

Chasm or Bridge: The Impact of Digital Inclusive Finance on Farmers' Incomes

-- Evidence from China

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Abstract: The increase in the level of development of digital inclusive finance provides unlimited possibilities for the economic development of each country. By using panel data of 31 provinces in China from 2011-2020, a panel fixed effects model, mediating effects model and threshold regression model were constructed to conduct an empirical study and found that: digital inclusive finance can promote the growth of farmers' income by expanding the breadth of coverage and depth of use, with a more significant impact on the eastern and central regions of the mediating variable is the level of innovation and entrepreneurship. With the development of digital inclusive finance, there is a non-linear change in the coefficient of the impact of the level of digital inclusive finance development on the per capita disposable income of rural residents, which first decreases and then increases.

Keywords: Digital Inclusive, Finance Farmers' Income, Digital Economy, Economic Development.

1. Introduction

In 2005, the United Nations introduced the concept of "inclusive finance", which requires equality of opportunity and commercial sustainability to provide access to financial services at an affordable cost for micro and small enterprises, farmers, urban low-income people, poor people and special groups with financial needs, such as people with disabilities and the elderly. Since the reform and opening up, China has been committed to addressing the problems of poverty, urban and rural development, the wide gap between the rich and the poor, and the uneven distribution of income, and "inclusive finance" has provided an effective tool to reduce the "financial exclusion" of low-income groups. However, inclusive finance still has problems such as the need to build bank branches, large human and material costs, and a large information asymmetry with the demand side of financial services, making it difficult for the development of inclusive finance to reach rural and remote areas. With the development of digital and big data technologies, the combination of digital tools and inclusive finance offers the possibility of solving the above problems. Whether digital inclusive finance can increase farmers' income and its influence mechanism, and enhance the happiness of residents' life, is worth further in-depth research.

The paper is organized as follows. Section 2 provides a review of the existing literature. Section 3 conducts theoretical research and hypotheses. Section 4 provides a description of the variables and the current situation, Section 5 presents the empirical analysis and results, and Section 6 concludes with a summary of the findings.

2. Literature Review

The impact of digital inclusive finance on income is centered around the development of digital inclusive finance, which can increase income, and the existence of a "digital and information divide" that exacerbates the gap between rich and poor.

Zhang Xun et al. (2019)[1] found that with the third technological revolution based on the Internet, digital finance in China not only developed faster in the lagging regions, but also significantly increased household income, especially for rural low-income groups, suggesting that digital development can increase the accessibility and equity of social development for residents. Zuo Xiaofan et al. (2020)[2] found that Internet use had a significant income-increasing effect on low-income groups, and that educational human capital, social capital and non-farm employment were the mediating mechanisms for achieving income growth in the digital economy. Wen Ruisong (2020)[3] argues that the Internet can open up access to information for poor people, improve the ability of farmers to use information to get out of poverty and get rich, promote the development of special industries in poor areas, and stimulate the endogenous power of self-development in poor areas.

With the development of digital economy, due to the differences in the possession and use of new technologies in different regions, classes and industries, a "digital divide" will emerge, and information gap and the division between rich and poor will emerge, with poor regions becoming information islands, making it increasingly difficult to catch up with developed regions and increasing the sense of relative deprivation (Xie Jungui et al., 2003)[4]. The digital divide contributes to the further marginalization and impoverishment of developing countries (Tan, 2003)[5], and Li Jin (2006)[6] argues that the "digital divide" is a new kind of wealth gap in the information age, and the horse-trading effect caused by the digital divide will generate a series of social problems. Ai et al. (2022)[7] found that digitalization has a significant negative relationship with the incidence of rural poverty, and the mechanism of influence is that digital technology can affect poverty through the channels of promoting household income and weakening the income gap, but the digital divide caused by the unequal allocation of data resources may widen the urban-rural income gap.

3. Theoretical Mechanism and Hypothesis

Ragnar Nurske's vicious circle theory of poverty[8] argues that the lack of capital is the key factor that hinders the development of developing countries. Due to the low level of per capita income in developing countries, both the supply of funds for investment (savings) and the demand for products (consumption) are insufficient, which limits capital formation and keeps developing countries trapped in a vicious circle of low income for a long time. In contrast, digital inclusive finance offers the possibility of capital formation, and therefore, the first hypothesis of this paper is proposed

H1: Digital inclusive finance can promote the growth of rural residents' disposable income per capita.

Digital inclusive finance can provide mobile payment, transfer and savings, credit, finance, insurance and other functions remotely through digital technology, which can realize the flow of capital and other factors of production across the limits of time and space. Digital inclusive finance provides capital accumulation for the development of micro, small and medium-sized enterprises, which is conducive to promoting technological innovation and progress of industrial enterprises, creating more jobs for low-income groups and promoting the expansion of agricultural production activities and innovative development[9], and promoting local economic and income growth. Accordingly, the second hypothesis of this paper is proposed

H2: Digital inclusive finance raises rural residents' per capita disposable income by promoting innovation and entrepreneurship

Whether the income growth effect of digital inclusive finance has the nonlinear characteristics of the level of digital inclusive finance development is verified by constructing a panel threshold model after completing the above empirical study.

4. Variable Selection and Description of The Current Situation

4.1. Data Sources

There are two main sources of primary data: the data required for the explanatory variables and related control variables of the empirical model are mainly obtained from the China Statistical Yearbook; the data of digital financial inclusion are obtained from the Digital Financial Inclusion Index of Peking University[10], and the time period of the empirical study is selected as 2011-2020 according to the above-mentioned report, and the research subjects are 31 provinces (autonomous regions and municipalities directly under the central government, and the data of Hong Kong, Macao Special Administrative Region and Taiwan are not used in order to avoid the reliability of the empirical results due to missing data), with a total of 310 samples.

4.2. Variable Selection

The explanatory variable is the per capita disposable income of rural residents, and the core explanatory variable is

the composite index (*Indfiic*) in the Digital Inclusive Finance Index of Beihang University. The panel fixed effects also incorporate the breadth of coverage (*lncover*), depth of use (*lndepth*) and digitization degree index (*Indigital*) of the Digital Inclusive Finance Index as explanatory variables. The control variables were selected as the level of economic development, industrial structure development, level of digital infrastructure, level of consumption, level of infrastructure and education. The level of economic development (*x1*) is measured by the gross regional product, and the sustained economic growth can effectively increase the income of residents (Zhang et al., 2021)[11]; the level of industrial structure (*x2*) is measured using the value added of the primary industry as a proportion of the annoyance of the gross regional product, rural residents mainly obtain income through agricultural production and business activities, and the higher the output value of the primary industry, the higher the possibility of rural residents to obtain income growth. The level of digital infrastructure (*x3*) is measured using Internet penetration, and Internet and big data technologies can not only identify and dynamically monitor users easily and quickly, but also promote the development of new industries such as e-commerce, cultivate the "blood generating" function of farmers with industrial development (Ruisong Wen, 2022)[12], and help alleviate the income gap. Consumption (*x4*) reflects the level of purchasing power of the region, generally speaking, the higher the consumption, the higher the income and standard of living of the region; The level of infrastructure development (*x5*) is measured by the number of road miles. "To get rich, first build roads", the improvement of transportation infrastructure level can reduce the transportation cost and time cost of human capital mobility, and promote factor mobility to areas with higher income (Li Dongkun et al., 2021)[13]. Education status (*x6*) is measured using years of education, and higher human capital represents a greater likelihood of higher income. To reduce errors associated with the definition of indicators and to ensure data stability, some of the indicators are logarithmically treated.

4.3. Analysis of the Current Situation

Figure 1 depicts the per capita disposable income of rural residents and the level of digital inclusive finance in each province of China in 2020, from which it can be seen that there is a strong correlation between the digital inclusive finance index and the level of per capita disposable income of rural residents in each region, and most regions with a high digital inclusive finance index also have a higher level of per capita disposable income of rural residents, and regions with a low digital inclusive finance index also have a lower level of per capita disposable income of rural residents. For example, Shanghai's digital financial inclusion index is 432, which is in the first place in China, and Shanghai's per capita disposable income of rural residents is also the highest in China, at 34,911 yuan; while Gansu's digital financial inclusion index and the level of per capita disposable income of rural residents are also in the last place in China.

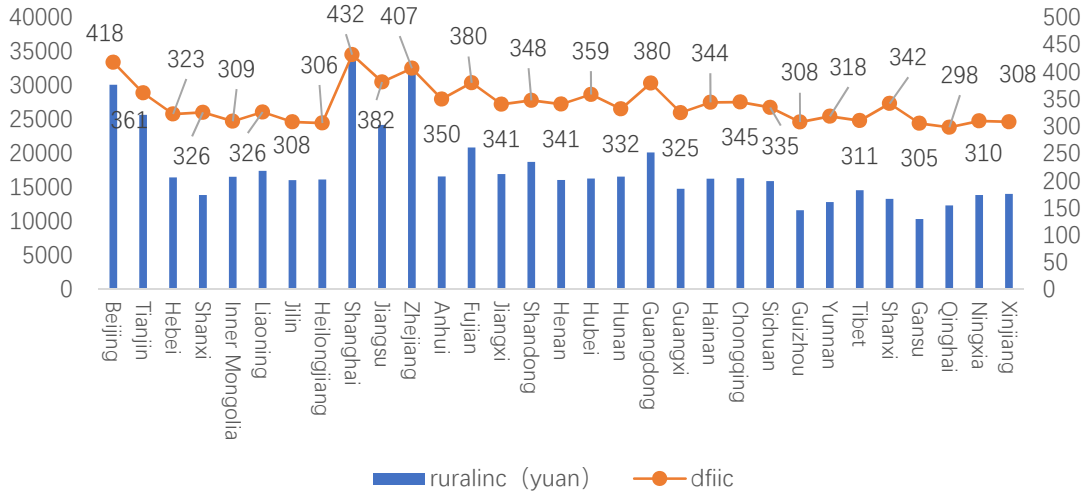


Figure 1. Digital inclusive finance index and per capita disposable income of rural residents by region in China in 2020

Table 1 shows the descriptive statistics of the main variables. The explained variable is the logarithm of the per capita disposable income of rural residents, with the mean value of 9.349, the minimum value of 8.271 and the maximum value of 10.46. The core explanatory variable is the logarithm of the digital inclusive finance index, with the mean value of 5.212, the minimum value of 2.786 and the maximum value of 6.068. The development level of digital

inclusive finance in different regions has There is a certain gap in the development level of digital inclusive finance in different places. The minimum value of Internet penetration is 18.6%, the maximum value is 96%, and there is a large gap. Internet penetration is the basic condition for the development of digital inclusive finance, which also shows that there is a large gap between the development levels of digital inclusive finance in different places.

Table 1. Descriptive statistics of the main variables

VARIABLES	N	mean	sd	min	max
lnruralinc	310	9.349	0.414	8.271	10.46
lndfiic	310	5.212	0.677	2.786	6.068
lncover	310	5.060	0.844	0.673	5.984
lndepth	310	5.195	0.651	1.911	6.192
Indigital	310	5.510	0.698	2.026	6.136
x1	310	9.742	0.983	6.407	11.62
x2	310	9.652	5.063	0.243	26.10
x3	310	52.40	13.71	18.60	96
x4	310	9.291	2.300	5.600	19.06
x5	310	11.67	0.836	9.400	12.74
x6	310	9.169	1.082	4.666	12.88

5. Empirical Tests and Analysis

5.1. Model Construction

For hypothesis 1, a panel fixed effects model is set as in equation 1, $lnruralinc_{it}$ is the dependent variable, X_{it} is the explanatory variable, including the digital financial inclusion index ($lndfiic_{it}$) and the lower three dimensional indicators ($lncover$, $lndepth$, $Indigital$), α_1 is the effect of the explanatory variable on the dependent variable coefficient, x_{it} denotes the control variable, β is the coefficient of the effect of the control variable on the dependent variable, i represents the region, t represents the year, u_i and u_t represent the sample individual fixed effects and time fixed effects, respectively, and ε_{it} denotes the random error term.

$$lnruralinc_{it} = \alpha_0 + \alpha_1 X_{it} + \beta x_{it} + u_i + u_t + \varepsilon_{it} \quad (1)$$

For hypothesis 2, digital inclusive financial development increases rural residents' income by promoting technological progress and innovation, a panel mediation effect model can

be set up as in Eqs. 2, 3, and 4. The conditions for hypothesis 2 to hold are: γ_1 , δ_1 , and ϵ_2 are significant, and the significance or otherwise of ϵ_1 determines the extent of the mediation effect. ϵ_1 is significant, there is partial mediation, and vice versa, there is full mediation.

$$lnruralinc_{it} = \gamma_0 + \gamma_1 ln dfiic_{it} + \beta x_{it} + u_i + u_t + \varepsilon_{it} \quad (2)$$

$$innovation_{it} = \delta_0 + \delta_1 ln dfiic_{it} + \beta x_{it} + u_i + u_t + \varepsilon_{it} \quad (3)$$

$$lnruralinc_{it} = \epsilon_0 + \epsilon_1 ln dfiic_{it} + \epsilon_2 innovation_{it} + \beta x_{it} + u_i + u_t + \varepsilon_{it} \quad (4)$$

The panel threshold regression model is set up as in equation 5, the threshold variable is the digital financial inclusion development index, τ_n is the threshold value, I is the indicative function, and the condition in parentheses is

taken as 1 when it is satisfied, otherwise it is taken as 0.

$$\ln ruralinc_{it} = \vartheta_3 + \vartheta_{21} \ln dfiic_{it} \cdot I(df iic \leq \tau_1) + \vartheta_{22} \ln dfiic_{it} \cdot I(\tau_1 < df iic \leq \tau_2) + \dots \vartheta_{2n+1} \ln dfiic_{it} \cdot I(\tau_n \leq df iic) + \beta x_{it} + u_i + u_t + \varepsilon_{it} \quad (5)$$

5.2. Empirical Test

After confirming the variables, it is necessary to choose whether to use the mixed regression model, fixed effect model or random effect model by LM test and Hausman test respectively. The p-values of LM test and Hausman test are significant, and it is considered that the random effect model is better than the mixed regression model and the fixed effect model is better than the random effect model, so this paper mainly reports the regression results of fixed effect model for analysis, Table 2 The results of mixed regression model, fixed effect model and random effect model are also reported.

5.3. Analysis of Empirical Results

As shown in Table 2, Models 1-2, 3-4, and 5-6 show the regression results of the mixed regression model, fixed-effects model, and random-effects model without and with control variables, respectively, and the results of each

regression show that the development of digital inclusive finance can significantly contribute to the improvement of rural residents' income. After adding the control variables, the coefficients all decrease slightly, but are still positive and significant. The results of model 4 show that the regression coefficient of digital inclusive financial development on rural residents' income is 0.127, which passes the 1% significance check, which indicates that, on the whole, a 1 percentage point increase in digital inclusive finance can promote rural residents' income growth by 12.7%; each unit increase in the level of economic development can raise rural residents' income by 0.139 units, and each unit increase in road mileage can promote The improvement of transportation infrastructure is conducive to opening up the "last mile", and rural residents can sell more agricultural products to big cities or other regions in the same region through the development of transportation and logistics, which is conducive to expanding the sales routes of agricultural products and avoiding the emergence of "supply exceeds demand" and "demand" in the local market. This is conducive to the expansion of agricultural products' marketing channels and the avoidance of the phenomena of "supply exceeding demand" and "low price hurting farmers" in the local market.

Table 2. Full-sample regression results

VARIABLES	(1) pols1	(2) pols2	(3) fe1	(4) fe2	(5) re1	(6) re2
ln dfiic	0.463*** (19.32)	0.256*** (13.53)	0.162*** (6.05)	0.127*** (4.45)	0.180*** (6.70)	0.147*** (4.76)
x1		0.231*** (12.04)		0.139*** (4.77)		0.147*** (5.25)
x2		0.003 (1.09)		0.001 (0.54)		-0.002 (-0.66)
x3		0.009*** (9.61)		0.000 (0.94)		0.001*** (2.90)
x4		-0.010*** (-2.96)		0.003** (2.15)		0.001 (0.37)
x5		-0.218*** (-11.31)		0.107** (2.55)		-0.100*** (-2.78)
x6		-0.037** (-2.45)		0.013 (0.92)		0.032*** (3.06)
Constant	6.937*** (55.16)	8.227*** (33.83)	8.273*** (87.47)	5.691*** (11.51)	8.207*** (78.59)	7.793*** (19.69)
R-squared	0.571	0.895	0.989	0.993		

Robust t-statistics in parentheses

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

The digital inclusive finance index is a combination of coverage breadth, usage depth and digitization level. The income growth effect of digital inclusive finance on rural residents can be further tested for the effects of coverage breadth (model 7), usage depth (model 8) and digitization level (model 9) on the income of rural residents. As shown in Table 3, the effect of breadth of coverage on rural residents' income is significantly positive, which indicates that using mobile communication devices and Internet technology development to improve rural residents' access to digital inclusive finance and digital inclusive finance account coverage can significantly increase farmers' income; the effect of depth of use on rural residents' income is

significantly positive, which indicates that rural residents' use of digital inclusive finance does not only stop at mobile The digitalization level has a significant suppressive effect on rural residents' income, which may be due to the fact that the digitalization level indicator consists of indicators such as the percentage of mobile payment amount, the average loan interest rate, the use of Flower and Sesame credit and the convenience of QR code payment, etc. Spending first and repaying later This would create the illusion of a short-lived consumption boom, which is not conducive to the increase of savings and the improvement of rural residents' ability to resist risks.

Table 3. Regression results of the sample by dimension and region

VARIABLES	(7) Incover	(8) Indepth	(9) Indigital	(10) Non-western	(11) Western
Incover	0.048*** (4.56)				
Indepth		0.062*** (3.46)			
Indigital			-0.051*** (-3.14)		
Indfiic				0.108** (2.13)	-0.048 (-0.78)
Control variable	Yes	Yes	Yes	Yes	Yes
Constant	6.009*** (12.07)	5.737*** (10.18)	6.095*** (10.24)	6.873*** (8.95)	8.269*** (9.00)
R-squared	0.992	0.992	0.991	0.991	0.996

Robust t-statistics in parentheses

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

China's development has always been characterized by regional imbalances, mainly including uneven economic development and large differences in natural endowments. For example, the eastern region with a high level of economic development contributes half of the country's GDP, while the western region with a low level of economic development only accounts for about 30% of the country's regional GDP. The central and eastern regions have vast plains, mild climate and fertile land, which are suitable for developing agricultural cultivation, and the topography is suitable for laying transportation infrastructure, well-developed transportation and communication; the western regions have more mountains, plateaus and basins, and soil erosion and land desertification are more serious, so this paper conducts heterogeneity analysis according to non-western and western regions to test whether the impact of digital inclusive finance on rural residents' income has regional Heterogeneity, the results are shown in models 10 and 11 in Table 3: only in the eastern and central regions, digital inclusive finance can significantly promote the income growth of rural residents with a coefficient of 0.108, which passes the 5% significance test; in the western region, digital inclusive finance instead reduces the income level of rural residents, but the effect is not significant.

To ensure the accuracy and reliability of the model, we

chose to add the control variable social security level (x_7) (measured by the number of beds in health care institutions) and change the time interval (the concept of digital inclusive finance was introduced in 2016, so the impact of digital inclusive finance on rural residents' income may be smaller in 2011-2015, so 2011-2015 was chosen as the time interval) for Robustness test, the results are shown in models 12 and 13 in Table 4, after adding the control variable x_7 , the effect of x_7 on the explanatory variables is positively significant, and the coefficients and significance of the core explanatory variables do not change fundamentally, indicating that the model has stability; regression with the sample of 2011-2015, the coefficients are significant at the 1% level and slightly smaller than the regression of the sample of 2011-2020. The coefficients of the core explanatory variables indicate that the above model results are reliable.

Referring to the study of (Sun Qian et al., 2021)[14], one item of digital inclusive finance lag was selected as the instrumental variable and tested for endogeneity, and the test results are shown in Table 4, Model 14, where the instrumental variable passed the correlation test and the coefficient of digital inclusive finance development index was still significant at the 1% level, indicating the stability of the benchmark regression results.

Table 4. Robustness and endogeneity tests

VARIABLES	(12) Add x	(13) Change time	(14) Endogenous
Indfiic	0.132*** (4.87)	0.117*** (4.54)	0.303*** (8.30)
Control variable	Yes	Yes	Yes
x_7	0.128*** (3.41)		
Constant	5.718*** (10.36)	4.772*** (3.22)	6.129*** (17.31)
R-squared	0.993	0.986	0.997

Robust t-statistics in parentheses

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

From the previous theoretical analysis, it can be seen that the effect of digital inclusive finance on the income growth of rural residents may be achieved by increasing technological innovation and progress, for this reason, the intermediary effect model is constructed by stepwise test to test this theoretical mechanism, and the regression results are shown

in Table 6. models 15-17 are the intermediary effects in rural areas, model 15 is the effect of digital inclusive finance as an independent variable on the income of rural residents, with a significant coefficient of 0.259; Model 16 is the effect of digital inclusive finance as the independent variable on innovation (measured by the logarithm of domestic patent

applications granted) with a significant coefficient of 0.172, indicating that digital inclusive finance can promote the growth of rural residents' income; the regression results from Model 17 show that the direct effect of digital inclusive

finance on rural residents' income is significant with a coefficient of 0.250, and the effect of innovation on rural residents' income. The coefficient is 0.035, and there is a partial mediating effect, and the mediating effect is positive.

Table 5. Stepwise regression results of the mediating effect

VARIABLES	(15) X-Y	(16) X-M	(17) X-M-Y
innovation			0.035** (2.07)
Lndfiic	0.256*** (15.51)	0.172*** (3.04)	0.250*** (15.01)
Control variable	Yes	Yes	Yes
Constant	8.227*** (40.95)	-3.072*** (-4.46)	8.334*** (40.39)
R-squared	0.895	0.920	0.897

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6 shows the results of the threshold regression for the national sample, which passed the double-threshold significance test of the digital inclusive finance index, but failed the three-threshold test, with the first threshold value of 45.56 and the second threshold value of 282.2235. When the digital inclusive finance development index is less than or equal to 45.56, that is, at the early stage of digital inclusive finance development, the initial policy preference of digital inclusive finance is strong, and its impact The coefficient of disposable income of rural residents is 0.315, which passes the 1% significance test; in the middle of the development of digital inclusive finance, there is a lack of sustainable development momentum, and digital inclusive finance has

problems such as unclear regulatory system and mixed financial institutions, and its ability to influence the growth of disposable income of rural residents decreases, and the influence coefficient is 0.271 in this range; when the digital inclusive finance index exceeds 282.2235, the development of digital inclusive finance enters a higher level of development, and with the continuous improvement of policies, the supply side of financial services, the demand side and the Internet companies providing digital technology form a good interactive and synergistic ecosystem, and the effect of digital inclusive finance on the income growth of rural residents improves, with the impact coefficient increasing to 0.283.

Table 6. Threshold effect regression results

VARIABLES	(18)
Lndfiic (dfiic≤45.56)	0.315*** (16.64)
Lndfiic (45.56<dfiic≤282.2235)	0.271*** (19.56)
Lndfiic (dfiic>282.2235)	0.283*** (21.21)
Control variable	Yes
Constant	3.144*** (4.40)
R-squared	0.975

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6. Conclusion and Policy Recommendations

Digital inclusive financial development plays an important role in promoting China's rural economic development and income growth, and provides an effective reference for countries around the world to mitigate the urban-rural development gap and poverty governance. This paper quantitatively investigates the impact and mechanism of digital inclusive finance development on rural residents' disposable income through panel fixed effects, mediating effects and threshold regression. The empirical results show that: first, digital inclusive finance can effectively promote the growth of per capita disposable income of rural residents in China, and the impact is more significant in the eastern and

central regions when examined by regions. Second, the development of digital inclusive finance mainly increases the income of rural residents by expanding its coverage breadth and deepening its usage depth. Third, digital inclusive finance achieves farmers' income growth mainly through the mediating effect of promoting innovation and entrepreneurship. Fourth, with the development stage and level of digital inclusive finance, there is a non-linear change of digital inclusive finance on the per capita disposable income of rural residents that first decreases and then increases. Improving the policies and regulatory system related to digital inclusive finance and establishing a path mechanism for digital inclusive finance to achieve income increase for low-income groups are conducive to reducing the urban-rural gap and improving residents' life satisfaction and living standards.

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