Digital Village Construction and County Population Return: A Quasi-Natural Experimental Study Based on "National Integrated Demonstration County of E-Commerce in Rural Areas"

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**Abstract**

Abstract: In the context of rural revitalization strategy and the increasing prominence of "big city disease", how to effectively achieve population decentralization and promote balanced development of urban and rural areas is an important challenge for China's economic and social development. This paper is based on the theory of population potential energy transformation. is a quasi-natural experiment based on the "national e-commerce into rural integrated demonstration counties" (referred to as "digital business to promote agriculture"). , using county-level panel data from 2010 to 2019 and the dynamic monitoring of mobile population in 2017. The study uses OLS, Probit, multi-period DID, PSM and event study methods to explore the impact and mechanism of the return of population to the county. The study shows that: (1) the effect of digital business promotion on population return to counties is significant, among which, the promotion effect of digital business promotion on population return to counties and towns is more significant compared with rural areas, and the results are still significant using multiple estimation strategies; (2) the heterogeneity analysis shows that the effect of digital business promotion on population return to less developed regions such as central, western and northeastern regions is significant, but the effect on population return to developed regions such as eastern regions is not significant; (3) the effect of digital business promotion on population return to counties and towns is not significant; (4) the effect of digital business promotion on population return to counties and towns is not significant. (3) The first digital divide represented by ICT and the second digital divide represented by human capital negatively moderate the relationship between NCBR and population return. and the level of local public services also positively moderate the relationship. ; (4) The analysis of the mechanism of action shows that economic development, industrial structure optimization and income growth play an important mediating role in NCBR leading to population return. The analysis shows that economic development, industrial structure optimization and income growth play an important mediating role in the return of population to the country. To sum up, in the future, we should strengthen the cultivation of vocational skills and digital literacy of returning residents, promote urbanization construction with county cities as the important carrier, and improve county public services, so as to better utilize the policy effect of digital business to promote the return of population to the county.

**JEL classification numbers:** J12, L14.

**Keywords:** digital countryside, population return, e-commerce into rural areas, comprehensive demonstration counties, digital divide, digital business to promote agriculture

1. Introduction

Since the reform and opening up, driven by better employment opportunities, higher wages and better public services, China's labor force has shown a trend of migration from rural areas to cities and towns, and from small and medium-sized towns to large cities (especially mega cities) (Ran and Xu, 2005; Sun, 300 et al., 2012; Li Qiang, 2003; Xia Yiran and Lu Ming, 2015). While promoting economic growth and increasing residents' income (Xie, 2012; Peng, 2015; Xu and Li, 2008), population migration has also brought a series of social governance and economic development problems, such as "big city disease" and rural decay (Koo et al., 2013; Wang and Zhang, 2001; Liu, 2014), which is one of the important factors causing the unbalanced and insufficient development of urban and rural areas in China (Zeng et al., 2021; Wang, 2008; Liu, 2007). Therefore, how to promote the return of population to the county as well as to achieve a reasonable distribution of population in urban and rural areas has become an important task and challenge for China's economic and social development, and an important issue of concern for the academic community.

For a long time, scholars have conducted many discussions on issues such as the influencing factors of population return from both theoretical and empirical dimensions. In terms of theory, domestic and foreign scholars have explored from different disciplinary perspectives, mainly including push-pull theory, neoclassical economics, new migration economics, life-cycle theory, human capital theory, and social network theory. Push-pull theory puts forward the basic framework of population migration, pointing out that the push of the inflowing place and the pull of the outflowing place jointly drive population migration (Lee, 1966); neoclassical economics believes that whether the mobile population returns depends on the mobile population's measurement of the costs and benefits of mobility, and when the mobile population does not get the expected income or the economic and psychological costs are too high resulting in the inability to maximize income, the mobile population will make the decision to return (Lewis and Notes, 1954; Todaro, 1969; Krieger, 2008). The new migration economics, on the other hand, shifts the subject of interest maximization from the individual to the household, stating that the decision to migrate depends on collective household expectations (Stark, 1982). Life cycle theory divides migration into two stages, i.e., working when young and returning when old, and even in the absence of exogenous push and pull forces, migrating laborers who reach a particular stage of their "life cycle" will return home as expected (Davies et al., 1991). Human capital theory suggests that educational attainment and human capital are important influences in labor force return decisions, and that migrant workers with lower human capital are disadvantaged in terms of wages and benefits and are prone to return decisions (Thomas, 2008). Social network theory, on the other hand, emphasizes the importance of social ties and social network relationships in outflow locations in population migration (Massey et al., 1993; Li et al., 2021).

More scholars have studied the factors influencing the return of population at the empirical level. In terms of individual factors, education level, age, and marital status all influence the decision to leave and return to China (Wang and Zhao, 2013); in terms of family factors, some scholars believe that family factors have a greater influence on individual return decisions, and laborers are more likely to return to China when there are elderly people in need of care, children left behind, and spouses. In addition, social capital and human capital within the family also have a positive impact on laborers' decision to return home (Li and Long, 2009). In terms of economic factors, the difference in economic level between the inflow and outflow places has a stronger influence on the willingness to return, and the economic recession in the inflow place significantly enhances the willingness of mobile labor to return (Constant and Massey, 2002), while the developed non-agricultural industries, sufficient employment opportunities, good employment environment, good infrastructure, better quality of education, and higher level of medical care in the outflow place have a positive influence on migrant workers' return (Wang,l., 2014). In terms of institutional culture, many special factors in China have received attention from scholars; the constraints of the household registration system (Li et al., 2012) and the supportive policies of the frequent inflowing places (Qin et al., 2014) have contributed to the return of outgoing laborers, in addition to the immigrant culture of settling down and re-locating, the broad and ambiguous family responsibilities, and ethical concepts have profoundly influenced the return of the population.

By analyzing the existing literature, we can find that: first, the existing theoretical studies on population return mainly draw on the traditional population migration theory, which focuses on population outflow. Currently, driven by the rural revitalization strategy and urban cluster development strategy, etc., population return is both a need for economic and social development and a new population migration trend that is taking place. Therefore, it is particularly important to explore the mechanisms and patterns of population return under the new situation. Second, previous empirical studies on the influencing factors of population return have mainly focused on demographic characteristics, lacking attention to relevant policies such as rural revitalization strategy and digital village construction, which have many impacts on county economic and social development, which may in turn be transmitted to population return. In particular, it should be noted that the 20th Party Congress proposed to "comprehensively promote rural revitalization and adhere to the priority development of agriculture and rural areas", which is not only the top-level design for future rural and county economic and social development, but also constructs a good macro policy environment for the return of population to the county. In view of this, studying the policy effects of rural development in China and the impact on population return can provide scientific guidance for future population distribution prediction and population policy optimization in urban and rural areas.

In recent years, along with the continuous promotion of Digital China and the construction of digital countryside, the digital economy is profoundly changing the economic and social operation mode of China. Through the superposition, penetration and proliferation of data technology, data elements and digital infrastructure, the digital economy has alleviated many defects faced by the rural economy, such as poor flow of production factors (Wen et al., 2018), poor operation of the value chain (Hong and Zheng, 2009), and poor supply and demand chain obstruction (Liu, 2003). Further, some scholars have argued that the digital economy, as a new economic form that accelerates the reconstruction of economic development and governance models, has high growth, strong diffusion and cost reduction (Wang, Yu, and Fu, 2021), which not only provides technical support for agriculture to improve production efficiency, but also greatly releases the vitality of rural innovation (Chen, Y., 2021). In addition, some scholars believe that the digital economy is a new means and tool to support the comprehensive revitalization of rural areas by building a virtual space twinned with the "physical world" and the "digital world" to empower agricultural production, rural circulation, social governance, life patterns, cultural concepts, and other application scenarios (Chen, 2021). It is a new means and tool to support the comprehensive revitalization of the countryside (Young, 2019). In view of this, the state has introduced the policy of "comprehensive demonstration counties of e-commerce into rural areas" (referred to as "digital business to promote agriculture").

Currently, studies on the effects of digital commerce policies on rural development focus on rural industrial structure and rural residents' income. For example, Tao et al. (2022), based on panel data of 1858 counties across China from 2000 to 2020, found that the comprehensive demonstration policy of e-commerce into rural areas reduced the proportion of primary industries in county economies and further optimized the structure of non-agricultural industries, increased the proportion of service industries, and prompted the transformation of county economies to tertiary industries; Wang Qi et al. (2021) similarly (2020), based on county-level data in China, found that e-commerce development has a significant driving effect on county economies; Tang Yuehwan et al. (2020), based on county-level panel data, found that the comprehensive demonstration policy of e-commerce into rural areas can raise local farmers' per capita income by about 3%. So, can digital commerce promote the return of population in counties?

In order to accurately analyze the causal relationship between digital commerce and rural development and population return in counties, this paper is based on county-level data in China from 2010-2019, and uses a quasi-natural experiment in which the Ministry of Finance, the Ministry of Commerce, and the State Council Leading Group Office of Poverty Alleviation and Development jointly and gradually carried out comprehensive demonstration counties of e-commerce into rural areas from 2014-2017 to study the the impact of digital commerce on the return of population to China's counties. The possible marginal contributions of this paper are: (1) to analyze the impact of digital village construction on the return of rural population, and to identify the cause and effect of the quasi-natural experiment of "national comprehensive demonstration counties of e-commerce into rural areas", which can contribute to rural revitalization and "big city disease". (2) we analyze the mechanism of the digital business policy on the return of population to the county from both theoretical and empirical aspects, which makes up for the deficiencies of the literature; (3) we analyze the policy effect of digital business on the return of population from the change of the return pattern, which provides a scientific basis for policy optimization.

1. Theoretical analysis and research hypothesis

The literature on regional government policies and regional population mobility is often analyzed based on the traditional push-pull theory (Hauser and Duncan, 1959; Bogue, 1959), but the push-pull theory ignores the issue of migrating population itself - human capital differences, while the construction of digital villages involves regional economic The digital village construction involves regional economic development, which has higher requirements for human capital, and for this reason, we draw on the potential energy transformation theory of population migration for analysis. This theory is based on the basic assumption of rational human beings, which believes that the differences between the individual (internal) and the external environment of the place of migration and departure together constitute the migration potential, i.e., migration potential energy, and this potential energy stimulates the migration motivation or tendency of the population, and this migration motivation and tendency need intermediate realization channels to be transformed into actual migration behavior. Population migration behavior depends not only on the driving force generated by the interaction of intrinsic needs and the surrounding environment, but also on the realization channel that transforms the demand motivation into real migration behavior (Xiao , 2010). Aiming at the theory of population potential energy transformation and combining the characteristics of digital technology, this paper analyzes three aspects: individual potential energy, regional potential energy and realization channels.

First, from the perspective of individual potential, the outflow population is more compatible with digital technology characteristics than the local population, and the outflow population is more likely to enjoy the dividends of digital village construction, and this excess benefit attracts the outflow population to return. On the one hand, from the viewpoint of digital technology itself, high human capital level is more likely to enjoy high digital benefits. First, the higher the education level, the greater the exposure to digital technology and the more proficient the individual is in mastering Internet skills (Hargittai, 2005) and enjoying the "information benefits" of the digital age (Vicente and López, 2011), thus being in an advantageous position in the digital divide. The second is the age factor, with younger people being more receptive to digital technology than older people (Scheerder et al., 2017), and this difference also exists among older people, with younger older people being more receptive to digital technology (Peacock and Künemund, 2007); the third is the gender factor, with men being more likely to enjoy digital benefits than women. digital benefits, and the European Commission (2012), using personal and household data from the EU, Norway, and Iceland to estimate the frequency of Internet use, found that factors such as younger age, male gender, living in urban areas, higher income levels, and employment or labor force participation positively influenced Internet use. (Chen, and Huang, 2003) On the other hand, in terms of outflow population characteristics, the outflow population is younger, more educated, and more male dominated relative to the outflow population (Liu, and Jiang, 2019). Therefore, the coupling of the two aspects leads to a stronger attraction of digital village construction to the outgoing population.

Second, from the perspective of regional potentials, economic interests are the main factors influencing population return (Wang and Ye, 2006). On the one hand, the difference in the level of economic development at the regional level is the most important driving mechanism of population movement under the conditions of reform and opening up in China. Currently, the differences in economic development levels between regions form external potentials for population migration that vary in height from region to region, making it possible for the population to migrate and flow from regions with low levels of economic development to regions with high levels of economic development (Chen, and Wang, 2018; Gao, 1995). On the other hand, at the individual level, differences in expected employment opportunities (Zhou, 1997) and expected income (Institute of Demography, Chinese Academy of Social Sciences, 1997) between regions are the direct causes of migration, and as rational people, when access to increased employment opportunities and increased monetary income in the place of migration will directly drive the population to move out (Zhang and Tang, 2008). The construction of digital countryside takes digital technology innovation as the core driver of rural revitalization, realizing scientific production, visualization of governance, intelligent life and convenient consumption in rural areas, while "digital countryside" broadens the business boundary of traditional industries and accelerates the cultivation and growth of new industries, new modes and new business models in rural areas (Xia et al., 2019). This multifaceted enhancement has led to a further narrowing of the economic development level between rural and urban areas, providing an opportunity for population return. In terms of employment, the spread of digital technology has brought more advanced production technologies and thus improved production efficiency, which has led to the transformation of the industrial structure in rural areas and even counties, thus providing more employment opportunities; in terms of income, economic forms such as digital platforms have expanded the market accessibility of local products and changed the status of local producers as price takers; not only that, e-commerce such as Taobao, Jingdong, and Jindo have broken the agricultural product buyers pricing power, thus allowing local producers to gain more revenue, thus driving up the overall income level within the county (Zeng et al., 2018).

Finally, from the perspective of realization channel, migration behavior is the migration potential or potential energy formed by environmental forces and individual forces, which needs to be transformed into real migration behavior through the realization channel. The popularity of digital technology brought by the construction of digital villages can significantly compress the time and cost of information transmission, and the out-migrants can more comprehensively understand and grasp the development status of the out-migration place (Chen, Tan, and Wang, Peng, 2020); not only that, the instantaneous communication performance of information unique to digital technology makes it more convenient for out-migrants to maintain local social relationships, (Lu, 2020) This two-way transmission efficiency is enhanced makes information completely symmetrical, thus making it easier for out-migrants with return intentions to transform into return behavior.

Based on the above analysis, the following research hypotheses are proposed:

(1) The construction of digital villages has a catalytic effect on the return of local population.

(2) Digital village construction further promotes population return by boosting regional economic development, increasing residents' income and optimizing employment structure.

In response to the characteristics of population mobility, some scholars believe that the mobile population will continuously match the level of economic environment according to their own and family levels in the process of mobility, showing a gradual upward mobility phenomenon, i.e., stepwise mobility (Du, Peng, and Zhang, Aviation, 2011). So does this phenomenon still exist among the returning population? Compared with rural areas, counties have approximate urban life, better public services, more employment opportunities, and relatively higher income, etc. Meanwhile, under the rural revitalization strategy, the digital countryside construction implemented by the state is often county-based, and some scholars point out that e-commerce, one of the representatives of digital countryside, is more capable of achieve the continuous clustering, creation and upgrading of industries in the county, thus boosting local employment (Xu Chan et al., 2015), and for this reason, this paper puts forward the following hypothesis:

(3) The construction of digital villages has prompted the returning population to prefer the county and townships to the rural areas.



Figure 1 Digital village construction and population return

1. Study Design
	1. Policy Background

In July 2014, the Ministry of Finance and the Ministry of Commerce jointly issued a notice on the comprehensive demonstration of e-commerce in rural areas. Each county (city) included in the list can receive about 20 million yuan of financial support from the central government, and these funds are mainly used for (1) the construction of county-level e-commerce public service centers; (2) the construction of town and village e-commerce service site systems; (3) the construction of county and village three-level logistics and distribution systems; (4) the construction of standardized systems and uplink systems for agricultural products ; (5) rural e-commerce skills training systems In 2015, the Ministry of Commerce, the Central Internet Information Office and the Development and Reform Commission jointly issued the "Thirteenth Five-Year Plan for E-Commerce", which proposed to actively carry out e-commerce into rural areas to achieve the number of business farmers. 2018, the General Office of the State Council incorporated this policy into 30 major In 2021, the Ministry of Commerce, the Central Internet Information Office and the Development and Reform Commission continued to launch the "Fourteenth Five-Year Plan" for e-commerce development, highlighting the integration of e-commerce with one, two and three industries, promoting the revitalization of rural industries and the construction of digital countryside, and vigorously implementing the "In 2022, the No. 1 document of the Central Government further specifies the implementation of the "digital business development" project to realize the empowering effect on the rural business sector, comprehensively improve the digitalization, networking and intelligent level of the rural business sector, and promote high-quality rural e-commerce, It will promote the high-quality development of rural e-commerce, which will in turn support and promote the development of agricultural production and the revitalization of rural industries (Xu, 2022).

From the perspective of policy strength, by the end of 2021, the comprehensive demonstration project of e-commerce into rural areas has accumulated support for 1338 counties, including the first batch of 56, the second batch of 200, the third batch of 240, the fourth batch of 260, the fifth batch of 260, the sixth batch of 164, the seventh batch of 148. Central financial funds accumulated investment of about 10 billion yuan, local financial investment of more than 16 billion yuan, by the end of 2020, the country completed 2120 county-level public service centers for electric business and logistics distribution centers, 137,000 village-level electric business service sites, basically to achieve full coverage of express network townships (Tao et al., 2022). From the perspective of policy effects, in 2021, the national rural network retail sales of 2.05 trillion yuan, an increase of 11.3% year-on-year, the growth rate accelerated by 2.4% compared with the previous year. Sichuan, for example, in the rural e-commerce product brands successfully cultivated "Yajiang matsutake", "Qing Shen bamboo weave", "Wenchuan sweet cherry" and other agricultural products online marketing characteristics of the brand more than 400 In addition, there are more than 500 e-commerce enterprises. The implementation of the digital business to promote the implementation of agricultural network sales in Sichuan Province continued to improve, achieving an average annual growth rate of more than 50% between 2015 and 2020. According to a sample survey of major agricultural markets in Sichuan Province, the cold chain circulation rate of fruits and vegetables, meat and aquatic products increased by 17 percentage points, 20 percentage points and 19 percentage points respectively compared with 2010, and the scale and standardization of cold chain logistics have been significantly improved. In general, the construction of "national e-commerce into rural areas comprehensive demonstration counties" has significantly improved the development of e-commerce in rural areas, both in terms of policy strength and policy effect.

* 1. Model setting

As an integral part of digital village construction, digital business development provides a good policy basis for this paper to study the relationship between digital village construction and population return. The implementation of the digital business development project will produce pre- and post-policy and inter-county differences for counties, so this paper adopts the double-difference-in-differences (DID) method. dID can control for the above two differences and more accurately identify the net effect of digital village construction on population return. During the policy pilot period, the construction of demonstration counties was approved in batches, so the timing of the policy's impact was not consistent. For this reason, this paper adopts a multi-temporal double-difference approach. The following double-difference model was developed for identification, drawing on the setting method of Callaway et al. (2020), as follows:

 (1)

where the subscript i denotes county and the subscript t denotes time; the explanatory variable is the degree of population return in county *i* in year *t, which is* expressed by the net population inflow growth rate in this paper; is a dummy variable for the number of business pro-agriculture policies, and takes 1 when county *i* is selected as a model county in year *t* (in that year and thereafter), otherwise takes 0; represents a set of control variables for county *i in year t*; with represent urban and year fixed effects, respectively; in equation (1) if the value is greater than 0, it means that the construction of the demonstration county has promoted the population flow into the county compared with the control counties.

* 1. Data sources

The data in this paper are mainly divided into 3 parts: (1) The list of comprehensive demonstration counties of e-commerce into rural areas and the corresponding implementation years are obtained from the data disclosed on the official website of the Ministry of Commerce . (2) County-level control variables are mainly from the 2010-2019 China County and City Economic and Social Statistical Yearbook and China's Revolutionary Old Areas. The China County and City Economic and Social Statistics Yearbook provides comprehensive statistics on the population, gross domestic product, industrial structure, fixed asset investment, financial development, and human capital development in China's counties, providing detailed research data for this paper. (3) In the further analysis section later, we use individual-level data: the Monitoring of Mobility Dynamics Data (CMDS). After merging the county panel data, on the one hand, the missing variables are excluded; on the other hand, the selection of model counties does not involve the more economically developed cities, so the more economically developed first-tier cities are further excluded from the sample in this paper; municipal districts and county-level cities are better than ordinary counties in terms of both policy support and economic level, so municipal districts and county-level cities are further excluded in this paper. In addition, in order to more accurately represent the return of population in the county panel data, we take 2010 as the base year and remove the counties with population inflow.

* 1. Variable definition

1. Explained variables. The population return (RP), due to the lack of statistics on population return at this stage, is expressed by the net population inflow growth rate, which is calculated as follows: define the total population at the end of the year as Tp, the household population as Hp, and the year as t, then RP = (Tpt -Tp2010 )/Tp2010 -(Hpt -Hp2010 )/Hp2010 . This indicator reflects the relative growth rate of the resident population excluding the growth rate of the household population, as shown in Table 1.

2. core explanatory variables.

In this paper, we choose the dummy variable of the number of businesses to promote agriculture as the core explanatory variable, which takes the value of 1 when a county is approved as a "national comprehensive demonstration county of e-commerce into rural areas" in the year of approval and the following years, and 0 otherwise.

3. Control variables.

Population return is also influenced by other factors, and this paper controls for the level of government expenditure (logarithm of total fiscal expenditure, denoted by GE), government revenue (logarithm of local budget revenue, denoted by MS), financial level (logarithm of year-end loans from financial institutions, denoted by FD), human capital level ( the ratio of the number of secondary and elementary school students enrolled in school to the household population, denoted by HC), ICT infrastructure level (the ratio of the number of fixed telephone subscribers to the total number of households, denoted by ICT), industrial development level (the ratio of the value added of the secondary industry to GDP, denoted by IC), population density (the ratio of the total population to the area of the county, denoted by PD), the share of agricultural industry (the ratio of the value added of the primary industry to GDP expressed by AD).

3. Other variables.

The county economic level (logarithm of GDP per capita, denoted by EC), rural residents' income level (logarithm of disposable income per capita of rural residents, denoted by AI), urban and rural residents' income (logarithm of disposable income per capita of urban residents, denoted by CI), primary industry employment level (ratio of employment in the primary industry to total employment, denoted by AW), secondary industry employment level (the ratio of employment in the secondary industry to total employment, denoted by IW), employment level in the tertiary industry (the ratio of employment in the tertiary industry to total employment, denoted by TI).

Table 1 Descriptive statistics

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable Symbols | Variable Name | Sample size | Average value | Standard deviation |
| PR | Return of population | 10910 | -0.054 | 0.048 |
| Eco\_ount | E-commerce pilot | 10910 | 0.177 | 0.382 |
| GE | Government spending levels | 10910 | 12.336 | 0.601 |
| FD | Level of financial development | 10910 | 13.234 | 1.042 |
| MS | Government Revenue | 10910 | 10.854 | 1.069 |
| HC | Human Capital Level | 10910 | 11.495 | 3.283 |
| ICT | ICT infrastructure level | 10910 | 10.412 | 8.732 |
| ID | Industrial development level | 10910 | 0.202 | 0.118 |
| AD | Level of agricultural development | 10910 | 0.427 | 0.159 |
| PD | Population density | 10910 | 0.030 | 0.028 |
| EC | Economic Development Level | 10910 | 35355 | 29303 |
| AI | Income level of rural residents | 10092 | 9.096 | 0.515 |
| CI | Income of urban and rural residents | 8355 | 9.680 | 0.376 |
| AW | Employment level of primary industry | 2716 | 0.471 | 0.174 |
| IW | Secondary industry employment level | 2716 | 0.245 | 0.132 |
| TI | Tertiary industry employment level | 2716 | 0.284 | 0.110 |

1. Empirical Analysis
	1. Baseline regression

Based on the previous setting, this paper relies on equation (1) and gradually adds control variables to the regression, and the results are shown in Table 2. Model (1) is a univariate regression result, and when controlling only for time and individual fixed effects, the regression coefficient of Eco\_count is positive and significant at the 1% level, indicating that the construction of model counties significantly contributes to the increase in the level of population return in the county, and the level of population return increases by 0.9% compared to non-model counties. The regression coefficient of Eco\_couny remains significantly positive and does not change significantly after the stepwise inclusion of control variables in models (2) to (9). This suggests that the conclusion that the number of businesses promoting the return of population is robust to controlling for other factors influencing the return of population, and hypothesis 1 holds.

Table 2 Baseline return

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  | Explained variable: population return |
|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Eco\_count | 0.009\*\*\* | 0.009\*\*\* | 0.009\*\*\* | 0.008\*\*\* | 0.008\*\*\* | 0.007\*\*\* | 0.007\*\*\* | 0.007\*\*\* | 0.008\*\*\* |
|  | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| GE |  | -0.009\*\* | -0.009\*\*\* | -0.005 | -0.002 | -0.002 | -0.002 | -0.002 | -0.002 |
|  |  | (0.003) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| FD |  |  | 0.003 | 0.004 | 0.005\*\* | 0.004\* | 0.005\* | 0.005\* | 0.004\* |
|  |  |  | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| MS |  |  |  | -0.007\*\*\* | -0.007\*\*\* | -0.007\*\*\* | -0.007\*\*\* | -0.007\*\*\* | -0.006\*\* |
|  |  |  |  | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| HC |  |  |  |  | -0.000\*\*\* | -0.000\*\*\* | -0.000\*\*\* | -0.000\*\*\* | -0.000\*\*\* |
|  |  |  |  |  | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ICT |  |  |  |  |  | 0.000\*\*\* | 0.000\*\*\* | 0.000\*\*\* | 0.000\*\*\* |
|  |  |  |  |  |  | (0.000) | (0.000) | (0.000) | (0.000) |
| ID |  |  |  |  |  |  | 0.013 | 0.010 | -0.004 |
|  |  |  |  |  |  |  | (0.018) | (0.017) | (0.021) |
| PD |  |  |  |  |  |  |  | 0.779\*\* | 0.766\*\* |
|  |  |  |  |  |  |  |  | (0.389) | (0.389) |
| AD |  |  |  |  |  |  |  |  | -0.013 |
|  |  |  |  |  |  |  |  |  | (0.010) |
| Time fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Regional fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 10910 | 10910 | 10910 | 10910 | 10910 | 10910 | 10910 | 10910 | 10910 |
| R2 | 0.210 | 0.210 | 0.211 | 0.212 | 0.216 | 0.217 | 0.217 | 0.219 | 0.219 |

* 1. Parallel trend test and dynamic analysis based on event study method

An important prerequisite for using the double difference method to test the effect of the counting business promotion policy on population return is the assumption that there is no policy shock and that the trends between the experimental and control groups are the same and do not deviate systematically over time. Therefore, the model needs to test whether the trends of population return movements are the same between the treatment and control groups before using the double difference method for assessment. In addition to this, there may be lagged effects and dynamic changes in the effects of the construction of model counties. For this reason, this paper adopts the idea of Event Study (Fama, 1991) to test the dynamic effects of parallel trend premise assumptions and policy implementation. The specific model is set as follows:

..... . (2)

where denotes the dummy variable for the "event" of the number of farmers. In the kth year before county i is awarded the policy pilot in year t, the takes the value of 1; when county i gets the policy pilot in year t, in the kth year after takes the value of 1; otherwise The selection of control variables is consistent with the baseline regression. In order to visualize the dynamic changes of the "event" of business development, the estimated coefficients at 95% confidence intervals are plotted based on the regression results.



Figure 2. Parallel trend and dynamic test

As can be seen from Figure 2, in the first seven years of the policy shock, the estimates are not significant, indicating that there is no significant difference in the population return trend between the treatment group and the control group before the policy pilot in the demonstration counties, which indicates that the hypothesis of parallel trend is valid; in the second five years of the policy pilot, the difference between that year and the first year The coefficient is not significant, which shows that there is a time lag in the effect of the policy pilot on population return and there is no expected effect, but there is a continuous increase in the trend of population return from the second year to the fourth year, which indicates that the effect of the policy on population return gradually increases. There is a decline in the trend of population return in the fifth year, which may be due to the small sample size with only the 2014 policy pilot entering the model test.

* 1. Robustness test
		1. Placebo test

Although this paper has controlled for county characteristics variables in the baseline regression, there may still be some non-observed county characteristics factors that make the estimation of population return by the number of business promotion policies influential. In traditional simultaneous point double difference, it is sufficient to randomly select counties equal to the number of demonstration counties from all sample counties as the treatment group. However, there is a time difference in the policy shock time of the demonstration counties in the multi-temporal double difference, and it is necessary to generate a pseudo-treatment group and a pseudo-control group at the same time randomly, i.e., a sample period is randomly selected for each sample object as its policy time. In view of this, to further ensure the robustness of the estimation results, this paper uses the following placebo test: in the previous benchmark regression, 26, 98, 125, 134, 147, and 90 demonstration counties from 2014 to 2019 are counted in the regression analysis, respectively, and in accordance with the policy time order of the demonstration counties in the benchmark regression, the stata software is used to construct the pseudo The 500 shocks of model counties to 1091 sample counties were obtained by using stata software to obtain 500 sets of dummy variables ; the 500 kernel densities and their p-value distributions are presented in the figure, and the results are shown in Figure 3. The random treatment process of mainly concentrated around 0, while the estimated coefficient of the actual policy is 0.008, which is significantly lower than the placebo test result. This also reflects from the side that the quantitative assessment results of this paper were not significantly affected by this potential factor. The estimated results are robust.



Figure 3 Placebo test

* + 1. Model selection problem: PSM-DID

The selection of demonstration counties, especially after 2015 tends to select poor counties and old revolutionary counties as demonstration counties, therefore, the pilot of the policy may not be completely randomized, and simply treating them as treatment and control groups based on the policy pilot may violate the parallel trend assumption, for this reason, this paper draws on Yi, Famin et al. (2021) and applies the propensity score matching-double difference method ( PSM-DID) to further treat the sample. In this paper, based on the method proposed by Imbens (2015) for comparing the great likelihood values of Logit models, five first-order covariates for matching are screened from the logarithm of fixed asset investment, the logarithm of fiscal budget expenditure, the logarithm of year-end loans from financial institutions, health services (logarithm of the number of beds in hospitals and health centers), and basic education (logarithm of the number of students enrolled in secondary schools); using After estimating the propensity scores using the above covariates, a period-by-period matching was conducted by referring to the one-to-one matching method of Liu Ye et al. (2016) to find the uniquely matched control group counties for each year of the policy treatment group counties. After matching and removing the one treatment group county that failed to succeed, finally this paper obtained 214 treatment counties affected by the policy and 172 control group counties matched with it. The regression results are shown in the first column of Table 2. The regression coefficients are lower and the significance level is also lower, which may be caused by the time lag of the policy due to the short selection of the policy sample time interval.



Figure 4 Kernel density of propensity scores before and after matching

* + 1. Policy interference problem

As an important government project for the construction of digital villages, other similar policies in the time window of 2014-2019 may bias the estimation of this paper. Since 2014, the Ministry of Agriculture and Rural Affairs has carried out the project of "Rural Information into Villages and Homes"[[3]](#footnote-3) . The project is a basic project for "Internet+" modern agriculture in rural areas, and the operation system of "provincial operators + county-level operation centers + village-level agricultural information societies" is built to solve the problem of information entering villages and households. The problem of "the last kilometer". There are similarities between this pilot project and this paper. In order to exclude the potential impact of this policy pilot, and drawing on the approach of Yi, Famin et al. (2021), this paper further controlled for the pilot counties of the "rural information into the village" project and conducted regression analysis according to Equation (1). The results show that the pilot counties of the "rural information to households" project did not have an impact on this paper.

* + 1. Policy preference issues

In the two years after the number of business to promote agriculture, there is an obvious policy tendency in the approval of demonstration counties, and the "13th Five-Year Plan for Poverty Alleviation" issued by the State Council in 2016 included e-commerce into the poverty alleviation and development work system, and the Ministry of Commerce document in 2017 also proposed that the comprehensive demonstration work was further tilted to poor areas and less developed old revolutionary areas. This policy tendency may make the estimation of this paper have self-selection bias (Wang Qi et al., 2021), for this reason, this paper further controls the dummy variables of poor counties and old revolutionary areas, and the results are shown in column 4 of Table 2, which indicate that the impact of the number of businesses on the return of population is not significantly affected by the policy tendency.

* + 1. Panel time interval problem

The model counties were entered into the sample regression for a total of six years from 14 to 19 years, while the sample space selected in this paper is more 10 years to 19 years in total, considering the large span of the sample space, which may lead to estimation bias (Jiang and Jian, 2014), the sample of 12 to 17 years in total was selected for re-estimation in this paper. The estimation results are shown in the fifth column of Table 2. The results show that after reducing the sample time span, the estimation results are less significant and have lower coefficients, which may be due to the shortening of the time interval due to the time lag, which makes the policy play less effective.

Table 2 Robustness tests

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  | (1) | (2) | (3) | (4) | (5) |
| Eco\_count | 0.004\*\* | 0.008\*\*\* | 0.008\*\*\* | 0.008\*\*\* | 0.003\* |
|  | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Old Revolutionary Counties | No | Yes | No | No | No |
| National-level poverty-stricken counties | No | No | Yes | No | No |
| Information into the village into the household policy | No | No | No | Yes | No |
| Control variables | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes | Yes | Yes |
| Regional fixed effects | Yes | Yes | Yes | Yes | Yes |
| N | 3860 | 10910 | 10910 | 10910 | 4364 |
| *R*2 | 0.449 | 0.219 | 0.217 | 0.217 | 0.606 |

* 1. Heterogeneity analysis

Based on the theoretical analysis above, this paper further examines the heterogeneity of the impact of digital commerce on population return from four aspects: region, ICT infrastructure, human capital, and regional public service level. Based on the criteria of the National Bureau of Statistics (NBS), the paper divides the country into four regions: East, Central, West and Northeast; based on the median ICT level of each county in the sample from 2010 to 2014, the counties are divided into two groups: "ICT-high" and "ICT-low"; Based on the median human capital level of each county, counties were divided into two groups: "high human capital level" and "low human capital level"; based on the difference of common service level of each county, counties were divided into "high public service level" and "low public service level". Based on the differences in the level of common services, counties were divided into two groups: "high public service level" and "low public service level". Table 4 reports the estimation results of the heterogeneity test. First of all, the estimation results at the level of regional differences show that the number of businesses to promote agriculture has a significant contribution to the return of population to the central, western and northeastern regions, but not to the eastern region. The main reason may be that, compared with the eastern region, other regions have more out-migration and the mobile population is more sensitive to policy changes, thus attracting the local population to return, and according to the potential energy transformation theory of population return in the previous paper, the less economically developed regions have more potential energy and are more likely to form a return trend. Secondly, in the difference of ICT level, the estimation results show that counties with higher ICT level have a stronger impact on population return with their digital business promotion policies, i.e., the higher the level of regional ICT infrastructure, the smaller the digital access divide, and the more it helps the population return. Furthermore, the difference in human capital level indicates that the enhancement effect of high human capital level is significant, while the enhancement effect of low human capital level is not significant. Counties with higher levels of human capital are better able to promote regional economic development with their policy pilots, and thus are more likely to attract population return. Finally, the difference in public service levels among counties indicates that the difference in county financial investment has a more significant effect on regional population return, and higher levels of financial investment are more likely to attract talent return.

Table 3 Heterogeneity analysis

|  |  |  |
| --- | --- | --- |
|  |  |  |
| Variables | Regional differences | ICT level differences | Differences in human capital levels | Differences in public service levels |
| Eastern Region | Central Region | Western Region | Northeast Region | High ICT level | Low ICT level | High level of human capital | Low human capital levels" | High public service level | Low public service level |
| Eco\_count | 0.004 | 0.005\*\* | 0.011\*\*\* | 0.009\*\*\* | 0.009\*\*\* | 0.007\* | 0.010\*\*\* | 0.004 | 0.012\*\*\* | 0.002 |
|  | (0.003) | (0.003) | (0.003) | (0.004) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| Control variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Individual fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 2260 | 3380 | 3350 | 1920 | 5460 | 5281 | 5407 | 5407 | 5397 | 5349 |
| R2 | 0.313 | 0.238 | 0.383 | 0.133 | 0.267 | 0.269 | 0.256 | 0.272 | 0.307 | 0.206 |

* 1. Role channel test

The baseline model and robustness tests suggest that the construction of model counties can significantly promote the return of population to the county, so what is the underlying logic? Based on the theoretical analysis in the previous paper, this paper draws on Wang Qi et al. (2021), firstly, the logarithmic value of GDP per capita is used to represent regional economic development. The regression results are shown in Table 5, and the results indicate that the number of businesses to promote agriculture significantly promotes the county economic growth in the model counties, which undoubtedly attracts the outflow population to return to their hometowns. Second, we use the logarithm of rural residents' human disposable income and the logarithm of county residents' per capita disposable income to measure the impact of digital business to promote agriculture on the improvement of regional income level, and the results show that the construction of demonstration counties significantly promotes the improvement of per capita disposable income level. Empirical studies show that a greater proportion of the mobile population is in rural areas, which further indicates the existence of income enhancement channels. Further, we analyze the employment optimization channel, using the proportion of the employed population in primary, secondary and tertiary industries to the total population, and the results show that the number of business promotion agriculture optimizes the county's industrial structure, and the number of business promotion agriculture makes the proportion of employed workers in primary industries decrease, while promoting the employment of workers in secondary and tertiary industries to increase, hypothesis 2 holds

|  |  |  |
| --- | --- | --- |
| Table 4 | Mechanism of action analysis |  |
| Variables | Economic Growth | Revenue Boost | Employment Optimization |
| GDP per capita | Income of rural residents | Income of urban and rural residents | Primary Industry | Secondary Industry | Tertiary Industry |
| Eco\_count | 0.047\*\*\* | 0.039\*\*\* | 0.005\*\* | -0.014\*\* | 0.006\* | 0.009\* |
| Control variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Individual fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
|  | (0.008) | (0.005) | (0.003) | (0.006) | (0.003) | (0.005) |
| N | 10910 | 10092 | 8276 | 2622 | 2622 | 2622 |
| R2 | 0.971 | 0.978 | 0.979 | 0.937 | 0.950 | 0.863 |

1. Further analysis

The above estimation results show that the mechanism of the effect of the county-based perspective of digital business on population return exists, and based on the previous theory, the pattern of the rural construction on population return should also be changed, after all, the construction of digital countryside is more like the improvement of efficiency for rural towns, and the countryside obviously cannot accommodate more labor force return, so the return should happen more in the county or township. To this end, this paper examines the pattern of population return based on the dynamic monitoring data of the mobile population in 2017. There is a sample self-selection problem in matching the number of businesses to promote agriculture with the dynamic monitoring data of the mobile population, and to eliminate this bias, this paper uses the PSM method in the causal inference analysis framework to conduct the analysis. Compared with the traditional OLS, instrumental variables and Heckman two-step methods, PSM can solve the problem of sample self-selection bias very effectively, and there is no qualification of model form setting, parameters and exogenous explanatory variables when dealing with endogenous problems (Hu, Anning and Jingfeng, 2015). The large sample size (87,923) in this paper can achieve high-quality matching results and more accurate estimation results, which meet the data requirements of PSM.

Specifically, here the core explanatory variable number of business Xingnong is treated, in the data processing, in accordance with the conclusions of the previous event study method, the effect of the policy role is played only after two years of policy implementation, for this reason this paper assigns a value of 1 to the samples of 2014 and 2015 that move out of the model counties, and the rest are 0. In order to eliminate the influence of the number of business Xingnong in the place of migration on the return of population, this paper removes the samples of 2014 and In order to eliminate the influence of the number of incoming counties on the return of population, the samples of incoming counties in 2015 are deleted. In order to ensure the quality of matching and the reliability of the estimation results, common support and balance trend tests were conducted in this paper, and the test results showed that the range of propensity score intervals became larger after matching and satisfied the assumption of balance. In further analysis of the return location of the returning population, this paper further selects the sample of returning and screens the sample of moving out place to rural areas on the basis of the above.

Table 5 Counting business and return to the countryside

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  | (1) Before treatment | (2) Nuclear matching | (3) Nearest Neighbor Matching | (4) Caliper matching |
| Eco\_count | 0.145\* | 0.151\*\* | 0.189\*\* | 0.166\*\* |
|  | (0.075) | (0.075) | (0.091) | (0.365) |
| Control variables | Yes | Yes | Yes | Yes |
| Regional fixed effects | Yes | Yes | Yes | Yes |
| N | 87923 | 87923 | 62575 | 87923 |
| *R*2 | 0.027 | 0.033 | 0.034 | 0.043 |

The estimation results in Table 5 indicate a significant contribution of Numerical Business Prosperity Farming to population return. When comparing the average treatment effect before matching, the average treatment effect of counting business prospering agriculture on population return after matching significantly increases from 0.145 to 0.151, 0.189 and 0.166, which indicates that the use of PSM effectively eliminates the effect of other factors and the average treatment effect mainly comes from the effect of counting business prospering agriculture. Table 6 shows that, among the returning population, the digital business promotion of agriculture makes the returning population more inclined to go to townships and counties than to return to rural areas, which also verifies the previous view that the construction of digital villages makes the return pattern change, and the returning population is more inclined to go to more economically developed regions, and hypothesis 3 holds.

Table 6 Homecoming mode

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  | (1) Before treatment | (2) Nuclear matching | (3) Nearest Neighbor Matching | (4) Caliper matching |
| Eco\_count | 0.681\*\* | 0.598\* | 0.777\* | 0.781\*\* |
|  | (0.351) | (0.318) | (0.467) | (0.365) |
| Control variables | Yes | Yes | Yes | Yes |
| Regional fixed effects | Yes | Yes | Yes | Yes |
| N | 794 | 794 | 256 | 782 |
| *R*2 | 0.192 | 0.219 | 0.291 | 0.269 |

1. Conclusions and Policy Recommendations

In the process of national implementation of rural revitalization strategy, digital business to promote agriculture and digital empowerment for farmers is an important initiative. As population mobility is a powerful driving force for China's economic development, it is of great theoretical and practical significance to study the economic and social impacts of population mobility. To this end, this paper analyzes the impact of digital rural construction on the return of population flow, using the "comprehensive demonstration of e-commerce into rural areas" policy as a quasi-natural experiment.

First, based on the theory of potential energy transformation of population migration, this paper analyzes and finds that in terms of individual potential energy, the migrating population is more suitable for the application characteristics of digital technology in terms of education level, age and gender, and the migrating population is better able to solve the digital divide problem than the migrating population; in terms of regional potential energy, the income-generating effect of digital village construction provides a regional potential energy difference for the returning population; in terms of realization channels, digital technology In terms of realization channel, digital technology can significantly compress the time and cost of information transmission, which facilitates the return flow of population; digital village construction achieves the continuous gathering, creation and upgrading of industries in the county, which promotes the gathering of return population to the county center. Second, empirically, a multi-period double difference model was constructed based on a quasi-natural experiment of "national comprehensive demonstration counties of e-commerce into rural areas" using domestic county panel data from 2010-2019, and the regression analysis found that: digital commerce and rural development have a significant role in promoting population return to the county, and the results are still significant after applying multiple estimation strategies. The heterogeneity analysis shows that digital business promotion has a significant impact on population return in central, western and northeastern China, but not in eastern China, and the first digital divide represented by ICT and the second digital divide represented by human capital still exist. Finally, further analysis reveals that the construction of digital countryside promotes the change of population return pattern: the returning population tends to move to county cities and townships compared to rural areas. Based on the above findings, this paper has the following policy recommendations:

First, focus on the cultivation of vocational skills and digital literacy of returning talents to bridge the digital divide. The heterogeneity analysis in this paper shows that the pilot policies of e-commerce demonstration cities show significant differences in promoting population return due to different regions, different levels of digital infrastructure, and different levels of human capital. Therefore, it is necessary to effectively strengthen the supporting funds for the transformation of county e-commerce to address the funding gap in the central and western regions, small and medium-sized, and financially deficient pilot counties, and promote the construction and improvement of Internet infrastructure in these counties. In view of the high human capital level of the returning population, the government should actively provide the returning population with corresponding technical guidance and personnel training, which can be based on the "Rural Netflix Cultivation Program", "Rural E-Commerce Entrepreneurship Support Program" and "County-level Integrated Media Center Construction", The government can draw on measures such as the "county-level integrated media center construction" to train digital talents for local digital rural development and attract and retain them.

Secondly, taking rural revitalization as an opportunity to promote county urbanization and attract the population back to the county. on May 6, 2022, the General Office of the Central Committee of the Communist Party of China and the General Office of the State Council issued the Opinions on Promoting Urbanization with County Cities as Important Carriers, which pointed out that large cities may not be able to solve the huge agricultural transfer population, and orderly promoting the return of mobile population to their hometowns and realizing local employment nearby is a solution to The new path of migrant population urbanization. The empirical analysis of this paper finds that, under the influence of the policy of promoting agriculture by counting business, the returning population tends to settle in counties and towns more than in rural areas. Moreover, the analysis of the channels of action also shows that digital business promotion promotes the gradual transfer of the employed population from the primary industry to the secondary and tertiary industries, which indicates that the construction of digital countryside has a good promotion effect in promoting the concentration of population and industry in the county. Therefore, it is necessary to promote the pilot experience of digital business in a larger scale, and combine digital technology in the construction of digital villages to promote the upgrading of local industrial structure. In addition, local governments should allocate public facilities as needed, solidify the industrial foundation of the county, promote local employment and sustainable income generation for residents, and drive high-quality development of the county economy.

Third, narrowing the gap in social security levels between regions and promoting the equalization of public services will enhance the willingness of returning populations to settle. Some scholars point out that the returning population tends to move out again (Bai, Nansheng et al. 2002; Shi, Zhilai and Yang, Yunyan 2012; Wangzhi, Cheng and Zhao, Zhong 2013), and the level of public services is the key factor (Koo, 2010). The heterogeneity analysis in this paper shows that the level of local public services has a positive moderating effect on the relationship between the number of businesses and the return of population, which shows that it is not only necessary to make the outgoing population "come back" but also to make the outgoing population "stay" and effectively improve the well-being of the returning population. This paper argues that it is necessary to improve the sense of well-being in backward areas. To this end, this paper argues that it is necessary to improve the level of social security and government services in backward areas (Li, 2020). Digital technology can be further applied for digital transformation to promote digital technology to enhance medical, education, health, and culture in the county, integrate medical and educational resources between regions, establish corresponding databases, and realize the sharing of public service resources in each region through online teaching of educational knowledge and remote services of medical institutions. Promote the digital transformation of county government services, promote online operation, collaborative disposal and closed-loop management of government services, and facilitate business administration, taxation, certification of licenses and administrative permits, thereby facilitating employment and entrepreneurship for people returning to their hometowns.

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