Will Low-Income Populations Love Spicy Foods More? Accounting for Tastes

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Abstract: Based on the Theory of Rational Addiction (TORA), this paper identifies the correlation between income and the preference for spicy foods by analysing the China Health and Nutrition Survey (CHNS) data. The results show that compare with high-income residents of same area, the low-income residents prefer to spicy foods in China. The regression results of IV and Lewbel IV all support it. According to the result, the channel of health behaviours and health awareness are possible causal channels for the negative correlation between income and the preference for spicy foods, rather than health capital stock and food selection.
Keywords: Spicy taste; Income; Rational addiction

JEL Classification：I12；I31；D12

1. Introduction

Spicy foods are considered as a mainstay of culinary foodways in China (Byrnes and Hayes, 2013). Sichuan cuisine is the most famous local dishes in China that is characterised by an extremely spicy taste. Conversely, also in China, Guangdong cuisine is rarely spicy (Lan, 2001). Sherman and Billing (1999) argued that the different attitudes to spicy foods presumably resulted from the climate diversity among different regions. Generally, the spicy taste of foods is caused by capsaicin. Physiologically, capsaicin promotes energy metabolism, making people consume more energy substances to generate heat energy. Thus, after eating spicy foods, people can feel hot and thus sweat (Byrnes and Hayes, 2013). According to Chinese historical records, it was widely accepted that capsicum had the capability to warm people and was thus used to alleviate negative influences of moist and chilly climates. Consequently, spicy foods are healthful for residents living in the Southwest (including Sichuan and Hunan) and the Northeast of China, where the climate is moist or chilly. In comparison, in the Southeast of China (including Guangdong), the climate is extremely hot and the spicy foods are not essential for the residents living there(Lan, 2001). This may be the reason why residents living in different regions have different attitudes to spicy foods.

Even though the "Climate Hypothesis" can explain the current situation in China, it can't explain for ancient China and other countries around the world. From an historical perspective, spicy foods were not popular in Sichuan until Qing Dynasty. In Tang and Song Dynasties, residents in Sichuan actually preferred sweet foods rather than spicy foods (Liang, 2014). From a global perspective, spicy foods are extremely popular in India and Mexico (Mathew et al., 2000;

Lopez-Carrillo et al., 2003), where the climates are extremely hot, and the residents prefer non-spicy foods in north Europe, where the climate is relatively cold. In comparison with countries in north Europe, many regions of China have similar climates, but the intensity of the preference for spicy foods is varied (Ahn et al., 2011; Ahn and Ahner, 2013).Compared with "Climate Hypothesis", Zhou (2014) proposes that geographical proximity may have greater influence on dietary habits. In his theory, dietary habits are considered as a part of culture. In geographically adjacent regions, cultural exchange and integration are more frequent, whereby residents in adjacent regions tend to have similar preferences of tastes. For example, Sichuan cuisine is considered as a product of cultural exchange and integration in Sichuan, where many residents actually immigrated from Hunan and Guangxi in Qing Dynasty (Wu, 2010). As residents in Hunan and Guangxi usually love spicy foods, the spicy taste is maintained in Sichuan cuisine since Qing Dynasty (Liang, 2014).

However, there are also defects in the "Geography Hypothesis". The waves of immigration from Hunan and Guangxi to Sichuan emerged in early Qing Dynasty while the shift of preferences of tastes occurred in later Qing Dynasty, more than one hundred years later, which cannot be explained by the Geography Hypothesis (Zhou, 2014). Based on the Directed Technical Change Model (Acemoglu, 1998; Acemoglu 2002), Liang (2014) gives an explanation of the shift from an economic perspective. According to his theory, condiments can be considered as the basic factors of production while cookeries can be considered as the tools. In a specific period, which taste was the mainstream taste mainly depended on which condiment was the most abundant condiment. Presumably, the abundance of capsicum changed preferences of tastes in Sichuan during later Qing Dynasty. This hypothesis is known as the "Technique Hypothesis" (Liang, 2014).

It is worth noting that all above can only explain formation and shifts of taste preferences from a macroscopic point of view, but they cannot explain individual variations in preferences of tastes in the same geographical region. In addition, there are few studies on individual taste preferences. Some facts show that income may play a key role in determining individual preferences of tastes and there is a negative correlation between income and the preference for spicy foods. Firstly, in comparison with residents living in north Europe, Indians and Mexicans have lower income and love spicy foods more. Secondly, in provinces of China that had lower per capita income, residents tended to consume more spicy foods (Table 1). Thirdly, in Sichuan, the popularity of spicy foods originated from a region known as Dabashan, which was a relatively impoverished region. Fourthly, street foods in China tend to be spicier in comparison with foods offered by luxury restaurants, even though the stall of the street food and the luxury restaurant are located in the same street[①].

[①] Huang and Isaak (2015) argued that, in comparison with high-income populations, low-income populations tended to use relatively low-quality and low-nutrition food materials in cookery because of economic reasons. According to their opinions, in order to improve tastes of dishes made from inferior food materials, chilies were

----------Table 1----------

Some researchers explain the formation of individual taste preferences through four hypotheses. Social and cultural backgrounds (Robin and Schiller, 1980; Stevens, 1990), repeated exposure to specific tastes (Logue and Smith, 1986; Rozin, 1990; Ludy and Mattes, 2012), genetic and physiological basis (Duffy and Bartoshuk, 2000; Duffy, 2007; Perry et al., 2007; Hayes et al., 2011), and individual personalities (Byrnes and Hayes, 2013) may potentially affect individual preferences of tastes. All of these hypotheses support that individual preferences of tastes are passively formed, where only uncontrollable factors play roles. Moreover, some studies show that the foods preference is due to special liking itself (Cowart, 1981; Duffy et al., 2009; IFICF, 2012).

To sum up, preferences of tastes are inherent and people cannot make a choice on it, which is the so-called "De Gustibus Non EstDisputandum"[②]. Stigler and Becker (1977) refute this opinion, and think that taste preferences are correlated with economic factors. According to their theory, personal economic conditions can influence individuals' behaviours and thus play an important role in the formation of taste preferences. Becker and Murphy (1988) develop the theory and proposed the Theory of Rational Addiction (TORA).In the book "Accounting for Taste", Becker (1998) asserts that economic research methods had significant advantages as they were much more powerful in comparison with traditional biological, cultural, and physiological research methods. Currently, economic research methods are rarely used in studies on the preference for spicy foods.

Following the Theory of Rational Addiction, this paper uses the China Health and Nutrition Survey (CHNS) data to identify the correlation between income and the preference for spicy foods. It is expected to provide a new explanation for formation of individual taste preferences, which can be a supplement for previous research. In China, there are no studies on this topic using micro-data. Consequently, the first contribution of the paper is that it innovatively analyse individual data to determine the correlation between income and the preference of spicy foods. Internationally, most quantitative studies on the preference of spicy foods are medical studies (e.g. Ramirez-Victoria et al., 2001), whereas in the field of social sciences related studies are few.

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usually added into these dishes. As the spicy taste caused by chilies was so intense, other abnormal tastes resulting from inferior food materials can be partly hidden. In contrast, high-income population tended to use superior food materials which inherently have superior tastes. For dishes made from these food materials, an intense spicy taste can be detrimental because it hid original tastes of food materials. After long-term exposure to foods with spicy tastes or non-spicy tastes, populations in different income groups formed different preferences of tastes. In current China, this opinion has sparked much debate. Some people asserted this opinion was reasonable and well-documented whereas some others, who believed that there were no correlations between income and preferences of tastes, asserted that this opinion was discrimination against individuals who loved spicy foods as it linked these individuals with poverty and inferiority. Hopefully, this study that used economic methods can give some reliable conclusions on this issue.

② "De Gustibus Non EstDisputandum" is a Latin proverb. It means that, in matters of taste, there can be no disputes. Stigler and Becker (1977) refuted the idea in their paper that used the proverb as the title.

Moreover, previous researches only focused on the correlation rather than the causal relationship (Byrnes and Hayes，2013; lv et al.，2015). In comparison, this study uses instrumental variables to identify the causal relationship, which is the second contribution to this topic. To our knowledge, it is the first time that this issue is studied from an applied micro-econometric perspective. As previously mentioned in the footnote, there are much debates about whether low-income individual love spicy foods more. According to the path analysis of this study, even though the phenomenon that low-income individual love spicy foods more actually existed, there is still no evidence that proved the discriminatory explanation proposed by Huang and Isaak (2015). The neutral explanation can be used to calm the folk controversy, which is one contribution in this paper.

The main results show that Chinese residents with lower income have a greater preference for spicy foods. It is still robust when other potential factors are controlled. Income had a causal effect on the preference for spicy foods in China. The channel of health behaviours and health awareness rather than the channel of health capital stock and food selection are possible causal pathway for the negative correlation between income and the preference for spicy foods.

Following the section of introduction, the theories and the research methods used in this study will be explained in section 2, after which the research data and the empirical analysis will be discussed in section 3 and 4, followed by conclusions given in section 5.

2. Theory and Methods

2.1 Theory

Becker and Murphy (1988) develop the Theory of Rational Addiction. They think that rational individuals will automatically and consistently maximise their utility as time goes on, whereby specific preferences of tastes will be formed. The mathematical expression of the utility is shown in equation (1).

$$U(0) = \int_0^T e^{-\sigma t} U[Y(t), C(t), S(t)]dt \qquad (1)$$

In the equation, *U(0)* is the discounted maximised utility in a specific period and σ represents a constant rate of time preference. In period *t*, individual utility depends on the consumption of non-addictive goods *Y(t)*, the consumption of addictive goods *C(t)*, and the total consumption of addictive goods before t *S(t)*. Due to the reinforcement effect, U_{cs}, the second derivatives of *U* with respect to *C* and *S*, is greater than 0, which means that the more addictive goods an individual consumed before, the greater the margin effect of *C(t)* will be. Due to the tolerance effect, for a rational individual, it will be recognised that consumption of a harmful good (U_s<0) will have

negative effects on utility in future while consumption of a beneficial good (U_s>0)will have positive effects on utility in future. U_s is the partial derivative of U with respect to S. The change of S satisfies equation (2).

$$\dot{S}(t) = S(t) - S(t-1) = C(t) - \delta S(t) - h[D(t)] \qquad (2)$$

In the equation, $\dot{S}$ is the rate of change over time in *S* and *C(t)* is the consumption of addictive goods. The instantaneous depreciation rate δ represents the exogenous rate of disappearance of the physical and mental effects of consumption of *C* in the past, and *D*(t) represents expenditures on endogenous depreciation or appreciation.

The addictive consumption is considered as a "rational" behaviour (Chaloupka, 1991).In this paper, spicy taste is considered as addictive consumption. If a spicy food is an inferior good, as income increases the demand will decrease, whereas if a spicy food is a normal good, the correlation is difficult to determine. As health is a normal good, if the cooking style of spicy foods is unhealthy, the relationship between income and the preference for spicy foods may be negative.

The most empirical researches focus on assessing the impacts of exogenous changes in income on unhealthy addictive consumption, such as smoking and drinking (Apouey and Clark, 2014). About unhealthy diets, most studies are centred on the causal impact of income on obesity rates and individual preferences for fried foods (Cawley, 2011; Rosa Dias, 2010). Compared with Europe and the United States, China currently does not have a serious problem of obesity. Meanwhile, fried foods such as chips and fried chicken are not mainstream foods in China. However, spicy foods are much more popular in China, which has not attracted much attention from researchers.

Currently, there is no consensus on influences of spicy foods on individual health. Some studies think that consumption of spicy foods containing chili peppers is detrimental to health (Mathew et al., 2000; Archer and Jones, 2002; Lopez-Carrillo et al., 2012), but others suggest otherwise (Ramirez-Victoria et al., 2001; Westerterp-Plantenga et al., 2005; Ludy and Mattes, 2011; lv et al., 2015). However, this paper focuses on rational preference of tastes, rather than correlation between consumption of spicy foods and health. According to the Theory of Rational Addiction, an absolutely individual will form a specific taste in order to maximise the utility. the utility under the budget constraint. Therefore, this paper analyzes the correlation between income and intensity of the preference for spicy foods.

However, when confronted with complicated issues, individuals sometimes cannot make absolutely rational decisions due to personal defects in cognition. Based on Suranovic et al. (1999), the function including cognitive limitations is shown in equation (3).

$$U_t(S) = B_t(S) + L_t(S) + C_t(S) \qquad (3)$$

In the equation, *B* represents the current benefit from the addictive taste. *L* represents the fully discounted future loss caused by the addictive taste and *C* represents the instant adjustment cost for changing the preference for the addictive taste.

Based on Suranovic et al. (1999), the individual's problem then is

$$\underset{s,y}{Max} W_A = U_A(s) + \Gamma(y)$$

$$s.t. p_s s + p_y y = I_A \qquad (4)$$

where Γ is the utility function for the composite good y. W_A is the sum of the current utility effects from the good of the addictive taste and the composite good at age A. p_s and p_y are prices of the good of the addictive taste and the composite good respectively, and I_A is income at age A. The first order Kuhn-Tucker conditions are,

$$\Gamma' - \mu p_y \geq 0 \qquad (5)$$

$$U'_A - \mu p_s \geq 0 \qquad (6)$$

where μ in the marginal utility of income. The second-order sufficient conditions for a maiximum are,

$$U''_A < 0 \text{ and } \Gamma'' < 0 \qquad (7)$$

For individuals, majority of utility loss will occur at or near the end of life, whereby utility loss at younger ages is significantly discounted. Furthermore, when individuals shift from less addicted to more addicted (formation of addiction), the instant adjustment cost is approximately 0. In contrast, when individuals shift from more addicted to less addicted (alleviation of addiction), the instant adjustment cost is significantly greater than 0. Consequently, health behaviour and health awareness may influence the preference for spicy foods. It will be discussed in detail in the following channel analysis.

To sum up, the spicy taste depends on income and price of the composite good according to the TORA. For simplification, this paper only analysis correlation between income and intensity of the preference for spicy foods. And this paper also tests the channel effect of health behaviour and health awareness on income-spicy nexus according to the cognitive limitations rational addiction theory.

2.2 Regression Model

The regression model is shown:

$$Taste_i = \alpha_0 + \alpha_1 Income_i + X_i'\gamma + \mu_i \quad (8)$$

In equation (8), $Taste_i$ represents the intensity of the preference for spicy foods and $Income_i$ represents the individual income. α_1 is the regression coefficient of *Income*, reflecting the correlation between income and the preference for spicy foods when other baseline factors (shown as X_i in the equation) are exhaustively controlled. μ_i is the residual.

In this study, basic demographic characteristics (e.g. genders, ages, and races) and all available parental background factors (varied, depending on used data base) are controlled. The effect of these controlled factors on income and the preference for spicy foods will not be highlight in this study.

In order to identify how income affects the preference for spicy foods through pathway, a pathway variable C_i is added into the regression, shown in equation (9).

$$Taste_i = \beta_0 + \beta_1 Income_i + X_i'\gamma + C_i\eta + \varepsilon_i \quad (9)$$

Income can affect the preference for spicy foods through pathway C_i. The absolute value of the estimated value of β_1 (represented by $\hat{\beta}_1$) should be less than the absolute value of the estimated value of α_1 (represented by $\hat{\alpha}_1$). Moreover, the significance (*P* value of the regression coefficient of *Income*) will decrease. According to the method proposed by Cutler and Lleras-Muney (2010), $1 - \hat{\beta} / \hat{\alpha}$ is calculated, representing the proportion of effects directly caused by the pathway variable on the preference for spicy foods.

The possible channel in which income can influence intensity of the preference for spicy foods are shown as follows. Firstly, individual with different levels of income have different life styles. In comparison with low-income individual, high-income individual usually have better health behaviours, for example, more exercise and less smoking (Dupas, 2011). As the preference for spicy foods is correlated with health, income may influence the preference for spicy foods via its influence on health behaviours. Secondly, high-income individual usually have greater health awareness. As health awareness is correlated with healthy dietary habits, income may influence the preference for spicy foods via its influence on health awareness (Stanton et al., 2015; Geaney et al., 2015). Thirdly, as an important human capital, the stock of health capital is positively correlated with income (Ettner, 1996; Frijters et al., 2005). As the preference for spicy foods is correlated with health, income may be correlated with the preference for spicy foods via its correlation with health capital stock. Fourthly, according to some folktales (as aforementioned in the footnote), in ancient China, in order to conserve limited foods, capsicums are added into spoiled foods to alleviate the odour caused by food spoilage. It is considered that foods composed

of low-quality food materials tended to be spicier in comparison with foods composed of high-quality food materials. According to previous studies, income has significant influence on food selection (Aguiar and Hurst, 2005; Ma et al., 2009). It makes sense that high-income individual prefer high-quality foods with less spicy taste whereas the situation of low-income individual is opposite, whereby income influences the preference for spicy foods via its influence on food selection.

2.3 Instrumental Variable

Endogeneity is an unavoidable problem in this study. Firstly, endogeneity can result from reverse causality, and it may have influences on health and thus have indirect influences on income. Secondly, endogeneity can arise as a result of omitted variables (e.g. genetic backgrounds, personalities, and etc.), which may affect both income and taste preferences. Thirdly, measurement error can also lead to endogeneity. If problems caused by endogeneity are ignored, the result can only reflect the correlation rather than the causal relationship between income and the preference for spicy foods.

In order to solve endogeneity, this paper uses the logarithms of per capita house/apartment values as instrumental variable represented by Z_i, which must be correlated with income, and independent of taste preferences. Individuals with pleasant personalities may tend to consume spicy foods more frequently (Byrnes and Hayes, 2013). Supposing individuals with pleasant personalities also tend to invest more money in houses/apartments, the instrumental variables chosen in this study will be unsuitable, because the exclusion restriction is not satisfied. According to some studies, individual genetic backgrounds can influence individual taste preferences (Hayes et al., 2011). If the genetic backgrounds are also correlated with preferences of properties, the instrumental variable will be unsuitable due to the same reason as above mentioned. Furthermore, if there is an obvious gap of chillies sold around housing between expensive housing and cheap housing, the chosen instrumental variables will be unsuitable. However, the possibilities of these situations above mentioned are extremely low. In most situations, the logarithms of per capita house/apartment values should satisfy the exclusion restriction and can be a proper instrumental variable.

Even though the logarithms of per capita house/apartment values are considered as suitable instrumental variables, the analytical result was still verified by other methods in order to ensure its robustness. If the analytical results are consistent, the results should be credible. In equation (4), $Income_i$ is an endogenous variable. Therefore, this paper uses the method of Lewbel (2012) to test the results. X represents the exogenous variables shown in equation (8).

$$Income_i = a_0 + \tilde{X}_i\gamma + \nu_i \qquad (10)$$

In the equation (10), variable X includes age, gender, marital status, employment, years of schooling and other exogenous variables. In comparison, gender and marital status are more

independent of preferences of tastes. Thus, the two variables are considered as exogenous variables in equation (10), represented by $\tilde{X}_i . v_i$ in equation (10) is the residual. Both $\tilde{X}_i$ and $[Z_i - E(Z_i)] \cdot \nu_i$ can be used as instrumental variables[③].

Based on Lewbel (2012), several conditions should be satisfied in advance. Firstly, $E(\tilde{X}_i u_i) = 0$. It means that all exogenous variables should be independent of residuals in equation (4) and (6). We treat gender and marital status to independent with taste preferences[④]. Secondly, $\mathrm{cov}(Z_i, u_i \nu_i) = 0$. This is the exclusion restriction, which can be satisfied by the chosen instrumental variable. Thirdly, $\mathrm{cov}(Z_i, \nu_i^2) \neq 0$. This condition is relatively difficult to satisfy because the instrumental variable should simultaneously satisfy the exclusion restriction and be correlated with ν_i^2.

Even though it is difficult to satisfy all the conditions, the method of Lewbel (2012) is helpful generally. Firstly, it may violate the exclusion restriction by using per capita house/apartment worth as the instrumental variable. This paper can use Lewbel's IV to test the exogeneity of the per capita house/apartment worth by overidentification test directly. Secondly, if the results are the same with IV and Lewbel's IV, it will be more robust.

3.Research Data

All the data is from the China Health and Nutrition Survey (CHNS).The CHNS was designed to examine the influences of social and economic transformations in China on individual, nutrition, demographics, and health status.The CHNS has released 9 waves of data so far (1989, 1991, 1993, 1997, 2000, 2004, 2006, 2009 and 2011).There is a question related to the preference for spicy foods in wave 2009. The question is, for the respondent, to which extent the spicy foods were tolerable. Three options, "a little spicy", "moderate spicy", and "extreme spicy", were available for the question. The answer can be the proxy variables of the preference for spicy foods.

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③ Detailed deductive reasoning about this has been discussed by Lewbel (2012) and it will not be repeated in this paper. The command used in Stata is "ivreg2h", which has been discussed by Baum et al. (2012).

④ It can be a little farfetched here as it is difficult to ensure that an instrumental variable is absolutely independent of preferences of tastes. In practice, this restriction can be partly relaxed (Lewbel, 2012). For example, in Lewbel's (2012) study, variables of some individual characteristics such as age and employment were used as $\tilde{X}_i$ in Engle Curve, and these variables were considered as exogenous variables. In this study, overidentification test was used to test exogeneity of variables. Details about this will be given in following part of the paper.

As only the wave 2009 contained these two questions, other waves are not analysed in the study.
In the study, per capita family income is considered as the leading explanatory variable whereas household registration status, marital status, gender, age, years of schooling, employment, medical history, health behaviours, health awareness, and nutrient intakes were considered as controlling variables. As aforementioned, the logarithms of per capita house/apartment values are used as the instrumental variable. Finally, there are 5926 observations in the data set.

----------Table 2----------

Table 2 shows summary statistics of key variables including levels of the preference for spicy foods (1-3from the lowest to the highest level), per capita family income (yuan), household registration status (1 = non-agricultural household, 0 = agricultural household), marital status (0 = others, 1 = married), gender (0 = female, 1 = male), age, years of schooling, employment (0 = unemployment, 1 = farmer and junior worker, 2= senior worker, 3= manager), the status of major chronic diseases including hypertension, diabetes, myocardial infarction, apoplexy, and asthma (0 = unaffected, 1 = affected), smoking (0 = no, 1 = yes), attitudes to body building(0= no attitude, 1=dislike very much, 2=dislike, 3=neutral, 4=like, 5=like very much),awareness of the Dietary Guideline (0 = no, 1 = yes), attitudes to the priority of eating a healthy diet (1=not important at all, 2=not very important, 3=important, 4=very important, 5=extremely important), average intakes of nutrients including energy, fat, and protein, and per capita house/apartment worth.

4. Empirical Analysis

4.1 Preference for spicy foods and income

4.1.1 OLS estimate

The data description shows that there are different taste preferences among income groups. More precisely, the lower the income was, the more intense the preference for spicy foods was. The averages of the logarithms of per capita incomes are 8.864, 8.826, and 8.630, in the groups that had low, medium, and high preference for spicy foods, respectively.

----------Table 3----------

Table 3 shows the regression results of the baseline data using the Order Logit Regression (OLOGIT) (columns (1) and (3)) and the Ordinary Least Squares (OLS) (columns (2) and (4)).
In columns (1), income has a significant negative effect on individual spicy taste. In columns (3), after controlling a set of explanatory variables, especially province variables, the negative effect still holds. It is valid to exclude the explanation of the “Climate Hypothesis” and the “Geography

Hypothesis"[5].

In columns (2) and columns (4), OLS results show the same income effect. The proxy variable of spicy taste is not a numerical variable. This paper pays attention to plus or minus of the coefficient and significance level. Due to the results of OLS are similar with OLogit, and OLS is more concise than OLogit. Therefore, below only report the results of OLS (Angrist and Pichke, 2008).[6]

In Table 3, the results show that individual with agricultural household registration, male, married, working, young prefer very spicy significantly. Compare with individual from Liaoning, individual from Jiangsu, Shandong, Henan, Hubei and Guangxi like light tastes, taste of someone from Hunan and Guizhou is spiciest. It is accord with geographical spicy preference in China (Lan, 2001)

4.1.2 IV estimate

The IV regression result is shown in Table 4. In columns (1) and (2), the first stage result presents that there is a positive correlation between income and household value. The weak Instruments variable test shows that the f-statistics is 225.137, and *p*-value is 0. It indicates that there is no weak Instruments variable. The second stage results are in columns (3) and (4). The results suggest that there is still negative relation between income and taste, and the coefficient value is greater than OLS. It means that it underestimate the income negative effect on spicy taste in OLS. The results are significant in 10% level, but the *p*-value is 0.055, which is a bit higher than 0.05.

----------Table 4----------

The result of the Lewbel's IV is shown in Table 5. These IVs have stronger predictive power and are also plausibly excludable based on the tests ofover-identification restrictions. These results indicate that there is also no weak Instruments variable. The Hansen J-test does not reject the null hypothesis that states that all instrumental variables are exogenous. The results show that income decrease degree of individual spicy preference significantly both in 2SLS and GMM, the coefficients are -0.0716 and -0.0732 respectively. It also supports the previous results, which represent the income negative effect on spicy taste.

----------Table 5----------

[5] If the variable of individual hometowns rather than the variable of locations is controlled, the analytical result may be more accurate. However, in the database of CHNS, the information about individual hometowns is not available. Thus, in this study, the variable of locations was used to replace the variable of individual hometowns. The problems caused by immigration were not considered in this study.

[6] In following analysis, if OLOGIT is used to replace OLS, the results are consistent.

4.2 Path Analysis

4.2.1 Health Behaviour

Income is one of key determinant of health behavior. Healthy behaviors are completely different among various income groups (Dupas, 2011). Mokdad et al.(2004) point that the leading causes of death in 2000 were tobacco (18.1% of total US deaths), poor diet and physical inactivity (16.6%), high income and education individual is more inclined to less smoke and better life-style. Balia and Jones (2011) also mention that a clear socioeconomic gradient in smoking initiation and cessation as well as on mortality, which penalizes individuals from low socioeconomic groups. Jin and Jones-Smith (2014) indicate that children with lower family incomes tend to have less healthy physical fitness status. The individual with good health habits eats more healthily(less spicy food). Therefore, this paper adds smoke and body building information to test influence of health behaviors.

----------Table 6----------

Table 6 shows that there is a positive correlation between smoke and spicy preference. Someone who likes body building, will prefer light. It also indicates that individual with healthy life-style will incline to light. Controlling healthy behavior variable, coefficient of income decrease from -0.0164 (columns (4) of table 3) to -0.0155 (columns (1) of table 6), and the *p*-value decrease from 0.020 to 0.027. The value of $1-\hat{\beta}/\hat{\alpha}$ is 5.488%, it means that healthy behavior can explain 5.488% in correlation between income and spicy taste. In columns (2), dropping some observations who answer "does not participate" to whether body building, the coefficient of incomes decrease from -0.0164 to -0.0145(columns (2) of table 6), and healthy behavior can explain 11.585%.

4.2.2 Health Awareness

Health cognition is one of key factors in income-taste influencing mechanism. Kenkel (1991) thinks that the variation of health cognition is the reason of various health behaviors, the high SES individual will have better health cognition. In recent research, Stanton et al. (2015) and Geaney et al.(2015) all find that there is significant positive correlation between health cognition and health diet. Meanwhile, Yoshioka et al.(2004), Ludy and Mattes(2011) mention that chili intake is closely linked with health diet, and eating too much chili can harm health.

CHNS provides self-reported question, which ask people about "whether know the Dietary Guidelines" and "How important is eating a healthy diet priority in your life". Respondents are asked to answer "not important at all", "not very important", "important", "very important" or "the most important" in second question. Controlling healthy behavior variable, the coefficient of income decrease from -0.0164 (columns (4) of table 3) to -0.0155 (columns (3) of table 6), and the

p-value decrease from 0.020 to 0.027. The value of $1-\hat{\beta}/\hat{\alpha}$ is 5.488%. The results of health behavior and health cognition support the rational addiction framework with cognitive limitations (Suranovic et al., 1999).

4.2.3 Health Capital Stock

As aforementioned, there is a significant correlation between income and health capital stock. It is widely accepted that health capital stock can promote increase of income (Ettner, 1996; Frijters et al., 2005).Moreover, it has been mentioned before that eating too much spicy will lead to risk of disease. Diseases history represents the change of health capital stock. CHNS provides the diseases history question, which is about "Has a doctor ever told you that you suffer from high blood pressure, diabetes, myocardial infarction, apoplexy, asthma?"

According to the result shown in Table 6, controlling diseases history variable, there are not significant change in coefficient of income (-0.0164 vs -0.0165)and significant level(0.020 vs 0.018). The reason may be that eating spicy may not increase the risks of these five chronic diseases directly. Some empirical research indicates that eating too much spicy food may increase the risk of gastric cancer. There is not enough gastric cancer information in CHNS to exam effect of eating spicy food.

4.2.4 Food Selection

Due to availability of ingredients, the poor may obtain low quality and type of ingredients, it need to add more chili to keep the food tasting good, but the rich just the reverse (Aguiar and Hurst, 2005; Ma et al., 2009). Aguiar and Hurst (2005) find that there is a difference among income group in pattern of nutrient intake. But, CHNS cannot provide information about freshness and level of ingredients. It can't exam the influence of ingredients in income-taste influencing mechanism. There is a correlation between nutrient and ingredients. Therefore, this paper tests whether nutrient intake will work in income-taste influencing mechanism. Strauss (1982) and Pitt (1983) find that income is positive correlated with intake of energy, protein, and fat. Adrian and Daniel (1976) argue that carbohydrate was a special energy substance, the consumption of which could be positively or negatively correlated with income. Ma et al. (2009) state that, as the income effect and the substitution effect of carbohydrate have mutually reversed effects on the consumption of carbohydrate, the correlation between income and the consumption of carbohydrate can be ambiguous. According to his analysis of the CHNS data, income was positively correlated with consumption of energy, protein, and fat, whereas the correlation between income and the consumption of carbohydrate cannot be identified[⑦]. In order to identify whether income had indirect influences on the preference for spicy foods through direct influences

[⑦]A similar result was obtained in this study. When other baseline factors are controlled the result was still robust. As this study does not focus on this issue, the detailed result will not be discussed here.

on food selection, variables of nutrient intake are used as the pathway variables in this section.

According to the result shown in Table 6, controlling food selection variable, there are not significant change in coefficient of income and significant level. Within this study, there is no evidence that income can affect the preference for spicy foods via the pathway of food selection. Even though the phenomenon shows that low-income individual love spicy foods more actually, there is no evidence that preference was formed via the mechanism proposed by Huang and Isaak (2015).

For the four path analyses, after the pathway variables were added into the regression, the coefficients do not change significantly. To some extent, it indicates that the benchmark of this study was robust. If estimated values of key parameters of regression significantly change after the pathway variables were added, the changes are more likely to result from the instability of the regression model rather than the effect of the pathway variables.

4.2.5 Pathway Analysis Based on Instrumental Variable

The IV results of four channels Influences above are shown in table 7. The results show that controlling health behaviours, the absolute values of income coefficient decrease. The values of $1-\hat{\beta}/\hat{\alpha}$ are 6.501% and 12.310% respectively. It means that healthy behaviours can explain 6.501% and 12.310%. Meanwhile, there is no obvious change in income coefficient after controlling diseases history and nutrient intake. It indicates that the results of OLS are robust. When controlling all channels Influence variables, the proportion increases to 25.726%.

----------Table 7----------

It is worth noting that not all possible channels are included in this study. Actually, it is impossible to include all possible channels in one study. Consequently, four possible channels that were most close to the income-taste system were analysed in this study. Furthermore, there might be some overlap among the four channels. For example, individual health awareness can affect individual health behaviours. Lastly, only suggestive evidence can be provided by this study, and thus further study on this issue is still required in future.

5. Conclusion

After reviewing previous research on preference for spicy foods, there are defects both in the "Climate Hypothesis" and the "Geography Hypothesis". Based on the Directed Technical Change Model (Acemoglu, 1998; Acemoglu 2002), Liang (2014) gives a more dependable explanation.

However, all the hypotheses can only explain the issue from a macroscopic point of view rather than an individual perspective.

Currently, it is considered that social and cultural backgrounds (Robin and Schiller, 1980; Stevens, 1990), repeated exposure to specific tastes (Logue and Smith, 1986; Rozin, 1990; Ludy and Mattes, 2012), genetic and physiological basis (Duffy and Bartoshuk, 2000; Duffy, 2007; Perry et al., 2007; Hayes et al., 2011), and individual personalities (Byrnes and Hayes, 2013) can affect individual preferences of tastes. However, all of these theories support that individual preferences of tastes are passively formed, where the effects of economic factors are ignored. According to Stigler and Becker (1977), personal economic conditions can influence individuals' behaviours and thus play an important role in the formation of taste preferences. In comparison with traditional biological, cultural, and physiological research methods, economic research methods have significant advantages. Following this opinion, they proposed the Theory of Rational Addiction (TORA) (Becker and Murphy, 1988).

Based on reviewing the relevant hypotheses and explanation of eating spicy food, this paper studies the correlation between income and eating spicy food. According to the Theory of Rational Addiction (Becker and Murphy, 1988), this paper finds that income is significant correlation with eating spicy food under controlling a series of demographic characteristic variable, especially region variables; the results of IV and Lewbel IV support the income impact on eating spicy food; health behaviors and health cognition can explain income-taste influencing mechanism, this prove the rational addiction framework with cognitive limitations (Suranovic et al., 1999); however, stock of health and nutrient intake don't determine why the poor like eating spicy food.

There are some limitations in this paper. Firstly, due to lack of detailed information, it is impossible to distinguish different spicy tastes caused by different condiments in this study. Secondly, only semi-quantitative variables rather than quantitative variables are used in this study to describe the intensity of the preference for spicy food, which decreases reliability and validity of this study. Thirdly, this study only identifies that low-income individual tended to love spicy food more, but it cannot explain why and how the preference for spicy food is formed. Unfortunately, there is no data about this[⑧].We will improve them in the future research.

[⑧]Zhu et al. (2013) are establishing database that can provide information like this.

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Table 1: Economic conditions and indexes of the preference for spicy foods by location in China

	Sichuan	Hunan	Hubei	Beijing	Shanxi	Anhui	Jiangsu	Shandong	Zhejiang	Shanghai	Fujian	Guangdong
Per capita GDP/10,000 yuan	3.25	3.68	4.26	9.32	4.27	3.17	7.46	5.63	6.85	9.01	5.79	5.85
Per capita disposable income/10,000 yuan	2.24	2.34	2.29	4.03	2.29	2.31	3.25	2.83	3.79	4.39	3.08	3.31
Indexes of the preference for spicy foods	151.0	59.0	29.2	26.1	24.7	19.9	17.4	15.9	13.5	11.5	11.2	8.8

The data of indexes of the preference for spicy foods is quoted from Lan's paper (2001). The data of per capita GDP and per capita disposable income is quoted from China Statistical Yearbook 2013. It is worth noting that the index data and the economic data were collected in 1970s and 2013, respectively. As preferences of tastes did not significantly change in past 30 years, the negative correlation between economic conditions and the preference for spicy foods should still exist.

Table 2: Summary statistics of key variables

Variables	Means	Std. Dev.	Min.	Max.
Levels of the preference for spicy foods	1.582	0.640	1	3
Per capita family income/yuan	11979.460	14372.620	0	285090.200
Household registration status	0.392	0.488	0	1
Marital status	0.843	0.364	0	1
Genders	0.503	0.500	0	1
Ages	48.559	14.876	17.970	96.210
Years of schooling	7.720	4.190	0	18
Employment	0.886	0.843	0	3
The status of major chronic diseases				
Hypertension	0.113	0.317	0	1
Diabetes	0.024	0.152	0	1
Myocardial infarction	0.006	0.080	0	1
Apoplexy	0.011	0.106	0	1
Asthma	0.011	0.105	0	1
Smoking	0.346	0.476	0	1
Attitudes to body building	2.374	0.987	0	5
Awareness of the Dietary Guideline	0.137	0.344	0	1
Attitudes to the priority of eating a health diet	3.240	0.757	1	5
Average intakes of nutrients				
Energy/kilocalories	2234.233	1173.583	473.378	54230.390
Fat/g	78.921	108.474	1.508	5750.521
Protein/g	67.849	25.780	12.059	448.216
Per capita house/apartment worth/yuan	49959.93	62719.7	100	800000

Table 3: Regression results of the baseline data using the Order Logit Regression (OLOGIT) and the Ordinary Least Squares (OLS)

	(1) OLOGIT	(2) OLS	(3) OLOGIT	(4) OLS
Per capita family income	-0.0371***	-0.0216***	-0.0289**	-0.0164**
	(0.0116)	(0.00670)	(0.0126)	(0.00697)
Household registration status			-0.103***	-0.0541***
			(0.0382)	(0.0195)
Marital status			0.149***	0.0754***
			(0.0440)	(0.0221)
Genders			0.232***	0.120***
			(0.0321)	(0.0167)
Ages			-0.00930***	-0.00479***
			(0.00132)	(0.000667)
Years of schooling			-0.00149	-0.000934
			(0.00507)	(0.00257)
Locations				
Heilongjiang			0.125*	0.0665*
			(0.0718)	(0.0386)
Jiangsu			-0.329***	-0.163***
			(0.0725)	(0.0355)
Shandong			-0.186***	-0.0999***
			(0.0710)	(0.0360)
Henan			-0.160**	-0.0832**
			(0.0753)	(0.0385)
Hubei			-0.182***	-0.0951***
			(0.0702)	(0.0356)
Hunan			0.389***	0.210***
			(0.0630)	(0.0340)
Guangxi			-0.195**	-0.0986**
			(0.0786)	(0.0396)
Guizhou			0.440***	0.240***
			(0.0620)	(0.0334)
Employment				
Junior worker			0.0939**	0.0454**
			(0.0387)	(0.0201)
Senior worker			0.144**	0.0747**
			(0.0573)	(0.0305)
Manager			0.279***	0.147***
			(0.0688)	(0.0378)
Cons		1.773***		1.811***
		(0.0601)		(0.0768)
cut1	-0.326***		-0.415***	

	(0.104)		(0.142)	
cut2	1.059***		1.041***	
	(0.105)		(0.143)	
Observations	5964	5964	5964	5964

***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

Cluster-robust standard errors are reported in parenthesis.

Liaoning is considered as the reference of locations.

Unemployment is considered as the reference of employment.

Table 4: Result of instrumental variable regression

	(1)	(2)	(3)	(4)
	Preference for spicy foods	Logarithm of per capita family income	Preference for spicy foods	Preference for spicy foods
	OLS	First Stage	IV-2SLS	IV-GMM
Logarithm of per capita family income	-0.0164**		-0.0723*	-0.0723*
	(0.00697)		（0.0377）	（0.0377）
Logarithm of per capita house/apartment worth		0.201***		
		（0.0134）		
F statistics		225.137		
Observations	5964	5964	5964	5964

***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

Cluster-robust standard errors are reported in parenthesis.

Other controlled variables are the same as the ones shown in column (4) in Table 3.

Table 5: Result of Lewbel instrumental variable regression

	(1) Preference for spicy foods OLS	(2) Preference for spicy foods IV	(3) Preference for spicy foods Lewbel-IV-2SLS	(4) Preference for spicy foods Lewbel-IV-GMM
Logarithm of per capita family income	-0.0164**	-0.0723*	-0.0716***	-0.0732***
	(0.00697)	（0.0377）	（0.0201）	（0.0199）
F statistics		225.137	255.248	255.248
Hansen			0.120	0.120
Observations	5964	5964	5964	5964

***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

Cluster-robust standard errors are reported in parenthesis.

Table 6: Result of path analysis

	(1) Health behaviour	(2) Health behaviour	(3) Health awareness	(4) Health capital stock	(5) Food selection	(6) Total	(7) Total
Per capita family income	-0.0155**	-0.0145**	-0.0155**	-0.0165**	-0.0166**	-0.0155**	-0.0143**
	(0.00700)	(0.00709)	(0.00697)	(0.00699)	(0.00702)	(0.00706)	(0.00714)
Smoking	0.0991***	0.102***				0.0966***	0.0990***
	(0.0223)	(0.0230)				(0.0222)	(0.0230)
Attitudes to body building (Reference: dislike very much)							
Have no attitudes	-0.0668					-0.0483	
	(0.0543)					(0.0553)	
Dislike	-0.00483	0.0659				0.00468	0.0568
	(0.0365)	(0.0433)				(0.0375)	(0.0436)
Neutral	0.00556	0.0764*				0.0209	0.0734
	(0.0391)	(0.0457)				(0.0400)	(0.0459)
Like	-0.0175	0.0503				-0.000798	0.0484
	(0.0414)	(0.0476)				(0.0422)	(0.0479)
Like very much	-0.170*	-0.101				-0.161*	-0.116
	(0.0957)	(0.0982)				(0.0971)	(0.0987)
Awareness of the Dietary Guideline (Chinese Pagoda)			0.00693			0.00883	0.00951
			(0.0253)			(0.0254)	(0.0263)
Attitudes to the priority of eating a healthy diet (Reference: not important at all)							
Not very important			-0.0188			-0.0200	-0.0419
			(0.0761)			(0.0770)	(0.0951)
Important			-0.157**			-0.156**	-0.189**
			(0.0663)			(0.0672)	(0.0871)
Very important			-0.183***			-0.180***	-0.218**
			(0.0675)			(0.0685)	(0.0881)
Most important			-0.140*			-0.127	-0.141
			(0.0788)			(0.0803)	(0.0977)
The status of major chronic diseases							
Hypertension				0.0323		0.0376	0.0427
				(0.0278)		(0.0278)	(0.0287)
Diabetes				0.0136		0.0181	0.0260
				(0.0499)		(0.0500)	(0.0512)
Myocardial infarction				0.0990		0.105	0.113
				(0.122)		(0.123)	(0.133)

Apoplexy				-0.123*		-0.133**	-0.145**
				(0.0660)		(0.0655)	(0.0664)
Asthma				-0.0158		-0.0304	-0.0331
				(0.0812)		(0.0815)	(0.0825)
Average intakes of nutrients							
Energy					0.0000179	0.0000154	0.00000732
					(0.0000239)	(0.0000237)	(0.0000243)
Fat					-0.000232	-0.000200	-0.000129
					(0.000230)	(0.000227)	(0.000233)
Protein					0.000243	0.000277	0.000409
					(0.000489)	(0.000485)	(0.000498)
Cons	1.811***	1.743***	1.951***	1.816***	1.773***	1.910***	1.896***
	(0.0837)	(0.0867)	(0.102)	(0.0770)	(0.0816)	(0.108)	(0.127)
Observations	5964	5604	5964	5964	5964	5964	5604

***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

Cluster-robust standard errors are reported in parenthesis.

Table 7 Result of path analysis based on instrumental variables

	(1) Preference for spicy foods OLS	(2) Preference for spicy foods IV	(3) Preference for spicy foods IV	(4) Preference for spicy foods IV	(5) Preference for spicy foods IV	(6) Preference for spicy foods IV	(7) Preference for spicy foods IV
Per capita family income	-0.0164** (0.00697)	-0.0723* （0.0377）	-0.0676* （0.0380）	-0.0634* （0.0382）	-0.0731* （0.0387）	-0.0710* （0.0395）	-0.0537 （0.0393）
Health behaviour			√				√
Health awareness				√			√
Health capital stock					√		√
Food selection						√	√
Observations	5964	5964	5964	5964	5964	5964	5964

***, **, and * indicate statistical significance at the 1%, 5%, and 10% level.

Cluster-robust standard errors are reported in parenthesis.