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Research article

Research on the heterogeneous effects of residents' income on mental health

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Abstract: The influence of residents' income on mental health is complex, and there are heterogeneous effects of residents' income on different types of mental health. Based on the annual panel data of 55 countries from 2007 to 2019, this paper divides residents' income into three dimensions: absolute income, relative income and income gap. Mental health is divided into three aspects: subjective well-being, prevalence of depression and prevalence of anxiety. Panel Tobit model is used to study the heterogeneous impact of residents' income on mental health. The results show that, on the one hand, different dimensions of residents' income have a heterogeneous impact on mental health, specifically, absolute income has a positive impact on mental health, while relative income and income gap have no significant impact on mental health. On the other hand, the impact of different dimensions of residents' income on different types of mental health is heterogeneous. Specifically, absolute income and income gap have heterogeneous effects on different types of mental health, while relative income has no significant impact on different types of mental health.

Keywords: residents' income; mental health; heterogeneity analysis

1. Introduction

Residents' incomes are closely related to their mental health. Mental health refers to a good or normal state of human psychology. The ideal state of mental health requires maintaining the corresponding state of intact personality, correct cognition, appropriate emotion, reasonable will, positive attitude, etc. These ideal states require a strong correlation with people's psychological

emotions, and horizontal and vertical changes in income often lead to corresponding changes in psychological expectations. The impact of absolute income on people's mental health is more based on living security and other basic issues. For example, for people living below the poverty line, the negative impact of income reduction on mental health is greater than that of income increase on improving mental health, because the decline in income will bring huge risks to their income security and mental health. The increase of income is closely related to basic living and medical security [1]. When the income decreases, it will threaten the income security, lead to deterioration of mental health, and form a cycle of poverty or income instability and deterioration of mental health. The horizontal and vertical changes of income are based on people's comparison with other reference objects according to their own in-depth changes. For example, the income gap between all (residents) formed through horizontal comparison is expanded or narrowed, which has a certain impact on mental health; the comparison between income growth and expectation formed through vertical comparison also has an impact on mental health.

There is a correlation between residents' income and mental health, but the existing literature is relatively scattered. There are mainly two branches of literature, one of which is about the relationship between residents' income and mental health. Specifically, it includes the measurement of residents' income, the measurement of mental health, and the impact of residents' income on mental health.

Scholars measure residents' income mainly from three aspects: absolute income, relative income and income inequality. Firstly, the absolute income mainly indicates the level of the research object, which can be a total amount indicator or a relative intensity indicator; Most of the literatures often use gross income indicators or relative income strength indicators to measure absolute income, such as disposable income or per capita disposable income. They measure absolute income based on the total amount index, and most of them choose disposable income as the measure index of residents' absolute income. Some literatures measure the absolute income of residents based on cash flow. At the same time, the literature also shows that the reason for choosing household per capita disposable income to measure income lies in two aspects. On the one hand, disposable income is the final expenses that a family can use for discretionary use. All kinds of insurance, housing provident fund or housing subsidies, income taxes and miscellaneous expenses in the study need to be deducted from the total income, so household disposable income is used. On the other hand, the family disposable income needs to be averaged by family members to finally reflect the degree of family health protection. Similar studies also measure residents' absolute income based on survey data from the perspective of cash flow. Secondly, the relative income measurement is based on the absolute income measurement, and the income level is measured by constructing corresponding indicators through comparison and other methods. Generally, the relative position and subjective feeling can be used for measurement. Finally, the income gap has become one of the common problems in various countries [2]. Therefore, the income inequality is often studied and analyzed from the perspective of income gap. Scholars mainly use Gini coefficient to measure income inequality [3].

The existing studies mainly used the Symptom Checklist 90 (SCL-90), Hamilton Depression Scale (HAMD), and the Self Rating Depression Scale for Flow and Call (CES-D) to measure mental health. These scales mainly use several questions covering emotion, consciousness, thinking and other aspects to measure people's mental health. These scales can reflect people's current mental health status comprehensively and accurately. The Symptom Checklist 90 (SCL-90) was developed by Derogatis in 1973 and is one of the most widely used mental health test scales in the world. The

scale is divided into nine subscales, including somatization, obsessive compulsive symptoms, interpersonal sensitivity, depression, anxiety, hostility, terror, paranoia and psychosis, from the aspects of feeling, thinking, emotion, consciousness, behavior, living habits, interpersonal relationship, diet and sleep, including 90 assessment items to comprehensively assess mental health. Hamilton Depression Rating Scale (HAMD) was developed by Hamilton in 1960. It is the most widely used scale in clinical assessment of depression. The scale has three versions, including 17 items, 21 items and 24 items. The lower the total score of the scale, the lighter the depression, which can better reflect the severity of depression. The Self Rating Depression Scale (CES-D) was developed by Radloff of the National Institute of Mental Health in 1977 to screen the subjects with depressive symptoms. CES-D consists of 20 questions, investigating 20 symptoms, including worry, anorexia, depression, inferiority, depression, fatigue, despair, failure, fear, and sleep disorder. The higher the total score of the scale is, the higher the degree of depression is. When the total score is less than or equal to 15 points, there is no depressive symptom. If the total score is 16 to 19 points, there is likely to be depressive symptom. If the total score is greater than or equal to 20 points, there must be depressive symptom. In addition, some scholars selected different indicator systems and constructed other scales to measure mental health according to the characteristics of the survey objects. Kozma and Stones [4] compiled the Memorial University of Newfoundland Happiness Scale (MUNSH) in the early 1980s. The scale contains 24 items and attempts to comprehensively measure the happiness from two aspects: short-term emotional response and long-term emotional experience.

The impact of residents' income on mental health is mainly reflected in the impact of different types of residents' income on mental health and the impact of residents' income on different types of mental health. First of all, there is no unified conclusion on the impact of different types of residents' income on mental health. Muntaner, et al. [5] and Jenkins, et al. [6] found that both low income and debt are related to mental illness, but the impact of income seems to be mainly regulated by debt. De Neve and Oswald [7] used the sibling fixed effect to estimate the impact of life satisfaction and positive emotions on future income. The results show that happiness and income are two-way. Kahn, et al. [8] studied the relationship between national income inequality and individual family income and the physical and mental health of women with young children. The results showed that high income inequality increased the risk of poor mental and physical health. Secondly, residents' income has a heterogeneous impact on different types of mental health. Huang, et al. [9] based on the panel data of residents' income and mental health in 55 countries from 2007 to 2017, and found that national income has significant heterogeneity on mental health, which is reflected in three aspects: the impact mechanism on different types of mental health, different income levels and different mental health. In addition, Knight, et al. [10] found that the widening income gap can bring people more optimistic income expectations, which can encourage people to live and work more actively, thus improving subjective well-being. Yatham, et al. [11] and Thomson, et al. [12] found that in low-and-middle income countries, the mental health of young people are more susceptible to depression and anxiety. To sum up, the impact of residents' income on different types of mental health is heterogeneous.

The other branch of literature is about the factors affecting mental health. The factors mainly include personal, family background and social factors. First, personal factors affect people's mental health. The personal factors affecting people's mental health mainly include gender, education level, economic status, socio-economic status, employment, etc. There are significant differences in each person's gender, education level, economic status, socio-economic status, etc. These significant

differences originate from different characteristics of psychological expectations; For example, as far as gender is concerned, Chinese men are affected by traditional culture. Because of their higher requirements for career progress, their subjective well-being in career and other aspects is difficult to meet; Similarly, educational level will limit the acquisition of subjective well-being, and the horizontal and vertical comparison of economic conditions will also bring different subjective well-being. In terms of gender, Asadullah, et al. [13] used data from the China Comprehensive Social Survey (CGSS) to study the determinants of subjective well-being in China during 2005–2010. Regression results show that gender has a greater impact on well-being. Salk, et al. [14] conducted a meta-analysis of depression data sets in more than 90 countries. The transnational analysis results show that in countries with more gender equality, there is a greater gender difference in major depression, but not in depression symptoms. In terms of economic difficulties, Richardson, et al. [15] found that over time, greater economic difficulties indicate greater depression and stress, more serious anxiety and alcohol dependence. Butterworth, et al. [16] studied the relationship between depression and economic difficulties over time, and found that there was a strong correlation between current economic difficulties and depression. In addition, socio-economic status refers to the position of individuals or groups in society, reflects the social class and status of different people, and is a comprehensive reflection of income level, education level, occupational status, wealth and other indicators. In terms of socio-economic status, Koster, et al. [17] used the data of 2593 men and women aged 55–85 years to test the relationship between socio-economic status and the onset of depression in the elderly, and determined the relative contributions of psychosocial factors, physical health status and behavioral factors in explaining this relationship. The results showed that the probability of accidental depression in people with low educational background and low income was significantly higher than that in other people, that is, in the elderly, lower socio-economic status predicted the occurrence of depression. Lorant, et al. [18] used the annual Belgian family group survey data (1992–1999) to explore whether the longitudinal changes of socio-economic factors affect the changes of depression level. Among them, socio-economic factors include living standards, educational level, employment status and social relations. The results showed that there was a significant relationship between the worsening socio-economic environment and depression. Specifically, the decrease of living standard among different years is related to the increase of depressive symptoms and cases of severe depression. The living environment can also affect depression. Stopping cohabitation with a partner will increase depressive symptoms and incidence rate, while environmental improvement will reduce these symptoms and incidence rate, and the negative impact is greater than the positive impact. In terms of unemployment, Paul and Moser [19] examined the impact of unemployment on mental health through 237 cross-sectional studies and 87 longitudinal studies using meta analysis. The results show that the unemployed show more pain than the in-service. Significant differences were also found in several indicator variables of mental health (distress, depression, anxiety, psychosomatic symptoms, mixed symptoms of subjective well-being and self-esteem). The average number of unemployed people with psychological problems is 34%, while the proportion of in-service people is 16%.

Secondly, family is a micro unit of social composition, and many relevant factors that affect people's mental health. Many studies have examined residents' income from the whole family level. Many family members rely a lot on the family such as life and emotion. In terms of family income, Kahn, Wise, Kennedy and Kawachi [8] studied the relationship between family income and the physical and mental health of women with young children. The results showed that high inequality in

family income increased the risk of poor mental health. In addition, family status also has an important impact on mental health. The family status includes the family's economic status, the evolution of economic status, and the degree of harmony. There is a close relationship between family economic status and individual psychological behavior. When family economic status is relatively high, people have a stronger sense of self superiority, which can promote the healthy development of psychology; At the same time, the family economic status will also evolve with the influence of family composition. When the economic status continues to improve in the process of economic status evolution, it will strengthen the formation of mental health. On the contrary, when the economic status continues to decline in the process of economic status evolution, it often makes people become anxious. Moreover, as the family life has the characteristics of path dependence, which will worsen the psychological status and influence mental health.

In addition, social factors affect people's mental health. Social factor is one kind of external a feature which is often uncontrollable for people, so it more stems from the social uncertainty. Social factors affecting people's mental health mainly include economic crisis [20–22], economic growth, income inequality, social support, credit cycle and social capital. Economic crisis often leads to the loss of people's basic living security, and the economic crisis has a strong impact on personal living security, which affects people's mental health. Gili, et al. [23] pointed out that during the economic crisis from 2006 to 2010, the prevalence of most types of mental health disorders among primary health care participants increased significantly, especially depression. Unemployment and difficulty in mortgage payment were the main risk factors. Bartoll, et al. [24] showed that the mental health of men deteriorated during the Spanish economic crisis, especially those with lower socio-economic status. Katikireddi, et al. [25] evaluated the short-term differences in population mental health before and after the economic recession in 2008, and discussed the differences in gender, age and socio-economic status of these changes and their causes. The results show that there is no clear evidence that increased inequality is related to economic recession. Social and economic inequality often affects people's mental health through horizontal comparison between people. Lorant, Deliege, Eaton, Robert, Philippot and Ansseau [18] selected 51 epidemiological studies, 5 incidence rate studies and 4 persistence studies to study the relationship between depression and socio-economic status using meta-analysis. The study found that individuals with low socioeconomic status had a higher probability of depression, but the probability of new onset was lower than that of persistent depression, and the socio-economic inequality of depression was heterogeneous. Social support often affects mental health through people's expectations of society. Social support has a close relationship with individual mental health. Social support mainly includes material assistance or direct service such as objective, actual or visible support and subjective, experienced or emotional support. Rueger, et al. [26] conducted a meta-analysis of 341 articles to assess the relationship between social support and adolescent depression. Stress buffering analysis showed that different stress environments may not allow young people to take full advantage of social support. They also proposed the value of seeking a better understanding of the process of pressure buffering (the effect of social support is enhanced) and reverse pressure buffering (the effect of social support is weakened). The credit cycle affects mental health. Li, et al. [27] studied the relationship between credit cycle and happiness using the fixed effect model. The results show that there is a negative correlation between credit cycle and happiness, that is, credit growth will reduce the overall happiness index of a country or region. To sum up, scholars have provided a wealth of literature and proved the relationship between residents' income and mental health, which provides a good research foundation for this study, but also leaves

enough research space for this study.

The marginal contribution of this paper mainly includes the following two aspects. On the one hand, this paper aims to study the heterogeneous impact of different dimensions of residents' income on mental health. The existing research mainly studies the impact on mental health from a single dimension of residents' income, while this paper attempts to divide residents' income into absolute income, relative income and income gap to study the heterogeneous impact of different dimensions of residents' income. The results show that different dimensions of residents' income have heterogeneous effects on mental health. Specifically, absolute income has a positive impact on mental health, while relative income and income gap have no significant impact.

On the other hand, this paper studies the heterogeneous effects of different dimensions of residents' income on different types of mental health. The mental health was divided into subjective well-being, depression prevalence and anxiety prevalence, and the heterogeneous impact of different dimensions of residents' income on different types of mental health was studied. The results show that different dimensions of residents' income have heterogeneous effects on different types of mental health. Specifically, absolute income and income gap have heterogeneous effects on different types of mental health, while relative income has no significant impact on different types of mental health.

The remaining of this paper is organized as follows. The second chapter is the research hypothesis of residents' income on mental health. The third chapter introduces the model, variables and data sources built in this paper. The fourth chapter is an empirical analysis of the heterogeneous impact of residents' income on mental health. The fifth chapter is the conclusion.

2. Research hypothesis

2.1. Different dimensions of residents' income and mental health

Different dimensions of residents' income have heterogeneous effects on mental health. First, absolute income has a significant positive impact on mental health. The absolute income is the income level that one can obtain for the final investment and consumption during a certain period. The mental health of a social individual will be affected by the income level of the individual. According to Maslow's hierarchy of needs theory proposed by Abraham Maslow, the needs of individual residents can be divided into five categories from low to high: physiological needs, security needs, social needs, respect needs and self-realization needs. The theory of hierarchy of needs can explain the conduction relationship between residents' absolute income and their mental health. The basis for residents to meet Maslow's needs at all levels is absolute income. After the needs at different levels are met, they will feel different happiness and pay attention to their own mental health to varying degrees, which can explain the relationship between absolute income and mental health. When the absolute income level is relatively low, people will first want to meet the lowest level of needs - physiological needs, that is, basic material resources needs, food and clothing needs, busy with livelihood, people often spend more time on work, but not their own psychological state, ignoring their own mental health. At this time, people's food and clothing problems can be effectively solved by increasing their absolute income. When the absolute income has improved to a certain extent and people have met the basic survival and security needs, they will have more time to pay attention to their own mental health. After the needs are met, people tend to pursue higher levels

of needs. The happiness level one experienced is determined by the level of needs satisfied. People will try to meet higher levels of needs, in order to obtain richer and stronger happiness, that is, people's spiritual needs, such as respect needs and self-realization needs. When the absolute income of individuals is higher and higher, their mental health will show a better state.

Secondly, relative income will also have an impact on residents' mental health. The relative position of individuals in income distribution and socio-economic status is an important factor affecting people's mental health, which is mainly due to the gap between the relative position and people's expectation of their own income position. The correlation with absolute income is not necessarily strong. Some analyses even analyze the impact of such mental health from the perspective of relative deprivation of income. Relative deprivation of income refers to the degree of deprivation when people compare their income with one or some reference objects and find themselves at a disadvantage. The main and most direct way that relative deprivation of income affects farmers' mental health is psychological mechanism. As the result of income comparison, income relative deprivation has "jealousy effect" and "tunnel effect" on individual utility. "Jealousy effect" refers to that when the income level of oneself is lower than that of the comparative group, the lower the income is relative to others, the lower the utility of the individual. The "tunnel effect" believes that although the individual income level is lower than that of the comparative group, this gap makes itself see the hope of the future, which will improve the expectation of future income, thus bringing higher utility to the relative deprivation. Individuals with a higher degree of income deprivation often lack social support, so it is difficult to effectively eliminate the impact of pressure and negative emotions with the help of external forces. Long term exposure to this psychological state will lead to mental health problems, increase the probability of mental illness, such as anxiety and depression, which will have a negative impact on individual mental health.

In addition, the income gap has an impact on the mental health of residents. According to the income gap hypothesis, economic differences also have a direct impact on individual health. According to the theory of relative deprivation of income, the widening of income gap will lead to the improvement of the sense of relative deprivation, which will have a negative impact on the mental health of residents. The aggravation of the income gap will increase people's psychological pressure, produce negative emotions such as depression and anger, thus infringing on people's mental health. At the same time, the income gap may harm the mental health of residents by affecting the supply of public health care. The internal income gap in rural areas and the urban-rural income gap will affect the allocation and utilization of rural medical services, reduce the accessibility of low-income groups to mental health products and services, and lead to a negative correlation between income gap and mental health. In addition, the expansion of the income gap will erode social capital, and the weakening of social capital will be difficult to meet people's changing fairness preferences. The improvement of the sense of unfairness will further harm people's mental health. Relative deprivation will also affect social stability, reduce social cohesion and create harmful psychological pressure on people by increasing crime rates and social conflicts.

Based on the above analysis, this paper proposes hypothesis 1: different dimensions of residents' income have a heterogeneous impact on mental health.

2.2. Residents' income and different types of mental health

The income of residents has a heterogeneous effect on different types of mental health. First,

absolute income has a heterogeneous impact on different types of mental health. Absolute income has a positive impact on subjective well-being. With the growth of income, people's subjective well-being will increase. Absolute income helps to meet people's basic needs, maintain their basic survival, enable people to have better opportunities to receive better education, obtain better nutrition and medical care, bring greater sense of achievement and security, and thus improve people's subjective well-being. Absolute income will increase the incidence rate of depression. Depression refers to a disease caused by various reasons and characterized by depression. People with high absolute income tend to spend more time at work. They often bear longer pressure. High pressure work takes up their time, so they do not spend too much time in relaxing activities to relieve stress. Stress cannot be released, and symptoms such as depression and loss of interest occur. After a long time of accumulation, the prevalence of depression will eventually increase. Absolute income helps to reduce the incidence rate of anxiety disorder. People with high absolute income are more likely to meet their needs, be relatively satisfied with their quality of life, reduce their worries about future uncertainty and fear of future life, and thus reduce their anxiety.

Secondly, relative income has a heterogeneous impact on different types of mental health. Relative income in a low position has a negative impact on subjective well-being, and then affects mental health. The theory of relative deprivation points out that when individuals compare themselves with other people or groups of people they choose, if they find that they are not in a superior position but in a inferior position after comparison, they will have a negative impact, a feeling of being deprived psychologically, and thus have a negative impact on individual mental health. Relative income will increase the incidence rate of depression. If a person's income level is at a lower level compared with others, when the income gap is large, it will cause psychological imbalance of people with low income, forming a huge psychological gap, bringing more sense of loss and frustration to low-income groups, and low-income groups will bear greater psychological pressure and living burden, thus affecting the mental health of residents, resulting in a large psychological gap and a negative attitude towards life. In the long run, low-income residents may suffer from depression and other mental diseases. Relative income will increase the incidence rate of anxiety disorder. With the increase of the relative income gap, the huge psychological gap of low-income groups will make them often in a state of anxiety, which may increase the incidence rate of anxiety in the long run.

In addition, income gap has a heterogeneous impact on different types of mental health. The expansion of income gap has both economic incentive effect and economic inhibition effect. Economic incentive effect means that with the widening of income gap, residents with fast income growth will have better living conditions and environment, which will, to a certain extent, encourage residents with slow income growth to work hard to obtain more income, so that people will have more positive psychological emotions and promote the healthy development of psychology. The economic inhibition effect refers to the continuous expansion of the income gap, which will cause some people to hate the rich or degenerate, thus inhibiting the overall increase of residents' income to a certain extent. The income gap will affect people's happiness. When the mobility and uncertainty of the whole society reach a certain height, the society is no longer static. At this time, the income level and social status level of individual residents will be regarded as a kind of information, which will affect the psychological expectations of other individuals for income and social status, thus affecting the level of personal subjective well-being. According to this theory, the income gap can generate signal transmission between individuals through psychological expectations, which affects

people's psychological emotions. The changing trend of income gap will increase the incidence rate of depression. The gradual change of income gap makes low-income groups feel depressed, especially when the phenomenon of "equal work but different pay" appears and the degree of different pay becomes larger and larger, some people tend to spend more time on their work, they often suffer more pessimistic and depressed negative emotions and greater work pressure, and their life time is occupied by high-pressure work, which makes them unable to spend time on relaxing activities to relieve pressure, The pressure cannot be released, and the long-term accumulation will eventually lead to an increase in the prevalence of depression. In addition, income gap will increase the incidence rate of anxiety disorder. The larger the income gap is, the more dissatisfied people are with the quality of life, and they are full of worries and fears about the future, which eventually leads to the onset of anxiety disorder.

Based on the above analysis, this paper proposes hypothesis 2: residents' income has a heterogeneous impact on different types of mental health.

3. Model and variable description

3.1. Panel Tobit model

This paper mainly studies the heterogeneous impact of residents' income on mental health. The mental health index is between 0 and 1 because comprehensive indicators are used to measure the mental health by weighting the entropy method. However, the OLS estimators for such truncated data may be biased and inconsistent to a large extent. The Tobit model constructed by economist Tobin in 1958 for truncated factor variables and dependent variable constraints can achieve consistency of final estimation results by using maximum likelihood estimation (MLE). Since the explained variable mental health is a comprehensive index calculated according to the entropy method, and the index value is between 0 and 1, with significant truncation characteristics, the basic model of this paper adopts the Tobit model. Tobit model is different from the discrete selection model and the general face variable selection model. It is mainly derived from the fact that its dependent variable is a restricted dependent variable. The actual model consists of two parts: a selection equation model that represents constraints and a continuous variable equation model that satisfies constraints. The general form of Tobit model is as follows:

$$Y_i^* = \beta_0 + \beta_1 X_i + \mu_i \tag{1}$$

Among them, Y_i^* is the mental health index, which is an unobservable potential variable in practice, so it can be measured by other methods. X_i refers to the explanatory variables determined in the model, namely, the income indicators of the three dimensions of absolute income, relative income and income gap. β_1 is the parameter to be estimated in the model, reflecting the impact of residents' income gap on mental health. β_0 is the general intercept term of the equation. μ_i obeys the normal distribution. The unobservable variables in this paper are measured by relevant indicators such as positive emotions and negative emotions, and standardized, Therefore, the relationship between the interpretable positive and negative emotion index Y and the unobservable potential variable of mental health Y_i^* can be expressed as the following constraint equation:

$$Y_i = \begin{cases} c_i, & (Y_i^* \geq c_i) \\ Y_i^*, & (b_i < Y_i^* < c_i) \\ b_i, & (Y_i^* \leq b_i) \end{cases} \tag{2}$$

Among them, c_i and b_i represents the constant of the intercept point. The Tobit model is set in the typical form: $c_i = 1$, $b_i = 0$.

The Tobit basic model form of Eqs (1) and (2) does not limit the data of the model, but its demonstration is more adaptive to the section data type. Considering that the sample and data type in this paper are panel data, in order to avoid the loss of sample data information, and also to comprehensively consider the time and cross-sectional information of variable data, Equals (1) and (2) are further improved, and a panel Tobit model is constructed to study the heterogeneous impact of residents' income on residents' mental health. The specific form of panel Tobit model is as follows:

$$Y_{it}^* = \beta_0 + \beta_1 X_{it} + \sum \beta_j Z_{ijt} + \mu_i + \nu_t + \varepsilon_{it} \tag{3}$$

Among them, Y_{it}^* is the dependent variable. As we not only consider the mental health index, but also study each dimension of the mental health index, namely subjective well-being, depression prevalence and anxiety prevalence. All of them are the dependent variable. X_{it} is the independent variable, which include absolute income, relative income and income gap, completely consistent with the independent variables of Tobit model. Z_{ijt} is a series of control variables closely related to mental health, including healthy life expectancy at birth, freedom to choose life, generosity, corruption perception, positive effect and negative effect. β_0 is the intercept term of the equation. The regression coefficient β_1 is to determine the effect of residents' income on mental health. β_j is the coefficient in front of the control variables. μ_i is the individual fixed effect. ν_t is the time fixed effect. $\varepsilon_{it}$is the random disturbance.

For the parameter estimation of Tobit model, it is necessary to consider the truncation characteristics of model data in the parameter estimation of basic model. The use of OLS estimation may produce biased estimation results, that is, deviation of model results. The panel Tobit model estimation method is based on the two-step method, combined with the characteristics of panel model estimation that includes both data time and information on the cross section. The maximum likelihood estimation can find a phylogenetic tree with a high probability of generating observation data. It can improve the unbiased effect of parameter estimation. Therefore, the maximum likelihood method is used to estimate the parameters of the model.

3.2. Heterogenous effects Variable measure and data source

3.2.1. The Explained variable

The explanatory variable of this article is mental health. In view of the differences in mental health measured by the method, this paper mainly measures residents' mental health from three aspects: subjective well-being, depression prevalence and anxiety prevalence. It constructs a mental health index to measure mental health. The construction of mental health includes the positive indicator of subjective well-being and the two reverse indicators of the prevalence of depression and anxiety. In order to avoid the interference of subjective factors during empowerment, this paper uses entropy weight method to measure the mental health of residents in various countries. Entropy

weight method is to determine the index weight according to the dispersion characteristics of each index data, which can effectively avoid the interference of subjective factors when weighting, so as to objectively and accurately measure the mental health status of residents in various countries. In this paper, the specific implementation steps of using entropy weight method to construct the mental health index of residents in various countries are as follows:

First, in order to eliminate the differences in units and dimensions between subjective well-being, depression prevalence and anxiety prevalence, this paper uses the range method to standardize these three indicators. For the positive indicator subjective well-being and the negative indicator depression prevalence and anxiety prevalence, different standardized processing algorithms need to be adopted.

Specifically, the standardized calculation formula for subjective well-being of positive indicators is:

$$Hap_{it} = \frac{Happiness_{it} - min\ (Happiness_{it})}{max(Happiness_{it}) - min\ (Happiness_{it})} \tag{4}$$

Among them, $Happiness_{it}$ represents the subjective well-being index value of the ith country before the standardization in the t year. Hap_{it} represents the subjective well-being index value of the ith country after the standardization in the t year. $max(Happiness_{it})$ represents the maximum value of subjective well-being of the ith country in the t year. $min\ (Happiness_{it})$ represents the minimum value of subjective well-being of the ith country in the t year.

The standardized calculation formula for the depression prevalence and anxiety prevalence is:

$$Dep_{it} = \frac{max\ (Depressive_{it}) - Depressive_{it}}{max(Depressive_{it}) - min\ (Depressive_{it})} \tag{5}$$

$$Anx_{it} = \frac{max\ (Anxiety_{it}) - Anxiety_{it}}{max(Anxiety_{it}) - min\ (Anxiety_{it})} \tag{6}$$

Among them, $Depressive_{it}$ represents the depression prevalence index value before the standardization of the ith country in the t year. Dep_{it} represents the depression prevalence index value after the standardization of the ith country in the t year. $max(Depressive_{it})$ represents the maximum value of depression prevalence of the ith country in the t year. $min\ (Depressive_{it})$ represents the minimum value of depression prevalence of the ith country in the t year. $Anxiety_{it}$ represents the anxiety prevalence index value before the standardization of the ith country in the t year. Anx_{it} represents the anxiety prevalence index value after the standardization of the ith country in the t year. $max(Anxiety_{it})$ represents the maximum value of anxiety prevalence of the ith country in the t year. $min\ (Anxiety_{it})$ represents the minimum value of anxiety prevalence of the ith country in the t year.

The second step is to calculate the information entropy of each indicator based on the standardized indicator value:

$$E_{Hap} = -\frac{1}{ln(NT)} \sum_{i=1}^{N} \sum_{t=1}^{T} [(Hap_{it} / \sum_{i=1}^{n} Hap_{it}) ln\ (Hap_{it} / \sum_{i=1}^{n} Hap_{it})] \tag{7}$$

$$E_{Dep} = -\frac{1}{ln(NT)} \sum_{i=1}^{N} \sum_{t=1}^{T} [(Dep_{it} / \sum_{i=1}^{n} Dep_{it}) ln\ (Dep_{it} / \sum_{i=1}^{n} Dep_{it})] \tag{8}$$

$$E_{Anx} = -\frac{1}{ln(NT)} \sum_{i=1}^{N} \sum_{t=1}^{T} [(Anx_{it} / \sum_{i=1}^{n} Anx_{it}) ln\ (Anx_{it} / \sum_{i=1}^{n} Anx_{it})] \tag{9}$$

Among them, n represents the number of evaluation years.

The third step is to calculate the weight of each indicator based on information entropy:

$$W_{Hap} = \left(1 - E_{Hap}\right) / \left(\left(1 - E_{Hap}\right) + \left(1 - E_{Dep}\right) + \left(1 - E_{Anx}\right)\right) \tag{10}$$

$$W_{Dep} = \left(1 - E_{Dep}\right) / \left(\left(1 - E_{Hap}\right) + \left(1 - E_{Dep}\right) + \left(1 - E_{Anx}\right)\right) \tag{11}$$

$$W_{Anx} = \left(1 - E_{Anx}\right) / \left(\left(1 - E_{Hap}\right) + \left(1 - E_{Dep}\right) + \left(1 - E_{Anx}\right)\right) \tag{12}$$

The fourth step is to use the linear weighting method to calculate the mental health index of each year $Mental_{it}$, based on the standardized index value and index weight.

$$Mental_{it} = \left(W_{Hap} * Hap_{it} + W_{Dep} * Dep_{it} + W_{Anx} * Anx_{it}\right) \tag{13}$$

The mental health index $Mental_{it}$ is between 0 and 1. The bigger $Mental_{it}$ is, the better the mental health is. Conversely, the smaller $Mental_{it}$ is, the worse the mental health is.The data of subjective well-being in this paper comes from Gallup World Poll. The data on the prevalence of depression and anxiety are from Global Burden of Disease Study 2019.

3.2.2. The Explanatory variable

The explanatory variable is residents' income. Economic policy uncertainty [28], digital finance [29], digital currency [30], total factor productivity [31] and other factors will affect residents' income levels. In view of the different impacts of different dimensions of residents' income on people's expectations, this paper presents a multi-dimensional study of residents' income, including absolute income, relative income and income gap. In order to reflect the income level obtained by economic entities for final investment and consumption by residents in a certain period, this paper uses per capita disposable income to measure the absolute income level of countries. Per capita disposable income refers to the disposable income obtained by residents through their own economic activities. It is the income balance after deducting a series of taxes, including personal income tax, and is generally used by residents for consumption expenditure and savings.

Relative income is the income relative to other groups or the historical income level. Since relative income reflects a comparative concept, this paper chooses to measure relative income by using the link growth rate of per capita disposable income according to its definition and connotation. The monthly rate of per capita disposable income refers to the growth rate of income that residents can use for their own consumption and savings through participating in economic activities. It is a relative change compared with the per capita disposable income of the previous year. Monthly growth rate of per capita disposable income objectively reflects the change level of relative income.

The income gap is the income difference among social members due to the existence of factors such as production efficiency among individuals in the income distribution process; Income is a flow indicator. The income gap corresponds to income equality in concept, reflects the gap between the high income level and the low income one, and also reflects the gap between high and low income levels of individuals in proportion to the total income level of the population. This paper selects Gini coefficient from Lorenz curve to measure income gap quantitatively. And the relevant data of residents' income in this paper are all from the World Bank.

3.2.3. The Control variable

This paper selects control variables from objective factors and subjective factors after considering the positive and negative effects comprehensively, which mainly include healthy life expectancy at birth, freedom to choose life, generosity, positive and negative effects. Health life expectancy at birth, as an important indicator to measure the health status of the population and the level of economic development in various countries, affects individual mental health in many ways. The freedom to choose life affects mental health in emotional experience and life beliefs. Get happy and positive emotions through generosity, so as to help individuals eliminate anger, hatred, jealousy and other negative emotions, continuously accumulate satisfaction with life, and promote individual mental health. The positive influence can awaken the potential positive psychological quality of individuals and promote the healthy development of individual psychology. Negative emotions have adverse effects on individual personality, interpersonal communication and cognitive level, which greatly endanger people's mental health. The relevant data of control variables selected in this paper are all from Gallup World Poll.

3.3. Sample selection

In this paper, we choose the national panel data from 2007 to 2019. The sample starts from 2007 based on the availability of data. The core explanatory variables are relative income, absolute income and income gap. As a large number of data related to residents' income before 2007 are missing or not published. Therefore, the starting point of this paper is 2007. The deadline for sample time is set as 2019, which is mainly restricted by the lag of relevant indicators such as mental health. The explanatory variable indicators, such as depression and anxiety disorder, are derived from the report issued by the Global Burden of Disease. Up to now, the latest report published is in 2020, so our sample is up to 2019.

This paper selects 55 countries as the research sample, which basically covers all income level countries at all stages, including high-income countries, middle-income countries and low-income countries [32–34]. Most of them have made great progress at the economic development and are middle-income and high-income countries [35–38]. The reason of our selection is that the developed countries may pay more attention to mental health, and invest more in health and other aspects. Accordingly, their mental health related data are more likely to be available; The final empirical results can more fully reflect the actual situation and have a strong reference value for mental health policy formulation and adjustment, which is conducive to solving practical and typical problems. The 55 countries are Canada, Chile, Germany, Denmark, Spain, the United Kingdom, Israel, Italy, Japan, South Korea, Lithuania, Panama, Sweden, Uruguay, the United States, Argentina, Armenia, Belarus, Brazil, China, Colombia, Costa Rica, the Dominican Republic, Ecuador, Guatemala, Kazakhstan, Mexico, Peru, Paraguay, Russian Federation, Thailand, South Africa, Bangladesh, Bolivia, Cameroon, Egypt, Ghana, Honduras, India, Kenya, Kyrgyzstan, Cambodia, Moldova, Mauritania, Nicaragua, Pakistan, Philippines, Senegal, El Salvador, Ukraine, Niger, Nepal, Tanzania, Uganda.

3.4. Descriptive statistics

The descriptive statistics of our data are shown in Table 1. For each variable, Table 1 shows the sample size, mean value, standard deviation, minimum value, maximum value, range, skewness and kurtosis.

Table 1. Descriptive statistics.

Variables	N	Mean	Standard Errors	Min	Max	Range	Skewness	Kurtosis
Absolute income	715	1.274	1.632	0.039	6.509	6.470	1.604	4.323
Relative income	715	2.392	3.175	-14.76	14.70	29.45	-0.562	6.520
Income gap	715	0.395	0.082	0.240	0.634	0.394	0.340	2.727
Mental health	715	0.597	0.102	0.340	0.830	0.490	-0.112	2.316
Subjective well-being	715	5.663	1.026	2.903	7.971	5.068	-0.006	2.260
Depression prevalence	715	3.739	0.838	2.195	6.044	3.849	0.386	2.427
Anxiety prevalence	715	4.349	1.320	2.115	9.276	7.161	0.716	3.766
Healthy life expectancy	715	4.154	0.092	3.848	4.305	0.457	-0.767	3.085
Freedom to choose life	715	0.755	0.128	0.335	0.970	0.635	-0.622	2.873
Generous	715	-0.010	0.153	-0.307	0.551	0.858	0.653	3.240
Positive impact	715	0.682	0.108	0.347	0.884	0.536	-0.622	2.535
Negative impact	715	0.263	0.076	0.112	0.503	0.391	0.379	2.627

The results in Table 1 show that the maximum absolute income is 6.509, the minimum is 0.039, the average is 1.274, and the standard deviation is 1.632; The maximum value of relative income is 14.70, the minimum value is −14.76, and the range is 29.45. It reveals that there is a large difference between absolute income and relative income. However, the difference of mental health level is small, the maximum value is 0.830, the minimum value is 0.340, and the average value is 0.597. The skewness characteristics of variables are investigated from the skewness of data, which basically presents symmetrical distribution or moderate skewness distribution. According to Table 1, among the variables involved, only the skewness of the absolute income distribution is greater than 1, that is, the absolute income is highly asymmetric; This feature also fully shows that absolute income heterogeneity between different countries is very strong. The skewness of other variables in the model is less than 1 or even less than 0.5, indicating that the data distribution characteristics are relatively symmetrical or only moderately skewed. On the other hand, the kurtosis of different variables are also different. It can be seen from Table 1 that the kurtosis coefficients of 5 variables involved are greater than 3, so the distribution of these 5 variables shows a peak feature; The kurtosis of other variables is less than 3, and the peak features are relatively flat. From the perspective of variable classification, absolute income and relative income in income indicators have peak characteristics, and the kurtosis of these two variables are the first and second largest of all variables, indicating that these two variables are more heterogeneous. Based on the analysis of variable skewness and kurtosis, most of the explanatory variable income variables have asymmetric and peak characteristics, which illustrates the heterogeneity of the influence of explanatory variables from another perspective. Most of the remaining control variables and regulatory variables show moderate skewness and non-peak characteristics.

4. Empirical analysis

This section aims to empirically test the heterogeneous impact of residents' income on mental health. In section 4.1, this paper studies the heterogeneous impact of different dimensions of residents' income on mental health. In sections 4.2–4.4, this paper studies the heterogeneous effects

of absolute income, relative income and income gap on different types of mental health.

4.1. Heterogeneous effects of different dimensions of residents' income on mental health

According to the setting of formula (3) of the econometric model, the range of the explained variable mental health index is [0,1], which is a truncated data. Therefore, we use the panel Tobit model to study the heterogeneous impact of different dimensions of residents' income on mental health. Since the explained variable mental health index is a two-way restricted dependent variable, in order to fully extract relevant information, this paper uses the maximum likelihood estimation method to obtain the parameter estimation results as shown in Table 2. Among them, Column (1) of Table 2 shows the impact of absolute income on mental health, Column (2) shows the impact of relative income on mental health, and Column (3) shows the impact of income gap on mental health.

Table 2. Heterogeneous effects of different dimensions of residents' income on mental health

Variables	(1)	(2)	(3)
	Mental Health	Mental Health	Mental Health
Absolute income	0.013***		
	(0.004)		
Relative income		0.000	
		(0.000)	
Income gap			0.009
			(0.061)
Healthy life expectancy	-0.181***	-0.140**	-0.146**
	(0.058)	(0.058)	(0.058)
Generous	0.045***	0.040***	0.040***
	(0.015)	(0.015)	(0.015)
Freedom to choose life	0.032**	0.035**	0.038**
	(0.016)	(0.016)	(0.016)
Positive impact	0.142***	0.149***	0.149***
	(0.030)	(0.030)	(0.030)
Negative impact	-0.109***	-0.114***	-0.115***
	(0.027)	(0.027)	(0.027)
sigma_u	0.095***	0.092***	0.092***
	(0.009)	(0.009)	(0.009)
sigma_e	0.027***	0.027***	0.027***
	(0.001)	(0.001)	(0.001)
Constant	1.243***	1.081***	1.100***
	(0.233)	(0.233)	(0.241)
N	715	715	715
Countries	55	55	55

Notes: The values in the brackets are standard errors; *, * * and * * * indicate that the results are significant at 10%, 5% and 1% levels respectively.

It can be seen from Table 2 that different dimensions of residents' income have heterogeneous effects on mental health. First, the absolute income of residents has a significant positive impact on mental health. The results of column (1) in Table 2 show that the regression coefficient of absolute

income is 0.013, which is significantly positive at the 1% statistical level. In order to intuitively understand the economic meaning of the estimation coefficient, this paper calculates that the average marginal effect of absolute income is 0.013. It indicates the elasticity of absolute income to mental health. On average, every 10% increase in absolute income will lead to a 1.3% increase in mental health. This shows that absolute income improves people's mental health. This is because absolute income is closely related to people's own survival needs and development. Absolute income provides necessary basic living conditions, such as food, clothing and housing, which are necessary to meet basic human needs. When absolute income increases, people's mental health will be improved. It can be seen that there is a significant positive correlation between absolute income and mental health level, whether in a statistical or economic sense. These results show that the increase of absolute income can significantly improve people's mental health.

Secondly, the increase of relative income does not affect people's mental health. The results of column (2) in Table 2 show that the regression coefficient of relative income is small, 0.000, and not statistically significant. This shows that the increase of relative income has not improved people's mental health. In addition, the increase of income gap does not affect people's mental health. The results of column (3) in Table 2 show that the regression coefficient of income gap is 0.009, but it is not statistically significant, indicating that the improvement of income gap does not affect people's mental health.

To sum up, different dimensions of residents' income have heterogeneous effects on mental health. Specifically, the absolute income of residents has a significant positive impact on mental health, while the relative income and income gap do not affect people's mental health.

4.2. Heterogeneous Effects of absolute Income on different types of mental health

According to the setting of formula (3) of the econometric model, the value ranges of the explained variables subjective well-being, prevalence of depression and prevalence of anxiety are [0,10], which are truncated data. Therefore, this section uses the panel Tobit model to study the heterogeneous impact of absolute income on different types of mental health. Given that explained variables subjective well-being, prevalence of depression and prevalence of anxiety are two-way restricted dependent variables, in order to fully extract relevant information, this paper uses the maximum likelihood estimation method to obtain parameter estimation results as shown in Table 3. Among them, Column (1) of Table 3 shows the impact of absolute income on subjective well-being, Column (2) shows the impact of absolute income on the prevalence of depression, and Column (3) shows the impact of absolute income on the prevalence of anxiety.

Absolute income has a heterogeneous effect on different types of mental health. From the results of panel Tobit model in columns (1), (2) and (3) of Table 3, we can see that the impact of absolute income on different types of mental health is heterogeneous. First, absolute income has a significant positive impact on subjective well-being. As shown in Column (1) of Table 3, the impact coefficient of absolute income on subjective well-being is 0.262, which is significant at the 1% significance level. In addition, the average marginal effect of absolute income is 0.255. It indicates the elasticity of absolute income to subjective well-being, that is, on average, every 10% increase in absolute income increases subjective well-being by about 25.5%. This result shows that increasing absolute income is conducive to improving people's subjective well-being. This is because people with higher absolute income tend to have better health and psychological conditions, live longer and

experience less life pressure, which can help people realize the development of sense of security, status and ability to meet self-realization. In addition, the rich scored higher in interpersonal trust and other characteristics. Therefore, absolute income has a significant positive impact on subjective well-being.

Table 3. Heterogeneous Effects of Absolute Income on Different Types of Mental Health

Variables	(1) Subjective well-being	(2) Depression prevalence	(3) Anxiety prevalence
Absolute income	0.262***	-0.028*	-0.043*
	(0.041)	(0.017)	(0.023)
Healthy life expectancy	1.538**	1.307***	0.976***
	(0.672)	(0.206)	(0.282)
Generous	0.144	-0.241***	-0.221***
	(0.181)	(0.052)	(0.070)
Freedom to choose life	0.660***	0.253***	0.408***
	(0.189)	(0.054)	(0.073)
Positive impact	1.671***	-0.034	-0.046
	(0.348)	(0.104)	(0.142)
Negative impact	-0.988***	0.310***	0.585***
	(0.324)	(0.092)	(0.126)
sigma_u	0.549***	0.840***	1.280***
	(0.061)	(0.081)	(0.123)
sigma_e	0.340***	0.092***	0.125***
	(0.009)	(0.003)	(0.003)
Constant	-2.433	-1.906**	-0.083
	(2.707)	(0.835)	(1.147)
N	715	715	715
Countries	55	55	55

Notes: The values in the brackets are standard errors; *, * * and * * * indicate that the results are significant at 10%, 5% and 1% levels respectively.

Secondly, absolute income has a significant negative impact on the prevalence of depression. Column (2) in Table 3 shows that the influence coefficient of absolute income on the prevalence of depression is −0.028, which is significant at the 10% significance level. In addition, the average marginal effect of absolute income is −0.031. It indicates the elasticity of absolute income to the prevalence of depression. On average, every 10% increase in absolute income decreases the prevalence of depression by about 3.1%. The results show that the increase of absolute income will reduce the prevalence of depression. With the increase of absolute income, people's basic living needs are guaranteed, and the life pressure is decreasing. People can spend more time on leisure things such as communicating and relaxing with family and friends, which alleviates the pressure and negative feelings encountered in life to a certain extent, thus reducing the probability of people suffering from depression.

Finally, absolute income has a significant negative impact on the prevalence of anxiety disorder. The result of column (3) in Table 3 shows that the influence coefficient of absolute income on the prevalence of anxiety disorder is −0.043, which is significant at the level of 10%. In other words, the increase of absolute income is conducive to reducing the prevalence of anxiety disorder. In addition, the average marginal effect of absolute income is −0.044. It indicates the elasticity of absolute

income to the prevalence of anxiety, that is, on average, the prevalence of anxiety will decrease by 4.4% every 10% increase in absolute income. This result is in line with reality. Higher absolute income can bring more material satisfaction, and people do not need to worry more about their basic life needs, thus relieving people's anxiety about the uncertainty of current and future life. That is to say, with the increase of absolute income, people's lives have been guaranteed, thus reducing the prevalence of anxiety disorders.

To sum up, absolute income has a heterogeneous impact on different types of mental health. Specifically, the increase of absolute income will help improve people's subjective well-being and reduce the prevalence of depression and anxiety.

4.3. Heterogeneous effects of relative income on different types of mental health

According to the Eq (3) of the econometric model, the value ranges of the explained variables subjective well-being, depression prevalence and anxiety prevalence are [0,10], which are truncated data. Therefore, this section uses the panel Tobit model to study the heterogeneous impact of relative income on different types of mental health. For the parameter estimation method, the maximum likelihood estimation method is used in this paper, and the parameter estimation results are shown in Table 4. Among them, column (1) of Table 4 shows the impact of relative income on subjective well-being, column (2) shows the impact of relative income on the depression prevalence, and column (3) shows the impact of relative income on the anxiety prevalence.

Table 4. Heterogeneous effects of relative income on different types of mental health.

Variables	(1)	(2)	(3)
	Subjective well-being	Depression prevalence	Anxiety prevalence
Relative income	0.008	0.002	-0.001
	(0.005)	(0.001)	(0.002)
Healthy life expectancy	2.003***	1.302***	0.920***
	(0.755)	(0.207)	(0.284)
Generous	0.133	-0.228***	-0.205***
	(0.184)	(0.051)	(0.070)
Freedom to choose life	0.791***	0.230***	0.388***
	(0.193)	(0.053)	(0.073)
Positive impact	1.729***	-0.047	-0.063
	(0.363)	(0.104)	(0.142)
Negative impact	-1.121***	0.314***	0.588***
	(0.334)	(0.093)	(0.127)
sigma_u	0.736***	0.822***	1.253***
	(0.084)	(0.079)	(0.120)
sigma_e	0.340***	0.092***	0.126***
	(0.010)	(0.003)	(0.003)
Constant	-4.157	-1.898**	0.122
	(3.049)	(0.839)	(1.155)
N	715	715	715
Countries	55	55	55

Notes: The values in the brackets are standard errors; *, * * and * * * indicate that the results are significant at 10%, 5% and 1% levels respectively.

Table 4 shows that relative income has no significant impact on different types of mental health. Specifically, we can see that the coefficients in front of relative income on different types of mental health are small and not statistically significant. The reason may be that the relative income is measured by the monthly growth rate of per capita disposable income, which refers to the income growth rate that residents can use for their own consumption control and savings through participating in economic activities. It is the relative change of per capita disposable income compared with the previous year. In the short term, people's per capita disposable income will not fluctuate sharply, and its growth rate is small. Therefore, relative income has no significant impact on different types of mental health.

4.4. Heterogeneous effects of income gap on different types of mental health

According to the setting of formula (3) of the econometric model, the value ranges of the explained variables subjective well-being, prevalence of depression and prevalence of anxiety are [0,10], which are truncated data. Therefore, this section uses the panel Tobit model to study the heterogeneous impact of income gap on different types of mental health. For the parameter estimation method, the maximum likelihood estimation method is used in this paper, and the parameter estimation results are shown in Table 5. Among them, Column (1) of Table 5 shows the impact of income gap on subjective well-being, Column (2) shows the impact of income gap on the prevalence of depression, and Column (3) shows the impact of income gap on the prevalence of anxiety.

Table 5. Heterogeneous influence of income gap on different types of mental health.

Variables	(1)	(2)	(3)
	Subjective well-being	Depression prevalence	Anxiety prevalence
Income Gap	-0.709	-0.642***	-0.365
	(0.700)	(0.220)	(0.303)
Healthy life expectancy	1.736**	1.184***	0.878***
	(0.774)	(0.207)	(0.286)
Generous	0.139	-0.209***	-0.193***
	(0.185)	(0.052)	(0.071)
Freedom to choose life	0.823***	0.226***	0.378***
	(0.192)	(0.053)	(0.073)
Positive impact	1.740***	-0.071	-0.077
	(0.364)	(0.104)	(0.143)
Negative impact	-1.089***	0.338***	0.604***
	(0.338)	(0.093)	(0.127)
sigma_u	0.746***	0.807***	1.264***
	(0.086)	(0.077)	(0.121)
sigma_e	0.340***	0.092***	0.125***
	(0.010)	(0.003)	(0.003)
Constant	-2.789	-1.141	0.452
	(3.202)	(0.859)	(1.188)
N	715	715	715
Countries	55	55	55

Notes: The values in the brackets are standard errors; *, * * and * * * indicate that the results are significant at 10%, 5% and 1% levels respectively.

The income gap has a heterogeneous effect on mental health, which is mainly reflected in different types of mental health. It can be seen from the results of panel Tobit model in columns (1), (2) and (3) of Table 5 that the impact of income gap on different types of mental health is heterogeneous. On the one hand, income gap has no significant impact on subjective well-being and the prevalence of anxiety disorder. As shown in columns (1) and (3) of Table 5, the influence coefficients of income gap on subjective well-being and prevalence of anxiety are −0.709 and −0.365, respectively, and are not statistically significant. This result shows that raising the income gap does not affect people's subjective well-being and the prevalence of anxiety disorder. On the other hand, income gap has a significant negative impact on the prevalence of depression. The results of column (2) in Table 5 show that the influence coefficient of income gap on the prevalence of depression is −0.642, which is significant at the 1% significance level. The results show that the increase of income gap will reduce the prevalence of depression.

To sum up, income gap has a heterogeneous impact on different types of mental health. Specifically, the increase of income gap does not affect people's subjective well-being and the prevalence of anxiety, but reduces the prevalence of depression.

5. Conclusions

Based on the annual panel data of 55 countries from 2007 to 2019, this paper divides residents' income into three dimensions: absolute income, relative income, and income gap. Mental health is divided into three aspects: subjective well-being, prevalence of depression, and prevalence of anxiety. Panel Tobit model is used to study the heterogeneous impact of residents' income on mental health, and the following conclusions are drawn.

On the one hand, different dimensions of residents' income have heterogeneous effects on mental health. Specifically, absolute income has a positive impact on mental health, while relative income and income gap have no significant impact on mental health. On the other hand, the impact of different dimensions of residents' income on different types of mental health is heterogeneous. Specifically, absolute income and income gap have heterogeneous effects on different types of mental health, while relative income has no significant impact on different types of mental health.

Based on the existing literature, this paper studies the heterogeneous impact of residents' income on mental health, and has made some achievements. This is of great significance for promoting and improving the mental health service system. However, the development of mental health is a huge research topic. The conclusions obtained in this paper are only part of the results of quantitative research on the development of mental health, and the research space is still quite large. We believe that further research can be carried out from the following aspects:

First of all, this paper only measures and analyzes the residents' income, mental health and other variables from a macro perspective, rather than from a micro perspective, which has certain limitations. At the same time, in view of objective issues such as data availability, the total analysis cannot conduct detailed research and analysis on different populations, so it is difficult to provide more detailed policy recommendations for different populations. In the next step, we should deeply study the differences between different gender, different age, different education levels and other groups, so as to provide more specific and targeted policy recommendations for promoting the improvement of the mental health system and economic development.

Secondly, based on the existing literature, this paper selects the factors that affect the mental

health status through the induction and classification of existing relevant literature. When selecting influencing factors, due to the limitation of data availability and model estimation effect, it may be difficult to cover all factors affecting mental health. But, in the next step of the work, we can select the influencing factor indicators from more perspectives.

Finally, future research can also focus on the strategies to improve the level of mental health. By summarizing and drawing on the existing practical experience of mental health development, the policy effect of promoting mental health development is simulated. After continuously expanding the theoretical research related to the development of mental health, integrate the theory with practice and provide practical policy suggestions for further improving the mental health service system. While continuously expanding the theoretical research related to the development of mental health, we need to integrate theory with practice and to provide practical policy suggestions for further improving the mental health service system.

The study has some limitations. There are many factors affecting mental health, natural, social, technological innovation and many other factors may have an impact on mental health[39]. Therefore, referring to Huang et al [40], the determinants of mental health in a framework composed of economic, environmental and social models provide new directions for expanding this study.

Conflict of interest

The authors declare there is no conflict of interest.

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