An Empirical Study on Digital Economy Development and Residents' Mental Health Based on CFPS Data

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Abstract. The development of the digital economy is reshaping how the society operates and profoundly impacting residents' mental health. This paper utilizes data from five waves (2012, 2016, 2018, 2020, and 2022) of the China Family Panel Studies (CFPS) and applies a two-way fixed-effects model for analysis. The results show that: (1) Digital economy development has a direct and positive impact on the mental health of Chinese residents. (2) The digital economy indirectly improves mental health levels by mitigating income inequality and increasing individual absolute income. (3) The impact pathway of the digital economy on residents' mental health exhibits group differences based on gender, age, and employment status. Based on these findings, we should deepen the construction and universalization of digital infrastructure, build a multi-level digital skills training system, implement precise policy interventions, and improve supporting systems for the digital economy.

Keywords: Digital economy; Mental health; CFPS; Income opportunity inequality.

1. Introduction

The global economy and the way society operates are updating with the development of digital economy. As a new economic form driven by digital technology, the digital economy, through optimized resource allocation, improved production efficiency, and the creation of new industries, has become an important engine for economic growth[1][30] (Zhao et al., 2020; Guo & Xiao, 2025). This transformation, while releasing the digital dividend, simultaneously reshapes social structures and alters resource allocation methods. Its combined effects have a complex impact on residents' mental health. On the one hand, the inclusive nature of the digital economy, by creating jobs, expanding income channels, and optimizing public services, may increase individual absolute income and alleviate opportunity inequality[9][11] (Wan et al., 2024; Zhang et al., 2024), thereby improving mental health levels. The prevalence of digital infrastructure resulting from digital economy development can strengthen individual family and social networks, enhancing social capital and positively influencing mental health [10][22](Chen & Zhu, 2022; Sun et al., 2024). On the other hand, the digital economy has restructured social and work patterns, impacting people's mental health. For example, the prevalence of remote work leads to social isolation, algorithmic recommendations cause information overload, and technological substitution creates job insecurity[7][25] (Zhang et al., 2021; Wang et al., 2024). The digital divide exacerbates inequalities, increasing psychological pressure on vulnerable groups such as the elderly and youth, leading to increased mental health risks[14][18] (Liu & Su, 2022; Jia & Liu, 2023).

Existing research largely focuses on the direct impact of the digital economy on production efficiency and income distribution, with less attention paid to its socio-psychological effects. While a small number of studies have explored the relationship between the digital economy and mental health, conclusions have not reached a consensus due to different data sources and theoretical perspectives. The mechanism by which the digital economy influences mental health through income remains unclear. Mental health is an important foundation for individual well-being and social harmony. It not only affects individual quality of life and social function but is also closely related to social stability. The "Healthy China 2030" planning outline explicitly states the need to promote people's mental health and improve the mental health service system. Therefore, exploring how digital economy development affects residents' mental health has significant practical and policy

implications. Based on this, this paper aims to systematically answer the following questions: Does the development of the digital economy, and through what mechanisms, affect residents' mental health? Are there significant differences in this mechanism's effect among different groups?

To verify the above questions, this paper uses multi-period data from the China Family Panel Studies (CFPS) and digital economy patent indicators at the prefecture-level city level. First, a two-way fixed-effects model is constructed, utilizing the shift-share instrumental variables method to mitigate endogeneity bias. Second, the paper examines the mediating roles of income opportunity inequality and individual absolute income in the digital economy's impact on mental health. Finally, the paper explores the differences in the impact pathway of the digital economy on mental health across different groups. The research finds that: (1) Digital economy development has a direct positive impact on mental health. (2) The digital economy can indirectly improve mental health levels by mitigating income opportunity inequality and increasing individual absolute income. (3) The impact pathway of the digital economy on residents' mental health differs significantly across groups based on gender, age, and employment status. The marginal contributions of this paper are as follows: First, in terms of research topic, existing literature focuses on the economic effects of the digital economy on production efficiency and income distribution, while systematic research on its impact on mental health is limited. This paper uses multi-period tracking data to empirically test the causal relationship between the digital economy and residents' mental health, filling the research gap in the assessment of the social costs and benefits of technological change. Second, from a research perspective, this paper takes income opportunity inequality and individual absolute income as mediating variables to reveal the pathway by which the digital economy improves mental health by alleviating structural opportunity barriers and enhancing individual economic capacity. Third, in terms of indicator construction, this paper integrates multi-period CFPS tracking data, using the internationally recognized Center for Epidemiological Studies Depression Scale (CES-D) to measure mental health and adopting a parametric method to construct an income opportunity inequality indicator at the prefecture-level city level.

2. Theoretical Framework and Research Hypothesis

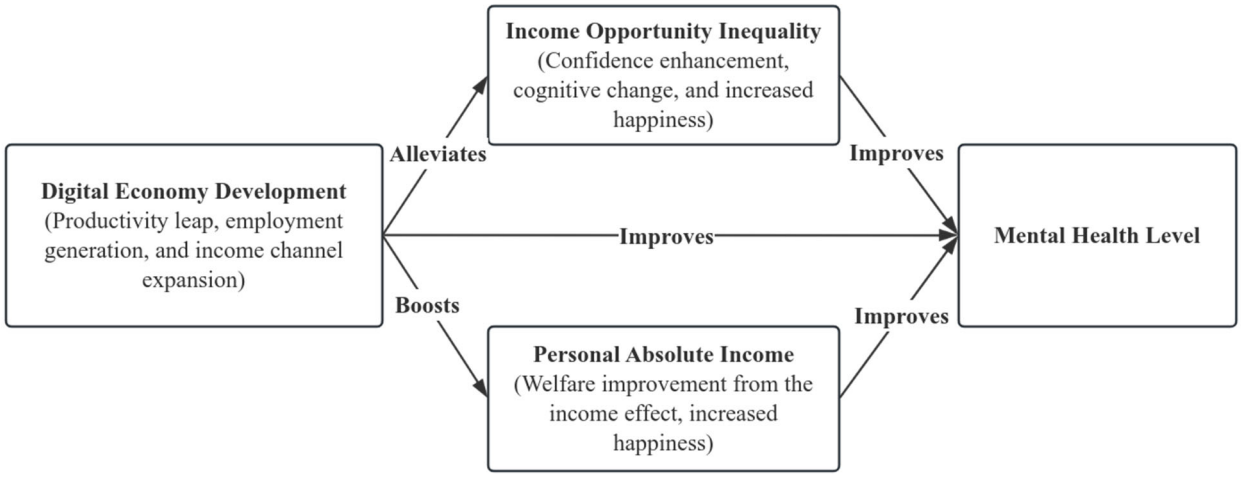

Figure 1. Pathways of the Impact of Digital Economy Development on Mental Health Level

The digital economy, which utilizes digital knowledge and information as key production factors, significantly impacts productivity, job creation, and the improvement of residents' absolute income levels[11][27] (Li et al., 2021; Wan et al., 2024), reducing income opportunity inequality[9] (Zhang et al., 2024). Meanwhile, it promotes the popularization of the internet and digital devices, bridging the digital divide and subsequently improving residents' mental health[36] (Xu et al., 2013). Increased income improves mental health[50] (Thomson et al., 2022), with empirical evidence showing that high-income groups have better mental health than low-income groups[31] (Wang et al., 2019). The

alleviation of income opportunity inequality also significantly improves residents' mental health[4] (Li et al., 2025). Based on the relevant literature, this paper constructs a theoretical framework to study the impact pathway of digital economy development on mental health, as shown in Figure 1.

2.1. The Impact of the Digital Economy on Mental Health

The digital economy, by optimizing the allocation of production factors and innovating social interaction models, has a multi-layered positive impact on individual mental health. In terms of income, digital technology enhances labor participation elasticity and skill premiums[5] (Xu et al., 2024), and the platform economy fosters diverse employment forms[2] (Wang & Xi, 2025), significantly expanding income channels. Income growth, through a lower marginal propensity to consume, reduces the perceived economic pressure and effectively alleviates anxiety. In terms of public services, the prevalence of digital infrastructure overcomes the geographical constraints of medical resources. Online consultation platforms improve the accessibility of primary mental health services, and digital education, through the dissemination of MOOC resources, breaks down intergenerational barriers in human capital transmission. Improved equality of opportunity reduces feelings of relative deprivation[8] (Li et al., 2024). At the level of social support, mobile social networks expand weak ties, and social media use enhances subjective well-being through emotional resonance and information sharing[22][10] (Chen & Zhu, 2022; Sun et al., 2024). Elderly people use digital tools to maintain intergenerational interaction, significantly reducing the risk of social isolation. Technological innovation further strengthens the psychological benefit effect; AI emotion recognition systems improve the accuracy of mental health screening, and smart wearable devices build health warning mechanisms through real-time monitoring of physiological data. The synergistic effect of these pathways essentially involves the digital economy promoting a systematic improvement in mental health levels through factor reorganization, service universalization, and network reconstruction.

2.2. The Impact of Income Opportunity Inequality on Mental Health

Research on the relationship between income opportunity inequality and mental health is still in its exploratory phase. Early literature mainly focused on individuals' subjective perceptions of economic opportunities, measuring income opportunity inequality from a subjective perspective. Some scholars have found that the more positive an individual's subjective judgment of the possibility of economic mobility, the lower their risk of depressive tendencies[51] (Vega et al., 1987). An empirical study of Mexican Americans found a significant positive correlation between this group's subjective perception of opportunity availability and their mental health status[43] (Franzini & Fernandez-Esquer, 2004). However, perceived income opportunity inequality does not reflect actual income opportunity inequality; therefore, subsequent literature mainly starts from objective income opportunity inequality to study its relationship with mental health. Some scholars have empirically found that income opportunity inequality can negatively impact mental health by weakening confidence in the future and altering perceptions of inequality[4] (Li et al., 2025). Some scholars focus on specific groups, finding that the opportunity inequality effect of urbanization harms the health of the agricultural transfer population[32] (Ding et al., 2018). Most scholars focus on the impact of income opportunity inequality on happiness, finding that it weakens happiness[28][34][35] (Shi et al., 2006; He et al., 2011; Wan et al., 2021). Individual happiness is closely related to mental health, which to some extent corroborates the relationship between income opportunity inequality and mental health.

2.3. The Impact of Individual Absolute Income on Mental Health

Traditional economic theory suggests that an increase in income level raises the consumer's budget constraint to a higher level, tangent to a higher indifference curve, leading to higher utility. This means that an increase in income can bring individuals better welfare and higher happiness levels, thus improving mental health. Easterlin proposed the "Easterlin paradox" in 1974[42], arguing that income growth does not equate to increased happiness. However, the applicability of this conclusion

in different countries is prompting academic reflection. Chinese scholars have found through rural and urban household surveys that absolute income always has a significant positive effect on subjective well-being[33] (Luo, 2017). Some scholars have found, based on data from the Chinese Economic Life Survey, that the "income-happiness puzzle" in China cannot be definitively confirmed[19] (Xia, 2022). Other scholars, based on data from the China Family Panel Studies, have found that increased income improves mental health[29] (Chen et al., 2021). Numerous empirical studies have also shown that absolute income can improve subjective well-being and enhance mental health[21][45][49] (Stevenson & Wolfers, 2013; Jebb et al., 2018; Li et al., 2022).

In summary, the development of the digital economy, a new economic form, not only has a direct positive impact on mental health but also improves residents' mental health by reducing income opportunity inequality and increasing individual absolute income. To verify the above analysis, three hypotheses are proposed for testing.

Hypothesis 1: Digital economy development has a positive impact on residents' mental health.

Hypothesis 2: The digital economy improves residents' mental health by mitigating income opportunity inequality.

Hypothesis 3: The digital economy improves residents' mental health by increasing individual absolute income.

3. Econometric Model, Methods, and Data Description

3.1. Econometric Model

Because many unobservable and time-invariant individual characteristics, such as personality and genes, influence mental health, and because this paper uses multi-period CFPS data spanning a considerable time period, a two-way fixed-effects model is employed to eliminate systematic cross-period influences, such as macroeconomic fluctuations and policy changes. The econometric model is designed as follows:

$$\text{MentalHealth} = \beta 0 + \beta 1 \text{DigitalEconomy} + X + \alpha i + \lambda t + \varepsilon i,t \quad (1)$$

In Model (1), MentalHealth is the dependent variable representing mental health level; DigitalEconomy is the explanatory variable representing the level of digital economy development; X represents control variables, including individual and household characteristics, as well as socio-economic characteristics at the prefecture-level city; αi and λt are individual and time fixed effects, respectively; and $\varepsilon i,t$ is the error term

To avoid endogeneity problems caused by omitted variables and reverse causality, this paper uses instrumental variables (IV). Following Zheng[3] (2025), the interaction term of terrain ruggedness and the previous year's national internet user numbers is used as an instrumental variable. The specific instrumental variable model is as follows:

$$\text{Digital Economy} = \gamma 0 + \gamma 1 \text{Instrument} + Z + \alpha i + \lambda t + ui,t \quad (2)$$

$$\text{Mental Health} = \delta 0 + \delta 1 \text{DigitalEconomy}\hat{} + X + \alpha i + \lambda t + vi,t \quad (3)$$

Model (2) is the first-stage regression model of the instrumental variable, and Model (3) is the second-stage regression model. In Models (2) and (3), Instrument represents the instrumental variable; Z represents control variables; αi and λt are individual and time fixed effects, respectively; and ui,t and vi,t are the random error terms.

3.2. Data and Variable Description

3.2.1. Data Source

The dependent variable, individual and household-level control variables, and mediating variables used in this paper are all from the China Family Panel Studies (CFPS). Since the 2010 and 2014 waves lack the core dependent variable CESD-8, data from five waves (2012, 2016, 2018, 2020, and 2022) are used. After matching individual and household data, samples with serious missing values or obvious outliers are removed. Prefecture-level city control variables are from *the China City Statistical Yearbook* and prefecture-level city statistical yearbooks. The explanatory variable, the level of digital economy development, comes from the Digital Economy Research Database (DERD) of the China Research Data Service Platform. After matching the CFPS individual data with prefecture-level city control variables and the level of digital economy development, the final sample is obtained, encompassing 127 prefecture-level cities.

3.2.2. Variable Description

The core explanatory variable is the level of digital economy development. Following Sun et al.[20] (2022), the number of utility model patents authorized for the digital economy is used to represent the level of digital economy development; a higher number of authorized patents indicates a higher level of digital economy development. First, referring to the Cross-reference Table of International Patent Classification and National Economic Industry Classification (2018), the industry to which each patent belongs is determined based on the patent classification number. Next, further matching is done based on the Statistical Classification of Digital Economy and its Core Industries released by the National Bureau of Statistics in 2021, finally obtaining the data on the number of utility model patents authorized for the digital economy at the prefecture-level city level.

The dependent variable is residents' mental health level, measured using a modified version of the Center for Epidemiological Studies Depression Scale (CES-D), adapted from Radloff's work[47]. It consists of eight questions, including: "I feel depressed", "I feel that doing anything is very difficult", "I sleep poorly", "I feel happy", "I feel lonely", "I enjoy my life", "I feel sad and unhappy", and "I feel that life cannot go on". Respondents rate the frequency of various feelings or behaviors over the past week, with four options: 1 (almost never, less than one day), 2 (sometimes, 1-2 days), 3 (often, 3-4 days), and 4 (most of the time, 5-7 days). Two questions are positively worded, so the scores are reversed during processing. Finally, the scores of the eight questions are summed to obtain the CESD-8 depression score. A higher score indicates a more severe level of depression and a lower level of mental health.

Following Zheng[3] (2025), the interaction term of terrain ruggedness and the previous year's national internet user numbers is used as the instrumental variable. The theoretical basis for choosing this as an instrumental variable is twofold. First, geographical slope variations significantly influence the level of regional digital infrastructure. The more rugged the geological structure and the more significant the elevation difference, the greater the difficulty in laying digital infrastructure. Second, as an exogenous variable representing natural geographical features, this indicator has no direct relationship with the mental health status of regional residents. By constructing time and space interaction terms, it effectively eliminates endogeneity bias and overcomes the inherent defect of insufficient time-dimension variation of the terrain ruggedness variable in panel data models, thus ensuring the robustness of the estimation results.

Following Sun et al.[10] (2024) and Li et al.[4] (2025), this paper controls for individual, household, and prefecture-level city characteristics. Individual characteristics include age, education level, marital status, organizational membership, self-rated health status, subjective social status, and social trust level; household characteristics include total annual household income and household size; and prefecture-level city characteristics include per capita GDP and the number of registered unemployed urban residents at the end of the year. The definitions of each variable are shown in Table 1.

Table 1. Variable Definitions

Variable Type	Variable Name	Variable Definition
Dependent Variable	Mental Health Level	Sum of eight CESD-8 depression indicators
Explanatory Variable	Digital Economy Level	Logarithm of the number of utility model patents authorized for the digital economy
Control Variables	Age	Calculated based on year of birth
	Education Background	1=Illiterate/Semi-literate, 2=Primary, 3=Junior High, 4=High School/Vocational, 5=Associate's Degree, 6=Bachelor's Degree, 7=Master's Degree, 8=Doctorate
	Marriage Status	1=Married, 0=Other
	Organization Membership	Membership in the Communist Party, Youth League, or Trade Union (1=Yes, 0=No)
	Self-Rated Health	1=Very Healthy, 2=Healthy, 3=Fairly Healthy, 4=Average, 5=Unhealthy
	Subjective Social Status	Self-reported social status (1=Very Low, 5=Very High)
	Social Trust Level	Scale of social trust (1=Least Trusting, 5=Most Trusting)
	Household Size	Number of people in the household
	Household Annual Income	Logarithm of total annual household income (in Yuan)
	Per Capita GDP	Logarithm of per capita GDP (in Yuan)
	Urban Registered Unemployment	Logarithm of the number of registered urban unemployed at year-end (in persons)

4. Empirical Analysis and Results

4.1. Baseline Regression Results

This study uses model (1) and a two-way fixed-effects estimation method to examine the impact of the digital economy on residents' mental health. Table 2 presents the results. Columns (1) to (3) sequentially show the regression results controlling for individual effects, time effects, and both individual and time effects. In all regression results, the coefficient for the digital economy development level variable is negative. After controlling for individual and time effects, the digital economy development level is significantly negative at the 5% level. Since the mental health level is the sum of depression indicators, a higher score indicates poorer mental health. Therefore, digital economy development significantly improves residents' mental health, confirming Hypothesis 1.

4.2. Endogeneity Test

A potential issue is reverse causality between digital economy development and residents' mental health. Additionally, numerous factors influence mental health, leading to potential omitted variable bias. This study uses the interaction term of terrain ruggedness and the previous year's national internet users as an instrumental variable (IV). Models (2) and (3) are employed to address endogeneity using two-stage least squares (2SLS). The results are shown in Table 3. In the first-stage regression, the instrumental variable has a significant negative impact on the digital economy development level, indicating a high correlation between the two. The F-statistic is 179.434, far greater than 10, rejecting the null hypothesis of weak instruments. In the second-stage regression, the F-statistic is 509.875, rejecting the null hypothesis of instrument underidentification. The instrumental variable passes both weak instrument and underidentification tests, indicating its validity.

After controlling for endogeneity using the instrumental variable, the coefficient for the digital economy development level variable remains negative and still has a significant positive impact on mental health. This is consistent with the baseline regression results, suggesting the robustness of the findings and confirming Hypothesis 1.

Table 2. Baseline Regression Results

Variables	(1) Mental Health Status	(2) Mental Health Status	(3) Mental Health Status
Level of Digital Economy Development	-0.116 (0.063)	-0.105 (0.019)	-0.150 (0.064)
Age	0.133 (0.019)	-0.005 (0.002)	0.260 (0.129)
Education Level	0.127 (0.068)	-0.210 (0.018)	0.118 (0.067)
Marital Status	-0.359 (0.167)	-0.815 (0.053)	-0.349 (0.167)
Organizational Membership (or Group Membership)	0.025 (0.100)	-0.208 (0.053)	0.051 (0.100)
Self-Rated Health Status	0.535 (0.040)	1.025 (0.018)	0.528 (0.040)
Subjective Social Status	-0.237 (0.041)	-0.353 (0.020)	-0.257 (0.041)
Level of Social Trust	0.100 (0.021)	0.178 (0.010)	0.101 (0.021)
Household Size	-0.068 (0.048)	-0.188 (0.019)	-0.104 (0.049)
Annual Household Income	-0.055 (0.031)	0.023 (0.011)	-0.053 (0.031)
Per Capita Regional GDP (Gross Domestic Product)	-0.357 (0.228)	-0.483 (0.050)	-0.364 (0.228)
Number of Registered Unemployed in Urban Areas at Year-End	0.362 (0.134)	0.062 (0.031)	0.410 (0.135)
Individual Fixed Effects	Controlled	Uncontrolled	Controlled
Time Fixed Effects	Uncontrolled	Controlled	Controlled
Observations	11,410	31,716	11,410
R^2	0.684	0.173	0.685

Note: Standard errors are clustered at the village level (in parentheses). Denote significance at the 10%, 5%, and 1% levels, respectively. This applies throughout.

4.3. Robustness Checks

4.3.1. Changing the Dependent Variable

The China Family Panel Studies (CFPS) uses the CES-D scale to measure depression. This scale has various forms, including CESD-8 and CESD-20. CESD-20 comprises 20 questions. After converting the scores of positively worded questions, the total score from all 20 questions yields the CESD-20 score. Following Sun et al.[10] (2024), this study replaces the dependent variable, mental health level, with CESD-20 to address potential robustness issues stemming from the measurement of the indicator. As shown in Column 1 of Table 4, the digital economy development level still has a significant positive impact on mental health, indicating the robustness of the baseline regression results.

Table 3. Endogeneity Test Regression Results

Variables	(1) Level of Digital Economy Development	(2) Mental Health Status
Instrumental Variables	-0.071 (0.005)	
Level of Digital Economy Development		-5.207 (0.456)
Age	-0.006 (0.001)	-0.034 (0.004)
Education Level	0.035 (0.006)	-0.002 (0.041)
Marital Status	-0.016 (0.018)	-0.910 (0.111)
Organizational Membership (or Group Membership)	-0.024 (0.018)	-0.367 (0.114)
Self-Rated Health Status	0.003 (0.006)	1.010 (0.037)
Subjective Social Status	0.031 (0.007)	-0.180 (0.042)
Level of Social Trust	-0.010 (0.003)	0.126 (0.021)
Annual Household Income	0.159 (0.006)	0.760 (0.081)
Household Size	0.027 (0.004)	0.152 (0.027)
Per Capita Regional GDP (Gross Domestic Product)	1.590 (0.014)	8.092 (0.753)
Number of Registered Unemployed in Urban Areas at Year-End	0.824 (0.010)	4.309 (0.389)
Constant Term	-21.112 0.171	-99.069 10.292
Weak Instruments Test (F-statistic)	179.434	
Underidentification Test (F-statistic)		509.875
Observations	28,064	28,064
R^2	0.646	

4.3.2. Excluding Samples with Low Credibility

Since the CFPS data is based on subjective responses from interviewees, it is significantly influenced by personal subjective factors, and the credibility of the responses cannot be guaranteed. The CFPS dataset lacks a direct measure of response credibility. Therefore, following Li[6] (2024), this study conducts a robustness check based on the survey question, "The degree to which the respondent was eager to end the survey". Responses were assigned scores from 1 to 7, with 1 representing "not at all eager" and 7 representing "very eager". This study assumes that respondents who indicated eagerness had lower credibility. Respondents with scores of 5 or lower were considered to have higher credibility, while those with scores above 5 were considered to have lower credibility. After excluding data with lower credibility, a robustness check was performed. As shown in Column

2 of Table 4, even after removing unreliable data, the digital economy development level still has a significant positive impact, demonstrating the robustness of the baseline regression results.

Table 4. Robustness Check Regression Results

Variables	(1) Mental Health Status(CESD-20)	(2) Mental Health Status(CESD-8)
Level of Digital Economy Development	-0.288 (0.148)	-0.126 (0.067)
Age	-0.422 (0.531)	0.256 (0.140)
Education Level	0.021 (0.165)	0.110 (0.072)
Marital Status	-0.886 (0.396)	-0.434 (0.177)
Organizational Membership (or Group Membership)	0.085 (0.243)	0.015 (0.107)
Self-Rated Health Status	1.058 (0.101)	0.542 (0.043)
Subjective Social Status	-0.624 (0.104)	-0.256 (0.044)
Level of Social Trust	0.183 (0.052)	0.101 (0.022)
Annual Household Income	-0.078 (0.124)	-0.106 (0.053)
Household Size	-0.102 (0.080)	-0.034 (0.033)
Per Capita Regional GDP (Gross Domestic Product)	0.056 (0.529)	-0.288 (0.245)
Number of Registered Unemployed in Urban Areas at Year-End	1.127 (0.308)	0.365 (0.143)
Individual Fixed Effects	Controlled	Controlled
Time Fixed Effects	Controlled	Controlled
Observations	7,768	10,117
R^2	0.702	0.690

5. Further Analysis

5.1. Mechanism Analysis

5.1.1. Specifications of the Mechanism

The digital economy may improve residents' mental health through two mechanisms: increasing personal absolute income and reducing income inequality of opportunity. This paper, referencing Peng et al.[13] (2024), constructs the following model:

$$md_{it} = \alpha_0 + \alpha_1 digit_{it} + \alpha_2 X_{it} + \mu_i + v_t + \varepsilon_{it} \quad (4)$$

In Model (4), represent the mediating variables of personal absolute income and income inequality of opportunity, respectively; is the explanatory variable of digital economy development level; represents control variables; and represent individual fixed effects and time fixed effects, respectively;

and is the error term. This study uses annual personal work income from the CFPS to represent personal absolute income. Income inequality of opportunity at the prefecture-level is calculated using the parametric method. Based on Roemer's theoretical framework, the income determination equation is set as follows:

$$lnincome_i = \alpha C_i + \beta E_i + \quad \mu_i \tag{5}$$

where represents personal income; and are estimated parameters; and is the random error term. This study uses the mean log deviation (MLD) to calculate income inequality of opportunity (IOP), referencing Li et al.[4] (2025). Considering data availability, age, gender, hukou (household registration status), household size, father's education level, and mother's education level are selected as environmental variables. Finally, individual micro-data is matched with prefecture-level data to obtain the prefecture-level income inequality of opportunity indicator.

5.1.2. Regression Results

Based on the theoretical analysis, this paper uses Model (4) to further explore the effects of the digital economy on residents' mental health through increasing personal absolute income and reducing income inequality of opportunity. The regression results are shown in Table 5.

Column (1) of Table 5 shows that digital economy development significantly alleviates income inequality of opportunity. Specifically, the digital economy, through the improvement of digital inclusion and other digital technologies, increases the accessibility and depth of financial services for vulnerable and impoverished groups, alleviating their liquidity constraints and thus increasing the rate of human capital accumulation and opportunities for individuals to earn income through effort[16][53] (Demirguc-Kunt et al., 2008; Ye et al., 2023). The digital economy also improves enterprise productivity through improved digital infrastructure, thereby creating more jobs[23] (Sun & Guo, 2021). Improved digital infrastructure can also break down barriers to labor mobility and search constraints, optimizing labor resource allocation and increasing job opportunities[46] (Kuhn & Mansour, 2014). Increased job opportunities and employment can increase the opportunities for a larger portion of the workforce to earn income, alleviating income inequality of opportunity[30] (Zhao et al., 2020), and this alleviation improves mental health levels[4] (Li et al., 2025), thus verifying Hypothesis 2.

Column (2) of Table 5 shows that digital economy development significantly increases personal absolute income. The digital economy is a new economic form and a higher-level mode of production. While optimizing production relations and productivity, it also compels workers to improve their skills to meet market demands, thereby increasing their income[24] (Luo & Wang, 2021). The digital economy expands the boundaries and scope of economic development, creating opportunities and space for upward mobility for workers and broadening income channels[15][17] (Yuan et al., 2022; Liu, 2023). An increase in workers' absolute personal income has a significant positive impact on mental health levels[29] (Chen et al., 2021), thus verifying Hypothesis 3.

5.2. Heterogeneity Analysis

5.2.1. Analysis of Differences Across Genders

Columns (1) and (2) of Table 6 show that the digital economy has a significant positive impact on the mental health of men, but a weaker positive impact on the mental health of women. This is because men generally have higher labor force participation rates than women[39] (Blau, 2025) and are more likely to work in industries closely related to digital technologies[52] (Wu et al., 2024). The digital economy may significantly increase the absolute income of men by creating new job opportunities[44] (Goldin, 2014) and alleviate income inequality of opportunity by reducing skill premiums within industries[37] (Acemoglu & Restrepo, 2020). Furthermore, societal gender role expectations may strengthen the correlation between income and mental health for men, with income increases leading to more direct improvements in their mental well-being. The limited participation of women in the

digital economy may stem from structural factors: women are more concentrated in low-skill, informal employment[40] (Blau & Kahn, 2017), and these jobs are more susceptible to the substitution effects of the digital economy, resulting in limited income growth potential. Simultaneously, women's mental health is more easily affected by non-economic factors such as social support networks and the burden of family care[48] (Ross et al., 1989), leading to less pronounced effects of the income mechanism.

Table 5. Mechanism Analysis Regression Results

Variables	(1) Income Opportunity Inequality	(2) Individual Absolute Income
Level of Digital Economy Development	-0.010 (0.002)	0.055 (0.022)
Age	-0.007 (0.003)	0.185 (0.040)
Education Level	-0.002 (0.002)	0.376 (0.025)
Marital Status	-0.004 (0.004)	0.106 (0.055)
Organizational Membership (or Group Membership)	0.001 (0.002)	-0.010 (0.032)
Self-Rated Health Status	0.003 (0.001)	0.007 (0.013)
Subjective Social Status	0.001 (0.001)	0.011 (0.014)
Level of Social Trust	-0.001 (0.001)	-0.004 (0.007)
Annual Household Income	-0.001 (0.001)	0.356 (0.019)
Household Size	-0.002 (0.001)	-0.069 (0.010)
Per Capita Regional GDP (Gross Domestic Product)	-0.001 (0.005)	0.214 (0.078)
Number of Registered Unemployed in Urban Areas at Year-End	-0.009 (0.003)	0.016 (0.045)
Individual Fixed Effects	Controlled	Controlled
Time Fixed Effects	Controlled	Controlled
Observations	11,434	8,927
R^2	0.533	0.715

5.2.2. Analysis of Differences Across Employment Status

Individuals were categorized into two groups—employed and unemployed—based on their responses to the "current employment status" question in the CFPS survey. Heterogeneity analysis was then conducted. Columns (3) and (4) of Table 6 show that the digital economy has a significant positive impact on the currently employed group, but the effect is not significant for the unemployed group. This is because the digital economy provides more opportunities for promotion and income increases for the employed. On the one hand, the development of the digital economy has spawned numerous emerging industries and jobs, such as internet marketing, big data analysis, and artificial intelligence applications. This allows employed individuals to more easily find high-paying jobs that match their skills, thereby increasing their absolute income and improving their mental health[38] (Autor, 2015). On the other hand, the digital economy has also promoted digital transformation within

companies, increasing total factor productivity[1] (Guo & Xiao, 2025), and providing employees with more opportunities for promotion and career development[12] (Xiao et al., 2024), further enhancing their psychological satisfaction. For the unemployed group, although the digital economy has created new job opportunities, these opportunities often require specific digital skills and knowledge. The unemployed may lack the necessary education and training opportunities to adapt to the demands of the digital economy[38][41] (Autor, 2015; Deming, 2017), thus failing to fully enjoy the income increases and improved mental health brought about by the digital economy. Furthermore, the development of the digital economy may exacerbate labor market competition[37] (Acemoglu & Restrepo, 2020), leading to greater pressure and frustration for the unemployed during the job search process, thereby negatively impacting their mental health.

Table 6. Regression Results of Heterogeneity Analysis by Gender and Employment Status

Variables	(1)Male Mental Health Status	(2)Female Mental Health Status	(3)Employed Mental Health Status	(4)Unemployed Mental Health Status
Level of Digital Economy Development	-0.148 (0.082)	-0.134 (0.104)	-0.186 (0.079)	-0.319 (0.447)
Age	0.159 (0.161)	0.381 (0.221)	0.248 (0.145)	0.447 (1.676)
Education Level	0.169 (0.093)	0.069 (0.102)	0.150 (0.099)	0.856 (0.797)
Marital Status	-0.302 (0.232)	-0.512 (0.250)	-0.269 (0.207)	-2.711 (1.145)
Organizational Membership (or Group Membership)	0.022 (0.130)	0.083 (0.164)	-0.022 (0.114)	1.694 (0.940)
Self-Rated Health Status	0.522 (0.055)	0.548 (0.062)	0.476 (0.048)	1.230 (0.335)
Subjective Social Status	-0.283 (0.054)	-0.210 (0.065)	-0.268 (0.050)	-0.202 (0.293)
Level of Social Trust	0.115 (0.028)	0.094 (0.033)	0.098 (0.025)	-0.102 (0.156)
Annual Household Income	-0.071 (0.066)	-0.143 (0.075)	-0.058 (0.065)	-0.745 (0.351)
Household Size	-0.038 (0.041)	-0.075 (0.049)	-0.099 (0.037)	0.309 (0.276)
Per Capita Regional GDP (Gross Domestic Product)	-0.554 (0.305)	-0.220 (0.352)	-0.575 (0.278)	2.037 (1.693)
Number of Registered Unemployed in Urban Areas at Year-End	0.543 (0.181)	0.231 (0.207)	0.306 (0.166)	2.554 (1.185)
Individual Fixed Effects	Controlled	Controlled	Controlled	Controlled
Time Fixed Effects	Controlled	Controlled	Controlled	Controlled
Observations	6,249	4,978	8,170	1,300
R^2	0.686	0.677	0.691	0.691

5.2.3. Analysis of Differences Across Age Groups

Age is an important factor influencing participation in digital life, with different age groups having access to different digital resources. Following Yu & Liu[26] (2021), individuals were categorized into digital natives (18-38 years old), digital immigrants (39-59 years old), and digital refugees (60 years old and above) for heterogeneity analysis. The results in Table 7 show that the regression coefficients

for the impact of digital economy development on the mental health of all three groups are negative, indicating that digital economy development improves their mental health. However, the effect is significant only for the digital immigrant group, not for the digital native and digital refugee groups.

The possible reasons are: Digital natives grew up in an environment with widespread digital technology and have higher digital literacy; therefore, the marginal improvement in income opportunities due to technological advancements is limited. They are also in the early stages of their careers and are limited by experience and resources, and have not yet fully utilized digital technologies to improve their income and mental health. Digital immigrants are a generation that gradually adapted to and integrated into digital technology development. They typically have more work experience and life experience, allowing them to better utilize existing experience combined with new skills to enter higher value-added positions, thereby increasing their income levels[41] (Deming, 2017). Digital refugees are those marginalized or unable to adapt during the development of digital technology. Due to factors such as age and education level, their ability to accept and apply digital technology is relatively weak, leading to many inconveniences and frustrations in daily life[18] (Liu & Su, 2022). Lack of digital skills also makes it difficult for them to find suitable jobs, further increasing their psychological stress.

Table 7. Regression Results of Heterogeneity Analysis by Age

Variables	(1)Digital Natives Mental Health Status	(2)Digital Immigrants Mental Health Status	(3)Digital Refugees Mental Health Status
Level of Digital Economy Development	-0.076	-0.185	-0.445
	(0.096)	(0.107)	(0.354)
Age	0.399	-0.112	0.971
	(0.169)	(0.228)	(0.999)
Education Level	-0.058	-0.018	0.162
	(0.085)	(0.167)	(0.680)
Marital Status	-0.211	-0.807	-2.034
	(0.202)	(0.406)	(0.925)
Organizational Membership (or Group Membership)	0.018	0.120	0.184
	(0.143)	(0.181)	(0.522)
Self-Rated Health Status	0.499	0.618	0.368
	(0.064)	(0.065)	(0.192)
Subjective Social Status	-0.311	-0.168	-0.200
	(0.067)	(0.066)	(0.174)
Level of Social Trust	0.121	0.114	0.038
	(0.033)	(0.035)	(0.092)
Annual Household Income	-0.140	-0.065	-0.070
	(0.075)	(0.084)	(0.230)
Household Size	-0.069	-0.045	-0.239
	(0.041)	(0.059)	(0.151)
Per Capita Regional GDP (Gross Domestic Product)	-0.188	-0.723	0.138
	(0.360)	(0.374)	(1.378)
Number of Registered Unemployed in Urban Areas at Year-End	0.309	0.673	-0.259
	(0.212)	(0.221)	(0.612)
Individual Fixed Effects	Controlled	Controlled	Controlled
Time Fixed Effects	Controlled	Controlled	Controlled
Observations	4,672	4,366	566
R^2	0.662	0.704	0.727

6. Conclusions and Implications

This paper utilizes CFPS data and a two-way fixed-effects model to examine the impact of digital economy development on residents' mental health. It explores the mechanisms through which the digital economy improves residents' mental health by mitigating income opportunity inequality and increasing individual absolute income.

The paper also investigates the differences in the impact pathways of the digital economy on residents' mental health across gender, age, and employment status groups. First, digital economy development significantly improves residents' mental health levels. Second, the digital economy improves residents' mental health through the pathways of mitigating income opportunity inequality and increasing individual absolute income. Third, the improvement effect of digital economy development on the mental health of men is greater than that of women; the improvement effect on employed groups is greater than that of unemployed groups; and the improvement effect on digital immigrant groups is greater than that of digital natives and digital refugees.

Based on these findings, the following implications are proposed:

First, deepen digital infrastructure construction and universalization. In promoting the construction of new digital infrastructure, emphasis should be placed on strengthening network coverage and digital service accessibility in remote areas and for vulnerable groups, reducing the cost of digital access, and improving the integrated urban-rural digital public service system. By improving the equalization level of digital infrastructure, the access gap between regions and groups can be narrowed, ensuring that all residents share the benefits of digital economy development and providing a fundamental guarantee for improving mental health.

Second, construct a multi-layered digital skills training system. Government departments should work with enterprises and social organizations to establish a life-cycle digital skills training mechanism, focusing on improving residents' digital literacy and employment competitiveness. Differentiated training content should be designed for different groups, such as providing digital entrepreneurship guidance for women, developing skills transformation courses for unemployed groups, and simplifying technical operation training for digital refugees. By mitigating income opportunity inequality and improving individual absolute income levels, the empowering effect of the digital economy on mental health can be unleashed. At the same time, enterprises should be encouraged to innovate flexible employment models, broaden income channels in the digital economy, and enhance residents' economic security and psychological resilience.

Third, implement precise policy interventions. For men, the construction of digital economy employment positions and career development channels should be strengthened, fully leveraging the direct driving effect of income improvement on mental health. For women, targeted skills training, digital entrepreneurship support, and family-friendly employment policies are needed to enhance their ability to participate in the digital economy and reduce gender disparities. For employed groups, the career advancement and rights protection mechanisms in the digital economy field should be improved; for unemployed groups, digital public service positions should be developed, and career transition guidance should be strengthened. In terms of age, the integration mechanism of digital skills and work experience should be optimized for digital immigrants; career early planning and digital resource adaptability should be strengthened for digital natives; and user-friendly digital tools should be promoted for digital refugees, relying on communities to carry out digital reverse mentoring to reduce barriers to technology use.

Fourth, improve supporting institutions for the digital economy. A sound data element allocation mechanism and digital labor rights protection system should be established to prevent the risk of income polarization that may be exacerbated by the digital economy. The digital transformation of mental health services should be promoted, and intelligent mental intervention platforms should be developed, integrating digital technology deeply into the entire chain of mental health promotion. An interactional mechanism of "technology empowerment - equal opportunities - income optimization - mental improvement" should be established to form a virtuous cycle between the digital economy and mental health. At the same time, digital ethics regulation should be strengthened to reduce the

potential negative impacts of information overload and social comparison on mental health, ensuring that the benefits of digital economy development reach all residents.

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