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M.Sc. Yanjun Ren

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Dean:	Prof. Dr. Joachim Krieter
1. Examiner:	Prof. Dr. Jens-Peter Loy
2. Examiner:	Prof. Dr. Martin Schellhorn
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List of Abbreviations

2SLS	Two Stage Least Square
AIDS	Almost Ideal Demand System
AR	Anderson–Rubin
AUD	Alcohol use disorder
BMI	Body Mass Index
CHIP	Chinese Household Income Project
CHNS	China Health and Nutrition Survey
CLR	Conditional Likelihood-Ratio
GATS	Global Adult Tobacco Survey
GDP	Gross Domestic Product
IV	Instrumental Variable
LM	Moreira Lagrange multiplier
OLS	Ordinary Least Square
QUAIDS	Quadratic Almost-Demand System
TAR	Tibet Autonomous Region
WHO	World Health Organization
XUAR	Xinjiang Uyghur Autonomous Region

Abstract in English

This cumulative dissertation presents five contributions that attempt to shed light on the issues regarding food consumption, income inequality and health in China.

Given the fact that income disparity has become extremely serious in China, chapter 2 and 3 investigate food consumption and the impact of education on income differentials between ethnic minorities and Han. In particular, after estimating a two-stage demand model for different income classes, our empirical results in chapter 2 indicate that there exist substantial differences in food consumption across various income classes, meanwhile, the projected food consumption under different income distribution patterns shows that changes in income distribution have significant influences on food consumption. Thus, we conclude that a more equal income distribution would associate with a higher food demand in rural China. By using an instrumental variable approach to account for the endogeneity of education in income equations, chapter 3 reveals that there exists significant income inequality to the disadvantage of ethnic minorities for the full, female, and urban samples, and depending on the instrument also for the rural sample. Nevertheless, our results for these samples show specific returns to education for ethnic minorities, which implies that a portion of the income gap can be overcome with additional education. It is well-known that alcohol and cigarette consumption can lead to harmful health outcomes and have been increasingly recognized as serious public health concerns worldwide. To implement the most efficient public health policy to control alcohol and cigarette consumption, it is particularly important to understand the relationship between the two goods and the role of education in their consumption. Therefore, chapter 4 and 5 mainly focus on the interdependence between alcohol and cigarette consumption and the impact of education on these unhealthy consumption behaviors and their intergenerational persistence. A structural equation model is applied as an alternative to estimate the interdependence between alcohol and cigarette consumption in case of the absence of price variation. The empirical results indicate that alcohol and cigarettes are complementary goods for men in China; when the demand for alcohol (cigarettes) increases, the demand for cigarettes (alcohol) will also increase, ceteris paribus. From a public health perspective this implies that measures for reducing alcohol or cigarette consumption might have a double dividend effect on health. Moreover, we find that education exerts a negative impact on unhealthy consumption like smoking and binge drinking, when accounting for the endogeneity of education in unhealthy consumption equations. Specifically, an additional year of education decreases the probability of smoking, drinking, and

binge drinking by 3.4%, 2.8%, and 1.8%, respectively. We also find that an additional year of education can counteract intergenerational persistence of smoking and binge drinking from the father, but that it has no significant impact on intergenerational persistence from the mother. In addition, we observe no impact of education on the intergenerational persistence of drinking from both parents. Following our research topic, chapter 6 tends to shed light on the relationship between income and overweight regarded as a consequence of unhealthy food consumption. By using an extended life-course utility model where income serves as a budget constraint and as a source of future health utility, the empirical estimations are conducted for overweight initiation and cessation, as well as participation reflecting a decision to start and previous decisions to not stop. The results suggest that body weight and the probability of overweight initiation increase with income but at a decreasing rate, which indicates an inverted U-shape relationship; while the probability of overweight cessation decreases with income but at an increasing rate, which indicates a U-shape relationship. Our findings conclude that in contrast to developed countries, low-income individuals are less likely to be overweight in a transition country like China. The major reason is probably because of an income constraint for unhealthy food consumption; however, when income exceeds the critical value of the inverted U-shape curve, it reverses because low-income individuals seem to profit less from future health. In particular, this change appears to happen earlier with increasing income for women and urban residents.

Abstract in German

Diese kumulative Dissertation besteht aus fünf Beiträgen, die sich mit den Themen Lebensmittelkonsum, Einkommensungleichheit und Gesundheitsaspekte in China befassen.

Vor dem Hintergrund, dass sich die Einkommensungleichheit in China dramatisch entwickelt hat, werden in den Kapiteln 2 und 3 vor allem der Lebensmittelkonsum und der Einfluss von Bildung auf die Einkommensungleichheit bei ethnischen Minderheiten und Han-Chinesen untersucht. Nach dem Schätzen eines zweistufigen Nachfragemodells für verschiedene Einkommensklassen weisen insbesondere unsere empirischen Resultate in Kapitel 2 daraufhin, dass es über verschiedene Einkommensklassen substantielle Unterschiede beim Lebensmittelkonsum gibt; darüber hinaus zeigt der projizierte Lebensmittelkonsum unter Verwendung verschiedener Verteilungsmuster, dass Veränderungen in der Einkommensverteilung signifikanten Einfluss auf den Lebensmittelkonsum haben. Daraus schließen wir, dass eine höhere Einkommensgleichheit mit einer höheren Lebensmittelnachfrage im ländlichen China einhergehen würde. Unter Verwendung eines Instrumentalvariablenansatzes zur Berücksichtigung der Endogenität von Bildung in Einkommensgleichungen weisen die Ergebnisse in Kapitel 3 darauf hin, dass eine bedeutende Einkommensungleichheit zum Nachteil von ethnischen Minderheiten für die gesamte, die weibliche und die urbane Bevölkerung existiert. Abhängig vom angewandten Verfahren gilt dies auch für die ländliche Bevölkerung. Nichtsdestotrotz zeigen unsere Ergebnisse für diese Gruppen einen besonderen Nutzen der Bildung für ethnische Minderheiten, was darauf hinweist, dass ein Teil der Einkommenslücke mit zusätzlicher Bildung überwunden werden kann. Wie bekannt ist, können Alkohol- und Zigarettenkonsum zu Gesundheitsschäden führen und werden zunehmend als ernste Probleme für die Volksgesundheit weltweit erkannt. Um die effizienteste Gesundheitspolitik zur Kontrolle von Alkohol- und Zigarettenkonsum zu implementieren, ist es besonders wichtig, das Verhältnis zwischen den beiden Gütern und die Rolle der Bildung bei ihrem Konsum zu verstehen. Daher konzentrieren sich Kapitel 4 und 5 hauptsächlich auf die Wechselbeziehung zwischen Alkohol- und Zigarettenkonsum und auf den Einfluss der Bildung in Bezug auf diese ungesunden Konsumgewohnheiten sowie auf ihre Tradierung von Generation zu Generation. Alternativ wird ein strukturelles Gleichungsmodell angewandt, um die Wechselwirkung von Alkohol- und Zigarettenkonsum zu schätzen. Wenn keine Preisänderungen vorliegen, zeigen die empirischen Ergebnisse, dass Alkohol und Zigaretten für Männer in China

komplementäre Güter darstellen. Wenn die Nachfrage nach Alkohol (Zigaretten) steigt, steigt auch die Nachfrage nach Zigaretten (Alkohol), ceteris paribus. Aus der Sicht des öffentlichen Gesundheitswesens bedeutet dies, dass Maßnahmen zur Eindämmung des Alkohol- oder des Zigarettenkonsums möglicherweise einen doppelt positiven Effekt auf die Gesundheit haben. Mehr noch, wir stellen fest, dass Bildung ungesunden Konsum wie Rauchen und Komatrinken bremst, wenn wir Endogenität von Bildung bei den Gleichungen in Bezug auf den ungesunden Konsum begründen. Insbesondere minimiert ein weiteres Bildungsjahr die Wahrscheinlichkeit von Rauchen, Trinken und Komatrinken um 3,4 %, 2,8 % beziehungsweise um1,8%. Wir stellen außerdem fest, dass ein zusätzliches Bildungsjahr die Tradierung von Rauchen und Komatrinken von einer Generation zur nächsten bei väterlichem, nicht aber bei mütterlichem Konsum verhindern kann. Außerdem ist kein Zusammenhang zwischen Bildung und Tradierung bei Konsum durch beide Elternteile feststellbar. Unserem Forschungsgebiet folgend untersuchen wir in Kapitel 6 das Verhältnis von Einkommen und Übergewicht als Folge von ungesundem Lebensmittelkonsum. Unter Anwendung eines erweiterten Lebenszyklus-Nutzwert Modells, in dem das Einkommen als Budgetbegrenzung dient und als eine Quelle des künftigen Gesundheitsnutzens, werden die empirischen Schätzungen für Beginn und Ende von Übergewicht durchgeführt wie auch für die Teilnahme unter Berücksichtigung der Entscheidung zu beginnen und einer früheren Entscheidung nicht aufzuhören. Die Ergebnisse weisen darauf hin, dass Körpergewicht und die Wahrscheinlichkeit von beginnendem Übergewicht mit dem Einkommen zunehmen aber mit abnehmender Geschwindigkeit, was auf eine umgekehrte U-Form-Beziehung hinweist; während die Wahrscheinlichkeit einer Beendigung des Übergewichts mit dem Einkommen abnimmt, aber mit zunehmender Geschwindigkeit, was auf eine U-Form-Beziehung deutet. Aus unseren Resultaten ist zu schließen, dass im Gegensatz zu entwickelten Ländern, Individuen mit einem niedrigen Einkommen in einem Schwellenland wie China mit geringerer Wahrscheinlichkeit übergewichtig sind. Der Hauptgrund dafür ist wahrscheinlich ein geringes Einkommen, das ungesunden Lebensmittelkonsum beschränkt. Wenn aber das Einkommen einen kritischen Wert auf der umgekehrten U-Form Kurve überschreitet, verkehrt sich dieses, da Individuen mit niedrigerem Einkommen weniger von künftiger Gesundheit zu profitieren scheinen. Dieser Wechsel scheint sogar früher einzutreten, wenn das Einkommen von Frauen und der städtischen Bevölkerung steigt.

Chapter 1

Introduction and Summary

Since China has implemented its Reform and Opening up policy to liberalize its markets and trade, the economy has experienced sustained growth, especially after becoming a member of the WTO. Chinese agriculture has witnessed drastic and rapid transformation over the past decades. The fast-changing process is expected to continue in the near future. Especially, in recent years the government has increasingly invested in improving the infrastructure and living standards in rural areas, which has driven a strong increase in farmers' household income. In 2015 farms' household average net income reached 11,422 Yuan, with a nominal growth rate of 8.9% and an actual growth rate of 7.5% compared to 2014, both of which tend to increase gradually[1].

However, as income increases, income disparity has become more serious in recent decades. According to the World Bank, the Gini coefficient increased from 0.26 in 1984 to 0.47 in 2004 in China and has approached 0.5 in recent years, which is almost the same as that of relatively high-inequality Latin American countries. Specifically, the rural Gini coefficient increased from 0.21 to 0.37 between 1978 and 2006 showing an unambiguous upward trend (Sutherland and Yao 2011), and is reported to have been 0.60 in 2012.[2] In terms of the distribution of disposable income among rural household, the share of the bottom 20% is about 6.3%, whereas the share of the top 20%

[1] The data are taken from National Bureau of Statistics of China (NBSC).

[2] This is according to The Report of Income Gap in China, China Household Finance Survey.

accounts for about 43.5% in 2004 (Zheng and Henneberry 2010a). Although the government has taken measures to alleviate inequality and poverty, the poorest are not correctly targeted in many cases; this leads to even higher poverty and inequality levels in rural China (Wu et al. 2015). As seen in the above discussion, to a large extent, economic development in China has generally favored the wealthier members of society, especially in rural areas.

Some studies (Park et al. 1996; Pinstrup-Andersen and Caicedo 1978; Raunikar et al. 1985), and specifically one study by Zheng and Henneberry (2010) in urban China have revealed that different income distribution may cause a varying demand system. Thus, in the first contribution, we hypothesize that in societies such as China, where visible changes have occurred in income distribution, food demand projections should take into account the expected changes in income distribution, rather than using average estimates of price and income elasticities for the whole population.

Meanwhile, income inequality is also pronounced along racial and ethnic lines in many countries, as well as in China. With the foundation of the People's Republic of China in 1949, the government started to reclassify ethnic groups and autonomous areas and progressively set up a preferential policy framework. Fifty-five ethnic minorities alongside the Han-majority have been classified since 1949. Regarding income differentials between ethnic minorities and Han, the literature suggests differences in human capital, household and regional characteristics as the major determinants. For instance, comparing differences in occupational attainment between ethnic minorities and Han in Xinjiang Uyghur Autonomous Region (XUAR), Hannum and Xie (1998) find an increasing gap in occupational attainment between ethnic minorities and Han over time. Gustafsson and Li (2003) indicate an increasing income gap of 19.2% in 1988 to 35.9% in 1995, indicating lower income levels for ethnic minorities. Similarly, Johnson and Chow (1997) find that ethnic minorities in rural and urban areas earn approximately 19% and 4.5% less than Han, respectively. Li (2003) discovers that ethnic minorities earn 9% less than Han. Actually China has implemented a very advanced preferential policy framework to tackle labor market discrimination and ethnic inequalities, but one look into the Xinjiang Uyghur Autonomous Region (XUAR) and the Tibet Autonomous Region (TAR) tells us how poorly these policies have been enforced (Gilley 2001, Yee 2003, Hillman 2008).

Since education as a crucial human capital determinant in income equations (Mincer 1974),[4] more education is generally regarded as a major factor for finding "better jobs" and earning higher incomes. Income gaps between ethnic groups can largely be attributed to in-between-group differentials and labor market discrimination in job access and wages. The major in-between-group differential is educational attainment. In the second contribution, the main hypothesis of our study is that returns to education might be higher for ethnic minorities with more education because of the scarcity of ethnic minorities with higher educational attainments in the Chinese labor market (Ding 2006, Hannum 1999, 2002); this means that one additional year of education for ethnic minorities will lead to more additional income increase for ethnic minorities in comparison to Han with the same years of education.

Moreover, the overall health risk behavior is more prevalent for low-income individuals than for other socioeconomic groups (see Lantz et al., 1998) in developed countries. It is claimed that income generally has a positive correlation with health-related behaviors (Benzeval et al. 2000; Binkley 2010; Jolliffe 2011); thus, individuals with lower income tend to make less healthy consumption choices. As a consequence, they are more likely to suffer from nutrition-related health problems such as overweight and obesity (Ball and Crawford 2005; Sobal and Stunkard 1989). However, the opposite is true for developing countries. For example, a number of studies shows that overweight is relatively more widespread among high-income individuals (Popkin (1999); Monteiro et al. (2004), as well as Fernald (2007).

With the development of the economy and increasing incomes, calorie consumption has been enhanced (Ogundari and Abdulai 2013); consequently, overweight and obesity have risen and become major health challenges in many developing countries (B. M. Popkin 1999; B. Popkin and Ng 2007). In China the diet has been shifting away from high-carbohydrate food towards high-energy density food (Batis et al. 2014; Du et al. 2004), which is an important cause of overweight. One recent study by Tafreschi (2015) shows that approximately 30% of individuals in China are overweight or obese in recent years. Thus, in the last contribution, we argue that in a transition economy like China the relationship between the consequences of unhealthy food consumption and income might be mixed with the situation in developing and developed societies.

Besides concerning the food consumption, the health-related consumption behaviors such as smoking and drinking are increasingly recognized as serious public health concerns worldwide. In

specific, there are over 300 million cigarette smokers in China who consume roughly one-third of the world's cigarettes (WHO, 2015); 1.4 million people in China die annually from smoking-related diseases, and this number is expected to rise to over 3 million by 2050 if current smoking rates will continue (Yang et al. 2015). In term of alcohol consumption, according to the WHO the total recorded alcohol per capita (15+ years) consumption of pure alcohol is increasing from 3.31 liters in 2000 to 5.75 liters in 2010. Specifically, the consumption on spirit is still the leading alcohol consumption type taking up about 69% among the different type of the alcohol consumption in 2010 (beer, 28%; wine, 3%).

As the harmful health outcomes from alcohol and cigarette consumption have been well documented (Bazzano et al. 2007; Cochrane et al. 2003; Deng et al. 2006; Hao et al. 2004; Ruitenberg et al. 2002), a number of policies have been introduced to restrict alcohol and cigarette consumption, particularly in developed countries. Policies aimed at reducing alcohol-related problems include taxation, consumption restriction for the underage and limited availability of alcoholic beverages. National legislators have begun to actively consider national bans on smoking in public and work places as well as on cigarette advertising.

Nevertheless, tobacco control in China has remained particularly cumbersome because of the tobacco industry. There is, however, no comprehensive public health policy in China for reducing alcohol-consumption (Hao et al. 2005); for example, there is no official age-limit for purchasing or consuming alcohol. Alcohol use is, thus, also prevalent among adolescents in China (X. Li et al. 1996). An efficient public health policy that seeks to minimize citizens' burden and to maximize welfare gains should consider the relationship between alcohol and cigarette consumption. Due to insufficient price variation, the approach starting with a structural equation model that was introduced by Tauchmann et al. (2013) is used in the third contribution to better understand the relation between alcohol and cigarette consumption in China.

Given the limited empirical research into the situation in China, this cumulative dissertation consists of five independent contributions that empirically analyze food consumption, income inequality, as well as health-related issues such as alcohol and cigarette consumption, as well as overweight. The first study (Chapter 2) is devoted to examine heterogeneity in food consumption among various income classes and to investigate the impact that changes in income distribution patterns have on food demand in rural China. The second study (Chapter 3) investigates the impact

of education on income inequality between ethnic minorities and Han in China by using an instrumental variable approach to account for the endogeneity of education in income equations. The third study (Chapter 4) attempts to shed light on the relationship between cigarette and alcohol consumption using a structural equation model. The fourth study (Chapter 5) addresses how education impacts the unhealthy consumption behaviors and their intergenerational persistence. The last study (Chapter 6) provides a theoretic model and empirical estimation to detect how income affects overweight regarded as a consequence of unhealthy food consumption.

Each study is summarized below. The summary includes the aim of the contribution, the data, the methods applied, and the main results. The main conclusions, policy implications, and limitations of each contribution are presented in Chapter 7.

Heterogeneity in food consumption among income classes in rural China

Given the fact that income disparity has become extremely serious in rural China, the primary objectives of this study are to examine heterogeneity in food consumption among various income classes and to investigate the impact that changes in income distribution patterns have on food demand in rural China.

We partition the households into five income classes according to the distribution of household per capita net income. Using household data drawn from the China Health and Nutrition Survey (CHNS) in 2011, a two-stage demand model is applied to estimate a food demand system for each of the income classes. After obtaining the estimated income elasticities of eight studied food groups for each income class, we then examine the responsiveness of food demand to the changes in income distribution.

Our empirical results indicate that there exist substantial differences in food consumption across various income classes. Specifically, the lowest-income households are more sensitive to price and income changes than the highest-income households for all the studied food groups. In general, income responsiveness is higher for meats, aquatic products, and particularly for dairy products. Based on estimated income elasticities, the projected food consumption under different income distribution patterns shows that changes in income distribution have significant influences on food consumption. In addition, we conclude that more equal distribution in income would associate with higher demand for food in rural China.

The impact of education on income inequality between ethnic minorities and Han in China

This article analyzes the impact of education on income inequality between ethnic minorities and Han in China by using the data from the China Health and Nutrition Survey (CHNS) over the period 1993-2011. An instrumental variable approach using two institutional changes is applied to address the endogeneity of education in income equations for various subsamples. To investigate the impact of education on income inequality between ethnic minorities and Han, we introduce an interaction term between the ethnic minority status and years of education.

Our results suggest that there exists significant income inequality to the disadvantage of ethnic minorities for the full, female, and urban samples, and depending on the instrument also for the rural sample. Nevertheless, our results for these samples show specific returns to education for ethnic minorities, which implies that a portion of the income gap can be overcome with additional education. We find that in general one additional year of education will increase earned incomes of ethnic minorities by 26.3-28% and in particular by 13.5-14.4% for women from an ethnic minority group, by 10.4-14% for ethnic minorities with urban household registration, and by 10.8% for ethnic minorities with rural household registration. However, we cannot obtain conclusive results for the male sample due to weak instruments.

Drink and smoke; drink or smoke? – The interdependence between alcohol and cigarette consumption for men in China

The interdependence between alcohol and cigarette consumption has received little attention in the literature on consumer behavior, particularly in transition economies such as China. The available literature generally addresses the interdependence between alcohol and cigarette consumption by estimating demand systems; however, in our case data on price variation and price information for a specific consumer are limited. A structural equation model is applied as an alternative to estimate the interdependence between alcohol and cigarette consumption with absence of price variation, using parental consumption patterns as instrumental variables for offspring's consumption. The empirical investigation is conducted by using the data from the China Health and Nutrition Survey (CHNS) over the period from 1993 to 2011.

The results indicate that alcohol and cigarettes are complementary goods for men in China. When the demand for alcohol (cigarettes) increases, the demand for cigarettes (alcohol) will also increase,

ceteris paribus. From a public health perspective this implies that measures for reducing alcohol or cigarette consumption might have a double dividend effect on health.

Unhealthy consumption behaviors and their intergenerational persistence: the role of education

This paper investigates the impact of education on unhealthy consumption behaviors and their intergenerational transmissions, using data from the China Health and Nutrition Survey (CHNS). After identifying a statistically significant positive correlation between filial and parental unhealthy consumption behaviors, an instrumental model is employed to account for the endogeneity of education in unhealthy consumption equations.

We find that education has a negative impact on unhealthy consumption for all individuals considered in the sample. Specifically, an additional year of education decreases the probability of smoking, drinking, and binge drinking by 3.4%, 2.8%, and 1.8%, respectively. We also find that an additional year of education can counteract intergenerational persistence of smoking and binge drinking from the father, but that it has no impact on intergenerational persistence from the mother. In addition, we observe no impact of education on the intergenerational persistence of drinking from both parents.

Low-Income and Overweight in the Transition Economy of China?

Evidence from a Life-Course Utility Model

Previous literature has shown that low-income individuals are more likely to make poor health choices in developed countries. From an extended life-course utility model where income serves as a budget constraint and as a source of future health utility, we attempt to investigate the relationship between income and overweight.

The empirical estimations are conducted for overweight initiation and cessation, as well as participation reflecting a decision to start and a previous decision to not stop. The data used for this research is from the China Health and Nutrition Survey (CHNS). The results suggest that body weight and the probability of overweight initiation increase with income but at a decreasing rate, which indicates an inverted U-shape relationship; while the probability of overweight cessation decreases with income but at an increasing rate, which indicates a U-shape relationship.

Our findings conclude that in contrast to developed countries, low-income individuals are less likely to be overweight in a transition country like China. The major reason is probably because of an income constraint for unhealthy food consumption; however, when income exceeds the critical value of the inverted U-shape curve, it reverses because low-income individuals seem to have less utility from future health. In particular, this change appears to happen earlier with increasing income for women and urban residents.

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Chapter 2

Heterogeneity in Food Consumption among Income Classes in Rural China

Yanjun REN[1], Yanjie ZHANG[2], Jens-Peter LOY[3], Thomas GLAUBEN[4]

[1,3] Department of Agricultural Economics, University of Kiel, Germany.
[2,4] Leibniz Institute of Agricultural Development in Transition Economies (IAMO), 06120 Halle (Saale), Germany.

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Abstract

Given the fact that income disparity has become extremely serious in rural China, the primary objectives of this study are to examine heterogeneity in food consumption among various income classes and to investigate the impact that changes in income distribution patterns have on food demand in rural China. In this study, we partition the households into five income classes according to the distribution of household per capita net income. Using household data drawn from the China Health and Nutrition Survey (CHNS) in 2011, a two-stage demand model is applied to estimate a food demand system for each of the income classes. After obtaining the estimated income elasticities of eight studied food groups for each income class, we then examine the responsiveness of food demand to the changes in income distribution. Our empirical results indicate that there exist substantial differences in food consumption across various income classes. Specifically, the lowest-income households are more sensitive to price and income changes than the highest-income households for all the studied food groups. In general, income responsiveness is higher for meats, aquatic products, and particularly for dairy products. Based on estimated income elasticities, the projected food consumption under different income distribution patterns shows that changes in income distribution have significant influences on food consumption. In addition, we conclude that more equal distribution in income would associate with higher demand for food in rural China.

Keywords: Income distribution, food demand, expenditure elasticity, price elasticity, rural China.

2.1 Introduction

Since China has implemented its Reform and Opening up policy to liberalize its markets and trade, the economy has experienced sustained growth, especially after becoming a member of the WTO. In recent years the government has increasingly invested in improving the infrastructure and living standards in rural areas, which has driven a strong increase in farmers' household income. In 2015 farms' household average net income reached 11,422 Yuan, with a nominal growth rate of 8.9% and an actual growth rate of 7.5% compared to 2014, both of which tend to increase gradually[3]. J. Huang, Yang, and Rozelle (2011) concluded that rising income, urbanization, and market liberalization has significantly changed the Chinese diet and consumption patterns. As Zhang et al. (2012) reported, these notable changes include a greater demand for food, a demand for a more diverse range of food, and a demand for higher-quality food. This is supported by other studies, which have found that households in rural China tend to consume more meats (Halbrendt et al. 1994; Fan et al. 1995) and other higher-quality foods (Yu and Abler 2009) as incomes increase.

However, as income increases, income disparity has become more serious in recent decades. According to the World Bank, the Gini coefficient increased from 0.26 in 1984 to 0.47 in 2004 in China and has approached 0.5 in recent years, which is almost the same as that of relatively high-inequality Latin American countries. Specifically, the rural Gini coefficient has increased from 0.21 to 0.37 between 1978 and 2006 showing an unambiguous upward trend (Sutherland and Yao 2011), and is reported to have been 0.60 in 2012.[4] In terms of the distribution of disposable income among rural households, the share of the bottom 20% is about 6.3%, whereas the share of the top 20% accounts for about 43.5% in 2004 (Zheng and Henneberry 2010). Although the government has taken measures to alleviate inequality and poverty, the poorest are not correctly targeted in many cases; this leads to even higher poverty and inequality levels in rural China (Wu et al. 2015). As seen in the above discussion, to a large extent, economic development in China has generally favored the wealthier members of society, especially in rural areas.

Given the high level of income inequality in rural China, research has attempted to answer the following question: Are there any differences in food consumption for various income classes that can help us to understand the structure of food consumption and that provides policy implications

[3] The data are taken from the National Bureau of Statistics of China (NBSC).

[4] This is according to The Report of Income Gap in China, China Household Finance Survey.

to improve the welfare of rural households, especially for the lowest-income households? However, the evidence from previous studies is mixed from this perspective. For instance, Han, Cramer, and Wahl (1997) found that households in different income groups share an identical food demand system. Similar results can be found in Han and Wahl (1998), who showed that different income groups share a common demand function for fruit and vegetables. Contrary to the aforementioned empirical work, Zhou, Wu, and Tian (2003) declared that the consumption level of animal products by higher-income groups is substantially higher than that of lower-income groups, and Huang and Gale (2009) also showed that the demand for animal products in China is strongly related to income in low-income classes, while the relationship tends to weaken as income grows; these results are similar to a study carried out by Zheng and Henneberry (2011) in urban China. Although extensive research has been done on food demand in China, to the best of our knowledge, no existing study attempts to investigate the food demand for different income classes according to income distribution in rural China.

Using a data set drawn from the China Health and Nutrition Survey (CHNS) in 2011, we partition the sample into five income classes according to household per capita disposal income. We apply a two-stage demand model to estimate a demand system for five income classes. A Working–Leser model is employed in the first stage to obtain the income and price elasticity for the studied food; in the second stage, a quadratic almost-demand system (QUAIDS) is used to estimate expenditure and price elasticities for each food group. Afterwards, unconditional price and income elasticities for each food group are calculated and discussed.

Some studies (Park et al. 1996; Pinstrup-Andersen and Caicedo 1978; Raunikar et al. 1985), and specifically one study by Zheng and Henneberry (2010) in urban China have revealed that different income distribution may cause a varying demand system; thus, the second objective of this study is to investigate the responsiveness of food demand to the changes in income distribution in rural China. We hypothesize that in societies such as China, where visible changes have occurred in income distribution, food demand projections should take account the expected changes in income distribution, rather than using average estimates of price and income elasticities for the whole population. Finally, as a comparison, we also provide the demand projections for studied food groups in the next decades when maintaining current income distribution and growth.

This study is organized as follows. In the next section, we will provide a brief introduction about the two-stage demand model and the estimation procedures. Section 3 describes the data used in this study. Section 4 presents the estimation results, while the findings appear in Section 5.

2.2 Econometric model

2.2.1 First-stage demand model

In the first stage, a household decides how to allocate their budget to food and non-food commodities. We follow the Working–Leser model (Working 1943) and extend it with a quadratic term as shown in Eq. (1), which is similar to the formula used by Ecker and Qaim (2008) and Khanal, Mishra, and Keithly (2016):

$$w_F = \alpha_F + \gamma_F ln\, p_F + \beta_F\, ln\, M + \lambda_F (ln\, M)^2 \tag{1}$$

where w_F is the share of studied food expenditure in household per capita disposal income (M), and p_F is the aggregated food price computed as stone price index. To control for the effects of socio-demographic factors on food budget share, we implement a linear demographic translation through the intercept (Pollak and Wales 1981), where $\alpha_F = \alpha_0 + \sum_{k \epsilon K} \delta_k z_k$, z_k is a vector of variables representing household characteristics that include household size, regional dummy, ratio of seniors, and ratio of children. This model can be estimated by using an OLS regression. After obtaining all the parameters, we then calculate the income elasticity, and uncompensated (Marshallian) price elasticities for total food through Equations (2)-(3) as follows:

$$\eta_F = 1 + \frac{\beta_F}{\omega_F} + \frac{2\lambda \ln M}{\omega_F}, \tag{2}$$

$$\varepsilon_F = -1 + \frac{\gamma_F}{\omega_F}. \tag{3}$$

2.2.2 Second-stage demand system

In the second stage, we address the question of how households consume each food group under their food expenditure constraints. Deaton and Muellbauer (1980) developed the widely-used Almost Ideal Demand System (AIDS), and Banks, Blundell, and Lewbel (1997) further extended this system by proposing a quadratic almost ideal demand system (QUAIDS) that allows goods to be luxuries at low levels and necessities at higher levels of total expenditure. The budget shares in the QUAIDS are given as:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} lnp_j + \beta_i \, ln\left[\frac{m}{a(p)}\right] + \frac{\lambda_i}{b(p)}\left\{ln\left[\frac{m}{a(p)}\right]\right\}^2 \quad (4)$$

where w_i is the budget share of ith food item; subscript i and j indicate goods, n is the number of the studied goods in the system; p_j and m are prices of food commodity group j and total expenditure for the studied food, respectively. Further, α_i, β_i, γ_{ij} and λ_i are parameters to be estimated, with a special case existing when $\lambda_i's$ are zero, the QUAIDS reduces to AIDS, where *lna(p)* is the translog of the price index and is defined as

$$\mathrm{lna(p)} = \alpha_0 + \sum_{j=1}^{n} \alpha_j \mathrm{lnp_j} + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} \mathrm{ln\, p_i lnp_j}, \quad (5)$$

and *b(p)* is the Cobb-Douglas price aggregator,

$$\mathrm{b(p)} = \prod_{i=1}^{n} \mathrm{p_i}^{\beta_i}. \quad (6)$$

Then, the adding-up condition, homogeneity, and Slutsky symmetry require:

$$\sum_{i=1}^{n} \alpha_i = 1, \ \sum_{i=1}^{n} \beta_i = 0, \sum_{i=1}^{n} \lambda_i = 0, \ \sum_{i=1}^{n} \gamma_{ij} = 0., \quad (7)$$

$$\sum_{j=1}^{n} \gamma_{ij} = 0., \ \text{and} \quad (8)$$

$$\gamma_{ij} = \gamma_{ji}, \ i \neq j. \quad (9)$$

In addition to prices and income effects, we also need to control for the effect of demographic variables on the food demand system. There are several ways to get around this problem; we follow the procedure derived by Poi (2012), each household's expenditure function is expressed with z as a vector of s characteristics as follows:

$$e(p, z, u) = m_0(p, z, u)^* e^{R(p,u)}, \quad (10)$$

where $m_0(p,z,u)$ scales the expenditure function to account for household characteristics. Then Equation (10) can be decomposed as

$$m_0(p, z, u) = \overline{m_0}(z) * \emptyset(p, z, u). \quad (11)$$

The first term measures the increase in the household's expenditure as a function of the z vector not controlling for any changes in the consumption pattern, while the second

term controls for changes in relative prices and actual goods consumed. Poi (2012) specified the parameterization of the above function in QUAIDS as

$$\overline{m_0}(z) = 1 + \rho' z, \text{ and} \tag{12}$$

$$\ln\emptyset(p,z,u) = \frac{\prod_{j=1}^{k} p_j^{\beta_j} (\prod_{j=1}^{k} p_j^{\eta_j' z} - 1)}{\frac{1}{u} - \sum_{j=1}^{k} \lambda_j ln p_j}, \tag{13}$$

where η_j' represents the *j*th column of *s*k* parameter matrix η. Finally, the expenditure share equation with demographic variables follows the below equation form (Poi 2012),

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} ln p_j + (\beta_i + \eta_i' z)\, ln\left[\frac{m}{\overline{m_0}(z)a(p)}\right] + \frac{\lambda_i}{b(p)c(p,z)}\left\{ln\left[\frac{m}{\overline{m_0}(z)a(p)}\right]\right\}^2, \tag{14}$$

where $(p,z) = \prod_{j=1}^{k} p_j^{\eta_j' z}$, and imposing adding-up requires $\sum_{j=1}^{k} \eta_{rj} = 0$ for *r=1,2,....s*. The uncompensated price elasticity of good *i* with respect to changes in the price of good *j* can be described as

$$\varepsilon_{ij}^{M} = -\delta_{ij} + \frac{1}{\omega_i}\left(\gamma_{ij} - \left[\beta_i + \eta_i' z + \frac{\lambda_i}{b(p)c(p,z)} \ln\left(\frac{m}{\overline{m_0}(z)a(p)}\right)\right] * \left(\alpha_i + \sum_{j=1}^{n} \gamma_{ij} ln p_j\right) - \frac{(\beta_j + \eta_i')\lambda_i}{b(p)c(p,z)}\left(\ln\left(\frac{m}{\overline{m_0}(z)a(p)}\right)\right)^2\right), \tag{15}$$

where δ_{ij} is defined such that $\delta_{ij} = 0$ for *i=j* and $\delta_{ij} = 1$ for $i \neq j$.

The expenditure elasticity for good *i* is given by

$$\eta_i = 1 + \frac{1}{\omega_i}\left[\beta_i + \eta_i' z + \frac{\lambda_i}{b(p)c(p,z)} \ln\left(\frac{m}{\overline{m_0}(z)a(p)}\right)\right]. \tag{16}$$

The price and income elasticities from second-stage are conditional on the first-stage. Following the procedures introduced by Carpentier and Guyomard (2001), and widely used by Boysen (2012) and Khanal, Mishra, and Keithly (2016), we calculate unconditional income and price elasticities for each food group based on the two-stage demand system estimation, and the unconditional expenditure elasticities are given by

$$\eta_i^U = e_i \eta_F, \tag{17}$$

and unconditional Marshallian price elasticities are

$$\varepsilon_{ij}^{U,\mathrm{u}} = \varepsilon_{ij} + w_{j|\mathrm{F}}\left(\frac{1}{e_j} + \varepsilon_F\right) \times e_i e_j + \mathrm{w}_F w_{j|\mathrm{F}} \eta_F e_i \times \left(e_j - 1\right),. \tag{18}$$

where $w_{j|F}$ denotes the budget share of the *j*th food commodity in the second stage.

To achieve the second objective of this study, the estimated income elasticities are used to project the demand for each group under the different hypothetical changes in income and income distribution. As discussed by Zheng and Henneberry (2010), several assumptions need to be noticed when making these projections. For example, the prices of foods and the consumer's preference are assumed to be unchanged for each income class, population size is assumed to be consistent, while the effects associated with population migration from rural to urban and market development are not considered. Thereby, the changes in food demand are solely caused by changes in income and income distribution. The simulated impact of changes in income distribution on the quantity consumed of each studied food group is estimated based on the following equation:

$$\Delta Q_{i(c)} = \left(\frac{\Delta M}{M}\right)_c E_{M,i(c)} q_{i(c)}^0 N_C \ , \tag{19}$$

where $\Delta Q_{i(c)}$ represents the change of total quantity consumed of food group *i* for the households in income class *C* as a result of income changes in that class; $\left(\frac{\Delta M}{M}\right)$ represents the changes in income in class *C*; $E_{M,i(c)}$ are the income elasticities for *i*th food commodity in class *C*; $q_{i(c)}^0$ is the current average quantity consumed of food group *i* for each household in class *C*; N_C is the number of households in class *C*.

The last objective of this study is to project the quantity consumed in upcoming decades if maintaining current income growth and income distribution levels. Using estimates of price and income elasticities, we can project the change of each food group as income and price change through the equation proposed by Park et al (1996),

$$\%\Delta Q_i = \sum_{j=1}^{n} \varepsilon_{ij} \%\Delta P_j + \eta_i^U \%\Delta y \ \ , \quad (i, j = 1, 2, \ldots, n) \ , \tag{20}$$

where ε_{ij} indicate the various price elasticities, and η_i represents the estimated income elasticity for food commodity *i*. Therefore, given the percentage changes in price and income, the change in quantity consumed can be calculated accordingly. With the assumption of unchanged prices, here we solely examine how uniform income growth influences the food consumption in upcoming decades. It should be noted that the projections from a uniform increase in income would be biased

when significant changes occurred in income distribution in the future, but it still provides an overview for future food demand.

2.3 The data

The data used in this study is drawn from China Health and Nutrition Survey (CHNS), coordinated by the Carolina Population Centre, Chapel Hill, USA, which was designed to examine the effects of the health- and nutrition-related issues in China, and to detect how the social and economic transformation of Chinese society is affecting the health and nutritional status of its population. Using a multistage, random cluster process to draw a sample of roughly 4,400 households with a total of 26,000 individuals, the CHNS was initially conducted in nine provinces: Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong, which are substantially different in geography, economic development, and public resources, as well as food consumption. Thus, the data has been widely used to conduct research on food, nutrition, and health-related research issues in China (Batis et al. 2014; L. Chen and Cheung 2013; Popkin and Du 2003; Zhong et al. 2012). In 2011, three additional municipal cities, Beijing, Chongqing, and Shanghai were included; this increased the sample size to around 6,000 households covering more than 30,000 individuals.

In the dietary questionnaire, the dietary assessment is a combination of three consecutive 24-hour periods at the individual level. The three consecutive days were randomly allocated to start from Monday to Sunday. For the 24-hour recall, respondents recorded the types, amounts, types of meal and place of consumption of all food consumed.[5] Based on an individual's consumption amount, household yearly food consumed quantities are computed and aggregated under eight main food groups, namely grains, vegetables, oil and fat, meats (pork, beef, mutton, and poultry), eggs, aquatic products, dairy products, and fruits.

Moreover, CHNS conducted a detailed community survey consisting of food market information such as infrastructure, services, and organization, as well as the prices of foods at the community levels. Using an adjusted free market price for each specific food commodity from CHNS, food expenditure is calculated by multiplying quantity consumed with free market prices (Burggraf et

[5] See Batis et al. (2014) and Zhai et al. (2014) for more details.

al. 2015), and then the value-weighted price index for each food group can be obtained by the following equation (Khanal et al. 2016):

$$\overline{P_g} = \sum_{i=1}^{k} \frac{V_i^g}{V_g} * P_i, \tag{21}$$

where $\overline{P_g}$ represents the price index for food group *g,* and *g=1,2…7,8.* $\frac{V_i^g}{V_g}$ represents the value-weighted share of food item *i* in group *g,* and P_i represents the price of food item *i.*

After matching the household food consumption data with related data sets and deleting the outliers, we keep 2,908 households in the rural area for this study. In accordance with the standard of division by China's National Bureau of Statistics for rural households, we equally divide our sample into five classes based on the distribution of household per capita disposal income. The description of yearly per capita food consumption, income, food expenditure, and socio-demographics among the different income classes for the sample in rural China is reported in Table 2.1. Firstly, in the view of the quantities of foods consumed by rural households, as expected, there exists significant inequality in food consumption, especially for meats, aquatic products, dairy products, and fruits, which show an upward trend with income increases. Obviously the consumption of meats, aquatic products, and fruits for the highest-income class (C5) is considerably higher than that for the lowest-income class (C1); this suggests a higher potential for growth in demand for these food groups in lower-income households. In addition, grains, vegetables, oil and fat consumption initially increase and then decrease gradually across income classes. For instance, the consumption of grain, a staple food in the Chinese diet, reaches the highest level of around 138.89 kg for the lower-income class of C2, but for the highest-income class it drops to 128.73 kg, indicating that the higher-income class tends to consume less staple foods than the lower-income classes do. Secondly, there exists a substantial difference in income across various classes, for instance, per capita disposal income of the highest-income class is approximately ten times more than that of the lowest-income group, indicating remarkable income inequality in rural China. However, in terms of expenditure on studied foods, the highest-income households spent only around 900 CNY more than the lowest-income households did; this illustrates that the differences in food expenditure across various income classes are not as large as income, which is similar to the evidence from urban Jiangsu in China (Zheng and Henneberry 2010). Finally, regarding the expenditure shares presented in Table 2.1, the share of food expenditure in household per capita net income decreases

from 0.634 for the lowest-income group to 0.120 for the highest-income group. This suggests that food expenditure plays a dominant role in household income for the lowest-income households. The share of each food commodity in total food expenditure proves that, in general, grains, vegetables, and meats are the main food resources for rural households. In particular, the share of grain consumption is approximately 37 percent for the lowest-income class, indicating a strongly monotonous diet for the lowest-income households.

As shown in the bottom part of Table 2.1, lower-income households are more likely to have a larger household size and a higher ratio of children and seniors. Most of the middle- and highest-income households live in the south of China, which clearly indicates the significant regional difference in income distribution.

Table 2. 1 Income, food expenditure, and socio-demographics by income classes

Variable	C1	C2	C3	C4	C5	All
Per Capita Quantity Consumed (*Kg/Year*)						
Grains	125.72	138.89	138.68	135.50	128.73	133.48
	(48.31)	(57.31)	(53.13)	(53.51)	(48.94)	(52.57)
Oil and Fat	14.48	16.93	14.95	15.08	14.13	15.11
	(11.03)	(12.18)	(11.14)	(11.91)	(10.55)	(11.41)
Vegetables	84.20	106.01	104.15	100.29	104.08	99.75
	(47.56)	(51.93)	(50.53)	(49.49)	(51.92)	(50.91)
Meats	12.82	25.31	28.51	28.47	30.11	25.00
	(15.40)	(22.85)	(23.98)	(23.47)	(23.02)	(22.84)
Eggs	7.26	8.07	8.44	9.73	11.01	8.89
	(8.95)	(8.85)	(9.53)	(9.48)	(9.53)	(9.36)
Aquatic products	3.02	7.65	6.81	10.53	13.21	8.21
	(8.61)	(14.15)	(12.25)	(15.53)	(18.02)	(14.46)
Dairy Products	1.61	1.78	1.99	2.67	3.23	2.25
	(6.13)	(6.09)	(6.66)	(7.48)	(8.41)	(7.02)
Fruits	12.16	19.51	23.32	21.54	28.69	21.00
	(21.62)	(30.79)	(33.11)	(30.31)	(34.83)	(30.90)
Mean Expenditure Shares *(%)*						
Grains	0.36	0.27	0.26	0.24	0.22	0.27
Oil and Fat	0.14	0.13	0.11	0.10	0.09	0.11
Vegetables	0.20	0.21	0.20	0.19	0.20	0.20
Meats	0.18	0.26	0.28	0.29	0.29	0.26
Eggs	0.05	0.04	0.04	0.04	0.05	0.04
Aquatic products	0.02	0.04	0.04	0.06	0.07	0.05
Dairy Products	0.01	0.01	0.01	0.02	0.02	0.01
Fruits	0.04	0.05	0.06	0.06	0.07	0.06
Per Capita Food expenditure and Household Income *(CNY/Year)*						
Expenditure	1943.09	2907.15	3043.32	3039.37	3215.02	2829.76
	(795.41)	(1202.58)	(1435.31)	(1539.31)	(1492.91)	(1396.84)
Income	3094.06	5967.47	9207.59	14388.81	27741.86	12077.66
	(931.35)	(800.30)	(1124.97)	(1824.81)	(9259.66)	(9679.32)
Food expenditure	0.64	0.49	0.34	0.21	0.13	0.37
Demographic Variables						
Residence (1 = South)	0.48	0.65	0.62	0.60	0.54	0.58
	(0.50)	(0.48)	(0.49)	(0.49)	(0.50)	(0.49)
Household Size	3.84	3.83	3.65	3.27	2.97	3.51
	(1.75)	(1.67)	(1.57)	(1.34)	(1.28)	(1.57)
Ratio of Seniors (%)	0.22	0.18	0.15	0.15	0.15	0.17
	(0.34)	(0.32)	(0.28)	(0.30)	(0.30)	(0.31)
Ratio of Children (%)	0.18	0.16	0.14	0.12	0.11	0.14
	(0.21)	(0.19)	(0.18)	(0.17)	(0.19)	(0.19)

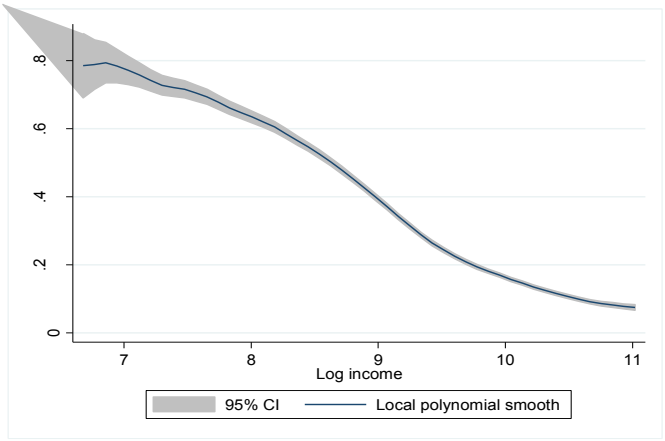
Source: Authors' calculation based on CHNS data regarding 2,908 households in the rural areas of 11 provinces (Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, Shandong, Beijing, Chongqing, and Shanghai), in 2011.Per capita food expenditure here refers to total expenditure on the studied food items. Standard deviations are in parentheses.

2.4 Results

In the first stage, using the OLS estimation for a Working-Leser model as reported in Table 2.9.A.1 in the appendices, the coefficients for income and aggregate price index are statistically significant for most of the income classes and R^2 is approximately 0.691 for the pooled sample, the income and price elasticities for total food expenditure can be obtained using the estimates in the Working-Leser model. In the second stage, a QUAIDS model is estimated by iterated feasible generalized non-linear least squares, and parameters for most of the independent variables are statistically significant as presented in Table 2.10.A.2. Parameters of the squared logarithm of expenditure are all significantly different from zero in most of the estimations, with the exception of vegetables and dairy products; this indicates the quadratic term of expenditure needs to be taken into consideration rather than the AIDS model in our demand system.

2.4.1 Income and price elasticities for total food expenditure

Since the coefficient of household per capita net income and its squared term are all statistically significant for the pooled sample, this result is consistent with the theory indicating a nonlinear relationship between income food expenditure as shown in Figure 2.1 Based on the estimates from the Working-Leser model across various income classes presented in Table 2.9.A.1, income elasticity for food expenditure (E_F) is evaluated at the means of explanatory variables for the five classes as well as for the total sample.



Source: Authors' estimations based on CHNS sample, 2011.

Figure 2. 1 Nonparametric Engel curve for total food share in income

As mentioned above, strong differences exist in expenditure shares, and we also find notable differences in income elasticities for food among various income classes as presented in Table 2.2, ranging from 0.686 for the lowest-income class to 0.128 for the highest-income class. This implies that a 1% income increase will drive 0.686% growth of the expenditure on studied food for the lowest-income households, but growth of only 0.128% for the highest-income households. The results demonstrate that food demand in rural China is in line with Engel's law, and also suggest that there are substantial differences in food consumption among different income classes, especially the inequality between the lowest- and the highest-income households. Unlike income elasticities, the price elasticities show slight differences across the five income classes and range from -0.690 to -0.876, indicating that food expenditure is inelastic in price changes in rural China.

Table 2. 2 Income and price elasticities for studied food calculated from the Working-Leser model

	C1	C2	C3	C4	C5	All
E_F	0.686	0.450	0.324	0.231	0.128	0.370
ε_F	-0.876	-0.865	-0.835	-0.690	-0.719	-0.840
ε_F^c	-0.431	-0.640	-0.722	-0.639	-0.702	-0.704

Source: Authors' computations using CHNS data, 2011.

2.4.2 Price, expenditure, and income elasticities for each food group

As mentioned above, the price and expenditure elasticities are evaluated based on the parameters estimated from QUAIDS and at the sample means of explanatory variables. The conditional and unconditional Marshallian (uncompensated) own-price elasticities for eight studied food items for each income class are given in Table 2.3. Since the main concern of this research are income and price responsiveness across various income classes, the cross-price elasticities are not reported here. All own-price elasticities are statistically significant at 0.05% for all five income classes, as well as for the pooled sample. With the own-price elasticities, we can examine how the price change affects households' demand for each food group. As expected, all the own-price elasticities are negative, which qualifies the law of demand that own-price reaction coefficients are non-positive; the positive expenditure elasticities indicate that all food groups are normal goods for rural households.

For the whole sample, the conditional and unconditional own-price elasticities as presented in Table 2.3 and Table 2.4 appear higher in magnitude than that of previous studies (Burggraf et al.

2015; D. Chen et al. 2015; Fan et al. 1995; Zheng and Henneberry 2011). This suggests that for rural households these food commodities have become more price elastic, considering that households have more substitution possibilities for those food commodities as the economy develops. Among own-price elasticities, in general we find that animal products have higher price elasticities, for example, meats have the highest price elasticity for the whole population, as well as for the higher-income classes of C4 and C5; aquatic and dairy products have extremely large price elasticities for lowest-income households. This finding suggests that there are higher potentials of increasing the consumption of these food commodities in the rural area if effective policies are directed at lowering the prices of these foods. On the contrary, grain shows the lowest price elasticities, ranging from -0.131 to -0.308 among these food commodities, indicating that price might not be a significant factor influencing consumer's behavior in grain consumption in rural China.

Comparing the own-price elasticities across different income classes, we find that the variation of own-price elasticities is small between adjacent income classes, with the exception of the lowest-income class, which tends to have the highest price elasticities for most of the food groups. The result indicates that policy measures targeting lowering the price of food commodities with the highest price elasticities will promote increased consumption of these food commodities for the lowest-income households; on the other hand, for the rest of the food commodities (grain and fruits) the lowest-income classes are less price elastic than higher-income classes.

Similar to the previous studies for rural China, the results indicate that animal products and fruits have the highest expenditure elasticities for all income classes (Burggraf et al. 2015; Gao et al. 1996; Jiang and Davis 2007). The expenditure elasticities vary across the different income classes; this suggests changes in consumer preference in different income classes. However, the differences in expenditure elasticities for the studied food groups from low-income class to high-income class are quite small, except for the elasticity of aquatic products for the lowest-income class, and these homogeneous elasticities across various income classes reflect a more equal distribution of food expenditure than the distribution in income across income classes.

Unlike the food expenditure and own price elasticities, which show small variations across income classes, income elasticities are substantially different among different income groups and are consistently larger for the lowest-income class for all studied foods, which coincides with the

finding by Chen et al. (2015). Therefore, compared to the highest-income group, a growth in income for the lowest-income group would drive a greater increase in food demand in rural China than if income growth was uniform across the income groups. Specifically, grains have the lowest income elasticities across these groups; as expected, meats, aquatic products, dairy products, and fruits have the highest income elasticities, which implies that with income growth the demand for these food groups would increase substantially. Additionally, K. S. Huang and Gale (2009) find that grains are inferior goods except for the lowest-income class in China; this implies that with increasing income levels, the demand for grains will decrease. However, we have a different finding in rural China, namely that income elasticities of grains are positive for all income classes, although for the highest-income class it is relatively small (around 0.044) and is very close to zero for the highest-income group. Similar to the results from Zheng and Henneberry (2010), these authors' calculated income elasticity is about 0.031 for urban Jiangsu Province. Furthermore, the income elasticities for oil and fat and eggs are comparatively small, especially for the highest-income class, which are 0.066 and 0.049, respectively. This indicates that with an income increase, the demand for these foods is relatively small. Thus, we can conclude that the consumption of grains, oil and fat, and eggs is approaching a saturation level for the highest-income group. In general, our findings indicate that rural households would increase the demand for all the studied food commodities with increasing income levels, but to a different extent for various income classes. In particular, they have the highest demand for animal products, dairy products, as well as fruits.

Table 2. 3 Conditional and unconditional own price elasticities by income classes

Var.	C1	C2	C3	C4	C5	All
Conditional price elasticity						
Grains	-0.246	-0.269	-0.392	-0.341	-0.195	-0.281
Oil and Fat	-0.507	-0.310	-0.468	-0.356	-0.355	-0.404
Vegetables	-0.942	-0.741	-0.966	-0.845	-0.910	-0.880
Meats	-1.844	-1.287	-1.154	-1.105	-0.995	-1.218
Eggs	-0.923	-0.300	-0.394	-0.510	-0.071	-0.498
Aquatic products	-2.100	-1.137	-1.168	-0.383	-0.556	-0.780
Dairy Products	-1.909	-1.303	-0.491	0.187	0.576	-0.503
Fruits	-0.745	-0.941	-1.016	-0.436	-0.854	-0.708
Unconditional price elasticity						
Grains	-0.173	-0.196	-0.308	-0.260	-0.131	-0.211
Oil and Fat	-0.468	-0.263	-0.427	-0.316	-0.320	-0.366
Vegetables	-0.886	-0.666	-0.887	-0.751	-0.821	-0.813
Meats	-1.823	-1.250	-1.099	-0.983	-0.918	-1.222
Eggs	-0.909	-0.286	-0.381	-0.492	-0.055	-0.484
Aquatic products	-2.105	-1.134	-1.160	-0.357	-0.547	-0.790
Dairy Products	-1.907	-1.301	-0.492	0.193	0.579	-0.504
Fruits	-0.735	-0.932	-1.005	-0.406	-0.828	-0.700

Source: Authors' computations using CHNS data, 2011.

Table 2. 4 Expenditure and income elasticities by income classes

Var.	C1	C2	C3	C4	C5	All
Expenditure elasticity						
Grains	0.476	0.452	0.503	0.452	0.371	0.400
Oil and Fat	0.957	0.850	0.643	0.582	0.556	0.673
Vegetables	1.121	0.977	0.964	0.854	1.007	0.976
Meats	1.803	1.596	1.531	1.603	1.493	1.640
Eggs	1.027	0.680	0.544	0.646	0.419	0.675
Aquatic products	2.430	1.723	1.506	1.563	1.689	1.824
Dairy Products	1.681	1.316	1.811	1.824	1.670	1.730
Fruits	1.302	1.530	1.568	1.326	1.294	1.448
Income elasticity						
Grains	0.331	0.185	0.162	0.119	0.044	0.147
Oil and Fat	0.664	0.348	0.206	0.153	0.066	0.247
Vegetables	0.778	0.400	0.309	0.225	0.119	0.359
Meats	1.251	0.653	0.491	0.422	0.176	0.604
Eggs	0.713	0.278	0.175	0.170	0.049	0.248
Aquatic products	1.687	0.705	0.484	0.411	0.199	0.671
Dairy Products	1.166	0.538	0.581	0.480	0.197	0.637
Fruits	0.903	0.626	0.503	0.349	0.153	0.533

Source: Authors' computations using CHNS data, 2011.

2.4.3 Food demand projection

To address the second goal of this study, detecting how income distribution changes affect food consumption in rural China, we examine four scenarios where income varies by 1% of the total population income as proposed by Zheng and Henneberry (2010). Scenario 0 increases the incomes of all five income classes at the same rate, but keeps the current population income distribution pattern; scenarios 1 and 2 increase the incomes of lower- (C1 and C2) and higher- (C4 and C5) income classes, respectively, while keeping the incomes of the remaining income classes constant. Lastly, scenario 3 redistributes current incomes from the highest-income class (C5) to lower-income classes (C1 and C2) but keeps the total population income constant. As presented in Table 2.5, the current income distribution shows that the total incomes of the lowest-income class only account for 5.17% of the total population income, while that of the highest-income class accounts for approximately 45.78%. Taking a selected 1% of total income of the whole sample as the amount of the variation in the four scenarios, a 1% variation in total sample incomes translates into a variation of 19.34%, 10.03%, 4.20%, and 2.18% for income classes C1, C2, C4, and C5, respectively.

Table 2.5 also shows the projected income distribution under the four scenarios. Particularly, the income distribution is unchanged under scenario 0; regarding scenarios 1 and 3, which favored lower-income classes, the new income distribution changes little compared with the current income distribution. For instance, under scenario 3, if an amount of 1% of the total sample income is transferred from the highest- (C5) to the lowest- (C1) income class, the shares of total incomes by lowest income and highest income only change 1% and -1%, respectively. However, as the main focus of this study is to detect income response to alternative income distribution patterns, a small variant in income distribution patterns would be large enough to drive a remarkable change in food consumption.

Table 2. 5 Projected distribution of households, population, and incomes by income class

	C1	C2	C3	C4	C5
Households	20.00	20.00	20.00	20.00	20.00
Population	21.72	21.90	20.82	18.66	16.89
Incomes	5.17	9.97	15.29	23.79	45.78
Scenario 0					
All 1%	5.17	9.97	15.29	23.79	45.78
Scenario 1					
Increase in C1	6.11	9.87	15.14	23.55	45.33
Increase in C2	5.12	10.86	15.14	23.55	45.33
Scenario 2					
Increase in C4	5.12	9.87	15.14	24.54	45.33
Increase in C5	5.12	9.87	15.14	23.55	46.32
Scenario 3					
Transfer C5 to C1	6.17	9.97	15.29	23.79	44.78
Transfer C5 to C2	5.17	10.97	15.29	23.79	44.78

Source: Authors' computations using CHNS data, 2011.

The projected increase in food demand under various incomes and income distribution in rural China under four scenarios considered is reported in Table 2.6. Based on the current consumption level for the whole surveyed sample, since there are no changes in the income distribution under the scenario 0, the estimated demand increases for studied food are given by the average income elasticities due to a uniform 1% increase in total incomes of all the surveyed households. In scenario 1, a 1% of total income increase given to the lower income classes (C1 or C2) will drive substantial increase in the demand for studied foods, especially to the lowest income class, for instance, if incomes increase 1% of the total sample income for the lowest income class the demand for dairy products will grow 2.71% accordingly. In scenario 2, when income growth is given to higher-income class (C4 or C5) the estimated demand will increase with relatively lower extent than in scenario 1, and even lower than if incomes increase uniformly for all populations. However, similar to scenario 1, in scenario 3, we also find a higher increase in estimated demand for all food groups if transferring 1% of the total sample income from the highest-income class (C5) to lower-income classes (C1 or C2).

Table 2. 6 Projected increase in food demand under various income classes and income distribution scenarios.

		Estimated demand increase						
			Scenario 1		Scenario 2		Scenario 3	
	Current consumption (kg)	Unchanged distribution	Increase in C1	Increase in C2	Increase in C4	Increase in C5	Transfer C5 to C1	Transfer C5 to C2
Grains	382697	0.15	1.02	0.39	0.10	0.01	0.92	0.37
Oil and Fat	43263	0.25	2.09	0.80	0.13	0.01	1.96	0.77
Vegetables	286575	0.36	2.14	0.86	0.19	0.02	1.94	0.81
Meats	71799	0.60	2.08	1.33	0.41	0.04	1.67	1.24
Eggs	25465	0.25	1.92	0.52	0.16	0.01	1.76	0.49
Aquatic products	23407	0.67	2.13	1.33	0.45	0.07	1.68	1.18
Dairy Products	6401	0.64	2.71	0.94	0.48	0.06	2.23	0.81
Fruits	60031	0.53	1.73	1.20	0.31	0.04	1.42	1.10

Source: Authors' computations using CHNS data, 2011.

As discussed above, a different income distribution might have largely different impacts on food consumption in rural China. In order to provide an overview for food consumption in the future, we assume that the prices and income growth are consistent as shown in Table 2.7. There are two average income growth rates, one is about 7.6% from 1997 to 2014, while the other is approximately 7.9% from 2001 to 2014. According to the two income growth rates, food demand in 2020, 2025, and 2030 are projected, respectively, using the quantity consumed in 2014 for respective food groups as a base-year demand as reported by China's National Bureau of Statistics. As presented in Table 2.8, the projected demand for all food groups increases as expected, while the demand for grain, oil and fat, and eggs is relatively lower than for other foods, for instance, the projected demand for aquatic and dairy products is 9.7 and 9.0 in 2030, with approximately 42.76% and 40.28% increases compared with the quantities consumed in 2014, respectively. This implies that policies focusing on increasing rural household income will improve the food demand in rural China dramatically.

Table 2. 7 Income growth assumption by income classes

Year	Income growth rate (%)	
	1979-2014	2001-2014
2014	7.616	7.918
2020	8.196	8.544
2025	8.868	9.275
2030	9.655	10.135

Source: The data in 2014 is from China's National Bureau of Statistics.

Table 2. 8 Projected food demand in rural China

			Projected Per Capita Food demand						Projected Per Capita Food demand Change					
	Income elasticities	2014 Base	2020		2025		2030		2020		2025		2030	
Grains	0.147	159.1	161.0	163.0	165.2	167.4	169.8	172.3	1.20	2.48	3.81	5.23	6.72	8.31
Oil and Fat	0.247	13.6	13.9	14.2	14.5	14.8	15.2	15.5	2.02	4.18	6.46	8.90	11.50	14.29
Vegetables	0.359	88.9	91.5	94.3	97.3	100.6	104.1	107.8	2.94	6.10	9.48	13.12	17.04	21.30
Meats	0.604	29.2	30.6	32.2	34.0	35.9	37.9	40.3	4.95	10.37	16.28	22.79	29.95	37.91
Eggs	0.248	8.89	9.1	9.3	9.5	9.7	9.9	10.2	2.03	4.19	6.49	8.94	11.54	14.35
Aquatic products	0.671	6.8	7.2	7.6	8.0	8.5	9.1	9.7	5.50	11.55	18.19	25.54	33.67	42.76
Dairy Products	0.637	6.4	6.7	7.1	7.5	7.9	8.4	9.0	5.22	10.95	17.22	24.14	31.77	40.28
Fruits	0.533	27.1	28.3	29.6	31.0	32.5	34.2	36.0	4.37	9.12	14.28	19.93	26.10	32.91

Source: Authors' computations using CHNS data, 2011.

2.5 Conclusions

The demand for eight major food groups is estimated by income class using a household data set drawn from the CHNS in rural China. The Working-Leser model is employed in the first step to investigate the responsiveness of demand for total studied food expenditure to the changes in income. The quadratic almost ideal demand system is then estimated for the eight food groups using a non-linear seemingly unrelated regression technique in the second step. After obtaining the estimated income elasticities of studied food groups for various income classes, we examine the responsiveness of food demand to the changes in income distribution.

The results suggest that there are significant differences in food demand across various income classes. The lowest-income households are more sensitive to income and price changes than the highest-income households for most of the food groups. We conclude that effective policies directed to lowering food prices or increasing household incomes will result in substantially higher demand for food in rural China, especially for the lowest-income households since they have the highest own-price and income elasticities for most of the food groups.

According to the projected increase in demand for the studied food groups under four scenarios, we can draw several conclusions. Firstly, we can conclude that a small change in income distribution will drive considerable variation in food consumption. Secondly, any policies designed to increase incomes that favor lower-income households will give stronger rise to food demand than policies that favor higher-income classes. Thirdly, policies intended to redistribute income from higher-income classes to lower-income classes will drive higher demand for food as well, although there is no growth in average income for the whole population. Fourthly, a uniform increase in income would also boost food demand by a larger amount than if the income growth was solely received by higher-income classes. Finally, keeping the current income distribution and growth, the projected food consumption in rural China would increase consistently in the next decades, especially for aquatic and dairy products.

In conclusion, income elasticities for rural households are still relatively large, and there exists substantial inequality in food consumption. Consequently, policies designed to increase household income in rural areas would be helpful to increase their food consumption, especially to improve the welfare of the lowest-income class. As the estimation results indicate, quite different food demand patterns are shown in various income classes, and hence income distribution should be taken into account instead of an average estimation for the population as a whole.

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Appendices:

Table 2. 9.A.1 Working–Leser model estimation

	Dependent variable: Share of studied food expenditure					
	C1	C2	C3	C4	C5	All
Log of Income	-0.119***	-0.111**	0.023	0.235***	-0.883*	-0.075***
	(0.026)	(0.056)	(0.049)	(0.064)	(0.534)	(0.009)
Squared Log of Income	-0.005***	-0.009***	-0.014***	-0.021***	0.038	-0.008***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.026)	(0.000)
Residence	0.081***	0.093***	0.067***	0.022***	0.012**	0.053***
	(0.016)	(0.016)	(0.012)	(0.008)	(0.005)	(0.005)
Household Size	-0.002	0.003	0.003	-0.005	-0.000	0.001
	(0.005)	(0.005)	(0.004)	(0.003)	(0.002)	(0.002)
Ratio of Seniors	-0.020	-0.027	-0.024	-0.016	-0.003	-0.010
	(0.025)	(0.025)	(0.019)	(0.014)	(0.009)	(0.009)
Ratio of Children	-0.025	-0.076**	-0.041	-0.022	0.002	-0.029**
	(0.036)	(0.038)	(0.032)	(0.024)	(0.013)	(0.014)
Log Price Index	0.080***	0.067***	0.057***	0.068***	0.036***	0.059***
	(0.014)	(0.012)	(0.010)	(0.008)	(0.005)	(0.005)
Intercept	1.718***	1.943***	1.120***	-0.250	5.126*	1.574***
	(0.192)	(0.468)	(0.410)	(0.404)	(2.748)	(0.055)
N	581	582	582	582	581	2908
F	30.169	38.757	58.150	27.517	33.922	897.611
R^2	0.277	0.328	0.422	0.256	0.302	0.691

* p<0.10, ** p<0.05, *** p<0.010.

Source: Authors' calculations based on CHNS data.

Table 2. 10.A.2 Parameters of QUAIDS for the full sample with IFGNL estimation

	Grains	Oil and Fat	Vegetables	Meats	Poultry	Aquatic products	Dairy Products	Fruits
Log Prices of (γ_{ij})								
Grains	0.304***	0.030	-0.045***	-0.231***	0.011	-0.070***	-0.013*	0.014
	(0.026)	(0.020)	(0.010)	(0.051)	(0.008)	(0.014)	(0.007)	(0.020)
Oil and Fat		0.168***	0.027**	-0.293***	0.034***	-0.066***	-0.018**	0.119***
		(0.028	(0.014)	(0.039)	(0.010)	(0.015)	(0.008)	(0.014)
Vegetables			0.027***	-0.031	0.002	-0.005	-0.005*	0.031*
			(0.007)	(0.034)	(0.004)	(0.008)	(0.003)	(0.014)
Meats				0.702***	-0.072***	0.147***	0.034*	-0.256***
				(0.077)	(0.023)	(0.029)	(0.019)	(0.030)
Poultry					0.027***	-0.017***	-0.008**	0.022**
					(0.006)	(0.006)	(0.003)	(0.010)
Aquatic products						0.041***	0.014***	-0.045***
						(0.013)	(0.005)	(0.014)
Dairy Products							0.008**	-0.012
							(0.004)	(0.008)
Fruits								0.128***
								(0.022)
Log Expenditure (β_i)	-0.099***	-0.172***	-0.036	0.427***	-0.046***	0.084***	0.019	-0.179***
	(0.030)	(0.023)	(0.022)	(0.024)	(0.015)	(0.020)	(0.013)	(0.017)
Squared Log Expenditure (λ_i)	0.011***	-0.019***	-0.004	0.035***	-0.004**	0.007***	0.001	-0.027***
	(0.004)	(0.003)	(0.003)	(0.005)	(0.002)	(0.003)	(0.002)	(0.003)
Residence	0.013***	-0.003***	0.003***	-0.017***	0.003***	0.003***	0.000	-0.001
	(0.003)	(0.001)	(0.001)	(0.002)	(0.000)	(0.001)	(0.000)	(0.000)
Household Size	-0.001	0.001***	0.000	-0.001	0.000	0.000	0.000	0.001***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ratio of Seniors	-0.006**	-0.002**	-0.005***	0.007***	0.000	0.002**	0.000	0.003***
	(0.003)	(0.001)	(0.001)	(0.002)	(0.000)	(0.001)	(0.000)	(0.001)
Ratio of Children	0.003	0.001	0.004	0.004	0.000	0.000	-0.001**	-0.003**
	(0.005)	(0.002)	(0.002)**	(0.004)	(0.001)	(0.001)	(0.001)	(0.002)
Intercept	-0.276***	-0.195***	0.108***	1.235***	-0.055***	0.233***	0.049***	-0.099***
	(0.039)	(0.046)	(0.028)	(0.054)	(0.020)	(0.029)	(0.016)	(0.035)
Scaling parameters for demographics ($_o$)	Coefficient	Standard errors						
Residence	0.700***	(0.200)						
Household Size	-0.016	(0.021)						
Ratio of Seniors	-0.182**	(0.087)						
Ratio of Children	0.116	(0.190)						
Log-likelihood = 24559.145								

Source: Authors' calculations based on CHNS data. Standard errors are given in parentheses. * p<0.1, **p<0.05, *** p<0.01.

Chapter 3

The Impact of Education on Income Inequality between Ethnic Minorities and Han in China

Bente CASTRO CAMPOS[1], Yanjun REN[1*] and Martin PETRICK[2]

Institute of Agricultural Economics, University of Kiel, Wilhelm-Seelig-Platz 6/7, 24118 Kiel, Germany

Leibniz Institute of Agricultural Development in Transition Economies, Theodor-Lieser-Str. 2, 06120 Halle (Saale), Germany.

[*]Corresponding author.

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Abstract

This article analyzes the impact of education on income inequality between ethnic minorities and Han in China by using the data from the China Health and Nutrition Survey (CHNS) over the period 1993-2011. An instrumental variable approach using two institutional changes is applied to address the endogeneity of education in income equations for various subsamples. To investigate the impact of education on income inequality between ethnic minorities and Han, we introduce an interaction term between the ethnic minority status and years of education. Our results suggest that there exists significant income inequality to the disadvantage of ethnic minorities for the full, female, and urban samples, and depending on the instrument also for the rural sample. Nevertheless, our results for these samples show specific returns to education for ethnic minorities, which implies that a portion of the income gap can be overcome with additional education. We find that in general one additional year of education will increase earned incomes of ethnic minorities by 26.3-28% and in particular by 13.5-14.4% for women from an ethnic minority group, by 10.4-14% for ethnic minorities with urban household registration, and by 10.8% for ethnic minorities with rural household registration. However, we cannot obtain conclusive results for the male sample due to weak instruments.

Keywords: income inequality; ethnic minorities; education; endogeneity; China

3.1 Introduction

The Chinese government started in the end of 1978 to implement economic reforms known as "Socialism with Chinese characteristics." China has since then experienced high economic growth; the average GDP annual growth rates have been approximately 7-9%, and poverty rates have largely declined from 60.7% in 1990 to 6.3% in 2011[1], lifting 500 million people out of severe poverty. Nevertheless, income inequality in China has severely increased after 1990 (Benjamin et al. 2005, Li and Sicular 2014). China has shifted from a comparatively equal to a very unequal society. The national Gini coefficient in China currently stands at high levels between 0.47 and 0.52 (Yue et al. 2013).[2] In such an unequal situation disadvantaged social groups such as ethnic minorities usually suffer more from income inequality. How is the situation in China? Is there considerable income inequality between ethnic minorities and Han, the majority group, in China? In addition, China's ethnic minorities, with a few exceptions, have generally less education than do Han (Hannum 1999, 2002, Ding 2006). If there is income inequality between ethnic minorities and Han, can additional education, which is usually linked to higher incomes, help to reduce it?

To address these questions, we adjust Mincer's income equation by including the ethnic status and an interaction term between the ethnic status and years of education as additional variables. Data for this research are taken from the China Health and Nutrition Survey (CHNS)[3] over the period 1993-2011. We pay special attention to educational attainment because with more education individuals usually earn more; yet this also implies that education might be endogenous in the income equation, as individuals might increase their educational attainment to receive higher incomes; therefore, we use an instrumental variable approach to capture the endogeneity of education in income equations by applying two institutional changes.

To analyze income inequality between ethnic minorities and Han matters, as it has real life consequences. Ethnic minorities who earn less over the lifecycle also have less for the basic needs of their families and fewer savings for retirement; thus, they might end up to be poorer and less integrated in society; this might buttress social tensions. Given that ethnic tensions are an ever more crucial global issue, useful lessons about income differentials between ethnic groups can be learned from a transition country like China.

This article proceeds as follows. Section 2 briefly reviews the essential literature on the income effect of ethnic minority status and on the education efficiency (return to education) gap between

ethnic minorities and Han in China. Section 3 provides the empirical framework, which is an amendment of Mincer's income equation. Section 4 describes the data and provides descriptive statistics. Section 5 shows the empirical findings for the full sample and for the female, male, urban, and rural subsamples. In the last section we draw conclusions.

3.2 Literature review

3.2.1 The income effect of ethnic minority status

Income inequality is pronounced along racial and ethnic lines in many countries. Income gaps between ethnic groups can be attributed to at least two possible explanations, which are not mutually exclusive and interlinked with other pre-labor market circumstances. First, differences in between-group income differentials, such as in education, labor market experience, and occupational composition can explain a portion of the income gap. Second, labor market discrimination in job access and wages can explain another portion of the income gap (Becker 1971).

Over time many governments have tried to tackle income inequality by addressing these two major issues with all kinds of public policies, including affirmative action, equal opportunity legislation, and educational and financial benefits for the disadvantaged. The recent literature, however, suggests that despite all of these public efforts, there is still considerable income inequality throughout the world. For example, ethnic minorities in Vietnam earn approximately 11% less than does the majority group (Hung et al. 2009). The causes are largely attributed to lower labor market returns due to ethnic minorities' characteristics. In Latin America, a large portion of the ethnic wage gap in favor of the white can be attributed to differences in educational attainment and occupational segregation (Ñopo et al. 2010). In Israel, changes in the earnings structure through skill-based technological change have mainly led to increased inequality between ethnic minorities and the majority group (Haberfeld and Cohen 2007). In Great Britain, the income gap is mainly attributed to ethnic minorities making up a larger portion in lower paying jobs (Brynin and Güveli 2012). In the United States, the income gap between whites and blacks has been persistent over time and is largely attributed to skill differences (Altonji and Blank 1999). Nevertheless, Fang and Heywood (2006) find no considerable difference in earnings in output-based pay between Europeans and non-Europeans in Canada.

In China, with the foundation of the People's Republic of China in 1949, the government started to reclassify ethnic groups and autonomous areas and progressively set up a preferential policy framework. Fifty-five ethnic minorities alongside the Han-majority have been classified since 1949. Actually China has implemented a very advanced preferential policy framework to tackle labor market discrimination and ethnic inequalities, but one look into the Xinjiang Uyghur Autonomous Region (XUAR) and the Tibet Autonomous Region (TAR) tells us how poorly these policies have been enforced (Gilley 2001, Yee 2003, Hillman 2008). Regarding income differentials between ethnic minorities and Han, the literature suggests differences in human capital, household and regional characteristics as the major determinants. Hannum and Xie (1998) compare differences in occupational attainment between ethnic minorities and Han in XUAR by using 1982 and 1990 census data. They find an increasing gap in occupational attainment between ethnic minorities and Han over time. Gustafsson and Li (2003) analyze rural income differences between ethnic minorities and Han based on survey data from 19 provinces in 1988 and 1995. They find an increasing income gap of 19.2% in 1988 to 35.9% in 1995, indicating lower income levels for ethnic minorities. By using the 1988 Chinese Household Income Project (CHIP) data, Johnson and Chow (1997) find that ethnic minorities in rural and urban areas earn approximately 19% and 4.5% less than Han, respectively. Li (2003) uses the CHIP data for 1995 and discovers that ethnic minorities earn 9% less than Han. Yang (2005) and Appleton et al. (2005), however, observe mixed results. Yang (2005), who studies variations in the returns to education based on the 1988 and 1995 CHIP data, observes largely insignificant coefficients for the ethnic minority status. Similar results have been obtained by Appleton et al. (2005) who analyze the CHIP data for 1988, 1995, 1999, and 2002. Except for 1995, they observe insignificant coefficients for the ethnic minority status in all other years considered. The authors, moreover, suggest that from 1990 to 2002 ethnic minorities' wages in urban areas increased faster than Han's wages. Based on the 1989-2006 CHNS data, Hasmath and Ho (2015) find that ethnic minorities earn 8-17% less than Han; however, after controlling for education, experience, and gender, no considerable wage gap in favor of the Han remained. Nevertheless, through additional qualitative interviews with ethnic minorities in Beijing, Shanghai, and Shenzhen, the authors find that discrimination, lack of *guanxi* (social networks), and cultural differences led to difficulties in finding good jobs for ethnic minorities in China's urban labor market.

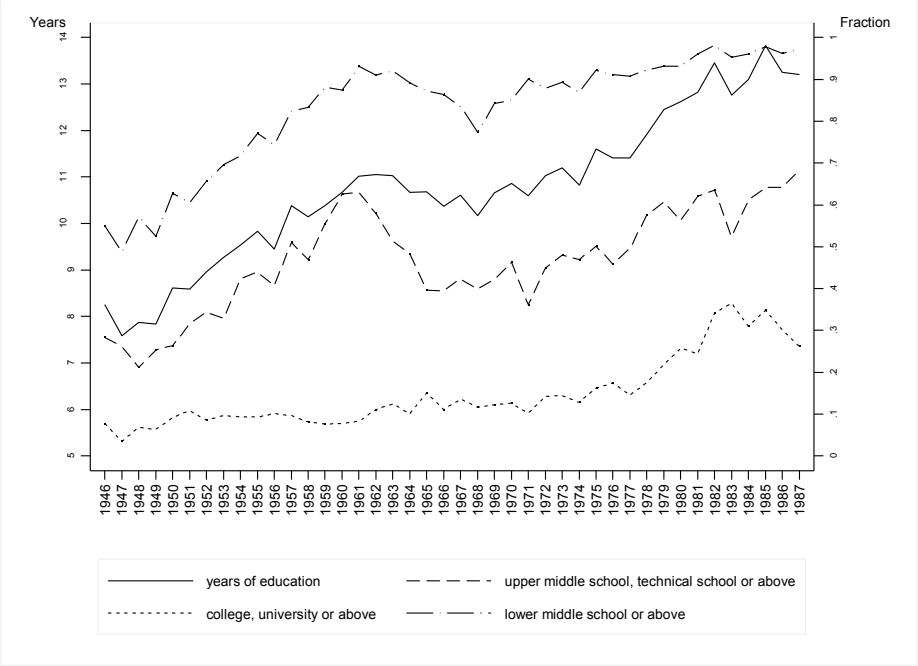
3.2.2 The return to education gap between ethnic minorities and Han

Education is a crucial human capital determinant in income equations (Mincer 1974).[4] More education is generally regarded as a major factor for finding "better jobs" and earning higher incomes. There is an extensive literature concerned with the impact of education on incomes in China, particularly after the transition to a more market based economy. Returns to education in China have been low in the 1980s and 1990s. Byron and Manaloto (1990), Johnson and Chow (1997), and Liu (1998) find that returns to education were approximately 3-4%. Other studies (e.g., Bishop and Chiou 2004) find that returns to education in the middle of the 1990s in China were approximately 5-6%. Since the middle of the 1990s returns to education have risen. Qian and Smyth (2008) report that returns to education in urban China in 2005 were approximately 12-13%. Ge and Yang (2011) observe that in 2007 returns to education in urban China stood at 11.4%, an increase of roughly 7.8 percentage points compared to 1988. Both studies' estimation results are based on OLS specifications. Ren and Miller (2012), however, find lower returns to education with 7.4% and 7.5% for men and women, respectively, in urban China in 2006; yet the returns to education have almost doubled compared to the 1990s. A limited number of returns to education' studies have controlled for the endogeneity of education with instrumental variables (see Chen and Hamori 2009, Fang et al. 2012, Fleisher et al. 2005, Heckman and Li 2004, Li and Luo 2004, Mishra and Smyth 2013, Wang et al. 2014, Zhang et al. 2007). These studies mostly use conventional instruments for education, such as spouse's education, parental education, parental income, number of siblings, or year of birth. The returns to education are usually higher compared to studies which have applied OLS estimation techniques. Card (1999) observes that the IV results are usually 20-40% higher than the OLS results because of different marginal returns to schooling for the subgroups considered.

Regarding the ethnic status, Fang et al. (2012) find that the ethnic minority status has a statistically significantly negative effect in the returns to education equation by using CHNS data for the period 1997-2006. In contrast, Wang et al. (2014) find that the ethnic minority status has no statistically significant effect in the private returns to education equation by using data from the CHIP. Mishra and Smyth (2013) find that the returns to education for the Korean minority in urban areas in Northeast China are approximately 10.6% and 10.2% for women and men, respectively, when an OLS approach is used. The returns to education are with 16.4% and 24.1% for women and men,

respectively, considerably higher when an IV approach is used. This confirms the finding that returns to education are higher when an IV approach is applied.

Institutional changes are found to be significant instruments for education (Fang et al. 2012, Song 2012, Xie and Mo 2014). Fang et al. (2012) and Song (2012) initially use the 1986 Compulsory Education Law (Law) as instrument for education in the returns to education equation; this method is further complemented by Xie and Mo (2014) by including an additional institutional change—the 1991 Provisions on the Prohibition of Using Child Labor (Provisions)— as instrument for education in the health outcome estimation. The regulations imply that individuals who were born before 1971 were not affected by the Law and individuals who were born before 1975 were not affected by the Provisions. The introduction of these two regulations has considerably increased educational attainment in China. Xie and Mo (2014) have shown convincing evidence that there are notable increases in educational attainment between 1971 and 1972 and between 1974 and 1975 that exceed the long-term trend of increasing educational attainment in China (Figure 3.1).



Data source: Calculated by the authors from the CHNS, 1993–2011.

Figure 3. 1 Educational attainment by year of birth

3.3 Empirical framework

3.3.1 The benchmark model

We employ an adjusted Mincer approach to investigate the differences in earned incomes between ethnic minorities and Han. The following function is estimated

$$Ln\ (Income) = \alpha_0 + \alpha_m Minority_i + \alpha_e Yearseduc_i + \alpha_{me} Minority_i * Yearseduc_i + \sum_K \theta_{ik} X_{ik} + \varepsilon \qquad (1)$$

where the dependent variable is the logarithm of earned income.[5] Earned income is used because we are primarily interested in income differences that result from unequal payment.[6] The crucial independent variables in our model are *Minority* (0/1) which stands for the ethnic minority status, *Yearseduc* which stands for years of education, and an interaction term (*Minority*Yearseduc*) between the ethnic minority status and years of education. X_{ik} includes other individual characteristics as well as regional and time fixed effects. A thorough description of these variables will be given in section 4. Standard errors (ε) are robust to a clustered sample design. Altogether we estimate a total sample and separate subsamples for women and men and for individuals with urban and rural household registration.

3.3.2 The income effect of ethnic minority status and returns to education

Income gaps between ethnic groups can largely be attributed to in-between-group differentials and labor market discrimination in job access and wages. If there are inequalities in earned incomes for ethnic minorities, α_m has a negative sign which indicates that ethnic minorities have less earned income than do Han; this might be related to on the job or wage discrimination against ethnic minorities, differences in Chinese Mandarin (*Putonghua*) language proficiency, or differences in the cultural integration of ethnic minorities.

The major in-between-group differential is educational attainment. α_e is expected to have a positive sign, as the returns to education are usually positive. The main hypothesis of our study is that returns to education might be higher for ethnic minorities with more education because of the scarcity of ethnic minorities with higher educational attainments in the Chinese labor market (Ding 2006, Hannum 1999, 2002); therefore, α_{me} is expected to be positive. If α_{me} is positive, this means that one additional year of education for ethnic minorities will lead to more additional income increase for ethnic minorities in comparison to Han with the same years of education.

There might be several driving forces at different educational levels that could explain the higher returns to education for ethnic minorities in China. First, at lower levels of education institutional factors such as the Law and Provisions presumably raise the education of ethnic minorities who would otherwise follow low-income generating activities or help with household chores (assuming independence of taste and ability factors). Second, at higher levels of education the preferential policies for ethnic minorities might be major driving forces for the higher returns to education for ethnic minorities in China. For example, ethnic minorities receive extra points in the university entrance exams and might, therefore, have less forgone income and higher returns to education than do Han. Furthermore, ethnic minorities with university degrees might signal to potential employers to be from the "ethnic elite" who enjoy higher political and economic power within the respective autonomous regions; therefore, they might get better job possibilities and receive higher incomes.

Other potential in-between-group differences between ethnic minorities and Han include household size and regional characteristics. We discuss these factors more thoroughly in section 4.2.

3.3.3 Accounting for the endogeneity of education in the income equation

To control for the endogeneity of education, we use two institutional changes as instruments. The 1986 Compulsory Education Law and the 1991 Provisions on the Prohibition of Using Child Labor have been used as instruments for education in previous studies (Fang et al. 2012, Song 2012, Xie and Mo 2014).

The 9-year Compulsory Education Law that officially came into effect in July 1986 covers six years of primary school and three years of junior middle school. The goal was to increase educational attainment and to eliminate illiteracy in China. The law expects children who reached the age of six to enroll in school for nine compulsory years without any tuition fee (Fang et al. 2012); thus, normally a pupil would finish the nine years of compulsory schooling at the age of 15. This implies that individuals who were born before 1971 were not affected by the law (Xie and Mo 2014).

The Provisions on the Prohibition of Using Child Labor that came officially into effect in April 1991 prohibits employment of children who are younger than 16 years of age. This implies that individuals who were born before 1975 were not affected by the provisions (Xie and Mo 2014).

The Provisions complement the Compulsory Education Law, as young adults can only start working after terminating their compulsory education at the age of 15.

The variables for the instruments are not directly reported in the CHNS and are constructed based on the year of birth. Two dummy variables are used. First, for the 1986 Compulsory Education Law variations in the implementation of the Law in different provinces are considered (Huang 2015). A dummy variable is then constructed for those affected and unaffected by the Law in each province. The threshold birth year for those affected by the Law is 1971 for Beijing, Chongqing, Liaoning, and Heilongjiang; 1972 for Shandong, Jiangsu, Shanghai, Hubei, and Henan; 1973 for Guizhou, and 1976 for Hunan and Guangxi. Second, for the 1991 Provisions all individuals who were born after 1991 are affected by the regulation and all individuals who were born before 1991 are unaffected by the regulation.

The IV model is estimated by the following two stage least square (2SLS) procedure.

$$\widehat{Yearseduc}_i = \beta_0 + \beta_l Law_i + \beta_m Minority_i + \sum_K \beta_{ik} X_{ik} + \vartheta \quad (2)$$

$$\widehat{Yearseduc}_i = \gamma_0 + \gamma_p Provisions_i + \gamma_m Minority_i + \sum_K \gamma_{ik} X_{ik} + \omega \quad (3)$$

where equations (2) and (3) are the first stage regressions for the endogenous variable of education when the Law and the Provisions are used as instruments, respectively. In the second stage of the regression the actual value of $Yearseduc_i$ is substituted by the predicted value from the equations (2) and (3). The estimation in the second stage is as follows:

$$Ln\,(Income) = \alpha_0' + \alpha_m' Minority_i + \alpha_e' \widehat{Yearseduc}_i + \alpha_{me}' Minority_i * \widehat{Yearseduc}_i + \sum_K \alpha_{ik}' X_{ik} + \varepsilon' \quad (4)$$

where $\widehat{Yearseduc}_i$ is the predicted value of years of education from the regression in the first stage. All other independent variables controlled for are the same as in model (1).

3.4 Data and descriptive statistics

3.4.1 Data

We use data from the CHNS. The CHNS applies a multistage, random cluster process to draw a sample of roughly 4,400 households with a total of 26,000 individuals. The sample includes waves from 1989 to 2011 and was conducted in nine provinces (Heilongjiang, Liaoning, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou) for the years 1989, 1991, 1993, 1997, 2000, 2004, 2006, 2009, 2011, and three municipalities (Beijing, Shanghai, Chongqing) for the year 2011.

The CHNS uses a weighted sampling scheme to randomly select four counties in each province (one low income, two middle income, and one high income) and selects the provincial capital and lower income cities when possible. The CHNS randomly selects villages and townships within the counties, urban and suburban neighborhoods within the cities.

In the sample used for this article, the total number of 26,000 observations is reduced by the following restrictions. First, the 1989 and 1991 waves are excluded from the analysis because the household registration type (*hukou*), which is used for setting up the urban and rural subsamples, is initially reported in 1993; thus, we restrict our sample to the period 1993-2011. Second, our sample contains only full-time workers who reported to earn an individual wage, including annual wage, bonus, or other income from the job. This implies that individuals who are still at school, part-time workers, or individuals who are doing unpaid family work are excluded from the analysis. Moreover, our sample includes only individuals within the official working age of 16 to 65 years. Third, missing observations are dropped from the analysis. The total sample used in our research, thus, consists of 13,851 observations. The subsamples for Han and ethnic minorities include 12,594 and 1,257 observations, respectively. The subsamples for individuals with urban and rural household registration include 8,385 and 5,466 observations, respectively.

3.4.2 Descriptive statistics

Table 3.1 provides descriptive statistics of the variables used in our study for the full sample, for ethnic minorities, and for Han. Subsamples for gender (female/male) and household registration (urban/rural) are also shown. Approximately 9% of our sample are ethnic minorities. This proportion is similar to the national average of approximately 8.4%; therefore, no additional weighting based on ethnicity is applied in our study.

All annual earned income values are adjusted to reflect 2011 prices. The adjustment is computed by dividing the annual average Consumer Price Index for 2011 by the annual average for earlier years. Ethnic minorities and Han have average annual earned incomes of 12,195 CNY and 14,243 CNY, respectively. The difference of means in annual earned incomes between ethnic minorities and Han is different from zero. The t-statistic is 5.6174 with 13,849 degrees of freedom, and the corresponding two-tailed p-value is 0.0001, which is less than 0.05. This difference renders our research important and demands for a more rigorous econometric analysis that will be conducted with this study.

Women's and men's average annual earned incomes are 12,469 CNY and 15,128 CNY, respectively. The difference of means in annual earned incomes between women and men is also different from zero (t-statistic -12.5085, two-tailed p-value 0.0001). This renders the usage of two sub-samples for women and men important. Furthermore, the wage inequality ratio in China in 2014 for women to men stood at 0.63 (GGGR 2014). With deregulation more and more private companies seem to make use of discriminatory measures against women in the Chinese labor market (Gustafsson and Li 2000, Chi and Li 2008, Zhang et al. 2008, Li et al. 2011). When considering the ethnic status, the difference in earned incomes between women and men is also pronounced in our sample. Women with an ethnic minority and Han status earn on average 10,351 CNY and 12,678 CNY, respectively. Men with an ethnic minority and Han status earn on average 13,413 CNY and 15,301 CNY, respectively. Women with an ethnic minority status have, thus, the lowest average annual earned income by gender comparison.

Previous studies find a considerable urban-rural income gap (Khan and Riskin 2005, Sicular et al. 2007, Li and Sicular 2014) and regional income differences in China (Démurger et al. 2006, Gustafsson and Li 2002). In our sample people with urban and rural household registration have annual earned incomes of 15,701 CNY and 11,536 CNY, respectively. The difference of means in annual earned incomes between urban and rural household registration is also different from zero (t-statistic -19.6874, two-tailed p-value 0.0001). This renders the usage of two sub-samples for urban and rural areas important. Ethnic minority people usually live in less-developed rural areas in China (Gustafsson and Li 2003). When considering the ethnic status, the difference in earned incomes between urban and rural household registration in our sample is also pronounced. Ethnic minorities and Han with urban household registration earn on average 13,985 CNY and 15,829 CNY, respectively. Ethnic minorities and Han with rural household registration earn on average 10,657 CNY and 11,660 CNY, respectively. Ethnic minorities in rural areas have, thus, the lowest average annual earned income by regional comparison.

Regarding education, the literature suggests that returns to education are usually positive. The question arises whether there is income inequality for ethnic minorities because of less educational attainment. Ethnic minorities and Han have on average 9.681 and 10.556 years of education, respectively. The difference of means in years of education between ethnic minorities and Han is different from zero (t-statistic 6.7129, two-tailed p-value 0.0001). This renders the usage of an interaction term between ethnic minority status and years of education important. Ethnic minorities

with rural household registration and women with an ethnic minority status have with 7.463 and 9.340 years, respectively, the lowest average years of education.

The descriptive statistics include additional individual characteristics, regional, and time control variables (Table 3.1). Alongside the ethnic status and years of education, there are other important explanatory variables that might be crucial to explain the income gap between ethnic minorities and Han. One important individual characteristic is the household size. Preferential policies have allowed ethnic minorities in rural areas to have more than one child, while for most of the Han people the one-child policy was applied from 1979 until 2015. The policy could have a link with lower income, in particular for women with an ethnic minority status who might engage in child rearing rather than follow an income generating activity. In our sample, the average household size for ethnic minorities and Han is 3.91 and 3.85 children, respectively. There is no difference of means in household size between ethnic minorities and Han (t-statistic -1.3996, two-tailed p-value 0.1616). The variable will, therefore, be tested for its significance in the econometric model settings.

Other important determinants that might have a link with ethnic minorities' lower incomes are language and cultural barriers. The CHNS has neither information on Chinese Mandarin (*Putonghua*) language proficiency nor on cultural integration of ethnic minorities. However, the ethnic minority dummy and the interaction term (Minority*Yearseduc) implicitly control for language and culture alongside possible discrimination. Yet with the available CHNS data, it is impossible to completely disentangle these factors. In our view, the CHNS database is still the best available secondary data source to analyze income inequality between ethnic minorities and Han at an aggregate level for China.

Table 3. 1 Summary statistics for full-time workers by ethnic status, gender, and household registration

	Total					Han					Ethnic minorities				
	Full	Female	Male	Urban	Rural	Full	Female	Male	Urban	Rural	Full	Female	Male	Urban	Rural
Dependent variables															
Annual earned income (CNY)	14057	12469	15128	15701	11536	14243	12678	15301	15829	11660	12195	10351	13413	13985	10657
	(12340)	(11349)	(12856)	(13064)	(10658)	(12438)	(11458)	(12952)	(13162)	(10666)	(11147)	(9934)	(11728)	(11541)	(10565)
Main independent variables															
Minority (Ethnic minority 0/1)	0.091	0.090	0.092	0.069	0.124										
	(0.29)	(0.29)	(0.29)	(0.25)	(0.33)										
Yearseduc (Years of education)	10.476	10.427	10.510	12.024	8.102	10.556	10.534	10.570	12.006	8.193	9.681	9.340	9.906	12.262	7.463
	(4.41)	(4.71)	(4.20)	(4.26)	(3.50)	(4.39)	(4.66)	(4.19)	(4.26)	(3.48)	(4.58)	(5.03)	(4.24)	(4.25)	(3.58)
Instrumental variables															
Law (The 9-year Compulsory	0.251	0.304	0.215	0.232	0.280	0.250	0.305	0.213	0.234	0.276	0.255	0.296	0.229	0.198	0.305
education Law)	(0.43)	(0.46)	(0.41)	(0.42)	(0.45)	(0.43)	(0.46)	(0.41)	(0.42)	(0.45)	(0.44)	(0.46)	(0.42)	(0.40)	(0.46)
Provisions (The Provisions on the	0.195	0.235	0.168	0.172	0.230	0.193	0.233	0.166	0.172	0.225	0.216	0.256	0.189	0.164	0.260
Prohibition of Using Child Labor)	(0.40)	(0.42)	(0.37)	(0.38)	(0.42)	(0.39)	(0.42)	(0.37)	(0.38)	(0.42)	(0.41)	(0.44)	(0.39)	(0.37)	(0.44)
Control variables															
Individual characteristics															
Age	39.57	37.77	40.78	39.85	39.13	39.50	37.66	40.74	39.86	38.92	40.25	38.82	41.19	39.76	40.67
	(11.17)	(10.68)	(11.32)	(10.35)	(12.30)	(11.12)	(10.60)	(11.29)	(10.40)	(12.18)	(11.65)	(11.44)	(11.70)	(9.75)	(13.06)
Age squared	1690.34	1540.54	1791.37	1695.23	1682.85	1683.84	1530.98	1787.16	1696.70	1662.89	1755.45	1637.72	1833.21	1675.37	1824.27
	(899.12)	(832.72)	(927.76)	(834.98)	(989.51)	(893.63)	(824.25)	(923.45)	(839.55)	(975.06)	(950.35)	(909.48)	(969.18)	(771.38)	(1076.58)
Household size	3.86	3.85	3.87	3.62	4.23	3.85	3.85	3.86	3.62	4.23	3.91	3.86	3.95	3.60	4.18
	(1.42)	(1.41)	(1.43)	(1.29)	(1.54)	(1.42)	(1.41)	(1.43)	(1.29)	(1.55)	(1.43)	(1.39)	(1.45)	(1.29)	(1.48)
Male (0/1)	0.597			0.579	0.625	0.597			0.581	0.623	0.602			0.556	0.642
Married (0/1)	0.816	0.799	0.828	0.829	0.796	0.819	0.803	0.829	0.830	0.800	0.789	0.754	0.812	0.816	0.766
Urban (0/1)	0.605	0.633	0.587			0.620	0.644	0.603			0.462	0.516	0.427		
Government or SOE	0.486	0.487	0.486	0.648	0.238	0.497	0.496	0.497	0.646	0.253	0.383	0.394	0.375	0.678	0.129
Collective enterprise	0.279	0.260	0.291	0.121	0.521	0.266	0.248	0.278	0.117	0.508	0.407	0.384	0.421	0.169	0.611
Farming	0.037	0.037	0.037	0.023	0.059	0.036	0.036	0.037	0.024	0.057	0.043	0.050	0.038	0.009	0.072
Private enterprise	0.148	0.156	0.142	0.153	0.139	0.151	0.160	0.145	0.158	0.139	0.118	0.116	0.119	0.091	0.141
Foreign enterprise	0.009	0.013	0.007	0.010	0.008	0.009	0.013	0.006	0.010	0.008	0.009	0.010	0.008	0.005	0.012
Other (reference)	0.041	0.046	0.037	0.045	0.035	0.041	0.046	0.037	0.045	0.035	0.041	0.046	0.038	0.048	0.036
Observations	13851	5579	8272	8385	5466	12594	5079	7515	7804	4790	1257	500	757	581	676

The mean values are reported for continuous variables and the percentages for discrete variables. The standard deviation is in parentheses. Regional controls include dummies for Chongqing (reference), Beijing, Liaoning, Heilongjiang, Shanghai, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou. Time controls include year dummies for 1993 (reference), 1997, 2000, 2004, 2006, 2009, 2011.

Data source: Calculated by the authors from the CHNS, 1993–2011.

3.5 Results

3.5.1 OLS estimations for the impact of ethnic status and education on earned income

Table 3.2 shows the OLS estimation results for the full, female, male, urban, and rural samples. The columns (1) to (5) in Table 3.2 provide the results without the interaction term, and the columns (6) to (10) provide the results with the interaction term (Minority*Yearseduc).

Regarding the ethnic minority status, the estimation results show a negative and statistically significant effect of the ethnic minority status on earned income in all models without interaction term, except for the rural sample (column (5)). Similarly, the ethnic minority status is negative and statistically significant in the full, female, male, and rural samples for the models with interaction term (columns (6), (7), (8), (10)), but is insignificant in the urban sample (column (9)). Gustafsson and Li (2003), Li (2003), and Johnson and Chow (1997) also find statistically significant coefficients for the ethnic minority status in income equations. Our OLS estimation results provide additional evidence that there exists income inequality to the disadvantage of ethnic minorities in China. With the inclusion of regional and work-related controls as well as household size, education, and other individual characteristics, we find that there is still a portion in the income gap that is attributed to the ethnic minority status. The income gap to the disadvantage of ethnic minorities might be related to discrimination in job access and wages, language and cultural barriers, as well as other pre-labor market differences.

Regarding years of education, the estimation results clearly show a statistically significantly positive effect of years of education on earned income in all model specifications. Considering the full samples, one additional year of education increases earned incomes by 4.9-5%. Precisely, the returns to education for women range from 6.1-6.3%, for men from 3.8-3.9%, for urban areas are 4.8%, and for rural areas range from 3.7-3.8%.

However, the OLS estimation results show statistically significant returns to education for ethnic minorities only for the full and the female samples. An additional year of education will increase earned incomes for ethnic minorities by 1.6% for the full sample and by 2% for women. As mentioned earlier, institutional factors might be major driving forces for the higher returns to education for ethnic minorities in China. In the next section the potential endogeneity of years of education will be analyzed with an instrumental variable approach.

Table 3. 2 OLS estimation for earned income equations by gender and household registration

Variables	Dependent variable: Logarithm of earned income									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Full sample	Female	Male	Urban	Rural	Full sample	Female	Male	Urban	Rural
Minority	-0.119***	-0.137**	-0.102**	-0.087**	-0.122	-0.280***	-0.330***	-0.205*	-0.191	-0.220**
	(0.05)	(0.06)	(0.05)	(0.04)	(0.08)	(0.10)	(0.13)	(0.11)	(0.13)	(0.11)
Yearseduc	0.050***	0.063***	0.039***	0.048***	0.038***	0.049***	0.061***	0.038***	0.048***	0.037***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Minority*Yearseduc						0.016**	0.020**	0.010	0.009	0.013
						(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Male	0.282***			0.197***	0.375***	0.281***			0.197***	0.374***
	(0.02)			(0.02)	(0.03)	(0.02)			(0.02)	(0.03)
Age	0.067***	0.082***	0.064***	0.050***	0.083***	0.067***	0.081***	0.064***	0.050***	0.082***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Age squared	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Married	0.029	-0.068*	0.096***	0.046*	-0.007	0.029	-0.069**	0.096***	0.046*	-0.007
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
Urban	0.129***	0.127***	0.126***			0.129***	0.125***	0.126***		
	(0.03)	(0.04)	(0.03)			(0.03)	(0.04)	(0.03)		
Household size	-0.016	-0.015	-0.019*	-0.019**	-0.009	-0.016	-0.015	-0.019*	-0.019**	-0.009
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Government or SOE	0.094*	0.132*	0.056	0.056	0.236**	0.093*	0.130*	0.056	0.055	0.236**
	(0.05)	(0.07)	(0.06)	(0.04)	(0.10)	(0.05)	(0.07)	(0.06)	(0.04)	(0.10)
Collective enterprise	-0.006	0.070	-0.068	0.080*	0.080	-0.006	0.069	-0.067	0.079*	0.080
	(0.05)	(0.07)	(0.06)	(0.05)	(0.09)	(0.05)	(0.07)	(0.06)	(0.05)	(0.09)
Farming	-0.031	-0.021	-0.043	0.069	0.064	-0.031	-0.024	-0.042	0.068	0.063
	(0.07)	(0.10)	(0.07)	(0.06)	(0.11)	(0.07)	(0.10)	(0.07)	(0.06)	(0.11)
Private enterprise	0.060	0.080	0.039	-0.044	0.293***	0.060	0.078	0.040	-0.044	0.292***
	(0.05)	(0.07)	(0.06)	(0.05)	(0.10)	(0.05)	(0.07)	(0.06)	(0.05)	(0.10)
Foreign enterprise	0.331***	0.389***	0.279***	0.284***	0.522***	0.332***	0.388***	0.281***	0.283***	0.523***
	(0.08)	(0.11)	(0.10)	(0.09)	(0.14)	(0.08)	(0.11)	(0.10)	(0.09)	(0.14)
Regional controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	6.753***	6.513***	7.124***	6.945***	6.651***	6.775***	6.543***	7.137***	6.955***	6.665***
	(0.18)	(0.25)	(0.20)	(0.16)	(0.28)	(0.18)	(0.25)	(0.20)	(0.16)	(0.28)
N	13851	5579	8272	8385	5466	13851	5579	8272	8385	5466
R^2	0.379	0.388	0.372	0.540	0.238	0.380	0.388	0.372	0.540	0.238
F	105.259	71.341	83.775	131.961	41.435	109.527	69.773	82.975	128.079	45.274

* p<0.10, ** p<0.05, *** p<0.010.

Minority stands for the ethnic minority status (0/1) and *Yearseduc* for years of education. Robust standard errors (clustered on community id) are in parentheses. Regional controls include dummies for Chongqing (reference), Beijing, Liaoning, Heilongjiang, Shanghai, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou. Time controls include year dummies for 1993 (reference), 1997, 2000, 2004, 2006, 2009, 2011. The reference group for the type of work unit is 'others'. For the subsamples the respective male and urban dummies are excluded from the analysis.

Data source: Calculated by the authors from the CHNS, 1993–2011.

3.5.2 The estimation of the impact of two institutional changes on educational attainment

Before we proceed with the IV estimations, the relationship between the authorization of the regulations (Law and Provisions) and educational attainment will be explored. Xie and Mo (2014) have already shown convincing evidence that there are notable increases in educational attainment between 1971 and 1972 and between 1974 and 1975 that exceed the long-term trend of increasing educational attainment in China, which renders the impacts of the Law and Provisions on educational attainment important. To further explore the impacts of the Law and Provisions on educational attainment in our samples, we provide OLS estimations in Table 3.3.

The results for the full sample and for almost all subsamples suggest that both instrumental variables have statistically significantly positive impacts on educational attainment. Only the coefficient of Law for the rural sample is insignificant, which implies that for the rural sample the Law might not be a valid instrument for education. In general, individuals who are regulated by the Compulsory Education Law and by the Provisions on Using Child Labor receive roughly 0.76 and 1.1 years of additional education, respectively. The impacts of the regulations are particularly pronounced for women and in urban areas. Xie and Mo (2014), who obtain similar results for women, explain that traditionally parents would invest more in the education of their sons rather than in the education of their daughters. The regulations have, therefore, higher impacts on women. The higher impact of the regulations in urban areas might indicate higher enforcement of the Law and the Provisions in urban rather than in rural areas, where children often have to help with household chores instead of going to school (Castro Campos 2013). Even though our results show a strong correlation between the two institutional changes and education in the male sample, based on the previous discussion a weak instrument problem is likely to occur for the male and rural subsamples.

Table 3. 3 The effects of institutional changes on years of education by gender and household registration

Variables	Dependent variable: Years of education									
	(1) Full sample	(2) Female	(3) Male	(4) Urban	(5) Rural	(6) Full sample	(7) Female	(8) Male	(9) Urban	(10) Rural
Law	0.757***	0.917***	0.415*	1.040***	0.326					
	(0.17)	(0.22)	(0.21)	(0.24)	(0.22)					
Provisions						1.066***	1.270***	0.720***	1.336***	0.711***
						(0.19)	(0.25)	(0.21)	(0.25)	(0.25)
Minority	-0.429	-0.891**	-0.138	-0.234	-0.061	-0.438	-0.912***	-0.141	-0.253	-0.069
	(0.28)	(0.35)	(0.31)	(0.41)	(0.26)	(0.28)	(0.35)	(0.31)	(0.42)	(0.26)
Male	0.682***			0.377***	1.210***	0.673***			0.367***	1.203***
	(0.10)			(0.11)	(0.15)	(0.10)			(0.11)	(0.15)
Age	0.053*	0.118***	0.034	0.017	0.036	0.082**	0.158***	0.061	0.044	0.075
	(0.03)	(0.04)	(0.04)	(0.05)	(0.04)	(0.03)	(0.05)	(0.04)	(0.05)	(0.05)
Age squared	-0.002***	-0.003***	-0.001***	-0.001**	-0.002***	-0.002***	-0.004***	-0.002***	-0.001**	-0.002***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Married	-0.106	-0.541***	0.125	-0.098	0.038	-0.111	-0.556***	0.125	-0.085	0.018
	(0.14)	(0.19)	(0.16)	(0.18)	(0.19)	(0.14)	(0.19)	(0.16)	(0.18)	(0.19)
Urban	3.228***	3.556***	2.997***			3.230***	3.555***	2.997***		
	(0.19)	(0.22)	(0.21)			(0.19)	(0.22)	(0.21)		
Household size	-0.184***	-0.250***	-0.170***	-0.254***	-0.071*	-0.183***	-0.247***	-0.170***	-0.247***	-0.073*
	(0.05)	(0.07)	(0.05)	(0.08)	(0.04)	(0.05)	(0.07)	(0.05)	(0.08)	(0.04)
Government or SOE	0.683**	0.738*	0.630*	0.177	1.235***	0.671**	0.707*	0.631*	0.167	1.226***
	(0.31)	(0.38)	(0.33)	(0.37)	(0.32)	(0.31)	(0.38)	(0.34)	(0.37)	(0.32)
Collective enterprise	-0.558*	-0.650*	-0.471	-1.108***	0.220	-0.563*	-0.672*	-0.465	-1.105***	0.213
	(0.32)	(0.39)	(0.34)	(0.42)	(0.30)	(0.32)	(0.39)	(0.34)	(0.43)	(0.30)
Farming	-0.892*	-0.922	-0.783	-0.920	-0.307	-0.908*	-0.934	-0.793	-0.911	-0.331
	(0.51)	(0.59)	(0.52)	(0.63)	(0.33)	(0.51)	(0.59)	(0.53)	(0.64)	(0.33)
Private enterprise	-0.347	-0.468	-0.288	-0.974**	0.670**	-0.366	-0.496	-0.301	-0.991**	0.643**
	(0.33)	(0.37)	(0.37)	(0.40)	(0.31)	(0.33)	(0.37)	(0.37)	(0.40)	(0.31)
Foreign enterprise	-0.368	-0.442	-0.381	-0.996	0.850	-0.357	-0.437	-0.379	-0.954	0.829
	(0.57)	(0.68)	(0.59)	(0.67)	(0.68)	(0.57)	(0.69)	(0.59)	(0.67)	(0.68)
Regional controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	7.506***	6.872***	8.430***	11.853***	6.609***	6.987***	6.126***	7.913***	11.413***	5.858***
	(0.91)	(1.21)	(1.01)	(1.19)	(1.03)	(0.98)	(1.29)	(1.03)	(1.24)	(1.06)
N	13851	5579	8272	8385	5466	13851	5579	8272	8385	5466
F	61.676	59.182	46.099	20.792	21.536	69.441	72.089	48.918	27.012	22.077
R^2	0.345	0.432	0.296	0.217	0.239	0.347	0.434	0.297	0.219	0.241

* p<0.10, ** p<0.05, *** p<0.010.

The variable *Law* refers to the 9-year Compulsory Education Law and the variable *Provisions* to The Provisions on the Prohibition of Using Child Labor. *Minority* stands for the ethnic minority status (0/1) and *Yearseduc* for years of education. Robust standard errors (clustered on community id) are in parentheses. Regional controls include dummies for Chongqing (reference), Beijing, Liaoning, Heilongjiang, Shanghai, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou. Time controls include year dummies for 1993 (reference), 1997, 2000, 2004, 2006, 2009, 2011. The reference group for the type of work unit is 'others'. For the subsamples the respective male and urban dummies are excluded from the analysis.

Data source: Calculated by the authors from the CHNS, 1993–2011.

3.5.3 Instrumental variable estimation for the impact of ethnic status and education on earned income

Tables 3.4 to 3.6 show the IV regression results for the full sample and for the subsamples for both model settings without (columns (1) to (5)) and with interaction terms (columns (6) to 10)). Tables 3.4 and 3.5 include with the Law and Provisions only one instrument, respectively, and Table 3.6 includes both instruments. Each table contains the major second and first stage coefficients as well as weak identification and endogeneity test results. Over-identification test results are additionally reported in Table 3.6 because more than one instrument is used to instrument years of education (Baum et al. 2007).

We first examine the results for the models without interaction terms (columns (1) to (5)) given in Table 3.4. We find that the IV estimates for the ethnic minority status are all statistically insignificant, except for the urban sample. Nevertheless, all coefficients for the ethnic minority status have negative signs. The IV estimates for years of education are all statistically significantly positive, except for the rural sample. Generally, the F statistics should be larger than 10 to discard a weak instrument problem when one instrument is used (Staiger and Stock 1997). The F statistics are all larger than 10, except for the male and the rural samples, which indicates that the Law is a valid instrument to explain the variations in years of education for the full, female, and urban samples.

Let us now turn to the results for the models with interaction term (columns (6) to (10)) given in Table 3.4. The IV estimates for the ethnic minority status have a negative sign in all samples and are statistically significant in the full, female, and urban samples. The potential reasons for this income inequality have been mentioned in section 5.2. The IV estimates for years of education are all statistically significantly positive, except for the male and rural samples. The IV estimates for the interaction term are all positive and statistically significant in the full, female, and urban samples. When including the interaction term (Minority*Yearseduc) as a second endogenous variable, the Stock-Yogo weak ID test critical value is 7.03 for the 5% tolerance level (Stock and Yogo 2005). As expected, the results for the male and rural samples are still unreliable due to the low F statistics, which indicates weak instrument problems. The test results show that the Law is invalid for instrumenting the interaction term (Minority*Yearseduc) in the male and rural samples; therefore, we cannot get conclusive results about how education impacts the earned incomes of ethnic minorities compared to Han in the male and rural samples.

On the basis of the results given in Table 3.4, we can conclude that the IV estimation results for the full, female, and urban samples with interaction terms (columns (6), (7), (9)) are the most reliable. This supports the findings that the impact of the Law is particularly pronounced for women and in urban areas. Our results confirm that there are specific returns to education for ethnic minorities. The results show that one additional year of education will increase earned incomes of ethnic minorities by 27.4% and in particular by 13.5% for women from an ethnic minority group and by 10.5% for ethnic minorities with urban household registration.

Regarding returns to education, the results show that one additional year of education will increase earned incomes by 19.8-19.9% for the full sample, which is much larger than the 4.9-5% obtained from the OLS estimations, but in line with previous findings (Card 1999). For women, the returns to education are with 18-18.2% slightly lower than the average. For individuals with urban household registration, the returns to education are within the range of 11.2-11.4%.

The next step is to estimate the earned income equations with Provisions as a single instrument (Table 3.5). The IV estimation results for the models without interaction terms (columns (1) to (5)) show statistically significantly negative results for the ethnic minority status only in the urban sample; all the other samples show statistically insignificant results, but with negative signs. For years of education all results are statistically significantly positive. The F statistics for all samples exceed the threshold value of 10. For the models with interaction terms (columns (6) to (10)), the ethnic minority status is statistically significantly negative in all samples, except for the male sample. For years of education all results are again statistically significantly positive. The IV estimates for the interaction term are all positive and statistically significant in all samples, except for the male sample. The F statistics for the models with interaction term are below the threshold value of 7.03 only for the male sample, which renders the results for the male sample unreliable; this indicates that Provisions as a single instrument is invalid for instrumenting the interaction term for the male sample.

Table 3. 4 Instrumental variable estimation with one instrument (law) for earned income equations by gender and household registration

Variables	Dependent variable: Logarithm of earned income									
	(1) Full sample	(2) Female	(3) Male	(4) Urban	(5) Rural	(6) Full sample	(7) Female	(8) Male	(9) Urban	(10) Rural
Second stage										
Minority	-0.057	-0.032	-0.068	-0.071*	-0.097	-2.770**	-1.330**	-8.397	-1.359*	-1.132
	(0.06)	(0.09)	(0.08)	(0.04)	(0.13)	(1.19)	(0.58)	(10.39)	(0.70)	(0.70)
Yearseduc	0.199***	0.182***	0.296*	0.114***	0.523	0.198***	0.180***	0.389	0.112***	0.486
	(0.05)	(0.05)	(0.16)	(0.03)	(0.34)	(0.06)	(0.06)	(0.34)	(0.03)	(0.32)
Minority*Yearseduc						0.274**	0.135**	0.825	0.105*	0.134
						(0.12)	(0.06)	(1.01)	(0.06)	(0.09)
First stage										
Law	0.757***	0.917***	0.415*	1.040***	0.326					
	(0.17)	(0.22)	(0.21)	(0.24)	(0.22)					
Minority*Law						1.332***	2.372***	0.760**	1.800***	2.110***
						(0.40)	(0.67)	(0.35)	(0.54)	(0.28)
N	13851	5579	8272	8385	5466	13851	5579	8272	8385	5466
Weak identification tests										
Kleibergen-Paap rk Wald F statistic	45.212	27.962	7.992 [x]	47.247	4.433 [x]	17.216	13.791	1.014 [x]	21.008	2.289 [x]
Endogeneity test										
Endogeneity test of endogenous regressors	16.181	5.823	9.945	5.266	9.870	23.383	12.636	14.184	8.901	12.522
Chi-square(2) P-value	0.000	0.016	0.002	0.022	0.002	0.000	0.002	0.001	0.012	0.002

* p<0.10, ** p<0.05, *** p<0.010. The variable *Law* refers to the 9-year Compulsory Education Law. *Minority* stands for the ethnic minority status (0/1) and *Yearseduc* for years of education. Robust standard errors (clustered on community id) are in parentheses. [x] denotes that the respective test results are not qualified.

Notes: Weak identification tests are used to test whether the instruments are weakly correlated with the endogenous explanatory variable. When one instrument is used, there is no weak instrument problem when the F statistic is larger than 10. When two instruments are used, there is no weak instrument problem when the Stock-Yogo weak ID test critical value is larger than 7.03 for the 5% tolerance level. The endogeneity test is used to test whether the instrumented explanatory variable is really endogenous; the model qualifies if the respective p-value is smaller than 0.05. All regressions control for the variables given in Table 3.2. For the subsamples the respective male and urban dummies are excluded from the analysis.

Data source: Calculated by the authors from the CHNS, 1993–2011.

Table 3. 5 Instrumental variable estimation with one instrument (provisions) for earned income equations by gender and household registration

Variables	Dependent variable: Logarithm of earned income									
	(1) Full sample	(2) Female	(3) Male	(4) Urban	(5) Rural	(6) Full sample	(7) Female	(8) Male	(9) Urban	(10) Rural
Second stage										
Minority	-0.062	-0.045	-0.074	-0.069*	-0.108	-2.841**	-1.436***	-8.707	-1.785*	-0.944**
	(0.05)	(0.08)	(0.07)	(0.04)	(0.09)	(1.26)	(0.52)	(10.43)	(0.93)	(0.48)
Yearseduc	0.186***	0.166***	0.251***	0.121***	0.311***	0.177***	0.151***	0.293*	0.120***	0.287***
	(0.04)	(0.04)	(0.08)	(0.03)	(0.11)	(0.04)	(0.04)	(0.16)	(0.03)	(0.11)
Minority*Yearseduc						0.280**	0.144***	0.854	0.140*	0.108*
						(0.12)	(0.05)	(1.01)	(0.07)	(0.06)
First stage										
Provisions	1.066***	1.270***	0.720**	1.336***	0.710***					
	(0.19)	(0.25)	(0.21)	(0.25)	(0.25)					
Minority*Provisions						1.301***	2.361***	0.546	1.587***	2.227***
						(0.42)	(0.66)	(0.42)	(0.53)	(0.32)
N	13851	5579	8272	8385	5466	13851	5579	8272	8385	5466
Weak identification tests										
Kleibergen-Paap rk Wald F statistic	83.523	50.243	22.452	71.355	19.718	26.967	25.139	0.975 [x]	17.125	10.103
Endogeneity test										
Endogeneity test of endogenous regressors	24.040	8.816	17.442	10.469	15.637	31.811	15.465	20.368	13.284	18.688
Chi-square(1) P-value	0.000	0.003	0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.000

* p<0.10, ** p<0.05, *** p<0.010. The variable *Provisions* refers to The Provisions on the Prohibition of Using Child Labor. *Minority* stands for the ethnic minority status (0/1) and *Yearseduc* for years of education. Robust standard errors (clustered on community id) are in parentheses. [x] denotes that the respective test results are not qualified.

Notes: Weak identification tests are used to test whether the instruments are weakly correlated with the endogenous explanatory variable. When one instrument is used, there is no weak instrument problem when the F statistic is larger than 10. When two instruments are used, there is no weak instrument problem when the Stock-Yogo weak ID test critical value is larger than 7.03 for the 5% tolerance level. The endogeneity test is used to test whether the instrumented explanatory variable is really endogenous; the model qualifies if the respective p-value is smaller than 0.05. All regressions control for the variables given in Table 3.2. For the subsamples the respective male and urban dummies are excluded from the analysis.

Data source: Calculated by the authors from the CHNS, 1993–2011.

On the basis of the results given in Table 3.5, we can conclude that the IV estimation results with interaction terms for the full, female, urban, and rural samples are the most reliable (columns (6), (7), (9), (10)). The results for the ethnic minority status are statistically significantly negative. The potential reasons for this income inequality have been mentioned in section 5.2. We find that there are specific returns to education for ethnic minorities. One additional year of education will increase earned incomes of ethnic minorities by 28% and in particular by 14.4% for women from an ethnic minority group. Moreover, the returns to education for ethnic minorities with urban and rural household registration are 14% and 10.8%, respectively.

Regarding returns to education, we find that an additional year of education can increase earned incomes by 17.7-18.6% for the full sample, by 15.1-16.6% for the female sample, by 12-12.1% for the urban sample, and by 28.7-31.1% for the rural sample. The IV estimates are again higher than the OLS estimates (Table 3.2) and slightly lower than the IV estimates when the Law is considered as a single instrument (Table 3.4), except for the rural sample, where a weak instrument problem is observed when the Law is considered as a single instrument.

We will now examine the results given in Table 3.6, where both instruments (the Law and the Provisions) are used. We find that there are overlapping instrumental variable effects, which means that the coefficients for either the Law or the Provisions are insignificant when both instruments are used. When four instrumental variables are used (the Law, the Provisions, and their interactions with the ethnic minority status), the Stock-Yogo weak ID test critical value is 11.04 for the 5% tolerance level (Stock and Yogo 2005). Similar to the findings in Table 3.4, there are weak instrument problems for the male and rural samples when interaction terms are considered. This implies that for the rural sample, the Provisions as a single instrument for education should be used (Table 3.5) rather than the Law (Table 3.4) or both instruments (Table 3.6). Despite the overlapping instrumental variable effects, the estimation results for all the other samples are in line with previous findings.

On the basis of the results given in Table 3.6, the results for the ethnic minority status are statistically significantly negative in the urban sample for the models without interaction term and in the full, female, urban, and rural samples for the models with interaction terms. The potential reasons for this income inequality have been mentioned in section 5.2. Furthermore, we can conclude that there are specific returns to education for ethnic minorities. The results show that one

additional year of education will increase earned incomes of ethnic minorities by 26.3% and in particular by 13.6% for women from an ethnic minority group and by 10.4% for ethnic minorities with urban household registration.

Regarding returns to education, we find that an additional year of education can increase earned incomes by 17.7-18.9% for the full sample, by 15.6-17% for the female sample, and by 11.2-11.9% for the urban sample.

Finally, it has to be mentioned that the IV estimator might overestimate the average marginal return to education because of heterogeneous effects of human capital. For example, the Law and Provisions might lead to higher returns to education for less-educated individuals. A one year increase in educational attainment is, thus, not the same at each given year of education. Furthermore, dummy variables that indicate whether an individual is affected or not by the Law or the Provisions based on the year of birth as predictor of education are imprecise, as within-year-variation is not considered. For example, individuals who were born earlier in the year might terminate compulsory schooling earlier than individuals who were born later in the year. Additionally, the distance to tertiary education schools is not controlled for in our estimations but might affect whether an individual continues schooling or not.

Table 3. 6 Instrumental variable estimation with two instruments (law and provisions) for earned income equations by gender and household registration

Variables	Dependent variable: Logarithm of earned income									
	(1) Full sample	(2) Female	(3) Male	(4) Urban	(5) Rural	(6) Full sample	(7) Female	(8) Male	(9) Urban	(10) Rural
Second stage										
Minority	-0.061	-0.042	-0.074	-0.070*	-0.109	-2.669**	-1.359***	-6.289	-1.336*	-0.956**
	(0.05)	(0.08)	(0.07)	(0.04)	(0.09)	(1.08)	(0.52)	(6.22)	(0.70)	(0.45)
Yearseduc	0.189***	0.170***	0.251***	0.119***	0.297***	0.177***	0.156***	0.252**	0.112***	0.273***
	(0.04)	(0.04)	(0.08)	(0.02)	(0.11)	(0.04)	(0.04)	(0.12)	(0.02)	(0.10)
Minority*Yearseduc						0.263**	0.136***	0.614	0.104*	0.110*
						(0.11)	(0.05)	(0.60)	(0.06)	(0.06)
First stage										
Law	0.264*	0.386	0.009	0.482*	-0.1.00					
	(0.18)	(0.25)	(0.25)	(0.26)	(0.26)					
Provisions	0.910***	1.060***	0.715***	1.046***	0.769***					
	(0.21)	(0.28)	(0.25)	(0.27)	(0.27)					
Minority*Law						1.071	1.668*	0.746	1.865*	1.037*
						(0.71)	(0.98)	(1.083)	(0.94)	(0.50)
Minority*Provisions						0.309	0.828	-0.148	0.108	1.261*
						(0.74)	(0.91)	(1.11)	(0.91)	(0.47)
N	13851	5579	8272	8385	5466	13851	5579	8272	8385	5466
Weak identification tests										
Kleibergen-Paap rk Wald F statistic	42.991	26.615	11.240	38.357	10.142	15.942	13.482	2.020 [x]	16.371	5.189 [x]
Overidentification test										
Hansen J statistic	0.103	0.117	0.159	0.078	1.579	0.745	0.576	0.727	0.837	1.581
Chi-square(1) P-value	0.748	0.733	0.690	0.780	0.209	0.689	0.750	0.695	0.658	0.454
Endogeneity test										
Endogeneity test of endogenous regressors	25.293	9.424	17.229	10.947	12.713	31.491	15.382	15.292	11.921	15.442
Chi-square(1) P-value	0.000	0.002	0.000	0.001	0.000	0.000	0.000	0.000	0.003	0.000

* p<0.10, ** p<0.05, *** p<0.010. The variable *Law* refers to the 9-year Compulsory Education Law and the variable *Provisions* to The Provisions on the Prohibition of Using Child Labor. *Minority* stands for the ethnic minority status (0/1) and *Yearseduc* for years of education. Robust standard errors (clustered on community id) are in parentheses. [x] denotes that the respective test results are not qualified.
Notes: Weak identification tests are used to test whether the instruments are weakly correlated with the endogenous explanatory variable. When two instruments are used, there is no weak instrument problem when the Stock-Yogo weak ID test critical value is larger than 7.03 for the 5% tolerance level. When four instruments are used, there is no weak instrument problem when the Stock-Yogo weak ID test critical value is larger than 11.04 for the 5% tolerance level. The endogeneity test is used to test whether the instrumented explanatory variable is really endogenous; the model qualifies if the respective p-value is smaller than 0.05. All regressions control for the variables given in Table 3.2. For the subsamples the respective male and urban dummies are excluded from the analysis.
Data source: Calculated by the authors from the CHNS, 1993–2011.

3.6 Conclusions

In this article, we examine the impact of education on income inequality between ethnic minorities and Han in China by using CHNS data over the period 1993-2011. Based on several OLS and IV estimations, this article enhances our understanding of the specific returns to education for ethnic minorities. We contribute to the existing literature by including the ethnic minority status and an interaction term between the ethnic minority status and years of education in Mincer's income equation. We control for the endogeneity of education with institutional changes. The main hypothesis of our study is that returns to education might be higher for ethnic minorities with more education because of the scarcity of ethnic minorities with higher educational attainments in the Chinese labor market (Ding 2006, Hannum 1999, 2002). Institutional factors might be major driving forces for the higher returns to education for ethnic minorities in China.

The OLS results show that there is statistically significant income inequality to the disadvantage of ethnic minorities in China. The income difference might be attributed to language and cultural barriers, discrimination in job access and wages, as well as pre-labor market inequalities. Nevertheless, the OLS results show specific returns to education for ethnic minorities for the full sample and for the female sample, which implies that a portion of the income gap can be overcome with additional education. For the full sample, an additional year of education will increase earned incomes for ethnic minorities by 1.6%, and for the female sample by 2%. The OLS results show that an additional year of education will roughly increase earned incomes by 3.8-6.3% depending on the sample considered.

However, the potential endogeneity of education and the resulting simultaneous causality between educational attainment and earned income has to be taken into account. Therefore, we apply an IV approach to control for the endogeneity of education by using two instrumental variables, the 1986 Compulsory Education Law and the 1991 Provisions on the Prohibition of Using Child Labor (see also Fang et al. 2012, Song 2012, Xie and Mo 2014). The endogeneity test results suggest that years of education is indeed an endogenous variable in all models considered, but the weak identification tests suggest that the Law is weakly identified in the male and rural samples and that the Provisions are weakly identified in the male sample; therefore, reliable conclusions can be drawn for the full, female, and urban samples when the Law or the Provisions are used as an

instrument for education and for the rural sample when the Provisions are used as an instrument for education.

Our IV estimation results suggest that there exists significant income inequality to the disadvantage of ethnic minorities for the full, female, and urban samples when either the Law or the Provisions are used as an instrument for education and for the rural sample when the Provisions are used as an instrument for education. We find that for the full sample one additional year of education will increase earned incomes of ethnic minorities by 26.3-28%. In particular, one additional year of education will increase earned incomes by 13.5-14.4% for women from an ethnic minority group, by 10.4-14% for ethnic minorities with urban household registration, and by 10.8% for ethnic minorities with rural household registration.

The returns to education from IV estimations show that an additional year of education can increase earned incomes by 17.7-19.9% for all individuals. In particular, an additional year of education can increase earned incomes by 15.1-18.2% for women, by 11.2-12.1% for individuals with urban household registration, and by 28.7-31.1% for individuals with rural household registration. The higher returns to education from IV estimations in comparison to OLS estimations are a common phenomenon in the literature (Card 1999).

The following limitation of our study should be noted. The CHNS sample over the period 1993-2011 includes only nine provinces so that our findings cannot be generalized for overall China (Gustafsson and Li 2002). The TAR and XUAR are not included in our study; yet income inequalities between ethnic minorities and Han in these two regions are particularly pronounced (Gilley 2001, Hannum and Xie 1998, Yee 2003); therefore, further regional specific studies are required.

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Notes:

[1] See http://povertydata.worldbank.org/poverty/country/CHN
[2] The Gini coefficient ranges from zero (perfect equality) to one (perfect inequality).
[3] See https://www.cpc.unc.edu/projects/china.
[4] Educational attainment depends on child characteristics (including "innate ability"), household characteristics, school and teacher characteristics (quality) and costs related to schooling, where school and teacher characteristics (quality) and prices related to schooling are both linked to education policies and local community characteristics (List and Rasul 2011, p. 140 based on Glewwe and Kremer 2006).
[5] In the CHNS, respondents are asked to report their earned income (annual wage) which includes the annual wage, bonus, and other income from the job.
[6] For a discussion on different income measures, please refer to Li and Sicular (2014).

Chapter 4

Drink and Smoke; Drink or Smoke? – The Interdependence between Alcohol and Cigarette Consumption for Men in China

Yanjun REN; Bente CASTRO CAMPOS; Jens-Peter LOY

Institute of Agricultural Economics, University of Kiel, Wilhelm-Seelig-Platz 6/7, 24118 Kiel, Germany

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Abstract

The interdependence between alcohol and cigarette consumption has received little attention in the literature on consumer behavior, particularly in transition economies such as China. The available literature generally addresses the interdependence between alcohol and cigarette consumption by estimating demand systems; however, in our case data on price variation and price information for a specific consumer are limited. A structural equation model is applied as an alternative to estimate the interdependence between alcohol and cigarette consumption with absence of price variation, using parental consumption patterns as instrumental variables for offspring's consumption. The empirical investigation is conducted by using the data from the China Health and Nutrition Survey (CHNS) over the period from 1993 to 2011. The results indicate that alcohol and cigarettes are complementary goods for men in China. When the demand for alcohol (cigarettes) increases, the demand for cigarettes (alcohol) will also increase, *ceteris paribus*. From a public health perspective this implies that measures for reducing alcohol or cigarette consumption might have a double dividend effect on health.

Keywords: alcohol and cigarette consumption; structural model, instrumental variable; China

4.1 Introduction

A number of studies have shown that extensive alcohol and cigarette consumption can lead to harmful health outcomes (Bazzano et al. 2007; Cochrane et al. 2003; Deng et al. 2006; Hao et al. 2004; Ruitenberg et al. 2002), and has been increasingly recognized as a serious public health concern worldwide. As a consequence a number of policies have been introduced to restrict alcohol and cigarette consumption, particularly in developed countries. Policies aimed at reducing alcohol-related problems include taxation, consumption restriction for the underage, and limited availability of alcoholic beverages. Other strategies include regulating alcohol consumption through drunk-driving laws and limiting alcohol promotion as well as increasing public education and health campaigns (Babor 2010). Similar and in some countries even heavier restrictions have been imposed on smoking. Smoking is banned in almost all public places in Europe, the US and Australia among other countries. The major reason for such restrictive measures on smoking is that smoking not only negatively affects smokers but also non-smokers. Since 2011 smoking has been officially banned in public places in China. There is, however, no comprehensive public health policy in China for reducing alcohol-consumption (Hao et al. 2005); for example, there is no official age-limit for purchasing or consuming alcohol. Alcohol use is prevalent among adolescents in China (X. Li et al. 1996).

The set of policies to reduce alcohol and cigarette consumption is huge; however, the policies are neither equally effective in improving public health nor efficient in reducing public health costs. Cook and Moore (2002) argue that the most effective policy is alcohol taxation (see also Gallet, 2007). With a meta-analysis Gallet (2007) finds significant evidence that consumers drink less when prices for alcoholic beverages are increased. There is a large body of empirical literature on alcohol and cigarette demand analysis; however, the literature almost exclusively focuses on developed countries. The literature on China shows that an increased price has actually a very limited effect on alcohol consumption (Balestrini and Gamble 2006; Ogwang and Cho 2009; Tian and Liu 2011). Tian and Liu (2011) estimate that in China the price elasticity for spirit is -0.12; it indicates that alcohol taxation might be ineffective to reduce alcohol consumption in China.

To implement the most efficient public health policy to control alcohol and cigarette consumption, it is particularly important to understand the relationship between the two goods. Policy

implications will differ depending on whether alcohol and cigarettes are substitutes or complements (see Yu and Abler, 2010). A tax imposed on alcohol or cigarettes will decrease the consumption of both goods when they are complements; this could lead to a comparatively larger public health benefit. A tax imposed on alcohol (cigarettes) will increase the consumption of cigarettes (alcohol) when they are substitutes; this might offset a portion of the public health benefit.

There has been an extensive literature that investigates the demand for alcohol and cigarettes. Separate demand functions are estimated by a number of authors such as Jones (1989); Yen (1994); Goel (2004); Selvanathan and Selvanathan (2004); Lance et al. (2004); Yen (2005); Harris et al. (2006); Tan et al. (2009); Ogwang and Cho (2009); Kasteridis et al. (2010); Bilgic et al. (2010); Yuan and Yen (2012); Nguyen (2012). Alcohol and cigarette consumption in a demand system analysis are estimated by Sharpe et al. (2001) and Su and Yen (2000). The correlation between alcohol and cigarette consumption is, however, not the focus in these studies. There is a limited number of articles that investigate the actual relationship between alcohol and cigarette consumption. Jones (1989b) finds that in the US alcohol and tobacco are complements by using quarterly expenditure data for the period 1964 to 1983. Aristei et al. (2008) and Aristei and Pieroni (2010) also find that alcohol and tobacco are complements for Italian households (see also Decker and Schwartz, 2000). Decker and Schwartz (2000) conclude that higher alcohol prices decrease both alcohol and cigarette consumption; this indicates a complementary relationship between the two commodities; meanwhile, they also find that higher cigarette prices tend to decrease smoking participation but increase alcohol consumption; this indicates a substitutional relationship.

Although the research on alcohol and cigarette consumption in China has been studied, most of the authors analyze the two commodities separately from each other (Bishop et al. 2007; Cai and Wang 2010; Cochrane et al. 2003; Hu et al. 2007; Kenkel et al. 2009; Pan et al. 2006; Wang et al. 2006; Wu 1998; Yen et al. 2009; Yuanliang and Zongyi 2005). Only one paper by Yu and Abler (2010) analyzes interdependencies between alcohol and cigarette consumption in rural China by using panel data for 10 years (1994-2003). Their results indicate that alcohol and cigarettes are complements; however, they observe no statistically significant effect of cigarette prices on either alcohol or cigarette consumption. It is suggested that taxes on alcohol might have a double dividend effect on health, but an increase in taxes on cigarettes might be ineffective for reducing alcohol or cigarette consumption in rural China (Yu and Abler 2010).

This paper contributes to the existing literature by investigating the interdependence between alcohol and cigarette consumption in China based on individual consumption data employing a structural equation model introduced by Tauchmann et al. (2013). In this model parent's consumption patterns are used as instruments for offspring's consumption. The data are individual observations from the China Health and Nutrition Survey (CHNS) from 1993 to 2011; furthermore, the effects of major demographic variables are analyzed and policy implications are discussed.

The organization of this paper is as follows. The next section outlines the conceptual framework and econometric specification. Section 3 describes the data set used in this study. Section 4 shows our estimation results. In the last section we present our research findings and draw conclusions.

4.2 Conceptual framework

4.2.1 Structural equation model

The CHNS reports the quantities consumed of alcohol and cigarettes but provides no information on the actual expenditures. The available price data are only at community level. The prices of alcohol and cigarettes show no significant variation over the survey period and across communities. As a result of the data limitation, a structural equation model is employed in our analysis to consider insufficient price variation. Instead of specifying a conventional demand system, the analysis is based on a structural, interdependent model of the consumption of both commodities. The interdependence between alcohol and cigarette consumption is analyzed based on the quantities demanded. The model assumes that

$$Q_{ait} = \alpha_a Q_{cit} + \beta_a x_{it} + \delta_a z_{ait} + \varepsilon_{ait} \quad (1)$$

$$Q_{cit} = \alpha_c Q_{ait} + \beta_c x_{it} + \delta_c z_{cit} + \varepsilon_{cit} \quad (2)$$

where Q_{ait} and Q_{cit} stand for the quantity of alcohol and cigarettes consumed by individual *i* in year *t*, respectively. For equation (1) it is assumed that the demand for alcohol Q_{ait} is a linear function of cigarette consumption Q_{cit}. Control variables x_{it} and variables that are specific for alcohol consumption z_{ait} are included. The coefficient $\alpha_a$in equation (1) measures the marginal effect of cigarette consumption on alcohol consumption when cigarette consumption is changed by one unit, *ceteris paribus*. For equation (2) it is assumed that the demand for cigarettes Q_{cit} is a

linear function of alcohol consumption Q_{ait}. Control variables x_{it} and variables that are specific for cigarette consumption z_{cit} are included. The coefficient α_c in equation (2) measures the marginal effect of cigarette consumption on alcohol consumption, if alcohol consumption is reduced by one unit, *ceteris paribus*.

Tauchmann et al. (2013) have demonstrated that the relationship between cross-price elasticity and cross-demand effect of alcohol and cigarettes has always reverse signs; this means that if the cross-price elasticity is negative, the cross demand has a positive effect. As a result of increased demand for alcohol (cigarettes), the demand for cigarettes (alcohol) also increases. The goal of this paper is to estimate the cross-demand effect of the coefficients α_a and α_c and to identify the relationship between alcohol and cigarettes. This requires first to assess whether the quantities consumed are endogenous to each other.

4.2.2 Instrumental variables

To estimate equations (1) and (2) in their current form might lead to biased results as alcohol and cigarette consumption could be jointly determined. In this case an instrumental variable approach is commonly used. The reduced form representation for Q_{ait} and Q_{cit} is

$$Q_{ait} = \gamma_{a1}x_{it} + \gamma_{a2}z_{ait} + \gamma_{a3}z_{cit} + v_{ait} \tag{3}$$

$$Q_{cit} = \gamma_{c1}x_{it} + \gamma_{c2}z_{cit} + \gamma_{c3}z_{ait} + v_{cit} \tag{4}$$

respectively; the coefficients from the reduced form representation for alcohol consumption are estimated in the following way:

$$\gamma_{a1} \equiv \frac{\alpha_a\beta_c+\beta_a}{1-\alpha_a\alpha_c},\ \gamma_{a2} \equiv \frac{\delta_a}{1-\alpha_a\alpha_c}, \gamma_{a3} \equiv \frac{\alpha_a\delta_c}{1-\alpha_a\alpha_c}, v_{ait} \equiv \frac{\alpha_a\varepsilon_{cit}+\varepsilon_{ait}}{1-\gamma_a\alpha_c} \tag{5}$$

The same approach applies for cigarette consumption. The interdependence between alcohol and cigarette consumption through instrumental variables is reflected in the alcohol and cigarette specific variables z_{ait} and z_{cit}, respectively. A valid instrumental variable influences alcohol (cigarette) consumption without directly influencing cigarette (alcohol) consumption. It has been well documented that parent's consumption behavior has significant influence on their children's consumption behavior (Charles et al. 2014; Chen and Cheung 2013; Cox et al. 2000; Grawe and

Mulligan 2002; Melchior et al. 2010; Waldkirch et al. 2004; Wickrama et al. 1999). For example, Schmidt and Tauchmann (2011) find that in Germany parental drinking and smoking behavior has a statistically significant influence on filial drinking and smoking behavior. Alongside with the learning story proposed by Tauchmann et al. (2013) that children may learn smoking and drinking behavior from their parents, parents' personal preferences (Charles et al. 2014; Chen and Cheung 2013) and biological reasons might as well play a pronounced role in offspring's consumption behavior (French and Popovici 2011). For instance, Davies and Soundy (2009) conclude that there are several specific genes having influence on the development of nicotine dependence based on the evidence from twin and family studies. The results from other research (Boardman et al. 2010; Loukola et al. 2014; MacKillop et al. 2010) also support this idea; they indicate that genetics play a substantial role in the etiology of nicotine dependence. Similarly, a number of studies have revealed that alcohol dehydrogenase (ADH) and aldehyde dehydrogenase (ALDH) both play a significant role in alcohol consumption and risk of alcoholism (Edenberg 2007; Mayfield et al. 2008; Stickel et al. 2017; Tawa et al. 2016). Therefore, we assume that parental alcohol and cigarette consumption might affect filial consumption through genetic inheritance, no matter whether parents and children are living in the same household or not. In this way, parental drinking (smoking) behavior might serve as a potentially valid instrument for filial alcohol and cigarette consumption since they are highly correlated; moreover, parental drinking (smoking) behavior has less likelihood to be directly correlated with filial cigarette (alcohol) consumption, given the fact that there are different genes influencing alcohol and cigarette consumption, respectively.

For the instruments to be valid, parental smoking (drinking) has, conditional on parental drinking (smoking) behavior, no direct effect on filial alcohol (tobacco) consumption; while this does not mean that the cross-correlation between parental smoking (drinking) and filial drinking (smoking) is zero. As the vectors z_{ait} and z_{cit} each include two instruments of maternal consumption and paternal consumption that are each parameterized in terms of three "drinking" and two "smoking" indicators, the coefficients α_a and α_c are over-identified. The over-identification test is applied to test for possible model over-identification and validation of instruments.

First, in the reduced form equation all possible instruments are included. An F-test is used to test whether the unrestricted model (including all instrumental variables) or the restricted model should be used. Since we have one endogenous variable and more than one instrument, the F-test for weak

instruments is not straightforward. When instruments are weak, point estimators will be biased, and the Wald test is unreliable. There are several tests recommended by Finlay and Magnusson (2009) allowing to have the correct size even if the instruments are weak, such as the Anderson-Rubin (*AR*) test (Anderson and Rubin 1949), the Kleibergen-Moreira Lagrange Multiplier (*LM*) test (Kleibergen 2007; Moreira 2003), and the Conditional Likelihood-Ratio (*CLR*) test. We use the *CLR* test since it is more powerful than the *AR* and *LM* tests (Andrews et al. 2006). Second, the over-identification (*J*) test recommended by Finlay and Magnusson (2009) is applied in this study. Finally, the valid instruments are used in the structural model to estimate α_a and α_c. The estimation results are compared and the most reliable model is selected.

4.2.3 The econometric specification

The estimation approach that is usually applied for such a theoretical setting is a standard IV-estimation. A closer look at the CHNS data (see section 3), however, reveals that the sample includes a large proportion of non-consumers. Zero consumption accounts for approximately 51 % and 56 % for alcohol and cigarettes, respectively. In our case the application of an OLS approach leads to inconsistent results as an OLS approach considers the actual consumption data only and does not consider zero consumption data. The most commonly used methods to address zero consumption data is proposed by Heien and Wessells (1990) and Shonkwiler and Yen (1999). They assume that an individual decides on his/her consumption in a two-step process. First, s/he makes the decision to participate (smoke and/or drink) or not. Second, s/he decides about the actual quantities demanded. However, the *HW* (Heien and Wessells) estimator is well known for lacking a decent basis. The drawback of the *CTS* (consistent two-step) estimation procedure is that a variable that only affects the decision to consume but not the decision on the actual quantities consumed is required. Tauchmann et al. (2013) have stated that it is hard to identify such a variable for alcohol and cigarette consumption; therefore, a Tobit model is used in our structural equations. Although a Tobit model follows strict assumptions[6], it is a widely used model to account for zero consumption patterns.

[6] It requires normal distributed errors and assumes that any variable in the model affects the participation decision and consumption equation with the same sign (Greene 2011).

To estimate the structural equation model, the instrumental variable (iv) Tobit model is applied. The iv-Tobit model follows a two-stage procedure. First, all coefficients θ are estimated by a Tobit procedure to predict Q_{ait} and Q_{cit}. Second, the structural model is estimated by a Tobit procedure with the predicted regressors of Q_{ait} and Q_{cit}. The primary objective of this article is to show the relationship between alcohol and cigarette consumption. The emphasis is on the signs of α_a and α_c.

4.3. Data

Data from the CHNS are used in this article. The survey begins in 1989 with a sample of approximately 4,400 households with a total of approximately 16,000 individuals. Follow-up surveys conducted in 1991, 1993, 1997, 2000, 2004, 2006, 2009 and 2011. The CHNS has a multi-stage random cluster design and surveys people from nine provinces in China (Liaoning, Heilongjiang, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, and Guizhou) for the years from 1989 to 2011, as well as from three municipalities (Beijing, Shanghai, and Chongqing) for the year 2011 as shown in the map in Figure 4.1. The twelve regions considered vary in terms of their economic development, public resources, and geographic features among other factors. Alongside with health and nutrition related questions, the CHNS captures a wide range of socioeconomic characteristics.

Since 1993 the survey covers a number of questions on consumers' drinking and smoking behaviors. Regarding the drinking behavior, the respondents are asked *"Did you drink beer or any other alcoholic beverage last year?"*, and "*How often did you drink beer or any alcoholic beverage?*" Individuals who drank any alcoholic beverage last year were further required to report the types of each alcoholic beverage (beer, grape wine including various colored wines, rice wine, and liquor) and quantities (bottle for beer, Liang (Chinese ounce) or 50g for other alcoholic beverages) of alcoholic beverages consumed in each typical drinking week in the previous year. To calculate the quantity of pure alcohol consumed, we follow the measurement recommended by Li et al. (2011). The percent of pure alcohol is 4 % for beer, 52 % for liquor, and 10 % for wine; moreover, the beer bottle volume is set at 640 ml, which is most common in China. The questions on consumers' cigarette consumption include "*Have you ever smoked cigarettes?*", if respondents have answered *"Yes",* they are further asked *"Do you still smoke cigarettes now?"* and *"How*

many cigarettes do you smoke per day". Based on these questions, we can define an individual as an ex-smoker or a current smoker.

Figure 4. 1Map of Survey Regions

The darker shaded regions in this map are the provinces in which the survey has been conducted.
Source: http://www.cpc.unc.edu/projects/china/about/proj_desc/chinamap

As aforementioned, parental alcohol and cigarette consumption behaviors serve as essential instruments in our analysis. In the CHNS each individual has his/her own ID as well as his/her parental IDs; thus, we can match individuals' consumption with parents' consumption using the parental-child identifiers to select a sample consisting of parents-offspring pairs. In other words, matching here means that the sample is confined to families for which two generations participate in the CHNS but who not necessarily live in the same household. As aforementioned, the CHNS is not a fixed point survey; therefore, it is strongly unbalanced, especially when matching the children's information with parents' information. As indicated in similar studies, researchers who use the CHNS data commonly conduct pooled estimations and control for time fixed effects instead of considering a panel structure (Qin, Wang, and Zhuang 2016; Eriksson, Pan, and Qin 2014; Dolton and Xiao 2015); thus, this procedure is also used in our analysis.

The WHO reports that men are more likely to consume alcohol in China than women; approximately 58 % and 29 % of Chinese men and women consume alcohol, respectively. The

WHO also informs that there are more than 300 million smokers in China, which accounts for almost one-third of the world's total. The Global Adult Tobacco Survey (GATS) states that approximately one-third (28.1 %) of the Chinese population smoked in 2010, including 52.9 % men and 2.4 % women (WHO 2010). The proportion of female smokers is also very low in our sample; it accounts for roughly 1.59 %.

This lack of variation for female consumers pertains us from drawing reliable conclusions. A pooled male and female sample might also disguise the true relationship of alcohol consumption and other socio-demographic and economic factors (Yen et al. 2009). It seems that alcohol and cigarette consumption is more a male's behavior in China; therefore, this paper focuses on adult men's alcohol and cigarette consumption. We restrict our sample to men older than sixteen years of age. After merging all other variables regarding individuals' demographic, socio-economic and household background information, the sample consists of 6,124 individuals.

The definitions and summary statistics of all variables used in our study are presented in Table 4.1. The dependent variables are the quantities consumed of alcohol (Q_{ait}) and cigarettes (Q_{cit}). In the total sample, men consumed on average 6.79 *gram* of pure alcohol per week and 5.93 cigarettes per day. Among the men who reported to consume, the average amounts consumed are 14.58 *grams* of pure alcohol per week and 13.50 cigarettes per day. The probability that men consume alcohol (cigarettes) is 49 % (44 %), respectively, in our sample. The relatively large proportion of non-consumption in the sample is accounted for to avoid estimation bias (see section 2.3).

Parental alcohol and cigarette consumption are chosen as specific variables for filial alcohol and cigarette consumption, respectively (see section 2.2). To avoid unobserved heterogeneity, a set of indicators is used to identify parents' alcohol and cigarette consumption[7], instead of using the actual amounts of parental alcohol and cigarette consumption (Table 4.1).[8] The descriptive statistics show that 90 % of mothers reported no alcohol consumption in the previous year; 2 %, 4 % and 5 % reported to have consumed alcohol daily, weekly and monthly, respectively. The

[7] In terms of parental drinking behavior, parents who drink alcohol almost every day are defined as daily consumers; parents who drink alcohol three to four times a week or once or twice a week are defined as weekly consumers; parents who drink alcohol once or twice a month or no more than once a month are defined as monthly consumers.

[8] We use the indicators because when using the actual amount of parental alcohol and cigarette consumption as instruments, most of the over-identification tests are rejected; this indicates that the actual amount of parental alcohol and cigarette consumption are actually correlated with the unobserved factors of the disturbances in structural equations.

alcohol consumption figures are higher for fathers compared with those for mothers. The descriptive statistics show that 38 % of fathers reported no alcohol consumption in the previous year; approximately 25 % are daily consumers; 22 %, and 15 % reported to have consumed alcohol weekly and monthly, respectively. The cigarette consumption data show similar patterns. Among the mothers 95 % never smoked, 1 % smoked in the past, and 4 % still smoke. Among the fathers 34 % never smoke, 8 % smoked in the past, and 58 % still smoke.

The individual consumer control variables consist of age, age squared, marital status, and the highest education level of father and mother. A set of regional dummies that distinguish between residences in different provinces and urban versus rural controls are used. Year dummies are included to control for the time fixed effects (section 2.1) because the available panel structure is strongly unbalanced.(see also Dolton and Xiao 2015; Eriksson et al. 2014; Qin et al. 2016). The other variables often controlled for include labor market status, education, number of children, current living situation and income (Su and Yen 2000; Yen 2005), which are excluded by Tauchmann et al. (2013) due to their potential endogeneity. However, the intergenerational impact of parents on their offspring might be mainly through family income and education (Blanden et al. 2007; Chen and Cheung 2013; Restuccia and Urrutia 2004). In order to avert unobserved heterogeneity and reverse causality invalidating our instruments, we also control for education, occupational status, and household income as a comparison to check the robustness of our estimation results.

Table 4. 1 Descriptive statistics of the main variables

Variable	Definition	Mean	Std.Dev.
Quantity of pure alcohol	Amount of pure alcohol consumed per week (gram)	6.79	12.87
	Among the consuming	14.58	15.56
Quantity of cigarettes	Number of cigarettes consumed per day	5.93	8.08
	Among the consuming	13.50	6.82
Drink	Probability of alcohol consumption	0.49	0.50
Smoke	Probability of cigarette consumption	0.44	0.50
Parental consumption			
Father's alcohol consumption			
	Father never drinks (base)	0.38	0.49
	Father is a daily drinker	0.25	0.43
	Father is a weekly drinker	0.22	0.42
	Father is a monthly drinker	0.15	0.35
Mother's alcohol consumption			
	Mother never drinks (base)	0.90	0.31
	Mother is a daily drinker	0.02	0.14
	Mother is a weekly drinker	0.04	0.18
	Mother is a monthly drinker	0.05	0.22
Father's cigarette consumption			
	Father never smokes (base)	0.34	0.48
	Father ever smoked	0.08	0.27
	Father still smokes	0.58	0.49
Mother's cigarette consumption			
	Mother never smokes (base)	0.95	0.22
	Mother ever smoked	0.01	0.08
	Mother still smokes	0.04	0.20
Control variables			
Age	Age in year	26.03	7.60
Age squared	Age square	735.50	465.00
Married	Married (0/1)	0.41	0.49
Education father	Father's highest education level	1.53	1.26
Education mother	Mother's highest education level	0.98	1.18
Education	Highest education level	2.44	1.18
Presently working	Presently working? (0/1)	0.76	0.43
Logarithm of income	Logarithm of household income	9.67	1.13
Urban	Lives in urban area (0/1)	0.28	0.45

Source: Authors' calculations based on CHNS samples. In total, we have 6124 observations. The mean values are reported for continuous variables and the percentages for discrete variables.

Notes:

[a]: Individuals who drink alcohol almost every day are defined as daily consumers; individuals who drink alcohol three to four times a week or once or twice a week are defined as weekly consumers; individuals who drink alcohol once or twice a month or no more than once a month are defined as monthly consumers.

[b]: *Education* refers to the highest education level, there are seven categories defined as: 0, no school; 1, graduated from primary school; 2, lower middle school degree; 3, upper middle school degree; 4, technical or vocational degree; 5, university or college degree; 6, master's degree or higher. The same definition for the *Education father* and *Education mother.*

4.4 Estimation results

First, the significance of the instruments in the reduced form Tobit specification as given in equations (3) and (4) is tested (Table 4.2). Second, the standard and instrumental Tobit model specifications for both equations are compared (Tables 4.3 and 4.4).

4.4.1 Reduced form results for the Tobit specification

Maternal and paternal alcohol and cigarette consumption data are employed as instruments in the reduced form estimations (Table 4.2). Column (1)-(4) and (5)-(8) show the results for alcohol and cigarette consumption, respectively. In the aggregate, there is a positive correlation between a son's alcohol and cigarette consumption and his parent's consumption. Our estimation results are robust with different model specifications.

For alcohol consumption as shown in columns (1)-(4), the coefficients for parental smoking behavior are statistically significantly positive in all model specifications. Parent's prior smoking behavior has no statistically significant effects but parent's current smoking behaviors have significant cross-effects on sons' alcohol consumption. The results show that parents who consume alcohol positively affect their son's alcohol consumption. Specifically, paternal alcohol consumption has a comparatively stronger effect on a son's alcohol consumption than has maternal alcohol consumption. The F-test that the instruments are jointly zero is rejected (F-statistic is approximately 20) for all model specifications; this implies that parental alcohol consumption behavior is highly correlated with a son's alcohol consumption (Q_{ait}). The results also show a statistically significantly positive cross correlation between parental current cigarettes consumption and their son's alcohol consumption. In order to reassess the validity of instruments, an over-identification test has been conducted in the structural Tobit estimation.

Table 4. 2 Tobit reduced form estimation for alcohol and cigarette consumption

	Amount of pure alcohol (Q_{ait})				Amount of cigarettes (Q_{cit})			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Father is a daily drinker	10.149***	10.147***	10.064***	9.907***	1.476***	1.553***	1.498***	1.426**
	(0.91)	(0.91)	(0.91)	(0.90)	(0.57)	(0.56)	(0.56)	(0.56)
Father is a weekly drinker	10.792***	10.794***	10.690***	10.612***	1.041*	1.018*	0.934	0.900
	(0.88)	(0.88)	(0.88)	(0.87)	(0.58)	(0.58)	(0.58)	(0.57)
Father is a monthly drinker	6.840***	6.837***	7.010***	6.995***	-0.289	-0.184	-0.064	-0.063
	(0.85)	(0.85)	(0.86)	(0.85)	(0.67)	(0.66)	(0.66)	(0.66)
Mother is a daily drinker	10.628***	10.626***	10.642***	10.654***	2.315	2.386*	2.375*	2.394*
	(2.19)	(2.19)	(2.20)	(2.21)	(1.43)	(1.42)	(1.42)	(1.42)
Mother is a weekly drinker	5.896***	5.898***	5.872***	5.781***	1.899*	1.836	1.805	1.782
	(1.69)	(1.69)	(1.69)	(1.69)	(1.13)	(1.12)	(1.12)	(1.12)
Mother is a monthly drinker	9.814***	9.816***	9.998***	9.854***	1.541*	1.486	1.546*	1.485*
	(1.33)	(1.33)	(1.33)	(1.32)	(0.92)	(0.91)	(0.90)	(0.90)
Father ever smoked	1.033	1.038	0.882	0.842	2.907***	2.752***	2.598***	2.584***
	(1.16)	(1.16)	(1.16)	(1.16)	(0.86)	(0.85)	(0.85)	(0.85)
Father still smokes	1.189*	1.195*	1.184*	1.200*	4.348***	4.121***	4.114***	4.110***
	(0.69)	(0.69)	(0.69)	(0.69)	(0.49)	(0.49)	(0.49)	(0.49)
Mother ever smoked	6.774	6.786	6.860	6.354	2.867	2.505	2.596	2.353
	(4.77)	(4.77)	(4.75)	(4.75)	(2.48)	(2.46)	(2.48)	(2.48)
Mother still smokes	3.251**	3.258**	3.267**	3.337**	4.134***	3.938***	3.912***	3.955***
	(1.65)	(1.65)	(1.65)	(1.64)	(0.96)	(0.96)	(0.95)	(0.95)
Age	2.944***	2.941***	2.589***	2.596***	2.622***	2.697***	2.441***	2.441***
	(0.25)	(0.25)	(0.25)	(0.25)	(0.19)	(0.19)	(0.20)	(0.20)
Age Squared	-0.036***	-0.036***	-0.031***	-0.031***	-0.035***	-0.036***	-0.033***	-0.033***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Married	3.865***	3.867***	3.627***	3.433***	1.805***	1.767***	1.549***	1.473***
	(0.75)	(0.75)	(0.75)	(0.75)	(0.52)	(0.52)	(0.52)	(0.52)
Education mother	-0.077	-0.084	-0.034	-0.135	-0.904***	-0.661***	-0.631**	-0.682***
	(0.34)	(0.34)	(0.34)	(0.34)	(0.24)	(0.25)	(0.25)	(0.25)
Education father	0.065	0.056	0.085	-0.028	-0.139	0.123	0.147	0.096
	(0.29)	(0.30)	(0.30)	(0.30)	(0.21)	(0.21)	(0.21)	(0.21)
Urban	2.289***	2.265***	2.639***	2.399***	-0.215	0.522	0.835	0.722
	(0.76)	(0.79)	(0.79)	(0.79)	(0.51)	(0.53)	(0.53)	(0.53)
Education		0.043	0.017	-0.209		-1.361***	-1.375***	-1.475***
		(0.31)	(0.31)	(0.32)		(0.22)	(0.22)	(0.22)
Presently working			4.554***	3.928***			3.567***	3.271***
			(0.82)	(0.83)			(0.57)	(0.58)
Logarithm of income				1.563***				0.718***
				(0.41)				(0.26)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-65.274***	-65.306***	-63.283***	-75.460***	-43.286***	-42.083***	-40.804***	-46.356***
	(4.98)	(4.99)	(4.98)	(6.05)	(3.64)	(3.65)	(3.60)	(4.15)
N	6124	6124	6124	6124	6124	6124	6124	6124
F-statistic	21.471	20.840	20.805	20.344	34.317	34.502	35.685	34.882
Pseudo-R2	0.033	0.033	0.035	0.035	0.035	0.036	0.038	0.038

* p<0.10, ** p<0.05, *** p<0.010

Notes: Robust standard errors are in parentheses. Regional controls include dummies for Chongqing (reference), Beijing, Liaoning, Heilongjiang, Shanghai, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou. Time controls include year dummies for 1993 (reference), 1997, 2000, 2004, 2006, 2009, 2011.

Source: Authors' estimations based on CHNS samples.

The columns (5)-(8) show the reduced Tobit estimation for cigarette consumption. Parents' drinking behavior shows statistically significantly positive effects on a son's cigarette consumption. Paternal smoking behavior has a stronger influence than maternal smoking behavior on a son's cigarette consumption. When the father has ever smoked or is still smoking, the predicted amount of cigarettes consumed by a son are approximately three to four additional cigarettes compared to children whose fathers never smoked. The F-test that the instruments are jointly zero is rejected (F-statistic is approximately 35) for all models; this implies that the instruments are highly relevant to explain a son's cigarette consumption. The cross effects of parental alcohol consumption show statistically significant influence on a son's cigarette consumption, specifically, if the father or the mother is a daily drinker.

With regards to the control variables, there is a statistically significant age effect. A higher level of age statistically significantly increases the probability to consume alcohol and cigarettes until the effect decreases after a threshold indicated by a declining age-square coefficient. Tauchmann et al. (2013) and Yen et al. (2009) find similar results. It is also found that married individuals are more likely to consume alcohol and cigarettes than unmarried individuals; Yen et al. (2009) observe similar findings for China. The level of parental education is also controlled for in the analysis. Paternal education has no statistically significant effect on a son's alcohol and cigarette consumption. In contrast, maternal education shows a statistically significant negative effect on a son's cigarette consumption. The descriptive statistics indicate that the maternal education level is still very low; the average education level of mothers in our sample is below primary school. This means that maternal education can still be improved; this might even be a very efficient way to reduce filial cigarette consumption. Whether the individual lives in urban or rural area shows no statistically significant impact on cigarette consumption, while it indicates that urban residents drink alcohol more than do rural residents.

In the view of the additional control variables of education, occupation and income, we find that education has a negative impact on alcohol and cigarette consumption but is not statistically significant for alcohol consumption; while occupation and income both show a statistically significantly positive impact on alcohol and cigarette consumption. As aforementioned education, occupation and income might be potentially endogenous. We should, thus, be cautious when interpreting the coefficients for these variables.

4.4.2 Estimation results for the structural Tobit model

Tables 4.3 and 4.4 present the estimation results for the structural equations with and without the instrumental variables. A son's cigarette (Q_{cit}) and alcohol consumption (Q_{ait}) are instrumented with the indicators of parental cigarette and alcohol consumption, respectively. As the control variables in Tables 4.3 and 4.4 have largely the same magnitude and signs as in the reduced form specification, the further discussion will focus on α_a and α_c.

The coefficients of Q_{cit} show statistically significant positive effects on alcohol consumption in both models. Although the coefficients from the instrumental Tobit model (Table 4.4) are slightly higher than those from the regular Tobit estimation (Table 4.3), they have the same signs. The findings suggest that smoking increases not only the probability but also the propensity to drink. Nevertheless, a weak instrument test and the over-identification test need to be applied to verify the estimation results. All the specific variables of parental alcohol consumption are highly significant as in the Tobit reduced form estimation. The null hypothesis that all instruments are jointly zero in the first stage is significantly rejected as it is shown with the F-statistics (larger than 20). Moreover, we find that there is no weak instruments problem in our estimation using the *CLR* test. The P-value indicates that the estimates of Q_{cit} and Q_{ait} are highly significant (at the 5 % level) in various model specifications for alcohol and cigarette consumption.

The over-identification test in the second stage is not rejected for all the model specifications; this implies that either one or more of our instruments are valid or that our structural model is specified correctly; therefore, the estimates from the instrumental Tobit model are consistent, though the estimations from the regular Tobit model are likely to have smaller standard errors. The results from the instrumental estimation show that when cigarette consumption is reduced by one cigarette, the estimated alcohol consumption tends to decrease by approximately 0.8 gram per week for men in China.

Table 4. 3 Tobit estimation for alcohol and cigarette consumption

	Amount of pure alcohol (Q_{ait})				Amount of cigarettes (Q_{cit})			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Quantity of cigarettes	0.783***	0.790***	0.783***	0.778***				
	(0.04)	(0.04)	(0.04)	(0.04)				
Quantity of pure alcohol					0.277***	0.276***	0.273***	0.271***
					(0.01)	(0.01)	(0.01)	(0.01)
Father is a daily drinker	9.480***	9.467***	9.410***	9.291***				
	(0.85)	(0.85)	(0.84)	(0.84)				
Father is a weekly drinker	10.366***	10.393***	10.315***	10.260***				
	(0.82)	(0.82)	(0.82)	(0.82)				
Father is a monthly drinker	6.952***	6.917***	7.062***	7.053***				
	(0.81)	(0.81)	(0.81)	(0.81)				
Mother is a daily drinker	9.859***	9.830***	9.865***	9.880***				
	(2.06)	(2.07)	(2.08)	(2.08)				
Mother is a weekly drinker	5.625***	5.649***	5.620***	5.540***				
	(1.65)	(1.65)	(1.65)	(1.65)				
Mother is a monthly drinker	9.561***	9.593***	9.746***	9.629***				
	(1.24)	(1.24)	(1.24)	(1.24)				
Father ever smoked					2.876***	2.728***	2.590***	2.578***
					(0.82)	(0.82)	(0.81)	(0.81)
Father still smokes					4.163***	3.952***	3.939***	3.931***
					(0.46)	(0.46)	(0.46)	(0.46)
Mother ever smoked					1.712	1.361	1.465	1.305
					(2.56)	(2.54)	(2.56)	(2.56)
Mother still smokes					3.772***	3.578***	3.561***	3.591***
					(0.94)	(0.94)	(0.93)	(0.93)
Age	2.176***	2.132***	1.853***	1.863***	2.301***	2.375***	2.149***	2.152***
	(0.23)	(0.23)	(0.24)	(0.24)	(0.19)	(0.19)	(0.19)	(0.19)
Age Squared	-0.026***	-0.025***	-0.021***	-0.022***	-0.031***	-0.033***	-0.029***	-0.029***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Married	3.159***	3.188***	3.005***	2.849***	1.347***	1.310***	1.117**	1.067**
	(0.72)	(0.72)	(0.73)	(0.72)	(0.51)	(0.51)	(0.51)	(0.51)
Mother's highest education level	0.296	0.197	0.233	0.147	-0.893***	-0.656***	-0.628***	-0.664***
	(0.32)	(0.32)	(0.33)	(0.33)	(0.23)	(0.24)	(0.23)	(0.24)
Father's highest education level	0.076	-0.037	-0.014	-0.105	-0.142	0.115	0.136	0.100
	(0.28)	(0.29)	(0.29)	(0.29)	(0.20)	(0.20)	(0.20)	(0.20)
Urban	2.491***	2.168***	2.474***	2.279***	-0.541	0.171	0.459	0.387
	(0.72)	(0.75)	(0.76)	(0.75)	(0.49)	(0.50)	(0.51)	(0.51)
Education		0.585*	0.560*	0.371		-1.326***	-1.337***	-1.405***
		(0.30)	(0.31)	(0.31)		(0.21)	(0.21)	(0.21)
Presently working			3.749***	3.241***			3.227***	3.026***
			(0.78)	(0.79)			(0.55)	(0.56)
Logarithm of income				1.280***				0.489*
				(0.40)				(0.25)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-57.444***	-57.736***	-56.224***	-66.227***	-38.240***	-37.070***	-35.998***	-39.831***
	(4.71)	(4.71)	(4.73)	(5.80)	(3.49)	(3.50)	(3.46)	(4.03)
N	6124	6124	6124	6124	6124	6124	6124	6124
F-statistic	29.495	28.563	28.146	27.376	54.900	53.845	54.326	52.383
Pseudo-R2	0.048	0.048	0.049	0.049	0.047	0.048	0.050	0.050

* p<0.10, ** p<0.05, *** p<0.010

Notes: Robust standard errors are in parentheses. Regional controls include dummies for Chongqing (reference), Beijing, Liaoning, Heilongjiang, Shanghai, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou. Time controls include year dummies for 1993 (reference), 1997, 2000, 2004, 2006, 2009, 2011.

Source: Authors' estimations based on CHNS samples.

Table 4. 4 Tobit structural model estimation for alcohol and cigarette consumption

	Amount of pure alcohol (Q_{ait})				Amount of cigarettes (Q_{cit})			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Quantity of cigarettes	0.803**	0.851**	0.845**	0.851**				
	(0.31)	(0.33)	(0.33)	(0.33)				
Quantity of pure alcohol					0.311***	0.314***	0.303***	0.295***
					(0.08)	(0.08)	(0.08)	(0.08)
Father is a daily drinker	9.453***	9.392***	9.334***	9.206***				
	(0.86)	(0.87)	(0.87)	(0.86)				
Father is a weekly drinker	10.347***	10.350***	10.272***	10.213***				
	(0.83)	(0.83)	(0.83)	(0.83)				
Father is a monthly drinker	6.948***	6.914***	7.057***	7.049***				
	(0.92)	(0.92)	(0.92)	(0.92)				
Mother is a daily drinker	9.827***	9.738***	9.772***	9.770***				
	(2.01)	(2.02)	(2.01)	(2.01)				
Mother is a weekly drinker	5.605***	5.599***	5.569***	5.482***				
	(1.53)	(1.54)	(1.54)	(1.53)				
Mother is a monthly drinker	9.544***	9.555***	9.705***	9.584***				
	(1.27)	(1.27)	(1.27)	(1.27)				
Father ever smoked					2.857***	2.707***	2.575***	2.566***
					(0.80)	(0.79)	(0.79)	(0.79)
Father still smokes					4.114***	3.898***	3.897***	3.897***
					(0.47)	(0.47)	(0.47)	(0.47)
Mother ever smoked					1.553	1.185	1.327	1.201
					(2.47)	(2.46)	(2.45)	(2.45)
Mother still smokes					3.683***	3.479***	3.483***	3.527***
					(1.01)	(1.00)	(1.00)	(1.00)
Age	2.154***	2.066***	1.792***	1.791***	2.266***	2.336***	2.121***	2.129***
	(0.39)	(0.42)	(0.40)	(0.40)	(0.19)	(0.19)	(0.19)	(0.19)
Age Squared	-0.026***	-0.024***	-0.021***	-0.021***	-0.031***	-0.032***	-0.029***	-0.029***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Married	3.137***	3.130***	2.949***	2.787***	1.282**	1.237**	1.062**	1.025**
	(0.78)	(0.79)	(0.78)	(0.78)	(0.52)	(0.52)	(0.52)	(0.52)
Mother's highest education level	0.305	0.217	0.254	0.173	-0.892***	-0.656***	-0.629***	-0.663***
	(0.36)	(0.35)	(0.35)	(0.35)	(0.23)	(0.23)	(0.23)	(0.24)
Father's highest education level	0.077	-0.043	-0.021	-0.111	-0.147	0.108	0.131	0.098
	(0.28)	(0.29)	(0.29)	(0.29)	(0.20)	(0.20)	(0.20)	(0.20)
Urban	2.497***	2.165***	2.465***	2.272***	-0.564	0.142	0.433	0.368
	(0.72)	(0.73)	(0.74)	(0.74)	(0.50)	(0.51)	(0.52)	(0.52)
Education		0.629	0.606	0.428		-1.320***	-1.333***	-1.398***
		(0.38)	(0.38)	(0.40)		(0.21)	(0.21)	(0.21)
Presently working			3.682***	3.172***			3.188***	3.003***
			(0.85)	(0.85)			(0.55)	(0.55)
Logarithm of income				1.256***				0.467*
				(0.38)				(0.26)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-57.214***	-57.157***	-55.675***	-65.403***	-37.821***	-36.608***	-35.656***	-39.378***
	(5.69)	(5.72)	(5.62)	(6.70)	(3.54)	(3.53)	(3.51)	(4.18)
N	6124	6124	6124	6124	6124	6124	6124	6124
Weak instrument robust tests CLR (P-values)	0.017	0.018	0.019	0.018	0.000	0.000	0.000	0.001
Test for over-identifying restriction (P-values)	0.248	0.235	0.228	0.261	0.731	0.768	0.799	0.806

Notes: Two-step standard errors are in parentheses. Regional controls include dummies for Chongqing (reference), Beijing, Liaoning, Heilongjiang, Shanghai, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou. Time controls include year dummies for 1993 (reference), 1997, 2000, 2004, 2006, 2009, 2011.

Source: Authors' estimations based on CHNS samples.

The estimation results for cigarette consumption with and without instrumental variables are given in columns (5)-(8) of Tables 4.3 and 44, respectively. The coefficients for Q_{ait} from the regular and instrumental Tobit estimations are statistically significant and have positive signs. The over-identification test in the second stage is not rejected at the conventional level of significance; this suggests that the instrumental variables of parental cigarette consumption are jointly valid instruments; thus, the estimations from the instrumental Tobit model are consistent. When an individual consumes one gram of alcohol less, the predicted amount of cigarettes he consumes is likely to reduce by almost 0.3 cigarette per day.

It is highlighted in section 2 that the relationship between cross-price elasticity and cross-demand effects of alcohol and cigarettes has always reverse signs. Unlike Yu and Abler 's (2010) findings that alcohol and cigarettes are complements but not vice versa, in our estimation cross-demand effects α_a and α_c are both positive; hence, cigarettes and alcohol are complements for men in China, and vice versa. When the demand for alcohol (cigarettes) increases, the demand for cigarettes (alcohol) will also increase, *ceteris paribus*. From a public health perspective this implies that measures for reducing alcohol or cigarette consumption might have a double dividend effect on health.

4.5. Conclusion

Harmful influences of smoking and drinking have been increasingly recognized as serious public health concerns. An efficient public health policy that seeks to minimize citizens' burden and to maximize welfare gains should consider the relationship between alcohol and cigarette consumption. Due to insufficient price variation, the approach starting with a structural equation model that was introduced by Tauchmann et al. (2013) is used in this study to better understand the relationship between alcohol and cigarette consumption in China. The empirical estimation conducted for men older than 16 years of age uses data from the CHNS covering the period from 1993 to 2011. A structural Tobit model is employed to address the censoring of the data. To account for the potential endogeneity of alcohol and cigarette consumption in the structural estimation, parents' consumption behaviors are used as instruments for sons' alcohol and cigarette consumption, respectively.

The main finding of our research is that alcohol and cigarettes are complementary goods for men in China. When the demand for alcohol (cigarettes) increases, the demand for cigarettes (alcohol) will also increase, *ceteris paribus*. This implies that a positive health effect could be achieved if only one of the two commodities is targeted with health measures, for example through a tax. This kind of positive health effect is often referred to as a double dividend health effect, or in a more popular vernacular, it is a health measure that could "kill two birds with one stone".

The results also indicate that parental alcohol and cigarette consumption has a significantly positive influence on a son's alcohol and cigarette consumption, respectively. This suggests that parental alcohol and cigarette consumption behavior serves as a valid instrument for filial alcohol and cigarette consumption behavior if endogeneity is observed. Another interesting finding is that maternal education has a statistically significant effect on filial cigarette consumption. Any policy that seeks to improve women's education in China might be helpful for reducing filial cigarette consumption.

Finally, it can be concluded that the structural model serves as an excellent alternative if only consumption data are available. A limitation of this study is the comparatively small sample size; this stems from the fact that individual and parental data are merged. Further studies with other data sources are required to verify our results. To provide more elaborate policy recommendations, it might be fruitful in future studies to analyze the relationship between socio-economic factors and harmful health behavior, particularly due to China's rapid economic shift over the last decades and the respective change in consumption behavior.

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Chapter 5

Unhealthy Consumption Behaviors and Their Intergenerational Persistence: the Role of Education

Yanjun REN[1]; Yanjie ZHANG[2]; Bente CASTRO CAMPOS[3]; Jens-Peter LOY[4]

[1,3,4] Department of Agricultural Economics, University of Kiel, Germany.

[2] Leibniz Institute of Agricultural Development in Transition Economies (IAMO), 06120 Halle (Saale), Germany.

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Abstract

This paper investigates the impact of education on unhealthy consumption behaviors and their intergenerational persistence, using data from the China Health and Nutrition Survey (CHNS). After identifying a statistically significant positive correlation between filial and parental unhealthy consumption behaviors, an instrumental model is employed to account for the endogeneity of education in unhealthy consumption equations. We find that education has a negative impact on unhealthy consumption for all individuals considered in the sample. Specifically, an additional year of education decreases the probability of smoking, drinking, and binge drinking by 3.4%, 2.8%, and 1.8%, respectively. We also find that an additional year of education can counteract intergenerational persistence of smoking and binge drinking from the father, but that it has no impact on intergenerational persistence from the mother. In addition, we observe no impact of education on the intergenerational persistence of drinking from both parents.

Keywords: unhealthy consumption, intergenerational persistence, education, China

5.1 Introduction

Cigarette smoking and alcohol consumption are two crucial behaviors that can negatively affect health and longevity (Bazzano et al. 2007; Deng et al. 2006; Hao et al. 2004; Ruitenberg et al. 2002). The Chinese government is increasingly concerned about the public health burden that arises from cigarette smoking and alcohol consumption. National legislators have begun to actively consider national bans on smoking in public and work places as well as on cigarette advertising. Nevertheless, tobacco control in China has remained particularly cumbersome because of the tobacco industry. There are over 300 million cigarette smokers in China who consume roughly one-third of the world's cigarettes (WHO, 2015); 1.4 million people in China die annually from smoking-related diseases, and this number is expected to rise to over 3 million by 2050 if current smoking rates will continue (Yang et al. 2015).

Alcohol consumption is another harmful health-related behavior. It is increasing faster in China than it is in other countries and shows a steady rise (Cochrane et al. 2003; Hao et al. 2005). The 2007 national survey of alcohol consumption has revealed that in China 55.6% of men and 15.0% of women were frequent alcohol consumers (Li et al. 2011)[9]. Alcohol use disorders (AUDs)[10] have become a frequent problem linked to disturbances in mental and physical health (Tang et al., 2013). Precisely, the AUD rates in China are 9.3% and 0.2% among men and women, respectively; this is comparatively larger than it is in other countries (WHO 2014).

To control and better understand the determinants of cigarette smoking and alcohol consumption, a large number of studies have been conducted. These studies mainly focus on the impact of social demographic variables, such as income, on cigarette smoking and alcohol consumption. Furthermore, the impact of price on an individuals' unhealthy consumption behavior has been extensively studied (Bishop et al. 2007; Tian and Liu 2011; X. Yu and Abler 2010). Bishop et al. (2007) find that price elasticity for cigarettes is approximately -0.5; however, income is less likely to affect cigarette smoking as the income elasticity is quite low ranging between 0.003 and 0.038. Yu and Abler (2010) find that neither price nor income have statistically significant impacts on cigarette smoking. Regarding alcohol consumption in China, Tian and Liu (2011) conclude that

[9] They consider drinking on 5-7 days per week as frequent drinking.

[10] AUDs encompass harmful patterns of drinking such as alcohol dependence and abuse.

price has no significant impact since the price elasticity is virtually zero for beer and only −0.12 for liquor. Yen et al. (2009) also find that income does not affect alcohol consumption for men while sociodemographic factors such as education, employment, and marital status play a significant role.

Moreover, previous studies suggest that parental consumption behavior may also influence filial consumption behavior (Charles et al. 2014; Melchior et al. 2010; Waldkirch et al. 2004, 2004; Wickrama et al. 1999). Regarding cigarette smoking and alcohol consumption the empirical results are mixed. Some studies find a positive correlation between parental and filial alcohol consumption (Schmidt and Tauchmann 2011; Waldkirch et al. 2004), while others find no significant correlation (J. Yu 2003). Alternatively, filial consumption behavior might either depend on the maternal or on the paternal consumption behavior. Francesconi et al. (2010) find that a young adult who lives with an unmarried mother has a higher smoking propensity. Gundy (2002) finds that alcohol consumption is higher among children whose mothers typically drink approximately three or more drinks daily or who drink on a weekly basis, while fathers' alcohol consumption only positively influence sons' drinking behavior. The studies suggest that parental consumption behavior influences filial health outcomes; nevertheless, it has largely been ignored in the literature on China.

If there exists a higher correlation of unhealthy consumption behaviors between generations, how could offspring be efficiently prevented from their parental unhealthy consumption behaviors? It has been found that education as a form of human capital investment can improve cognitive skills and enhance positive health behavior (Berger and Leigh 1989; Kenkel 1991). Some studies have revealed that education has a negative effect on the probability of smoking or on binge drinking (Cowell 2006; Jensen and Lleras-Muney 2012; Kemptner et al. 2011; Nayga 1999). However, other studies cannot provide evidence that education causes better health behavior (Reinhold and Jurges 2010; Xie and Mo 2014; Zhong 2015).

Our hypothesis is that education may discourage offspring from maintaining parental unhealthy habits such as smoking and drinking since higher educated people are more aware of the harmful consequences of unhealthy consumption. To the best of our knowledge, the impact of education on the intergenerational persistence of unhealthy consumption has not been studied so far.

A reverse relationship between education and health has been indicated, as positive health behavior could also affect the demand for education (Currie and Hyson 1999) and school performance. Zhao

et al. (2012) find that smoking among teenagers can reduce their learning productivity. Based on mathematical test results, the authors find that smoking one cigarette per day can lower students' scores by approximately 0.08 standard deviations. Balsa, Giuliano, and French (2011) also indicate that alcohol consumption also negatively influences students' academic performance. These findings suggest that the endogeneity of education in estimating the impact of education on cigarette smoking and alcohol consumption should be taken into consideration.

Since law changes as natural experiments generate exogenous variation in years of schooling both across regions and over time, some studies have applied an instrumental variable approach by using changes in compulsory schooling laws (Kemptner et al. 2011; Xie and Mo 2014). Some other institutional changes have been used, such as college attendance during war time (de Walque 2007), the number of academic track schools in a state (Amin et al. 2013), and the abolition of secondary school fees (Reinhold and Jurges 2010). Xie and Mo, (2014) investigate the causal effect of education on health using the Compulsory Schooling Law and the Provisions on the Prohibition of Using Child Labor as instruments for education; they cannot obtain conclusive results for smoking due to a violation of the exogeneity of their instruments. A limitation of this research is that they do not consider variations in the implementations of the Law in different provinces in China, which has been well documented by Huang (2015).

Although many studies have estimated the causal link between health and education, no study has investigated how education impacts intergenerational transmissions of unhealthy consumption behaviors with consideration of its endogeneity. Does education have an impact on unhealthy consumption behaviors as well as their intergenerational persistence? To answer this question, our study's contribution to the literature is threefold. First, we identify the correlation between offspring's and parent's unhealthy consumption behavior (smoking, drinking, and binge drinking). Second, we examine how education affects filial unhealthy consumption by using two institutional changes as instrumental variables for education. Third, we investigate the impact of education on the intergenerational persistence of unhealthy consumption.

The remainder of the paper is organized as follows. In Section 2, we introduce the econometric models for unhealthy consumption participation and the estimation strategy of our study. In Section 3, we describe the CHNS data and present descriptive statistics of the main variables. In Section 4,

we present our estimation results. In the last section, we discuss the results, draw conclusions, and provide policy recommendations.

5.2 Empirical approach

5.2.1 Benchmark model for intergenerational persistence of unhealthy consumption behavior

Since Becker and Tomes (1979, 1986) initially presented an economic model of intergenerational transmissions, there has been significant interest in intergenerational mobility among economists. Our benchmark model is defined as follows:

$$Prob_{(Y=1)} = \beta_0 + \boldsymbol{\beta_1 Parent} + \boldsymbol{\alpha X} + \varepsilon_i \quad (1)$$

where *Y* is a binary variable which is one if the child has a health-risk consumption behavior and zero if the child has no health-risk consumption behavior. As Cowell (2006) points out, most empirical studies that focus on smoking and drinking are not only of concern for policy makers but also provide an interesting comparison to one another. In our study, we also estimate two main health-related behaviors, cigarette smoking and alcohol consumption. Both behaviors may have potential negative health consequences. Smoking incorporates a high risk of premature death, while a certain light-to-moderate drinking might actually decrease all-cause mortality (Hao et al. 2004). Therefore, we specify alcohol consumption into two indicators of "drinking" and "binge drinking", as a harmful effect of binge drinking on health has been observed (Bazzano et al. 2007).

The main independent variable ***Parent*** is a set of dummy variables for the maternal and paternal consumption behaviors. Six dummy variables are separately used to indicate whether the mother (father) is a current smoker/drinker/binge drinker. First, we separately introduce the maternal and paternal consumption behaviors in our models, then we include both of them. This is done to identify intergenerational persistence of unhealthy consumption behaviors. As most of the studies have found that parental consumption behaviors have a positive impact on filial consumption behavior, $\boldsymbol{\beta_1}$ is expected to have a positive sign. $\boldsymbol{X}$ is the vector for control variables including individual demographic variables as well as year and regional dummies to control for year and regional fixed effects. ε_i is the disturbance with $\varepsilon_i \sim N(0, 1)$.

5.2.2 Impact of education on unhealthy consumption behaviors

After identifying the intergenerational persistence of unhealthy consumption behaviors, we further illustrate the impact of education on unhealthy consumption behaviors (smoking, drinking, and binge drinking). Our empirical model is defined as:

$$Prob_{(Y=1)} = \beta_0' + \boldsymbol{\beta_1'}\boldsymbol{Parent} + \boldsymbol{\beta_2'}Education + \boldsymbol{\alpha X} + \mu_i \quad (2)$$

Education is measured by the years of education an individual has acquired. $\boldsymbol{X}$ is the vector of control variables as in Equation (1). μ_i is the disturbance with $\mu_i \sim N(0,1)$.

The coefficients $\boldsymbol{\beta_1'}$ and $\boldsymbol{\beta_2'}$ are used to capture the intergenerational persistence of parents' unhealthy consumption behaviors to their children as in Equation (1) and the impact of education on these unhealthy consumption behaviors, respectively. We hypothesize that higher education leads to better health knowledge and could reduce the probability of unhealthy consumption behaviors such as smoking and binge drinking; thus, $\boldsymbol{\beta_2}$ is assumed to be negative; however, the impact of education on drinking is ambiguous since moderate drinking might not necessarily be an unhealthy consumption behavior.

To obtain a consistent estimate for education, the potential endogeneity of education has to be taken into consideration. As mentioned earlier, law changes as quasi-experiments generate exogenous variation in years of schooling both across regions and over time. Changes in the Compulsory Schooling Law serve as a valid instrumental variable (Kemptner et al., 2011; Xie and Mo, 2014; Huang, 2015). Additionally, the enactment of the Provisions on the Prohibition of Using Child Labor in 1991, which aims to prohibit child labor in China, has increased educational attainment and serves as a valid instrument (Xie and Mo 2014).

The 9-year Compulsory Education Law which was officially enacted on July 1, 1986 is expected to boost middle school education and to eradicate illiteracy. The law regulates that children who reached the age of six are to enroll in school without any tuition fee for nine compulsory years, covering six years of primary school and three years of junior middle school (Fang et al. 2012). In general, young individuals will complete the nine years of compulsory schooling at the age of 15; this indicates that individuals who were born after 1971 were affected by the law. Huang (2015) suggests that the variations in the Law's implementation in different provinces should be considered; specifically, individuals born after 1971 are affected by the Law in Beijing, Chongqing,

Liaoning, and Heilongjiang; after 1972 in Shandong, Jiangsu, Shanghai, Hubei, and Henan; after 1973 in Guizhou, and after 1976 in Hunan and Guangxi. We define individuals who were born after these threshold years with "1" because they are affected by the Law and individuals who were born before these threshold years with "0" because they are unaffected by the Law.

The other institutional change is the Provisions on the Prohibition of Using Child Labor, which was enforced in April 1991. As a complementary regulation to the Compulsory Education Law, it indicates that children below 16 years of age are not allowed to be employed for any type of work. In this way, young adults can only start working after completing their compulsory education at the age of 15. We define individuals who were born after 1975 with "1" because they are affected by the Provisions and individuals who were born before 1975 with "0" because they are unaffected by the Provisions. The first stage to obtain the predicted year of education follows the equation as below:

$$\widehat{\boldsymbol{Education}} = \alpha_0 + \alpha_1 Law + \alpha_2 Provisions + \boldsymbol{\alpha X} + u_i \quad (3)$$

A valid instrument for years of education should have a high correlation with the instrumented variable and should be uncorrelated with the error component in the respective model. In other words, the Law and the Provisions should affect individuals' education but should not directly affect individuals' unhealthy consumption behaviors. Thus, our estimations involve two stages. In the first stage, a joint F-test is used to test the correlation between the instruments and the potentially endogenous variable (years of education). In the second stage, a Wald test of exogeneity is applied to test whether the variable is indeed endogenous. When the test is rejected, the estimates from the regular Probit model (Equation 2) will be biased. Since two instruments are employed in each estimation, the Amemiya-Lee-Newey test is used to test for possible model over-identification and validation of instruments (Newey 1987).

5.2.3 Impact of education on intergenerational persistence of unhealthy consumption

To detect how education impacts the intergenerational persistence of unhealthy consumption, we further introduce the interaction term between parental unhealthy consumption and offspring's education. The estimated model is defined as following:

$$\boldsymbol{Prob_{(Y=1)}} = \beta_0 + \boldsymbol{\beta_1' Parent} + \boldsymbol{\beta_2' \widehat{Education}} + \boldsymbol{\beta_3' Parent} * \boldsymbol{\widehat{Education}} + \boldsymbol{\alpha X} + \delta_i \quad (4)$$

where $\widehat{Education}$ is the estimated value of the years of education from Equation (3). The definitions of dependent and control variables are the same as in Equation (1). Our main concern is the coefficient of the interaction term, β_3'. The null hypothesis is that additional education can prevent individuals from persisting their parents' unhealthy behaviors, therefore, β_3' is assumed to be negative. Given the potential endogeneity of education, the interaction term between parental unhealthy consumption and the two instruments for education (the Law and the Provisions) are used as instrumental variables for the interaction term in Equation (4).

5.3. Data and variables

5.3.1 Data

The data used in this study are from the China Health and Nutrition Survey (CHNS) over the period of 1991-2011. The CHNS covers nine provinces (Heilongjiang, Liaoning, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou for the years of 1989, 1993, 1997, 2000, 2004, 2006, 2009, 2011, and three municipalities (Beijing, Shanghai, Chongqing) for the year 2011. The provinces and municipalities vary substantially in geography, economic development, public resources, and health indicators (see Map 1). The CHNS applies a multistage, random cluster process to draw a sample of roughly 4,400 households with a total of approximately 26,000 individuals. Counties in the nine provinces are stratified by income (low, middle, and high), and a weighted sampling scheme was used to randomly select four counties in each province. The CHNS randomly selects villages and townships within the counties, urban and suburban neighborhoods within the cities. The questions regarding our main dependent variables have been reported since 1991; thus, we drop the data for the first wave in 1989.

5.3.2 Variables

Health behaviors in this study are identified by cigarette smoking and alcohol consumption. Regarding cigarette smoking, the respondents are asked "*Do you still smoke cigarettes now?*"; those who reported to smoke (not to smoke) are defined as smokers (non-smokers). Regarding alcohol consumption, the respondents are asked "*Did you drink beer or any other alcoholic beverage last year?"*; those who reported to drink (not to drink) beer or any alcoholic beverage last year are defined as alcohol drinkers (non-alcohol drinkers). The respondents further reported the types of alcoholic beverages (beer, grape wine, rice wine, and liquor) and quantity (bottle for beer, Liang (Chinese

ounce) or 50g for other alcoholic beverages) they consumed in a typical week within the previous year. According to the quantity of each alcoholic beverage consumed, we calculated the percent of pure alcohol consumed based on Li et al. (2011). The percent of pure alcohol is 4% for beer, 52% for liquor, and 10% for wine; moreover, the beer bottle volume is set at 640 ml, which is most common in China. According to the National Institute on Alcohol Abuse and Alcoholism (NIAAA) of the United States, one "standard" drink contains roughly 14 grams of pure alcohol. We define a male who consumes 14 drinks and a female who consumes 7 drinks a week as a binge drinker[11], respectively.

We match filial alcohol and cigarettes consumption with their parental consumption using the parental-child identifiers to select a sample consisting of parental-offspring pairs. After merging all other variables regarding filial demographic, socio-economic and household background information, we restrict our sample to offspring older than sixteen years of age. Our sample consists of 13,470 observations over the period from 1991 to 2011. There are approximately 25.6%, 35.1%, and 10.8% smokers, drinkers, and binge drinkers, respectively (Table 5.1). Regarding parental consumption behaviors, we observe that approximately 4.7% and 58.8% of mothers and fathers are smokers, respectively. 12.7% of mothers are drinkers and 5% are binge drinkers. Similar to smoking behavior, we also find that fathers have a higher probability of being a drinker and binge drinker with proportions of 62.6% and 24.3%, respectively. In general, fathers are more likely to smoke and to drink as well as to be binge drinkers than are mothers. As stated by Tang et al. (2013), women are discouraged from drinking alcohol as well as from using illicit substances in Chinese culture. Nevertheless, they also indicate that the current differential between men and women tends to diminish in the future.

Education is the key explanatory variable in this study; it is measured as formal years of education ranging from 0-21 years. In our sample, the average of years of education obtained by the offspring

[11] As defined by the National Institute on Alcohol Abuse and Alcoholism (NIAAA), for women, low-risk drinking is no more than 3 drinks on any single day and no more than 7 drinks per week. For men, it is no more than 4 drinks on any single day and no more than 14 drinks per week. The study by Li et al., (2011) has defined binge drinking as consumption of 50 grams or more pure alcohol for men/ 40 grams or more for women on at least 1 day in the previous 12 months. Since we have no information on daily drinking behavior, it should be noted that the probability of binge drinking calculated from our measurement may be higher than that from the NIAAA.

is around 9.5 years (Table 5.1), which indicates most of them have obtained six years of primary education and three years of secondary education. The evidence from two institutional changes which may influence the individual's educational attainment shows that there are approximately 58.3% and 45.8% of the total sample population affected by the Law and the Provisions, respectively.

The other explanatory variables controlled for in this study are gender, age, age squared, working status (presently working), marital status, the logarithm of household income, residence (urban or rural), and parental age (Table 5.1). Additionally, we also include regional dummies to account for disparities in education and healthcare investment across provinces, and for differences in provincial characteristics. We also include dummies for the different survey waves to control for changes in individuals' consumption behaviors over time.

Table 5. 1 Descriptive statistics of main variables.

Variable	Definition	Mean	Std.Dev.
Dependent variables			
Smoking	Probability of smoking	0.256	0.436
Drinking	Probability of drinking	0.351	0.477
Binge drinking	Probability of binge drinking	0.108	0.310
Parents unhealthy consumption behavior			
Smoker Mother	Mother smokes (0/1)	0.047	0.211
Smoker Father	Father smokes (0/1)	0.588	0.492
Drinker Mother	Mother is a drinker	0.127	0.333
Drinker Father	Father is a drinker	0.626	0.484
Binge Mother	Mother is a binge drinker	0.050	0.218
Binge Father	Father is a binge drinker	0.243	0.429
Education			
Education	Years of education	9.538	4.168
Instrumental variables for education			
Law	Affected by the 9-Years Compulsory Education Law	0.583	0.493
Provisions	Affected by the Provisions on the Prohibition of Child Labor	0.458	0.498
Control variables			
Male	Male=1; female=0	0.646	0.478
Age	Age in year	23.880	6.941
Age Squared	Age squared	618.600	412.400
Married	Married (0/1)	0.283	0.450
Logarithm of Income	Logarithm of household income (inflated to 2011)	9.318	1.152
Presently Working	Presently Working? (Working=1; Not working=0)	0.740	0.438
Urban	Lives in urban area? (Urban=1; rural=0)	0.284	0.451
Age Mother	Mother's age in year	51.100	8.504
Age Father	Father's age in year	53.190	8.920
Year dummies			
Yr1991	In 1991 (Reference)	0.176	0.381
Yr1993	In 1993	0.171	0.376
Yr1997	In 1997	0.167	0.373
Yr2000	In 2000	0.170	0.375
Yr2004	In 2004	0.081	0.272
Yr2006	In 2006	0.071	0.258
Yr2009	In 2009	0.077	0.266
Yr2011	In 2011	0.089	0.284
Regional dummies			
Liaoning	Resides in Liaoning (Reference)	0.069	0.253
Heilongjiang	Resides in Heilongjiang	0.046	0.209
Jiangsu	Resides in Jiangsu	0.116	0.321
Shandong	Resides in Shandong	0.103	0.304
Henan	Resides in Henan	0.130	0.336
Hubei	Resides in Hubei	0.105	0.307
Hunan	Resides in Hunan	0.105	0.306
Guangxi	Resides in Guangxi	0.159	0.366
Guizhou	Resides in Guizhou	0.141	0.348
Beijing	Resides in Beijing	0.007	0.081
Shanghai	Resides in Shanghai	0.014	0.119
Chongqing	Resides in Chongqing	0.005	0.072

Source: Authors' calculations based on CHNS samples. In total, we have 13,470 observations.

5.4. Results

5.4.1 The intergenerational persistence of unhealthy consumption behaviors

The estimates for the correlation between individuals' unhealthy consumption and their parents' consumption are presented in Table 5.2. We gradually introduce maternal and paternal smoking and drinking behaviors in the estimations, then we consider both of them.

In line with previous studies (Green et al. 1991; Schmidt and Tauchmann 2011; Waldkirch et al. 2004), our results show that parents' smoking and drinking behaviors have statistically significantly positive correlations with children's smoking and drinking behaviors. As shown in Column (1) and (2), when separately introducing mother and father's smoking behavior in the smoking estimation, both of the variables "*Smoker Mother*" and "*Smoker Father*" have positive and statistically significant impacts on children's smoking behaviors, as well as when including both of them in the estimation. The marginal effects from the smoking estimation show that individuals whose mothers or fathers are current smokers have 5.6% or 6.7% higher probability to smoke than do those whose mothers or fathers are non-smokers, respectively.

Similar findings are also observed for drinking and binge drinking. The results show that parents' drinking and binge drinking behaviors have statistically significant positive correlations with children's drinking behaviors in all model specifications. Specifically, according to the marginal effects from the estimation for drinking, individuals whose mothers or fathers are drinkers are 21.7% and 18.7%, respectively, more likely to be also drinkers. Surprisingly, drinking mothers even have a higher contribution to the probability of children being binge drinkers than do drinking fathers. Regarding binge drinking, individuals whose mothers or fathers are binge drinkers have 12.5% or 14.1% higher probability to be also binge drinkers, respectively. The results indicate that the offspring is more likely to persist with alcohol consumption rather than with cigarette smoking.

Table 5. 2 Probit estimations for smoking, drinking, and binge drinking.

	Smoking				Drinking				Binge Drinking			
	(1)	(2)	(3)	Marginal	(5)	(6)	(7)	Marginal	(9)	(10)	(11)	Marginal
Smoker Mother	0.268***		0.247***	0.056***								
	(0.07)		(0.07)	(0.02)								
Smoker Father		0.299***	0.296***	0.067***								
		(0.03)	(0.03)	(0.01)								
Alcohol Mother					0.846***		0.734***	0.217***				
					(0.04)		(0.04)	(0.01)				
Alcohol Father						0.700***	0.632***	0.187***				
						(0.03)	(0.03)	(0.01)				
Binge Mother									1.117***		0.858***	0.125***
									(0.06)		(0.06)	(0.01)
Binge Father										1.045***	0.967***	0.141***
										(0.03)	(0.04)	(0.01)
Male	2.100***	2.114***	2.117***	0.483***	0.911***	0.914***	0.945***	0.280***	0.364***	0.385***	0.396***	0.058***
	(0.07)	(0.07)	(0.07)	(0.01)	(0.03)	(0.03)	(0.03)	(0.01)	(0.04)	(0.04)	(0.04)	(0.01)
Age	0.171***	0.172***	0.171***	0.039***	0.075***	0.070***	0.074***	0.022***	0.070***	0.071***	0.070***	0.010***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)
Age squared	-0.002***	-0.002***	-0.002***	-0.001***	-0.001***	-0.001***	-0.001***	-0.000***	-0.001***	-0.001***	-0.001***	-0.000***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Married	0.214***	0.215***	0.212***	0.048***	0.187***	0.188***	0.193***	0.057***	0.120***	0.110***	0.119***	0.017***
	(0.04)	(0.04)	(0.04)	(0.01)	(0.03)	(0.03)	(0.03)	(0.01)	(0.04)	(0.04)	(0.04)	(0.01)
Logarithm of Income	-0.001	0.002	0.003	0.001	0.044***	0.041***	0.033**	0.010**	0.075***	0.067***	0.061***	0.009***
	(0.02)	(0.02)	(0.02)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.02)	(0.02)	(0.00)
Presently Working	0.284***	0.286***	0.285***	0.065***	0.200***	0.201***	0.216***	0.064***	0.037	0.034	0.038	0.006
	(0.04)	(0.04)	(0.04)	(0.01)	(0.03)	(0.03)	(0.03)	(0.01)	(0.04)	(0.04)	(0.04)	(0.01)
Urban	0.046	0.067**	0.070**	0.016**	0.083***	0.125***	0.117***	0.035***	-0.053	0.014	0.011	0.002
	(0.03)	(0.03)	(0.03)	(0.01)	(0.03)	(0.03)	(0.03)	(0.01)	(0.04)	(0.04)	(0.04)	(0.01)
Constant	-4.917***	-5.223***	-5.229***		-3.116***	-3.614***	-3.693***		-3.477***	-4.127***	-4.059***	
	(0.25)	(0.25)	(0.25)		(0.20)	(0.20)	(0.20)		(0.25)	(0.26)	(0.26)	
N	13470	13470	13470	13470	13470	13470	13470	13470	13470	13470	13470	13470
Chi^2	1942.475	1939.093	1960.387		2255.502	2350.031	2583.803		1017.278	1441.531	1632.267	
Pseudo R^2	0.285	0.291	0.292		0.160	0.168	0.192		0.125	0.186	0.212	

* p<0.10, ** p<0.05, *** p<0.010

Notes: The cells show coefficients and marginal effects with robust standard errors in parentheses. We also control for regional and year fixed effects as well as parents' ages in each regression.

Source: Authors' estimations based on CHNS samples.

5.4.2 Impact of education on unhealthy consumption behaviors

To investigate how education affects unhealthy consumption behaviors and their intergenerational persistence, we then introduce education in our benchmark model as discussed in Equation (2). The estimation results are presented in Table 5.3.

We find that education has a statistically significant impact on smoking, drinking, and binge drinking. The marginal effect of education is negative and statistically significant for smoking and binge drinking, suggesting that higher education decreases the probability of smoking and binge drinking. In particular, an additional year of education leads to a 0.8% and 0.1% decrease in the probability of smoking and binge drinking, respectively, which is unexpectedly lower than in other studies (Cowell 2006; Huang 2015; Kemptner et al. 2011; Reinhold and Jurges 2010). With respect to drinking, the marginal effect of education is positive and statistically significant, indicating that an additional year of education raises the probability of being a drinker by approximately 0.2%. The finding seems to be implausible since more education is expected to reduce the probability of drinking. However, as mentioned previously, the estimation of these coefficients might be biased due to the potential endogeneity of education. Thus, we attempt to employ an instrumental Probit estimation to further address this issue and to better understand the impact of education on smoking, drinking, and binge drinking. In addition, the coefficients of parental consumption behaviors that indicate the intergenerational persistence of smoking, drinking, and binge drinking are almost of the same magnitude as in the benchmark models.

Table 5. 3 Probit estimations of the impact of education on individual's unhealthy consumption.

	Smoking		Drinking		Binge Drinking	
	(1)	Marginal	(3)	Marginal	(5)	Marginal
Yearseduc	-0.033***	-0.008***	0.007**	0.002**	-0.008*	-0.001*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Smoke Mother	0.227***	0.051***				
	(0.07)	(0.02)				
Smoke Father	0.285***	0.065***				
	(0.03)	(0.01)				
Alcohol Mother			0.734***	0.217***		
			(0.04)	(0.01)		
Alcohol Father			0.632***	0.187***		
			(0.03)	(0.01)		
Binge Mother					0.859***	0.126***
					(0.06)	(0.01)
Binge Father					0.967***	0.141***
					(0.04)	(0.01)
Male	2.130***	0.482***	0.946***	0.280***	0.394***	0.058***
	(0.07)	(0.01)	(0.03)	(0.01)	(0.04)	(0.01)
Age	0.178***	0.040***	0.072***	0.021***	0.072***	0.010***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
Age squared	-0.002***	-0.001***	-0.001***	-0.000***	-0.001***	-0.000***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Married	0.203***	0.046***	0.197***	0.058***	0.116***	0.017***
	(0.04)	(0.01)	(0.03)	(0.01)	(0.04)	(0.01)
Logarithm of Income	0.029	0.006	0.027*	0.008*	0.068***	0.010***
	(0.02)	(0.00)	(0.02)	(0.00)	(0.02)	(0.00)
Presently Working	0.272***	0.061***	0.220***	0.065***	0.034	0.005
	(0.04)	(0.01)	(0.03)	(0.01)	(0.04)	(0.01)
Urban	0.135***	0.031***	0.103***	0.030***	0.025	0.004
	(0.03)	(0.01)	(0.03)	(0.01)	(0.04)	(0.01)
Constant	-5.205***		-3.697***		-4.056***	
	(0.25)		(0.20)		(0.26)	
N	13470	13470	13470	13470	13470	13470
Chi^2	1992.609		2591.583		1632.775	
Pseudo R^2	0.296		0.193		0.212	

Notes: The variable *Yearseduc* indicates the years of education. The cells show coefficients with robust standard errors in parentheses. We also control for regional and year fixed effects in each regression, as well as the control variable for parents' age.

Source: Authors' estimations based on CHNS samples.

To further clarify the impact of education on these three consumption behaviors, two institutional changes (Law and Provisions) are introduced as instruments for years of education obtained by individuals. As discussed previously, a valid instrument is required to be highly correlated with the instrumented variable and to be uncorrelated with the disturbance; thus, we first employ an OLS regression to investigate the impact of the Law and the Provisions on years of education according to Equation (3). The estimation results are presented in Table 5.4. The estimates from column (1) and (2) suggest that these two instrumental variables have significantly positive impacts on educational attainment. When we include both instrumental variables in the education equation, the coefficient declines slightly. Generally, individuals regulated by the Law or the Provisions receive approximately 0.3 or 1.0 more years of education, respectively. The estimated coefficient

of the Law is lower than that reported by Xie and Mo (2014), and the coefficient of the Prohibition is higher than that by Xie and Mo (2014). This might have been expected since we match the data to include parents' information and only consider individuals with parents' information.

Table 5. 4 OLS estimation of the impact of institutional changes on individual's educational attainment.

	Yearseduc		
	(1)	(2)	(3)
Law	0.635***		0.321***
	(0.10)		(0.11)
Provisions		1.116***	1.007***
		(0.11)	(0.11)
Male	0.015	0.020	0.021
	(0.07)	(0.07)	(0.07)
Age	0.263***	0.299***	0.319***
	(0.06)	(0.06)	(0.06)
Age squared	-0.004***	-0.004***	-0.004***
	(0.00)	(0.00)	(0.00)
Married	-0.563***	-0.571***	-0.570***
	(0.09)	(0.09)	(0.09)
Logarithm of income	0.827***	0.833***	0.831***
	(0.04)	(0.04)	(0.04)
Presently working	-0.715***	-0.719***	-0.718***
	(0.09)	(0.09)	(0.09)
Urban	1.842***	1.810***	1.809***
	(0.08)	(0.08)	(0.08)
Constant	-0.765	-1.357*	-1.792**
	(0.82)	(0.81)	(0.84)
Observations	13470	13470	13470
F	160.435	167.200	161.499
R^2	0.250	0.254	0.254

* p<0.10, ** p<0.05, *** p<0.010

Notes: The cells show coefficients with Newey's two-step estimator, errors are presented in parentheses. We also control for regional and year fixed effects in each regression, as well as for parents' age. The variables of *Law* and *Provisions* indicate whether an individual is affected by the 9-Years Compulsory Education Law and the Provisions on the Prohibition of Child Labor, respectively.

Source: Authors' estimations based on CHNS samples.

After observing a high correlation between education and the two instrumental variables, we introduce the Law and the Provisions into the model (2) and use Newey's two-step estimator in our analysis. The estimation results are reported in Table 5.5. Education remains negative and

statistically significantly correlated with smoking and binge drinking, but with a larger magnitude than that from the regular Probit model. As expected, the coefficient of education for drinking changes from a statistically significantly positive sign in the regular Probit model to a statistically significantly negative sign in the instrumented Probit model; this suggests that additional education actually decreases the probability of drinking.

From the Wald test of exogeneity for the instrumented variables, the null hypothesis of no endogeneity is rejected as the P value is less than 0.05 (Table 5.5); this indicates that the estimators from the regular Probit model are inappropriate and likely to be biased. To further examine the validity of the instrumental variables, over-identification tests are applied. The over-identification test in the second stage cannot be rejected in all model specifications; this suggests that the instrumental variables of the two institutional changes are jointly valid instruments (Table 5.5).The estimators from the instrumental model are consistent and convincing.

Therefore, we conclude that an additional year of education reduces the probability of smoking, drinking, and binge drinking by 3.4%, 2.7%, and 1.8%, respectively (Table 5.5). Our findings are in line with previous studies (Cowell 2006; Huang 2015; Kemptner et al. 2011; Reinhold and Jurges 2010); while the estimated impact of education on smoking is higher than that reported by Huang (2015), who finds that an additional year of education will decrease the smoking probability by 1.5 percentage points. The reason is that we use a subsample from the whole population, and the average age (approximately 23 years) is lower than the 32.46 years reported in Huang (2015). This difference implies that improving education to reduce smoking might have a specific influence on younger people.

Regarding the coefficient of parents' unhealthy consumption behaviors, we find that parents' unhealthy consumption behaviors have statistically significant and positive impacts on children's unhealthy consumption behaviors; this is similar to the findings from the benchmark model (Table 5.2). Specifically, we find that the intergenerational persistence of smoking from both mother and father is with 2.6% and 4.9%, respectively, comparatively lower than in the benchmark model, which is approximately 5.6% and 6.7% for mother and father, respectively. However, there are only slight changes in the intergenerational persistence of drinking and binge drinking compared with the regular Probit model.

5.4.3 Impact of education on intergenerational persistence of unhealthy consumption behaviors

The estimation results for Equation (4) considering the interaction term between years of education and parents' unhealthy consumption are presented in Table 5.6. To obtain convincing results, we use an instrumental Probit model by including an interaction term between parental unhealthy consumption behaviors and the Law and the Provisions as instruments for the interaction term in Equation (4). As shown in column (1), the interaction term between "*Smoke Mother*" and "*Yearseduc*" is insignificant, indicating that education has no specific impact on individuals whose mothers are current smokers compared with individuals whose mothers are non-smokers. However, the coefficient for the interaction term between "*Smoke Father*" and "*Yearseduc*" is statistically significantly negative; this suggests that an additional year of education can decrease the probability to smoke of individuals with smoking fathers. However, we find that an additional year of education cannot prevent intergenerational persistence of binge drinking from mothers, but we do find it can counteract the intergenerational persistence from fathers, as the coefficient of the interaction term *("Binge Father*Yearseduc")* is statistically significantly negative. However, we find that education has neither a statistically significant impact on the intergenerational persistence of drinking from mothers nor from fathers.

The Wald test of exogeneity for the instrumented variables indicates that the estimators from the instrumented Probit model are consistent. The over-identification test in the second stage cannot be rejected in all model specifications for smoking, drinking, and binge drinking; this indicates that the estimators from the instrumental model are consistent and convincing. We conclude that an additional year of education can counteract intergenerational persistence of unhealthy consumption behaviors from fathers but not from mothers. Our findings imply that individuals whose mothers have unhealthy consumption behaviors are more likely to follow unhealthy consumption behaviors. Our findings imply that policies designed to decrease intergenerational persistence of unhealthy consumption behaviors through education may not be efficient when mothers have unhealthy consumption behaviors; it might require other measures that directly influence mothers' consumption behaviors rather than filial education.

Table 5. 5 Instrumental Probit estimation of smoking and drinking.

	Smoking				Drinking				Binge drinking			
	(1)	(2)	(3)	Marginal	(5)	(6)	(7)	Marginal	(9)	(10)	(11)	Marginal
Yearseduc	-0.180***	-0.169***	-0.168***	-0.034***	-0.088**	-0.104***	-0.101***	-0.028***	-0.093**	-0.144***	-0.131***	-0.018**
	(0.04)	(0.04)	(0.04)	(0.01)	(0.04)	(0.04)	(0.04)	(0.01)	(0.05)	(0.05)	(0.05)	(0.01)
Smoke Mother	0.144*		0.134*	0.026*								
	(0.08)		(0.07)	(0.02)								
Smoke Father		0.248***	0.246***	0.049***								
		(0.03)	(0.03)	(0.01)								
Alcohol Mother					0.856***		0.745***	0.204***				
					(0.04)		(0.04)	(0.01)				
Alcohol Father						0.709***	0.639***	0.175***				
						(0.03)	(0.03)	(0.01)				
Binge Mother									1.122***		0.874***	0.133***
									(0.05)		(0.06)	(0.01)
Binge Father										1.026***	0.944***	0.148***
										(0.04)	(0.04)	(0.01)
Male	2.121***	2.130***	2.134***	0.424***	0.913***	0.916***	0.947***	0.260***	0.363***	0.383***	0.394***	0.060***
	(0.07)	(0.07)	(0.07)	(0.03)	(0.03)	(0.03)	(0.03)	(0.01)	(0.04)	(0.04)	(0.04)	(0.01)
Age	0.209***	0.207***	0.207***	0.012***	0.093***	0.091***	0.095***	0.009***	0.085***	0.098***	0.094***	0.006***
	(0.02)	(0.02)	(0.02)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.02)	(0.02)	(0.00)
Age squared	-0.003***	-0.003***	-0.003***		-0.001***	-0.001***	-0.001***		-0.001***	-0.001***	-0.001***	
	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	
Married	0.123***	0.129***	0.128***	0.025***	0.137***	0.129***	0.136***	0.037***	0.074	0.030	0.049	0.008
	(0.04)	(0.04)	(0.04)	(0.01)	(0.04)	(0.04)	(0.04)	(0.01)	(0.05)	(0.05)	(0.05)	(0.01)
Logarithm of Income	0.146***	0.139***	0.139***	0.028***	0.117***	0.127***	0.117***	0.032***	0.138***	0.182***	0.163***	0.024***
	(0.04)	(0.04)	(0.04)	(0.01)	(0.03)	(0.03)	(0.03)	(0.01)	(0.04)	(0.05)	(0.05)	(0.01)
Presently Working	0.168***	0.178***	0.178***	0.035***	0.137***	0.126***	0.143***	0.039***	-0.019	-0.064	-0.050	-0.007
	(0.05)	(0.05)	(0.05)	(0.01)	(0.04)	(0.04)	(0.04)	(0.01)	(0.05)	(0.06)	(0.06)	(0.01)
Urban	0.386***	0.384***	0.383***	0.077***	0.245***	0.318***	0.306***	0.085***	0.131	0.288***	0.259***	0.036**
	(0.09)	(0.09)	(0.09)	(0.01)	(0.07)	(0.08)	(0.08)	(0.02)	(0.09)	(0.10)	(0.10)	(0.02)
Constant	-4.841***	-5.102***	-5.108***		-3.076***	-3.572***	-3.652***		-3.619***	-4.123***	-4.080***	
	(0.25)	(0.26)	(0.26)		(0.20)	(0.20)	(0.21)		(0.26)	(0.27)	(0.28)	
N	13470	13470	13470	13470	13470	13470	13470	13470	13470	13470	13470	13470
Chi^2	1916.323	1982.725	1986.862		2260.154	2320.435	2578.479		1025.061	1342.543	1519.043	
Wald test of exogeneity	0.000	0.001	0.001		0.007	0.002	0.002		0.055	0.003	0.009	
Test for over-identifying restriction (P-values)	0.241	0.273	0.224		0.273	0.142	0.175		0.854	0.733	0.611	

* p<0.10, ** p<0.05, *** p<0.010

Notes: The variable *Yearseduc* indicates the years of education. The cells show coefficients with Newey's two-step estimator, errors are presented in parentheses. We also control for regional and year fixed effects in each regression, as well as for parents' age.

Source: Authors' estimations based on CHNS samples.

Table 5. 6 Instrumental Probit estimation of the impact of education on intergenerational persistence of smoking, drinking, and binge drinking

	Smoking			Drinking			Binge drinking		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Yearseduc	-0.069***	-0.011	-0.011	-0.092**	-0.074*	-0.072	-0.087*	-0.078	-0.074
	(0.01)	(0.02)	(0.02)	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)
Smoke Mother	0.719		0.728						
	(1.01)		(1.02)						
Smoke Father		1.304***	1.259***						
		(0.32)	(0.32)						
Smoke Mother* Yearseduc	-0.062		-0.068						
	(0.12)		(0.13)						
Smoke Father* Yearseduc		-0.108***	-0.104***						
		(0.03)	(0.03)						
Drink Mother					1.064***	1.057***			
					(0.27)	(0.28)			
Drink Father				0.357		0.140			
				(0.37)		(0.38)			
Drink Mother* Yearseduc				0.052		0.063			
				(0.04)		(0.04)			
Drink Father* Yearseduc					-0.038	-0.044			
					(0.03)	(0.03)			
Binge Mother							1.698***		0.764
							(0.56)		(0.60)
Binge Father								2.023***	1.773***
								(0.34)	(0.35)
Binge Mother* Yearseduc							-0.059		0.011
							(0.06)		(0.06)
Binge Father* Yearseduc								-0.104***	-0.087**
								(0.04)	(0.04)
Male	2.119***	2.127***	2.131***	0.915***	0.915***	0.947***	0.362***	0.371***	0.384***
	(0.07)	(0.07)	(0.07)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)
Age	0.185***	0.190***	0.188***	0.092***	0.091***	0.093***	0.084***	0.088***	0.086***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Age squared	-0.003***	-0.003***	-0.003***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Married	0.182***	0.182***	0.180***	0.138***	0.128***	0.136***	0.073	0.048	0.065
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)
Logarithm of Income	0.056***	0.059***	0.060***	0.116***	0.122***	0.110***	0.137***	0.150***	0.136***
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)	(0.05)	(0.05)
Presently Working	0.244***	0.242***	0.242***	0.140***	0.128***	0.149***	-0.019	-0.036	-0.025
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.06)	(0.06)
Urban	0.183***	0.189***	0.190***	0.244***	0.298***	0.282***	0.120	0.198*	0.183*
	(0.04)	(0.04)	(0.04)	(0.07)	(0.08)	(0.08)	(0.09)	(0.10)	(0.10)
Constant	-4.908***	-5.746***	-5.742***	-3.018***	-3.810***	-3.859***	-3.647***	-4.353***	-4.280***
	(0.25)	(0.31)	(0.31)	(0.21)	(0.27)	(0.28)	(0.26)	(0.28)	(0.29)
N	13470	13470	13470	13470	13470	13470	13470	13470	13470
Chi^2	2000.109	2047.738	2049.147	2259.055	2335.772	2593.960	1025.232	1388.592	1562.737
Wald test of exogeneity	0.010	0.000	0.000	0.003	0.003	0.001	0.097	0.000	0.005
Test for over-identifying restriction (P-values)	0.585	0.763	0.538	0.514	0.380	0.634	0.946	0.338	0.383

* p<0.10, ** p<0.05, *** p<0.010.

Notes: The variable *Yearseduc* indicates the years of education. The cells show coefficients with Newey's two-step estimator, errors are presented in parentheses. We also control for regional and year fixed effects in each regression, as well as for parents' age. Source: Authors' estimations based on CHNS samples.

5.5 Conclusion

This paper investigates the impact of education on unhealthy consumption behaviors and their intergenerational persistence. After identifying a statistically significant correlation between parental and filial unhealthy consumption behaviors, we attempt to illustrate the impact of education on filial unhealthy consumption behaviors. However, due to the presence of potential endogeneity of education in health behaviors estimations, it requires more rigorous estimation to obtain reliable results. Since the 9-year Compulsory Education Law and the Provisions on the Prohibition of Using Child Labor as quasi-experiments having significant influence on the education attainment, we employ an instrumental estimation by using these two institutional changes as instruments for education in unhealthy consumption equations. Through introducing an interaction term between parental unhealthy consumption and filial education, we further clarify the impact of education on the intergeneration persistence of unhealthy consumption. The data used is from the CHNS over the period 1991-2011.

The empirical estimation results indicate that in China parental unhealthy consumption behaviors have statistically significant and positive correlations with children's unhealthy consumption behaviors; therefore, our findings suggest that there exists significant intergenerational persistence of unhealthy consumption behaviors. Precisely, the probability of intergenerational persistence of smoking is approximately 2.6% and 4.9% from mother and father, respectively, while that of binge drinking is approximately 13.3% and 14.8% from mother and father, respectively. Drinking behavior has the largest probability of intergenerational persistence which is approximately 20.4% and 17.5% from mother and father, respectively.

We also find that an additional year of education has a statistically significant negative impact on smoking, drinking, and binge drinking. One additional year of education decreases the probability to be smoking, drinking, and binge drinking by 3.4%, 2.8%, and 1.8%, respectively. Another interesting finding is that an additional year of education can counteract intergenerational persistence of smoking and binge drinking from the father, but it has no impact on intergenerational persistence from the mother. Since drinking behavior is ambiguous to be considered as an unhealthy consumption behavior, we find that there is no impact of education on the intergenerational persistence of drinking.

Hence, our results suggest that policies oriented to control smoking and binge drinking should take parents' consumption behaviors into consideration; education is expected to be an efficient way to control unhealthy consumption behaviors in China; however, education may not be an efficient way to prevent intergenerational persistence of unhealthy consumption from the mother.

There are some limitations of our study: First, due to the absence of data on consumers' daily alcohol consumption, the definition of binge drinking in our study is different from other studies (see, Li et al., 2011), which may induce higher probability of binge drinking for our sample. Second, the primary goal of this study is to investigate the causal relationship between education and unhealthy consumption as well as its intergenerational persistence, further research needs to be conducted to shed light on the mechanism or channel through which these unhealthy consumption behaviors transmit to the next generation. Thus, the findings from our results should be cautiously interpreted and implemented.

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Chapter 6

Low-Income and Overweight in the Transition Economy of China? Evidence from a Life-Course Utility Model

Yanjun REN; Bente CASTRO CAMPOS; Jens-Peter LOY; Stephan BROSIG;

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Abstract

Previous literature has shown that low-income individuals are more likely to make poor health choices in developed countries. From an extended life-course utility model where income serves as a budget constraint and as a source of future health utility, we attempt to investigate the relationship between income and overweight. The empirical estimations are conducted for overweight initiation and cessation, as well as for participation reflecting a decision to start and a previous decision to not stop. The data used for this research is from the China Health and Nutrition Survey (CHNS). The results suggest that body weight and the probability of overweight initiation increase with income but at a decreasing rate, indicating an inverted U-shape relationship; while the probability of overweight cessation decreases with income but at an increasing rate, suggesting a U-shape relationship. Our findings conclude that in contrast to developed countries, low-income individuals are less likely to be overweight in a transition country like China. The major reason is probably because of an income constraint for unhealthy food items; however, when income exceeds the critical value of the inverted U-shape curve, it reverses because low-income individuals seem to have less utility from future health. In particular, this change appears to happen earlier with increasing income for women and urban residents.

Keywords: health behavior, low-income, overweight, life-course utility, China

6.1 Introduction

In the last decades, there has been a growing number of studies investigating the effect of income on individuals' health; meanwhile, policymakers all over the world are increasingly concerned about the relationship between health and low-income. In developed countries, the overall health risk behavior is more prevalent for low-income individuals than for other socioeconomic groups (see Lantz et al., 1998). It is claimed that income generally has a positive correlation with "good" health-related behaviors (Benzeval et al. 2000; Binkley 2010; Jolliffe 2011). Individuals with lower income tend to make less healthy consumption choices. As a consequence, they are more likely to suffer from nutrition-related health problems such as overweight and obesity (Ball and Crawford 2005; Sobal and Stunkard 1989).

From an economic perspective, the budget constraint is an important determinant of poor food consumption behaviors among low-income individuals (see Binkley, 2010). Especially in the nutrition related literature, researchers argue that low-income individuals cannot afford to purchase healthy food, since healthy food is comparatively expensive (Drewnowski and Darmon 2005; Drewnowski and Eichelsdoerfer 2010). Notwithstanding, Stewart et al. (2003) find that with additional income low-income households would not purchase more vegetables and fruits; furthermore, a number of vegetables and fruits are actually reasonably priced (Kuchler and Stewart 2008). This suggests that a budget constraint might not be the most crucial factor in explaining differences in unhealthy food consumption or health outcomes among individuals with different income levels in developed countries. Using a life-course utility model, Binkley (2010) puts forward another hypothesis: Low-income individuals have a comparatively higher direct utility from present consumption and a less intense desire for longevity in the future; therefore, they are more likely to have poor consumption behaviors.

However, the opposite is true for developing countries. For example, a number of studies show that overweight is relatively more widespread among high-income individuals (Fernald 2007; C. A. Monteiro et al. 2004; B. M. Popkin 1999). With the development of the economy and increasing incomes, calorie consumption has been enhanced (Ogundari and Abdulai 2013); consequently, overweight and obesity have risen and become major health challenges in many developing countries (B. M. Popkin 1999; B. Popkin and Ng 2007). In China, the diet has been shifting away from high-carbohydrate food towards high-energy density food (Batis et al. 2014; Du et al. 2004),

which is an important cause of overweight. One study by Tafreschi (2015) shows that approximately 30% of individuals in China are overweight or obese in recent years.

In a transition economy like China the relationship between the consequences of unhealthy food consumption and income might be a situation in-between developing and developed societies. The effect of income on body weight might change from positive to negative with economic development and income increase. However, to the best of our knowledge, there are only a few studies that investigate this transition (Deuchert et al. 2014; Hruschka and Brewis 2013; Pampel et al. 2012); they use cross-sectional data from various developing countries and provide substantial evidence for the reversal hypothesis. Tafreschi (2015), using the data from the China Health Nutrition Survey (CHNS), provides further evidence to support the reversal of the income gradient in China, but without consideration of an individuals' life-course utility.

The Body Mass Index (BMI) as a health outcome of food consumption has an important complicating factor compared to many other health issues (Jolliffe 2011). An individual's BMI can be used to determine whether an individual is overweight or obese. In this study, overweight is used to examine individuals' unhealthy food consumption behaviors. The major goal is to extend Binkley's (2010) life-course utility model for unhealthy food consumption by considering an income constraint. We attempt to shed light on the relationship between income and overweight in the transition economy of China through estimating overweight initiation, cessation, and participation.

The remainder of the paper is organized as follows. Section 2 outlines the theoretical framework of the life-course utility model. Section 3 presents the empirical model and estimation strategy. Section 4 introduces the data and main variables. Section 5 reports the empirical estimation results. The last section concludes.

6.2 Theoretical framework

A rational consumer relies on his/her utility function to decide what to consume. A life-course utility model as proposed by Binkley (2010) considers the dynamic effect of unhealthy consumption over time. We apply this model to the case of unhealthy food consumption behavior and extend it by allowing an income constraint in unhealthy food consumption decision making. The basic model is shown in equation 1.

$$U_L = U_1\big(X(M), Y(M)\big) + \theta(t)P(X(M))U_2(g(M)) \quad (1)$$

where U_L is the expected "lifetime" utility over two periods; U_1 and U_2 are the utilities for period 1 (*present*) and period 2 (*future*), respectively. X stands for the consumed quantity of unhealthy food at present and has a negative influence on the future utility. Y is the consumed amount of all other food items in the present. X and Y are both subject to a budget constraint of income M. Based on the underlying utility function, the present utility increases with consumption of X or Y. $\theta(t)$ is the discount rate at time t within the first period; it is assumed to be identical for all consumers and $0< \theta(t) <1$. Following (Binkley 2010), $P(X(M))$ denotes the probability of survival until the second period with consuming any nonzero quantity of an unhealthy food item X during period 1. An individual who consumes an unhealthy food item X is less likely to survive than an individual who does not consume X, implying that $P(X(M))<P(0)$ for any $X>0$. U_2 is the expected utility in the second period. In this study, we are primarily interested in analyzing a consumer's present consumption choice; therefore, U_2 is assumed to be simply a function of expected future income $g(M)$. In general, we assume that higher current income will lead to higher expected future income; thus, $\partial g(M)/\partial M > 0$. Prices and tastes are assumed to be unchanged in the model.

We focus on investigating the decision of whether to consume or not to consume an unhealthy food item, which is a binary choice. The difference in life-course utility with (X>0) and without (X=0) consuming unhealthy food is:

$$D = \big[U_1\big(X(M), Y(M)\big) + \theta(t)P(X(M))U_2\big(g(M)\big)\big] - [U_1\big(0, Y(M)\big) + \theta(t)P(0)U_2\big(g(M)\big)]$$

$$= \big[U_1\big(X(M), Y(M)\big) - U_1\big(0, Y(M)\big)\big] + [\theta(t)P\big(X(M)\big)U_2\big(g(M)\big) - \theta(t)P(0)U_2\big(g(M)\big)] \quad (2)$$

Then we define:

$$D_1 = U_1\big(X(M), Y(M)\big) - U_1\big(0, Y(M)\big) \quad (3)$$

$$D_2 = \theta(t)[P\big(X(M)\big) - P(0)]\, U_2\big(g(M)\big). \quad (4)$$

Thus, $$D=D_1+D_2 \ , \quad (5)$$

where D_1 is the difference in direct utility between consumption of a goods bundle containing X and one not containing X in period 1; D_2 is the difference in expected health utility from future life-expectancy when X is or is not consumed, respectively, in period 1. Therefore, the overall effect D

is the sum of D_1 and D_2. Since $U_1(X(M), Y(M)) \geq U_1(0, Y(M))$, so $D_1 \geq 0$; and $P\big(X(M)\big) - P(0) \leq 0$, therefore, $D_2 \leq 0$. With D_1 being positive but decreasing (according to assumed decreasing marginal utility of unhealthy food) and D_2 being negative to an increasing extent (according to assumed utility increasing with income), we expect a switch from increasing to decreasing overall lifetime utility at a certain income level. The optimization maximum holds when $X=0$.

The consumption decision of whether to consume X or not is deterd by the sign of D. Specifically, if there is no unhealthy consequence, the value of D will be solely decided by D_1, because $D_2=0$; then, we can follow the standard utility maximization theory, which determines whether a good is consumed or not. Marginal utility of good X is defined as MU_X; when $MU_X/p_x>\lambda$, the good X will be consumed, where λ is the marginal utility of income. Since λ will decline with income, we can conclude that the probability of consuming an unhealthy good X in the optimal consumption bundle will increase with income, except if X is inferior.

If X and Y are normal goods and consumption of the food groups X and Y, respectively, does not negatively affect the utility derived from the other group since $\frac{\partial U/\partial X(M)}{\partial X(M)}$ and $\frac{\partial U/\partial Y(M)}{\partial Y(M)}$ are non-negative, then the direct utility D_1 increases with income $\frac{\partial D_1}{\partial M} > 0$, which suggests that the direct utility D_1 increases with income.

If X has an adverse effect on an individual's health, the second portion of the health utility in the life-course utility function should be taken into consideration. By taking the first derivative of D_2 over M, we obtain

$$\frac{\partial D_2}{\partial M} = \theta(t)[P(X(M)) - P(0)]\frac{\partial U_2\big(g(M)\big)}{\partial g(M)}\frac{\partial g(M)}{\partial M} + \theta(t)\frac{\partial P(X(M))}{\partial X}\frac{\partial X(M)}{\partial M}U_2\big(g(M)\big). \quad (6)$$

As aforementioned, $P(X(M))$ is decreasing with consumption of unhealthy food X and $P\big(X(M)\big) - P(0) \leq 0$, then it is clear to obtain $\frac{\partial D_2}{\partial M} < 0$; this implies that the negative health utility from consuming unhealthy food X declines with income; thus, low-income individuals have lower future health utility of longevity.

The overall effect of income on life-course utility D is

$$\frac{\partial D}{\partial M} = \frac{\partial D_1}{\partial M} + \frac{\partial D_2}{\partial M}. \quad (7)$$

An increase in the pleasure from consuming *X* in the present will endure a potential loss of expected health utility in the future. A rational consumer, therefore, has to consider a trade-off between these two effects. From the theoretical framework, it can be argued that due to the income constraint low-income individuals are less likely to consume unhealthy food only when income increases, as unhealthy food is normally non-necessity food.

Initially, the consumed quantity of unhealthy food *X* is relatively low, as a result the direct utility from consuming *X* in the present exceeds the negative health utility in the future. Low-income individuals have limited resources available for excess food consumption, while higher-income individuals have more access to food. It suggests that the probability of consuming unhealthy food *X* tends to have a positive relationship with income. Low-income individuals, therefore, have lower probability of consuming *X*. A positive relationship between the probability of consuming unhealthy food *X* and income holds until the budget constraint sets in. At this point the future health utility exactly counteracts the direct utility from consuming *X*, and the health utility in the future dominates the life-course utility *D*, which indicates that the likelihood to consume *X* will decrease monotonously with income. At this stage, low-income individuals have a higher probability of consuming *X*. Binkley (2010) suggests that the probability of starting to consume unhealthy food *X* either decreases throughout the whole relevant range with an accelerating rate or first rises and then falls as income increases, which suggests that there is an inverted U-shape relationship between them.

Moreover, for a current unhealthy food consumer the hurdle posed by the budget constraint has been overcome, that is to say, it has no further role to play when price and income are unchanged. Therefore, the cessation decision of unhealthy food *X* consumption is solely determined by D_2, which is initially smaller in absolute value than D_1 and then becomes increasingly important. This indicates that the relationship between income and the likelihood of stopping unhealthy food consumption has a U-shape or an increasing slope. In the initial portion of the U-shape curve, low-income individuals seem to have a higher probability to stop consuming *X*, just because they can hardly maintain their previous consumption level of *X* when temporarily overcoming the budget constraint. However, negative health utility will eventually play the dominant role in the life-course utility function as income increases, which implies that cessation is more likely for high-income individuals. Thus, we argue that the probability of 'quitting' overweight (of the outcome or "type" of unhealthy consumption analyzed in this article) has a negative relationship with income at low

income levels but changes to a positive relationship at high income levels. Following Kenkel 's et al. (2009) strategy that consumption participation can be regarded as the result of a decision to start and a series of past decisions to not stop, we also estimate the effect of income on unhealthy food consumption participation, which is a consequence of an individuals' previous decisions.

6.3 Empirical methodology

6.3.1 The econometric model for the relationship between income and BMI

To investigate the relationship between income and unhealthy food consumption behaviors, we first examine the relationship between income and BMI, which can largely be considered a health outcome from food consumption. How the BMI is calculated will be explained in section 4.2. Unlike other studies (Ettner 1996; Fichera and Savage 2015; Goode et al. 2014), our focus is not to estimate the causal effect of income on the outcome of food consumption due to the high attrition rate when using panel estimation (Tafreschi 2015) and unavailability of suitable instrumental variables for income (Goode et al. 2014). These difficulties are quite common in the health economics literature when estimating the correlation between income and health (Apouey and Geoffard 2013; Goode et al. 2014; Reinhold and Jürges 2012). In this study, we estimate a non-linear model to detect an expected inverted U-shape between income and BMI, which is simply defined as

$$BMI_i = \beta_0 + \beta_1 Income + \beta_2 (Income)^2 + \sum_K \beta_k D_{ki} + \varepsilon_i, \quad (8)$$

where BMI_i presents i_{th} individual's BMI; *Income* is per capita household income. To address the non-linear relationship between income and BMI, we introduce the squared term of income. From our theoretical framework, β_1 and β_2 are expected to be positive and negative, respectively. D_{ki} includes a set of individuals' demographic variables and household characteristics, as well as other control variables. ε_i is the disturbance term.

With the estimated parameters from this model, we can calculate the critical value (threshold value) of income after which the reverse effect play the dominant role, using the following formula:

$$CV_{income} = \beta_1 / 2\beta_2 \quad (9)$$

6.3.2 The econometric models for overweight initiation, cessation, and participation

We assume that overweight is related to unhealthy food consumption and estimate three binary choice models: overweight initiation, cessation, and participation. Our principal concern is how

income affects the probability of starting and stopping consuming unhealthy food *X,* or the probability of starting and stopping having an outcome from unhealthy food consumption, which in our case is overweight and measured with the BMI (section 4.2). The models for overweight initiation, cessation, and participation are defined as follows:

$$Prob\ (Y = 1) = \beta_0 + \beta_1 Income + \beta_2 (Income)^2 + \sum_K \beta_k D_{ki} + \varepsilon_i \quad (10)$$

where *Y* presents an individual's status of overweight initiation, cessation, and participation in the years considered. We estimate Probit models for each situation. In the first model, the dependent variable *Overweight initiation* is defined by a binary indicator which equals to 1 if an individual was not overweight in the previous year but is overweight in the present year, and equals to 0 otherwise. In the second model, the dependent variable *Overweight cessation* is defined by a binary indicator which is 1 if an individual is overweight in the previous year but is not overweight in the present year, and equals to 0 otherwise. In this way, the entire sample is used in the first model of *Overweight initiation*, while the model for *Overweight cessation* is restricted only to those for whom *Overweight initiation* equals 1. The model for *Overweight participation* is defined by a binary indicator which is 1 if an individual is overweight based on the individual's current BMI value, and equals to 0 otherwise. All additional independent variables are the same as in model (8), and the same strategy is used as in equation (9) to obtain the critical value of income.

6.4. Data

6.4.1 The sample

To test our theoretical model, we use the CHNS data. By using a multistage, random cluster process to draw a sample of roughly 4,400 households with a total of 26,000 individuals, the CHNS is designed to investigate health and nutrition related issues in China, and is conducted in nine provinces: Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong, which are substantially different in geography, economic development, and public resources, as well as in health indicators. The CHNS began in 1989 and has been conducted for nine waves until now: 1989, 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011. In 2011 three additional municipal cities, Beijing, Chongqing, and Shanghai, were included (Figure 6.1). The CHNS data is an unbalanced panel database; therefore, we treat the data as pooled cross-sectional data. We use the data from 1991 to 2011, as the questionnaires and sampling procedure in the first

wave are not consistent with those applied in the following waves (Goode et al. 2014; Tafreschi 2015).

Figure 6. 1 Map of Survey Regions

The darker shaded regions in this map are the provinces in which the survey has been conducted.
Source: http://www.cpc.unc.edu/projects/china/about/proj_desc/chinamap

6.4.2 Dependent variables

The indicator for overweight is defined by an individual's BMI. We restrict our sample to adults who are 18 years old and above. All adults who participate in the CHNS are required to take physical measurements, including height and weight. After obtaining a respondents' height and weight, the BMI can be calculated by dividing weight (in kilogram) by height squared (in meters). By conventional standards, an individual is regarded as overweight when the BMI is between 25 and 29.9 (WHO 2015). [12] Wu (2006) argues that the classification from the World Health Organization (WHO) is commonly used for Western countries but is not applicable to China; therefore, we use the standard defined by Zhou (2002) in which a BMI of 24.0 to 27.9 is classified as overweight, and 28.0 and above as obese (see also Xie and Mo, 2014). The summary of BMI is shown in Table 6.1 with a mean value of approximately 22.81; its distribution is presented in Figure 6.2. Approximately 32.3% of the individuals considered in our sample are overweight or obese. The portion of 32.3% is relatively high compared to previous studies (Tafreschi 2015; Xie and Mo

[12] It defines four different BMI categories: 1) obese (BMI above 30); 2) overweight (BMI between 25.0 and 29.9); 3) healthy weight (BMI between 18.5 and 24.9); and 4) underweight (BMI below 18.5)

2014). Our sample, moreover, shows that 16.4% of the individuals considered have started being overweight, and 34.2% have stopped being overweight over time.

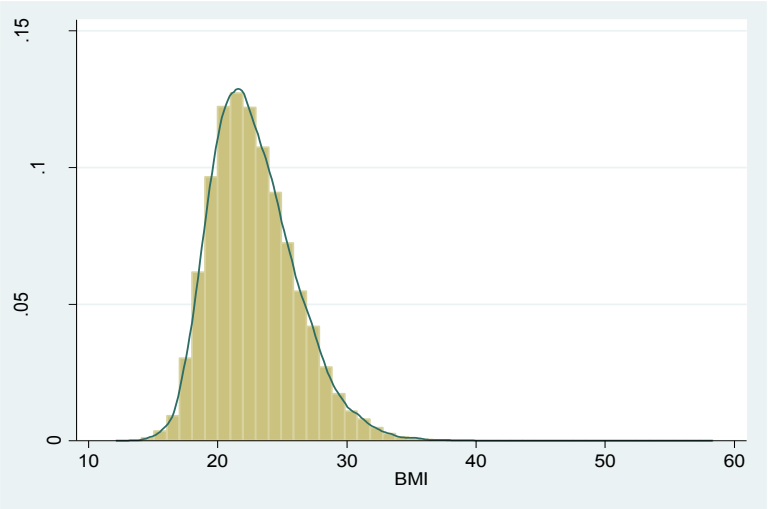

Figure 6. 2 The distribution of Body-Mass-Index (BMI) for the pooled CHNS sample

Resource: Authors' estimations based on CHNS samples

6.4.3 Independent variables

The key independent variables in our study are income and income squared. We use per capita household income rather than individual income since food consumption and nutrition related decisions are commonly made at the household level (Tafreschi, 2015). The per capita household income is adjusted by the consumer price index using 2011 as the reference year (Table 6.1). In the following, we refer to per capita household income simply as household income. The average annual household income is approximately 7,430 CNY. The CHNS also includes a range of individual demographic variables: gender, age, marital status, education, ethnic status, occupation, as well as household characteristics such as household size, and rural or urban residence. Table 6.1 also provides summary statistics for these demographic variables.

Table 6. 1 Definition and descriptive statistics of key variables

Variable	Definition	Mean	Std.Dev.
Dependent variables			
BMI	Weight/height^2	22.81	3.393
Start Overweight	1 if individual starts being overweight	0.164	0.371
Quit Overweight	1 if individual quits being overweight	0.342	0.474
Overweight	1 if individual is overweight	0.323	0.468
Income			
Income	Per capita household income adjusted to 2011 price index (10000 Yuan)	0.743	0.806
Income squared	Squared Per capita household income (10000 Yuan)	1.202	3.057
Control variables			
Male	Male=1; Female=0	0.486	0.500
Age 18-29	Age 18-29	0.199	0.399
Age 30-39	Age 30-39	0.179	0.384
Age 40-49	Age 40-49	0.195	0.396
Age 50-59	Age 50-59	0.239	0.427
Age 60+	Age above 60	0.135	0.342
Never married	Never married	0.125	0.331
Married	Married (0/1)	0.826	0.379
Widowed	Widowed (0/1)	0.011	0.105
Separated	Separated (0/1)	0.048	0.213
Below primary school	1 if highest level of education is below primary school, 0 if otherwise	0.247	0.431
Primary school	1 if highest level of education is primary school, 0 if otherwise	0.203	0.402
Middle school	1 if highest level of education is middle school, 0 if otherwise	0.499	0.500
College	1 if highest level of education is college, 0 if otherwise	0.050	0.218
Household size	Household size	3.965	1.578
Ethnic Minority	1 if individual is ethnic minority, 0 if not	0.129	0.335
Presently working	1 if individual is presently working, 0 if not	0.681	0.466
Urban	1 if individual lives in urban area, 0 if not	0.340	0.474

Notes: Authors' estimations based on CHNS samples.

6.5. Estimation results

To test our theoretical model, the relationship between income and BMI is estimated by first using OLS estimations; then, the relationship between income and overweight initiation, cessation, and participation are estimated by using maximum likelihood estimations. As mentioned in Pampel et al. (2012), males and females may differ in socially constructed body weight norms and ideas; thus, it is more reliable to estimate these relationships for the male and female samples separately, as well as for urban and rural residents.

6.5.1 The relationship between income and BMI

The OLS estimation results for the relationship between income and BMI (equation 8) are presented in Table 6.2. The positive coefficient of income and the negative coefficient of income squared are both significant at the 1% level in all sample specifications. The results suggest that individuals' BMI increases with household income but at a decreasing rate; this finding is in line with previous studies (Lakdawalla and Philipson, 2009; Philipson and Posner, 2003). Specifically, the critical point of the BMI-income quadratic curve is approximately 25,595 CNY for the pooled sample; approximately 95.8% of the individuals are below this threshold. This indicates that the household income of most individuals considered in our sample lies in the upward part of the inverted U-shape curve, where direct utility from consumption plays the dominant role in consumers' life-course utility. In addition, the marginal effect of income on individual BMI is approximately 0.483 when controlling for other variables at the mean values. The marginal effect shows that on average a 10,000 CNY increase in household income will lead to a rise in an individual's BMI of approximately 0.483.

The estimation results for the male and female as well as for the urban and rural subsamples are also shown in Table 6.2. In general, the coefficients of the key variables, which are income and income squared, are consistent with the estimation results of the pooled sample. Interestingly, the critical value of the BMI-income quadratic curve for females (approximately 24,708 CNY) is relatively lower than the value of 28,659 CNY for males, which suggests that females tend to decrease their BMI at a relatively lower income level compared with males. In the view of the urban and rural samples, we find that the critical value for the urban sample is approximately 26,045 CNY and for the rural sample it is approximately 33,967 CNY. The results indicate that urban residents are more likely to decrease their BMI at a lower income level than are rural residents.

Table 6. 2 OLS estimation of the relationship between income and BMI

Variables	Dependent variable: BMI					
	Male	Female	Rural	Urban	Pooled	
	(1)	(2)	(3)	(4)	(5)	Marginal effect
Income	0.791***	0.509***	0.625***	0.573***	0.671***	0.483***
	(0.12)	(0.13)	(0.13)	(0.16)	(0.10)	(0.06)
Income squared	-0.138***	-0.103***	-0.092**	-0.110**	-0.126***	
	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)	
Male			-0.270***	0.073	-0.140**	-0.140**
			(0.07)	(0.09)	(0.06)	(0.06)
Age 30-39	0.521***	0.378***	0.442***	0.484***	0.456***	0.456***
	(0.07)	(0.07)	(0.06)	(0.09)	(0.05)	(0.05)
Age 40-49	0.685***	1.114***	0.875***	1.067***	0.933***	0.933***
	(0.07)	(0.07)	(0.07)	(0.09)	(0.05)	(0.05)
Age 50-59	0.504***	1.122***	0.738***	1.075***	0.829***	0.829***
	(0.09)	(0.10)	(0.08)	(0.12)	(0.07)	(0.07)
Age 60+	0.127	0.555***	0.151	0.611***	0.291***	0.291***
	(0.11)	(0.13)	(0.12)	(0.13)	(0.09)	(0.09)
Married	0.948***	0.999***	0.827***	1.133***	0.971***	0.971***
	(0.09)	(0.09)	(0.08)	(0.11)	(0.07)	(0.07)
Widowed	0.538**	0.690**	0.695***	0.512*	0.591***	0.591***
	(0.22)	(0.29)	(0.22)	(0.28)	(0.18)	(0.18)
Separated	0.172	0.169	0.095	0.575***	0.289**	0.289**
	(0.16)	(0.16)	(0.14)	(0.20)	(0.12)	(0.12)
Primary school	0.249**	0.247***	0.121	0.041	0.092	0.092
	(0.10)	(0.09)	(0.08)	(0.15)	(0.07)	(0.07)
Middle school	0.552***	-0.226**	0.164*	-0.268**	0.034	0.034
	(0.10)	(0.10)	(0.09)	(0.12)	(0.07)	(0.07)
College	0.694***	-1.184***	0.067	-0.500***	-0.274**	-0.274**
	(0.16)	(0.20)	(0.19)	(0.18)	(0.13)	(0.13)
Household size	-0.042**	-0.044*	-0.054***	-0.031	-0.043**	-0.043**
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
Ethnic Minority	-0.168	-0.089	-0.365**	0.487**	-0.126	-0.126
	(0.13)	(0.16)	(0.14)	(0.19)	(0.13)	(0.13)
Presently working	-0.353***	-0.573***	-0.480***	-0.426***	-0.501***	-0.501***
	(0.07)	(0.07)	(0.08)	(0.09)	(0.06)	(0.06)
Urban	0.271**	0.256**			0.253***	0.253***
	(0.11)	(0.11)			(0.09)	(0.09)
Year dummies	YES	YES	YES	YES	YES	
Regional dummies	YES	YES	YES	YES	YES	
Constant	20.866***	21.854***	21.884***	21.569***	21.599***	
	(0.23)	(0.25)	(0.25)	(0.29)	(0.20)	
N	23378	25670	32066	16982	49048	49048
R^2	0.169	0.124	0.140	0.127	0.126	

* p<0.10, ** p<0.05, *** p<0.010.

Robust standard errors (clustered on community id) are in parentheses. Regional controls include dummies for Chongqing, Beijing, Liaoning, Heilongjiang, Shanghai, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou. Time controls include year dummies for 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011.

Source: Authors' estimations based on CHNS samples.

6.5.2 The relationship between income and overweight initiation

The estimation results for the relationship between income and overweight initiation are shown in Table 6.3. As our findings suggest the positive coefficient of income and the negative coefficient of income squared are both statistically significant at the conventional levels for all samples except for the female sample. The results indicate that there is an inverted U-shape relationship between 'starting' overweight and household income. This means that the probability of 'starting'

overweight increases with income at low income levels and then declines after the critical point at high income levels. We find that individuals will be less likely to start being overweight when their income exceeds the critical point of 20,416 CNY; however, 91.5% of the individuals considered in the pooled sample are still below this threshold, which implies that a majority of the individuals considered might still be at risk of becoming overweight. The marginal effect of income shows that the probability of starting to be overweight increases by approximately 2.3 percentage points if income rises by 10,000 CNY, controlling for all other variables at mean values.

The results for the different subsamples are largely consistent with the results from the pooled sample (Table 6.3). However, the insignificant coefficient of income and the negatively significant coefficient of income squared in the female subsample indicate that high-income females are less likely to start being overweight; similar results by Deuchert et al. (2014) also indicate a significantly negative correlation between overweight and obesity and per capita GDP for females, using the data from 52 different countries. Furthermore, we find that individuals living in urban areas have a lower threshold value (20,400 CNY), after which individuals are less likely to start being overweight with increasing income.

Table 6. 3 Probit estimation results for overweight initiation

Variables	Dependent variable: Overweight initiation					
	Male	Female	Rural	Urban	Pooled	
	(1)	(2)	(3)	(4)	(4)	Marginal effect
Income	0.221***	0.061	0.163***	0.102*	0.147***	0.023***
	(0.05)	(0.05)	(0.05)	(0.06)	(0.04)	(0.01)
Income squared	-0.041***	-0.028*	-0.033**	-0.025*	-0.036***	
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Male			-0.057**	-0.002	-0.036*	-0.009*
			(0.03)	(0.04)	(0.02)	(0.01)
Age 30-39	0.186***	0.079**	0.139***	0.107**	0.131***	0.033***
	(0.04)	(0.04)	(0.04)	(0.05)	(0.03)	(0.01)
Age 40-49	0.228***	0.312***	0.270***	0.279***	0.274***	0.068***
	(0.04)	(0.04)	(0.04)	(0.06)	(0.03)	(0.01)
Age 50-59	0.126**	0.247***	0.171***	0.198***	0.183***	0.045***
	(0.05)	(0.05)	(0.05)	(0.06)	(0.04)	(0.01)
Age 60+	0.031	0.117**	0.015	0.138**	0.064*	0.016*
	(0.05)	(0.05)	(0.05)	(0.07)	(0.04)	(0.01)
Married	0.360***	0.368***	0.294***	0.442***	0.357***	0.088***
	(0.05)	(0.05)	(0.05)	(0.07)	(0.04)	(0.01)
Widowed	0.317***	0.258**	0.241**	0.338***	0.281***	0.070***
	(0.11)	(0.12)	(0.12)	(0.12)	(0.09)	(0.02)
Separated	0.186*	0.150**	0.149**	0.213**	0.184***	0.046***
	(0.10)	(0.07)	(0.07)	(0.10)	(0.06)	(0.01)
Primary school	0.047	0.095**	0.035	-0.016	0.025	0.006
	(0.05)	(0.04)	(0.03)	(0.06)	(0.03)	(0.01)
Middle school	0.190***	-0.027	0.057	-0.011	0.043	0.011
	(0.04)	(0.04)	(0.04)	(0.05)	(0.03)	(0.01)
College	0.218***	-0.330***	-0.040	-0.062	-0.048	-0.012
	(0.07)	(0.08)	(0.08)	(0.07)	(0.05)	(0.01)
Household size	-0.018*	-0.010	-0.013*	-0.014	-0.013**	-0.003**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Ethnic Minority	-0.080	0.028	-0.056	0.093	-0.020	-0.005
	(0.05)	(0.05)	(0.05)	(0.06)	(0.04)	(0.01)
Presently working	-0.163***	-0.160***	-0.164***	-0.141***	-0.160***	-0.040***
	(0.03)	(0.03)	(0.03)	(0.04)	(0.02)	(0.01)
Urban	0.111***	0.174***			0.140***	0.035***
	(0.04)	(0.04)			(0.03)	(0.01)
Year dummies	YES	YES	YES	YES	YES	
Province dummies	YES	YES	YES	YES	YES	
Constant	-1.351***	-1.031***	-1.118***	-0.930***	-1.119***	
	(0.10)	(0.09)	(0.10)	(0.12)	(0.08)	
N	16343	16743	22365	10721	33086	33086
Chi2	864	797	1044	663	1285	
Pseudo R-squared	0.083	0.053	0.055	0.064	0.059	

* p<0.10, ** p<0.05, *** p<0.010.

Robust standard errors (clustered on community id) are in parentheses. Regional controls include dummies for Chongqing, Beijing, Liaoning, Heilongjiang, Shanghai, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou. Time controls include year dummies for 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011.

Source: Authors' estimations based on CHNS samples.

6.5.3 The relationship between income and overweight cessation

Table 6.4 presents the estimation results for the relationship between income and overweight cessation. The negative coefficient of income and positive coefficient of income squared are both statistically significant as expected; thus, the probability of 'quitting' overweight declines with income but at a decreasing rate. This indicates that there is a U-shape relationship between income

and overweight cessation with the critical point of 22,307 CNY; however, approximately 91% of the individuals considered in the pooled sample are below this threshold. Moreover, the marginal effect of income on overweight cessation indicates that a 10,000 CNY increase in household income will lead to a decline in the probability of overweight cessation of approximately 4.7%, when keeping all other control variables at the mean values. The likelihood of stopping overweight will consistently increase after the household income exceeds the critical point of 22,307 CNY; however, there are no more than 10% of individuals who have incomes above this level.

Similar to the pooled sample, the estimations from subsamples suggest that the probability of overweight cessation first decreases and then after reaching a bottom value increases with income. The results also indicate that females and urban residents have lower critical values of 20,952 CNY and 23,000 CNY, respectively. This suggests that females and urban residents are more likely to 'quit' overweight at lower income levels.

Table 6. 4 Probit estimation results for overweight cessation

Variables	Dependent variable: Overweight cessation					
	Male	Female	Rural	Urban	Pooled	
	(1)	(2)	(3)	(4)	(4)	Marginal effect
Income	-0.276***	-0.176***	-0.241***	-0.161***	-0.232***	-0.047***
	(0.07)	(0.06)	(0.07)	(0.05)	(0.04)	(0.01)
Income squared	0.060***	0.042***	0.050**	0.035**	0.052***	
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	
Male			0.014	-0.134***	-0.046	-0.015
			(0.04)	(0.04)	(0.03)	(0.01)
Age 30-39	-0.366***	-0.286***	-0.358***	-0.290***	-0.324***	-0.105***
	(0.06)	(0.05)	(0.05)	(0.06)	(0.04)	(0.01)
Age 40-49	-0.382***	-0.610***	-0.583***	-0.430***	-0.519***	-0.168***
	(0.05)	(0.04)	(0.04)	(0.06)	(0.03)	(0.01)
Age 50-59	-0.433***	-0.633***	-0.566***	-0.554***	-0.550***	-0.179***
	(0.05)	(0.05)	(0.05)	(0.06)	(0.04)	(0.01)
Age 60+	-0.287***	-0.418***	-0.369***	-0.322***	-0.340***	-0.110***
	(0.07)	(0.06)	(0.06)	(0.07)	(0.04)	(0.01)
Married	-0.463***	-0.485***	-0.467***	-0.464***	-0.468***	-0.152***
	(0.07)	(0.07)	(0.06)	(0.08)	(0.05)	(0.02)
Widowed	-0.269*	-0.389**	-0.169	-0.553***	-0.328***	-0.107***
	(0.16)	(0.15)	(0.15)	(0.16)	(0.11)	(0.04)
Separated	-0.118	-0.346***	-0.331***	-0.320***	-0.317***	-0.103***
	(0.11)	(0.09)	(0.09)	(0.11)	(0.07)	(0.02)
Primary school	0.002	-0.016	0.055	0.006	0.054	0.017
	(0.07)	(0.05)	(0.05)	(0.06)	(0.04)	(0.01)
Middle school	-0.064	0.254***	0.110**	0.221***	0.160***	0.052***
	(0.06)	(0.05)	(0.04)	(0.06)	(0.04)	(0.01)
College	-0.065	0.625***	0.232**	0.327***	0.293***	0.095***
	(0.09)	(0.09)	(0.09)	(0.07)	(0.06)	(0.02)
Household size	0.022	-0.007	0.017	-0.014	0.005	0.002
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.00)
Ethnic Minority	-0.060	0.042	0.092	-0.203**	-0.007	-0.002
	(0.08)	(0.06)	(0.06)	(0.09)	(0.05)	(0.02)
Presently working	0.034	0.129***	0.080**	0.108**	0.095***	0.031***
	(0.05)	(0.04)	(0.04)	(0.05)	(0.03)	(0.01)
Urban	-0.009	0.035			0.017	0.006
	(0.05)	(0.04)			(0.03)	(0.01)
Year dummies	YES	YES	YES	YES	YES	
Province dummies	YES	YES	YES	YES	YES	
Constant	1.506***	1.023***	1.176***	1.237***	1.214***	
	(0.14)	(0.12)	(0.12)	(0.11)	(0.09)	
N	7041	8919	9698	6262	15960	15960
Chi2	1063	1289	1600	968	2012	
Pseudo R-squared	0.155	0.138	0.160	0.112	0.135	

* p<0.10, ** p<0.05, *** p<0.010.

Robust standard errors (clustered on community id) are in parentheses. Regional controls include dummies for Chongqing, Beijing, Liaoning, Heilongjiang, Shanghai, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou. Time controls include year dummies for 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011.

Source: Authors' estimations based on CHNS samples.

6.5.4 The relationship between income and overweight participation

The estimation results of overweight participation are shown in Table 6.5. Although the probability of overweight cessation tends to increase with income at high income levels, overweight initiation has been prevalent in a transition economy like China. Hence, in general, the relationship between income and overweight participation shows a similar pattern as overweight initiation (Deuchert et

al. 2014; Hruschka and Brewis 2013; Pampel et al. 2012). Our results support this finding. The relationship between income and the probability of overweight participation changes the sign from positive to negative as income increases, indicating an inverted U-shape relationship between income and overweight participation. For the pooled sample, the peak of this U-shape curve occurs at the point where income is approaching 22,727 CNY; however, 91.8% of the individuals considered in the pooled sample are below this level. From the marginal effect of income on overweight participation, we find that an increase of 10,000 CNY in household income decreases the probability of overweight participation of approximately 5.3%, when controlling all other variables at mean values.

Table 6.5 also shows that the estimation results for the subsamples are consistent with the pooled sample. However, the critical point of the inverted U-shape curve between income and overweight participation is lower for females and for urban residents than it is for males and rural residents, which indicates that females and urban residents tend to decrease the likelihood of being overweight earlier compared with males and rural residents (see also Tafreschi, 2015).

Table 6. 5 Probit estimation results for overweight participation

Variables	Dependent variable: Overweight participation					
	Male	Female	Rural	Urban	Pooled	
	(1)	(2)	(3)	(4)	(4)	Marginal effect
Income	0.325***	0.168***	0.270***	0.168***	0.250***	0.053***
	(0.05)	(0.04)	(0.05)	(0.05)	(0.04)	(0.01)
Income squared	-0.063***	-0.044***	-0.051***	-0.036***	-0.055***	
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Male			-0.099***	0.003	-0.058***	-0.019***
			(0.03)	(0.03)	(0.02)	(0.01)
Age 30-39	0.223***	0.122***	0.179***	0.156***	0.170***	0.056***
	(0.03)	(0.03)	(0.03)	(0.04)	(0.02)	(0.01)
Age 40-49	0.290***	0.403***	0.360***	0.356***	0.356***	0.116***
	(0.03)	(0.03)	(0.03)	(0.04)	(0.02)	(0.01)
Age 50-59	0.257***	0.428***	0.342***	0.382***	0.347***	0.114***
	(0.04)	(0.04)	(0.03)	(0.04)	(0.03)	(0.01)
Age 60+	0.149***	0.232***	0.147***	0.249***	0.175***	0.057***
	(0.05)	(0.04)	(0.04)	(0.05)	(0.03)	(0.01)
Married	0.395***	0.429***	0.368***	0.445***	0.407***	0.133***
	(0.04)	(0.05)	(0.04)	(0.06)	(0.03)	(0.01)
Widowed	0.316***	0.248**	0.251***	0.321***	0.278***	0.091***
	(0.10)	(0.11)	(0.09)	(0.11)	(0.07)	(0.02)
Separated	0.126	0.201***	0.181***	0.246***	0.214***	0.070***
	(0.08)	(0.06)	(0.06)	(0.08)	(0.05)	(0.02)
Primary school	0.080*	0.068**	0.023	-0.005	0.010	0.003
	(0.05)	(0.03)	(0.03)	(0.05)	(0.03)	(0.01)
Middle school	0.231***	-0.104***	0.043	-0.069	0.004	0.001
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.01)
College	0.286***	-0.468***	-0.003	-0.130**	-0.088*	-0.029*
	(0.07)	(0.07)	(0.07)	(0.06)	(0.05)	(0.02)
Household size	-0.025***	-0.010	-0.022***	-0.006	-0.016***	-0.005***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Ethnic Minority	-0.075	-0.026	-0.117**	0.116*	-0.045	-0.015
	(0.05)	(0.05)	(0.05)	(0.07)	(0.04)	(0.01)
Presently working	-0.169***	-0.216***	-0.202***	-0.175***	-0.199***	-0.065***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.01)
Urban	0.098**	0.132***			0.111***	0.036***
	(0.04)	(0.04)			(0.03)	(0.01)
Year dummies	YES	YES	YES	YES	YES	
Province dummies	YES	YES	YES	YES	YES	
Constant	-1.363***	-0.929***	-0.980***	-0.981***	-1.041***	
	(0.10)	(0.09)	(0.10)	(0.10)	(0.07)	
N	23378	25670	32066	16982	49048	49048
Chi2	1572	1557	1861	1079	2399	
Pseudo R-squared	0.113	0.078	0.093	0.073	0.086	

* p<0.10, ** p<0.05, *** p<0.010.

Robust standard errors (clustered on community id) are in parentheses. Regional controls include dummies for Chongqing, Beijing, Liaoning, Heilongjiang, Shanghai, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Guizhou. Time controls include year dummies for 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011.

Source: Authors' estimations based on CHNS samples.

6.6 Conclusion

From a life-course utility model in which income serves as a budget constraint and as a source of future utility, our hypothesis is that individuals with unhealthy food consumption patterns are at a higher risk of having a lower expected future health utility due to reduced longevity. Since health utility is a decreasing function of income in our theoretial model, low-income individuals tend to

have lower cost of future health utility. They are more likely to consume unhealthy food and have unhealthy consumption behaviors when their income constraint is overcome. Evidence for this theoretical consideration is given by increased incidences of overweight in developed countries. However, in a transition economy like China the income constraint still plays a significant role in individuals' food consumption behaviors; therefore, overweight as a consequence of unhealthy food consumption is investigated in our empirical estimations by using the data from the CHNS.

Our estimation results suggest that BMI and overweight initiation have an inverted U-shape relationship with household income, indicating that BMI and the probability of overweight initiation increase with income but at a decreasing rate. With income increases, overweight individuals are less likely to 'stop' overweight at low income levels and more likely to 'stop' it at high income levels. This result also suggests that low-income individuals have a higher probability to 'stop' overweight when their income lies in the left side of the U-shape curve. However, we argue that it is not because the absolute value of health utility exceeds the direct utility from consumption that plays the dominant role in lifetime utility, but because overweight individuals with low incomes can hardly maintain their previous food consumption and easily lose their weight.

Based on our findings, it is plausible that low-income individuals in China tend to have a more healthy diet. However, we argue that the reason is not because low-income individuals make more rational and knowledgeable food consumption choices, but because of an income constraint that denies them to consume food with higher calories and nutrition. Low income limits the availability for excess food consumption and increases physically demanding labor, while high income gives rise not only to excess food but also to avoidance of physically demanding labor (Pampel et al. 2012). Therefore, with income increases low-income individuals in a transition economy like China might increasingly consume more unhealthy food, which might lead to a higher overweight rate and nutrition related incidents until a certain income threshold is reached.

Another interesting finding is that urban residents tend to reach the threshold value of the relationship between income and body weight, as well as between income and overweight initiation, cessation, and participation earlier than do rural residents. Given the ongoing changes of the relationship between income and overweight participation from positive in developing regions to negative in developed regions (Carlos A. Monteiro et al. 2004; Sobal and Stunkard 1989; Tafreschi 2015), urban residents are more likely to reach the threshold value earlier, possibly because urban areas are more developed than are rural areas in China.

We also find the reversal of the relationship between income and BMI, as well as overweight initiation, cessation, and participation earlier for females than for males. One reason could be that females tend to understate their true body weight while the opposite is more likely true for males (Cawley 2004), and another reason might be that females are more likely to follow physician's suggestions to consume less unhealthy food with high calories once they become overweight (Loureiro and Nayga Jr 2006).

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Chapter 7

Conclusion

This dissertation consists of five contributions that empirically examine food consumption, income inequality and health-related issues in China. These studies not only contribute to the existing research, but also entail economic implications and recommendations for consumers and policy makers. Since there is a specific research question in each study and the interpretation of the results are also subject to some limitations, therefore, a final conclusion is drawn in this chapter and each contribution is concluded separately.

Heterogeneity in food consumption among income classes in rural China

The demand for eight major food groups is estimated by income class using a household data set drawn from the CHNS in rural China. The Working-Leser model is employed in the first step to investigate the responsiveness of demand for the total studied food expenditure to the changes in income. The quadratic almost ideal demand system is then estimated for the eight food groups using a non-linear seemingly unrelated regression technique in the second step. After obtaining the estimated income elasticities of studied food groups for various income classes, we examine the responsiveness of food demand to the changes in income distribution.

The results suggest that there are significant differences in food demand across various income classes. The lowest-income households are more sensitive to income and price changes than the highest-income households for most of the food groups. We conclude that effective policies directed to lowering food prices or increasing household incomes will result in substantially higher

demand for food in rural China, especially for the lowest-income households since they have the highest own-price and income elasticities for most of the food groups.

According to the projected increase in demand for the studied food groups under four scenarios, we can draw several conclusions. Firstly, we can conclude that a small change in income distribution will drive considerable variation in food consumption. Secondly, any policies designed to increase incomes that favor lower-income households will give stronger rise to food demand than policies that favor higher-income classes. Thirdly, policies intended to redistribute income from higher-income classes to lower-income classes will drive higher demand for food as well, although there is no growth in average income for the whole population. Fourthly, a uniform increase in income would also boost food demand by a larger amount than if the income growth was solely received by higher-income classes. Finally, keeping the current income distribution and growth, the projected food consumption in rural China would increase consistently in the next decades, especially for aquatic and dairy products.

In conclusion, income elasticities for rural households are still relatively large, and there exists substantial inequality in food consumption. Consequently, policies designed to increase household income in rural areas would be helpful to increase their food consumption, especially to improve the welfare of the lowest-income class. As the estimation results indicate, quite different food demand patterns are shown in various income classes, and hence income distribution should be taken into account instead of an average estimation for the population as a whole.

The impact of education on income inequality between ethnic minorities and Han in China

In this article, we examine the impact of education on income inequality between ethnic minorities and Han in China by using CHNS data over the period 1993-2011. Based on several OLS and IV estimations, this article enhances our understanding of the specific returns to education for ethnic minorities.

The results suggest that there exists significant income inequality to the disadvantage of ethnic minorities for the full, female, and urban samples when either the Law or the Provisions are used as an instrument for education and for the rural sample when the Provisions are used as an instrument for education. We find that for the full sample one additional year of education will increase earned incomes of ethnic minorities by 26.3-28%. In particular, one additional year of education will increase earned incomes by 13.5-14.4% for women from an ethnic minority group,

by 10.4-14% for ethnic minorities with urban household registration, and by 10.8% for ethnic minorities with rural household registration.

The returns to education from IV estimations show that an additional year of education can increase earned incomes by 17.7-19.9% for all individuals. In particular, an additional year of education can increase earned incomes by 15.1-18.2% for women, by 11.2-12.1% for individuals with urban household registration, and by 28.7-31.1% for individuals with rural household registration. The higher returns to education from IV estimations in comparison to OLS estimations are a common phenomenon in the literature (Card 1999).

The following limitation of our study should be noted. The CHNS sample over the period 1993-2011 includes only nine provinces so that our findings cannot be generalized for overall China (Gustafsson and Li 2002). The TAR and XUAR are not included in our study; yet income inequalities between ethnic minorities and Han in these two regions are particularly pronounced (Gilley 2001, Hannum and Xie 1998, Yee 2003); therefore, further regional specific studies are required.

Drink and smoke; drink or smoke? – The interdependence between alcohol and cigarette consumption for men in China

Due to insufficient price variation, the approach starting with a structural equation model that was introduced by Tauchmann et al. (2013) is used in this study to better understand the relation between alcohol and cigarettes consumption in China. A structural Tobit model is employed to address the censoring of the data and to account for the potential endogeneity of alcohol and cigarette consumption in the structural estimation, parental consumption behaviors are used as instruments for the sons' alcohol and cigarette consumption, respectively.

The main finding of our research is that alcohol and cigarettes are complementary goods for men in China. When the demand for alcohol (cigarettes) increases, the demand for cigarettes (alcohol) will also increase, *ceteris paribus*. This implies that a positive health effect could be achieved if only one of the two commodities is targeted with health measures, for example through a tax. This kind of positive health effect is often referred to as a double dividend health effect, or in a more popular vernacular it is a health measure that could "kill two birds with one stone".

The results also indicate that parental alcohol and cigarette consumption has a significantly positive influence on a son's alcohol and cigarette consumption, respectively. This suggests that the parental consumption behavior serves as a valid instrument for filial alcohol and cigarette consumption if endogeneity is observed. Another interesting finding is that maternal education has a statistically significant effect on filial cigarette consumption. Any policy that seeks to improve women's education in China might, thus, reduce filial cigarette consumption in China.

Finally, it can be concluded that the structural model serves as an excellent alternative if only consumption data are available. A limitation of this study is the comparatively small sample size, especially for conditional linear estimation; this stems from the fact that individual and parental data are merged. Further studies with other data sources are required to verify our results. To provide more elaborate policy recommendations, it might be fruitful in future studies to better understand the relationship between socio-economic factors and harmful health behavior, particularly due to China's rapid economic shift over the last decades and the respective change in consumption behavior.

Unhealthy consumption behaviors and their intergenerational persistence: the role of education

This paper investigates the impact of education on unhealthy consumption behaviors and their intergenerational persistence. Due to the presence of potential endogeneity of education in health behaviors estimations, it requires more rigorous estimation to obtain reliable results. Since the 9-year Compulsory Education Law and the Provisions on the Prohibition of Using Child Labor as quasi-experiments having significant influence on the education attainment, we employ an instrumental estimation by using these two institutional changes as instruments for education in unhealthy consumption equations. Through introducing an interaction term between parental unhealthy consumption and filial education, we further clarify the impact of education on the intergeneration persistence of unhealthy consumption.

The empirical estimation results indicate that there exists significant intergenerational persistence of unhealthy consumption behaviors in China. In particular, the probability of intergenerational persistence of smoking is approximately 2.6% and 4.9% from mother and father, respectively, while that of binge drinking is approximately 13.3% and 14.8% from mother and father,

respectively. Drinking behavior has the largest probability of intergenerational persistence which is approximately 20.4% and 17.5% from mother and father, respectively.

We also find that an additional year of education has a statistically significant negative impact on smoking, drinking, and binge drinking. One additional year of education decreases the probability to be smoking, drinking, and binge drinking by 3.4%, 2.8%, and 1.8%, respectively. Another interesting finding is that an additional year of education can counteract intergenerational persistence of smoking and binge drinking from the father, but it has no impact on intergenerational persistence from the mother. Since drinking behavior is ambiguous to be considered as an unhealthy consumption behavior, we find that there is no impact of education on the intergenerational persistence of drinking.

Hence, our results suggest that policies oriented to control smoking and binge drinking should take parents' consumption behaviors into consideration; education is expected to be an efficient way to control unhealthy consumption behaviors in China; however, education may not be an efficient way to prevent intergenerational persistence of unhealthy consumption from the mother.

There are some limitations of our study: First, due to the absence of data on consumers' daily alcohol consumption, the definition of binge drinking in our study is different from other studies (see, Li et al., 2011), which may induce higher probability of binge drinking for our sample. Second, the primary goal of this study is to investigate the causal relationship between education and unhealthy consumption as well as its intergenerational persistence, further research needs to be conducted to shed light on the mechanism or channel through which these unhealthy consumption behaviors transmit to the next generation. Thus, the findings from our results should be cautiously interpreted and implemented.

Low-income and Overweight in the Transition Economy of China?

Evidence from a Life-course Utility Model

From a life-course utility model in which income serves as a budget constraint and as a source of future utility, our hypothesis is that individuals with unhealthy food consumption are at a higher risk of having a lower expected future health utiltiy due to reduced longevity. In the transition economy of China income constraint still plays significant role in individuals' food consumption behaviors, overweight as a consequence of unhealthy food consumption is investigated in our empirical estimations.

The results suggest that BMI and overweight initiation have an inverted U-shape relationship with household income, indicating that BMI and the probability of overweight initiation increase with income but at a decreasing rate. With income increases, overweight individuals are less likely to stop overweight at low income level and more likely to stop it at high income level. This result also suggests that low-income individuals have a higher probability to stop overweight when their income lies in the left side of the U-shape curve. However, it is not because the absolute value of health utility exceeds the direct utility from consumption playing dominant role in lifetime utility, but because that for these overweight individuals with low income they can hardly maintain their previous food consumption and easily lose their weight.

Our finding implies that it is plausible that low-income individuals tend to have a more healthy diet in the transition economy of China. However, we argue that the reason is not because low-income individuals make more rational and knowledgeable food consumption choices, but because of an income constraint that denies them to consume food with higher calories and nutrition. Therefore, with income increases low-income individuals in a transition economy like China might increasingly consume more unhealthy food, which might lead to a higher overweight rate and nutrition related incidents until a certain income threshold is reached.

Another interesting finding is that urban residents tend to change the sign of the relation between income and body weight, as well as the relation between income and overweight initiation, cessation, and cessation earlier compared with rural residents. As known that the ongoing changes of the relationship between income and overweight participation from positive in developing regions to negative in developed regions (Sobal and Stunkard, 1989; Monteiro et al., 2004b;

Tafreschi, 2015), urban residents are more likely to have the reverse sign earlier since urban areas are mostly developed than rural areas in China.

We also find the earlier reversal of the relation between income and body weight, as well as overweight initiation, cessation, and cessation for females than that for males, one reason could be that females tend to understate their true body weight while the opposite is more likely true for males (Cawley, 2004), and another reason is that females are more likely to follow physician's suggestions to consume less unhealthy food with high calories once they become overweight (Loureiro and Nayga, 2006).

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Declaration of co-authorship

C | A | U Christian-Albrechts-Universität zu Kiel | Agrar- und Ernährungswissenschaftliche Fakultät

Declaration of co-authorship

If a dissertation is based on already published or submitted co-authored articles, a declaration from each of the authors regarding the part of the work done by the doctoral candidate must be enclosed when submitting the dissertation.

1. Doctoral candidate
Name: Yanjun REN

2. This co-author declaration applies to the following article:
Heterogeneity in food consumption among income classes in rural China

The extent of the doctoral candidat's contribution to the article is assessed on the following scale:

A. Has contributed to the work (0-33%)
B. Has made a substantial contribution (34-66%)
C. Did the majority of the work independently (67-100%)

3. Declaration on the individual phases of the scientific work (A,B,C)	Extent
Concept: Formulation of the basic scientific problem based on theoretical questions which require clarification, including a summery of the general questions which, it is assumed, will be answerable via analyses or concrete experiments/investigations	C
Planning: Planning of experiments/analyses and formulation of investigative methodology, including choice of method and independent methodological development, in such a way that the scientific questions asked can be expected to be answered	C
Execution: Involvement in the analysis or the concrete experiments/investgation	C
Manuscript preparation: Presentation, interpretation and discussion of the results obtained in article form	C

4. Signature of all co-authors		
Date	**Name**	**Signature**
28.11.2016	Yanjie Zhang	Yanjie Zh
28.11.2016	THOMAS GLAUBEN	
28.11.16	JENS-PETER LOY	

5. Signature of doctoral candidate		
Date	**Name**	**Signature**
28.11.2016	Yanjun Ren	Yanjun Ren

C | A | U Christian-Albrechts-Universität zu Kiel | Agrar- und Ernährungswissenschaftliche Fakultät

Declaration of co-authorship

If a dissertation is based on already published or submitted co-authored articles, a declaration from each of the authors regarding the part of the work done by the doctoral candidate must be enclosed when submitting the dissertation.

1. Doctoral candidate
Name: Yanjun REN

2. This co-author declaration applies to the following article:
The impact of education on income inequality between ethnic minorities and Han in China

The extent of the doctoral candidate's contribution to the article is assessed on the following scale:

- A Has contributed to the work (0-33%)
- B Has made a substantial contribution (34-66%)
- C Did the majority of the work independently (67-100%)

3. Declaration on the individual phases of the scientific work (A,B,C)	Extent
Concept: Formulation of the basic scientific problem based on theoretical questions which require clarification, including a summary of the general questions which, it is assumed, will be answerable via analyses or concrete experiments/investigations	A
Planning: Planning of experiments/analyses and formulation of investigative methodology, including choice of method and independent methodological development, in such a way that the scientific questions asked can be expected to be answered	C
Execution: Involvement in the analysis or the concrete experiments/investigation	A
Manuscript preparation: Presentation, interpretation and discussion of the results obtained in article form	A

4. Signature of all co-authors		
Date	Name	Signature
28.11.2016	Castro Campos, Bente	[signature]
29.11.2016	Petrick, Martin	[signature]

5. Signature of doctoral candidate		
Date	Name	Signature
28.11.2016	Yanjun Ren	[signature]

C | A | U Christian-Albrechts-Universität zu Kiel | Agrar- und Ernährungswissenschaftliche Fakultät

Declaration of co-authorship

If a dissertation is based on already published or submitted co-authored articles, a declaration from each of the authors regarding the part of the work done by the doctoral candidate must be enclosed when submitting the dissertation.

1. Doctoral candidate
Name: Yanjun REN

2. This co-author declaration applies to the following article:
Drink and smoke; drink or smoke? – The interdependence between alcohol and cigarette consumption for men in China

The extent of the doctoral candidat's contribution to the article is assessed on the following scale:

A Has contributed to the work (0-33%)
B Has made a substantial contribution (34-66%)
C Did the majority of the work independently (67-100%)

3. Declaration on the individual phases of the scientific work (A,B,C)	Extent
Concept: Formulation of the basic scientific problem based on theoretical questions which require clarification, including a summery of the general questions which, it is assumed, will be answerable via analyses or concrete experiments/investigations	C
Planning: Planning of experiments/analyses and formulation of investigative methodology, including choice of method and independent methodological development, in such a way that the scientific questions asked can be expected to be answered	C
Execution: Involvement in the analysis or the concrete experiments/investgation	B
Manuscript preparation: Presentation, interpretation and discussion of the results obtained in article form	B

4. Signature of all co-authors		
Date	**Name**	**Signature**
28.11.2016	Carlos Campos, Bruk	
28.11.16	J.-P. Lg	

5. Signature of doctoral candidate		
Date	**Name**	**Signature**
30.11.2016	Yanjun Ren	

C A U Christian-Albrechts-Universität zu Kiel | Agrar- und Ernährungswissenschaftliche Fakultät

Declaration of co-authorship

If a dissertation is based on already published or submitted co-authored articles, a declaration from each of the authors regarding the part of the work done by the doctoral candidate must be enclosed when submitting the dissertation.

1. Doctoral candidate

Name: Yanjun REN

2. This co-author declaration applies to the following article:

Unhealthy consumption behaviors and their intergenerational persistence: the role of education

The extent of the doctoral candidate's contribution to the article is assessed on the following scale:

A Has contributed to the work (0-33%)
B Has made a substantial contribution (34-66%)
C Did the majority of the work independently (67-100%)

3. Declaration on the individual phases of the scientific work (A,B,C)	Extent
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Execution: Involvement in the analysis or the concrete experiments/investigation	C
Manuscript preparation: Presentation, interpretation and discussion of the results obtained in article form	B

4. Signature of all co-authors

Date	Name	Signature
28.11.2016	[illegible]	[signature]
29.11.2016	Yanjie Zhang	[signature]
28.11.16	J.-P. Loy	[signature]

5. Signature of doctoral candidate

Date	Name	Signature
28.11.2016	Yanjun Ren	Yanjun Ren

C | A | U Christian-Albrechts-Universität zu Kiel | Agrar- und Ernährungswissenschaftliche Fakultät

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Name: Yanjun REN

2. This co-author declaration applies to the following article:

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Execution: Involvement in the analysis or the concrete experiments/investgation	C
Manuscript preparation: Presentation, interpretation and discussion of the results obtained in article form	B

4. Signature of all co-authors

Date	Name	Signature
28.11.2016	Castro Campos, Beate	
29.11.2016	Brosig, Stephan	S. Brosig
28.11.16	J. P.	

5. Signature of doctoral candidate

Date	Name	Signature
28.11.16	Yanjun Ren	Yanjun Ren

Yanjun REN

1. Personal Details

Contact: Department of Agricultural Economics, University of Kiel
Wilhelm-Seelig-Platz 6/7, 24118 Kiel, Germany

Tel.: +49 (0)431 880 4454, Email: yren@ae.uni-kiel.de

Place and Date of birth: **13 May 1986, Shaanxi, China**

Languages: Chinese (Native), English (Fluent), German (Fair)

2. Research Interests

Agricultural Economics, Health Economics, Applied Econometrics

3. Education

10/2012- Ph.D. candidate. University of Kiel, Germany.
Ph.D. Thesis: *Essays on Food Consumption, Income Inequality, and Health-related Issues in China*

9/2009-7/2012 MSc. Agricultural Economics and Management,
Northwest Agricultural and Forest University, China

9/2005-7/2009 Bachelor of Science in Physics,
Shaanxi University of Technology, China

4. Teaching Experience

Undergraduate level

Chinese for Agricultural Scientists (Kiel, summer semester 2015)

Principles of Microeconomics (Yangling, China, summer semester 2011).

5. Professional Association

Chinese Economic Association (CEA) Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues (GeWiSoLa)

6. Awards & Scholarships

2012-2016 CSC scholarship for PhD studies in Germany

2012 Best Student Award, Northwest Aagricultural and Forest University

2011 Best Student Award, Northwest Aagricultural and Forest University

2007 National Scholarship for Excellent Student Qualification