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Does Regional Digital Transformation Improve Regional and Individual Well-Being? Evidence from Pilot Policies in China

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Abstract

Well-being is considered an important value in people's lives and an indicator of social progress. In recent years, as Internet use has become more widespread, research on the relationship between ICT and well-being has become essential. Under these circumstances, digital transformation (DX), defined as the changes brought about or influenced by digital technology in all aspects of human life, has attracted national and international attention. However, few studies have quantitatively examined whether DX improves well-being. To fill this gap in the literature, this study uses DX-related pilot policies as a quasi-natural experiment to investigate the effects of DX on well-being. The DX-related pilot policies examined in this study include the Rural E-commerce Comprehensive Demonstration Counties (REDC) policy and the 15-Minute Convenient Living Circles policy. Chapter 1 finds that the REDC policy has a significant positive impact on the quality of life (QOL) of rural residents. Moreover, mechanism tests highlight the crucial roles of increased absolute material welfare, reduced urban-rural income inequality, and improved human capital in enhancing rural residents' QOL. Chapter 2 finds that the REDC policy has a significant positive impact on the subjective well-being (SWB) of Chinese residents. Additionally, mechanism tests reveal that the positive effect of rural e-commerce on SWB can be explained by enhanced absolute welfare, measured by total income, and greater social capital accumulation, measured by total expenditures on gifts for social relations. Chapter 3 finds that the 15-Minute Convenient Living Circles pilot policy has a significant positive impact on the QOL of residents in China. An important policy recommendation arising from these findings is to continue and expand both the REDC policy and the 15-Minute Convenient Living Circles pilot policy to further improve the well-being of Chinese residents.

Preface

In recent years, as Internet use has become more widespread, the adoption of “beyond GDP” measures (Stiglitz et al., 2009) has gained increasing importance, and well-being analysis has taken on a more prominent role in scientific research (Álvarez & Vicente, 2023). Well-being is considered essential for creating a healthy and productive society (Diener & Suh, 1997) and serves as both a fundamental value in people's lives and an indicator of social progress (Voukelatou et al., 2021).

As social conditions have changed dramatically in recent years—including the COVID-19 pandemic and the rapid development of generative AI—the use of digital technologies such as teleworking has expanded. Additionally, e-commerce has grown significantly, as lockdowns during the pandemic forced more consumers to shop online. Furthermore, digital transformation (DX), defined as the changes that digital technology brings about or influences in all aspects of human life (Stolerman & Fros, 2004), has attracted national and international attention.

In Japan, the promotion of regional DX is expected to create a society where citizens and businesses can fully benefit from digitalization through the development of new services, the sustainability of local communities, and improved well-being, as outlined in the “Vision for a Digital Garden City Nation.”

In China, “Digital China,” a national strategy for DX across all areas of society, is actively being promoted. As emphasized at the 19th National Congress of the Communist Party of China, responding to the growing demand for a better life is a central goal of China’s development agenda (Lei et al., 2023). Furthermore, since the 20th National Congress of the Communist Party of China, China has consistently issued a series of key directives aimed at enhancing people's happiness and well-being (Jin et al., 2023).

However, with the exception of a few studies (e.g., Jin et al., 2023; Nie et al., 2017) that use the Internet, smartphone adoption, and the Digital Economy Index as proxy indicators of DX, few studies have quantitatively examined whether DX improves well-being in both China and Japan.

To address this gap, this study employs DX-related pilot policies as a quasi-natural experiment—based on the concept of DX proposed by Stolerman and Fros

(2004)—to investigate whether local DX improves regional well-being and individual well-being (e.g., life satisfaction) in both Japan and China. If DX does have a positive effect, this study also seeks to identify the mechanisms through which it operates.

This study makes several contributions to the existing literature. First, this is the first attempt to quantitatively clarify the effects of regional DX on wellbeing as a quasi-natural experiment using DX-related pilot policies based on the concept of DX by Stolerman and Fros (2004), for which a clear definition is absent. In the domain of industrial organization, we focus on rural e-commerce, given that e-commerce is considered the ultimate form of digital transformation (Härting et al., 2017). Second, by comparing the results of our analysis in Japan and China, we can identify similarities and heterogeneities in the effects of regional DX on wellbeing. Third, we examine the potential mechanisms of the effects of regional DX on wellbeing (e.g., regional economic development, higher household consumption, and increased convenience).

The structure of this report is as follows. Chapter 1 provides an empirical analysis of the impact of e-commerce on regional “quality of life” based on objective indicators and its mechanisms, using province-level panel data. Chapter 2 combines provincial-level and individual-level panel data to conduct an empirical analysis of the impact of e-commerce on individual wellbeing based on subjective indicators (life satisfaction and subjective well-being) and its mechanisms. Chapter 3 uses panel data at the prefecture-level city level to provide an empirical analysis of the impact and mechanism of the “15-Minute Convenient Living Circles” pilot policy as a quasi-natural experiment in regional DX on regional “quality of life” based on objective indicators.

Chapter 1 Rural e-commerce and quality of life in China

1. Introduction

Raising the living standards of rural residents is an important means of achieving common prosperity (共同富裕). However, low agricultural labor productivity and high urban-rural income inequality are the main challenges to achieving a high-quality life for rural residents (Huang, 2022).

To develop the rural digital economy and improve the quality of life (QOL) of rural residents, China has placed particular emphasis on building rural digital infrastructure. Since the beginning of the 21st century, the digital infrastructure in rural areas has been relatively well developed with the implementation of informatization projects such as the “Extending Radio and TV Broadcasting Coverage to Every Village Project (村村通)” and the “Broadband Countryside (宽带乡村)” project. By 2020, the national fiber-optic and 4G coverage rate will exceed 99% in administrative and poor villages. The “same network, same speed” has been achieved in rural and urban areas, and the “first digital divide” has been eliminated (Zhu et al. 2022). Against this background, the level of development of the rural digital economy is steadily improving. However, existing studies offer mixed conclusions regarding the impact of the digital economy on farmers' QOL (Wang et al., 2023). Some scholars believe that the digital economy has had a positive impact on farmers' QOL. For example, Leng (2022), using the “Broadband China” policy as a quasi-natural experiment, found that the digital revolution increased the income of rural residents. They also showed that the pathways include reduced information costs and increased income from agricultural production. However, some scholars argue that the digital economy has had a negative impact on rural residents' QOL. For example, Zeng et al. (2022) used the smart city construction policy as a quasi-natural experiment and found that the construction of smart cities significantly increased the urban-rural income gap.

The digital economy is an economic situation driven by digital technology and the Internet, encompassing a vast array of sectors ranging from e-commerce and online services to digital finance and online entertainment (Cai et al., 2024). As the most active and intensive manifestation of the digital economy, e-commerce is rapidly permeating all areas of life and using information technology and big data to create new online and

offline retail models that are driving consumption sophistication and industry restructuring (Cao et al., 2021). Therefore, this study focuses on e-commerce, an important component of the digital economy. In recent years, China has experienced rapid e-commerce development, becoming the largest e-commerce market in the world. However, most of this growth has occurred in urban areas (Couture et al., 2021). To promote economic development in rural areas and narrow the economic gap between urban and rural areas, the Chinese government has been implementing a place-based policy, Rural E-commerce Demonstration County (hereafter REDC, in Chinese 电子商务进农村综合示范县) since 2014. Couture et al. (2021) have found that such e-commerce expansion in developing countries programs have connected rural areas to e-commerce and found that they have contributed significantly to increasing rural e-commerce consumption. Nevertheless, an important question remains as to whether this program can have a significant impact on the development of rural e-commerce (Zhao et al., 2024). Furthermore, the impact of rural e-commerce on quality of life is not clear.

In this chapter, I employ the Rural E-commerce Demonstration County (REDC) policy as a quasi-natural experiment. Based on panel data from 31 provinces in China, we use a fixed effects model to examine the impact of rural e-commerce on quality of life and its potential mechanisms.

2. Literature Review

2.1. QOL indicator and its influencing factors

Some studies focus on constructing indicator systems from different perspectives (e.g., objective, subjective, or a combination of both) to evaluate and measure QOL, while others consider only objective indicators such as economic factors, health, education, employment, infrastructure development, and standard of living (e.g., Hybel & Mulalic, 2022; Pasten & Santamarina, 2012). Subjective indicators of QOL include aspects such as life satisfaction, happiness, spirituality, and cultural influences (e.g., Welsch & Biermann, 2017; Rehdanz & Maddison, 2008).

Some studies have focused on factors affecting QOL. Empirical studies have shown that economic conditions such as income, unemployment, and inflation have a strong impact on people's subjective well-being (e.g., Clark & Oswald, 1994, Di Tella et

al., 2001, Easterlin, 2001). For a comprehensive review of the literature, see Frey and Stutzer (2002).

While many studies have constructed QOL indicator systems at various levels from different perspectives and studied related factors, few studies have analyzed the impact of rural e-commerce on QOL at the regional level. Even at the micro level, the impact of e-commerce, especially in rural areas, on the subjective well-being (SWB) and QOL of residents has not been fully examined (Jin et al., 2020). In this study, based on previous studies on QOL (Huang et al., 2024), QOL is defined as residents' economic status, social security, livelihood environment, education and culture, and living quality.

2.2. E-commerce and Rural E-commerce Demonstration Counties

E-commerce is a form of business operation in which buyers and sellers rely on Internet platforms and digital financial tools to enable online shopping for consumers and online transactions for merchants (Wei et al., 2024). Rural e-commerce essentially means using the Internet to purchase goods and services from rural areas or sell goods and services to rural-based customers (Kong, 2019).

E-commerce in China has experienced impressive growth and plays a pivotal role in driving economic expansion (Zhang et al., 2024). According to a McKinsey & Company report, Chinese e-commerce accounted for more than 40% of global e-commerce transactions in 2016, making it the largest e-commerce market in the world. The value of e-commerce transactions in China surged from RMB 6.09 trillion in 2011 to RMB 43.83 trillion in 2022, representing a remarkable annual growth rate of 17.88%. This significant increase in transaction size has also spurred the steady growth of the e-commerce service industry, which had a revenue scale of RMB 6.79 trillion in 2022, and the number of completed express delivery services nationwide exceeded 110.58 billion pieces. These figures represent a remarkable increase of nearly 170 times and more than 30 times, respectively, compared to 2011, when the revenue scale was RMB 0.04 trillion and the number of completed deliveries was 3.67 billion pieces. Notably, the e-commerce sector has emerged as an important source of employment opportunities, with employment rising from 26.9 million in 2014 to 69.37 million in 2022, highlighting the significant growth in employment prospects (MOFCOM, 2023).

Despite the significant growth in the scale of e-commerce development, as in many countries, there are considerable differences between urban and rural e-commerce

in China. In rural China, underdeveloped logistics infrastructure, lack of e-commerce human resources, and low market potential are major barriers to rural e-commerce development (Zhao et al., 2024).

To promote the development of e-commerce in rural areas, the Ministry of Finance and the Ministry of Commerce have jointly implemented the REDC (电子商务进农村综合示范县) program since 2014. The policy aims to promote the adoption of e-commerce in rural areas, facilitate rural economic transformation and upgrading, and coordinate urban and rural economic development (Wei, Yang et al., 2024). The REDC program includes multifaceted and specific measures to build rural e-commerce in China. First, a county-town-village delivery system has been established. This mainly includes the development of rural storage and logistics distribution systems, cold chain logistics distribution systems, and rural logistics service networks. Second, the construction of a public service system for agricultural products in urban areas has been promoted. This includes the construction of live (cross-border) e-commerce incubation centers and branding of specialty agricultural products. Third, rural e-commerce professionals have been cultivated. This mainly includes the dissemination of e-commerce knowledge and training in e-commerce entrepreneurship skills (Zhao et al., 2024). In addition, the policy actively expands the scope of e-commerce applications in rural areas, enhances the bidirectional distribution of industrial products to rural areas and agricultural products to cities, and diversifies marketing channels for agricultural products (Qin et al., 2023).

The county selection process for the REDC program is determined solely by the central government[1]. Specifically, the Ministry of Commerce of the People's Republic of China selects pilot counties through voluntary applications from counties. In selecting REDC program counties, priority is given to nationally designated poor counties and former revolutionary counties.

Each pilot county receives about RMB 20 million in financial support from the central government. From 2014 to 2019, a total of 1,231 counties were approved by the REDC program, with a total investment of about RMB 24.62 billion, of which 875 were nationally designated poor counties with an investment of about RMB 18 billion. Under the REDC program, China's rural e-commerce experienced rapid growth from 2014 to

[1] https://www.gov.cn/zhengce/content/2015-11/09/content_10279.htm

2022. Rural e-commerce sales increased from RMB 0.18 trillion in 2014 to RMB 2.17 trillion in 2022 (MOFCOM, 2023).

The REDC program started in 2014 and has been implemented gradually: in 2014, 56 counties were supported by the REDC program; in 2015, 200; in 2016, 240; in 2017 and 2018, 260; in 2019, 215; in 2020, 225; and in 2021, 206 new counties were selected. In total, 1,662 counties were selected from 2014 to 2021. Rural e-commerce has grown significantly with the construction of REDCs. Rural online retail sales reached RMB 2.17 trillion in 2022. More importantly, rural e-commerce sales have consistently increased, growing more than eightfold from RMB 110 billion in 2013 to RMB 894.54 billion in 2016. Since 2016, growth rates have slowed compared to the previous surge, but sales have steadily increased each year. These statistics indicate a significant expansion, or perhaps more widespread adoption, of e-commerce platforms in rural China after the implementation of the REDC policy (Wei et al., 2024).

2.3. Rural e-commerce and quality of life

To the best of my knowledge, there are no empirical studies on the impact of rural e-commerce on quality of life, but we review relevant empirical studies. Regarding the impact of rural e-commerce on SWB, Wei et al. (2024), employing a quasi-natural experiment of REDC policy and using CFPS panel data, find that rural e-commerce development led to an average 2.4% increase in residents' well-being scores. They also showed that this positive effect was due to an increase in absolute material welfare, a reduction in relative inequality, and an accumulation of social capital. Jin et al. (2020), based on survey data collected from Tonglu County, Zhejiang Province, the first pilot city of Alibaba's rural e-commerce service centers (RESCs) project, analyzed the impact of RESCs on the SWB of rural residents and found that RESCs significantly improved SWB of rural residents. Ma and Ma (2024), based on data from 220 Chinese cities from 2011 to 2020, examined whether the digital economy improves QOL of residents and found that it significantly enhances people's QOL.

3. Theoretical mechanisms

This section discusses the theoretical mechanisms through which rural e-commerce affects the quality of life of rural residents in terms of improvement of absolute material

welfare, reduction of urban-rural income inequality, and improvement of human capital.

3.1. Improvement of absolute material welfare

Rural e-commerce has the potential to improve the quality of life of rural residents by enhancing their absolute material well-being. Income and consumption are important objective indicators for measuring utility and well-being, and increasing income and consumption is an important way to improve residents' material well-being (Wei et al., 2024). However, due to relatively closed market conditions and high transaction costs, rural households in China have long suffered from the challenges of low consumption and liquidity constraints (Démurger & Xu, 2011; Zhao et al., 2022). E-commerce can be a solution to these challenges from both the supply and demand sides. On the supply side, e-commerce facilitates online market sales by rural households, including opening online sales channels for agricultural products (Tang & Zhu, 2020; Zang et al., 2022). On the demand side, lower prices can lower the threshold for rural consumers to trade (Couture et al., 2021). A large body of literature confirms the positive correlation between material welfare and well-being, suggesting that both absolute income and consumption contribute to people's SWB (e.g., Clark et al., 2008; Dehejia et al., 2007; Zheng & Ma, 2021). Thus, rural e-commerce has the potential to enhance the quality of life of rural residents by improving their absolute material well-being, including income and consumption.

3.2. Reduction of urban-rural income inequality

Rural e-commerce may reduce the urban-rural income inequality as follows: as e-commerce platforms become more widespread, farmers will be able to sell agricultural products, handicrafts, and other specialty products directly through these platforms, bypassing middlemen and prices. E-commerce platforms diversify income sources by providing farmers with employment opportunities in areas such as logistics, distribution, and online marketing. This will raise income levels and narrow the urban-rural income gap (Mukalayi and Inglesi-Lotz, 2023).

Narrowing the urban-rural income gap may improve QOL of rural residents. Two different hypotheses, the relative deprivation hypothesis and the tunnel effect hypothesis, have been used to explain the conflicting findings in the literature on the relationship between income inequality and SWB. The relative deprivation hypothesis holds that the negative effects of inequality on well-being are explained by the feelings of deprivation

when others are better off (Walker & Smith, 2002; Yitzhaki, 1979). Thus, when low-income individuals compare their incomes to others in higher income brackets, they experience a sense of unhappiness and dissatisfaction (Zhang & Awaworyi Churchill, 2020). In the context of this study, when low-income rural residents compare their incomes to those of high-income urban residents, they experience feelings of unhappiness and dissatisfaction and a lower QOL. Conversely, if the high urban-rural income gap is reduced, the QOL of rural residents would also improve.

There have been few empirical studies on the impact of rural e-commerce on urban-rural income inequality (Yin & Choi, 2022; Liu & Zhou, 2023), but the number has been increasing in recent years[2].

3.3. Improvement of human capital

Rural e-commerce has the potential to improve the quality of life of rural residents by enhancing human capital. Human capital, especially the ability to use digital and mobile applications, is required to engage in e-commerce. In addition, one of the focuses of the REDC program is to develop rural e-commerce human capital. This primarily includes dissemination of e-commerce knowledge and training in e-commerce entrepreneurial skills. Thus, rural e-commerce is expected to improve human capital. Additionally, the improvement of human capital may stimulate cultural and artistic activities and increase the mental satisfaction of the local residents. Empirical studies in the U.S. have also shown that when the level of human capital in a region improves, the quality of life in that region improves (Winters, 2011).

4. Methodology

4.1. Data

To analyze the impact of rural e-commerce on quality of life at the regional level, we constructed a provincial-level panel data set from 2011 to 2021. The dataset was collected

[2] Some studies have analyzed the impact of general e-commerce on urban-rural income inequality (Li et al., 2021; Yin & Choi, 2022). To be clear, “general e-commerce” is an umbrella category that includes and measures the overall development of e-commerce in both urban and rural areas (Liu & Zhou, 2023).

from two sources. First, we obtained a list of counties that have adopted the REDC program from the website of the Ministry of Commerce of the People's Republic of China. We then calculated the number of counties adopted into the REDC program by province. Second, we obtained socioeconomic indicators from Statistical Yearbook of China 2012-2022.

4.2. Variables

4.2.1. Dependent variable

The dependent variable, *QOL*, is a continuous variable that represents the QOL index in the province. Referring to Tan et al. (2022) and Wang et al. (2023), this study constructs a QOL index of rural residents from three dimensions: quality of affluence, quality of common, and quality of sharing. As shown in Table 1, the “quality of affluence (富裕質量)” reflects the material level of rural residents' lives, the “quality of common (共同質量)” reflects the development gap in rural residents' lives, and the “quality of sharing (共享質量)” reflects the social welfare of rural residents' lives. The QOL index of rural residents was measured using the entropy weight method.

Table 1. Quality of life index of rural residents

Dimension indicator	Secondary indicator	Measurement method	Property
Affluence（富裕質量）	income level in rural areas	per capita disposable income of rural households	+
	consumption level in rural areas	per capita consumption expenditure of rural households	+
Common（共同質量）	urban-rural income inequality	per capita disposable income of urban households/per capita disposable income of rural households	-
Share（共享質量）	civilization of rural residents	urbanization rate	+
	public health standards in rural areas	health technical personnel in health care institutions per 1000 persons in rural areas	+
	spiritual and cultural level in rural areas	per capita consumption expenditure of education, culture and recreation consumption expenditure of rural households	+

4.2.2. Independent variable

The independent variable, *REDC*, is a continuous variable that represents the total number of REDCs in the province. As the REDC policy started in 2014, *REDC* equals to 0 before 2014.

4.2.3. Control variables

Control variables, *X*, are the province-level socioeconomic indicators including real GDP per capita, ratio of expenditure for agriculture, forestry and water conservancy to fiscal expenditure, total power of agricultural machinery per capita, industry structure, ratio of fiscal expenditure to GDP.

4.3. Estimation model

This study examines the impact of rural e-commerce on QOL in 31 provinces in China based on panel data from 2012 to 2021. Owing to differences observed in rural e-commerce and QOL in each province, this study adopts a two-way fixed effects model:

$$QOL_{it} = \beta_0 + \beta_1 REDC_{it} + \beta_2 \boldsymbol{X}_{it} + \mu_i + \lambda_t + \varepsilon_{it}, \quad (1)$$

where the dependent variable QOL_{it} is the QOL index of rural residents in province i year t. The main independent variable $REDC_{it}$ indicates the number of rural e-commerce demonstration counties in province i year t. $\boldsymbol{X}_{it}$ is a set of control variables at the province-level that may influence QOL. μ_i denotes province fixed effects, capturing the unobservable and time-invariant characteristics of provinces. λ_t represents year fixed effects, capturing common time trends across all provinces, such as macro policies and economic cycles. ε_{it} is random disturbance term.

Table 2 provides descriptive statistics of the variables used in the analysis. Table 2 shows that the mean QOL index of rural residents is about 0.38 and the mean number of REDC is 4.81.

Table 2. Descriptive statistics

Variable	Definitions	Obs	Mean	Std. dev.	Min	Max
QOL index	quality of life index of rural residents	341	0.38	0.16	0.03	0.89
REDC	number of rural e-commerce demonstration counties	341	4.81	6.37	0	47
lnREDC	the natural logarithm of number of rural e-commerce demonstration counties	341	1.14	1.16	0	3.87
lnreal_gdp_per_capita	the natural logarithm of GDP per capita	341	10.75	0.42	9.71	11.92
expenditure_agriculture_ratio	ratio of expenditure for agriculture, forestry and water conservancy to fiscal expenditure	341	0.04	0.04	0.01	0.26
agricultural_machinery_per_capita	total power of agricultural machinery per capita	341	0.76	0.42	0.04	2.21
industry_structure_upgrading	tertiary industry/secondary industry	341	1.25	0.69	0.52	5.30
secondary_ratio	secondary industry/GDP	341	0.43	0.09	0.16	0.59
tertiary_ratio	tertiary industry/GDP	341	0.48	0.10	0.30	0.84

5. Results

5.1. Baseline results

Table 3 presents the baseline result of two-way fixed effects (TWFE) estimation. We find that the estimated coefficients on REDC are statistically significantly positive at the 5% level, suggesting that rural e-commerce development is likely to contribute to the QOL improvement of Chinese rural residents. According to our estimates, 1% increase in the number of REDC improved the QOL score of rural residents by 0.00005 points. Correspondingly, rural e-commerce development led to an increase in QOL of rural residents by about 0.01%, as the mean QOL score is 0.38 in the full sample.

Table 3. Baseline result of two-way fixed effects (TWFE) estimation

	(1)
VARIABLES	QOL index
lnREDC	0.005**
	(0.002)
lnreal_gdp_pc	0.126*
	(0.069)
expenditure_agriculture_ratio	-0.014
	(0.238)
agricultural_machinery_pc	0.047*
	(0.027)
industry_structure_upgrading	-0.155***
	(0.055)
secondary_ratio	-0.307
	(0.625)
tertiary_ratio	0.676
	(0.437)
Constant	-1.014*
	(0.581)
Province fixed effects	Yes
Year fixed effects	Yes
Observations	341

R-squared	0.957

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5.2. Robustness tests

The following two types of robustness tests were performed in this study. (1) To account for the potential lag effect of an increase in REDC on QOL, we employed REDC with a lag of one period data as a robustness check. (2) We control for regional time trends. Province-level administrative regions located in different economic belts may have marked differences in factors such as policy and natural environment, and these differences may change over time. Therefore, we control for regional time trends by constructing interaction terms between the eastern, central, and western dummy variables and the time trend variable. Columns (1) and (2) in Table 4 show the results of the analysis controlling for lagged effects and regional time trends, respectively. As shown in Table 4 (1) and (2), the estimated coefficients on REDC are statistically significantly positive at the 5% level, respectively, proving the robustness of the estimates in this paper.

Table 4. Robustness test results

	lag one period	controlling Region by year fixed effects
	(1)	(2)
VARIABLES	QOL index	
lnREDC	0.007**	0.011**
	(0.003)	(0.006)
lnreal_gdp_pc	0.123*	0.113
	(0.068)	(0.076)
expenditure_agriculture_ratio	-0.065	-0.090
	(0.213)	(0.318)
agricultural_machinery_pc	0.048*	0.054*
	(0.028)	(0.029)
industry_structure_upgrading	-0.152***	-0.148**
	(0.055)	(0.055)
secondary_ratio	-0.324	-0.182
	(0.624)	(0.675)
tertiary_ratio	0.641	0.776
	(0.425)	(0.496)
Constant	-0.967*	-0.980
	(0.567)	(0.656)
Province fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Region by year fixed effects	No	Yes
Observations	341	341
R-squared	0.958	0.960

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5.3. Mechanism tests

As the baseline results and robustness tests imply that rural e-commerce significantly increases QOL, we further explored multiple potential pathways for this positive effect. As analyzed in Section 3, these mechanisms include increases in absolute material welfare, reduction of the urban-rural income inequality, and improvements in human capital. Table

5 presents the results of our analysis.

5.3.1. Improvement of absolute material welfare channel

Section 3 argued that the development of rural e-commerce has the potential to improve the QOL of rural residents by increasing their absolute material welfare. Based on previous studies, we measure material welfare at both the income and consumption levels (e.g., Luo et al., 2022; Wei et al., 2024; Zhao et al., 2024; Zhou et al., 2023). Income and consumption were measured in terms of disposable income per rural resident and consumption expenditure per rural resident, respectively. As shown in Tables 5 (1), the estimated coefficients on REDC are statistically significantly positive at the 1% level, suggesting that rural e-commerce development is likely to contribute to the increase in per capita disposable income of rural households. On the contrary, as shown in Table 5 (2), the estimated coefficients on REDC are statistically insignificantly positive, suggesting that rural e-commerce development is unlikely to contribute to the increase in per capita consumption expenditure of rural households. According to our estimates, 1% increase in the number of REDC would result in 1.1% increase in per capita disposable income of rural residents.

5.3.2. Urban-rural income inequality channel

As emphasized in Section 3, the development of rural e-commerce may also contribute to narrowing the urban-rural income gap, thereby improving the QOL of rural residents. The simplest and most widely used measure of urban-rural income inequality in China is the ratio of disposable income per capita for urban residents to disposable income per capita for rural residents. This study also measured urban-rural income inequality using the urban-rural income ratio. As shown in Tables 5 (3), the estimated coefficients on REDC are statistically significantly negative at the 10% level, suggesting that rural e-commerce development is likely to contribute to the reduction of urban-rural income inequality.

5.3.3. Human capital channel

As highlighted in Section 3, the development of rural e-commerce may also contribute to improving human capital, thereby improving the quality of life of the rural population. Considering the theoretical analysis, existing studies, and data availability, we used per capita consumption expenditure of education, culture and recreation consumption expenditure of rural households as a proxy measure of human capital. As shown in Tables

5 (3), the estimated coefficients on REDC are statistically significantly negative at the 1% level, suggesting that rural e-commerce development is likely to contribute to the increase in per capita consumption expenditure of education, culture and recreation consumption expenditure of rural households. According to our estimates, 1% increase in the number of REDC would result in 4.7% increase in per capita consumption expenditure of education, culture and recreation consumption expenditure of rural households.

Table 5. Mechanism test results

VARIABLES	(1) lnrural_income	(2) lnrural_consumption	(3) income_gap	(4) lnrural_education
lnREDC	0.011***	0.001	-0.025*	0.047***
	(0.004)	(0.005)	(0.013)	(0.015)
lnreal_gdp_pc				
expenditure_agriculture_ratio				
agricultural_machinery_pc	0.035		-0.017	0.375**
	(0.031)		(0.085)	(0.141)
industry_structure_upgrading	-0.066**		0.301**	-0.316
	(0.031)		(0.135)	(0.252)
secondary_ratio	0.327		0.821	4.489*
	(0.380)		(1.401)	(2.409)
tertiary_ratio	0.401	0.268	-0.209	5.321**
	(0.324)	(0.257)	(1.132)	(2.205)
gov_exp_ratio	-0.522***	-0.158	0.809*	
	(0.095)	(0.221)	(0.403)	
lnrural_income		0.838***		
		(0.151)		
gross_dependency_ratio		-0.003		
		(0.003)		
gov_exp_edu_ratio				5.529***
				(1.530)
Constant	9.250***	1.312	1.811	1.461
	(0.342)	(1.487)	(1.228)	(2.046)
Province fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	341	341	341	341
R-squared	0.995	0.987	0.941	0.929

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

6. Conclusions

This study empirically examines the effects of the rural e-commerce demonstration county (REDC) policy on the quality of life (QOL) using province-level panel data from China. In the baseline results, we find that the REDC policy has a significant positive impact on the QOL of rural residents. This finding is robust to sensitivity checks that account for the lagged effect of the REDC policy and regional time trends. Moreover, mechanism tests highlight the crucial role of increases in absolute material welfare, reductions in urban-rural income inequality, and improvements in human capital in enhancing the QOL of rural residents.

An important policy recommendation arising from the results is to continue and expand the REDC policy to further improve the QOL of rural residents. As the REDC policy can improve QOL, we need to understand how rural e-commerce can be facilitated. As recommended by Wei et al. (2024), to strengthen the effectiveness of the REDC policy, policymakers should first initiate targeted measures to enhance digital inclusiveness. Specifically, the formulation and implementation of comprehensive digital literacy programs tailored to the unique needs of rural areas are crucial. These programs should focus on providing essential skills for navigating e-commerce platforms, understanding online payment systems, and using digital tools for entrepreneurial endeavors. At the same time, the construction of digital infrastructure in rural areas should be further strengthened, and the process of fully integrating rural areas into the digital economy should be accelerated.

Chapter 2 Rural e-commerce and subjective well-being in China

1. Introduction

Increasing people's subjective well-being (SWB) is crucial for the sustainable economic development of a nation (Wang et al., 2021). As material life becomes more affluent, the focus of the public, government, and academics has shifted to SWB[3]. Prior research has shown that people's well-being is a function of personal characteristics (Bartolini & Sarracino, 2015; Ram, 2010; Zhao & Guo, 2022), family characteristics (Myrskylä & Margolis, 2014; Pina & Bengtson, 1993; Schnittker, 2008), economic characteristics (e.g. Caporale et al. 2009; Clark et al. 2008; Di Tella et al. 2001; Knight & Gunatilaka, 2022; Kumar et al. 2021), social and institutional factors (Ahuvia, 2002; Knight & Gunatilaka, 2010; Zhang et al. 2017; Zhou et al., 2023), which have been shown to be influenced by quite a number of factors (Wei et al., 2024).

In recent years, with the advent of the digital age, the impact of digital economy sectors on people's SWB has inevitably attracted academic interest (e.g., Lei et al, 2023; Lu & Kandilov, 2021; Zheng & Ma, 2021). e-commerce constitutes a considerable part of the digital economy (Kong, 2019). With the rapid development of rural e-commerce in China, an increasing number of studies, mainly by Chinese scholars, discuss rural e-commerce from different perspectives (Liu et al., 2021). However, the impact of the development of e-commerce, especially rural e-commerce, on residents' SWB has not been fully examined, with some exceptions such as Jin et al. (2020) and Wei et al. (2024). E-commerce, which has boomed in rural China in recent years, has effectively increased rural residents' incomes and opened up rural consumption channels, which may improve SWB among rural residents. In addition, the development of rural e-commerce will make it easier for urban residents to purchase distinctive, high-quality agricultural products and other non-agricultural products, such as handicrafts, from rural areas around China online, potentially enhancing the SWB of the entire population, including urban residents. Nevertheless, to the best of my knowledge, existing studies have yet to examine comprehensively the impact of rural e-commerce development on the quality of life of not only rural residents but also the broader Chinese population.

[3] In this study, SWB and happiness are considered consistent and interchangeable.

This study aims to fill a gap in previous research by confirming the causal relationship between e-commerce development and residents' SWB in rural China. This study employed nationally representative data from the China Family Panel Study (CFPS) and analyzed the impact of rural e-commerce development on residents' SWB using a quasi-natural experiment[4] with the Rural E-Commerce Comprehensive Demonstration County (REDC) policy. The results provide interesting findings that complement existing studies in the following respects. The results reveal that the development of rural e-commerce increases the overall well-being score of residents, but has no statistically significant effect on the well-being score of rural residents, thus enriching the series of studies on the benefits of e-commerce development.

2. Literature Review

2.1. Well-being determinants: income and non-income factors

Recent studies agree that the determinants of individual well-being are diverse (Wang et al., 2021). Easterlin (1974) pointed out the “Easterlin Paradox” that income level and well-being values are not necessarily correlated. The “Easterlin Paradox” seems to apply to China because despite a marked increase in per capita income, the nation's sense of well-being has not increased (Knight & Gunatilaka, 2011). To identify the determinants of well-being in China, many studies have explored micro and macro factors (e.g., Appleton & Song, 2008; Brockmann et al., 2009; Graham et al, 2017; Jiang, Lu, & Sato 2012). Nevertheless, income is a leading indicator of individual happiness (Wang et al., 2021).

Factors other than income are increasingly considered important determinants of well-being. For example, in China, public spending, especially on education, health care, and social security for the poor, responds positively to the well-being of the population (Lu & Zhang, 2010).

[4] This policy shock is more exogenous than the digital use in prior studies. Thus, it helps to clarify the controversy in the prior literature on the impact of e-commerce development on the welfare of rural households (Wei et al., 2024).

2.2. Rural e-commerce and subjective well-being

While there are few empirical studies on the impact of rural e-commerce on SWB, some recent literature is noteworthy. For example, Zheng and Ma (2021) find that online shopping significantly increases rural residents' well-being and life satisfaction using survey data independently conducted in China. Using individual-level data from the 2018 China Family Panel Studies, Wang and Jia (2023) show that online shopping enhances the long-term SWB of consumers by increasing their proportion of hedonic consumption. Wei et al. (2024), employing a quasi-natural experiment of REDC policies and using panel data from the CFPS, found that rural e-commerce development led to an average 2.4% increase in the well-being scores of rural residents. They also showed that this positive effect was due to an increase in absolute material welfare, a reduction in relative inequality, and an accumulation of social capital. Jin et al. (2020), based on survey data collected from Tonglu County, Zhejiang Province, the first pilot city of Alibaba's RESC project, analyzed the impact of rural e-commerce service centers (RESCs) on the SWB of rural residents and found that RESCs shown to significantly improve the SWB of rural residents.

3. Theoretical mechanisms

This section discusses the theoretical mechanisms through which rural e-commerce affects residents' SWB, referring to Wei et al. (2024), in terms of absolute material welfare gains, relative inequality reduction, and social capital accumulation.

3.1. Improvement of absolute material welfare

Rural e-commerce has the potential to improve residents' SWB by enhancing their absolute material welfare. Income and consumption are important objective indicators of utility and well-being, and increasing income and consumption are key means of improving residents' material welfare (Wei et al., 2024). However, due to relatively closed market conditions and high transaction costs, rural households in China have long suffered from low levels of consumption and liquidity constraints (Démurger & Xu, 2011; Zhao et al., 2022). E-commerce can help address these challenges from both the supply and demand sides. On the supply side, e-commerce is likely to facilitate online market sales by rural households, including the creation of online sales channels for agricultural

products (Tang & Zhu, 2020; Zang et al., 2022). On the demand side, lower prices can reduce the transaction threshold for rural consumers (Couture et al., 2021). In addition, as discussed earlier in Section 1, the development of rural e-commerce will allow urban residents to easily purchase distinctive, high-quality agricultural products online from rural areas across China, potentially increasing the SWB of the entire population, including urban residents. A large body of literature confirms the positive correlation between material welfare and well-being, suggesting that both absolute income and consumption contribute to people's SWB (e.g., Clark et al., 2008; Zheng & Ma, 2021). Thus, rural e-commerce has the potential to enhance residents' SWB by improving their absolute material well-being, including their income and consumption.

3.2. Reduction of relative inequality

In addition to enhancing absolute material welfare, the development of e-commerce has the potential to reduce relative inequality in income, consumption, and social status, thereby further influencing residents' SWB (Wei et al., 2024).

First, the expansion of e-commerce has transformed traditional commercial models by enabling a greater number of agricultural products to access broader markets. E-commerce platforms connect rural producers directly with consumers across the country, removing many of the logistical and financial barriers that previously hindered access to traditional markets (Guo et al.). As a result, rural e-commerce is likely to contribute to a reduction in relative income inequality.

Second, e-commerce plays a significant role in narrowing consumption disparities. Historically, rural Chinese consumers have faced limited access to goods and services in terms of both variety and quality, primarily due to logistical challenges and high distribution costs in remote areas. However, the rise of e-commerce has enabled rural residents to access a wider array of products that were previously difficult to obtain through offline channels (Fan et al., 2018). Access to online markets allows rural consumers to enjoy the convenience, diversity, and competitive prices that urban consumers have long benefited from (World Bank & Alibaba, 2019).

Finally, the growth of e-commerce also has the potential to enhance the relative social status of rural residents. As rural consumers engage in e-commerce activities, they simultaneously acquire digital literacy and entrepreneurial competencies, which in turn elevate their social standing and self-esteem (Couture et al., 2021).

3.3. Accumulation of social capital

E-commerce is a digital platform that integrates social, commercial, and economic activities and has the potential to further promote social capital accumulation among rural residents. This facilitation can be understood in terms of social networks, social interactions, and social trust. First, with regard to social networks, as e-commerce permeates the daily lives of rural residents, spatial constraints are further removed and connections with relatives and friends are strengthened through commercial activities (Zhou et al., 2021).

Second, e-commerce is likely to facilitate social interaction. E-commerce is an effective means of carrying and communicating business information, allowing different users to communicate with each other (Liu et al.,).

Third, e-commerce has the potential to enhance the social trust of rural residents. Virtual social networks formed through e-commerce, along with mechanisms such as “post-sale credit assessment,” can help address the information asymmetry and uncertainty typical of anonymized online markets and reduce distrust between rural residents and outsiders (Li & Ku, 2018).

4. Methodology

4.1.Data

Panel data were constructed to analyze the impact of rural e-commerce on residents' SWB. The data set was collected from the following three sources. First, we use China Family Panel Studies (CFPS). China Family Panel Studies (CFPS) is a nationally representative, biennial longitudinal survey of Chinese communities, families, and individuals launched in 2010 by the Institute of Social Science Survey of Peking University, China. The CFPS is designed to collect longitudinal data at the individual, family, and community levels in contemporary China. The studies focus on the economic and non-economic well-being of the Chinese population, with a wealth of information on topics such as economic activities, educational outcomes, family dynamics and relationships, migration, and health. Given the variable set-up and the large number of continuous and missing values in the data, as well as the external effects of COVID-19, the empirical analysis in this study primarily uses survey data from two waves conducted in 2014 and 2018. Second, we use the list of counties that have adopted the REDC program from the website of the Ministry of

Commerce of the People's Republic of China. Third, we use the China Statistical Yearbook for province-level control variables.

4.2.Variables

4.2.1. Dependent variable

The dependent variable, *SWB*, is the subjective score of happiness. We measure *SWB* based on the single-item question which asks individuals about their happiness. In the CFPS questionnaire, respondents' SWB is evaluated based on their answers to the question: “How happy do you think you are?” Options are integers from 0 to 10, with larger values indicating greater happiness.

4.2.2. Independent variable

The independent variable, *REDC*, is a continuous variable that represents the total number of REDCs in the province. As the REDC policy started in 2014, *REDC* equals to 0 before 2014.

4.2.3. Control variables

Consistent with the literature on SWB (e.g., Koomson et al., 2024), we control for several variables that account for the characteristics of the respondent and their household. Moreover, in line with the literature (Cheng et al., 2016; Ding et al., 2021; Zhang & Awaworyi Churchill, 2020), the province-level control variables are also used. At the individual level, control variables include age, age squared, gender, marital status, years of education, hukou, and self-rated health status. At the household level, control variables include family size and net household income. At the province-level, control variables include GDP per capita and population.

4.3. Estimation model

This study examines the impact of rural e-commerce on SWB of residents in China based on panel data. This study adopts a two-way fixed effects model:

$$SWB_{ijt} = \beta_0 + \beta_1 REDC_{it} + \beta_2 \boldsymbol{X}_{it} + \beta_3 \boldsymbol{Z}_{jt} + \mu_i + \lambda_t + \varepsilon_{ijt}, \quad (1)$$

where SWB_{ijt} is the dependent variable which indicates SWB scores of the respondent *i* in province *j* and year *t*. In the CFPS questionnaire, respondents' SWB is evaluated based on their answers to the question: “How happy you are?” Options are integers from 0 to 10, with larger values indicating greater happiness (Knight & Gunatilaka, 2010; Sun et

al., 2016). The core independent variable $REDC_{it}$ indicates the number of rural e-commerce demonstration counties in province *i* year *t*. $\boldsymbol{X}_{it}$ and $\boldsymbol{Z}_{jt}$denote individual- and province-level control variables, respectively, consistent with the literature (e.g., Cheng et al., 2016; Hu, 2013). Individual-level control variables include age, gender, age, marital status, education, household registration, health status, household size, and household income. Province-level control variables include GDP per capita and population, obtained from official statistics of the National Bureau of Statistics of China. μ_i and λ_t denote province fixed effects and year fixed effects, respectively, which help us control for invariant selection bias at the county level and absorb common time-varying shocks to Chinese residents. ε_{ijt} is a random disturbance term.

Table 1 provides descriptive statistics of the variables used in the analysis. The SWB of residents, evaluated on a scale from 0 to 10, averages at 7.54. This figure suggests that Chinese residents generally perceive their well-being positively, aligning with findings from other recent studies on residents' SWB in China. For example, using data from the Chinese General Social Survey, Ding et al. (2021) observed that the average SWB for Chinese residents was 3.87 (on a 5-point scale of 1 to 5) in 2015.

Table 1. Descriptive statistics

Variable	Definitions	Obs	Mean	Std. dev.	Min	Max
SWB	Integers from 0 to 10, with higher numbers representing greater happiness	64,341	7.54	2.17	0	10
REDC	number of rural e-commerce demonstration counties	74,251	6.26	7.93	0	28
lnREDC	the natural logarithm of number of rural e-commerce demonstration counties	74,251	1.29	1.24	0	3.37
age	age	74,482	45.02	18.43	9	104
age_sq	square of the age	74,482	2366.31	1746.49	81	10816
gender	male = 1; female = 0	74,501	0.50	0.50	0	1
married	married =1; otherwise =0	67,734	0.77	0.42	0	1
yedu	years of education	72,186	7.21	4.91	0	21
hukou	household register, urban hukou=3; rural hukou=1	66,442	1.53	0.88	1	3
health	ranging from 1 to 5, with higher numbers representing less health	74,089	2.96	1.25	1	5
family_size	family size	73,600	4.34	2.01	1	21
lnnet_family_income	the natural logarithm of net household income	70,971	10.70	1.18	0	16.03
lnpcgdp	the natural logarithm of GDP per capita	74,251	10.82	0.42	10.18	11.85
lnpopulation	the natural logarithm of population at year-end	74,251	8.56	0.54	5.84	9.34

5. Results

5.1. Baseline results

Table 2 presents two-way fixed effect (TWFE) results with different combinations of control variables. Columns (1) - (3) presents results for the full sample and columns (4) - (6) presents results for the rural sample. Column (1) controls for individual characteristics, province fixed effects, and year fixed effects. We found that the estimated coefficients on REDC are statistically significantly positive at the 5% level, suggesting that rural e-commerce development is likely to contribute to the SWB improvement of Chinese residents. Column (2) controls for individual characteristics, household characteristics, province fixed effects, and year fixed effects. TWFE estimate remains significantly positive at the 5% level. Column (3) adds on province-level population and GDP per capita to account for province-level characteristics. TWFE estimate remains significantly positive at the 10% level. According to our estimates, 1% increase in the number of REDC improved SWB of Chinese residents by 0.00025 on a scale of 0-10. Conversely, as columns (4) - (6) present, for rural residents, the results were statistically insignificant.

Table 2. Baseline result of two-way fixed effects (TWFE) estimation

	full sample			rural		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Subjective well-being					
lnREDC	0.030**	0.026**	0.025*	0.005	-0.003	-0.008
	(0.013)	(0.013)	(0.014)	(0.019)	(0.019)	(0.020)
age	-0.144***	-0.144***	-0.145***	-0.137***	-0.133***	-0.133***
	(0.026)	(0.026)	(0.026)	(0.039)	(0.040)	(0.040)
age_sq	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
male	-0.092	0.543	0.540	0.312	0.260	0.282
	(0.598)	(0.719)	(0.718)	(1.064)	(1.064)	(1.064)
married	0.540***	0.520***	0.520***	0.623***	0.591***	0.589***
	(0.078)	(0.079)	(0.079)	(0.133)	(0.134)	(0.134)
yedu	0.014	0.015	0.015	0.027	0.022	0.022
	(0.013)	(0.014)	(0.014)	(0.020)	(0.021)	(0.021)

urban hukou	0.018	0.025	0.024	-0.018	-0.018	-0.012
	(0.084)	(0.086)	(0.086)	(0.142)	(0.144)	(0.144)
health (= 2)	-0.244***	-0.255***	-0.254***	-0.161**	-0.197***	-0.195***
	(0.046)	(0.047)	(0.047)	(0.070)	(0.072)	(0.072)
health (= 3)	-0.417***	-0.429***	-0.429***	-0.417***	-0.456***	-0.456***
	(0.044)	(0.045)	(0.045)	(0.068)	(0.069)	(0.069)
health (= 4)	-0.546***	-0.546***	-0.546***	-0.537***	-0.573***	-0.573***
	(0.055)	(0.057)	(0.057)	(0.085)	(0.088)	(0.088)
health (= 5)	-0.834***	-0.816***	-0.816***	-0.808***	-0.804***	-0.802***
	(0.064)	(0.066)	(0.066)	(0.094)	(0.096)	(0.096)
family_size		0.004	0.005		-0.010	-0.010
		(0.012)	(0.012)		(0.018)	(0.018)
lnnet_family_income		0.072***	0.073***		0.062***	0.060***
		(0.015)	(0.015)		(0.022)	(0.022)
lnpcgdp			-0.206			0.219
			(0.159)			(0.279)
lnpopulation			0.972			0.423
			(1.268)			(2.329)
Constant	9.905***	8.771***	2.688	9.525***	8.925***	2.980
	(1.117)	(1.156)	(10.035)	(1.702)	(1.738)	(18.213)
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	40,408	38,198	38,198	18,776	17,778	17,778
R-squared	0.688	0.689	0.689	0.680	0.681	0.681

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5.2. Robustness tests

The following two types of robustness tests were performed in this study. (1) To account for lag effects; to account for the potential lag effect of an increase in REDC on SWB improvement, we employed REDC with a lag of one period data as a robustness check. (2) Control for regional time trends. Province-level administrative regions located in different economic belts may have marked differences in factors such as policy and natural environment, and these differences may change over time. Therefore, in this paper,

we control for regional time trends by constructing interaction terms between the eastern, central, and western dummy variables and the time trend variable; Table 3 and Table 4 show the results of the analysis controlling for lagged effects and regional time trends, respectively. As shown in Table 3 (1) and (3), the estimated coefficients on REDC are statistically significantly positive at the 10% level, respectively, proving the robustness of the estimates in this paper. As shown in Table 4 (1) - (3), the estimated coefficients on REDC are statistically significantly positive at the 1% or 5% level, demonstrating the robustness of the estimates in this paper.

Table 3. Robustness tests results (lag effect)

	lag one period					
	full sample			rural		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	happiness					
lnREDC	0.023*	0.018	0.025*	0.010	0.002	-0.008
	(0.014)	(0.015)	(0.015)	(0.022)	(0.023)	(0.025)
age	-0.144***	-0.144***	-0.146***	-0.138***	-0.133***	-0.133***
	(0.026)	(0.026)	(0.027)	(0.039)	(0.040)	(0.040)
age_sq	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
1.gender	-0.073	0.568	0.558	0.316	0.256	0.275
	(0.604)	(0.725)	(0.723)	(1.067)	(1.063)	(1.061)
1.married_d	0.540***	0.519***	0.520***	0.623***	0.591***	0.590***
	(0.078)	(0.079)	(0.079)	(0.133)	(0.134)	(0.134)
yedu	0.014	0.015	0.015	0.027	0.022	0.022
	(0.013)	(0.014)	(0.014)	(0.020)	(0.021)	(0.021)
3.hukou	0.018	0.026	0.023	-0.018	-0.019	-0.013
	(0.084)	(0.086)	(0.086)	(0.142)	(0.144)	(0.144)
2.health	-0.245***	-0.255***	-0.254***	-0.161**	-0.197***	-0.195***
	(0.046)	(0.047)	(0.047)	(0.070)	(0.072)	(0.072)
3.health	-0.417***	-0.430***	-0.428***	-0.417***	-0.456***	-0.456***
	(0.044)	(0.045)	(0.045)	(0.068)	(0.069)	(0.069)
4.health	-0.546***	-0.546***	-0.545***	-0.537***	-0.573***	-0.572***
	(0.055)	(0.057)	(0.057)	(0.085)	(0.088)	(0.088)

5.health	-0.834***	-0.815***	-0.814***	-0.809***	-0.804***	-0.802***
	(0.064)	(0.066)	(0.066)	(0.094)	(0.096)	(0.096)
family_size		0.005	0.005		-0.010	-0.009
		(0.012)	(0.012)		(0.018)	(0.018)
lnnet_family_income		0.073***	0.074***		0.061***	0.060***
		(0.015)	(0.015)		(0.022)	(0.022)
lnpcgdp			-0.304*			0.267
			(0.160)			(0.305)
lnpopulation			2.049*			-0.080
			(1.180)			(2.373)
Constant	9.902***	8.755***	-5.450	9.530***	8.933***	6.776
	(1.121)	(1.161)	(9.283)	(1.702)	(1.735)	(18.243)
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	40,408	38,198	38,198	18,776	17,778	17,778
R-squared	0.688	0.689	0.689	0.680	0.681	0.681

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4. Robustness tests results (time trend by region)

	full sample			rural		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	happiness					
lnredc	0.043***	0.043***	0.034*	0.033	0.026	0.011
	(0.016)	(0.017)	(0.018)	(0.026)	(0.027)	(0.029)
age	-0.144***	-0.145***	-0.146***	-0.135***	-0.131***	-0.131***
	(0.026)	(0.026)	(0.026)	(0.039)	(0.040)	(0.040)
age_sq	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
male	-0.078	0.559	0.561	0.329	0.277	0.288
	(0.602)	(0.722)	(0.725)	(1.079)	(1.078)	(1.079)
married	0.541***	0.520***	0.521***	0.619***	0.584***	0.583***
	(0.078)	(0.080)	(0.080)	(0.133)	(0.134)	(0.134)
yedu	0.014	0.015	0.015	0.026	0.022	0.022
	(0.013)	(0.014)	(0.014)	(0.020)	(0.021)	(0.021)
urban hukou	0.022	0.028	0.027	-0.006	-0.007	-0.006
	(0.084)	(0.086)	(0.086)	(0.142)	(0.144)	(0.144)
health (= 2)	-0.243***	-0.253***	-0.252***	-0.160**	-0.195***	-0.194***
	(0.046)	(0.047)	(0.047)	(0.070)	(0.072)	(0.072)
health (= 3)	-0.417***	-0.430***	-0.429***	-0.418***	-0.457***	-0.456***
	(0.044)	(0.045)	(0.045)	(0.068)	(0.069)	(0.069)
health (= 4)	-0.546***	-0.547***	-0.546***	-0.537***	-0.572***	-0.572***
	(0.055)	(0.057)	(0.057)	(0.085)	(0.088)	(0.088)
health (= 5)	-0.836***	-0.818***	-0.818***	-0.813***	-0.808***	-0.807***
	(0.064)	(0.066)	(0.066)	(0.094)	(0.096)	(0.096)
family_size		0.005	0.006		-0.009	-0.008
		(0.012)	(0.012)		(0.018)	(0.018)
lnnet_family_income		0.072***	0.073***		0.061***	0.060***
		(0.015)	(0.015)		(0.022)	(0.022)
lnpcgdp			-0.383**			-0.321
			(0.172)			(0.364)
lnpopulation			2.040			4.140

			(1.350)			(2.935)
Constant	9.871***	8.739***	-4.567	9.391***	8.799***	-23.218
	(1.116)	(1.155)	(10.554)	(1.703)	(1.739)	(22.269)
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Region by year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	40,408	38,198	38,198	18,776	17,778	17,778
R-squared	0.688	0.689	0.689	0.680	0.681	0.681

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5.3. Mechanism tests

As the baseline results and robustness tests imply that rural e-commerce significantly increases SWB of Chinese residents, we further explored multiple potential pathways for this positive effect. As analyzed in Section 3, these mechanisms include increases in absolute material welfare, relative inequality reduction, and social capital accumulation. Table 5 presents the results of the analysis.

5.3.1. Improvement of absolute material welfare channel

We argued in section3 that the development of rural e-commerce has the potential to increase the SWB of residents by increasing their absolute material welfare. This study measured material welfare in terms of income, more specifically, total income. As shown in column (1) of Table 5, the estimated coefficients on REDC are statistically significantly positive at the 1% level, suggesting that rural e-commerce development is likely to contribute to the increase in total income of Chinese residents. Furthermore, as shown in column (4) of Table 5, the estimated coefficients on REDC are statistically significantly positive at the 1% level, suggesting that rural e-commerce development is likely to contribute to the increase in total income of rural residents as well. According to our estimates, 1% increase in the number of REDC would increase the total income of Chinese residents by 0.27% and that of rural residents by 0.34%.

5.3.2. Relative inequality reduction channel

As emphasized in Section 3, the development of e-commerce has the potential to improve

residents' SWB by reducing relative disparities in income and consumption and improving relative social status. This study measured relative social status by subjective assessment. As shown in columns (2) and (5) of Table 5, the estimated coefficients on REDC are statistically insignificant, indicating that rural e-commerce development is unlikely to contribute to relative inequality reduction.

5.3.3. Social capital channel

We further validated the social capital mechanism. Referring to existing literature (Li et al., 2024; Yang et al., 2021; Zhao, 2020; Zhou et al., 2023), social network is measured by the total expenditure spent on gifts for social relations. The greater the amount spent on gifts to relatives and friends, the more developed the social network (Li et al., 2024). As shown in columns (3) of Table 5, the estimated coefficients on REDC are statistically significantly positive at the 1% level, indicating that rural e-commerce development is likely to contribute to the expansion of social networks in China. Given the positive role of social capital in promoting people's SWB (Bartolini & Sarracino, 2015), we confirmed the validity of the mechanism of social capital accumulation.

Table 5 Mechanism tests results

	full sample			rural		
	(1)	(2)	(3)	(4)	(5)	(6)
	ln(total	relative	ln(gift	ln(total	relative	ln(gift
VARIABLES	income)	social status	expenditure)	income)	social status	expenditure)
lnREDC	0.274***	0.008	0.049***	0.343***	-0.004	0.014
	(0.046)	(0.007)	(0.012)	(0.075)	(0.010)	(0.017)
age	-0.076	-0.040**	0.069***	-0.296**	-0.056**	0.141***
	(0.096)	(0.018)	(0.026)	(0.120)	(0.027)	(0.035)
age_sq	0.001	0.001***	-0.001***	0.003**	0.001***	-0.002***
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
male	-0.357	0.117	0.409		0.046	0.805
	(2.232)	(0.224)	(0.484)		(0.284)	(0.846)
married	-0.209	0.034	0.190**	-0.488	-0.043	0.041
	(0.190)	(0.036)	(0.075)	(0.402)	(0.061)	(0.108)
yedu	0.039	0.000	-0.037***	0.032	-0.004	-0.055***
	(0.042)	(0.007)	(0.013)	(0.069)	(0.011)	(0.019)

urban hukou	-0.268	0.103**	-0.022	-0.675	0.101	-0.002
	(0.237)	(0.044)	(0.082)	(0.475)	(0.073)	(0.114)
health (= 2)	-0.288**	-0.044*	-0.020	-0.488**	-0.069*	0.002
	(0.142)	(0.024)	(0.044)	(0.248)	(0.036)	(0.061)
health (= 3)	0.003	-0.142***	-0.032	0.067	-0.165***	-0.002
	(0.134)	(0.023)	(0.042)	(0.241)	(0.034)	(0.059)
health (= 4)	-0.057	-0.171***	-0.053	0.128	-0.210***	-0.017
	(0.174)	(0.028)	(0.053)	(0.315)	(0.043)	(0.075)
health (= 5)	-0.608***	-0.267***	0.021	-1.014***	-0.304***	0.046
	(0.221)	(0.033)	(0.059)	(0.376)	(0.048)	(0.077)
family_size	-0.030	0.003	0.061***	0.006	0.001	0.025
	(0.038)	(0.006)	(0.012)	(0.068)	(0.009)	(0.018)
lnpcgdp	-0.599	-0.349***	0.032	1.534	-0.516***	0.296
	(0.486)	(0.079)	(0.171)	(0.995)	(0.135)	(0.246)
lnpopulation	4.428	-0.021	-3.110**	-18.426**	1.475	-2.338
	(3.728)	(0.643)	(1.560)	(8.264)	(1.197)	(2.332)
lnnet_family_						
income		0.005	0.153***		-0.002	0.135***
		(0.008)	(0.017)		(0.011)	(0.022)
Constant	-21.428	7.561	31.320***	156.493**	-2.656	20.286
	(29.669)	(5.122)	(12.142)	(64.953)	(9.431)	(18.097)
Province fixed						
effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed						
effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,720	38,046	33,880	4,198	17,704	15,214
R-squared	0.631	0.661	0.637	0.656	0.644	0.652

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

6. Conclusions

This study empirically examines the effects of the rural e-commerce demonstration county (REDC) policy on the subjective well-being (SWB) of Chinese residents. In the

baseline results, we find that the REDC policy has a significant positive impact on the SWB of Chinese residents. This finding is robust to sensitivity checks that account for the lagged effect of the REDC policy and regional time trends. Moreover, mechanism tests reveal that the positive effect of rural e-commerce on SWB can be explained by enhanced absolute welfare, measured by total income, and increased social capital accumulation, measured by the total expenditure spent on gifts for social relations.

An important policy recommendation arising from the results is to continue and expand the REDC policy to further improve the SWB of Chinese residents. As the REDC policy can improve SWB, we need to understand how rural e-commerce can be facilitated. As recommended by Zhang et al. (2024), local governments can promote rural e-commerce by implementing the following measures. Local governments should utilize the power of the Internet to overcome market segmentation and reduce transaction costs. In addition, transportation and communication infrastructure need to be improved to reduce logistics costs. Furthermore, local governments should also actively cultivate skilled professionals. This is especially critical in economically disadvantaged areas, where proactive measures should be taken to train and attract e-commerce personnel and increase human capital levels.

Two major limitations of this study are worth noting. First, SWB is derived from simple questions in the CFPS, which inevitably introduces subjectivity and potential self-reporting bias. This issue may not fully capture the multifaceted nature of well-being. Second, as pointed out by Wei et al. (2024), although we consider the REDC pilot policy as a quasi-natural experiment, we cannot completely rule out the possibility that the selectivity of the pilots could interfere with the estimation results.

Chapter 3 The effects of 15-minute convenient living circles on quality of life in prefecture-level cities

1. Introduction

Improving quality of life (QOL) has long been an explicit or implicit goal for individuals, communities, nations, and the world (Costanza et al., 2007). According to the World Health Organization (WHO) Quality of Life Group, QOL reflects an individual's perception of their place in life in relation to their goals, expectations, standards, and concerns (WHOQOL, 1995) As improving QOL is a major policy and lifestyle goal (Schuessler & Fisher, 1985), there is great potential in understanding QOL (Costanza et al., 2007).

Improving QOL of residents is an important indicator of a better life. The 20th National Congress of the Communist Party of China emphasized that quality development is of paramount importance for the overall promotion of socialist modernization. Thus, a significant improvement in QOL underscores the establishment of a moderately affluent society (Huang et al., 2024).

In recent years, to meet the growing needs of people seeking a better life, “15-minute convenient living circles (一刻钟便民生活圈)” have been promoted to target services to local residents and meet their needs for basic daily consumption and consumption of quality goods and services within a 15-minute walking distance. In May 2021, 12 departments including the Ministry of Commerce submitted “Opinions on Promoting the Construction of Urban Quarter-Hour Convenient Living Circle (关于推进城市一刻钟便民生活圈建设的意见)” to promote the construction of “15-minute convenient living circles”[5]. In October 2021, the Ministry of Commerce (MOFCOM) and others published a list of the first 30 pilot cities. The pilot cities were selected based on voluntary applications from cities, with the Ministry of Commerce working with relevant authorities and experts reviewing each city's application materials. It is hoped that the promotion of the “convenient 15-minute life zone” will raise living standards, happiness, and a sense of security. However, although there are individual case studies on pilot cities

[5] https://www.gov.cn/zhengce/zhengceku/2021-06/03/content_5615099.htm

of “15-minute convenient living circles” (Xie et al., 2023), to my knowledge, there is no empirical analysis on the impact of the selection of pilot cities on the quality of life in the cities.

Quality of life integrates multiple aspects such as health, education, the economy, and society, and more specifically reflects an individual's level of well-being. Therefore, a detailed study of QOL would not only improve the well-being of the population but also help promote the harmonious and sustainable development of society and clarify the relationship between economic growth and social progress. However, with a few exceptions, such as Huang et al. (2024), there are limited studies that extend beyond individual QOL to systematically index and measure urban QOL based on objective indicators and quantify the factors affecting it.

2. Literature Review

2.1. QOL indicator

Against the backdrop of China's pursuit of quality development, government policy goals are increasingly aligned with improving quality of life. In parallel, researchers have also placed growing emphasis on the measurement and improvement of quality of life. Some studies have focused on developing indicator systems from different perspectives (e.g., objective, subjective, or a combination of both), while others have focused solely on objective indicators such as economy, health, education, crime, employment, infrastructure development, and living standards (Hybel & Mulalic, 2021; Pasten & Santamarina, 2012). On the other hand, some studies assess quality of life by focusing on subjective feelings such as life satisfaction and subjective well-being (Welsch & Biermann, 2017; Perales et al. 2014). Furthermore, some studies integrate subjective and objective factors to assess quality of life (Costanza et al., 2007; Qin et al., 2022).

In studies that assess quality of life using subjective indicators, respondents were asked, “How would you rate your current level of life satisfaction?” or “Do you feel happy?” (Qin et al., 2022). It should be noted that measuring quality of life is based on the subjective feelings of residents, as happiness is a subjective assessment of current conditions and is influenced by a variety of factors (e.g. education, economy, culture). These factors pose difficulties in assessment and results will vary as respondents'

subjective feelings vary by region and time.

2.2. Factors influencing QOL

Some studies have focused on factors affecting quality of life (Huang et al., 2024). For example, Zhang et al. (2022) analyzed the impact of solid fuel use on the life satisfaction of rural Chinese residents using CFPS panel data from 2010 to 2018 and found that life satisfaction decreased when rural residents used solid fuel for cooking. Qin et al. (2022) used CFPS2014, 2016, and 2018 to construct a comprehensive index of family-level quality of life, considering income, expenditures, insurance, health, and future attitudes. Empirical analysis also reveals that family energy poverty undermines family quality of life.

The positive impact of ICTs on quality of life has been confirmed by existing studies; Ma et al. (2020) analyzed the relationship between Internet use and economic well-being of rural households and found that Internet use significantly increased household income and expenditure. Zhong et al. (2022) used CGSS data to investigate the impact of adoption on residents' self-rated health. The results showed that ICT adoption significantly improved residents' self-rated health. However, the impact of ICT on subjective quality of life is multiple, and ICT does not necessarily promote subjective quality of life. For example, Nie et al. (2017) and Zhang et al. (2020) using data from the China Family Panel Studies (CFPS) found that increased Internet use had a significant negative impact on subjective well-being and life satisfaction. Wang and Zhou (2023) used cross-sectional data from CFPS2018 to analyze the impact of information and communication technology (ICT), a core investment in smart cities, and human capital on subjective quality of life. The results show that ICT is negatively correlated with life satisfaction and frequency of happy (positive) emotions, but not with depressive (negative) emotions. In contrast, human capital was found to have a positive impact on life satisfaction and the frequency of happy emotions, but a negative impact on the frequency of depressive emotions.

3. Backgrounds

3.1. 15-minute convenient living circles

In order to promote the construction of "convenient 15-minute living zones" to meet the

growing needs of people for a better life, 12 departments including the Ministry of Commerce jointly issued "Opinions on Promoting the Construction of Urban Quarter-Hour Convenient Living Circle (关于推进城市一刻钟便民生活圈建设的意见)" in May 2021. It proposed to select cities across the country suitable for pilot implementation of living circles during the 14th Five-Year Plan period, and promote the construction of living circles with rational layout, improved business categories, comprehensive functions, smart and convenient services, orderly regulations, high-quality services, and harmonious commercial and residential areas. The nationwide promotion of this initiative will facilitate the construction of living circles, the establishment of convenient service chains, and the improvement of people's living standards, enhancing their interests, happiness, and sense of security. In October 2021, 11 departments, including the Ministry of Commerce, released a list of the first 30 pilot cities. Subsequently, the second list of 50 pilot cities was released in July 2022, the third list of 70 pilot cities was released in August 2023, and the fourth list of 60 pilot cities was released in September 2024.

According to MOFCOM, to date, the 80 pilot areas have built 1,402 community service circles with 280,000 commercial outlets covering more than 32 million people in 2,766 communities. The community service circles in the pilot areas now feature more balanced commercial networks, more diverse facilities and business forms, more vibrant market entities, and more service provision functions. Residents' sense of fulfillment has also increased[6].

4. Methodology

4.1. Data

We use panel data for 283 prefecture-level cities nationwide for the period 2012-2022. The data source used in this study is the “China City Statistical Yearbook. For the list of pilot cities for the “convenient 15-minute life circle,” we used the “The first batch of the 15-minute convenient living circles pilot city list (全国首批城市一刻鐘便民生活圈試点名单)” and ”the second batch of 15-minute convenient living circles pilot city list (全

[6] https://english.mofcom.gov.cn/PressConferenceHomepage/ServiceTrade/art/2023/art_b2eedc70bc3d46aaa3e3cdfb1fb57503.html

国第二批城市一刻鐘便民生活圏試点名单)". Some missing values were supplemented with data from provincial statistical yearbooks.

4.2. Variables

4.2.1. Dependent variables

The dependent variable in this study is QOL. Based on the previous literature and 2018 National Bureau of Statistics report, this study constructs a system of QOL index from five dimensions: residents' economic status, social security, livelihood environment, education and culture, and living quality (Table 1). To avoid subjective bias, this study calculates an index using the entropy weight method.

Table 1. Quality of life index

Category	Secondary indicator	Property
Residents' economic status	GDP per capita	+
Social security	Number of beds in medical institutions per 10,000 people	+
Livelihood environment	Area of parks and green land per capita	+
	Urban population density	-
Education and culture	Library books per capita	+
	Number of regular secondary schools students per 10,000 people	+
Living quality	Number of buses per 10,000 people	+

4.2.2. Independent variables

DID is the core independent variable indicates whether a prefecture-level city is selected as a pilot city of 15-minute convenient living circles in year t. If a prefecture-level city becomes a pilot city in year t, *DID* is set to 1 in year t and subsequent years, and 0 otherwise.

4.2.2. Control variables

Referring to the literature on QOL (Huang et al., 2024), and taking into account data availability, hukou population growth rate, GDP growth rate, financial development measured by the ratio of loans from financial institutions to GDP, and the ratio of fiscal expenditure to GDP.

4.3. Estimation model

Based on panel data from 2012 to 2022, we examine the impact of the "15-minute convenient living circles" pilot city policy on quality of life in 283 geographic cities across the country. The first 15-minute convenient living circles pilot city was selected in 2021, with new pilot cities selected in 2022, 2023, and 2024. The TWFE DID model under staggered treatment adoption is employed given that the treatment year in the whole sample is variant rather than uniform. The baseline regression model is as follows:

$$QOL_{it} = \alpha_0 + \beta_1 DID_{it} + \delta \boldsymbol{X}_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

In this model, QOL_{it} is the dependent variable which indicates QOL of prefecture-level city *i* in year *t*. DID_{it} is the core independent variable which indicates that if city *i* is selected as a pilot city in year *t*, its value is set to 1 in year *t* and the following years, otherwise it is set to 0. The parameter of interest, β_1, represents the size and significance of the policy effect on QOL. We expect this parameter to be significantly positive, implying that 15-minute convenient living circles can contribute to an increase in QOL. $\boldsymbol{X}_{it}$ represents the control variables. μ_i and λ_t represents the city-fixed effects and year-fixed effects respectively. ε_{it} is the error term.

Table 2 provides descriptive statistics of the variables used in the analysis.

Table 2. Descriptive statistics

Variable	Definitions	Obs	Mean	Std. dev.	Min	Max
QOL	QOL index	3,113	0.07	0.05	0.00	0.89
DID	A prefecture-level city is a pilot city of 15-minute convenient living circles =1; otherwise=0	3,113	0.03	0.16	0	1
hukou_pop_growth	Hukou population growth rate	3,113	0.30	3.71	-35.17	131.71
gdp_growth	GDP growth rate	3,103	7.18	3.82	-20.63	23.96
fin_dev	loans of financial institutions/GDP	3,109	1.25	0.97	0.17	16.74
gov_exp_gdp	fiscal expenditure/GDP	3,109	0.25	0.25	0.04	6.04

5. Results

5.1.Baseline regression results

Table 3 presents the baseline results. Column (1) shows the results for the balanced panel

and column (2) shows the results for the unbalanced panel. We found that the estimated coefficients on DID are statistically significantly positive at the 5% level, suggesting that 15-minute convenient living circles pilot policy is likely to contribute to the QOL improvement. According to our estimates, 15-minute convenient living circles pilot policy implementations increased the QOL score of rural residents by 0.005 points. Correspondingly, 15-minute convenient living circles pilot policy led to an increase in QOL score by about 7.14%, as the average QOL score is 0.07 in the full sample. Therefore, we found a statistically significant and economically large effect of 15-minute convenient living circles on QOL.

Table 3. Baseline result of DID methods.

	Unbalanced	Balanced
	(1)	(2)
VARIABLES	Score	Score
DID	0.005**	0.003**
	(0.002)	(0.002)
hukou_pop_g	-0.000	-0.000**
	(0.000)	(0.000)
gdp_growth	0.000	0.000
	(0.000)	(0.000)
fin_dev	-0.000	-0.000
	(0.001)	(0.001)
gov_exp_gdp	-0.002	-0.002
	(0.002)	(0.002)
Constant	0.066***	0.064***
	(0.001)	(0.001)
City fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Observations	3,103	3,003
R-squared	0.902	0.931

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5.2. Applicability tests

Applying the DID method necessitates adherence to certain assumptions. Non-compliance can cause significant deviation in estimates from the actual causal effect. This section discusses the key assumptions of the DID approach, specifically the Parallel Trends Assumption (PTA) and potential spillover effects.

5.2.1. Parallel trends tests

The baseline DID results confirmed that the pilot policy implementations effectively enhance people's QOL in China. However, one of the prerequisites for DID design is to satisfy the PTA, meaning that before policy implementations, the treated group and control group would have followed the same trend over time. To confirm the effectiveness of the staggered DID estimation result, this paper tests the parallel trend hypothesis. We adopted an event study analysis method for the staggered DID and the model is set up as follows:

$$QOL_{it} = \alpha_0 + \sum_{j\geqq -10, j\neq 0}^{j\leqq 1} \beta_j \quad DID_{it} + \delta \boldsymbol{X}_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

In (2), DID_{it} is assigned to 1 if the prefecture-level city is in the *j*th year after the 15-minute convenient living circles policy implementations and 0 otherwise. Other variables are defined consistently with the baseline model. To mitigate the risk of multicollinearity and ensure robustness in our estimations, the current year of policy enactment (period 0) serves as the referential baseline in conducting parallel trend tests.

Figure 1 provides a representation of the coefficients along with their 95% confidence intervals for each period. We found that none of the estimated coefficients were statistically significant until four years before the pilot policy implementation. This finding suggested that the QOL of residents living in pilot cities and non-pilot cities followed similar trends until four years prior to policy implementation. That is, although not perfect, using a staggered DID method is appropriate in this empirical design.

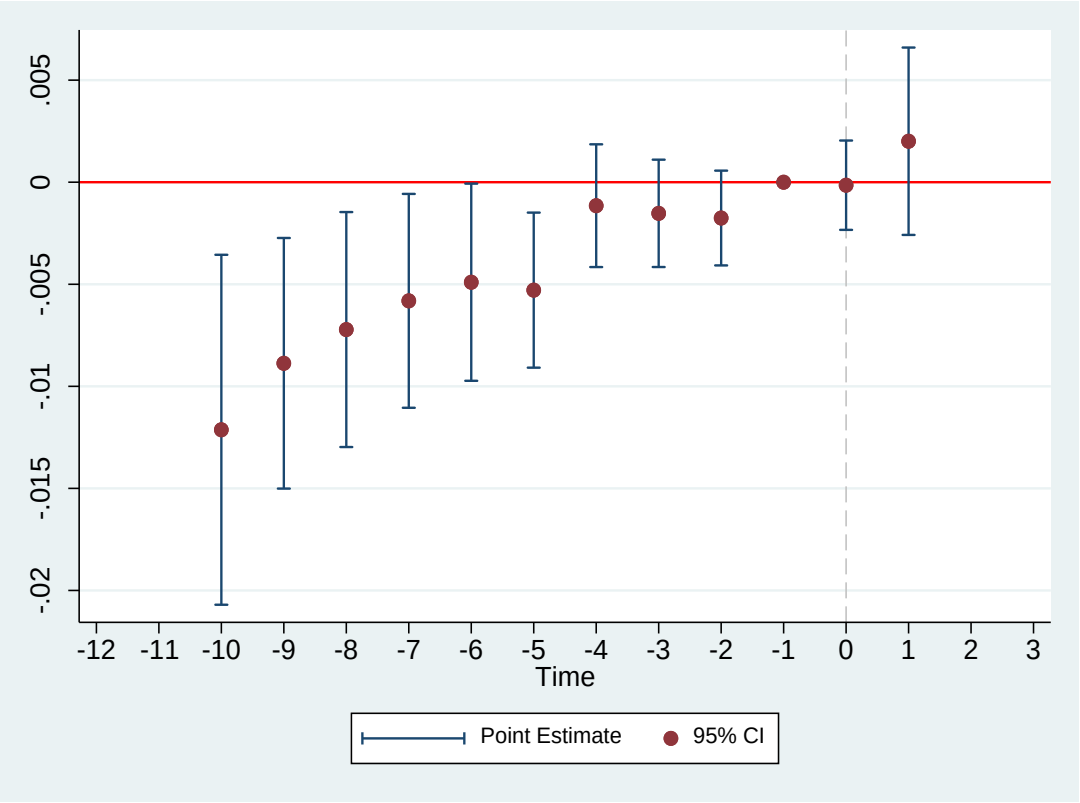

Figure 1. Result of the parallel trend test

5.3. Robustness tests

5.3.1. Bacon decomposition

Given the potential bias in staggered DID estimation, this study used the methods proposed by Goodman-Bacon (2021) and de Chaisemartin and D'Haultfoeuille (2022) to test estimation bias, respectively. According to Goodman-Bacon (2021), multi-period DID estimates can be categorized into newly treated units that treat previously untreated units as controls, newly treated units that treat units not yet treated as controls, and newly treated units that treat units already treated as controls. Of these, the third category already includes treatment effects, so its control group is not appropriate.

This study first conducted a Bacon decomposition to test for potential estimation bias. As shown in Table 4, the time-varying treatment group, which treats the never-treated group as the control group, has a weight as high as 94.86%. The fact that the time-varying treatment group assigns a significant weight to the never-treated group as the control group implies that there is no severe bias in the estimation results.

Table 4. Bacon decomposition

Bacon Decomposition	Beta	Total Weight
Timing groups	0.0002	0.0499
Never treated vs timing	0.0047	0.9486
Within	0.0555	0.0015

5.3.2. Placebo tests

To ascertain if unseen random factors could skew our DID results, this study executed placebo tests by constructing an artificial treatment group, as documented in studies by Niu et al. (2022), Zhou et al. (2023), and Wei et al. (2024).

Figure 2 shows that after repeating this randomization process 1000 times, the mean of the regression coefficients of these dummy policy variables is close to 0. In contrast, the true coefficient (0.004) in the baseline regression differs from the coefficients in the placebo test, thus confirming the robustness of baseline regression outcomes. These outcomes rule out the potential impact of unobservable chance factors, indirectly suggesting that the increase in Chinese residents' QOL is genuinely due to the implementation of the pilot policy.

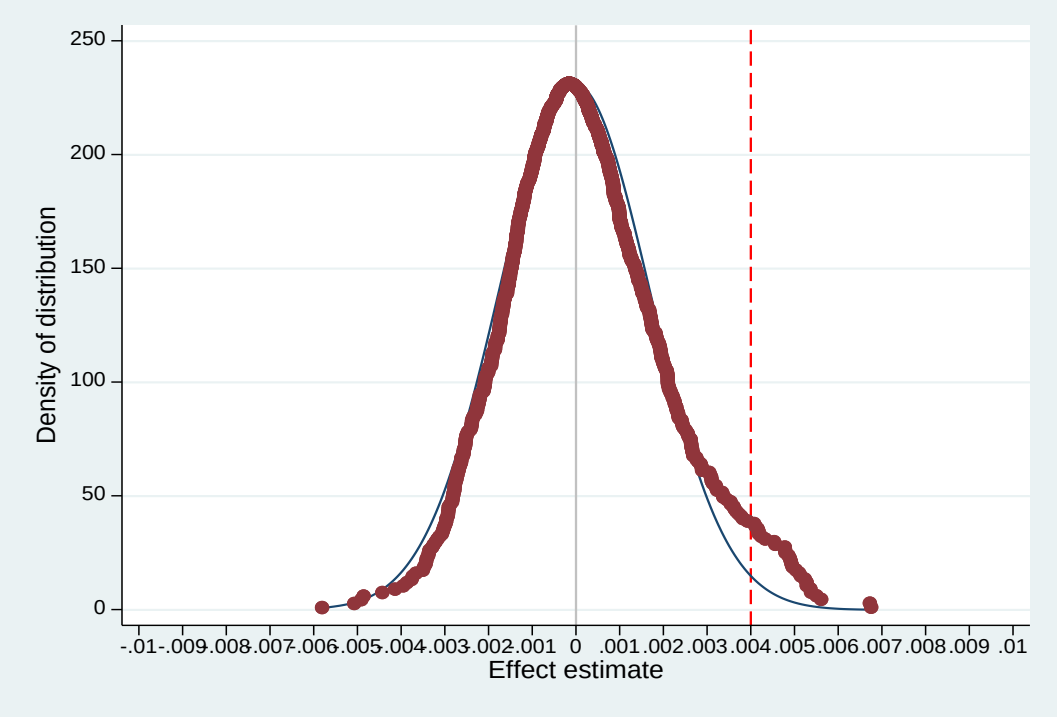

Figure 2. Result of the placebo tests

5.3.3. PSM-DID method

The propensity score matching (PSM) method is widely used to verify the robustness of estimation result regarding sample selection bias. This study adopted this method to match pilot cities with non-pilot cities to mitigate the influence of confounding factors by constructing a counterfactual control group. This study used kernel-based matching to match pilot cities with non-pilot cities. Among the matched samples, the deviations between treatment and control groups are significantly narrower and the samples satisfy the common support hypothesis, as depicted in Figure 3 and Figure 4. Table 5 reveals that the coefficients and significance levels of estimation results after kernel-based matching align with those of baseline regression, further indicating the robustness of baseline results.

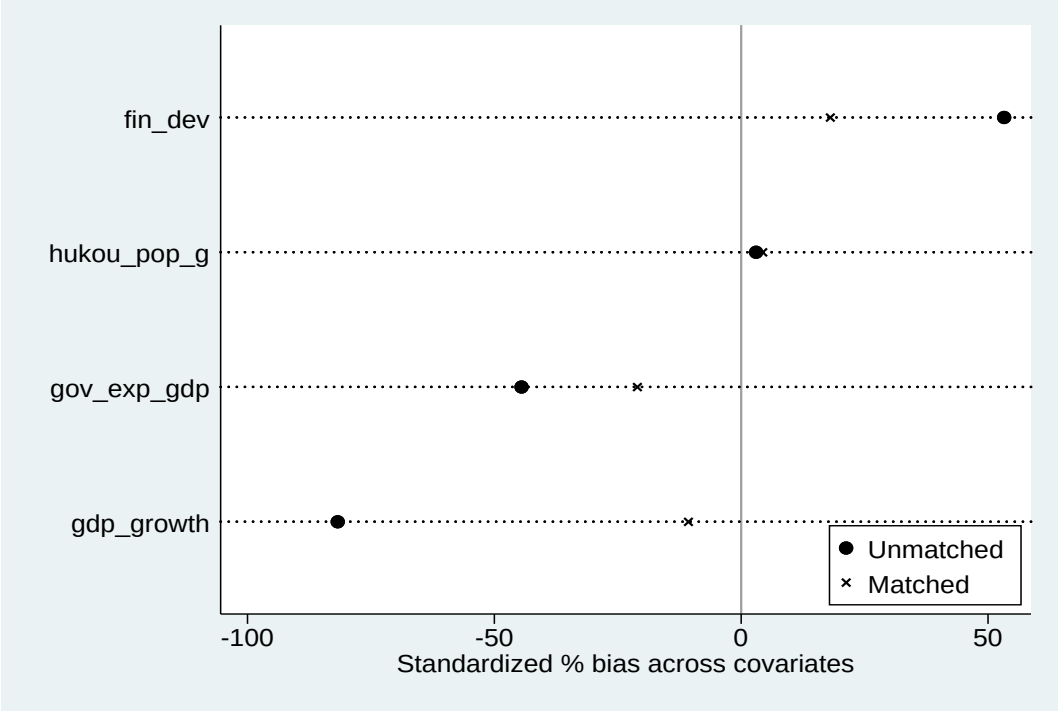

Figure 3 Result of balance test

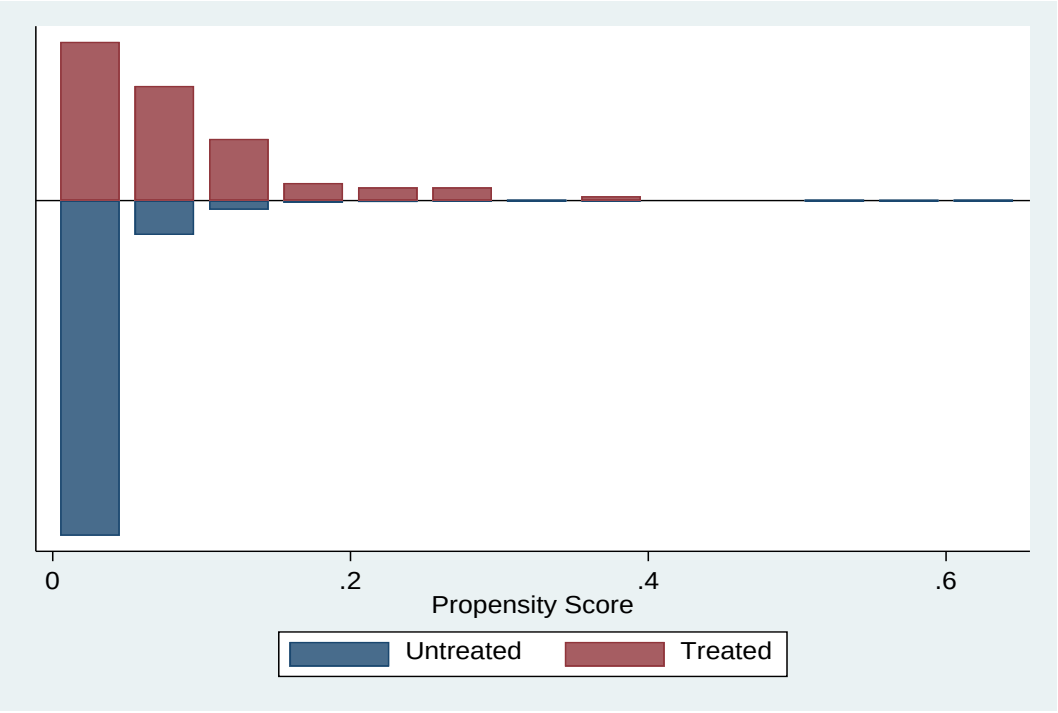

Figure 4 Result of common support test

Table 5. Result of PSM-DID

	Kernel matching
	(1)
VARIABLES	Score
did_compactcity	0.004**
	(0.002)
hukou_pop_g	0.000
	(0.000)
gdp_growth	0.000**
	(0.000)
fin_dev	-0.000
	(0.001)
gov_exp_gdp	-0.002
	(0.002)
Constant	0.087***
	(0.001)
Observations	3,099
R-squared	0.941

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

6. Conclusions

This study empirically examines the effects of the 15-minute convenient living circles pilot policy on quality of life (QOL) using prefecture-level city data from China. In the baseline results, we find that the pilot policy has a significant positive impact on the QOL of residents in China. The results remain valid after a series of assumption and robustness tests.

The results of this study have important policy implications. As the 15-minute convenient living circles pilot policy can improve QOL, we need to understand how 15-minute convenient living circles can be facilitated. “The Three-year Action Plan to Comprehensively Promote the Construction of 15-Minute Convenient Living Circles in

Cities (2023-2025)" formulated by 13 authorities, including the Ministry of Commerce, calls for the overall promotion of the construction of a wide variety of convenient 15-minute living spaces by 2025. Local governments are encouraged to voluntarily determine the content and timing of the activities and to bring a wide range of retailers and e-commerce companies into their communities to meet the needs of their residents through measures tailored to local conditions.

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