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FULL ARTICLE

E-commerce development and urban-rural income gap: Evidence from Zhejiang Province, China

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Abstract

This study aims to reveal how e-commerce affects the income gap between urban and rural areas in the context of developing world. An empirical examination was carried out by using the panel data of 11 cities in Zhejiang Province, China, from 2011 to 2018. The results show that there is an inverted-U relationship between e-commerce development and urban–rural income gap. Zhejiang is still on the left side of the inverted-U curve, where e-commerce development increases the urban–rural income gap. The government should create more favorable conditions for the popularization of rural e-commerce and advance the turning point.

KEYWORDS

China, digital dividends, e-commerce, Internet access, urban–rural income gap

JEL CLASSIFICATION

M31; R11

1 | INTRODUCTION

The dual urban–rural structure along with an evident income gap between urban and rural residents is a common phenomenon in developing countries (Lewis, 1954; Todaro, 1996). The great inequality in urban–rural income is not only detrimental to the sustainable development of national economy, but also a threat to the long-term social stability (Kibriya, Bessler, & Price, 2019). How to narrow the urban–rural income gap effectively is a worldwide challenge. Governments in developing countries are struggling to find solutions in institutions, technology, education, finance, organizations, etc. (Shin, 2012).

China, as the largest developing country in the world, has made remarkable achievements in economic development since the reform and opening up. However, there are many structural distortions behind this growth, such as the imbalance of urban and rural development (Jiang, Shi, Zhang, & Ji, 2011; Shin, 2016). The income and welfare levels of rural residents still lag significantly behind those of urban residents. Moreover, the principal social contradiction is the contradiction between the people's growing desire for a better life and the unbalanced and inadequate development in society, which is a highly valued consensus in China. China is striving to solve the problem of urban–rural divide.

In this context, Chinese government has put forward a series of informatization development strategies such as "Internet plus" and "Digital Village," aiming at promoting comprehensive development of China's economy and society through the popularization and application of information technology. Specifically, e-commerce, as an important application of information technology, has been developing rapidly in rural China. Taobao village,[1] Taobao town,[2] rural e-commerce service centre,[3] rural e-commerce industrial park, agricultural inputs commerce, and other new things have been successively emerged (Avgerou & Li, 2013; Cai, Wang, Xia, & Wang, 2019; Leong, Pan, Newell, & Cui, 2016). E-commerce is increasingly becoming an important way to increase farmers' income and integrate urban and rural development, especially in some eastern coastal areas (Qi, Zheng, Cao, & Zhu, 2019; Zeng, Jia, Wan, & Guo, 2017), among which, Zhejiang Province is quite a typical example. Rural e-commerce in Zhejiang develops very rapidly, and is in a leading position in China. In 2017, there were nearly 20,000 online stores registered in rural areas of Zhejiang. In 2018, 1,452 new rural e-commerce service centres were established in Zhejiang, and eventually constituted a total of 18,000 service centres, accounting for 68.2% of the administrative villages. By the end of 2018, there has been 326 e-commerce industrial parks built in Zhejiang, with a total investment of more than 50 billion yuan, and more than 50,000 e-commerce enterprises settled in. By June 2019, there were 1,573 Taobao villages and 240 Taobao towns in Zhejiang, whose scale is significantly larger than those of other provinces in China.[4]

The great practice of rural e-commerce in Zhejiang makes it available to explore the relationship between the development of e-commerce and the urban–rural income gap. Moreover, it can provide guidance and advanced experiences to develop e-commerce in the backward areas of developing countries, considering the lack of rural e-commerce development (Zeng, Guo, Yao, & Huang, 2019). However, few studies have investigated the impact of e-commerce development on urban–rural income gap, especially in the context of developing countries. In order to bridge the gaps in the literature, the overall goal of our study is to answer the following question: Has e-commerce played a role in narrowing the income gap between urban and rural areas in Zhejiang? If it has, how does e-commerce affect the urban–rural income gap? On the basis of literature review and theoretical analysis, this study empirically estimates the impact of e-commerce on the urban–rural income gap using a panel data of 11 prefecture-level cities in Zhejiang from 2011 to 2018, then discusses the findings, and proposes some practical implications from China. This study not only provides the evidence for promoting the application of e-commerce to solve the problem of urban–rural income distribution in developing countries, but also contributes to the research of e-commerce and urban–rural income distribution in development economics.

The rest of the paper is structured as follows: Section 2 reviews the relevant literature. Section 3 proposes a theoretical hypothesis about the relationship between e-commerce development and urban–rural income gap. Section 4 presents our data, and research methods. The empirical results are presented and discussed in Section 5 and Section 6, respectively. The last section concludes the paper.

[1]The Taobao village was first defined by AliResearch (founded in April, 2007 and belonging to Alibaba Group) as a village that includes a large number of e-businesses, who use Taobao as their main trading platform.

[2]Based on the concept of Taobao village, AliResearch further defined a Taobao town as a cluster with no less than three Taobao villages.

[3]Rural e-commerce service centers refer to provide agent purchase and sales services, aiming to realize the two-way circulation of "consumer goods to the countryside" and "agricultural products to the city." Other services are also provided, such as fee payment, reservation of hotel and ticket, information service, etc. (Jin, Li, Qian, & Zeng, 2020).

[4]Data source: *The China Taobao Village Research Report (2009–2019)* released by AliResearch, available from: http://www.100ec.cn/detail--6525509.html

2 | LITERATURE REVIEW

2.1 | ICT and urban–rural income gap

With the development of information communication technology (ICT), will there be an insurmountable digital divide between urban and rural residents? Or will rural enterprises and farmers share the digital dividends with the help of ICT? There has been a heated debate on this issue in academic field, forming two opposite theories. On one hand, urban leadership theory demonstrates that urban areas have advantages in providing supporting facilities and resources at a lower cost, and they will benefit more from the supply of the Internet. On the other hand, global village theory argues that despite of the high cost of providing and using the Internet in remote rural areas, the marginal income of using the Internet there is high. Because the Internet can reduce the cost of communication and coordination in doing business, and overcome obstacles such as geographical distance and economic scale (Forman, Goldfarb, & Greenstein, 2005).

In addition, relevant empirical studies have not reached a consensus. Some studies have shown that Internet use and electronic devices have significant and positive impacts on market sales, prices of agricultural products and farmers' welfare (Burga & Barreto, 2014; Khanal & Mishra, 2016; Shimamoto, Yamada, & Gummert, 2015). Ivus and Boland (2015) found that the Internet improved the income and employment rate of service industries in Canadian rural areas from 1997 to 2011, which was helpful to overcome the urban–rural development gap. The Internet helps to optimize the allocation of urban and rural resources and reduce the income gap between urban and rural areas (Gao, Zang, & Sun, 2018). Based on the micro-survey of Chinese farmers, it is found that the use of Internet significantly increases farmers' income and promotes farmers' income diversification (Leng, Ma, Tang, & Zhu, 2020; Ma, Nie, Zhang, & Renwick, 2020). Based on the analysis of China's provincial panel data, Han and Zhang (2017) pointed out that the popularization of Internet could narrow the urban–rural income gap, while Cheng and Zhang (2019) believed that Internet popularization tended to widen the urban–rural income gap at the first stage and then to narrow the gap, presenting an inverted-U trend. However, some studies have found that ICT may not bring benefits to farmers in developing countries (Fafchamps & Minten, 2012; Futch & McIntosh, 2009; Molony, 2008). Specifically, researchers believe that there are two reasons why it is difficult for rural enterprises and farmers to share digital dividends. One is the lack of access to the information technology and the other is the lack of ability to use it (Bowen & Morris, 2019). However, there are obvious differences between urban and rural areas about Internet penetration in developing countries, which is likely to further widen the gap between urban and rural income, employment and other economic characteristics, especially between urban and rural low-income families (Prieger, 2013).

In general, there is no consensus yet among studies on the relationship between ICT and urban–rural income gap. Moreover, most empirical studies examined the impact of ICT on urban–rural income gap from the perspectives of accessibility, penetration, and ownership of mobile phones, computers, and the Internet. Few literatures have studied it directly from the perspective of e-commerce application. E-commerce is a specific and in-depth application of ICT. To explore the relationship between ICT and urban–rural income gap, it is necessary to avoid general measurement of explanatory variables in order to get accurate conclusions.

2.2 | E-commerce empowering rural households

Most farmers in developing countries face the challenge of marketing their products, but the emergence of e-commerce has improved this situation in rural areas, since rural farmers have access to national and global markets through Internet trade (Yu & Cui, 2019). Moreover, e-commerce has an important influence on the sales decisions of smallholders, especially on promoting their sales in domestic market (Fan & Garcia, 2018; Galloway, Sanders, & Deakins, 2011). Similarly, some scholars have found that e-commerce could help increase farmers' selling orders (Zapata, Carpio, Isengildina-Massa, & Lamie, 2013). Tumibay, Layug, Yap, and Sembrano (2016) conducted a

qualitative analysis found that from the perspective of business model, the emergence of e-commerce contributed to direct communication and trade between farmers and consumers, which helps increase the value of agricultural products. E-commerce allows for the reconfiguration of interdependencies between villagers and middlemen (Leong et al., 2016). E-commerce has increased employment channels and livelihood options for farmers, which has an important impact on the development of rural and remote areas (Atasoy, 2013). E-commerce also has an important impact on the migration decision of farmers. Research shows that Taobao village residents are about 26% less likely to migrate than non-Taobao village residents (Qi et al., 2019). E-commerce can also promote the entrepreneurial activities of rural families (Yu & Cui, 2019; Zeng et al., 2017). E-commerce development is associated with higher consumption growth and the relationship is stronger for the rural sample (Luo, Wang, & Zhang, 2019).

More importantly, e-commerce has also significantly boosted farmers' income. Compared with the simple use of text message, digital newspaper, web browsing, and emails, e-commerce not only has the function of collecting information and facilitating communication, but also changes the marketing mode (Zeng et al., 2019). Cho and Tobias (2009) carried out a descriptive analysis by using the survey data of 374 small and medium-sized farm households and found that most farm households increased their revenue by 10% to 25% from MarketMaker platform in the United States. Based on the survey data of 2,131 farmers in China, Lu and Liao (2016) found that e-commerce generally had a significant positive impact on farmers' income from selling agricultural products. Research by Li, Tang, and Ren (2019) proved that the development of e-commerce and its spatial spillover effects have a positive impact on farmers' income, and the greater the government support, the stronger the positive impact will be. E-commerce has increased farmers' income, mainly due to increased marginal profits and increased sales (Zeng, Guo, & Jin, 2018). E-commerce participation in Taobao villages has a strong positive effect on household incomes (Luo & Niu, 2019).

Studies have examined the positive effect of e-commerce on the development of farmers from different perspectives such as sales volume, employment, entrepreneurship, income, etc. However, there are few studies examining the actual effect of e-commerce on farmers and rural areas from the perspective of urban–rural income gap. For farmers in developing countries, we should not only pay attention to their absolute income growth, but also focus on their relative income level.

3 | THEORETICAL HYPOTHESIS

The development of e-commerce is inseparable from four elements: network facilities, logistics and express, e-commerce platform, and e-commerce entrepreneurs (see Figure 1). Network facilities are the hardware for e-commerce development. The construction of network facilities in every country starts from the city, and then

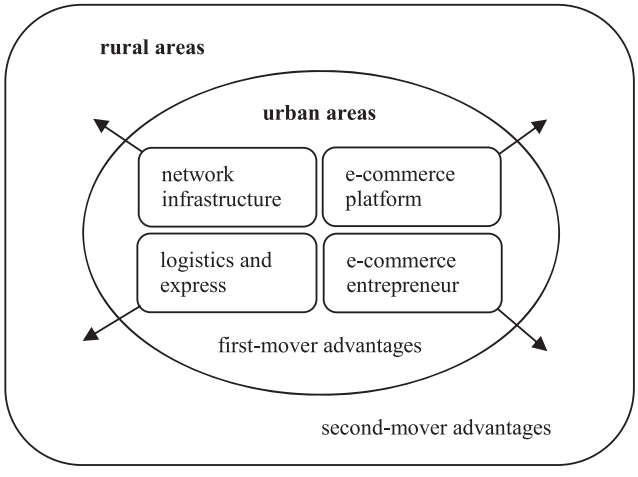

FIGURE 1 Development path of e-commerce: from urban areas to rural areas

gradually extends to the rural areas. As a result, "the first-level digital divide" between urban and rural areas, which is the gap in accessibility of information technology, has widened (Dimaggio, Hargittai, Celeste, & Shafer, 2004). Moreover, the concentrated urban population and convenient transportation provide important conditions for the prosperity of logistics and express industry, which leads logistics and express enterprises to start their business in urban areas first, and then gradually expand to urban suburbs and rural areas. The construction of e-commerce platform is a systematic project, involving mobile payment, making rules, network security, rights and interests maintenance, security services, etc. All these parts need a large number of technical and management talents to complete, but these people are mainly concentrated in prosperous cities. This is why the e-commerce platform started in the city. Based on the spatial spillover effect of technological innovation in urban areas, people close to the source of innovation always benefit first from the innovation diffusion due to the advantage of spatial proximity (Li et al., 2019). As the network facilities and logistics delivery in urban areas are more developed, the success rate of e-commerce platform promotion here is higher and the promotion cost is lower. For the same reason, the early use of e-commerce platform for marketing is the entrepreneurs in urban areas. They need to be forward-looking and be able to identify e-commerce entrepreneurial opportunities. As above, the four elements of e-commerce development are first available in urban areas. Therefore, e-commerce in a region usually starts from the city. In this case, the development of regional e-commerce only promotes the income growth of urban residents, but has no impact on the income of rural residents, leading to the widening of urban–rural income gap.

When the e-commerce in urban areas develops to a certain extent, the rural e-commerce begins to develop gradually. In a market economy, telecom operators, e-commerce platform enterprises, and logistics and express enterprises all have the impetus to develop potential rural markets. Moreover, some young people struggling in the city choose to return to their hometowns to engage in online marketing or provide professional e-commerce services for rural e-commerce entrepreneurs after finding rural e-commerce entrepreneurial opportunities. In the past, young people were reluctant to go back to the countryside because the market there was so small that they would not earn much money. The situation changes with the advent of e-commerce. Even in rural areas, young people can connect to the vast external market via a network cable and have the opportunity to make much money. From another perspective, in order to narrow the digital divide and urban–rural development gap, governments in developing countries will take measures to accelerate the expansion of Internet and logistics outlet coverage in rural areas. All these changes will undoubtedly promote the development of rural e-commerce.

However, it will take a long time to develop rural e-commerce in developing countries. We can roughly divide this process into two stages. In the first stage, some villages will obtain considerable dividends. They have superior conditions to develop e-commerce, such as good geographical location, products with local characteristics, and business tradition (Zeng et al., 2019). Residents in these villages have achieved significant income growth through the development of e-commerce. However, this phenomenon is only partial, not universal. For all rural areas, the promotion of e-commerce on the income of rural residents is still very limited. The urban–rural income gap continues to widen. As time goes by, conditions for more villages to develop e-commerce will be improved and rural e-commerce will enter a comprehensively rapid development stage, that is, the second stage. At that time, the rural e-commerce will develop with a huge late advantage. First, relevant bodies in urban areas have undertaken the responsibility of exploring and improving the development of e-commerce, especially the improvement of distribution services and e-commerce platforms. Thus, risk cost can be saved and the efficiency loss caused by "detours" can be directly avoided during the process of rural e-commerce development. Second, e-commerce entrepreneurs in urban areas gradually accumulated business experiences in the process of developing e-commerce. These experiences can provide valuable references for rural e-commerce entrepreneurs to promote the rapid development of rural e-commerce. Third, e-commerce is only "icing on the cake" for urban areas, but "sending charcoal in the snow" for rural areas. There has been a sound offline market environment with smooth information and convenient transactions in urban areas; while blocked information, lack of information, scattered transactions, and difficulties in having access to large markets hang over the rural areas (Poulton, Dorward, & Kydd, 2010; Wiggins, Kirsten, & Llambí, 2010). Thus, the development of e-commerce has a great role in improving the commercial circulation in rural areas. In line with the global

FIGURE 2 Location of Zhejiang Province and its 11 prefecture-level cities

village theory, the late development advantages and huge potentials of rural e-commerce will bring more benefits to rural residents. In such a stage, the development of e-commerce will play a role in narrowing the urban–rural income gap.

Thus, we hypothesize that: there is an inverted-U relationship between e-commerce development and the urban–rural income gap.

4 | EMPIRICAL METHODOLOGY

4.1 | Data

Since 2011, the Zhejiang Department of Commerce has released the relevant statistical data of e-commerce retail and consumption.[5] Zhejiang is the first region in China to collect e-commerce statistics. These data are quite valuable for the empirical study of e-commerce. In addition, Zhejiang has highly developed e-commerce, and is a typical example of developing the new economy. Therefore, it is significant to study the relationship between e-commerce development and urban–rural income gap in Zhejiang, which can provide a reference for other provinces in China and other developing countries. This study carries out an empirical analysis based on panel data of 11 prefecture-level cities in Zhejiang Province from 2011 to 2018. We collect the data from website of Zhejiang Provincial Department of Commerce and *Zhejiang Statistical Yearbook* published by Zhejiang Provincial Bureau of Statistics.[6] Figure 2 is a map showing the location of Zhejiang Province and its 11 prefecture-level cities.

[5]E-commerce statistics released by the Zhejiang Department of Commerce are available on the website: http://www.zcom.gov.cn/col/col1385821/index.html

[6]The electronic editions of Zhejiang Statistical Yearbook provided by Zhejiang Provincial Bureau of Statistics are available on the website: http://tjj.zj.gov.cn/col/col1525563/index.html

4.2 | Empirical model

In order to examine the impact of e-commerce on the urban–rural income gap, the two-way fixed effects panel data model is constructed as follows:

$$Gap_{it} = \beta_0 + \beta_1 e_{it} + \beta_2 e_{it}^2 + \beta_3 X_{it} + \mu_i + \lambda_t + \varepsilon_{it}, \quad (1)$$

where i represents prefecture-level city, t represents year, Gap represents urban–rural income gap, e represents e-commerce development, e^2 represents the square of e-commerce development, X represents a series of observable control variables, μ represents city fixed effects, λ represents time effects (the year dummy variables are introduced to control the unobservable factors changing with time), and ε represents random term.

4.3 | Variables

4.3.1 | Dependent variable

The dependent variable of this study is the urban–rural income gap. According to the current literature, the main indicators are urban–rural residents' income ratio and the Theil index. Although the urban–rural residents' income ratio is intuitive and simple, it ignores the facts of dual economic characteristics and a large proportion of rural population in developing countries. Theil index takes both the urban–rural income difference and the demographic structure into account, thus truly reflecting the dual urban–rural structure in developing countries (Cheng & Zhang, 2019). Therefore, this study uses the Theil index to measure urban–rural income gap. The specific calculation formula is:

$$Theil_{it} = \sum_{j=1}^{2} \left(\frac{I_{ijt}}{I_{it}}\right) \ln\left(\frac{I_{ijt}}{I_{it}} / \frac{P_{ijt}}{P_{it}}\right), \quad (2)$$

where I_{ijt} represents the total income of urban (j = 1) or rural (j = 2) residents in the i city in the t year, I_{it} represents the total income of residents in the i city in the t year, P_{ijt} represents the total population of urban or rural residents in the i city in the t year, and P_{it} represents the total population of the i city in the t year.

4.3.2 | Independent variables

The core independent variable of this study is the development of e-commerce. The study uses the concept of e-commerce in a narrow sense, which only refers to using e-commerce platforms to sell goods to consumers, and does not include the meaning of using e-commerce platforms to buy goods from sellers. Existing literature mainly discusses the impact of online sales on residents' income, but few studies reveal the impact of online consumption. Although online consumption may affect residents' income through some pathways such as employment in transport, storage, and post sectors, there is a lack of literature supporting the relationship between online consumption and urban–rural income gap.[7] Therefore, this paper only focuses on online sales. Given the differences in the economic aggregate of different regions, we use online retail sales to GDP ratio to measure the development of e-commerce.

[7]We have carried out empirical tests and the results show that online consumption has no significant impact on urban–rural income gap.

4.3.3 | Control variables

GDP per capita and GDP per capita squared

A large number of studies have shown that there is an important relationship between the urban–rural income gap and economic development, which may be positive U-shaped or inverted U-shaped (Cheng & Zhang, 2019). Therefore, we include the logarithm of GDP *per capita* and its square as control variables.

Opening degree

Some scholars have pointed out that the level of economic opening-up has an important impact on the urban–rural income gap in developing countries (Wei, Li, & Guo, 2013). Therefore, it is included as a control variable and measured by the proportion of total import and export to GDP.

Urbanization rate and urbanization rate squared

Scholars (Su, Liu, Chang, & Jiang, 2015) have been concerned about the impact of urbanization level on the urban–rural income gap. In this study, the control variables also include the proportion of permanent urban residents in the total population and its square.

Fiscal expenditure

Fiscal expenditure has an important impact on the incomes of urban and rural residents, and fiscal policy preferences in different regions of China may have different impacts on urban and rural areas (Liu & He, 2019). This paper uses the government expenditure to GDP ratio to measure it.

Industrial structure

Wu and Liu (2014) believed that the higher the proportion of the primary industry, the smaller the urban–rural income gap. As the proportion of secondary and tertiary industries increases, the urban–rural income gap become widen. In this study, the proportion of added values of secondary and tertiary industries to GDP is used to measure industrial structure.

Internet penetration and Internet penetration squared

Cheng and Zhang (2019) found that the relationship between Internet popularization and urban–rural income gap presented an inverted-U trend. Therefore, control variables include Internet penetration rate and its square. We use the number of Internet use households[8] to total population ratio to measure the Internet penetration rate.

Highway density

Some studies believe that transportation infrastructure has an important negative impact on urban–rural income gap by promoting population flow and commodity circulation (Huang, Xu, Li, & Luo, 2020). This study uses highway density to define regional transportation infrastructure, which is measured by dividing the length of roads by the land area.

Capital investment

Capital investment is an important factor that affects regional economic development and urban–rural income gap (Qi, Zheng, & Guo, 2019). Investment in fixed assets, such as public infrastructure, is likely to both widen and narrow the income gap between urban and rural areas (Raychaudhuri & Prabir, 2010). We use fixed asset investment to GDP ratio to measure capital investment.

[8]Only the number of Internet use households is provided in *Zhejiang Statistical Yearbook*. Broadband is installed in households. The telecommunications sector records only the number of households using the Internet, not the number of individuals using the Internet.

4.3.4 | Statistical description

Definition and descriptive statistics of each variable are shown in Table 1. We can see from Table 1 that the mean value of the Theil index reflecting the urban–rural income gap in Zhejiang from 2011 to 2018 is 0.049. Some scholars have pointed out that China's Theil index was 0.107 in 2016 (Cheng & Zhang, 2019), significantly higher than Zhejiang's Theil index. The average online retail sales to GDP ratio is 0.140, which indicates that e-commerce has played an important role in stimulating domestic demand of Zhejiang's economic development. This value is higher than the total import and export to GDP ratio, and is equal to the government expenditure to GDP. Zhejiang's overall economy is relatively strong, with a logarithmic GDP *per capita* of 11.221, equivalent to 80,000 yuan *per capita*. In addition, the urbanization rate has reached 62.9%, and the proportion of secondary and tertiary industries in GDP has reached 94.5%. On average, there are 36 Internet use households per 100 people, and about 1.157 kilometres of roads per square kilometre. The fixed asset investment accounts for 61.2% of GDP.

5 | RESULTS

5.1 | Baseline regression results

Table 2 presents the baseline regression results. Columns (1), (2), and (3) take the Theil index as the dependent variable and adopt pooled regression, fixed effects regression, and random effects regression, respectively. The estimation results of pooled regression and random effects regression are almost identical. The results of all regressions show that e-commerce development and its square have a significant impact on the urban–rural income gap. The P values of both F test and Hausman test are zero, indicating that fixed effects regression is significantly

TABLE 1 Definition and descriptive statistics of the variables

	Definition	Mean	S.D.
Dependent variable			
Theil index	an indicator reflecting the urban–rural income gap	0.049	0.022
Independent variables			
E-commerce development	online retail sales to GDP ratio	0.140	0.137
E-commerce development squared	the square of online retail sales to GDP ratio	0.038	0.075
Control variables			
GDP *per capita*	the logarithm of GDP *per capita*	11.221	0.382
GDP *per capita* squared	the logarithmic square of GDP *per capita*	126.063	8.527
Opening degree	total import and export to GDP ratio	0.076	0.039
Urbanization rate	permanent urban population to total population ratio	0.629	0.073
Urbanization rate squared	the square of urbanization rate	0.401	0.091
Fiscal expenditure	government expenditure to GDP ratio	0.142	0.051
Industrial structure	added values of secondary and tertiary industries to GDP ratio	0.945	0.024
Internet penetration	Internet use households to total population ratio	0.364	0.152
Internet penetration squared	the square of Internet penetration	0.155	0.191
Highway density	highway mileage per square kilometre	1.157	0.331
Capital investment	fixed asset investment to GDP ratio	0.612	0.159

TABLE 2 The baseline estimation results

	(1) POLS	(2) FE	(3) RE
E-commerce development	0.126*** (0.029)	0.091** (0.030)	0.126*** (0.029)
E-commerce development squared	−0.112*** (0.031)	−0.080*** (0.024)	−0.112*** (0.031)
Per capita GDP	−1.683*** (0.289)	−1.044*** (0.297)	−1.683*** (0.289)
Per capita GDP squared	0.075*** (0.013)	0.047*** (0.014)	0.075*** (0.013)
Opening degree	0.014 (0.056)	−0.093** (0.044)	0.014 (0.056)
Urbanization rate	1.146*** (0.270)	0.113 (0.197)	1.146*** (0.270)
Urbanization rate squared	−1.058*** (0.242)	−0.182 (0.240)	−1.058*** (0.242)
Fiscal expenditure	−0.062 (0.042)	−0.224*** (0.034)	−0.062 (0.042)
Industrial structure	−0.228** (0.097)	0.016 (0.250)	−0.228** (0.097)
Internet penetration	0.015 (0.059)	0.062*** (0.018)	0.015 (0.059)
Internet penetration squared	−0.004 (0.034)	−0.034*** (0.011)	−0.004 (0.034)
Highway density	−0.025*** (0.006)	−0.031 (0.019)	−0.025*** (0.006)
Capital investment	−0.014 (0.010)	0.030** (0.014)	−0.014 (0.010)
City fixed effects	NO	YES	NO
Year dummy variables	YES	YES	YES
Constant	9.484*** (1.536)	5.888*** (1.504)	9.464*** (1.533)
Number of observations	88	88	88

Notes: Robust standard errors are clustered at the city level.
Standard errors are reported in parentheses.
***Statistically significant at 1%.
**Statistically significant at 5%.
*Statistically significant at 10%.

superior to both pooled regression and random effects regression. Therefore, we focus on the estimation results of Column (2). We see that e-commerce development has a positive impact on the urban–rural income gap at the level of 5%, while the square of e-commerce development has a negative impact on the urban–rural income gap at the level of 1%. This indicates that there is an inverted-U relationship between e-commerce development and urban–rural income gap. Specifically, when the development level of e-commerce is lower than the critical value of the turning point, the development of e-commerce increases urban–rural income gap. When e-commerce further develops to a certain extent, it plays a role in narrowing the income gap between urban and rural residents. In other words, the development of e-commerce will ultimately benefit both urban and rural areas, and it needs to go through a transition from digital divide to digital dividends. In the long run, the development of e-commerce will bring benefits to help narrow the income gap between urban and rural areas. According to the estimated coefficients in Column (2), the turning point of the inverted-U curve is located where the online retail sales to GDP ratio is equal to 0.569 ($-0.091/(-2 \times 0.080)$). This is only a rough estimate of the turning point, not a precise estimate. Moreover, it reveals that online sales need to increase to a certain amount to pass the turning point. We believe that online sales will constitute a major part of GDP, which is an inevitable trend. With the rapid development of digital economy, cross-border e-commerce will gradually become an important mode of global trade. E-commerce also plays a major role in stimulating domestic consumption. We do not have to worry about the decline of traditional sales and employment problems. The new model is the result of consumers voting with their feet, showing that it can better meet the needs of consumers (Leong et al., 2016). The replacement of old models by new models symbolizes economic progress. New business models will also create new jobs (Zeng et al., 2019). The average online retail sales to GDP ratio in 2018 is 0.272, increasing by 16.74 percentage points compared to the previous year. Obviously, Zhejiang is still at the left side of the inverted U-curve, which means that the development of e-commerce in

Zhejiang is playing a role in widening the income gap between urban and rural areas. Assuming online retail sales in Zhejiang could maintain an annual growth rate of 16.74% in the next few years, it would take five years to cross the turning point of the inverted-U curve. However, it is well known that the COVID-19 outbreak in early 2020 has exerted a major impact on the global economy and society. The global epidemic and economic situation remain grim, which had a sustained impact on China's economic development. We assume that if the average growth rate of e-commerce in Zhejiang were about 10% in the next few years, it would take eight years for Zhejiang to cross the turning point of the inverted-U curve. In other words, Zhejiang's e-commerce development will narrow the urban–rural income gap by the end of 2026.

In addition, we find that most control variables (GDP *per capita*, GDP *per capita* squared, opening degree, fiscal expenditure, Internet penetration, Internet penetration squared, and capital investment) significantly affect the urban–rural income gap. In general, there is a positive U-shaped relationship between GDP *per capita* and the urban–rural income gap. However, there is an inverted U-shaped relationship between Internet penetration and the urban–rural income gap. Moreover, opening degree and fiscal expenditure contribute to narrow the urban–rural income gap, while capital investment tends to widen the urban–rural income gap.

5.2 | Endogenous issues

There may be endogenous problems in regression analysis due to unobserved variables and reverse causality. Specifically, unobserved factors may change over time and affect the development of e-commerce, resulting in estimation biases caused by missing variables. In addition, a reverse causal relationship may exist between e-commerce development and urban–rural income gap. In particularly, urban–rural income gap may affect the development of e-commerce, resulting in simultaneous bias. It is a common practice to use instrumental variables to address endogenous problems, especially the use of lagged endogenous variables as instrumental variables. It is common to use the lagged endogenous variables as instrumental variables. On one hand, due to the inertia of economic variables, the lagged term has a strong correlation with the current term; on the other hand, the dependent variables will not adversely affect the lagged endogenous variables. Table 3 presents the estimation results of instrumental variable regression. Column (1) uses the first-order lag of the ratio of online retail sales to GDP and its square as the instrumental variables. The first-stage regression shows that the instrumental variable significantly affects the endogenous variable, and the F value is significantly greater than 10, indicating that the instrumental variable has a strong explanatory power to the endogenous variable. Moreover, the second-stage results present that the development of e-commerce affects the urban–rural income gap in an inverted-U way.

Using the lagged term of endogenous variable meets the relevance requirements of instrument variables and eliminates the simultaneity bias caused by reverse causality. However, the lagged endogenous variable is not strictly exogenous. In order to improve the exogeneity of instrumental variables, this study introduces the interaction term of lagged ratio of online retail sales to GDP and the number of post offices in 1991, the interaction term of lagged ratio online retail sales to GDP and the number of telephones in 1991, and their squared terms, as instrumental variables (Huang, Yu, & Zhang, 2019). For historical variables, the longer the time range from the research sample is, the more exogenous they are. We adopt the number of post offices and the number of telephones in 1991, because of the data availability. Moreover, China's Internet access technology started with fixed-line access, and then developed into broadband, fibre optic, and wireless network access technologies. In regions with a high fixed-line coverage in the past, the Internet penetration rate and e-commerce development level are more likely to be high. Meanwhile, post office, as the executive department of laying fixed telephone, whose distribution determines the distribution of fixed telephone (Huang et al., 2019). Therefore, the number of post offices and the number of telephones in 1991 meets the relevance requirements of instrumental variables. As historical variables, the number of post offices and the number of telephones in 1991 have little impact on the urban–rural income gap from 2011 to 2018, making them better meet the exogenous requirements. However, the number of post offices and the number of telephones

TABLE 3 Estimation results of instrumental variable regression

	(1) 2SLS First-stage	(2) 2SLS First-stage	(3) 2SLS First-stage
L1. E-commerce development	0.935*** (0.035)		
L1. E-commerce development squared	1.221*** (0.024)		
L1. E-commerce development * Post offices		0.135*** (0.005)	
L1. E-commerce development * Post offices squared		0.021*** (0.001)	
L1. E-commerce development * Telephones			0.072*** (0.003)
L1. E-commerce development * Telephones squared			0.006*** (0.000)
Control variables	YES	YES	YES
City fixed effects	YES	YES	YES
Year dummy variables	YES	YES	YES
F-statistics	383.13***	359.87***	285.17***
	434.19***	286.65***	175.28***
	(4) IV regression	**(5) IV regression**	**(6) IV regression**
E-commerce development	0.103** (0.034)	0.115** (0.037)	0.120*** (0.035)
E-commerce development squared	−0.077*** (0.024)	−0.088*** (0.028)	−0.091*** (0.027)
Control variables	YES	YES	YES
City fixed effects	YES	YES	YES
Year dummy variables	YES	YES	YES
Constant	6.340*** (1.591)	6.432*** (1.598)	6.495*** (1.564)
Number of observations	77	77	77

Notes: Robust standard errors are clustered at the city level.
Standard errors are reported in parentheses.
***Statistically significant at 1%.
**Statistically significant at 5%.
*Statistically significant at 10%.

in 1991 are time-invariant variables, which cannot be measured in the fixed effects regression. Learning from Nunn and Qian (2014), we use the lagged ratio of online retail sales to GDP to reflect the time trend. We use the interaction terms of lagged online retail sales to GDP ratio and the number of post offices in 1991, and its square as instrumental variables in Column (2). Column (3) shows the regression of the interaction terms of lagged ratio of online retail sales to GDP and the number of telephones in 1991 and its square being instrumental variables. Both the first-stage regressions show that the instrument variable significantly affects the endogenous variable at the 1% level and the F value is much greater than 10, indicating that the instrumental variable has a strong explanatory power to the endogenous variable. The estimation results of the second-stage regression show that the development of e-commerce has an inverted-U effect on the urban–rural income gap. [Correction added on 21 September 2020, after first online publication: This paragraph has been corrected in this current version.]

TABLE 4 The effect of e-commerce development on urban–rural income ratio

	(1) POLS	(2) FE	(3) RE	(4) 2SLS	(5) 2SLS
E-commerce development	1.762*** (0.392)	0.945** (0.426)	1.762*** (0.392)	1.216** (0.486)	1.282** (0.424)
E-commerce development squared	−1.489*** (0.428)	−0.796** (0.362)	−1.489*** (0.428)	−0.883** (0.377)	−0.921** (0.383)
Control variables	YES	YES	YES	YES	YES
City fixed effects	NO	YES	NO	YES	YES
Year dummy variables	YES	YES	YES	YES	YES
Constant	121.655*** (23.598)	72.516*** (21.457)	121.308*** (23.568)	76.680*** (23.308)	77.380*** (23.011)
Number of observations	88	88	88	77	77

Notes: In Column (4), the interaction terms of lagged online retail sales to GDP ratio and the number of post offices in 1991 and its square are included as instrumental variables; In Column (5), the interaction terms of lagged online retail sales to GDP ratio and the number of telephones in 1991 and its square are included as instrumental variables.
Robust standard errors are clustered at the city level.
Standard errors are reported in parentheses.
***Statistically significant at 1%.
**Statistically significant at 5%.
*Statistically significant at 10%.

5.3 | Robust checks

5.3.1 | Using other dependent variables

Although the income ratio of urban and rural residents is relatively simple to measure rural–urban income gap, we use it to replace the Theil index for a robustness check. We find that the estimation results are consistent with the above empirical results (see Table 4), which further enhances the reliability of our conclusion.

We also use the incomes of urban and rural residents to replace the Theil index for regression analysis and check whether the impact of e-commerce development on the income of urban residents is larger than that of rural residents at the present stage. In Table 5, e-commerce developments are regressed on urban residents' income in Columns (1), (2), and (3). Columns (4), (5), and (6) take rural residents' income as dependent variable, instead. The results show that the development of e-commerce significantly contributes to the income growth of urban residents, but does not have a significant impact on the income of rural residents. Moreover, the regression coefficient of the impact of e-commerce development on urban residents' income is obviously larger. These results further verify the reliability of the conclusion that the development of e-commerce increases the income gap between urban and rural areas.

5.3.2 | Using dynamic panel data model

Some scholars believed that the urban–rural income gap had inertia, and they introduced the lagged urban–rural income gap into the model to carry out dynamic panel data regression (Han & Zhang, 2017). Here, we also try to use the dynamic panel data model for a robustness check. In Table 6, Columns (1), (2), (3), and (4) take the Theil index as dependent variable and introduce the lagged Theil index as independent variable. Columns (1) and (2) adopt difference GMM estimation method, and Columns (3) and (4) adopt system GMM estimation method. The autocorrelation tests show that there is no two-order sequence correlation of the residual terms at the significance level of 10%, thus the difference GMM and system GMM estimation methods can be used. In addition, Sargan tests show that all instrumental variables are valid. The results show that the development of e-commerce has a significant inverted-U impact on the urban–rural income gap, which is still valid after controlling the lagged Theil index, indicating that this study has a good reliability.

6 | DISCUSSION

This study provides new empirical evidence for the effects of e-commerce development. The development of e-commerce has an inverted-U effect on the urban–rural income gap, indicating that whether it is a digital divide or digital dividend depends on the stage of a region. Both the urban leadership theory and the global village theory are convincing to some extent. The high population concentration and the perfect conditions for the development of e-commerce provide a first-mover advantage for the urban areas, thus creating the urban–rural digital divide. This is an insurmountable stage. However, governments in developing countries can adopt a series of measures to advance the transition from digital divide to digital dividends. Due to problems in market transactions and information acquisition, e-commerce development in rural areas has more potential than that in urban areas. Specifically, e-commerce eliminates the constraints of time and space, and directly connects with the vast external market, which could make more economic activities in rural areas. Regions with low level of economic development, especially inland and mountainous areas, will obtain more digital dividends from the development of e-commerce. For example, although some poor areas are remote and far away from cities, they have advantages in developing ecological agriculture. The excellent soil and water quality, and absence of any industrial

TABLE 5 The effects of e-commerce on the urban and rural residents' income

	Y = the logarithm of urban residents' income			Y = the logarithm of rural residents' income		
	(1) FE	(2) 2SLS	(3) 2SLS	(4) FE	(5) 2SLS	(6) 2SLS
E-commerce development	0.105* (0.054)	0.161*** (0.038)	0.166*** (0.038)	0.003 (0.078)	0.030 (0.069)	0.024 (0.070)
Control variables	YES	YES	YES	YES	YES	YES
City fixed effects	YES	YES	YES	YES	YES	YES
Year dummy variables	YES	YES	YES	YES	YES	YES
Constant	20.194*** (4.300)	23.234*** (3.037)	23.320*** (3.045)	−2.038 (10.763)	0.776 (5.589)	0.673 (5.587)
Number of observations	88	77	77	88	77	77

Notes: Columns (2) and (5) include the interaction terms of lagged online retail sales to GDP ratio and the number of post offices in 1991 as instrumental variables; Columns (3) and (6) include the interaction terms of lagged online retail sales to GDP ratio and the number of telephones in 1991 as instrumental variables.
Robust standard errors are clustered at the city level.
Standard errors are reported in parentheses.
***Statistically significant at 1%.
**Statistically significant at 5%.
*Statistically significant at 10%.

TABLE 6 Estimation results of dynamic panel data models

	(1) DIFF-GMM	(2) DIFF-GMM	(3) SYS-GMM	(4) SYS-GMM
L1.Theil index	0.342*** (0.099)	0.351*** (0.101)	0.392*** (0.120)	0.392*** (0.120)
E-commerce development	0.085*** (0.031)	0.086*** (0.031)	0.098** (0.042)	0.098** (0.042)
E-commerce development squared	−0.065*** (0.025)	−0.065** (0.026)	−0.064** (0.030)	−0.064** (0.030)
Control variables	YES	YES	YES	YES
City fixed effects	YES	YES	YES	YES
Year dummy variables	YES	YES	YES	YES
Constant	4.566*** (1.463)	4.517*** (1.445)	4.159** (1.712)	4.171** (1.712)
AR (1)	0.052	0.053	0.038	0.039
AR (2)	0.826	0.849	0.580	0.541
Sargan	40.515 (p = 0.662)	40.793 (p = 0.690)	53.650 (p = 0.793)	53.987 (p = 0.810)
Number of observations	66	66	77	77

Notes: Lagged online retail sales to GDP ratio and its square being instrumental variables are added to Columns (1) and (3); The interaction terms of lagged online retail sales to GDP ratio and the number of post offices in 1991 and its square being instrumental variables are included in Columns (2) and (4).
Robust standard errors are clustered at the city level.
Standard errors are reported in parentheses.
***Statistically significant at 1%.
**Statistically significant at 5%.
*Statistically significant at 10%.

pollution make it possible for them to produce high-quality green products. Previously, people of these areas were poor because it was almost impossible for them to become rich in traditional trading modes. E-commerce can make a difference by helping them directly connect with cities and coastal areas, thus high-quality agricultural products can be sold at higher prices. In addition, adopting e-commerce can effectively make up for the shortcomings of farmers' lack of market information and sales channels. E-commerce helps to reduce their search costs and transaction costs, improve their market position, and strengthen their negotiation power. Therefore, they will get rid of the fate of selling products to middlemen at low prices, and obtain higher profit margins. In the long run, e-commerce makes it possible for rural–urban balanced development in developing countries. China is promoting this great practice, which has been successful in some areas.

In the meantime, we should realize that bringing e-commerce to rural areas in developing countries requires more than Internet access. Despite the rapid development of rural e-commerce in Zhejiang and its leading position in China, Zhejiang is still on the left side of the inverted-U curve. At present, the development of e-commerce in Zhejiang has a significant effect on the income of urban residents, but it has no significant effect on the income of rural residents, leading to the widening of urban–rural income gap. This indicates that the development of e-commerce empowering the rural residents to increase their income is only a partial phenomenon. This finding is consistent with Couture, Faber, Gu, and Liu (2018). They found little evidence for income gains to rural producers and workers. In addition, some scholars have found that e-commerce can significantly increase rural residents' income (Luo et al., 2019; Zeng et al., 2018), but the evidence they provided was based

[9]Data source: *The China Taobao Village Research Report (2009–2019)* released by AliResearch, available from: http://www.100ec.cn/detail--6525509.html
[10]Data source: http://data.chinabaogao.com/gonggongfuwu/2020/0424vz12020.html

on the samples from well-developed Taobao villages, which were not widely representative. Specifically, Taobao villages belong to the professional villages, which have a higher level of e-commerce development than the average level of e-commerce development of non-Taobao villages. Although the number of Taobao villages increases year by year, the proportion of Taobao villages is not high. By June 2019, there have been 4,310 Taobao villages in China.[9] In the second quarter of 2019, there were 541,000 villages in China.[10] Taobao villages only accounted for less than eight out of a thousand administrative villages. However, there is no denying that the rise of Taobao villages has provided a demonstration, as well as encouragement and enthusiasm for the development of e-commerce in rural areas. The government needs to create better conditions to promote the popularization of e-commerce in rural areas, so that rural areas can cross the turning point as soon as possible to reap digital dividends in an all-round way. First, it is necessary to accelerate the full coverage of rural broadband, speed up the internet, and reduce the fees. The rapid growth of e-commerce in China is largely attributed to an increase in the Internet penetration rate. The empirical results reveal that Internet use increases the likelihood of farmers' willingness to adopt e-commerce by 20% (Ma, Zhou, & Liu , 2020). Second, to develop rural e-commerce, we need to increase the constructions of transportation infrastructure, warehousing facilities, cold chain logistics facilities, and express delivery networks. The highly developed transportation can pave the way for the development of logistics and express industries, establishing a virtuous circle of co-evolution between e-commerce and logistics and express industries (Wang & Xiao, 2015). Third, the development of rural e-commerce requires e-commerce leaders and professional service talents to exert subjective initiative and successfully combine the surrounding resources and supporting conditions. The practice of Taobao village shows that an e-commerce entrepreneur taking the lead in development will bring imitation learning effect to relatives and neighbours around them, driving more people to engage in e-commerce and related industries. Economic activities on e-commerce platforms are embedded in offline social relations shaped by the behavioral norms of a local culture (Avgerou & Li, 2013). In China, the entire e-commerce industry still has a shortage of talents, which is more prominent in rural areas. Most talents with e-commerce majors from universities are reluctant to go to the countryside, which seriously restricts the development of rural e-commerce. Fourth, the development of rural e-commerce requires continuous inclusive innovations of e-commerce platform enterprises. If e-commerce platform enterprises can carry out some effective innovations according to the actual situation of rural population, which can greatly reduce the technical threshold of e-commerce, then e-commerce platform enterprises will obtain huge market dividends in rural areas. Due to its low entry threshold, the Taobao platform created by Alibaba provides an equal opportunity for the base of the pyramid (BOP) to participate in the market, and promotes farmer-led innovations. Moreover, virtual social platforms such as micro-blogs and *WeChat* have also become important channels for rural entrepreneurs to carry out e-commerce activities. In the past two years, the rise of live stream e-commerce has provided new opportunities for some rural entrepreneurs.

This study can provide some references for the future studies in ICT field. We claim that ICT is a broad concept, including fixed line telephone, mobile phone, computer, broadband, LAN, Internet, wireless network, etc. To study the relationship between ICT and urban–rural income gap, we should clarify the specific object first and then the specific use motivation. Taking the Internet as an example, people can use the Internet for learning, finance, entertainment, social interaction, shopping, marketing, working, searching resources, consulting, handling affairs, etc. Different Internet usage has different impacts on people's income. If different types of Internet use are mixed for research, it is likely to lead to biased results, and even completely wrong conclusions. This study focused on e-commerce, which is clear and helps to reach a rigorous conclusion. However, e-commerce is just one of the internet applications, there are many other internet applications in rural areas of developing countries that worth attention and research, such as online education, digital health, Internet financing, etc.

Finally, it should be pointed out that this paper only uses Zhejiang Province as an example to carry out empirical study and the sample size of data is limited. However, as the statistics of e-commerce continue to increase, the conclusion of this paper will be verified in subsequent studies with a broader time and more

samples. We argue that the conclusion of this study will be universal rather than unique to Zhejiang. On one hand, the analysis of theoretical logic of the inverted-U relationship between e-commerce development and urban–rural income gap is not limited to Zhejiang. On the other hand, although Zhejiang is a province with strong economic strength in China, there are internal development imbalances, and the development of some prefecture-level cities is still lagging behind. Therefore, each variable has a large range of variation, which indicates that the data we used is good for exploring the relationship between the development of e-commerce and urban–rural income gap.

7 | CONCLUSION

The wide income gap between urban and rural areas poses a common and critical issue for policymakers in the developing world. Smallholders in rural areas are considered disadvantaged in the supply chain and income growth. It is important for smallholders to gain access to the market; however, they face many difficulties in this area. In recent years, in some developing countries, especially in China, there has been a rapid proliferation of digital dividends in rural areas with the popularization of the Internet and the rapid development of information industries. However, whether the development of e-commerce can effectively narrow the urban–rural income gap in developing countries remains to be explored. Moreover, Zhejiang is the leading province in the development of rural e-commerce in China and the first region in China to collect e-commerce statistics. This study attempts to reveal how e-commerce affects the urban–rural income gap in Zhejiang, China using the panel data of 11 prefecture-level cities in Zhejiang Province from 2011 to 2018. We find that the development of e-commerce can play a significant role in first enlarging and then narrowing urban–rural income gap. Although rural e-commerce in Zhejiang is developing fast, Zhejiang is still at the left side of the inverted-U curve. The Chinese government should take actions for promoting the popularization of rural e-commerce so as to advance the turning point. Although e-commerce has increased the urban–rural income gap, in the long run, e-commerce is an important way to bring digital dividends to the rural population. As above, this study provides a reference for promoting the application of e-commerce to solve the problem of urban–rural income distribution in developing countries. To accelerate the development of rural e-commerce, a variety of measures should be taken, for example, promoting the popularity of rural Internet, strengthening road construction, improving logistics system, cultivating rural e-commerce leaders, encouraging young people to return hometowns to start businesses, introducing e-commerce professionals, actively cooperating with e-commerce platform enterprises.

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