrument variables. The Durbin–Wu–Hausman statistic is 35.43 with a *p*-value of 0.000, leading to a rejection of the null hypothesis that all independent variables are exogenous, thereby confirming the endogeneity at the 1% level. The Anderson canon Corr. LM statistic is 132.21 with a *p*-value of 0.0000, rejecting the non-identifiability hypothesis. Furthermore, the Cragg–Donald Wald F statistic is 106.10, exceeding the threshold of 10, suggesting strong instrument relevance.

These findings affirm that, even after addressing potential endogeneity, new infrastructure significantly fosters regional entrepreneurship. The instrumental variable regression outcomes align with the prior results, enhancing the credibility of the chosen IV and substantiating the study's hypothesis.

## 5. Mechanism Test

While preceding chapters have established that new infrastructure fosters regional entrepreneurship, they have only illuminated the overarching effect. The intricate mechanisms underpinning this relationship remain enigmatic—these represent the proverbial "black box" that requires further elucidation. Consequently, this study delves deeper into the operational dynamics of new infrastructure, examining its role in diminishing costs and augmenting efficiency, its magnetic pull on entrepreneurial talent, and its capacity to ease the financial constraints faced by entrepreneurs.

This exploration is pivotal to disentangling the nuanced ways in which new infrastructure catalyzes entrepreneurial activity. By dissecting the cost-efficiency nexus, talent attraction capability, and financial liberation afforded by new infrastructure, this research aims to provide a granular understanding of the multifaceted ways it underpins and propels the entrepreneurial ecosystem.

*5.1. Human Capital Agglomeration Effect*

The advent of new infrastructure not only paves the way for advanced facilities but also acts as a magnet for professional talent in related industries. The completion of such projects often persuades these specialists to either initiate their own ventures or join nascent companies within the locality. This phenomenon catalyzes a virtuous cycle, whereby the

establishment and growth of these companies further attract and retain high-caliber talent, thus fostering a concentration of human capital.

Moreover, the elevation in the level of new infrastructure endows entrepreneurs with an array of resources and optimal conditions for business creation, subtly enhancing the prospects of entrepreneurial success. This, in turn, inclines entrepreneurs to favor regions with superior new infrastructure for their entrepreneurial pursuits, ceteris paribus.

To empirically assess the agglomeration effect of human capital attributed to new infrastructure development and its consequent impact on regional entrepreneurship, this study employs the proportion of the population with undergraduate and higher education (undergra) and the increment in the urban high-skilled talent pool (highski) as proxy variables for human capital.

As indicated in the first column of Table 6, the impact of new infrastructure (NI) on human capital agglomeration is marked by a regression coefficient of 429.43, which is significant at the 1% level. The second column of Table 6 elucidates the influence of new infrastructure on urban population growth, with a regression coefficient of 802.14, which is also significant at the 1% level. These findings affirm a positive association between new infrastructure and human capital agglomeration, corroborating the hypothesis that new infrastructure investment is a substantial driver of regional entrepreneurship enhancement.

**Table 6.** Mechanism test.

| Variables | undergra (1) | highski (2) | IF (3) | LADF (4) |
|---|---|---|---|---|
| NI | 429.43 *** | 802.14 *** | 377.21 *** | 556.45 *** |
|  | (104.42) | (155.63) | (57.21) | (27.98) |
| Controls | Y | Y | Y | Y |
| Year FE | Y | Y | Y | Y |
| City FE | Y | Y | Y | Y |
| Cons | 557.41 *** | 619.09 *** | 989.87 *** | 877.38 *** |
|  | (46.51) | (23.68) | (331.54) | (207.32) |
| Observations | 1086 | 1086 | 1086 | 1086 |
| Adjusted R-squared | 0.45 | 0.60 | 0.66 | 0.71 |

When Controls is marked as YES, this indicates that the control variables are controlled. The *t*-statistics based on the standard errors clustered at the city level are reported beneath each coefficient estimate. The significance levels are indicated by *** for 1%, respectively.

*5.2. Alleviating Financial Constraints*

Access to capital is instrumental for entrepreneurs, particularly in the nascent stages of business development, as it provides necessary material and a financial foundation. The availability and ease of obtaining funds critically influence entrepreneurial decisions to embark on new ventures. A salient feature of new infrastructure is the establishment of a digital financial system, predicated on the underpinnings of information infrastructure like the Internet and big data. This system offers a rapid-review, readily accessible funding source for capital seekers, serving as a vital adjunct to traditional financial services.

The integration of the Internet and big data has addressed the issue of information asymmetry in lending, broadened the scope of financial services, and curtailed communication and coordination costs within service provision. New infrastructure initiatives have thus extended the reach and depth of financial services, mitigated financial credit constraints for entrepreneurs, fostered equitable entrepreneurial opportunities, and, by extension, spurred entrepreneurial activities.

To evaluate the impact of new infrastructure on easing entrepreneurial financing constraints, this study employs the regional ratio of inclusive finance to GDP (IF) and the per capita amount of digital finance loans (LADF) as representative variables. The regression analysis in the third column of Table 6 examines the relationship between new infrastructure and the regional inclusive finance ratio, with the new infrastructure (NI) regression coefficient registering at 377.21, which is significant at the 1% level. The fourth

column's analysis probes the influence of new infrastructure on the per capita digital finance loan amount, yielding a regression coefficient of 556.45, which is also significant at the 1% level.

The analyses consistently demonstrate a positive association between new infrastructure and the mitigation of financing constraints. This evidence corroborates the thesis that new infrastructure contributes to enhancing the level of regional entrepreneurship.

## 6. Conclusions and Discussion

This article takes 267 prefecture level cities in China from 2011 to 2017 as research samples and examines the impact of new infrastructure on the regional entrepreneurship level, a sustainable economic development policy goal, by constructing a fixed-effects model. The principal findings are manifold: The establishment of new infrastructure has been found to significantly elevate the level of regional entrepreneurship. This central tenet has withstood a battery of robustness checks, including the reconstruction of the dependent variable, the incorporation of lagged variables, the exclusion of outliers, and the consideration of endogeneity through instrumental variable techniques. This study elucidates that new infrastructure facilitates regional entrepreneurial growth via critical pathways—namely, the agglomeration of human capital and the reduction in financial constraints for entrepreneurs. These conduits highlight the multifaceted role of new infrastructure in fostering an environment that is conducive to entrepreneurial ventures. The stimulative effect of new infrastructure on entrepreneurship exhibits notable heterogeneity. In central cities and the central and western regions of China, where administrative levels are higher, the entrepreneurial impetus provided by new infrastructure is markedly stronger. Conversely, in peripheral cities and the eastern regions, which have lower administrative levels, the effect is relatively subdued. In summary, the research underscores the pivotal role of new infrastructure in shaping the entrepreneurial landscape of China. The findings have significant implications for policymakers and stakeholders, advocating for tailored infrastructure development strategies that consider regional disparities to maximize entrepreneurial outcomes. Consistent with the findings of Audretsch et al. (2015), McCoy et al. (2018), and Zhang and Bai (2023) [4,5,11], it was found that infrastructure construction, especially the development of information infrastructure, has a positive impact on entrepreneurial activities. The difference is that this article focuses on the impact of new infrastructure nationwide on the level of entrepreneurship in various regions rather than being limited to a specific region or type of infrastructure. In addition, the difference of this article lies in its more comprehensive research perspective, which not only examines the direct impact, but also deeply analyzes the heterogeneity of the impact mechanism and conditions, providing more detailed theoretical and practical guidance. This article explores heterogeneity, especially the more significant impact on entrepreneurship in central cities and central and western regions, providing valuable insights for regional differentiation strategies in new infrastructure investment. The unique feature of this article compared to previous similar studies is that it explains how new infrastructure promotes regional entrepreneurship through various mechanisms, such as human capital agglomeration and alleviating financing constraints, which has rarely been explored in depth in previous studies. In addition, the innovative and rigorous methodology of using bidirectional fixed-effects models and instrumental variable methods has improved the credibility and scientificity of the research conclusions.

The above research results have important guiding significance for policymaking. Due to the important role of new infrastructure construction in promoting regional entrepreneurship and sustainable economic development, in order to further stimulate regional entrepreneurial vitality, policymakers should consider the following points: they should continue to increase investment in new infrastructure, such as information networks and digital finance, especially in the central and western regions and remote areas, to narrow regional development gaps and create more entrepreneurial opportunities; combined with the construction of new infrastructure, they should implement more attractive talent policies, promote the agglomeration of human capital, and provide sufficient talent support for regional entrepreneurship.

At the same time, this article also has certain limitations. For example, in terms of the scope of data use, the dataset used in this study is from 2011 to 2017, which may not fully capture the latest dynamics of new infrastructure construction and its long-term effects. In terms of variable measurement, although this article attempts to comprehensively measure the level of new infrastructure and regional entrepreneurship, there may still be measurement errors or an insufficient reflection of all relevant factors, especially in the subdivision areas of entrepreneurial quality and new infrastructure. Regarding the issue of endogeneity, although this article adopts methods such as instrumental variables to alleviate potential endogeneity issues, it cannot completely exclude the interference of all unobserved factors, especially other policy changes or socio-economic factors related to the regional entrepreneurial environment.

Regarding future research, scholars can further refine heterogeneity analysis and explore the moderating effects of factors such as different levels of economic development, industrial structure, and population density on this impact. In addition, other potential mechanisms can be explored in depth, such as the impact of new infrastructure on corporate innovation capabilities and how to further stimulate regional entrepreneurial activities by promoting information flow and market expansion. Further exploration can be conducted on how different types of policy support (such as tax incentives, entrepreneurship subsidies, technology services, etc.) interact with the construction of new infrastructure to jointly promote regional entrepreneurial development. Finally, China's situation can be compared with other countries or regions to explore the impact of new infrastructure construction on regional entrepreneurship in different countries as well as the differences and applicability under different institutional backgrounds.

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