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The Road to Entrepreneurship: The Effect of China's Broadband Infrastructure Construction[1]

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The Road to Entrepreneurship: The Effect of China's Broadband Infrastructure Construction

Abstract: Reasonable assessments of the impact of information infrastructure construction on entrepreneurship will support the development of the digital economy in China. Using nationwide data from 2005 to 2017, this paper analyzes the causal effect of the "Broadband China" pilot policy on entrepreneurship based on a difference-in-differences approach. We find that information infrastructure construction significantly enhances entrepreneurship, which is robust under different settings. A mechanism exploration suggests that constructing information infrastructure benefits information acquisition, knowledge spillovers, and risk-taking behavior, which illustrate the internal mechanism of promoting entrepreneurship. Taken together, this paper supports the positive role of the digital economy in the promotion of entrepreneurship in addition to providing new insights into the construction of information infrastructure to support entrepreneurship.

Key words: information infrastructure, entrepreneurship, information acquisition, knowledge spillover, risk taking

JEL codes: G38; O18; O38

1. Introduction

Accelerating digital development, building a "Digital China," and creating a beneficial digital ecosystem have become the focus of government attention in China. Considering the sudden impact of the COVID-19 pandemic, the digital economy provides a constant impetus for lasting growth in China. National Bureau of Statistics (2020) data show that gross domestic product (GDP) fell by 6.8% year-on-year in the first quarter of 2020. However, elements of the digital economy actually grew by 13.2% in the same period.[2] There is an old Chinese saying: "if you want to get rich, build roads first." The construction of new digital infrastructure undoubtedly builds roads to the digital economy; however, an important question is whether and how the development of information infrastructure affects entrepreneurship.

In investigating the factors that affect entrepreneurship, many researchers have widely studied the topic, especially the impact of infrastructure (Audretsch et al., 2015), which is composed of multiple aspects, including entrepreneurship. Some components of infrastructure, such as roads, energy, and health-care systems, are necessary for most economic activities, while others are particularly important for entrepreneurship (Venkataraman, 2004). Although Ma et al. (2021) note the importance of transportation infrastructure to entrepreneurship, few studies focus on information infrastructure and entrepreneurship. Hence, this paper's focus on information infrastructure and entrepreneurship makes a marginal contribution to the literature.

Entrepreneurship is becoming increasingly important for the rapid development of China. In the context of the development of China's digital economy, this paper focuses on three major issues. First, does the construction of information infrastructure affect entrepreneurship? Second, how can endogenous problems be solved to obtain causal effects? Third, what is the mechanism of the influence of information infrastructure construction on entrepreneurship?

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[2] National Bureau of Statistics. (2020). Preliminary accounting results of gross domestic product (GDP) in the first quarter of 2020. Retrieved from http://www.stats.gov.cn/tjsj/zxfb/202004/t20200417_1739602.html.

These are important questions with both theoretical and practical significance. Therefore, how to effectively assess the impacts and mechanisms of information infrastructure on entrepreneurship has become a theoretical issue with guiding significance for the future development of the global digital economy.

While the links between information infrastructure construction and entrepreneurship have added new insights, endogeneity concerns and data availability problems remain. Interestingly, we find a good quasi-natural experiment in China's promotion of information infrastructure construction. First, China attaches significant importance to digital economy development following many important discussions on building a Digital China. Accordingly, China has pursued national development strategies, such as developing a digital economy and network informatization construction. Specifically, the landmark event in information infrastructure, the "Broadband China" pilot policy, leads to natural advantages to causal identification.[3] Therefore, the Broadband China pilot policy provides support for the present study, which has strong theoretical significance and policy value.

Second, studies struggle to measure entrepreneurship and the academic community has still not reached a consensus on its measurement. We must identify an appropriate method for measuring entrepreneurship at the city level. The Global Entrepreneurship Monitor's job market method for measuring entrepreneurial activity has some advantages because it measures new private enterprises as a percentage of the regional workforce or the total number of enterprises. However, few studies use this method due to data availability constraints. Fortunately, the State Administration for Industry and Commerce (SAIC) of the People's Republic of China recently released data on all newly formed companies. The newly available data give this issue an edge. Specifically, company registry data are far superior to survey-

[3] The Ministry of Industry and Information Technology and the National Development and Reform Commission selected a total of 120 cities (clusters) as Broadband China demonstration cities in three batches in 2014, 2015, and 2016. These clusters provide good data for research on information infrastructure construction.

based data. Compared with survey-based databases, company registry data are more comprehensive and relatively unexplored. In addition, these data best represent entrepreneurship activities in China (Kong and Qin, 2021; Tian and Xu, 2021).

To verify this causal effect, we empirically explore how information infrastructure affects entrepreneurship. Using the Broadband China pilot as a quasi-natural experiment, we investigate this causal effect using a difference-in-differences (DID) estimation. We crawl the enterprise registration information in the Enterprise Credit Information Publicity System to obtain the number of newly established private enterprises in China at the city level. We find that constructing information infrastructure promotes entrepreneurship, which subsequently supports the positive role of the digital economy. In economic terms, constructing information infrastructure increased the number of new start-ups by 1.04 per 1,000 people, which implies that entrepreneurship significantly increases by 54% (1.04/1.916) on average after the implementation of the Broadband China pilot policy. Information infrastructure construction is an important basis of the digital economy; therefore, its key role in entrepreneurship cannot be ignored.

In addition, we conduct several robustness tests to verify the above results. First, we use a dynamic DID method to test the parallel trend hypothesis. Second, we conduct a randomized placebo test to show that other confounding factors do not affect our results. Third, to ensure the accuracy of causal identification, we use the first round of Broadband China pilot cities in 2014 as the treatment group and cities from later rounds as the control group. These three tests help us to address endogeneity concerns and establish a causal effect between constructing information infrastructure and entrepreneurship.

The robustness checks include shortening the sample period to more clearly determine the causal effects. Specifically, we exclude the 2008 financial crisis and the government bailout programs in the following 2 years. In addition, we control the sample to 1 year before and after the policy. Second, we consider the influence of different urban political ranks on the baseline results; therefore, we exclude municipalities and vice-provincial capital cities from the sample. Third, although the regression considers the correlation of standard errors within cities, we can also correlate the unobserved entrepreneurship components within a province. Therefore, we use the heteroscedasticity of robust standard errors and clusters at the provincial level. We also control for the city- and province-year fixed effects (FEs). Following these considerations, the main results are still valid in all robustness tests.

We conduct two further empirical analyses to rule out other explanations. First, earlier studies have shown that connectivity, communication, and information exchange are critical for entrepreneurship. Transportation infrastructure reduces these barriers (Ma et al., 2021). Therefore, we also control for railway passenger volume (*Rails*) and road passenger volume (*Road*) in the baseline model. The results show that the construction of information infrastructure according to the Broadband China pilot policy still promotes entrepreneurship after considering the concerns arising from constructing transportation infrastructure. Second, minimum wages affect employment and entrepreneurship (Magruder, 2013; Kong et al., 2021). Therefore, we further control for the impact of the minimum monthly wage (*Mw1*) and minimum hourly wage (*Mw2*) in the baseline model, which also shows that the construction of information infrastructure following the Broadband China pilot policy still promotes entrepreneurship after considering minimum wage concerns.

Finally, we examine the mechanisms by which information infrastructure promotes entrepreneurship. First, the construction of information infrastructure has undoubtedly reduced the difficulty and increased the degree of information acquisition (i.e., an information acquisition mechanism). Second, the construction of information infrastructure promotes knowledge spillover among enterprises, which promotes entrepreneurship (i.e., a knowledge spillover mechanism). Third, the construction of information infrastructure improves enterprise risk-taking behavior, which promotes entrepreneurship (i.e., a risk-taking mechanism). These empirical findings show that constructing information infrastructure is conductive to information acquisition, technical knowledge spillovers, and risk-taking behavior, which provides some mechanical explanations of how it promotes entrepreneurship in a digital economy.

Relative to the existing literature, we make the following contributions. First, we supplement the relevant information infrastructure construction and entrepreneurship research. Studies focus on the influence of transportation infrastructure on economic links (Bernard et al., 2019; Wang and Wu, 2015), trade (Michaels, 2008; Duranton et al., 2014; Coşar and Demir, 2016; Donaldson, 2018), housing prices (Zheng and Kahn, 2013), knowledge spillovers and overflows, intercity passenger transport employment (Lin, 2017), and entrepreneurship (Ma et al., 2021). However, it is still unclear whether constructing information infrastructure affects entrepreneurship. This paper fills this knowledge gap.

Second, we use a unified framework to discuss the construction of information infrastructure to promote entrepreneurship by improving information acquisition, facilitating technical knowledge spillovers, and increasing risk-taking behavior. The framework clarifies the mechanisms and complements the literature on the important roles of information acquisition, technical knowledge spillovers, and risk-taking behavior in entrepreneurship (Hvide and Panos, 2014; Daoud et al., 2020; Kong and Qin, 2021).

Third, we investigate the possible underlying implications for our findings. We suggest that the Chinese government should further promote its Broadband China pilot policy, expand the scope of pilot cities, substantially upgrade the information infrastructure, expand network coverage, and accelerate informatization. Taken together, this paper provides evidence for the positive roles of the digital economy and the Broadband China pilot policy in entrepreneurship in China.

This paper is organized as follows. Section 2 introduces the institutional background and theoretically analyzes how constructing information infrastructure promotes entrepreneurship from three perspectives. Section 3 introduces the model and data. Section 4 evaluates the impact of constructing information infrastructure on entrepreneurship in addition to further robustness checks. Section 5 discusses the driving mechanisms, while Section 6 concludes.

2. Institutional background and theoretical analysis

2.1 Institutional background

In 1989, China began to build Internet backbone networks, and four major networks gradually formed (i.e., the China Public Computer Network, China Science and Technology Network, China Education and Research Computer Network, and China Golden Bridge Information Network). These backbone networks were previously independent of each other, and although users could easily search for and exchange information internally within each network, the connection between backbone networks was not smooth and the transmission between them was slow. To exchange information effectively and quickly between the backbone networks, public Internet switching centers, as physical nodes between networks, were established to effectively connect them. The construction of three public Internet exchange centers in Beijing, Shanghai, and Guangzhou has made the backbone networks more efficient, which has led to an explosion of information. In recent years, information technology has developed rapidly and the information infrastructure has achieved the initial goal.

However, China's broadband system still has some shortcomings, such as insufficient application services, lack of technological innovation ability, and an imperfect development environment, which restricts the further construction of information infrastructure. In 2014, 40 cities (clusters) were selected as Broadband China pilot cities to promote and realize national informatization. In 2015 and 2016, an additional 80 cities (clusters) were selected. The

Broadband China pilot policy is a quasi-natural experiment, which provides a good solution for endogeneity problems in economic models and valuable accumulated experience from testing the effects of the policy. Appendix Table A1 lists the Broadband China pilot cities.

Specifically, we exclude the new, adjusted, or missing data. The resulting statistical scope covers 237 prefecture-level cities. According to the list of pilot cities published on the websites of the Ministry of Industry and Information Technology and the National Development and Reform Commission, 120 prefecture-level cities (groups) are in the processing group, which comprises nearly half of the total sample.[4] We expect that the information infrastructure construction in the areas affected by the Broadband China pilot policy will be improved significantly and have a positive impact on local information acquisition, knowledge spillovers, and risk-taking behavior, which subsequently affect entrepreneurial decision-making behavior.

2.2 Related literature

This study is associated with other fields of literature. First, digital technology research studies are in their infancy. Most studies concentrate on Internet, digital economy, broadband, and related information infrastructure. Few studies focus on the empirical analysis of Internet development, such as how it affects innovation (Lee et al., 2019; Yang et al., 2022). As the digital economy develops in China, studies examine the measurement, international comparisons, and regional differences in the digital economy. This strand of literature is directly related to our paper, which studies the economic effect of broadband access. In particular, broadband access affects export intensity (Hagsten and Kotnik, 2017), technology spillovers (Chang, 2021), economic growth (Czernich et al., 2011), enterprise location decisions (Kim and Orazem, 2017), and enterprise productivity (Akerman et al., 2015; Chen et al., 2020).

[4] For further details, please refer to the websites of the Ministry of Industry and Information Technology and the National Development and Reform Commission.

Second, our paper is also related to the determinants of entrepreneurship. A large literature discusses the factors of farmers' and families' entrepreneurship from micro perspectives. Here, we focus on studies that argue for the impact of different entrepreneur factors on entrepreneurship, such as gender (Brooks et al., 2014), religion (Zhao and Lounsbury, 2016), and social capital (Martin et al., 2013). Formal institutions are also an integral factor conducive to entrepreneurial activity (Bylund and McCaffrey, 2017; Churchill, 2017).

Studies of the factors involved in macro entrepreneurship are directly related to our paper, such as foreign direct investment (Herrera et al., 2014), digital technology (Nambisan, 2017), anticorruption campaigns (Kong and Qin, 2021), minimum wage standards (Kong et al., 2021), high-tech industrial park policies (Tian and Xu, 2022), and talent (Bai et al., 2021).

These studies mainly discuss the impact of political, economic, cultural, and social factors on macro or micro entrepreneurship.

2.3 Theoretical framework

2.3.1 Information acquisition mechanism

Information technology increases the breadth and speed of information dissemination, which is conducive to capturing business opportunities (Shane, 2000) and acquiring resources (Xiao et al., 2010), which are two major problems in the entrepreneurship process. The construction of information infrastructure eases information access, which increases business opportunities and resources. Therefore, these two factors are prerequisites, rather than a spur, for entrepreneurship. From a family entrepreneurship perspective, empirical research studies find that the Internet has a positive impact on entrepreneurs through information acquisition, which promotes their entrepreneurial activities. The empirical evidence shows that information access promotes entrepreneurship. Therefore, the construction of information infrastructure is conducive to information access and promotes entrepreneurship. This paper anticipates that the construction of information infrastructure will facilitate entrepreneurs' activities through the information acquisition mechanism. Hence, we propose the following hypothesis:

Hypothesis 1: Information infrastructure construction promotes entrepreneurship through information acquisition mechanism.

2.3.2 Knowledge spillover mechanism

We believe that there is a knowledge spillover mechanism in play during the construction of information infrastructure, which affects entrepreneurship. We summarize the knowledge spillover effect, following the discussions by Arrow (1962) and Romer (1986), as the spillover of knowledge into organizations when they exchange information with other organizations. Almeida and Kogut (1999) point out that great geographical distances inhibit the free flow of knowledge and obstruct knowledge spillovers. The market segmentation phenomenon in China also makes knowledge spillovers more difficult. However, following the improvement of infrastructure construction in recent years, Wang et al. (2018) note that transportation infrastructure overrides the domestic market segmentation, which produces a knowledge spillover effect. This phenomenon becomes more obvious after the introduction of high-speed rail in China. Therefore, constructing information infrastructure may more effectively promote knowledge spillover, including spillover of enterprises' technical knowledge. Knowledge spillovers have a simultaneous effect on entrepreneurship. In their logical analysis, for example, Kong and Qin (2021) find that knowledge spillovers promote regional entrepreneurship because information infrastructure construction benefits knowledge spillovers and promotes entrepreneurship. Hence, this paper anticipates that information infrastructure construction will support entrepreneurial activities through the knowledge spillover mechanism. Thus, we propose hypothesis 2:

Hypothesis 2: Information infrastructure construction promotes entrepreneurship through a knowledge spillover mechanism.

2.3.3 Risk-taking mechanism

We analyze the risk-taking mechanism by which the construction of information infrastructure affects entrepreneurship. Whether the mechanism is information acquisition or knowledge spillovers, they both increase business opportunities and resource acquisition. If there is no risk-taking mechanism, however, entrepreneurship will not be stimulated because it is a risky behavior and the risk will be weighed against potential benefits. We illustrate another possibility by adding a risk-taking mechanism. When the digital economy grows at the micro enterprise level, the level of enterprise risk-taking behavior increases. Tian and Wang (2014) find that tolerance of failure is an important condition for promoting innovation because innovative activities are highly uncertain and have a probability of failure. Similarly, Kerr et al. (2014) show that the probability of entrepreneurial success is very low and unknowable before investment. Both Hvide and Panos (2014) and Daoud et al. (2020) find that tolerance of failure is an important condition for promoting entrepreneurship. Therefore, we anticipate that constructing information infrastructure increases enterprise risk-taking behavior, which promotes entrepreneurship. Hence, we propose hypothesis 3:

Hypothesis 3: Information infrastructure construction promotes entrepreneurship through a risk-taking mechanism.

Combining these three hypotheses, it is natural to consider that constructing information infrastructure promotes entrepreneurship. In the follow-up empirical study, we first examine the overall impact of information infrastructure construction on entrepreneurship and then examine the underlying mechanisms by which constructing information infrastructure promotes entrepreneurship (i.e., *H1*, *H2*, and *H3*).

3. Research design

3.1 Model

To establish causality, we regard the Broadband China pilot policy (hereinafter referred to as *Broadband*) as a quasi-experiment to estimate its impact on entrepreneurship by employing a staggered DID approach. The model is as follows:

$$Entrepreneurship_{it} = \alpha_0 + \alpha_1 Broadband_{it} + \gamma Controls_{it} + u_i + \theta_t + \varepsilon_{it}. \quad (1)$$

where $Entrepreneurship_{it}$ indicates the entrepreneurship status in city i at year *t*. $Broadband_{it}$ is a dummy variable that shows whether city i is connected by *Broadband* in year, which is equal to 1 if a city is selected as a policy pilot area, and 0 otherwise. $Controls_{it}$ is the control variables, which are defined in section 3.2.3. In addition, u_i and θ_t denote city and year FEs, respectively, while ε_{it} is the error term.

Considering *Broadband* at the city level, all regressions report city-level clustering robustness standard errors in the absence of specific instructions. The coefficient of interest is an estimation of the causal effects of construction of information infrastructure represented by *Broadband* on entrepreneurship. We expect α_1 to be positive if *Broadband* positively affects entrepreneurship activities by firms in a city.

3.2 Variables

3.2.1 Entrepreneurship

The academic community has still not achieved consensus on the measurement of entrepreneurship at the city level. It is difficult to accurately measure the differences in the level of entrepreneurship between cities (Kong and Qin, 2021; Tian and Xu, 2022). Therefore, we must identify a more appropriate method for measuring entrepreneurship at the city level. The Global Entrepreneurship Monitor uses the job market to measure entrepreneurial activity by measuring the number of new private enterprises as a proportion of the regional workforce or the total number of enterprises. This method has some advantages; however, few studies use the method because of data availability constraints.

Accordingly, we measure the entrepreneurial activities in a city by the number of new firms established in the city. Following Kong and Qin (2021) and Tian and Xu (2022), we aggregate this variable up to the city level and calculate the total number of new firm registrations in the city to capture its entrepreneurial activities. We use the job market to measure entrepreneurship in cities by comparing the total number of new firms with the workforce aged 14–65 years old (in thousands).

3.2.2 Broadband China pilot policy

The pilot cities were approved in different periods; therefore, we assign the value of the treatment group cities to 0 before the pilot and 1 in the year after the pilot to maintain our dynamic adjustment of the treatment group. If a city did not become a pilot city within this time span, the value is always 0. Taken together, the Broadband China pilot selected a total of 120 cities (clusters) in three batches in 2014, 2015, and 2016.

3.2.3 Other variables

Following Kong and Qin (2021), we control for the following economic variables: *LnGDP*, the natural logarithm of 1 plus the prefecture's GDP (in 100 millions); *GDP2%*, the percentage of GDP from secondary industries; *GDP3%*, the percentage of GDP from tertiary industries; *CPI*, for which we adopt provincial CPI due to the lack of prefecture-level city data; *LnPopulation*, the natural logarithm of 1 plus the prefecture's population (in 10,000s) at the end of the year; *Fiasset*, the percentage of GDP from fixed-asset investments; *Employ*, the natural logarithm of 1 plus the number of employees; and *Fiscal*, the ratio of budgetary revenue to budgetary expenditure. Table 1 lists the detailed descriptions for each variable.

[Insert Table 1 here]

3.3 Data sources and summary statistics

For this study, we select the data for Chinese prefecture-level cities from 2005 to 2017. Except for the core explanatory variables and explained variables, the other data we use in this paper are all from the China Stock Market & Accounting Research (CSMAR) and China Research Data Services Platform (CNRDS) databases. We winsorize continuous variables at the 1^{st} and 99^{th} percentiles. This results in a final dataset of 2,424 observations. Table 2 shows the results for the descriptive statistics, where the mean value of *Entrepreneurship* is 1.196, which indicates that on average every 1,000 people will create 1.196 new enterprises, which is consistent with the value obtained by Kong and Qin (2021).

[Insert Table 2 here]

4. Empirical results

4.1 Baseline results

Table 3 shows the results for Equation (1). Columns (1) and (2) show the results for univariate and added control variables, respectively. The coefficients reflect the effect of *Broadband* on entrepreneurship, which is significantly positive in Columns (1) and (2). The results show that *Broadband* significantly promotes entrepreneurship, which is consistent with our expectations. In the treatment group, the effect of the coefficient of *Broadband* on entrepreneurship is 1.040, which is statistically significant. In economic terms, constructing information infrastructure increases the number of new start-ups by 1.04 per 1,000 people, which implies that entrepreneurship significantly increases by 54% (1.04/1.916) on average after *Broadband* becomes effective.

Recall the old Chinese saying mentioned earlier: “if you want to get rich, build roads first.” The road to the digital economy is the construction of new digital infrastructure. With top-level scientific designs and effective deployment, China’s digital economy is a global leader in terms of development scale and quality. The obvious policy implication is that the construction of information infrastructure should be increased urgently. Therefore, China should increase the scale of pilot cities to further reap the dividends of entrepreneurial activities from constructing information infrastructure.

[Insert Table 3 here]

4.2 Robustness checks

4.2.1 Parallel trend test

We test the parallel trend hypothesis by examining the dynamic effect between *Broadband* and *Entrepreneurship*. Due to the inconsistent selection times of the treatment groups, we set the following dynamic DID model according to Beck et al. (2010):

$$Entrepreneurship_{it} = \beta + \beta_1 Before_{it}^{-5} + \beta_2 Before_{it}^{-4} + \beta_3 Before_{it}^{-3} + \beta_4 Before_{it}^{-2} + \beta_5 Before_{it}^{-1} + \beta_6 Current_{it}^{0} + \beta_7 After_{it}^{1} + \beta_8 After_{it}^{2+} + \gamma Controls_{it} + u_i + \theta_t + \varepsilon_{it}. \quad (2)$$

where $Before_{j,t}^{k+}$ (k = 1, 2, 3, 4, 5) is a dummy variable equal to 1 if the year is *k* years before the pilot year of Broadband China for the enterprises in the treatment group, and 0 otherwise. $Current_{it}^{0}$ and $After_{j,t}^{k+}$ (k=1，2+) are also dummy variables. The value is equal to 1 if the year is during/after the pilot years of Broadband China for the enterprises in the treatment group, and 0 otherwise. The remaining terms are defined as in Equation (1).

If the coefficients of β_1, β_2, β_3, β_4, and β_5 are not significant, the parallel trend hypothesis is satisfied. Table 4 reports the results for the parallel trend test. The coefficients of β_1, β_2, β_3, β_4, and β_5 are not significant. We find that the coefficients in the current period and thereafter are significantly positive at the 1% level with no significant difference between the treatment and control groups before policy implementation. The effect after the pilot year is significantly positive, which indicates that the baseline results meet the parallel trend hypothesis. Figure 1 shows the regression coefficients, with no significant difference between the affected and unaffected enterprises before the implementation of the Broadband China pilot policy. Therefore, we confirm the parallel trend assumption.

[Insert Table 4 here]

[Insert Figure 1 here]

4.2.2 Placebo test

To check whether our results show significant differences between the treatment and control groups in the impact of entrepreneurship, we conduct a placebo test. Specifically, we let the impact of *Broadband* on entrepreneurship become random and generate *Broadband_new*. This process is performed 1,000 times. After randomization, the effect of *Broadband_new* on improving entrepreneurship is no longer significant. Figure 2 shows that the *t* value of *Broadband_new* is distributed around 0, which is far less than the true value of 4.245 (1.040/0.245) estimated by the benchmark regression, which shows that it passes the placebo test. This result shows that our finding that entrepreneurship is promoted in the treatment group following *Broadband* is credible.

[Insert Figure 2 here]

4.2.3 Identifying assumption test

Inspired by the 2014 Broadband China pilot policy, other cities were expected to continue to pilot the Broadband China policy in 2015 and 2016. However, we find no evidence that the selected cities were published in advance before 2014, which indicates that the policy is largely exogenous and unpredictable for the selected cities in 2014. To ensure the accuracy of causal identification, we consider the first round of Broadband China pilot cities in 2014 as the treatment group and the other cities as the control group. Table 5 reports the relevant estimation results. Whether the control variables are or are not added, the coefficients are significantly positive at the 1% level, which indicates that our results pass the identifying assumption test.

[Insert Table 5 here]

4.3 Additional concerns

4.3.1 Shortened sample period

Following the 2008 financial crisis, China quickly launched a rescue plan. Both the financial crisis and rescue plan may affect entrepreneurial behavior. Considering the 2008 financial crisis, we therefore use a 2009–2017 sample regression to further exclude the potential impact of the 2010 government rescue plan. We also use a 2013–2017 sample regression, which is consistent with the DID results and excludes the impact of other types of potential policies to a certain extent. Table 6 shows the results of our estimates. After considering the potential impact of the financial crisis and government rescue programs in addition to shortening the sample period, *Broadband* still significantly promoted entrepreneurship and the relevant conclusions are robust.

[Insert Table 6 here]

4.3.2 Different city levels

Chinese cities at different administrative levels receive different levels of preferential policy treatment. Municipalities that are directly managed by the central government and vice-provincial capital cities receive more resources or policy support than ordinary prefecture-level cities, which may also affect entrepreneurship in these cities. Therefore, we remove these cities from the samples and conduct a robustness test. Table 7 presents all the regression results. After considering different city levels, *Broadband* still significantly promotes entrepreneurship and the relevant conclusions are robust.

[Insert Table 7 here]

4.3.3 Clustering robust standard errors and adjusting fixed effects

Although we consider the correlation of standard errors within cities in the regression, the unobserved entrepreneurship components within a province may also be correlated, which necessitates a high level of clustering. Therefore, we use the heteroskedasticity-robust standard error for provincial-level clustering. Column (1) of Table 8 reports the regression results.

In Columns (2) and (3), we add city- and province-year FEs (Province * Year FE) to strictly control for the various factors that may affect entrepreneurship. In each column, the results show that the coefficient of *Broadband* is significantly positive at the 1% confidence level, which indicates that *Broadband* is conducive to entrepreneurship and the relevant conclusions are robust.

[Insert Table 8 here]

4.3.4 Considering the impact of transportation infrastructure

Transportation infrastructure significantly reduces barriers to connectivity, communication, and information exchange, which are all critical for entrepreneurship. Considering the construction of high-speed railway as an exogenous change of transportation infrastructure, for example, Ma et al. (2021) find that entrepreneurship increased by about 3.5 percentage points after a high-speed rail service opened. We control for the impact of the development of urban roads and railways, specifically, railway passenger volume (*Rails*) and road passenger volume (*Road*). Table 9 shows the relevant results. In each column, the coefficient of *Broadband* is significantly positive; therefore, *Broadband* significantly promotes entrepreneurship and the relevant conclusions are robust.

[Insert Table 9 here]

4.3.5 Considering the impact of minimum wage

Minimum wages affect employment and entrepreneurship. For example, Magruder (2013) shows that due to a rise in minimum wage standards, formal employment increased and self-employment decreased. Using Chinese samples, Kong et al. (2021) investigates the impact of minimum wage policy on entrepreneurship and finds that minimum wage policies significantly inhibit entrepreneurship. Therefore, we further control for the impact of *Mw1* and *Mw2* at the city level. Table 10 reports all the regression results. In each column, the coefficient of *Broadband* is significantly positive (1.026 with standard error = 0.253; 1.001 with standard error = 0.246; 1.001 with standard error = 0.247). These results show that *Broadband* favors entrepreneurship and the relevant conclusions are robust.

[Insert Table 10 here]

5. Mechanism analyses

5.1 Information acquisition mechanism

The construction of information infrastructure represented by *Broadband* has undoubtedly reduced the difficulty and increased the degree of information acquisition. *Broadband* policies effectively compensate for the inherent instability of entrepreneurship, which promotes entrepreneurship. Information acquisition has a positive impact on entrepreneurs and promotes entrepreneurship; therefore, we expect that *Broadband* will stimulate entrepreneurial activity through the information acquisition mechanism.

We construct the following model:

$$Siv_{it} = \alpha_0 + \alpha_1 Broadband_{it} + \gamma Controls_{it} + u_i + \theta_t + \varepsilon_{it}. \quad (3)$$

where Siv_{it} is the information acquisition variable in Model (3). The data are derived from the CNRDS network search index database to represent the degree of information acquisition. In general, the higher the network search index, the more information acquired. All remaining variables are defined to follow Model (1).

Table 11 reports the impact of *Broadband* on information acquisition. In Columns (1) and (2), the coefficients of *Broadband* are significantly positive. Therefore, *Broadband* is conducive to information acquisition and increases Internet searches, which is evidence that constructing information infrastructure promotes entrepreneurship by effectively increasing entrepreneurs' access to information. Information acquisition and network searches are very important for market participants, especially entrepreneurs. Only with sufficient understanding of market information can we increase entrepreneurial opportunities and probability. Taken together, the results reflect the importance of the information acquisition mechanism in promoting entrepreneurship.

[Insert Table 11 here]

5.2 Technological knowledge spillover mechanism

At the micro enterprise level, good network infrastructure can not only promote technical knowledge spillovers from listed companies to their internal subsidiaries but also promote their technical cooperation with other external companies. This is reflected in *Broadband* promoting the innovation level of local listed companies' subsidiaries and the significant increase in joint innovation between local listed companies and other companies, respectively. Kong and Qin (2021) also believe that regional innovation is conducive to promoting entrepreneurship; therefore, we expect that the construction of information infrastructure promotes knowledge spillovers among enterprises, which likewise promotes entrepreneurship. We construct the following model for this technical knowledge spillover mechanism:

$$Innovation_{it} = \alpha_0 + \alpha_1 Broadband_{it} + \gamma Controls_{it} + u_i + \theta_t + \varepsilon_{it}. \qquad (4)$$

where $Innovation_{it}$ is the variable for enterprise technical knowledge spillovers.

Griliches et al. (1988) argue that the patent application year could better capture the actual time of innovation. Therefore, we also use the patent application year instead of the grant year to define enterprise technical knowledge spillover. Specifically, we use the patent applications from listed companies' subsidiaries (*Patz*) and the joint patent applications from listed companies and other external companies (*Patj*) to measure enterprise technical knowledge spillover. We further divide them into the number of invention patent applications (*Innz* and *Innj*) and the number of noninvention patent applications (*Othz* and *Othj*). All other variables are defined following Model (1).

Table 12 reports the impact of *Broadband* on enterprise technical knowledge spillover. The coefficient of *Broadband* is significantly positive in all columns; therefore, *Broadband* promotes enterprise technical knowledge spillover. Following *Broadband*, communications between the parent company and subsidiaries are more complete. In addition, the parent company has more comprehensive and sufficient information, and the direction of knowledge spillovers is generally from the parent to subsidiary companies. Hence, *Broadband* promotes subsidiary technology innovation. Outside the parent company, technological innovation depends on companies' understanding, absorption, and integration of new external knowledge (Caniëls, 2001). When companies acquire more external knowledge, their cooperation and innovation with external organizations will also increase (Cassiman and Veugelers, 2002). Therefore, *Broadband* promotes joint technological innovations with other external companies and technical knowledge spillovers, which undoubtedly increases entrepreneurship.

[Insert Table 12 here]

5.3 Risk-taking mechanism

Finally, at the micro enterprise level, Tian et al. (2022) find that the level of enterprise risk-taking behavior increases following the development of the digital economy. Tian and Wang (2014) also demonstrate that a tolerant attitude toward failure is an important condition for promoting innovation, due to the high uncertainty and probability of failure in innovation activities. The probability of entrepreneurial success is also very low and unknowable before investment (Kerr et al., 2014). Therefore, a tolerant attitude toward failure is an important condition for promoting entrepreneurship (Hvide and Panos, 2014; Daoud et al., 2020). Hence, we expect that constructing information infrastructure improves enterprise risk-taking behavior, which promotes entrepreneurship. We build the following model for this risk-taking mechanism:

$$Risk_{it} = \alpha_0 + \alpha_1 Broadband_{it} + \gamma Controls_{it} + u_i + \theta_t + \varepsilon_{it}. \quad (5)$$

where $Risk_{it}$ is enterprise risk-bearing. Following Boubakri et al. (2013), we use the earnings volatility index to measure and construct two indicators: the volatility of the return on total assets adjusted by the industry average (*Risk1*), and the range of the return on total assets adjusted by the industry average (*Risk2*). The definitions for all other variables are consistent with Model (1). The specific calculation formulas for $Risk_{it}$ are as follows:

$$Adj\_Roa_{it} = \frac{EBIT_{it}}{ASSET_{it}} - \frac{1}{X} \sum_{k=1}^{X} \frac{EBIT_{it}}{ASSET_{it}}. \tag{6}$$

$$Risk1_{it} = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T} \left(Adj\_Roa_{it} - \frac{1}{T}\sum_{t=1}^{T} Adj\_Roa_{it}\right)^2} \,|T = 3. \tag{7}$$

$$Risk2_{it} = Max\left(Adj_{Roa_{it}}\right) - Min\left(Adj_{Roa_{it}}\right). \tag{8}$$

where $EBIT_{it}$ is the earnings before interest and tax, $ASSET_{it}$ is the total assets at the end of the year, and Adj_Roa_{it} refers to the rate of return on total assets adjusted by the industry average. We adopt the calculation method from Equations (7) and (8), and take every 3 years (*t* years to *t*+2 years) as an observation period to calculate the standard deviation and range of *Roa* adjusted by industry as proxy variables for enterprise risk-taking behavior.

Table 13 reports the impact of *Broadband* on enterprise risk-taking behavior. In all columns, the coefficient of *Broadband* is significantly positive, which indicates that *Broadband* increases enterprise risk-taking behavior. Taken together, the construction of information infrastructure represented by *Broadband* increases enterprise risk-taking behavior, which is undoubtedly conducive to entrepreneurship.

[Insert Table 13 here]

6. Conclusion

The digital economy has significantly affected China's economic development. From an entrepreneurial perspective, we analyze how the construction of information infrastructure is beneficial to long-term economic development. Exploiting the exogenous event in which cities were selected for the Broadband China pilot at different times, we use the DID approach to study the causal impact of constructing information infrastructure on entrepreneurship. We crawl the panel data for prefecture-level cities from 2005 to 2017 for enterprise registration information in the Enterprise Credit Information Publicity System to obtain the number of new private enterprises at the city level. Our main findings are as follows. First, the Broadband China pilot policy significantly promotes entrepreneurship. Second, information infrastructure construction is conducive to the acquisition of information, technical knowledge spillovers, and the level of risk-taking behavior, which may be important channels to promote entrepreneurship.

Thus, we clearly show the underlying mechanisms of the effects of China's information infrastructure and the heterogeneous effects at different city levels. In line with the old Chinese aphorism mentioned earlier, China's road to the digital economy is the construction of new digital infrastructure. Based on its top-level scientific design and effective deployment, China's digital economy is a global leader in terms of the development scale and quality. The clear policy implication is that policy makers should concentrate on increasing the quality of the information infrastructure in addition to digital economic efficiency and competitiveness. The implementation of the Broadband China pilot policy should increase the scale of pilot cities and further reap the dividends brought by constructing information infrastructure.

Our results suggest that the government should focus on creating a valuable information environment and providing more failure-tolerant mechanisms for entrepreneurship. Thus, the digital economy can play a role in Broadband China. Therefore, we should not neglect the construction of information infrastructure as a means of realizing China's "Mass Entrepreneurship and Innovation" goals.

Appendix Table A1. List of Broadband China pilot cities

This table shows the specific year in which each city built broadband infrastructure. The Chinese names of these cities are reported in parentheses.

Policy implementation year	City
2014	Beijing (北京市), Tianjin (天津市), Shanghai (上海市), Changsha (长沙市), Zhuzhou (株洲市), Xiangtan (湘潭市), Shijiazhuang (石家庄市), Dalian (大连市), Benxi (本溪市), Yanbian (延边朝鲜族自治州), Harbin (哈尔滨市), Daqing (大庆市), Nanjing (南京市), Suzhou (苏州市), Zhenjiang (镇江市), Kunshan (昆山市), Jinhua (金华市), Wuhu (芜湖市), Anqing (安庆市), Fuzhou (福州市), Xiamen (厦门市), Quanzhou (泉州市), Nanchang (南昌市), Shangrao (上饶市), Qiangdao (青岛市), Zibo (淄博市), Weihai (威海市), Linyi (临沂市), Zhengzhou (郑州市), Luoyang (洛阳市), Wuhan (武汉市), Guangzhou (广州市), Shenzhen (深圳市), Zhongshan (中山市), Chengdu (成都市), Panzhihua (攀枝花市), Aba (阿坝藏族羌族自治州), Guiyang (贵阳市), Yinchuan (银川市), Wuzhong (吴忠市), Alaer (阿拉尔市).
2015	Taiyuan (太原市), Huhehaote (呼和浩特市), Eerduosi (鄂尔多斯市), Anshan (鞍山市), Panjin (盘锦市), Baishan (白山市), Yangzhou (扬州市), Jiaxing (嘉兴市), Hefei (合肥市), Tongling (铜陵市), Putian (莆田市), Xinyu (新余市), Ganzhou (赣州市), Dongying (东营市), Jining (济宁市), Dezhou (德州市), Xinxiang (新乡市), Yongcheng (永城市), Huanshi (黄石市), Xiangyang (襄阳市), Yichang (宜昌市), Shiyan (十堰市), Suizhou (随州市), Yueyang (岳阳市), Shantou (汕头市), Meizhou (梅州市), Dongwan (东莞市), Chongqing (重庆市), Mianyang (绵阳市), Neijiang (内江市), Yibin (宜宾市), Dazhou (达州市), Yuxi (玉溪市), Lanzhou (兰州市), Zhangye (张掖市), Guyuan (固原市), Zhongwei (中卫市), Kelamayi (克拉玛依市).
2016	Yangquan (阳泉市), Jinzhong (晋中市), Wuhai (乌海市), Baotou (包头市), Tongliao (通辽市), Shenyang (沈阳市), Mudanjiang (牡丹江市), Wuxi (无锡市), Taizhou (泰州市), Nantong (南通市), Hangzhou (杭州市), Suzhou (宿州市), Huangshan (黄山市), Maanshan (马鞍山市), Jian (吉安市), Yantai (烟台市), Zaozhuang (枣庄市), Shangqiu (商丘市), Jiaozuo (焦作市), Nanyang (南阳市), Ezhou (鄂州市), Hengyang (衡阳市), Yiyang (益阳市), Yulin (玉林市), Haikou (海口市), Yaan (雅安市), Luzhou (泸州市), Nanchong (南充市), Zhunyi (遵义市), Wenshan (文山壮族苗族自治州), Lhasa (拉萨市), Linzhi (林芝市), Weinan (渭南市), Wuwei (武威市), Jiuquan (酒泉市), Tianshui (天水市), Xining (西宁市).

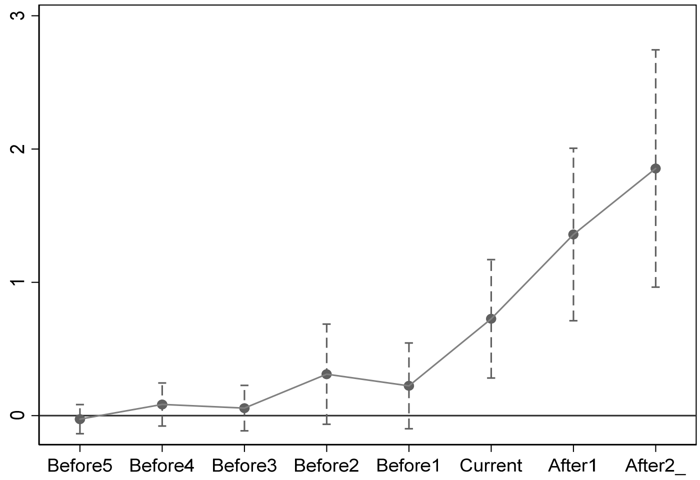

Figure 1. The dynamic effect of information infrastructure on entrepreneurship

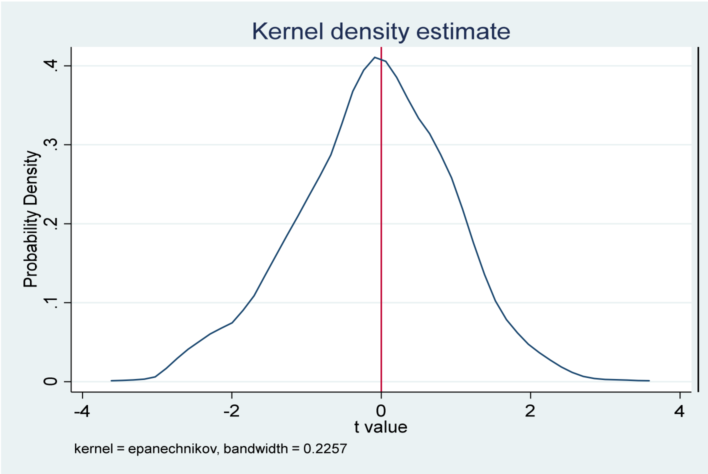

Figure 2. Random placebo test: The coefficient distribution of *Broadband_new*

Note: We randomly assigned pilot cities for constructing broadband infrastructure to conduct a placebo test and performed 1,000 baseline regressions to draw this figure.

Table 1. Variable Definitions

Variable	Measure	Data source
City level		
Entrepreneurship	Number of new private enterprises/labor force aged 14–65 years	Registration information from National Enterprise Credit Information Publicity System
Broadband	Year *t* is equal to 1 if a city is selected as a policy pilot area, and 0 otherwise	Website of Ministry of Industry and Information Technology, National Development and Reform Commission
LnGDP	Ln[1+GDP (100,000,000 yuan)]	China Stock Market & Accounting Research (CSMAR)
GDP2%	Percentage of GDP from secondary industries	CSMAR
GDP3%	Percentage of GDP from tertiary industries	CSMAR
CPI	Provincial consumer price index	CSMAR
LnPopulation	Ln[1+total city population (10,000 people)]	CSMAR
Fiasset	Fixed-asset investment/GDP	CSMAR
Employ	Ln[1+employees (10,000 people)]	CSMAR
Fiscal	Budgetary revenue/budgetary expenditure	CSMAR
Rails	Ln[Railway passenger volume (10,000 people)]	CSMAR
Road	Ln[Highway passenger capacity (10,000 people)]	CSMAR
Mw1	Minimum monthly wage	Chinese Research Data Services Platform (CNRDS)
Mw2	Minimum hourly wage	CNRDS
Firm level		
Svi1	Ln (number of Internet searches)	CNRDS
Svi2	Ln (1+number of Internet searches)	CNRDS
Patz	Ln (1+number of patent applications by subsidiaries)	CNRDS
Innz	Ln (1+number of invention patent applications of subsidiaries)	CNRDS
Othz	Ln (1+number of utility model patent applications + number of design patent applications of subsidiaries)	CNRDS
Patj	Ln (1+ number of joint patent applications by listed companies and other companies)	CNRDS
Innj	Ln (1+number of patent applications for joint invention by listed companies and other companies)	CNRDS
Othj	Ln (1+number of joint utility model patent applications by listed companies and other companies + number of joint design patent	CNRDS

	applications by listed companies and other companies)	
Risk1	Earnings volatility indicator	CSMAR
Risk2	Earnings volatility indicator	CSMAR
Leverage	Total liabilities/total assets	CSMAR
Roa	Net profit/total assets	CSMAR
Fixs	Fixed assets/total assets	CSMAR
Cash	Cash and cash equivalents net increase/total assets	CSMAR
SOEs	Equal to 1 if the final controller is the government, and 0 otherwise	CSMAR
Age	The number of years the business has been established	CSMAR

Table 2. Summary statistics

This table contains the summary statistics for the key variables used in our main analysis. The baseline regression sample includes 2,424 firm-year observations from 2005 to 2017. All variables are defined in detail in Table 1.

Variables	N	Mean	SD	Min.	P25	P50	P75	Max.
Entrepreneurship	2,424	1.916	1.869	0.245	0.724	1.256	2.406	11.52
LnGDP	2,424	6.871	1.028	4.420	6.168	6.831	7.495	9.656
GDP2%	2,424	48.74	11.30	18.57	41.98	48.98	55.93	79.36
GDP3%	2,424	37.47	9.446	16.79	31.50	36.19	42.30	68.60
CPI	2,424	102.7	1.946	97.65	101.5	102.3	103.9	110.1
LnPopulation	2,424	5.913	0.637	3.353	5.563	5.966	6.368	7.089
Fiasset	2,424	0.924	1.151	0.0422	0.427	0.639	0.934	8.488
Employ	2,424	3.610	0.823	1.988	3.054	3.488	4.026	6.348
Fiscal	2,424	0.469	0.225	0.0760	0.290	0.435	0.628	1.051

Table 3. Baseline results

This table shows the effects of broadband infrastructure on entrepreneurship. All variables are defined in detail in Table 1. We also control for the city and year fixed effects in the model. All robust standard errors in parentheses are clustered at the city level. ***, **, and * denote significance at levels of 1%, 5%, and 10%, respectively.

Variables	(1) ***Entrepreneurship***	(2) ***Entrepreneurship***
Broadband	1.053***	1.040***
	(0.246)	(0.245)
LnGDP		−0.139
		(0.325)
GDP2%		0.0118
		(0.0134)
GDP3%		0.0021
		(0.0172)
CPI		−0.0397
		(0.0260)
LnPopulation		−0.658
		(0.529)
Fiasset		−0.134
		(0.142)
Employ		0.0085
		(0.109)
Fiscal		−0.107
		(0.354)
Constant	0.969***	9.206**
	(0.0494)	(4.404)
Observations	2,424	2,424
City FE	Yes	Yes
Year FE	Yes	Yes
Adj. R^2	0.636	0.639

Table 4. Dynamic DID

This table shows the dynamic effect of broadband infrastructure on entrepreneurship. All variables are defined in detail in Table 1. ***, **, and * denote significance at levels of 1%, 5%, and 10%, respectively.

	(1)	(2)
Variables	***Entrepreneurship***	***Entrepreneurship***
Before-5	−0.0377	−0.0268
	(0.0552)	(0.0553)
Before-4	0.0749	0.0833
	(0.0804)	(0.0821)
Before-3	0.0513	0.0558
	(0.0839)	(0.0864)
Before-2	0.307	0.311
	(0.189)	(0.191)
Before-1	0.220	0.223
	(0.158)	(0.163)
Current	0.727***	0.726***
	(0.223)	(0.225)
After1	1.364***	1.359***
	(0.324)	(0.328)
After2+	1.863***	1.854***
	(0.449)	(0.452)
LnGDP		−0.0896
		(0.326)
GDP2%		0.0112
		(0.0127)
GDP3%		0.0003
		(0.0164)
CPI		−0.0410
		(0.0258)
LnPopulation		−0.612
		(0.529)
Fiasset		−0.103
		(0.136)
Employ		0.0106
		(0.115)
Fiscal		−0.110
		(0.357)
Constant	−0.171	7.700*
	(0.292)	(4.320)
Observations	2,424	2,424
City FE	Yes	Yes
Year FE	Yes	Yes
Adj. R^2	0.645	0.648

Table 5. Tests on the assumptions of time-varying DID

This table shows the results of analyses after retaining only the first round of Broadband China pilot cities in 2014 as the treatment group and other cities as the control group. All variables are defined in detail in Table 1. ***, **, and * denote significance at levels of 1%, 5%, and 10%, respectively.

	(1)	(2)
Variables	***Entrepreneurship***	***Entrepreneurship***
Broadband	1.916***	1.906***
	(0.415)	(0.406)
LnGDP		−0.102
		(0.373)
GDP2%		0.0067
		(0.0130)
GDP3%		−0.0041
		(0.0171)
CPI		−0.0432
		(0.0319)
LnPopulation		−1.025*
		(0.533)
Fiasset		−0.0647
		(0.136)
Employ		−0.0121
		(0.133)
Fiscal		0.0948
		(0.371)
Constant	0.934***	11.87**
	(0.0516)	(4.704)
Observations	1,782	1,782
City FE	Yes	Yes
Year FE	Yes	Yes
Adj. R^2	0.673	0.676

Table 6. Robustness test: Shortened sample period

This table shows the results of robustness analysis for a shortened sample period. To exclude the impact of the 2008 financial crisis, we use a 2009–2017 sample regression. We then use a 2011–2017 sample regression to further exclude the potential impact of the 2010 government rescue plan. We also use a 2013–2017 sample regression, which is consistent with the *DID* policy and excludes the impact of other types of potential policies to a certain extent. All variables are defined in detail in Table 1. ***, **, and * denote significance at levels of 1%, 5%, and 10%, respectively.

	2009–2017	2011–2017	2013–2017
Variables	***Entrepreneurship***	***Entrepreneurship***	***Entrepreneurship***
Broadband	0.886***	0.805***	0.551***
	(0.218)	(0.200)	(0.171)
LnGDP	−0.408	−0.0610	0.427
	(0.569)	(0.651)	(0.951)
GDP2%	0.0131	0.0062	0.0450
	(0.0261)	(0.0338)	(0.0527)
GDP3%	−0.0156	−0.0185	0.0263
	(0.0288)	(0.0346)	(0.0568)
CPI	−0.0795*	−0.199*	−0.110
	(0.0465)	(0.111)	(0.118)
LnPopulation	−0.549	−0.144	0.0455
	(0.697)	(1.053)	(1.012)
Fiasset	−0.194	−0.118	−0.0443
	(0.191)	(0.196)	(0.228)
Employ	0.0137	0.0343	0.115
	(0.114)	(0.111)	(0.106)
Fiscal	−0.269	−0.513	−1.046
	(0.580)	(0.719)	(0.884)
Constant	15.33**	24.46	7.003
	(6.943)	(15.23)	(18.01)
Observations	1,624	1,237	840
City FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adj. R^2	0.612	0.586	0.469

Table 7. Robustness test: City differences
The table shows the results of robustness analysis considering differences in city administrative levels. All variables are defined in detail in Table 1. ***, **, and * denote significance at levels of 1%, 5%, and 10%, respectively.

Variables	Eliminate municipalities directly under the central government	Eliminate vice-provincial capital cities	Ordinary prefecture-level cities
	Entrepreneurship	***Entrepreneurship***	***Entrepreneurship***
Broadband	1.080***	1.101***	1.147***
	(0.250)	(0.256)	(0.261)
LnGDP	−0.259	−0.184	−0.317
	(0.335)	(0.328)	(0.336)
GDP2%	0.0113	0.0110	0.0103
	(0.0135)	(0.0134)	(0.0135)
GDP3%	0.0003	0.0007	−0.0013
	(0.0176)	(0.0174)	(0.0178)
CPI	−0.0314	−0.0444*	−0.0348
	(0.0257)	(0.0265)	(0.0260)
LnPopulation	−0.653	−0.580	−0.577
	(0.533)	(0.538)	(0.544)
Fiasset	−0.154	−0.146	−0.169
	(0.142)	(0.143)	(0.143)
Employ	0.0124	0.0184	0.0222
	(0.110)	(0.111)	(0.112)
Fiscal	−0.0669	0.0119	0.0601
	(0.354)	(0.383)	(0.383)
Constant	9.124**	9.472**	9.351**
	(4.437)	(4.422)	(4.456)
Observations	2,388	2,297	2,261
City FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adj. R^2	0.639	0.636	0.636

Table 8. Robustness test: Clustering robust standard errors and adjusting fixed effects

The table presents robustness results for different clustered robust standard errors and FEs. All variables are defined in detail in Table 1. ***, **, and * denote significance at levels of 1%, 5%, and 10%, respectively.

Variables	(1) ***Entrepreneurship***	(2) ***Entrepreneurship***	(3) ***Entrepreneurship***
Broadband	1.040***	0.992***	0.992***
	(0.241)	(0.235)	(0.263)
LnGDP	−0.139	−0.121	−0.121
	(0.328)	(0.401)	(0.449)
GDP2%	0.0118	0.0200	0.0200
	(0.0134)	(0.0155)	(0.0180)
GDP3%	0.0021	0.0130	0.0130
	(0.0195)	(0.0211)	(0.0248)
CPI	−0.0397*	4.027***	0.0285*
	(0.0225)	(1.235)	(0.0167)
LnPopulation	−0.658	−1.110*	−1.110*
	(0.494)	(0.635)	(0.590)
Fiasset	−0.134	−0.257*	−0.257
	(0.206)	(0.152)	(0.241)
Employ	0.0085	0.0948	0.0948
	(0.120)	(0.120)	(0.132)
Fiscal	−0.107	0.0638	0.0638
	(0.320)	(0.397)	(0.497)
Constant	9.206*	−399.8***	5.402
	(5.072)	(125.1)	(5.136)
Observations	2,424	2,424	2,424
Cluster	Province	City	Province
Province FE * Year FE	No	Yes	Yes
City FE	Yes	Yes	Yes
Year FE	Yes	No	No
Adj. R^2	0.639	0.693	0.693

Table 9. Robustness test: Ruling out transportation infrastructure as an alternative explanation
The table shows the robustness results after controlling for the transportation infrastructure. All variables are defined in detail in Table 1. ***, **, and * denote significance at levels of 1%, 5%, and 10%, respectively.

Variables	(1) ***Entrepreneurship***	(2) ***Entrepreneurship***	(3) ***Entrepreneurship***
Broadband	1.038***	0.947***	1.049***
	(0.348)	(0.266)	(0.348)
LnGDP	−0.0944	−0.212	−0.0934
	(0.287)	(0.374)	(0.286)
GDP2%	0.0084	0.0149	0.0086
	(0.0100)	(0.0143)	(0.0100)
GDP3%	−0.0026	0.0072	−0.0036
	(0.0131)	(0.0189)	(0.0131)
CPI	−0.0053	−0.0453	−0.0037
	(0.0170)	(0.0281)	(0.0168)
LnPopulation	−0.260	−0.474	−0.253
	(0.633)	(0.640)	(0.633)
Fiasset	−0.132	−0.235	−0.129
	(0.117)	(0.159)	(0.118)
Employ	−0.114	−0.0196	−0.120
	(0.139)	(0.152)	(0.140)
Fiscal	0.121	−0.0424	0.121
	(0.218)	(0.369)	(0.217)
Rails	0.0065		0.0010
	(0.0529)		(0.0543)
Road		0.0097	0.0349
		(0.0728)	(0.0578)
Constant	3.649	8.813	3.216
	(4.383)	(5.371)	(4.385)
Observations	1,596	2,165	1,593
City FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adj. R^2	0.528	0.619	0.529

Table 10. Robustness test: Ruling out minimum wage as an alternative explanation

This table shows the robustness results after controlling for the minimum wage. All variables are defined in detail in Table 1. ***, **, and * denote significance at levels of 1%, 5%, and 10%, respectively.

Variables	(1) ***Entrepreneurship***	(2) ***Entrepreneurship***	(3) ***Entrepreneurship***
Broadband	1.026***	1.001***	1.001***
	(0.253)	(0.246)	(0.247)
LnGDP	−0.125	−0.103	−0.103
	(0.336)	(0.372)	(0.372)
GDP2%	0.0123	0.0083	0.0082
	(0.0145)	(0.0154)	(0.0154)
GDP3%	0.0028	−0.0034	−0.0035
	(0.0179)	(0.0182)	(0.0183)
CPI	−0.0450	−0.0434	−0.0437
	(0.0299)	(0.0331)	(0.0334)
LnPopulation	−0.664	−0.606	−0.605
	(0.570)	(0.577)	(0.577)
Fiasset	−0.116	−0.173	−0.173
	(0.154)	(0.170)	(0.169)
Employ	0.0475	0.0662	0.0661
	(0.118)	(0.117)	(0.117)
Fiscal	−0.136	−0.229	−0.229
	(0.371)	(0.388)	(0.389)
Mw1	−0.0002		−0.0001
	(0.0005)		(0.0007)
Mw2		−0.0270	−0.0219
		(0.0413)	(0.0629)
Constant	9.729**	9.578**	9.612**
	(4.653)	(4.769)	(4.807)
Observations	2,177	2,022	2,022
City FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adj. R^2	0.627	0.617	0.617

Table 11. Information acquisition mechanism

This table shows the results of the information acquisition mechanism. The dependent variable Siv_{it} is the information acquisition variable, which uses the network search index to represent the degree of information acquisition. In general, the higher the network search index, the more information acquired. All variables are defined in detail in Table 1. ***, **, and * denote significance at levels of 1%, 5%, and 10%, respectively.

	(1)	(2)
Variables	***Svi1***	***Svi2***
Broadband	0.0262***	0.0604***
	(0.0096)	(0.0221)
LnGDP	0.0746*	0.172*
	(0.0406)	(0.0935)
GDP2%	0.0004	0.001
	(0.0052)	(0.0120)
GDP3%	0.0009	0.0021
	(0.0058)	(0.0133)
CPI	0.0117	0.0270
	(0.0107)	(0.0247)
LnPopulation	−0.129	−0.297
	(0.0818)	(0.188)
Fiasset	0.0126	0.0290
	(0.0137)	(0.0315)
Employ	0.0122	0.0281
	(0.0136)	(0.0312)
Fiscal	−0.0644	−0.148
	(0.0729)	(0.168)
Leverage	0.270***	0.621***
	(0.0496)	(0.114)
Roa	−0.0166	−0.0382
	(0.0463)	(0.107)
Fixs	0.0605	0.139
	(0.0490)	(0.113)
Cash	0.0695**	0.160**
	(0.0315)	(0.0726)
SOEs	0.0297	0.0685
	(0.0193)	(0.0446)
Age	0.0110	0.0254
	(0.0079)	(0.0182)
Constant	4.176***	9.615***
	(1.436)	(3.307)
Observations	8,592	8,592
Firm FE	Yes	Yes
Year FE	Yes	Yes
Adj. R^2	0.465	0.465

Table 12. Knowledge spillover mechanism

This table shows the results of the knowledge spillover mechanism. We use the patent applications of listed companies' subsidiaries (*Patz*) and the joint patent applications of listed companies and other external companies (*Patj*) as measures. In addition, we further divide them into the number of invention patent applications (*Innz* and *Innj*) and the number of noninvention patent applications (*Othz* and *Othj*). All variables are defined in detail in Table 1. ***, **, and * denote significance at levels of 1%, 5%, and 10%, respectively.

Variables	Joint technological innovation with other external companies			Technological innovation of subsidiaries		
	Patj	***Innj***	***Othj***	***Patz***	***Innz***	***Othz***
Broadband	0.0423*	0.0352*	0.0406**	0.116**	0.0986**	0.0864**
	(0.0253)	(0.0207)	(0.0191)	(0.0486)	(0.0432)	(0.0415)
LnGDP	−0.0879	−0.0559	−0.0177	0.275	0.282	0.227
	(0.123)	(0.104)	(0.0879)	(0.298)	(0.274)	(0.232)
GDP2%	0.0045	0.0020	0.0049	0.0016	−0.0055	0.0094
	(0.0041)	(0.0032)	(0.0036)	(0.0146)	(0.0119)	(0.0116)
GDP3%	−0.0006	−0.0005	0.0008	−0.0041	−0.0084	0.0026
	(0.0049)	(0.0040)	(0.0038)	(0.0161)	(0.0139)	(0.0119)
CPI	0.0113	0.0104	0.0074	0.0493*	0.0360**	0.0446*
	(0.0090)	(0.0072)	(0.0071)	(0.0264)	(0.0182)	(0.0233)
LnPopulation	−0.0290	−0.0721	0.0268	0.341*	0.241	0.175
	(0.148)	(0.155)	(0.0956)	(0.202)	(0.245)	(0.160)
Fiasset	0.0482	0.0191	0.0472	0.0815	0.0463	0.0850
	(0.0313)	(0.0235)	(0.0289)	(0.0799)	(0.0704)	(0.0726)
Employ	−0.0102	−0.0015	−0.0086	0.0626	0.108*	0.0224
	(0.0290)	(0.0243)	(0.0222)	(0.0633)	(0.0559)	(0.0581)
Fiscal	−0.0739	−0.0585	−0.109	−0.563*	−0.295	−0.622**
	(0.117)	(0.0970)	(0.0990)	(0.292)	(0.252)	(0.247)
Leverage	−0.241**	−0.179**	−0.161*	−1.277***	−0.972***	−0.785***
	(0.120)	(0.0895)	(0.0959)	(0.284)	(0.277)	(0.211)
Roa	−0.215**	−0.115	−0.158**	−0.0762	−0.187	0.0134
	(0.0927)	(0.0721)	(0.0782)	(0.300)	(0.299)	(0.263)
Fixs	0.0834	0.106	0.0070	0.174	0.0518	0.252
	(0.0998)	(0.0751)	(0.0654)	(0.203)	(0.154)	(0.174)
Cash	0.0409	−0.0017	0.0751	0.373	0.326	0.336
	(0.0855)	(0.0565)	(0.0792)	(0.286)	(0.203)	(0.260)
SOEs	0.0650	0.0662	0.0297	0.0695	0.0475	0.129
	(0.0626)	(0.0497)	(0.0457)	(0.114)	(0.0815)	(0.0868)
Age	0.0415**	0.0305**	0.0186	0.0477	0.0294	0.0243
	(0.0169)	(0.0141)	(0.0113)	(0.0343)	(0.0326)	(0.0268)
Constant	−0.820	−0.538	−1.091	−8.995**	−6.861**	−7.539***
	(1.387)	(1.213)	(0.950)	(3.505)	(2.998)	(2.598)
Observations	13,294	13,294	13,294	6,434	6,434	6,434
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.046	0.042	0.033	0.137	0.127	0.106

Table 13. Risk-taking mechanism

This table shows the results of the risk-taking mechanism. The dependent variable $Risk_{it}$ is the risk-taking variable, which is measured by the earnings volatility index. All variables are defined in detail in Table 1. ***, **, and * denote significance at levels of 1%, 5%, and 10%, respectively.

	(1)	(2)
Variables	***Risk1***	***Risk2***
Broadband	0.0040***	0.0077***
	(0.0013)	(0.0025)
LnGDP	0.0047	0.0102
	(0.0080)	(0.0150)
GDP2%	−0.0004	−0.0006
	(0.0003)	(0.0006)
GDP3%	−0.0001	−0.0002
	(0.0004)	(0.0008)
CPI	−0.0002	−0.0005
	(0.0007)	(0.0014)
LnPopulation	0.0107	0.0202
	(0.0131)	(0.0249)
Fiasset	−0.0005	−0.0007
	(0.0014)	(0.0026)
Employ	0.0030*	0.0054
	(0.0018)	(0.0033)
Fiscal	0.0032	0.0075
	(0.0067)	(0.0127)
Leverage	0.0853***	0.162***
	(0.0093)	(0.0175)
Roa	−0.126***	−0.242***
	(0.0112)	(0.0213)
Fixs	0.0067	0.0135
	(0.0063)	(0.0118)
Cash	0.0010	0.0014
	(0.0076)	(0.0141)
SOEs	−0.0047	−0.0086
	(0.0055)	(0.0105)
Age	−0.0005	−0.0013
		(0.0020)
	(0.0011)	
Constant	−0.0398	−0.0674
	(0.115)	(0.216)
Observations	11,998	11,998
Firm FE	Yes	Yes
Year FE	Yes	Yes
Adj. R^2	0.130	0.133