E-commerce development, poverty reduction and income growth in rural China

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E-commerce Development, Poverty Reduction and Income Growth in Rural China

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Abstract

Purpose:

This research examines the impact of the National Rural E-commerce Comprehensive Demonstration Project (NRECDP) on poverty reduction and income growth in rural China.

Design/methodology/approach:

The study develops a theoretical framework, which considers the role of geographical, technological, institutional, and cultural factors for the e-commerce poverty alleviation (e-CPA) model. Empirically, this study applies the difference-in-differences (DID) model and the event study approach to evaluate the effectiveness of NRECDP on the basis of large-scale county-level and household-level panel data spanning 2010 to 2020.

Findings:

The study found that the NRECDP, as a government-led, information and communication technology (ICT)-enabled, market-based programme, has led to a significant increase in per capita output of primary industry employees, as well as in the disposable income of rural residents, especially those in national-level poverty-stricken (NP) counties. The interventions of the NRECDP achieved these positive outcomes through transportation and Internet infrastructure improvement, ICT adoption and human capital accumulation in impoverished towns and villages in remote rural areas. These effects are larger in the eastern region of China, followed by the central region, whereas the weakest effects were found in the western region. However, we found little evidence of the NRECDP increasing household developmental expenditure.

Originality/value:

This study explores poverty alleviation issues in China by developing for the first time a multi-faceted framework that is subsequently tested by both county-level and household-level large-scale observations. Also, it is the first study to provide nationwide empirical evidence on the effectiveness of e-CPA in narrowing down the spatial and digital divides in China. In addition to the impact of geography, technology, and governmental support, this study also sheds light on the role of culture in the adoption and diffusion of digital technologies and as a source of local entrepreneurial opportunities.

Research implications:

The study findings have important practical and policy implications for rural e-commerce development and self-sustained poverty alleviation solutions. The research revealed the significance of government NRECDP interventions for increasing rural income, reducing living costs, and empowering the rural population in its multiple social roles, namely, as consumers, producers, employees, and microentrepreneurs. The local cultural context may

also play a role in ICT adoption and entrepreneurship cultivation with a downstream effect on the effectiveness of e-CPA practices. Policymakers would need to ensure a supportive entrepreneur-friendly environment for rural e-commerce development, and continue implementing progressive policies for poverty alleviation.

1. Introduction

Ending poverty in all its forms everywhere is the first of the 17 Sustainable Development Goals (United Nations, 2023). During the past four decades, nearly 800 million people in China have been lifted out of poverty, with extreme poverty largely eliminated by 2020 (World Bank, 2022). This long journey of poverty alleviation in China has been divided into six distinct phases: initial relief-focused poverty alleviation (1949–1977); poverty reduction facilitated by structural reforms (1978–1985); a shift towards development-driven poverty relief initiatives (1986–1993); tackling critical problems in poverty relief (1994–2000); the pursuit of consolidation-oriented comprehensive poverty alleviation (2001–2012); and the implementation of targeted poverty alleviation measures (2013–2020) (Guo et al., 2019; Wang and Hu, 2020; Yang and Liu, 2021). In the process, the Chinese government initiated and applied, locally and nationally, a series of innovative strategies related to infrastructure, agri-food industry, human resources development, policy support and market access. Among them, the e-commerce poverty alleviation (e-CPA) initiative supports individuals in remote and poor rural regions to create jobs, initiate entrepreneurial endeavours, and market local top-tier agricultural products through online e-commerce platforms in order to increase the earnings of impoverished households (Yang and Liu, 2021).

The focus on e-commerce is determined by the rapid development of the Internet. The first two waves of Internet development brought portal websites and search engines in 1994, and social platforms in 2001. By June 2008, Chinese Internet users reached 253 million (CNNIC, 2008). Since then, the expansion of domestic 2G and 3G networks boosted the number of mobile phone users and tech start-ups, known as the third wave. During the past 20 years, the Internet has penetrated every aspect of Chinese people's daily lives. New multi-purpose social media apps (e.g., Weibo, WeChat, TikTok) have been launched; mobile payment apps linked to virtual banks have simplified the online transaction process; food/package delivery companies have provided group-purchase discounts and promotion prices; transportation mobility/ridesharing companies have offered coupons to attract consumers with lower prices than taxi companies; and e-commerce platforms (e.g., Taobao owned by Alibaba and JD.com) have changed the shopping habits of Chinese consumers.

These ICT developments have spread from urban to rural areas, and the rural economy has also witnessed significant ICT growth in recent years. Gradually, e-commerce has emerged as a pivotal tool for rural development and poverty reduction in China. E-commerce platforms encourage local people to engage in specialised production (Zhou *et al.*, 2021) and facilitate the transformation or upgrading of local industries, for example, shifting from unsustainable coal mining to agricultural tourism (Li and Qin, 2022; Zhang *et al.*, 2022). The agricultural products supply chain has also evolved with the adoption of ICT; as well as traditional processes, new platform-based self-operated e-commerce supply chains have developed, shortening supply chains, reducing stakeholders' costs and increasing control of product quality and food safety.

The positive effects of e-commerce on employment, income growth and overall economic development (Li and Qin, 2022; Liu et al., 2021; Luo and Niu, 2019) were the main reasons for the Chinese government's decision in 2014 to start implementing the NRECDP. The

NRECDP is a government-led, ICT platform-enabled, market-based poverty reduction strategy that aims to: (1) construct rural roads, e-commerce centres and stations to improve logistics in rural areas; (2) support ICT infrastructure construction to enable the rural population's access to digital networks and online transactions, particularly via e-commerce platforms; and (3) organise education and training activities to equip localities with the basics of e-commerce and to attract talent, including returning college students and young migrant workers. Each year, the NRECDP supports the development of rural e-commerce to promote the sales of local products in targeted poverty-stricken counties (Xu and Bian, 2022). Additionally, the cultivated rural e-commerce personnel popularise and disseminate e-commerce-related knowledge, creating more employment and entrepreneurial opportunities (Yi et al., 2021).

This study examines the impact of the NRECDP e-commerce intervention on poverty reduction and income growth among all the counties covered. To better understand the intervention effects examined and ground the development of the hypotheses in relevant theories and empirical evidence, the study considers the interplay of the geography of poverty, the digital divide of poverty, the role of institutions, and cultural particularities at regional level. So far the dominant approach for addressing regional inequalities has been to examine separately the impact of the first three factors on economic growth, while their joint impact on poverty alleviation and place-based policies, although crucial, has been largely overlooked (Barbero and Rodríguez-Crespo, 2022). Besides, Chinese regional culture has been found to have a significant impact on income growth and economic development (Li et al., 2021; Tan and Ludwig, 2016). However, none of the existing studies have incorporated these four factors into a theoretical model to study the complex nature of poverty and poverty alleviation. In fact, the geography of poverty, the technology divide, institutions, regional culture and the interactions among them have a profound impact on poverty incidence and regional development dynamics. Furthermore, on an empirical level, our understanding of the effects of the NRECDP e-commerce interventions on poverty alleviation and quality of life is still limited. Extant studies of e-CPA in China use either path analysis (Lin, 2016; Zhang, 2018) or an analysis of specific successful cases (Gao and Liu, 2020; Wang et al., 2021; Xu and Bian, 2022; Yu et al., 2018; Zeng et al., 2019), but none of them provides nationwide empirical evidence based on large-scale observations. Some empirical research may provide evidence of the effectiveness of e-CPA but lacks theoretical underpinnings or an examination of heterogeneity effects (Huang et al., 2020; Peng et al., 2021).

The present study makes both empirical and theoretical contributions to existing literature. Empirically, we extend existing data-driven empirical analysis by considering both county-level and household-level data. The study provides nationwide evidence based on large-scale observations, in contrast to some previous studies limited to specific successful cases (Gao and Liu, 2020; Wang et al., 2021; Xu and Bian, 2022; Yu et al., 2018; Zeng et al., 2019). Our additional analysis of survival and development expenditure of rural households further unveils the impact of the NRECDP intervention on 'quality of life' (Jorgenson, 1998; McGregor and Borooah, 1992; Meyer and Sullivan, 2003) by exploring whether people in these areas pursue psychological needs and self-fulfilment rather than basic human needs. Theoretically, this study builds on knowledge from various fields, namely, geography, technology, institutions and culture, and integrates them into a theoretical framework for

studying e-CPA. We emphasise particularly the importance of policy push to create the prerequisites for rural e-commerce development. In addition, regional culture may also play a role in the adoption and diffusion of ICTs and the detection of entrepreneurial opportunities.

The rest of the article is structured as follows. Section 2 presents a review of the relevant literature and proposes a theoretical framework that captures the role of geographical, technological, institutional and cultural factors in poverty incidence and e-CPA interventions. Section 3 proposes the study hypotheses for further empirical modelling. In Section 4, the study data and methodology are discussed. Section 5 presents the analysis of the data, the quantitative results of the estimated baseline models and the heterogeneity effect models. Section 6 discusses knowledge and policy implications as well as suggesting directions for future research.

2. Literature review

This section presents a review of the literature on the role of geographical, technological, institutional, and cultural factors in poverty alleviation.

2.1 Geography of poverty

Poverty is not evenly distributed geographically (Gauci, 2005; Green, 1994; Kodras, 1997). Geography of poverty (GOP) is a branch of human geography that explores the geographical patterns, distribution, areal types and evolution of poverty and its relationship with the geographical environment, as well as anti-poverty measures (Zhou and Liu, 2022). The rural poor are often concentrated in geographically remote, less favourable and weakly integrated regions, known as spatial poverty traps (Barbier, 2010; Bird *et al.*, 2010; Dasgupta *et al.*, 2005; Gray and Moseley, 2005). Spatial poverty traps show that geography plays a vital role in the distribution of income and economic growth (Sachs, 2008; Zhou and Liu, 2022). The strong relationship between poverty and geography is evident in China, where, in 2012, at the very beginning of the targeted poverty alleviation stage, 14 poverty-stricken areas in 680 counties were categorised into three groups by the State Council of China: (1) isolated mountainous hilly areas and old revolutionary areas in the east; (2) environmentally fragile mountainous plateaus in the central region; and (3) environmentally harsh desert, rocky desert and alpine mountain areas in the west (Ge *et al.*, 2019; Yang and Liu, 2021).

Geography contributes to poverty in various ways. Some poor areas are economically underdeveloped and face land conflicts because they are landlocked and situated in high mountain ranges, far from the coast, or because they lack suitable climate (i.e., tropical, desert) (Bird and Shepherd, 2003; Pani and Carling, 2013; Liu *et al.*, 2017; Yang and Liu, 2021). Many communities in these poor rural areas face geographical isolation, poor road conditions, the absence of bridges, and inadequate transportation services. These conditions pose challenges to the provision of basic services, transport of products to markets, access to economic and social activities and employment opportunities, access to education and career training, as well as to improving literacy rates and developing human capital. Therefore, uneven spatial development, also called the spatial divide (Hincks *et al.*, 2014), between remote and central areas is an important cause of rural poverty.

Improving road infrastructure has been considered an effective intervention for overcoming the spatial divide (Gachassin *et al.*, 2010; Naraya *et al.*, 2000; Porter, 2002; Sewell *et al.*, 2019). The strong positive relationship between rural road infrastructure investment and poverty reduction indicates that roads increase the connectivity of remote rural communities, shorten the geographical distance between counties and villages, and facilitate access to both social and economic opportunities (Booth *et al.*, 2000; Bryceson *et al.*, 2008; Porter, 2002). Additionally, from the transaction cost theory position (Coase, 1937), consumers can buy fresher agricultural products at lower prices and increase the frequency and volume of agricultural product transactions, thereby reducing transaction costs (Rindfleisch and Heide, 1997). Rural farmers can also benefit from lower production and transaction costs, diversified income, agricultural output growth, and larger volumes of trade (Faiz, 2012).

2.2 Digital divide of poverty and ICT adoption

In addition to the GOP, the distribution of digital technologies varies significantly across space and is known as the digital divide (Selwyn, 2004). The primary reason for the digital divide is the lack of Internet infrastructure in less economically developed regions (Selwyn, 2004; Van Dijk, 2006). From supply and demand perspectives, the barriers to building Internet infrastructure in remote rural areas are associated with (a) low demand due to low population density and consequent high costs (Park *et al.*, 2019; Salemink *et al.*, 2017), and (b) lack of supply due to technological challenges and low profitability for service providers (Chinn and Fairlie, 2006; Dohse and Lim, 2018; Kiiski and Pohjola, 2002). Without Internet infrastructure, the low-income population in rural and remote communities has very limited informational and transactional capabilities in Internet use (Cordes and Marinova, 2023). Hence, the developed areas tend to have higher rates of ICT diffusion and experience higher productivity growth than developing areas (Cardona *et al.*, 2013; Karlsson *et al.*, 2010; James, 2003). The growing digital divide may thus further marginalise poor regions that lack financial resources, ICT skills, good infrastructure and access to national and global markets (Adera *et al.*, 2014; Robinson *et al.*, 2015; Shafer, 2004).

ICT adoption in less developed regions can contribute to poverty reduction. Specifically, the introduction of ICT in poor areas can be skill-complementary, upgrading the productivity of skilled workers (Acemoglu, 1998; Goldin and Katz, 2008) and stimulating job creation (Hjort and Poulsen, 2019). Furthermore, ICTs, such as telecommunications and mobile payments, can (a) reduce transaction costs and price dispersion, (b) enhance access to new markets, knowledge and skills (Qureshi, 2011), and (c) accelerate social and business innovation (Cui *et al.*, 2017). Last, but not least, ICTs can strengthen financial inclusiveness (Mushtaq and Bruneau, 2019) and gender inclusiveness (Asongu *et al.*, 2021), and empower small/median-sized enterprises (SMEs) and women, with effects on the reduction of wealth concentration (Antonelli and Gehringer, 2017).

E-commerce, which is one category of ICT, has been increasingly used to promote income growth in China (World Bank and Alibaba Group, 2019). E-commerce has stimulated economic growth and household welfare through job creation and unemployment reduction

(Yu *et al.*, 2018), widening market access (Zhang, 2018), and connecting consumers and SMEs through shorter supply chains with lower distribution and marketing costs (Guo *et al.*, 2014). For example, the online retailer, Pinduoduo Inc., valued at an estimated US$63 billion in May 2020, has focused on traditional agriculture in China with the 'Internet Plus Agriculture' model, which integrates mobile Internet, cloud computing, big data, and other ICTs with traditional agricultural industries to promote economic restructuring. It supports sales of agricultural products on the livestreaming channels of Pinduoduo's e-commerce platform, ultimately improving farmers' and customers' well-being (Liang and Cheah, 2020).

2.3 Governmental E-commerce interventions for poverty alleviation

Public policy plays an important role in nurturing and fostering economic growth (Rodríguez-Pose, 2020), as well as in promoting income equality (Barbero and Rodríguez-Crespo, 2022). Government policies could include interventions such as investing in research and development (R&D) (Wang, 2018) and encouraging entrepreneurship (Bosma *et al.*, 2018). For interventions to help achieve the intended outcomes, the quality of the institutional support plays a vital role. While inclusive institutions encourage public engagement in economic activities by caring about equity and social welfare, extractive institutions are detrimental and inefficient, exploiting the majority to benefit a small group of the elite (Acemoglu and Robinson, 2012).

More recently, governments have turned their attention to harnessing ICT to alleviate poverty in less developed regions by introducing e-commerce-related interventions (Cordes and Marinova, 2023; Wu *et al.*, 2023). In contrast to cash and in-kind transfers, once established, e-CPA can be both effective and self-sustaining (Jha *et al.*, 2016; Leong *et al.*, 2016; Li *et al.*, 2019). However, the implementation of the e-CPA model requires extensive government support; governments can help establish e-commerce service systems, widen market reach (Ahi *et al.*, 2022; Martinez-Bravo *et al.*, 2022) and thus improve the plight of the impoverished population (McKague and Oliver, 2012). The quality of the national institutional environment, including the efficiency of the legal system and government policies, determines whether the technology will be adopted on a larger scale, and the extent to which any risks of e-commerce development will be mitigated (Ahi *et al.*, 2022). Hence, the institutions and their quality are an additional determinant in the economic growth models, beyond technology, capital and labour (Barbero and Rodríguez-Crespo, 2022; Rodríguez-Pose, 2020).

The effectiveness of governmental e-commerce interventions for poverty alleviation has been supported by a few studies conducted in China (Huang *et al.*, 2020; Leong *et al.*, 2016; Li *et al.*, 2019; Yin and Choi, 2022; Zeng *et al.*, 2019). Specifically, a survey-based study conducted in Shaanxi province found that the China Philanthropy e-commerce platform, developed for philanthropic poverty alleviation and supported by the Bank of China, positively affected skill development, family income and resource allocation for employees and their families (Huang *et al.*, 2020). An earlier study conducted by Leong *et al.* (2016) reported that, among five critical actors, institutional support in a rural e-commerce system in

a Taobao Village[1] in Zhejiang province largely resolved the constraints of space, finance, and human capital. Another study by Zeng *et al.* (2019) in Jiangsu province also highlighted the role of local government in promoting technology diffusion, enhancing industrial agglomeration, and monitoring product quality to reduce poverty. A recent study on the effect of e-commerce on the urban-rural income gap in China by Yin and Choi (2022) also found that e-commerce contributes to narrowing the gap, but only in regions where it is developed at a medium-to-high level and urbanisation is at a relatively low level. The study also found that in regions with a relatively high level of public expenditure and education, the effect of e-commerce on narrowing the urban-rural income gap is more than doubled.

2.4 Role of culture in e-commerce poverty reduction policy effectiveness

Hofstede's cultural dimensions (Hofstede, 1984), namely, individualism/collectivism (I/C), power distance (PD), uncertainty avoidance (UA), and short/long-term orientation (S/LTO) have been frequently applied to explore ICT adoption. For example, a study of mobile phone adoption found that people in individualistic cultures with low UA and STO (USA) tend to adopt ICT more quickly, since they tend to seek information themselves from direct and formal sources, while people in collectivistic cultures with high UA and LTO (South Korea) rely more on informal communication and cultural imitation typical of closely-connected social networks involving people with kinship, friendship, geographic and industrial ties (Lee *et al.*, 2013). The moderating role of culture for e-learning adoption is also significant, as evidenced in a meta-analysis of 45 peer-reviewed articles (Zhao *et al.*, 2021). This global-scale study showed that in collectivistic cultures, subjective norms exert a stronger influence on ICT users' behavioural intentions than in individualistic cultures, where perceived usefulness has a stronger effect. The ICT adoption rate varies considerably across 43 countries regardless of their income levels; however, it strongly correlates with PD and UA (Erumban and de Jong, 2006).

Culture can vary across the regions of a country (Hofstede *et al.*, 2010; Kaasa *et al.*, 2014), and this is the case in China (Kwon, 2012). For example, van de Vliet *et al.* (2013) surveyed respondents in 15 Chinese provinces and found the lowest levels of collectivism in highly developed eastern provinces with a temperate climate (e.g., Guangdong) and much higher levels in less developed western provinces with harsh climates (e.g., Gansu) (van de Vliert *et al.*, 2013). Comparing two areas, namely Shenzhen (a south-eastern coastal city) and Taiyuan (a central city) in China, Kwon reported that Shenzhen, as one of the most successful economic areas, scored more highly for individualism, UA and STO (Kwon, 2012). By analysing economic data, differences in economic development among Chinese provinces, and where modern businesses are located, and linking differences to regional cultural particularities, Li *et al.* (2021) conclude that regional culture significantly impacts the development of modern business gangs (i.e., enterprise clusters formed by geographical relations) and the regional economy. The study identifies five enterprise clusters, all located

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[1] The village can only be labelled as a Taobao Village if it is a rural community where at least 10% of the families use Taobao to sell their products, or where 100 online shops have been opened by villagers and the transaction volume is at least 10 million RMB per year.

in eastern areas. The authors argue, for example, that the Shandong business gang is greatly influenced by Confucian culture, firmly believing in righteousness, benevolence, wisdom, and credit, while also valuing the art of war. In contrast, the eastern Zhejiang culture shapes the predispositions and behaviour of the Zhejiang businessmen, who value practicality and emphasise individuality and capacity. Furthermore, the western region of China, situated inland, is much less exposed to Western culture and tends to be more traditional (Sun and Graham, 2013). Meanwhile, the original Chinese cultural context and *Guanxi* (social ties and interpersonal relations) still characterise local business practices in these inland areas (Tan and Ludwig, 2016).

Therefore, cultural variations across regions may affect ICT diffusion and entrepreneurial opportunities, with a downstream effect on e-CPA effectiveness.

Some evidence suggests that local cultural particularities can contribute to the success of the NRECDP; Yu *et al*. found regional cultural traditions inspired villagers to identify and pursue entrepreneurial opportunities (Yu *et al.*, 2018). For example, Shuyang county was selected by NRECDP in 2014 due to its valuable regional cultural traditions and great potential for rural e-commerce development. This county, known as the 'Hometown of Flowers and Trees in China' has a 500-year-long tradition of planting flowers and trees (Zeng *et al.*, 2019). In 2015, the county successfully integrated e-commerce with the plantation industry; the planting area was 481,000 mu (32,067 hectares) and sales of flowers and trees were 8.5 billion RMB (1.2 billion US dollars). By the end of 2015, there were 22 Taobao Villages in Shuyang county, in most of which nearly all households were engaged in planting flowers and trees, and, on average, about 35% of households participated in online shop operation (Zeng *et al.*, 2019).

On the basis of the above discussion, we propose a theoretical framework to explain the improvements delivered by NRECDP in rural China, which are presented in Figure 1. Given the spatial and digital divides of poverty, discussed earlier, the NRECDP has provided the prerequisites for e-commerce development through three paths: (1) road infrastructure improvements linking remote counties and villages through transportation and logistics systems; (2) Internet infrastructure expansion enabling ICT platforms to directly connect local agricultural producers with end consumers; and (3) education and training activities inspiring rural residents with ICT skills and entrepreneurship.
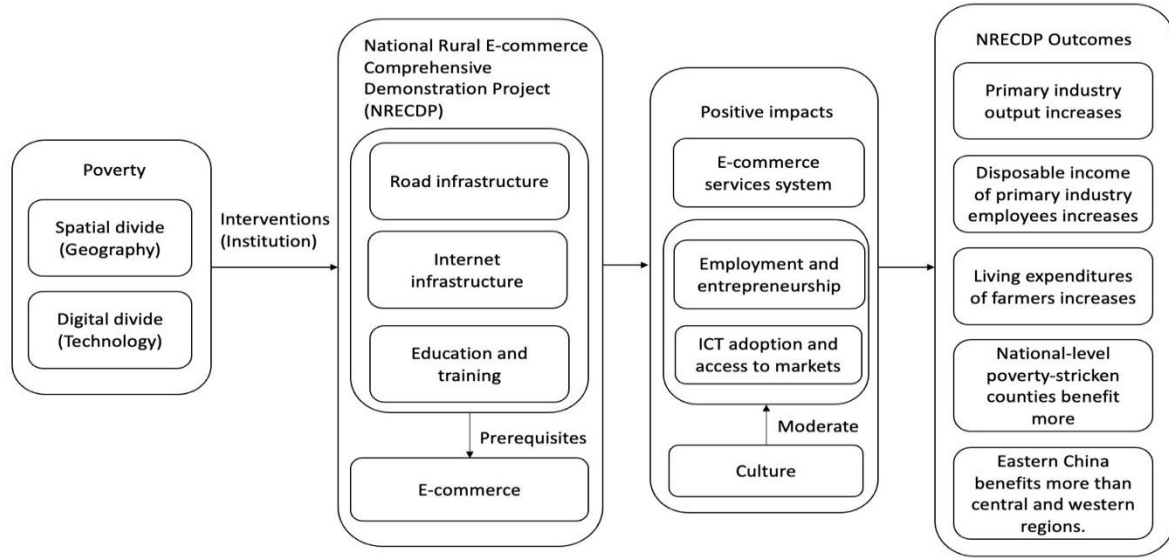
Figure 1. Theoretical framework for e-commerce poverty alleviation (e-CPA)

Source: Authors' own creation

3. Hypotheses development

With the government interventions discussed above, the NRECDP has facilitated the introduction and establishment of comprehensive e-commerce service systems that enable the monitoring of product quality and cultivate effective, efficient supply chains and high-quality signature local brands. It has also reduced the uncertainty of transactions between buyers and sellers, information asymmetry, and the risk of opportunism (Grover and Malhotra, 2003). Unit product cost reduces as output increases (Silberston, 1972; Stigler, 1958), mainly due to the inseparability of machine operating costs and factor transfer (transportation) costs. Also, human capital accumulation is essential for rural communities to break barriers to adopting ICT, access larger markets and create more jobs and entrepreneurs (Becker, 1994; Schultz, 1961a, 1961b, 1963). Therefore, e-CPA programmes, in this case, the NRECDP, can achieve diverse positive outcomes related to the local economy and farmers' income growth. The discussion of the NRECDP and poverty alleviation measures leads to the following hypothesis:

H1: The NRECDP has contributed to increasing (a) primary industry output, (b) the disposable income of primary industry employees, and (c) survival expenditures of farmers in the targeted counties.

The nationwide unified electronic information system of poverty alleviation, which captured data for 128,000 villages and 290,000 households, identified the most poverty-stricken areas in NP counties (Diallo, 2019). These NP counties, which were all covered by the NRECDP, had even wider spatial and digital divides than non-NP counties. These regions, where neither transportation nor telecommunication networks exist, could derive the greatest advantages from NRECDP interventions. With the introduction of road and Internet infrastructure, as well as ICTs, extremely remote and impoverished counties are expected to

leap from absolute deprivation to newfound opportunities and economic prosperity (Porter, 2002; Sewell *et al.*, 2019). Therefore, we propose the following hypothesis:

H2: NRECDP has more significant income-increasing effects in the NP counties than in the non-NP counties.

China has three major economic belts, in the eastern, central, and western regions. The western regions are entirely landlocked at a considerable distance from the coast, while the eastern coastal provinces boast extensive coastlines and abundant natural resources, particularly water (He *et al.*, 2019; Sun and Graham, 2013). Since the introduction of reforms in 1978, China has actively participated in bilateral, regional and multilateral trade (Luo and Zhi, 2019), starting with the establishment of free trade zones in eastern China for both domestic and international trade. The development of the eastern region has been prioritised as a means of driving the development of the west through a spillover effect (Yang, 1990). Under this strategy, the eastern coastal areas have gradually opened up to world commerce, trialling various reform measures which have then been extended to the central and western regions. Consequently, similar cultural characteristics, as well as a range of political, economic and social outcomes, are associated with geographical clusters (Rentfrow *et al.*, 2015). Entrepreneurs and businesses tend to cluster in the coastal regions of eastern China (Li *et al.*, 2021), leading to a swifter pace of technology adoption. Hence, the impact of NRECDP may be more pronounced in the counties in these regions than in the less economically developed counties in the western region. Therefore, we propose the following hypothesis:

H3: NRECDP has stronger income-increasing effects in the eastern region of China, followed by the central region, whereas the weakest NRECDP effect is in the western region.

To assess the impact of income-support programmes more accurately, consumption can be used as a more reliable poverty indicator than income, as it tends to be more stable and better reflects people's standard of living (Jorgenson, 1998; McGregor and Borooah, 1992; Meyer and Sullivan, 2003). Consumption structure encompasses various types of expenditure that reflect a household's income level and quality of life. Consumption can be divided into survival, enjoyment, and development, with different levels of consumer satisfaction (Wu, 2009). This research mainly focuses on a household's survival and development consumption. Since Keynes proposed the consumption function in *The General Theory of Employment, Interest, and Money*, economists generally believe that when income increases, the consumption of low-income earners grows faster relative to high-income earners (Keynes, 2018). In alignment with Maslow's hierarchy of needs theory, individuals initially give priority to satisfying their physiological and safety needs, followed by social needs (love and belonging), self-esteem (e.g., confidence, achievement, respect of others), and self-realisation needs (Maslow, 1943). Therefore, when a public policy strives to increase the income of poor households, these households are likely to first allocate resources to meet basic survival needs, necessary for maintaining health and labour force participation, and then to invest in development consumption to pursue higher-quality development opportunities.

Various consumption expenditures of rural residents, mainly farmers, in China are not sensitive to income growth since they face so many uncertainties in terms of climate conditions, market supply and demand, and prices of agricultural production materials (Lin, 2011). Instead, they tend to emphasise subsistence consumption, such as food, housing, and transportation; these priorities suggest a path-dependent tendency, where rural residents allocate their income primarily to living expenses (Chen and Li, 2013), with their consumer behaviours being more conservative than urban residents. Hence, survival consumption tends to rise with income for rural residents with low-income levels, allowing us to utilise survival consumption changes as an indicator of income variation.

Rural e-commerce can also yield expenditure savings for local residents, particularly in the purchase of production and living essentials. Online shops lower farmers' production and operational costs. During the one-month *Rural Taobao Spring Farming Festival* in March 2016, farmers from nearly 300 counties and 14000 villages in 27 provinces purchased over ten million agricultural items, saving nearly one billion RMB in expenditure (World Bank and Alibaba Group, 2019). Additionally, rural e-commerce offers a wide variety of products at lower cost, reducing the need for rural residents to travel to towns for shopping. With the growth of online shopping, rural consumers now have more options at competitive prices, benefiting from reduced logistics and delivery expenses. On the basis of this discussion, the following two hypotheses are proposed.

H4.1: In targeted counties, NRECDP has contributed to (a) an increase in total household expenditure; and (b) a larger increase in survival expenditure than in developmental expenditure.

H4.2: NRECDP has contributed to household expenditure decrease in targeted counties.

4. Methodology

4.1 Data

The county-level data from 2010 to 2020 was retrieved from the official annual statistical yearbooks, including GDP per capita, registered population, average disposable income per rural resident, added value of primary industry,[2] added value of secondary industry, public financial expenditure, loan balance of financial institutions at the end of the year, number of middle school students, number of fixed telephone users and other indicators. These variables reflect county characteristics and relate to spatial divide, digital divide, governmental support and educational level.

The NRECDP project has been implemented annually since 2014 and has evolved through three stages: (a) pilot (2014-2015); (b) advanced (2016-2019); and (c) consolidation (2020-present). Table 1 presents the three-stage NRECDP process in rural areas from 2014 to 2021. At the first pilot stage, 103 (about 40%) of the 256 counties covered were NP counties;

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[2] Based on the industrial classification for national economic activities (2017 version) from the National Bureau of Statistics of China, primary industry is agriculture, forestry, livestock farming, and fishery; secondary industry is mining, manufacturing, electric power, gas, water supply and construction; the third industry is the service industry.

at the second stage, with the participation of the Poverty Alleviation Office of the State Council, e-commerce development and poverty alleviation became more closely integrated. There are 769 selected NP counties among the 975 counties covered, that is, 78.9%. In the third phase of the policy, with the gradual removal of the NP counties and the new goal of rural revitalisation, only 192, less than 40%, of the 491 selected counties are NP counties.

The list of NRECDP counties during 2014-2019 comes from the website of the Ministry of Commerce, and the list of 832 NP counties was retrieved from the *National Key Counties for Poverty Alleviation and Development Work* published by the Poverty Alleviation and Development Office of the State Council in 2012.

Table 1. Number of counties covered by NRECDP and number of NP counties in NRECDP.

Year	No. of Provinces Covered	No. of Western Provinces	No. of Medium Provinces	No. of Eastern Provinces	No. of Counties Covered	No. of NP Counties	Poverty %
2014	8	1	5	2	56	14	25%
2015	25	12	8	5	200	89	45%
2016	22	12	8	2	240	156	65%
2017	21	10	8	3	260	237	91%
2018	22	10	7	5	260	238	92%
2019	28	12	8	8	215	138	64%
2020	28	12	8	8	287	110	38%
2021	28	12	8	8	204	82	40%

Notes: The covered western provinces are Xinjiang, Inner Mongolia, Tibet, Qinghai, Gansu, Ningxia, Shaanxi, Sichuan, Chongqing, Yunnan, Guizhou, and Guangxi; The covered central provinces are Heilongjiang, Jilin, Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan; The covered eastern provinces are Liaoning, Hebei, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan.

Source: Table created by authors

In order to measure the impact of the NRECDP on the growth of farmers' income in rural areas, this study has collected county-level panel data from 28 provinces, 321 cities, and 2117 counties in China from 2010 to 2020. The panel data set contains 1379 NRECDP counties, of which 767 are NP counties, accounting for 92.19% of all covered county samples, indicating that the policy is closely related to poverty alleviation.

The household data comes from the China Household Finance Survey (CHFS) by the Research Centre of the Southwestern University of Finance and Economics. The survey has been conducted every two years since 2011 and has currently completed five rounds of data collection, from 2011 to 2019. The coverage of CHFS data has been gradually expanded, the latest covering 29 provinces across the country (with districts and municipalities directly under the central government), 345 counties (districts, cities). The database collects detailed information on household demographic characteristics, assets and liabilities, income and consumption, insurance and protection, and are consistent with the National Bureau of Statistics in terms of age structure, urban-rural population structure, and gender structure

(Gan *et al.*, 2012). In contrast to other databases, CHFS asked in detail about specific poverty alleviation projects in the 2019 data.

4.2 Variables

Tables 2.1 and 2.2 present county-level and household-level variables respectively, and their definitions.

From the perspective of county-level analysis, the dependent variables used in the regression models include the output per primary industry employee, and the average disposable income of rural/urban residents. The reasons for selecting these three variables are as follows. Firstly, most local residents in rural areas covered by the NRECDP engage in cultivating crops, raising livestock, and fishing, which are primary industry activities. Through the NRECDP, they can benefit from e-commerce by connecting to cities and selling their products directly. Hence, we first focus on primary industry employees and examine the changes in output and their income during the post-NRECDP-intervention period. Secondly, since the NRECDP aims to alleviate poverty in rural and remote areas, we then shed light on the whole group of rural residents, and changes in their average disposable income. Thirdly, by regressing the average disposable income of urban residents in the counties covered, we further examine whether urban residents also benefit from rural e-commerce development.

The independent variables are treatment group and year dummies, helping to compare the differences between the counties covered and those not covered by the NRECDP.

The control variables account for factors that may affect a county's economic development and residents' increase in income. The first control variable is the proportion of the added value of the primary industry to GDP (Ind1). The higher the value of this variable, the more important the role of agriculture, forestry, animal husbandry and fishing in the economic development of the county, and the more potential to use the opportunity of agricultural e-commerce to realise the economic development of the county and increase the income of residents. The second control variable is the proportion of the added value of the secondary industry in GDP (Ind2). It helps measure the industry structure and development stage of a county and how the differences in industry structure will affect their economic development speed and the growth in people's income. The third control variable is the ratio of local fiscal general budgetary expenditure to GDP (FiscExp); higher fiscal expenditure means that the government is more willing to invest in public infrastructure, which will promote the development of local e-commerce. On the other hand, higher fiscal expenditure also enables the government to provide more benefits to low-income people in rural areas, thereby reducing their incentives to generate income through their own efforts. The fourth control variable is the proportion of the loan balances of various financial institutions to GDP at the end of the year (FinLoan). The higher the value of this variable, the easier it is to obtain credit. In an industry with low barriers to capital and technology, the decision of merchants engaged in e-commerce business will not be greatly affected by the difficulty of borrowing money from banks and other financial institutions (Guo *et al.*, 2014). However, other enterprises are more likely to obtain loans, invest and hire more people, thereby reducing

people's motivation to conduct their own online business through e-commerce (Qi *et al.*, 2019). The fifth control variable is the proportion of students in secondary schools in the total population (MidStudent), which can measure the education level and population structure of the county. On the one hand, the higher the number of middle school students, the more people in this county are willing to accept the education at junior high school level and above. On the other hand, the more middle school students, the more teenagers in the county. The education level and population structure of a region's population are important factors that can affect the economic development and the development potential of a region. The sixth control variable is the logarithm of the number of fixed telephone households (lFixPhone), which can measure the use of ICT by people in economically backward areas and the local ICT development level. The seventh is the logarithm of the registered residence population (lPoP). Generally speaking, the larger the economic volume and the higher the degree of economic development in the area, with a larger population, the more likely a certain industry is to produce an agglomeration effect.

Table 2.1 County-level variables and definitions

Variable	Definition
lInd1PC	the logarithm of the output per primary industry employee
lRurInc	the logarithm of the average disposable income of rural residents
lUrbInc	the logarithm of the average disposable income of urban residents
Post	equal 1 after intervention, 0 otherwise
Treat	equal 1 if covered by NRECDP, 0 otherwise
Ind1	the proportion of the added value of primary industry (agriculture, forestry, livestock farming, and fishery) to GDP
Ind2	the proportion of the added value of secondary industry (mining, manufacturing, electric power, gas, water supply and construction) to GDP
FiscExp	the ratio of local fiscal general budgetary expenditure to GDP
FinLoan	the proportion of the loan balances of various financial institutions to GDP at the end of the year
MidStudent	the proportion of students in secondary schools in the total population
lFixPhone	the logarithm of the number of fixed telephone households
lPoP	the logarithm of the registered residence population

Source: Table created by authors

From the perspective of household-level analysis, the dependent variables used in the regression models include (1) the logarithm of the total household income (lInc), (2) the logarithm of the total household consumption (lExp), (3) the logarithm of the household survival consumption (lLivExp), and (4) the logarithm of the household developmental consumption (lDevExp). This study also uses a set of household-level characteristics that affect household income and expenditure as control variables.

In the CHFS, household expenditure can be categorised as food, clothing, housing, daily necessities, transportation and communication, education and entertainment, medical care, and others. These are divided into family survival consumption (food, clothing, housing, daily necessities, transportation, and communication) and developmental consumption (education and entertainment).

Table 2.2 Household-level variables and definitions

Variable	Definition
lInc	the logarithm of the total household income
lExp	the logarithm of the total household consumption
lLivExp	the logarithm of household survival consumption (food, clothing, housing, daily necessities, transportation, and communication)
lDevExp	the logarithm of household developmental consumption (education and entertainment)
age	age of the head of household
gender	1 if the head of household is male, 0 if female
educ	1 if never been to school, 2 if primary school, 3 if secondary school, 4 if high school, 5 if vocation school, 6 if community college, 7 if bachelor's degree, 8 if master's degree, 9 if doctor's degree
married	1 if the head of household is married, 0 otherwise
nonagri	1 if the head of household works in non-agriculture sectors, 0 otherwise
ownhouse	1 if the head of household owns at least one house, 0 otherwise
morehouse	1 if the head of household owns more than one house, 0 otherwise
health	1 if the head of household is healthy, 0 otherwise
hhsize	the number of household members
labornum	the number of household members who are able to work in the labour force
netasset	the net assets of a household, measured in RMB
debt	the debt of a household, measured in RMB
farmer	1 if a farmer, 0 otherwise

Source: Table created by authors

In order to better demonstrate the difference between the NRECDP counties and non-NRECDP counties before interventions, this study successfully creates a unique dataset of 223 and 661 NRECDP counties by deleting counties with missing data at the first two stages. Table 3 shows the comparison of NRECDP counties and non-NRECDP counties during the two pre-intervention years at two stages. Overall, the per capita GDP of NRECDP counties, the proportion of added value of the secondary industry, and the proportion of middle school students are quite different from those of non-NRECDP counties, indicating that the policy has always focused on the counties with lower level of economic development and education. The comparison shows that the focus of the policy has changed over time: in the first two stages, there is a large gap between the indicators such as the per capita disposable income of

rural and urban residents in the NRECDP counties and the non-NRECDP counties, especially in the second stage.

Table 3. Statistical Comparison between treated and control counties.

Variable	Stage 1: 2011-2013 (223 treated vs 561 control counties)			
	Control	Treated	t-value	p-value
RurAvgInc	10454.94	7637.29	17.01	0.000
UrbAvgInc	21516.15	18406.42	8.82	0.000
GDPperCap	50467.59	30156.67	9.77	0.000
GDP	2425717	1496548	7.26	0.000
Ind1	0.16	0.21	-10.49	0.000
Ind2	0.53	0.47	8.68	0.000
FiscExp	0.14	0.24	-17.46	0.000
FinLoan	0.5	0.5	0.35	0.728
MidStudent	474.48	493.59	-2.44	0.015
FixPhone	1829.57	1267.5	9.64	0.000
PoP	51.89	50.64	0.80	0.425
	Stage 2: 2013-2015 (661 treated vs 513 control counties)			
RurAvgInc	12497.37	7649.17	41.35	0.000
UrbAvgInc	24748.07	20835.83	17.42	0.000
GDPperCap	53922.98	25099.25	22.61	0.000
GDP	2731425	1086782	20.14	0.000
Ind1	0.16	0.23	-20.42	0.000
Ind2	0.51	0.40	21.17	0.000
FiscExp	0.16	0.37	-24.72	0.000
FinLoan	0.58	0.64	-4.62	0.000
MidStudent	442.43	461.93	-3.96	0.000
FixPhone	1535.17	868.18	16.65	0.000
PoP	53.65	46.10	6.56	0.000

Notes: RurAvgInc = average disposable income of urban residents; UrbAvgInc = average disposable income of rural residents; GDP = gross domestic product, measured in million RMB; GDPperCap = gross domestic product per person, measured in RMB. Standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Source: Table created by authors

4.3 Models

Based on county-level panel data, this study adopts a DID baseline model to identify the impact of NRECDP on farmers' increase in income in the first two stages:

$$Y_{it} = \alpha_0 + \alpha_1 Post_{it} \times Treat_i + \alpha X_{it} + \gamma_i + \delta_t + \lambda_{rt} + \varepsilon_{it} \quad (1)$$

where Y_{it} measures the logarithm of the output per primary industry (agriculture, forestry, livestock farming, fishery) employee (Ind1PC), the average disposable income of rural residents (RurInc), or the average disposable income of urban residents (UrbInc) in county i in year t. The intersection term is a dummy variable reflecting the effect of the NRECDP in rural areas. X_{it} refers to a set of control variables. γ_i and δ_t represent county-fixed effects and time-fixed effects, respectively; τ_{rt} represents provincial-year fixed effects, controlling unobservable factors changing over years in different provinces, and ε_{it} is the unobserved standard error.

In order to examine the parallel trend assumption and the dynamic effects of policies, this paper sets the estimation equation as follows:

$$Y_{it} = \beta_0 + \left(\sum_{m=1}^{4} \beta_{1m} cYear_{i,t-m} + \sum_{n=0}^{5} \beta_{2n} cYear_{i,t+n} \right) \times cTreat_i + \beta X_{it} + \gamma_i + \delta_t + \lambda_{rt} + \varepsilon_{it} \quad (2)$$

where dummy variable $Year_{i,t}$ measures the effects before, during and after the policy shock. $Year_{i,t-m}$ is a dummy variable before the implementation of the policy, which is used to measure the time from the beginning of the policy to push forward m years; $Year_{i,t+n}$ is a dummy variable after the implementation of the policy, which is used to measure the time from the start year of the policy to push back n years. This event study method not only verifies the parallel trend assumption, but also measures the dynamic changes in the income-increasing effect for a period of time after the implementation of the policy.

Based on the household-level panel data, this paper further applies the DID model to identify the impact of NRECDP on the increase in household income/expenditure in the first two stages:

$$Y_{ht} = \alpha_0 + \alpha_1 Post_{ht} \times Treat_h + \alpha X_{ht} + \gamma_h + \delta_t + \lambda_{rt} + \varepsilon_{ht} \quad (3)$$

where Y_{ht} measures the logarithm of the total income (lInc), the logarithm of the total expenditure (lExp), the logarithm of the survival consumption (lLivExp) or the logarithm of the developmental consumption (lDevExp) in household h in year t. The intersection term is a dummy variable reflecting the effect of the NRECDP in rural areas. X_{ht} refers to a set of control variables. γ_h and δ_t represent household fixed effects and time fixed effects, respectively; τ_{rt} represents provincial-year fixed effects, controlling unobservable factors changing over years in different provinces, and ε_{ht} is the unobserved standard error.

5. Empirical results

5.1 Baseline model

Tables 4 and 5 present the results of the baseline DID model for 2014-2015 and 2016-2019 for NRECDP counties. The coefficients of the interaction term, *Post*Treat*, are statistically significant at a 1% level for columns (1)-(4). Strong statistical evidence was found of the effectiveness of the NRECDP interventions to increase the income of rural residents, especially those employed in primary industries. These findings are consistent with H1 and the findings of Peng *et al*. (2021) and Huang *et al.* (2020). They also provide a strong foundation from which to further investigate our specific hypotheses.

Table 4. Baseline DID Model Results for Counties Covered in 2014-2015

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	lInd1PC		*lRurInc*		*lUrbInc*	
Post*Treat	0.090***	0.100***	0.058***	0.040***	0.012	0.001
	(0.029)	(0.025)	(0.011)	(0.007)	(0.010)	(0.005)
Ind1	3.104***	2.786***	-0.424***	-0.106	-0.184**	-0.098
	(0.448)	(0.439)	(0.086)	(0.068)	(0.093)	(0.070)
Ind2	0.980***	0.479**	0.035	0.068**	0.069	0.024
	(0.222)	(0.205)	(0.041)	(0.034)	(0.049)	(0.026)
FiscExp	0.010	-0.008	0.019	0.136***	-0.081**	-0.014
	(0.010)	(0.008)	(0.046)	(0.038)	(0.036)	(0.023)
FinLoan	-0.031	-0.037	0.007	-0.001	-0.008	-0.013**
	(0.029)	(0.024)	(0.010)	(0.008)	(0.008)	(0.006)
MidStudent	-0.017***	-0.008	0.007***	0.005**	0.001	0.003*
	(0.006)	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)
lFixPhone	0.017	-0.008	0.003	-0.004	-0.009*	-0.005*
	(0.011)	(0.009)	(0.004)	(0.002)	(0.005)	(0.003)
lPoP	-0.094	-0.141***	0.124***	0.081***	0.075	0.060
	(0.070)	(0.054)	(0.040)	(0.031)	(0.055)	(0.038)
Constant	-0.337	0.359	8.294***	8.452***	9.496***	9.472***
	(0.314)	(0.281)	(0.159)	(0.114)	(0.187)	(0.146)
Observations	5,052	5,052	8,616	8,616	6,996	6,996
R2	0.603	0.670	0.954	0.974	0.922	0.974
County ID	1,166	1,166	1,136	1,136	1,051	1,051
Standard Error	City	City	City	City	City	City
County FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Province-Year FE	N	Y	N	Y	N	Y

Note: ***p < 0.01, **p < 0.05, *p < 0.1

Source: Table created by authors

Table 5. Baseline DID Model Results for Counties Covered in 2016-2019

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	lInd1PC		*lRurInc*		*lUrbInc*	
Post*Treat	0.078***	0.088***	0.071***	0.042***	0.011**	0.006
	(0.025)	(0.021)	(0.006)	(0.005)	(0.005)	(0.004)
Ind1	3.239***	3.120***	-0.377***	-0.103*	-0.142*	-0.094*
	(0.271)	(0.272)	(0.078)	(0.059)	(0.073)	(0.053)
Ind2	0.895***	0.592***	0.022	0.080**	0.065	0.025
	(0.140)	(0.112)	(0.044)	(0.034)	(0.044)	(0.029)
FiscExp	-0.003	-0.023	-0.002	0.043**	-0.061*	-0.001
	(0.011)	(0.015)	(0.027)	(0.021)	(0.033)	(0.014)
FinLoan	-0.017	-0.042**	0.031**	0.014	0.018**	-0.005
	(0.021)	(0.018)	(0.013)	(0.011)	(0.009)	(0.007)
MidStudent	-0.011*	-0.004	0.012***	0.005***	-0.001	0.004***
	(0.006)	(0.005)	(0.003)	(0.002)	(0.002)	(0.001)
lFixPhone	0.008	-0.008	0.001	-0.003	0.001	-0.001
	(0.008)	(0.008)	(0.004)	(0.003)	(0.003)	(0.002)
lPoP	-0.029	-0.085	0.213***	0.087***	0.063	0.029
	(0.069)	(0.057)	(0.051)	(0.032)	(0.063)	(0.038)
Constant	-0.762**	-0.262	7.768***	8.220***	9.366***	9.492***
	(0.296)	(0.241)	(0.195)	(0.117)	(0.203)	(0.139)
Observations	7,670	7,670	13,024	13,024	10,156	10,156
R2	0.625	0.684	0.947	0.970	0.928	0.974
County ID	1,758	1,758	1,713	1,713	1,554	1,554
Standard Error	City	City	City	City	City	City
County FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Province-Year FE	N	Y	N	Y	N	Y

*Note: ***p < 0.01, **p < 0.05, *p < 0.1*

Source: Table created by authors

5.2 Event study model

Figures 2 and 3 present the output per primary sector worker and disposable income per rural resident before and after government interventions during two phases. Prior to the policy shock, the coefficient was not significantly different from zero. This indicates that the estimation of the DID model satisfies the parallel trend assumption; and the per capita output of primary industry employees and the average disposable income of rural residents have both increased steadily after the implementation of the policy. Hence, the income growth effect of e-commerce poverty alleviation is sustainable in the long run.
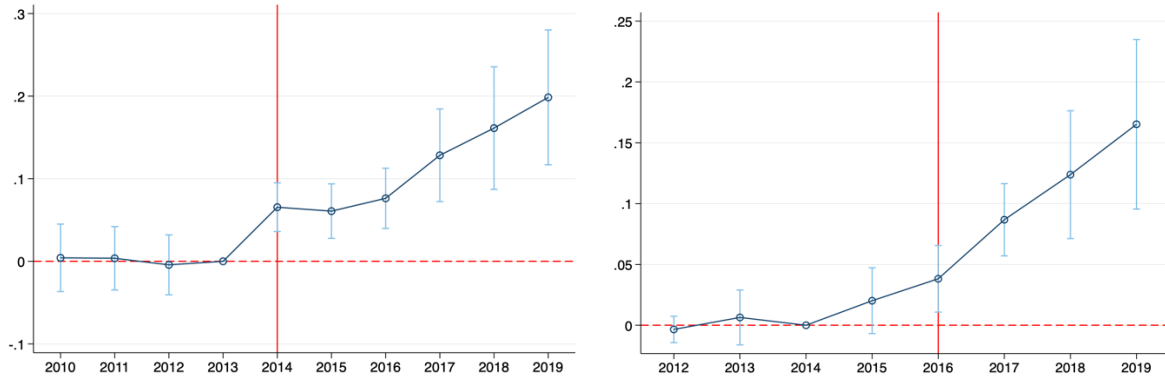
Figure 2. Output per primary sector worker during phase 1 (2014-2015) and phase 2 (2016-2019)
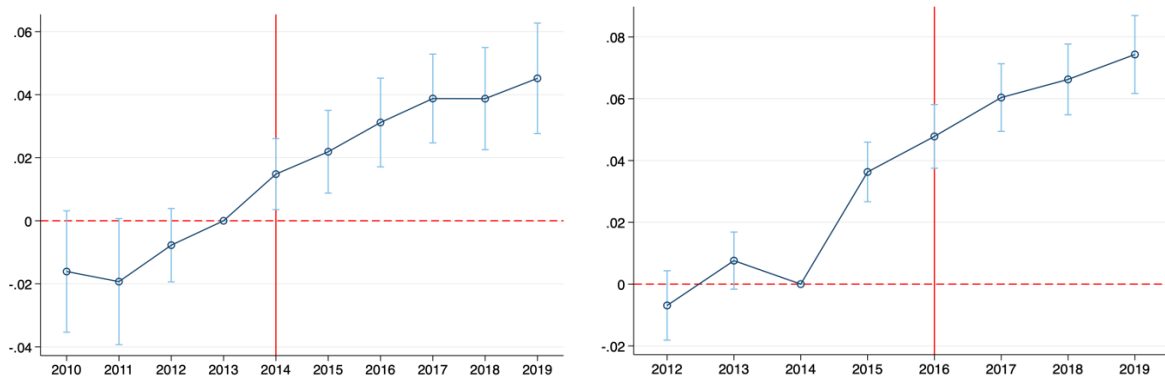
Source: Figure created by authors

Figure 3. Disposable income per rural resident during phase 1 (2014-2015) and phase 2 (2016-2019)

Source: Figure created by authors

5.3 Heterogeneity effect of poverty-stricken counties

Table 6 shows the heterogeneity effect of NRECDP by county. The results show that the income-increasing effect of the NRECDP on primary industry employees and rural residents is larger in NP counties, which can be attributed to the diminishing marginal effect in poverty alleviation work. Specifically, for NP counties, the output per primary industry worker increased by more than 10%, and the average disposable income of rural residents increased by more than 6%. For non-NP counties, in only the first phase of the policy, the per capita output of primary industry workers significantly increased by 9%, and the increase in the disposable income of rural and urban residents was not statistically significant. This is consistent with H2, that the marginal effect of one unit of poverty alleviation funds on the decrease in poverty population and the increase in income growth is declining.

Table 6. Heterogeneity Effect of NRECDP, by Poverty-Stricken County

Variables	NP Counties (1) lInd1PC	(2) lRurInc	(3) lUrbInc	Non-NP Counties (4) lInd1PC	(5) lRurInc	(6) lUrbInc
	2014-2015 Covered Counties					
Post*Treat	0.119***	0.106***	0.013	0.090**	0.000	-0.005
	(0.034)	(0.011)	(0.011)	(0.039)	(0.007)	(0.006)
Observation	4,453	7,497	6,054	4,623	7,846	6,413
R2	0.664	0.976	0.976	0.662	0.981	0.974
County ID	1,022	993	924	1,070	1,044	972
	2016-2019 Covered Counties					
Post*Treat	0.104***	0.060***	0.006	0.025	-0.002	0.005
	(0.024)	(0.006)	(0.004)	(0.024)	(0.004)	(0.005)
Observation	6,931	11,635	8,993	4,763	8,116	6,634
R2	0.678	0.969	0.972	0.676	0.982	0.977
County ID	1,572	1,526	1,389	1,112	1,088	1,010
Standard Error	City	City	City	City	City	City
Controls	Y	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Province-Year FE	Y	Y	Y	Y	Y	Y

Note: ***$p<0.01$, **$p<0.05$, *$p<0.1$

Source: Table created by authors

5.4 Heterogeneity effect of geographical regions

The results in Table 7 show that in the first two phases of the policy, the positive effect on primary industry employees and rural residents was more significant in eastern China, followed by central China, and the weakest in western China. This verifies H3. These clear regional differences may imply that e-commerce has a wider radiating area in these regions, and local residents have a stronger willingness to adopt e-commerce and lower adoption costs, making it easier to benefit from e-commerce activities.

Table 7. Heterogeneity Effect of NRECDP, by Economic Region

Variables	2014-2015 Covered Counties (1) lInd1PC	(2) lRurInc	(3) lUrbInc	2016-2019 Covered Counties (4) lInd1PC	(5) lRurInc	(6) lUrbInc
	East China					
Post*Treat	0.131***	0.030***	0.016*	0.189***	0.045***	0.014***
	(0.039)	(0.010)	(0.010)	(0.027)	(0.011)	(0.005)
Observation	2,157	3,520	2,725	2,599	4,280	3,479

	(1)	(2)	(3)	(4)	(5)	(6)
R2	0.651	0.984	0.970	0.667	0.983	0.975
County ID	463	479	442	563	579	536
			Central China			
*Post*Treat*	0.096**	0.040***	-0.007	0.053***	0.044***	-0.000
	(0.042)	(0.009)	(0.006)	(0.020)	(0.006)	(0.006)
Observation	1,706	3,970	3,618	2,374	5,291	4,899
R2	0.688	0.964	0.976	0.678	0.956	0.970
County ID	434	435	395	568	570	525
			West China			
*Post*Treat*	0.046	0.053**	0.002	0.015	0.029***	0.010**
	(0.038)	(0.024)	(0.022)	(0.017)	(0.008)	(0.005)
Observation	1,189	1,126	653	2,697	3,453	1,778
R2	0.702	0.984	0.988	0.711	0.976	0.987
County ID	269	222	214	627	564	493
Standard Error	City	City	City	City	City	City
Controls	Y	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Province-Year FE	Y	Y	Y	Y	Y	Y

Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Source: Table created by authors

5.5 Household-level income and expenditure

The results in Table 8 show that in the first two phases of the policy, although the income of rural residents has significantly increased by 12.2% and the living expenditure has increased by 5.6%, there is no obvious empirical evidence showing an increase in total household expenditure and developmental expenditure. It indicates that the living standards of these rural residents have seen some improvement, but far from enough to improve consumption structure, and they did not invest their extra income in long-term development. In addition, the income and living expenditure of farmers have experienced larger improvements compared to that of non-farmers. This implies that the NRECDP may accurately promote and benefit primary industry, rural areas, and poor populations, mainly farmers; the NRECDP may also lower the entertainment and education costs of the richer population in rural areas.

Table 8. Heterogeneity effect of NRECDP at household level

	(1)	(2)	(3)	(4)	(5)
VARIABLES	*lInc*	*lExp*	*lLivExp*	*lDevExp*	*lAvgExp*
			Full household sample		
*Post*Treat*	0.122***	0.031	0.056**	-0.088	-0.088
	(0.042)	(0.026)	(0.028)	(0.058)	(0.058)
Observations	12,754	13,293	13,296	10,083	10,083

R-squared	0.251	0.315	0.116	0.268	0.268
Family ID	3,536	3,536	3,536	3,510	3,510
			Only farmers		
Treat_Post	0.216***	0.066	0.145***	0.176	0.063
	(0.071)	(0.049)	(0.054)	(0.145)	(0.049)
Observations	5,482	5,783	5,786	3,858	5,783
R-squared	0.388	0.396	0.140	0.287	0.474
Family ID	2,746	2,790	2,792	2,428	2,790
			Only non-farmers		
Treat_Post	0.078	0.004	0.023	-0.234***	-0.015
	(0.065)	(0.040)	(0.043)	(0.089)	(0.040)
Observations	7,272	7,510	7,510	6,225	7,510
R-squared	0.297	0.271	0.117	0.293	0.339
Family ID	3,455	3,498	3,498	3,466	3,498
Controls	Y	Y	Y	Y	Y
Household FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Province-Year FE	Y	Y	Y	Y	Y

*Note: ***p < 0.01, **p < 0.05, *p < 0.1*

Source: Table created by authors

5.6 Robustness check

In order to verify the robustness of the results, a placebo test was conducted. One thousand counties were randomly selected in the full sample as the experimental group, and the rest as the control group, and a year from 2010 to 2020 was randomly selected as the policy shock year. Regressions were then run 500 times to obtain the distribution of coefficients of intersection terms. Figure 4 presents the results of the placebo test. The distribution is near 0 and the mean of distribution is not significantly different from 0, indicating that the significant positive coefficient obtained by the preceding regression models is affected by the policy shock.
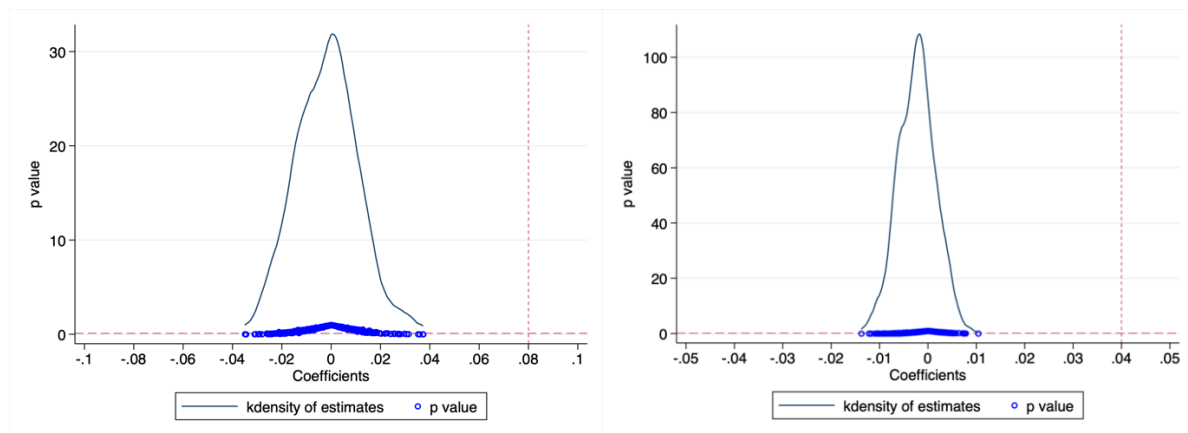

Figure 4. Placebo Test. Left: Output per primary sector worker. Right: Income per rural resident

Source: Figure created by authors

5.7 Summary of findings

Table 9 summarises the results of the hypothesis testing. To recap, hypotheses H1-H3 are fully supported, while H4.1 is only supported in the farmer group and H4.2 is only supported in the non-farmer group.

Table 9. Summary of findings and hypothesis testing

County Level		
	lInd1PC	*lRurInc*
Phase I		
Baseline model	0.100*** (-0.025)	0.040*** (-0.007)
Phase II		
Baseline model	0.088*** (-0.021)	0.042*** (-0.005)
	H1 supported	
Phase I		
NP Counties	0.119*** (-0.034)	0.106*** (-0.011)
Non-NP Counties	0.090** (-0.039)	0 (-0.007)
Phase II		
NP Counties	0.104*** (-0.024)	0.060*** (-0.006)
Non-NP Counties	0.025 (-0.024)	-0.002 (-0.004)
	H2 supported	
Phase I		
East China	0.131*** (-0.039)	0.030*** (-0.01)
Middle China	0.096** (-0.042)	0.040*** (-0.009)
West China	0.046 (-0.038)	0.053** (-0.024)
Phase II		
East China	0.189*** (-0.027)	0.045*** (-0.011)
Middle China	0.053*** (-0.02)	0.044*** (-0.006)
West China	0.015 (-0.017)	0.029*** (-0.008)
	H3 supported	
Household Level		
	only farmers	*exclude farmers*
lExp	0.066 (0.049)	0.004 (0.040)
	Insignificant	Insignificant
lLivExp	0.145*** (0.054)	0.023 (0.043)
	H4.1 supported	Insignificant
lDevExp	0.176 (0.145)	-0.234*** (0.089)
	Insignificant	H4.2 supported

*Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$*

Source: Table created by authors

6. Discussion and conclusion

6.1 Theoretical implications

From a theoretical perspective, this research may provide implications in three areas. Above all, this study first establishes a new e-CPA model that applies the technological, institutional, and geographical peripheries of the place-based policy implementation by Barbero and Rodríguez-Crespo (2022), to investigate the effectiveness of NRECDP practices. It provides much-needed empirical evidence to suggest that governmental interventions to improve e-CPA can positively impact rural e-commerce and financial outcomes in these regions. This finding is consistent with the resource-based discussion of Boateng (2016) and the hybrid elements of emerging rural e-commerce clusters of Zeng *et al.* (2019) and Y. Zhang *et al.* (2022), but this study analyses the importance of policy push in order to narrow spatial and digital divides to alleviate poverty by improving infrastructure, ICT diffusion and human capital. Secondly, this research emphasises these three factors as the prerequisites for rural e-commerce development in this new e-CPA model. The findings suggest that without these prerequisites, rural e-commerce may not fulfil its poverty alleviation role in isolation. Our findings support the assertions of Ahi *et al.* (2023), who suggest that the promise of e-commerce in poverty alleviation can only be achieved by putting effort into increasing e-commerce capabilities and mitigating e-commerce risks. Thirdly, while analysing the heterogeneity effects, this research sheds light on regional disparities and expands the model to reflect underlying factors such as geography and culture, which may help to explain the results. Our results suggest that geography, economic development, and culture may all affect the impact of poverty alleviation interventions in regions that are most closely connected to trading routes (coastal regions); those that, in Hofstede's terms, are more individualistic, are those in which interventions have greater impact. Considering culture as one of the factors that may influence the impact of interventions within one country is a novel idea that warrants more study, since cultural differences have previously been found to significantly affect the diffusion of technology, the cultivation of entrepreneurship and the development of the economy (Davis *et al.*, 1989; Lee *et al.*, 2013; Li *et al.*, 2021; Tan and Ludwig, 2016; Zhao *et al.*, 2021). Considering culture along with geography and other sociological factors can only enhance future models of e-CPA. Interestingly, the results suggest that while interventions have positively impacted household expenditure on survival items, developmental expenditure has not increased, suggesting that increases in income have also come with increases in costs, perhaps not resulting in the increases in disposable income that may have been expected. Our discussion of findings has implications for policy and future research, which are discussed in the next sections.

6.2 Policy and practice implications

The main findings, rooted in multi-year and multi-region data, also generate clear policy and practice implications.

First, the positive effects of the NRECDP suggest that e-CPA is an innovative and effective poverty reduction method. It has equipped the poor with improved infrastructure, new technologies and access to markets and training courses to mitigate spatial and digital divides. Compared to traditional poverty reduction methods, e-CPA can provide people in remote rural areas with a self-sustained approach to generating income and reducing living costs. New opportunities created by e-commerce allow individuals to take on multiple new social roles, as e-consumers, as microentrepreneurs, as agricultural producers, as employees working for food/package delivery companies. Therefore, more investment and incentives are expected to foster rural e-commerce development in the future. Following this track, the world is inspired to invent more hybrid poverty alleviation approaches, which combine government interventions and market operation as well as the introduction of technology.

Second, the observed variations in the effects on counties with different poverty levels during the different phases of the reform indicate that the policy implementation needs to be progressive. Valuable lessons learned from the initial phase are crucial for addressing more significant challenges in subsequent phases. During the first phase, the counties with better economic conditions, infrastructure, and human capital were selected, and the marginal benefit from e-commerce platforms to these rural areas was not as large as that to the extremely poverty-stricken counties. The previous experience of first phase implementation gave policymakers more confidence to increase farmers' income through e-commerce. During the second phase, the interventions accurately targeted poorer towns and villages in remote rural areas, and achieved a stronger poverty/inequality reduction impact, which could narrow the income gap between them and rural residents in other counties.

Third, the huge differences between regions in the increase in e-commerce revenue, and the huge potential of e-commerce in poverty areas, suggest that place-based policies perform better when considering geographical, technological, institutional, and cultural factors. In particular, valuable cultural traditions can be transformed into entrepreneurial ideas and win unique advantages during market competition; the local cultural environment can determine the effectiveness of adopting/diffusing new technology. Therefore, government interventions for economic growth should take geographical attributes into account, and value not only external resources (e.g., infrastructure, technology, funding) but also an open-minded and achievement-driven culture.

Fourth, the household-level findings indicate that while these improvements have had some positive effects, they are still not sufficient to stimulate developmental expenditure, such as education investment and entertainment activities. This suggests that one-year government intervention alone, albeit effective, cannot serve as a cure-all solution. The poor population in remote rural areas has been affected by their isolated environment and conservative ideologies; they demand a long-lasting and robust income generation system to gradually eradicate their fear of financial uncertainties in the future, increase their openness to new technologies, and cultivate their confidence to increase current consumption and long-

term investment. Therefore, place-based policy interventions should recognise the substantial impact of culture and traditional beliefs on different regions and ensure an entrepreneur-friendly environment with consistent support. In the poverty alleviation process, addressing this cultural factor may be more challenging than tackling spatial and digital divides.

6.3 Conclusions, limitations, and future research

The study has provided much-needed empirical evidence for the impact of e-CPA on financial outcomes. It is the first study to explore this in the context of the NRECDP in China. It establishes evidence for the positive impact of e-CPA and also suggests that geographical, economic and cultural differences between regions are important factors that may influence the effectiveness of poverty alleviation in this context.

Key limitations are the regional focus and the fact that this is a quantitative paper, and many of the findings would warrant deeper exploration through a qualitative approach. Further research would be needed to disentangle the specific effects of rural e-commerce on various stakeholders of agri-food value chains and in different regions. Specifically, it would be meaningful to explore how the poor population in rural areas engages in e-commerce value chains and benefits from rural e-commerce.

Future research could also focus on further exploring the influence of culture on e-CPA, specifically identifying local cultural contexts that may facilitate or hinder the effectiveness of poverty alleviation and income growth. For instance, research into the historical background of a particular industry in a local area, local cultural traditions, and the prevailing ideological tendencies among the local population can be conducted to compare these factors in different regions. Comparative analysis could shed light on the impact of these cultural factors on local industries, e-commerce development, and income growth, and deepen our understanding of the role of culture in e-CPA practices.

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