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The Impact of Digital Governance on Entrepreneurial Activity in Relatively Poor Areas: Evidence from Tibet, China

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Abstract: This paper examines the impact of digital governance on entrepreneurial activity in relatively poor areas from both theoretical and empirical perspectives. Our study is twofold. First, we utilize a economic geography model to theoretically analyze the influence of digital governance on regional entrepreneurial endeavors and develop research hypotheses. Second, using county panel data from Tibet spanning from 2001 to 2021, we empirically examine the influence of digital governance on entrepreneurial activity. The results show that digital governance can significantly increase regional entrepreneurial activity, and that the effect exhibits an upward and then a downward trend over time, with some spatial spillover effects. We argue that differences in regional network infrastructure are an important heterogeneity factor affecting digital governance's ability to increase entrepreneurial activity. Our conclusions remain robust to various tests.

Keywords: digital governance; entrepreneurship; relatively poor areas; new economic geographies

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1. Introduction

With rapid economic growth and urbanization, China has entered a new phase of economic growth, structural adjustment, and stimulus digestion. As a key element linking employment and technological progress, entrepreneurial activities are not only an important means to promote technological progress, enhance production efficiency, and drive economic growth but are also an effective way to achieve the goal of full employment and solve employment problems. According to publicly data, there will be nearly 9 million newly created enterprises in China in 2022, and the number of market entities will increase from 55 million in 2012 to 170 million in 2022, which indicates that China's "mass entrepreneurship" has achieved significant results. Although the number of newly created enterprises is increasing, the growth rate of these start-ups is actually on a downward trend compared to the overall surge in new business ventures. Under such circumstances, society must accelerate the transformation of the development mode, provide a better external environment for entrepreneurial activities, and inject a strong and sustained impetus for entrepreneurial activities. At this stage, digital governance is becoming a key force in reshaping China's urban development landscape [1]. With continuous advancements in digital governance, all kinds of resources in cities can be more fully integrated, which is a force that cannot be ignored to further promote entrepreneurial activities in China.

Scholars have conducted extensive research on regional entrepreneurial activity in recent years, revealing a multitude of factors that impact such activity. The level of entrepreneurial activity in a given region is influenced by both the level of skills and endowments of local entrepreneurs themselves [2–5], as well as the level of local infrastructure development [6,7], business environments [8,9], and other external conditions. In terms of the impact of entrepreneurs' own skill endowment on entrepreneurship, the level of entrepreneurs' own professional skills will inevitably affect their entrepreneurial behavior. In addition, existing research suggests that the financial literacy possessed by entrepreneurs [10], digital literacy [11], and their family background [12] have a significant

impact on entrepreneurial activity. The impact of the level of infrastructure development in a region on entrepreneurial activity has also been focused on by academics. Existing research primarily focuses on exploring the impact of information infrastructure, network infrastructure, and digital infrastructure on entrepreneurial activity. As network infrastructure continues to undergo improvements and new social networks emerge, the internet plays a positive role throughout the process of entrepreneurial activities [13]. Meng Hongwei et al. discovered that the development of information infrastructure can foster an increase in regional digital entrepreneurial activity by facilitating the diversified agglomeration of digital economy industries [14]. Liu Yajun et al. conducted a study focusing on the cities participating in the Broadband China Pilot Policy. Their findings revealed that the establishment of network infrastructure holds a crucial role in fostering regional entrepreneurial activity [15]. Digital infrastructure can link digital resources to SME growth [16]. Li Qirong et al. found that digital infrastructure development further enhances regional entrepreneurial activity, mainly by improving regional innovation levels [17].

As further research related to regional entrepreneurial activities progresses, an increasing number of scholars are realizing that the influence of digital governance on these activities cannot be disregarded [18]. At this stage, digital technologies have now become an integral part of citizens' engagement with the state [19]. Digital resources are naturally sustainable [20], and digital governance is continuously shaping and reshaping the relationship between citizens and administrations. Through socio-technical systems, data, services, technologies, and people are being brought together, empowering citizens to independently create public value in response to evolving societal needs [21]; for example, in Indonesia, where civil servants can better manage the developing country's creative economy through the Digital Innovation Co-Creation Programme [22]. Digital governance can also be a good way to reconcile the relationship between resource utilization and economic growth [23]. Simultaneously, certain scholars have highlighted the deficiencies of digital governance. For instance, those who examined the criminalization of digital violence in Mexico contended that such criminalization poses a threat to the human rights of politically active women [24]. Additionally, through their study of the digitization of the Australian nation, scholars have found that pernicious foreign entities are taking advantage of this phenomenon of digital age governance that weakens democracy through information warfare operations [25]. Regarding the impact of digital governance on regional entrepreneurial activities, existing studies demonstrate that digital governance can considerably enhance regional entrepreneurial activity. From a macro perspective, digital governance can optimize the business environment for enterprises and reduce the cost of entrepreneurship [26]. The promotion of digital governance represents a crucial aspect of the Chinese government's governance reform, and the establishment of a digital government has a substantial impact on urban entrepreneurship. By reducing systemic transaction costs and perceptions of uncertainty, it significantly contributes to urban entrepreneurial activity [27–29]. From a micro perspective, digital governance can reduce the threshold of corporate entrepreneurship, enabling more entrepreneurs to start small and micro enterprises, which in turn improves the level of regional entrepreneurship [30]. China's digital governance has made significant profress in several areas, including the application of big data platforms, user-side app promotion, the integration of "digital + grid" governance, and digital points system governance. This progress has changed traditional entrepreneurial models and created numerous opportunities for public entrepreneurship [31,32].

By analyzing the impact of digital governance on entrepreneurial activity and identifying specific impact mechanisms, scholars are trying to explore ways to promote regional entrepreneurial activity in a longer-lasting and more sustainable manner. Nonetheless, the data samples used in most of the studies are mostly based on developed cities or relatively developed regions. A small number of scholars also pay attention to entrepreneurial activities in relatively less-developed areas and some areas with large gaps between the rich and poor [33,34]. Not only is China among the fastest-growing nations in the world regarding digital governance, but its progress in digital infrastructure, particularly the advancement

of digital governance-linked amenities in relatively poor rural regions, remains unparalleled among numerous developing countries. Tibet, located in the southwestern part of China and known as the "Roof of the World", is the most typical relatively poor region, which is an ideal case to study how digital governance affects entrepreneurial activities in relatively poor areas. In this regard, using the county panel data of Tibet from 2001 to 2021 as a research sample, this study investigates the influence of digital governance on regional entrepreneurial activities within the framework of the National Pilot City Policy for Information Beneficence project. The goal is to contribute valuable insights and effective methods to international entrepreneurship and innovation-related research. The contributions of this paper are as follows: firstly, most studies lack micro-theoretical analyses of how digital governance affects regional entrepreneurial activity. This paper attempts to introduce digital governance policies within the framework of new economic geography to theoretically analyze the impact of digital governance on regional entrepreneurial activity. Secondly, although significant progress has been made in China-specific studies on digital governance-related research, most of the studies exclude Tibet from their data samples. As a typical relatively poor region, Tibet was included in the scope of "National Pilot City of Information Beneficence" as early as 2014, which was 10 years ago, and the impact of digital governance on entrepreneurial activities in various regions of Tibet should not be ignored. In addition, whether digital governance has a certain spillover effect has not been sufficiently researched in the academic world, and this study concludes that digital governance has a certain spillover effect based on theoretical analyses. Based on theoretical analyses, we believe that digital governance has certain spatial positive externalities, and this is verified by empirical tests.

2. Theoretical Background and the Model

2.1. Theoretical Assumptions and Background

Entrepreneurship and innovation constitute a significant driving force for promoting economic development in underdeveloped and relatively poor regions. Enhancing government digital governance can effectively contribute to shaping policies that are essential for labor and economic advancement [13], as well as organizing diverse entrepreneurial resources more efficiently and rationally [9]. The enhancement of government digital governance necessarily entails improving information infrastructure, elevating regional human capital, and establishing diverse digital platforms. By upgrading information infrastructure, the influence of geographical distance on entrepreneurial endeavors is significantly diminished. Furthermore, elevating the human capital level offers a more potent driving force for regional entrepreneurial activities. The development of digital platforms, particularly the creation of big data resource sharing platforms, permits continuous optimization of the region's entrepreneurial paradigm [3,7,14]. Tibet's digital governance reform centers on Lhasa and is spread throughout the region. Digital governance in Tibet has had a significant positive impact on entrepreneurial activities by vigorously improving information infrastructure. First, by strengthening the construction of network infrastructure, especially the coverage of optical broadband and mobile networks, entrepreneurs can more easily obtain information, conduct market research, and carry out online business. The establishment of the data center provides a strong computing and storage capacity for start-ups, supports big data analysis and cloud computing applications, and improves the technical ability and competitiveness of enterprises. In addition, the improvement of information infrastructure has also promoted the development of e-commerce platforms, providing entrepreneurs with new sales channels, especially helping farmers, herdsmen, and small and micro enterprises to sell products on the internet and expand market coverage. The popularization of digital financial services also benefits from the improvement of information infrastructure, providing entrepreneurs with convenient payment and financing channels and solving the problem of capital shortage.

New economic geography and center–periphery theory are our theoretical foundations [35]. We consider the realities of digital transformation in Tibet and introduce a

heterogeneous distribution function of population and digital infrastructure into the classical new economic geography model. Studying the impact of digital governance on entrepreneurial activities in Tibet using the new economic geography model is highly valuable. This approach not only enriches and broadens the research scope of economic geography and entrepreneurship but also offers a scientific foundation for the government to craft and refine digital governance policies. These insights can steer the judicious allocation of resources and foster balanced regional development. The findings can empower entrepreneurs and businesses to devise more impactful strategies, bolstering their competitiveness. Simultaneously, this investigation sheds light on Lhasa's pivotal role as a digital governance hub in driving regional entrepreneurship. It also aids in bridging the urban–rural digital divide, elevating residents' quality of life and advancing Tibet's sustainable progress.

The assumptions are as follows: there are two sectors, agriculture and industry. The agricultural sector is a sector with constant returns to scale, producing homogeneous agricultural products. The agricultural product market is a fully competitive market. The industrial sector is a sector with increasing returns to scale, using labor as fixed and variable input factors to produce heterogeneous industrial products. The industrial product market is a monopolistic competitive market. All citizens have the same preferences. The utility function of representative consumers is a two-tier utility function. The first tier is the Cobb–Douglas utility function, and the second tier is the CES utility function for differentiated industrial products.

We designed a strip-shaped area centered around city B, extending for a length of $2f$. We postulated the presence of $2R-1$ non-core cities evenly spaced within this region. Based on this framework, we constructed a model encompassing $2R$ cities, divided into two sectors and composed of two elements (for simplicity, we assumed a single core city). Given that digital infrastructure radiates outward from the core city B, the level of infrastructure development decreases with increasing distance from the core. Therefore, The formula for determining the digital infrastructure construction level in region r is as follows:

$$\phi(r) = \frac{\delta e^{-\frac{r^2}{2}}}{\sqrt{2\pi}} \tag{1}$$

Furthermore, presuming that the regional population is distributed with a dense concentration in core cities and a sparse concentration in marginal areas, the density function $\phi(r)$ and the probability function of population distribution $F(r)$ can be represented by the following equation:

$$\varphi_{lr} = \frac{1}{\sqrt{2\pi}} e^{-\frac{r^2}{2}}, F(r) = \int_{-\infty}^{r} \varphi_{lr} dr \tag{2}$$

Furthermore, we postulate that the circulation cost remains uniform when all products move within the designated strip area. For products originating outside this region, we hypothesize the existence of an additional fixed transaction cost, denoted as τ, upon their inflow. By incorporating this hypothesis with Equation (2), we deduce that the city's population can be represented by the following equation:

$$L_r = L\left[F\left(r + \frac{f}{R}\right) - F(r)\right] = L\int \frac{1}{\sqrt{2\pi}} e^{-\frac{r^2}{2}} dr \tag{3}$$

Based on the conclusion drawn from the center–periphery model, the equilibrium number of enterprises in city r is determined as follows:

$$n_r = \frac{1}{\sigma f} L \int_r^{r+\frac{f}{R}} \frac{1}{\sqrt{2\pi}} e^{-\frac{r^2}{2}} dr \tag{4}$$

2.2. Impact of Digital Transformation on Entrepreneurial Activities

We assess the influence of entrepreneurial endeavors in a city situated in the strip area, designated as a pilot for digital transformation. This pilot city provides a viable option for study. Presuming that being a digital transformation pilot city can lower production expenses for businesses through various means, thereby affecting the pricing of their products, we are presented with two choices for products originally sourced from outside the city: either continue importing them, with the cost of imported goods being τp, or opt for local production. Referring to Equation (1), the pricing model for products in the digitally transforming city r_T is represented by the equation below:

$$p_r^T = \sqrt{2\pi}\delta^{-1}e^{\frac{r^2}{2}}e^{(r-r_T)^2}p \tag{5}$$

Once $p_r^T < \tau p$ is established, locally produced products will attain market advantages, enabling new enterprises to thrive and invigorate local entrepreneurial activity. More specifically, we arrive at the following prerequisites:

$$\left\{\begin{array}{ll} r_1 = \frac{2r_T - \sqrt{6\ln\left(\frac{\tau}{\delta^{-1}\sqrt{2\pi}}\right) - 2r_T^2}}{3}, r_1 = \frac{2r_T + \sqrt{6\ln\left(\frac{\tau}{\delta^{-1}\sqrt{2\pi}}\right) - 2r_T^2}}{3} & p_r^T = \tau p \\ 0 < r < r_1 \text{ or } r_2 < 2 < f & p_r^T < \tau p \\ r_1 < r < r_2 & p_r^T > \tau p \end{array}\right\} \tag{6}$$

Cities situated at a distance greater than or equal to r_1 and less than or equal to r_2 from the central city B in the strip region tend to opt for establishing new enterprises locally, whereas other cities prefer importing products from beyond the region. Based on the above analysis, we propose the following hypotheses to be tested:

Hypothesis 1. *Digital governance can enhance entrepreneurial dynamism in Tibet.*

Hypothesis 2. *The effects of digital governance on entrepreneurial dynamism in a region are related to the level of previous digital infrastructure development in the region.*

Hypothesis 3. *The impact of digital governance on regional entrepreneurial vitality has a certain spatial spillover effect.*

3. Methods

3.1. Empirical Models

In 2014, Lhasa City was designated as a national pilot city for information beneficence [36], effectively serving as a quasi-natural experiment. In this paper, we use the double difference method to estimate the impact of the pilot information beneficence policy on regional entrepreneurial activity. Considering that Tibet's geographic environment and economic development situation are quite different from those of other provinces and regions, we select the districts and counties of Lhasa City as the experimental group and the counties and districts of other cities and municipalities in Tibet as the control group. By keeping other factors constant, the double difference method can be utilized to assess whether there is a noteworthy disparity in regional entrepreneurial activity between the experimental and control groups, both prior to and following the implementation of the pilot policy for information benefits. Therefore, the model form is set as follows:

$$Y_{ct} = \beta_0 + \beta_1 DID_{ct} + \beta_2 treatment_c + \beta_3 post_t + \sum_{m=4}^{4+k}\beta_m control_m + \eta_c + \gamma_t + \varepsilon_{ct} \tag{7}$$

where Y is the dependent variable, i.e., entrepreneurial activeness in the county area, and DID_{ct} is the core explanatory variable, defined as $DID_{ct} = treatment_c \times post_t$. In the

sample period, $treatment_c = 1$ if county (district) c is designated as a pilot policy area for information benefiting, and 0 otherwise. $post_t = 1$ when $t \geq 2014$, and 0 otherwise. In this paper, the experimental group is the districts and counties under the jurisdiction of Lhasa city, and the control group is the other districts and counties in Tibet. The subscripts c and t denote counties and years, respectively; control is a control variable that includes other factors that can affect regional entrepreneurial activity; η_c denotes county fixed effects, which control for individual factors that affect entrepreneurial activity but do not vary over time and are unobservable; γ_t is a time-fixed effect, which controls for factors that vary over time but not individually and that have an effect on entrepreneurial activity. For the double-difference model, one of the criteria for selecting control variables is to ensure that, after controlling for these variables, the experimental and control groups meet the ex-ante parallel trend assumption. For this reason, we control for time fixed effects from 2002 to 2012 in the actual regression, and ε_{ct} is a random error term. Considering that the actual Tibetan counties (among them) still have some differences in various aspects such as geography, resource endowment, and economic development, with reference to Bertrand et al. [37], this paper adopts robust standard errors clustered in counties in all the empirical regressions. The estimated coefficients represent the policy effects that are the focus of this paper, and if they are significantly positive, they indicate that the pilot policy of information benefit is effective.

In order to test the heterogeneity difference in the pilot policy of information benefit, this paper further extends on the basis of Equation (7) and constructs the following model:

$$Y_{ct} = \beta_0 + \beta_1 DID_{ct} \times netfac_c + \beta_2 DID_{ct} + \beta_3 netfac_c + \beta_4 treatment_c + \beta_5 post_t + \sum_{m=6}^{6+k} \beta_m control_m + \eta_c + \gamma_t + \varepsilon_{ct} \quad (8)$$

In Equation (8), $netfac_{ct}$ is the degree of network infrastructure improvement of each county (district) in the 3 years before the pilot policy started. Equations (7) and (8) focus on the question of whether the effect of the pilot policy on information beneficence is affected by the network infrastructure of counties (districts) prior to the implementation of the policy heterogeneity.

We conducted a study to investigate whether the pilot policy effect spills over into the neighboring districts of the experimental group. This paper sets a dummy variable $near_c$, and in the sample period, the neighboring counties around the experimental group are set to $near_c = 1$; otherwise it is 0. We define $DID_{ct} = near_c \times post_t$ and construct the following econometric model:

$$Y_{ct} = \lambda_0 + \lambda_1 DID_{ct} + \beta_2 treatment_c + \beta_3 post_t + \sum_{4}^{4+k} \lambda_m control_m + \eta_c + \gamma_t + \varepsilon_{ct} \quad (9)$$

In this case, the experimental group is the neighboring counties within a certain distance around Lhasa City County. The control group is the counties (districts) within the original control group, excluding the neighboring counties within a certain distance around Lhasa City. In Equation (9), if λ_1 is significantly positive, it signifies the existence of a favorable spillover effect of the policy on adjacent areas.

3.2. Variable Declaration

Dependent variable: Since entrepreneurial activities will definitely involve the act of company registration, we collated the business registration information of Tibetan counties and districts from 2001 to 2021 and selected the logarithmic value of the number of business registrations in each county in that year to measure the level of entrepreneurial activity in the county.

Core explanatory variables: The explanatory variable presented in this paper is digital governance, proxied by the double-difference variable DID_{ct} of the Information for All Pilot Policy Policy. Lhasa was established as a national pilot city for information beneficiaries

from 2014. $treatment_c$ and $post_t$ represent the policy group dummy variable and the time dummy variable, respectively. During the sample period, if c counties (districts) are designated as pilot policy areas for information beneficiaries, $treatment_c = 1$; otherwise, 0. When $t \geq 2014$, $post_t = 1$ and 0 otherwise.

Control variables: Due to the large time span of the sample, in addition to the Information Beneficiary Pilot Policy that affects county entrepreneurial activity, there exist numerous confounding factors that can influence it. Thus, it is imperative to mitigate the interference caused by these factors. Drawing on Liu Ruiming and Zhao Renjie [38], Zhang Jun [39], Guo Feng and Xiong Ruixiang [40], Xu Ming and Liu Jinshan [41], Huang Zhiping [42], and other scholars in related fields, this paper chooses the following control variables: the logarithm of county per capita gross domestic product (pgdp) to adjust for the influence of the county's economic development level; the relative size of the county's fiscal expenditures and revenue to account for the impact of financial dependence (fin); the ratio of the county's fiscal expenditures to the regional gross domestic product to mitigate the effects of government intervention (govspend); and finally, the ratio of the balance of residents' savings deposits to the county's gross domestic product (GDP). To reflect the impact of the savings rate (sav), the ratio of residents' savings to the county's GDP is considered. The degree of industrial scale (industry) is determined by calculating the logarithmic value of the total output value of industrial enterprises above a certain scale.

3.3. Data Description

The data originate from the China County (City) Social Statistics Yearbook, China County Statistics Yearbook, the statistical database of the China Economic Information Network, as well as the industrial and commercial enterprise registration database provided by the State Administration for Industry and Commerce (SAIC). In the process of data collation and splicing, samples with more missing dependent variables and main control variables are deleted. Samples with individual missing data points are filled in using the moving average method, ensuring balanced panel data for 60 counties and districts in Tibet spanning from 2001 to 2021. Table 1 presents descriptive statistics for each variable.

Table 1. Descriptive statistics.

Variable	Mean	SD	Min	Max	N
invwork cha	4.0353	2.1675	0.0010	8.7773	1260
did	0.0444	0.2062	0	1	1260
treatment	0.1167	0.3212	0	1	1260
post	0.3810	0.4858	0	1	1260
lnp gdp	9.4015	0.8385	6.8255	13.4757	1260
fin cha	17.8869	15.3661	0.6491	156.8297	1260
govspend cha	0.7000	0.6612	0.0373	3.1678	1260
sav cha	0.2588	0.2652	0.0013	0.6352	1260
industry cha	7.1619	2.3114	0.0010	13.4455	1260

4. Results

4.1. Results of the Empirical Model

Columns 1 through 3 in Table 2 present the regression outcomes for Equation (7), wherein all regressions account for the aforementioned control variables and employ robust standard errors clustered at the individual level. Column 1 of Table 2 contains the basic OLS regression results that do not control for individual fixed effects and time fixed effects, with a regression coefficient of DID_{ct} of 0.712, which is significantly positive at the 1% level. Column 2 presents the regression control for individual fixed effects, with the regression coefficient of *treatment* absorbed by the individual effects. The regression coefficient of DID_{ct} has a regression coefficient of 0.922, which remains significantly positive at the 1% level. The third column of the regression results controls for both individual and

time effects, with a regression coefficient of 0.248 for DID_{ct}. This is a significant decrease compared to columns 1 and 2, but it is still significantly positive. Taken together, digital transformation has a significant contribution to entrepreneurial activity in Tibetan counties, and on average, counties that have undergone digital governance increase their county entrepreneurial activity by 0.248 units. Therefore, Hypothesis 1 presented in this paper has been verified.

Table 2. Empirical model estimate result.

VARIABLES	1	2	3	4
DID	0.712 ***	0.922 ***	0.248 *	−0.705 ***
	(0.255)	(0.215)	(0.149)	(0.174)
$DID \times netfac$				1.105 ***
				(0.111)
Control	YES	YES	YES	YES
State FE	NO	YES	YES	YES
Year FE	NO	NO	YES	YES
Observations	1260	1260	1260	1260
R-squared	0.595	0.727	0.856	0.768

Notes: *** $p < 0.01$. * $p < 0.1$.

4.2. Identification Test

4.2.1. Parallel Trend Test

Based on previous studies, it has been observed that the creation of pilot cities for information benefits can significantly enhance entrepreneurial activity within the county. However, there is a possibility that the conclusion may be influenced by omitted variables. To ascertain the dependability of the double-difference identification approach presented in this paper, we conduct the following identification test:

Parallel trend test: To confirm the ex-ante parallel trend and examine the presence of any time lag effect related to the policy, this paper utilizes the event study method for investigating the dynamic impact of establishing an information beneficence pilot city. Specifically, the dependent variable in the following equation is estimated by substituting DID_{ct} in Equation (7), with dummy variables representing several years prior to and following the implementation of the pilot policy for information beneficence.

$$Y_{ct} = \beta_0 + \sum_{-13}^{7} \beta_s D_s + \beta_8 treatment_c + \beta_9 post_t + \sum_{m=10}^{10+k} \beta_m control_m + \eta_c + \gamma_t + \varepsilon_{ct} \quad (10)$$

where D_0 is a dummy variable for the year in which the Information Beneficiary Pilot Policy began to be implemented. s is taken to be negative to denote s years before the Information Beneficiary Pilot Policy was implemented, and positive to denote s years after the Information Beneficiary Pilot Policy was implemented. Due to the long period in the sample before the implementation of the pilot information beneficence policy, referring to Zhang et al. [43], this paper sets the 7th year before the policy occurs as the benchmark group. Figure 1 reports the size of the estimated parameters $\{\beta_{-13}, \beta_{-12}, \ldots, \beta_6, \beta_7\}$ and the corresponding 95% confidence intervals. As can be seen from Figure 1, none of the coefficient estimates were significant before the policy was implemented, while all of the coefficient estimates passed the test of significance at the 5% level for 1 year of policy implementation and beyond. The estimation results reveal two key findings. Firstly, they suggest that the experimental group and the control group exhibited a comparable parallel trend prior to the implementation of the policy. This means that the county's entrepreneurial activity in both groups followed a similar development trajectory. Secondly, the results indicate that the policy's impact initially increased, followed by a subsequent decrease. However, it remained consistently positive throughout.

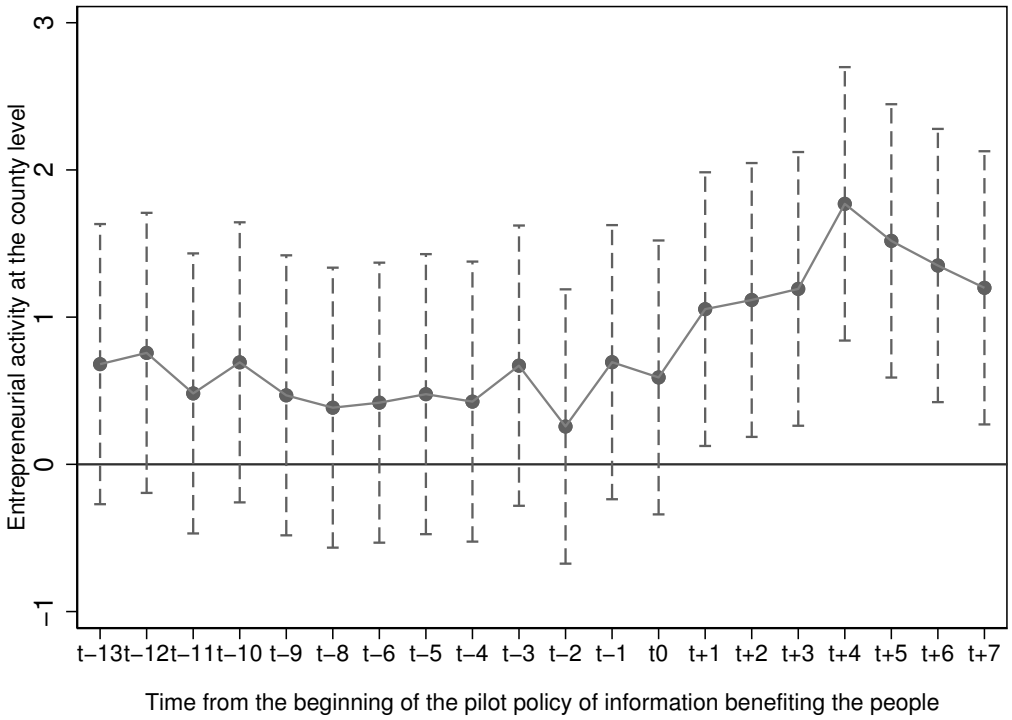

Figure 1. Dynamic impact of pilot policies on information for the people.

4.2.2. Placebo Test

To eliminate the potential influence of unobservable omitted variables on the impact of the Information Benefit Pilot Policy on entrepreneurial activity, this paper performs an indirect test by randomly selecting seven samples from the complete dataset to form the experimental group. We use the regression results of the 3rd column of Table 2 as the baseline results for the placebo test and repeat the process 500 times. Figure 2 reports the probability density distribution of the estimated coefficients. It can be found that the estimated coefficients of random assignment are centrally distributed around zero, and the estimated coefficients do not pass the significance test. This indicates that the estimated coefficients of randomly selecting counties other than Lhasa City as the experimental group for double-difference estimation are not significant, which implies that our benchmark regression results are robust.

4.2.3. Analysis of Heterogeneity and Spatial Spillover Effects

Differences in the network infrastructure of each region before the implementation of the pilot policy of information beneficence may lead to the policy effect showing different impact strengths in different regions. Therefore, it is necessary to analyze the heterogeneity for the baseline regression results. This paper constructs a dummy variable $netfac_c$ as an approximate proxy for the network infrastructure construction in each county based on the number of fixed telephone subscribers in the county in the third year before the implementation of the policy. If the number of fixed telephone subscribers in a county in 2011 is smaller than the median number of fixed telephone subscribers in all counties, it is defined as an area with a low level of network infrastructure, and $netfac_c$ takes the value of 0. Otherwise, it takes the value of 1. Equation (2) is empirically regressed, and the regression results are shown in column 4 of Table 1. We find that the regression coefficient of DID_{ct} decreases to -0.705, which is significant at the 10% level, while the regression coefficient of $DID_{ct} \times netfac_c$ is 1.105, which is significant at the 5% level. This result suggests that the network infrastructure development within the experimental group of counties with high levels is more affected by the pilot information welfare policy. Therefore, Hypothesis 2 presented in this paper has been verified.

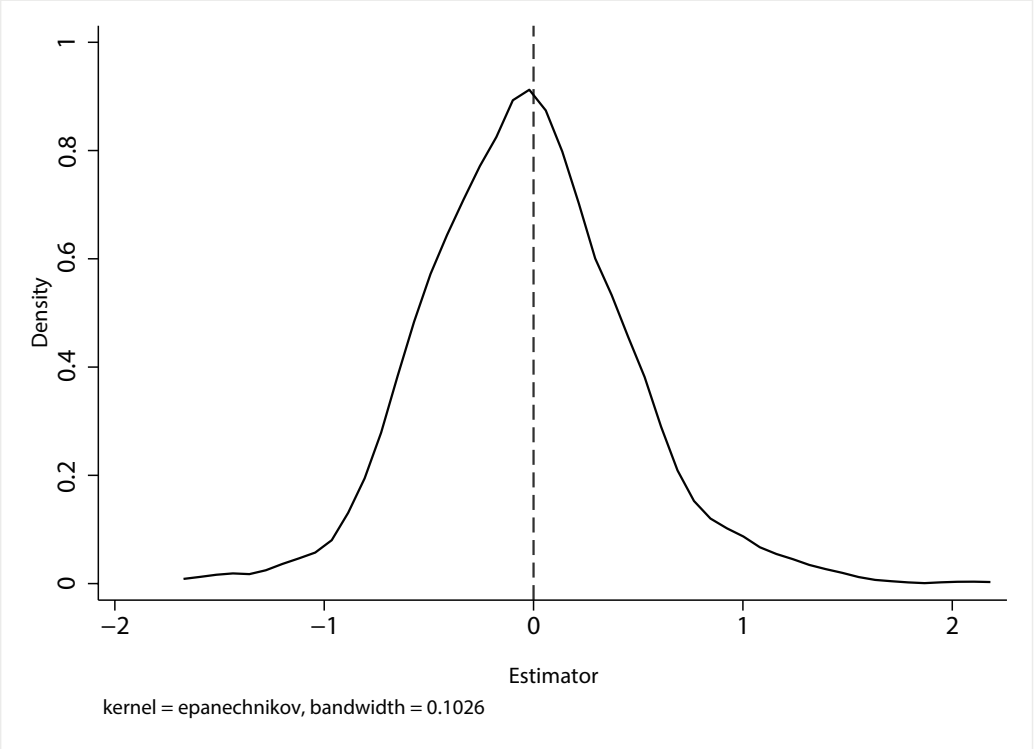

Figure 2. A placebo test for pilot policies to provide information benefits.

In addition, we believe that the pilot policy of information benefit has certain spatial spillover effects. For this reason, we draw on Cao Qingfeng (2020) [44], and take the counties of Lhasa City as a reference. We select the counties whose minimum distances from these counties are in the range of 0–50, 50–100, 100–150, 150–200, 200–250, 250–300, 300–350, and 350–400, respectively, A total of 9 groups of counties within 400–450 km are used as experimental groups for double difference regression, and the regression equation is shown in the following equation, where β_d is the coefficient we are interested in.

$$Y_{ct} = \beta_0 + \sum \beta_d D_d + \alpha_1 treatment_c + \alpha_2 post_t + \sum \beta_m control_m + \eta_c + \gamma_t + \varepsilon_{ct} \quad (11)$$

Figure 3 reports the estimation results of the coefficient β_d. Specifically, with the increase in the distance to the pilot counties of information beneficence, the driving effect of the pilot policy of information beneficence on the entrepreneurial activity in the neighboring counties (districts) will show a tendency to become smaller, then larger, and then smaller. According to the conclusion of the classic new economic geography, the development of a city has a siphon effect rather than a spillover effect on the cities within a certain range of the neighborhood. Combined with Figure 3, it can be seen that the pilot policy of information beneficence reduces the entrepreneurial activity of other counties in the range of 100–200 km in the surrounding area and has a significant impact on the entrepreneurial activity of the neighboring counties in the range of 200–400 km in the surrounding area. The spatial spillover effect of the Information Beneficence Pilot Policy is no longer significant after exceeding 400 km. Therefore, Hypothesis 3 presented in this paper has been verified.

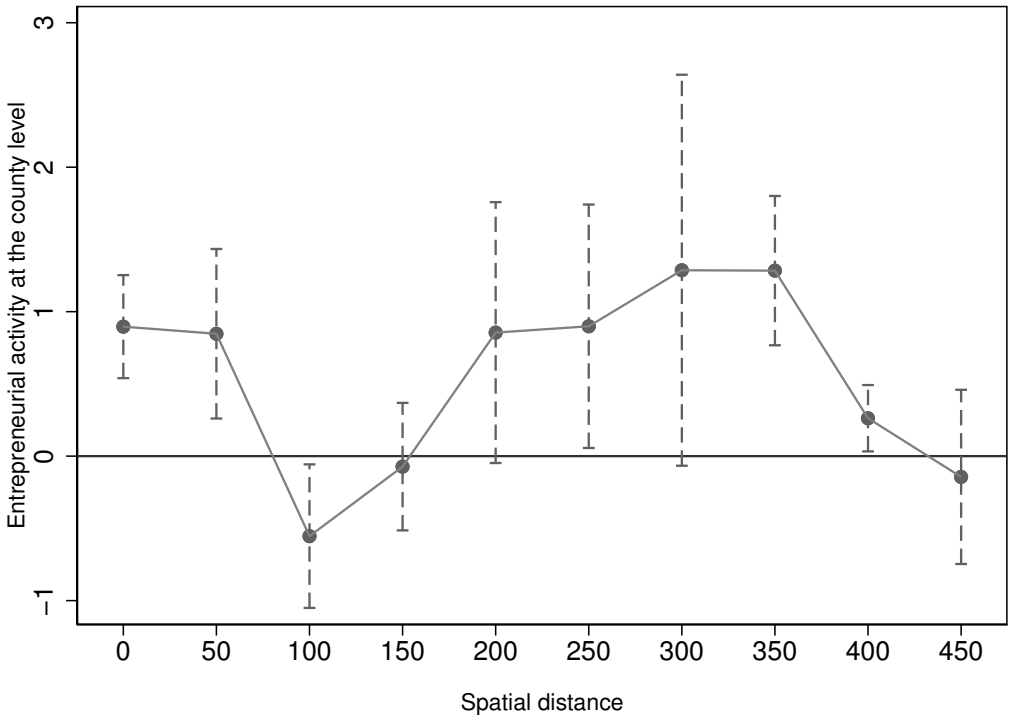

Figure 3. Spatial spillover tests for pilot policies on information for people.

4.2.4. Other Robustness Tests

To enhance the reliability of the baseline regression outcomes, this paper delves deeper into the effects of pilot information beneficence policies on entrepreneurial activity by employing the PSM-DID methodology. Initially, the likelihood of each county being designated as an information beneficence pilot region is predicted through the utilization of control variables outlined in the preceding section (via logit regression). Subsequently, various matching techniques—including radius matching, kernel matching, and nearest-neighbor matching—are applied to identify a suitable control group for the counties that have been actually chosen as pilot regions. This rigorous process ensures minimal disparities between the treatment and control groups prior to the implementation of the pilot program, thereby significantly reducing any potential experimentation bias arising from sample self-selection issues. Then, on this basis, double difference estimation is performed to obtain more robust results. The regression results are shown in Table 3. Columns (1)–(3) present the estimation results obtained through radius matching, kernel matching, and nearest-neighbor matching, respectively. Evidently, the estimated coefficients, signs, and significance levels across these various matching methods align consistently with the benchmark regression results tabulated in Table 2. Thus, the Information Benefit Pilot has a significant positive impact on entrepreneurial activity.

The benchmark results are further checked for robustness using the entropy balance method, which, unlike PSM-DID, is able to simultaneously control the multidimensional balance of covariates of the samples in the treatment and control groups. It can simultaneously take into account the first-order moments, second-order moments, third-order moments, and crossover moments of the covariates. Thus, it enables the two samples to be accurately matched. Column (4) of Table 3 reports the double difference estimation results of entropy-balanced matching. It can be seen that the estimated coefficients of entropy-balanced matching are larger than those of PSM-DID, but the difference is not significant. The sign and significance are consistent with the benchmark results, which once again verifies the robustness of the conclusions of this paper.

Table 3. Model estimate results.

VARIABLES	1	2	3	4
DID	0.429 ***	0.425 ***	0.418 ***	0.564 ***
	(0.160)	(0.153)	(0.156)	(0.131)
Control	YES	YES	YES	YES
State FE	NO	YES	YES	YES
Year FE	NO	NO	YES	YES
Observations	1022	1015	1100	1155
R-squared	0.881	0.856	0.856	0.864

Notes: *** $p < 0.01$.

5. Main Conclusions and Recommendations

5.1. Main Conclusions

This paper constructs a new economic geography model to analyze the impact of digital transformation on entrepreneurial activity at the theoretical level. The theoretical analysis suggests that digital transformation can promote regional entrepreneurial activity and proposes relevant hypotheses to be tested.

Based on the panel data of Tibetan counties from 2001 to 2021, the impact of digital transformation on regional entrepreneurial activities is examined using the double-difference estimation method with the quasi-natural experiment of "National Pilot Policy of Information Benefiting the People". The empirical study finds that urban digital transformation can indeed increase regional entrepreneurial activity. According to the regression coefficient, digital transformation can promote regional entrepreneurial activity by 0.248 units on average. This empirical result confirms Hypothesis 1. The better the urban network infrastructure before digital transformation, the better the policy effect. This empirical result confirms Hypothesis 2. Second, using event analysis, we find that the effect of digital transformation on entrepreneurial activity is somewhat persistent at the time level, which is manifested in a gradual increase of the effect in the four years after the implementation of the policy, followed by a decrease. In addition, we find that the effect of digital transformation on entrepreneurial activity has a certain spatial spillover effect, which is negative within 100–200 km of the pilot city and positive within 200–400 km. This empirical result confirms Hypothesis 3. In line with our research findings, certain scholars have also discovered the influence of China's digital government policies on entrepreneurial activities using city-level data. They also confirmed that government digital governance significantly and positively affects entrepreneurial endeavors [45]. However, they did not perform a deeper heterogeneity test of the empirical outcomes and neglected to explore the spatial spillover effects of digital governance on such activities.

5.2. Recommendations

First, we should summarize the experience of the "Information for the People Pilot City" in Tibet and expand the scope of the pilot project. Our findings show that the digital transformation of cities has a significant effect on entrepreneurial activity. Therefore, it is necessary to summarize the experience and further improve the top-level design, strengthen the institutional design of policies in terms of data sharing, digital governance, and precise services, and accelerate the digital transformation of other regions to continuously stimulate regional entrepreneurial vitality.

Secondly, it is necessary to strengthen the leadership of digital technology, deepen the reform of government services, giving full play to the advantages of digital technology in information collection, data processing, analysis, and sharing, embed digital technology into the process of entrepreneurial and innovative government services and the concept of government services, and achieve the unity of technological change and conceptual change. It will also promote the construction of a digital government based on big data

and break down the digital barriers to the construction of a "unified market" through the digital transformation of the city.

Thirdly, policy implementation should focus on reducing costs, promoting entrepreneurship and innovation, and rallying talents to enhance the well-being of enterprise workers. It should continuously optimize the business environment, reduce systemic transaction costs, improve online communication mechanisms for entrepreneurial activities, stabilize the expectations of entrepreneurs through information disclosure, and increase entrepreneurial enthusiasm. It is necessary to regularly promote entrepreneurship-related policies to entrepreneurs so that entrepreneurs can enjoy the policy dividends of entrepreneurship and innovation. It is also necessary to actively expand the scope of mobile entrepreneurship-related government services, improve the quality of services, attract talent concentration, and provide strong support for high-quality economic development.

Fourthly, we should actively promote the construction of network infrastructure throughout Tibet. Our research shows that the level of network infrastructure has a strong influence on the policy effects of digital transformation. The better the network infrastructure, the better the digital transformation policies play out.

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