THE RELATIONSHIP BETWEEN INCOME AND FOOD INTAKE IN CHINA

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การศึกษานี้เป็นการวิเคราะห์ผลของการรับประทานอาหารต่อรายได้ โดยการรับประทานอาหารนับว่าเป็นรูปแบบหนึ่งของการลงทุนเพื่อการเพิ่มพูนสุขภาพ การศึกษานี้ใช้ข้อมูลในปี พ.ศ. 2554 จากชุดข้อมูล China Health and Nutrition Survey ที่รวมหน่วยข้อมูลทั้งสิ้น 42870 หน่วย โดยพิจารณาตัวแปรตามที่ใช้แทนรายได้ทั้งสิ้น 6 ตัวแปร หรือรายได้ 6 รูปแบบ และมีตัวแปรอธิบายที่สำคัญ ได้แก่ การบริโภคอาหารในรอบ 3 วัน (กรัม) ค่าเฉลี่ยของพลังงานที่ได้จากการบริโภคอาหารในรอบ 3 วัน (กิโลแคลอรี) ค่าเฉลี่ยของคาร์โบไฮเดรตที่ได้จากการบริโภคอาหารในรอบ 3 วัน (กรัม) ค่าเฉลี่ยของโปรตีนที่ได้จากการบริโภคอาหารในรอบ 3 วัน (กรัม) และค่าเฉลี่ยของไขมันที่ได้จากการบริโภคอาหารในรอบ 3 วัน (กรัม) ทั้งนี้ คุณลักษณะส่วนบุคคล ของครัวเรือน และของพื้นที่ที่กลุ่มตัวอย่างอาศัยอยู่นั้นปรากฏอยู่ในการวิเคราะห์ทางสถิติด้วย ระเบียบวิธีวิจัยใช้ แบบจำลองสมการถดถอยเชิงเส้นหลายตัวแปร ที่ประมาณค่าสัมประสิทธิ์ด้วยวิธีกำลังสองน้อยที่สุด และใช้การทดสอบ Box-Cox เพื่อชี้ให้เห็นว่ารูปแบบทางฟังก์ชันของตัวแปรตามที่เหมาะสมนั้น คือ รูปแบบ Log ไม่ใช่รูปแบบเชิงเส้น

ผลการศึกษา พบว่า การบริโภคอาหารในฐานะของการลงทุนเพื่อสุขภาพที่ดีนั้น มีผลที่มีนัยสำคัญทางสถิติต่อรายได้ โดยค่าเฉลี่ยของการได้รับโปรตีนจากการบริโภคอาหารในรอบ 3 วันมีผลที่หนักแน่นที่สุด โดยมีผลเป็นบวกและมีนัยสำคัญทางสถิติสำหรับทุกรูปแบบของรายได้ที่ได้ทำการศึกษา ผลการศึกษานี้สอดคล้องกันกับทฤษฎีทุนมนุษย์ที่ มองว่าสุขภาพที่ดีสามารถเพิ่มรายได้ได้ ทั้งนี้ การศึกษายังพบว่า รายได้มีความสัมพันธ์ในเชิงบวกอย่างมีนัยสำคัญทางสถิติกับระดับการศึกษา และการมีอาชีพที่เป็นวิชาชีพของกลุ่มตัวอย่างด้วย

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This study investigated the effect of food intake, which is considered a form of health investment, on income in China, accounting also for socioeconomic factors. It used the 2011 wave of the China Health and Nutrition survey, including 42,870 observations in the analysis. Six dependent variables, each representing a different measure of income, were explored. The main explanatory variables included a 3-day total food consumption (grams), a 3-day average intake of energy (kilocalories), a 3-day average intake of carbohydrate (grams), a 3-day average intake of protein (grams) and a 3-day average intake of fat (grams). Personal, household, and area characteristics were also controlled for. Multivariate linear regression ordinary least squares models were used and the Box-Cox tests showed that the more appropriate functional form for the dependent variables were the log as opposed to the linear form.

Results showed that food intake, taken as an investment for health, had a statistically significant impact on income. In particular, the 3-day average protein intake seemed to have the strongest effect; it was persistently positive and statistically significant across all measures of income. This was consistent with an extended version of the human capital theory, where good health improves income. A positive and statistically significant relationship was also found between income and the following variables: education and professional types of occupation.

Field of Study: Health Economics and Health Care Management Student's Signature .....
Advisor's Signature .....

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ABBREVIATIONS

IBRD	International Bank for Reconstruction and Development
CHNS	China Health and Nutrition Survey
MDG	Millennium Development Goals
NBSC	National Bureau of Statistics of China
BMI	Body Mass Index
GSOEP	German Social and Economic Experts Group
GDP	Gross Domestic Product
WHO	World Health Organization
CCDC	Chinese Center for Disease Control and Prevention
CPI	Consumer Price Index

CHAPTER 1

INTRODUCTION

1.1 Problems and Significance

At the present, China is the most populous country in the world. As of 2011, the total population of China reached 1.344 billion people (The World Bank, 2011). Through the World Bank's data, we can also find that China's economy has grown rapidly. As of 2011, GDP reached 7.573 trillion USD from 1.211 trillion USD in 2000. Although China's economy has been developing rapidly in recent years, but it faces economic problems due to its huge population.

In recent years, China's economy has made great progress. But according to the World Bank's 2008 daily income of 1.25 US dollars. The impoverished population in China is as high as 254 million. At present, inequality still exists in China. There is a big difference between cities with fast economic development and cities with slow economic development. The gap between the rich and the poor is very serious in China.

Also, food intake of the population in some impoverished areas in China remains an important issue. In particularly, in some mountainous areas where the natural environment is harsh, it is difficult for people to obtain income, which means that adequate food intake is not guaranteed. Moreover, food consumption of the Chinese population has not yet entered a stable period. The dependence of food consumption expenditure on income is still large (Catherine, 1997).

Through some existing studies, we have found that food intake has a great influence on people's labor productivity and wages. Liu, Dow, Fu, Akin, & Lance (2008) estimated the impact of health (as a form of human capital) in the production of income. Estimates were made using the China Health and Nutrition Survey (CHNS) sample. The study found that household income was strongly influenced by health of family members, especially in rural areas. Because food intake is an important basis for ensuring health, based on the above study, we can find the importance of food

intake on income. These findings may have important implications for health and economic policy development.

Food consumption also depends on income. G. Li & Li (2000) found that the level of income determines the level of spending on food consumption. Because income of urban residents and rural residents is different, their food consumption expenditure also has obvious difference. In general, as income increases, the level of food expenditure consumption will increase accordingly. O. Zhang (2011) studied nutritional levels of 18-59 years old Chinese rural residents and found an effect of economic factors on the nutrition level of Chinese rural residents. The study showed that income level is an important economic variable that determines food consumption. The higher the income level, the higher the choice of food and the greater the ability to obtain food, the greater the likelihood that the nutrient intake structure will reach a reasonable level. Similarly, Jiang (2014) found a positive relationship between annual household income and nutrition intake and a positive relationship between household income and health.

The relationship between income and food intake is different between rural residents and urban residents. For rural residents, income will not only affect their food intake and nutrition level, but also food intake will affect the income. Especially in the agricultural industries, food intake and nutritional status of farmers play an important role in their labor productivity. Haddad and Bouis (1991) studied the relationship between nutritional status and agricultural productivity, it found that to be statistically significant.

This study wants to assess the association between income and household food consumption expenditures. The topic here is consistent with the Millennium Development Goals (MDG), where one of the goals to be reached in 2005 is to reduce the number of people living in poverty and hunger. But poverty and hunger are closely related to the lack of income; people may not have enough money to feed themselves, resulting in hunger, and food consumption is an important determinant of income.

This research can be used to provide advice for the government to implement relevant intervention programs to help poor people address their hunger problems, as food intake affects labor productivity. Adequate food intake is the most basic requirement for human development. It is also one of the most important factors affecting economic development. Nutritional status is one of the major material foundations and drivers of social development. It is an important factor that affects socio-economic development, adequate and appropriate food intake give people good nutritional status and energy so that people can get higher income.

1.2 General Information of China

China is located in eastern Asia with a land area of 9,600,000 km² and a population of 1.37 billion people (The World Bank, 2017). It is the most populous country in the world. There are over twenty-two provinces, five autonomous regions, four direct controlled municipalities (Beijing, Shanghai, Tianjin and Chongqing) and two mostly self-governing special administrative regions (Hong Kong and Macau).

Although the Chinese economy has been developing rapidly in recent years, it is still a developing country. The survey year of 2011 was also the year that saw a very fast rate in Chinese economic development. The Chinese Statistical Yearbook shows that the primary industry (agriculture) made up 10% in 2011. The secondary industry (industry) made up the largest proportion in terms of economic importance, at 46.6% in 2011. The proportion of the tertiary industry (services) reached 43.4%. Since the founding of the People's Republic of China, the industrial structures have been greatly changed. The proportion of the agricultural industry has declined. The proportions of the manufacturing and service industries have risen, judging from the change in the value added. The growth of the national economy has been driven by the manufacturing and service industries. At the beginning of the founding of the People's Republic of China, China was an agricultural country. Since the reform and economic liberalization, China's industrial structure has gradually become more substantial.

In 2011, following the China Central Poverty Alleviation and Development Work Conference, the poverty line was set at about 2,300 yuan per year. Now China's poverty

line is based on the constant price of 2,300 yuan. The poverty line standard set in 2011 for rural residents (per capita net income) was 2,300 yuan - 80% higher than the poverty standard of 1,274 yuan in 2010. According to the poverty standards raised in 2011 (per capita net income of rural households was 2,300 yuan/year), China had 82 million Poor people. This accounted for 13% of the total rural population and accounted for nearly one-tenth of the country's total population.

1.3 Food Intake in China

Food consumption takes up a large part of household income in China. Before the economic reform, the rate of China's economic development was relatively low. Many people were faced with malnutrition because of insufficient food intake. Nowadays, China's economy is developing rapidly. The continuous increase in the people's income has greatly improved their food intake. Table 1 shows per capita annual income and Engel's coefficient of urban and rural households from 1978-2011. The Engel's coefficient is the ratio of total food expenditure to total personal consumption expenditure. (http://www.docin.com, website) In 1978, income of rural residents and urban resident income was limited. Per capita income of rural residents was only 133.6 yuan. In 2005, it reached 3254.9 yuan, and it was 24.36 times that of in 1978. In 2011, it reached 6977.3 yuan. It can be seen that, from 1978 to 2011, the per capita income level of Chinese residents has changed dramatically.

As income rises, the proportion of food spending as a share of total income goes down. The Engel's coefficient has been declining. In 1978, the Engel's coefficients of urban and rural residents were 57.5% and 67.7% respectively. But in 2011, the Engel's coefficient in urban and rural area had fallen to 36.3% and 40.4%, respectively. In conclusion, the level of per capita income of Chinese residents has changed greatly. As residents' income levels rise, their food intake also increases. According to Engel's law, the decreasing Engel's coefficient indicates that the economic level of the Chinese population is improving.

Table 1: Per Capita Annual Income and Engel's Coefficient of Urban and Rural Households

Year	Per Capita Annual Disposable Income of Urban Households		Per Capita Annual Net Income of Rural Households		Engel's Coefficient of Urban Households	Engel's Coefficient of Rural Households
	Value (yuan)	Index	Value (yuan)	Index	(%)	(%)
1978	343.4	100.0	133.6	100.0	57.5	67.7
1980	477.6	127.0	191.3	139.0	56.9	61.8
1985	739.1	160.4	397.6	268.9	53.3	57.8
1990	1510.2	198.1	686.3	311.2	54.2	58.8
1991	1700.6	212.4	708.6	317.4	53.8	57.6
1992	2026.6	232.9	784.0	336.2	53.0	57.6
1993	2577.4	255.1	921.6	346.9	50.3	58.1
1994	3496.2	276.8	1221.0	364.3	50.0	58.9
1995	4283.0	290.3	1577.7	383.6	50.1	58.6
1996	4838.9	301.6	1926.1	418.1	48.8	56.3
1997	5160.3	311.9	2090.1	437.3	46.6	55.1
1998	5425.1	329.9	2162.0	456.1	44.7	53.4
1999	5854.0	360.6	2210.3	473.5	42.1	52.6
2000	6280.0	383.7	2253.4	483.4	39.4	49.1
2001	6859.6	416.3	2366.4	503.7	38.2	47.7
2002	7702.8	472.1	2475.6	527.9	37.7	46.2
2003	8472.2	514.6	2622.2	550.6	37.1	45.6

2004	9421.6	554.2	2936.4	588.0	37.7	47.2
2005	10493.0	607.4	3254.9	624.5	36.7	45.5
2006	11759.5	670.7	3587.0	670.7	35.8	43.0
2007	13785.8	752.5	4140.4	734.4	36.3	43.1
2008	15780.8	815.7	4760.6	793.2	37.9	43.7
2009	17174.7	895.4	5153.2	860.6	36.5	41.0
2010	19109.4	965.2	5919.0	954.4	35.7	41.1
2011	21809.8	1046.3	6977.3	1063.2	36.3	40.4

Source: National Bureau of Statistics of China (NBSC) Website, 2012.

Table 2 shows the composition of household consumption from 2008-2011. Among both urban and rural households, food consumption expenditure is the largest among all consumption items. Food consumption refers to all kinds of food consumed in a country or a region. For rural households, total household consumption rose significantly from 2008 to 2011. Food consumption rose from 11,342.7 yuan to 13,989.2 yuan. For urban households, from 2008 to 2011, the overall level of consumption rose. Food consumption also rose sharply, from 26,205.4 yuan to 37,458.5 yuan. The table suggests that food consumption plays an important role in household consumption.

Table 2: Household Consumption (in 100 million yuan)

Item	2008	2009	2010	2011
Total	**111670.4**	**123584.6**	**140758.6**	**164945.2**
Rural Households	**27677.3**	**29005.3**	**31974.6**	**37394.6**
Food	11342.7	11397.8	12249.1	13989.2
Clothing	1502.7	1619.8	1796.1	2265.7
Residence	5005.5	4850.9	5042.2	5792.3
Household Facilities, Articles and Services	1277.9	1589.8	1980.2	2504.4
Health Care and Personal Articles	2478.9	3030.7	3643.9	4609.9
Transportation and Communications	2609.2	2806.9	3136.6	3631.2
Financial Service	505.4	474.9	751.7	879.1
Insurance Service	179.3	275.7	240.6	281.4
Others	544.2	585.9	639.6	809.9
Urban Households	**83993.1**	**94579.3**	**108784.0**	**127550.6**
Food	26205.4	28419.4	31588.6	37458.5
Clothing	7172.4	8149.2	9495.8	11392.7
Residence	14187.0	15888.6	19168.1	21596.2
Household Facilities, Articles and Services	4255.8	4993.5	6119.7	7135.0

Health Care and Personal Articles	7418.4	8773.8	10049.5	12590.7
Transportation and Communications	8717.7	10677.4	13041.8	14624.1
Financial Service	2132.9	1995.8	3172.4	3686.1
Insurance Service	1536.2	1589.8	2165.4	2516.0
Others	4011.3	4745.9	3281.7	3954.5

Source: National Bureau of Statistics of China (NBSC) website, 2011.

Table 3 shows household consumption expenditures by region in 2011. The level of economic development in different regions is different. Different income levels of urban and rural residents determine different levels of consumption. Generally speaking, with increases in income, the level of consumption and food consumption of both urban and rural residents will increase correspondingly. For areas with a developed coastal economy, their consumption level in urban areas and rural areas is higher than that of inland regions with a relatively backward economy. In Beijing, Tianjin, Shanghai, Zhejiang and Guangdong provinces, where the economy is growing faster, household consumption levels are much higher than elsewhere. Due to different income levels of urban and rural areas and due to income level differences and living standards in different provinces, levels of household consumption differ across regions. Table 3 shows that the level of economic development has a great influence on consumption level.

Table 3: Household Consumption Expenditure by Region (2011)

Region	Level (yuan)			Urban/Rural Consumption Ration (Rural Household=1)
	All Households	Rural Household	Urban Household	
Beijing	27760.0	13659.2	30037.0	2.2
Tianjin	20624.3	9658.4	23359.7	2.4
Hebei	9550.5	4892.7	15330.7	3.1
Shanxi	9745.6	5626.7	14055.0	2.5
Inner Mongolia	13264.2	5945.3	18996.3	3.2
Liaoning	15635.4	7221.4	20560.5	2.8
Jilin	10810.8	6238.8	14803.8	2.4
Heilongjiang	10633.7	5898.5	14346.7	2.4
Shanghai	35438.9	17757.5	37557.5	2.1
Jiangsu	17166.5	10164.2	21597.7	2.1
Zhejiang	21346.3	12371.1	26856.4	2.2
Anhui	10054.7	5356.2	14923.3	2.8
Fujian	14958.3	8436.4	19761.6	2.3
Jiangxi	9522.5	5852.9	14028.9	2.4
Shandong	13565.4	7062.9	19983.5	2.8
Henan	9171.4	4928.9	15615.5	3.2
Hubei	10872.8	5652.6	15935.5	2.8
Hunan	10546.9	5606.8	16783.0	3.0
Guangdong	19578.1	7853.8	25526.8	3.3
Guangxi	9180.6	4670.8	15681.4	3.4
Hainan	9237.7	5203.6	13271.9	2.6
Chongqing	11831.7	4614.9	17972.6	3.9

Sichuan	9902.6	5881.6	15687.5	2.7
Guizhou	7388.5	3986.4	13876.7	3.5
Yunnan	8278.1	4824.6	14463.6	3.0
Tibet	4730.2	2774.7	11393.3	4.1
Shanxi	10053.5	4697.4	16213.4	3.5
Gansu	7492.6	3976.7	13573.8	3.4
Qinghai	8744.3	4904.7	13348.2	2.7
Ningxia	10491.9	4709.2	17038.0	3.6
Xinjiang	8895.0	4495.4	14662.9	3.3

Source: National Bureau of Statistics of China (NBSC) website, 2011.

1.4 Research Question

What is the relationship between income and food intake in China?

1.5 Objectives

General objective

To investigate the relationship between income and food intake in China.

Specific objectives

a. To quantify the impact of food consumption on income.

b. To investigate the effects of socioeconomic and demographic factors on income.

1.6 Scope

This research is based on the theory of human capital, which is expanded to focus on the relationship between food intake and income. In particular, this study investigates the impact of food consumption on income. In addition to food intake, socioeconomic and demographic factors such as age, education and occupation are used to examine differences in income across households. This study uses the 2011 China Health and Nutrition Survey (CHNS), supplemented by data from the National

Bureau of Statistics of China (NBSC), to investigate the relationship between income and food intake in China. The dataset covers 9 provinces from north to south in China. The survey covers about 5,839 households and 42,870 individuals in all years combined.

This research focuses on the quantification of the relationship between food intake and income in China. It provides a simple descriptive analysis of Chinese households' characteristics, household food consumption, occupation and other socioeconomic factors. More importantly, it analyzes the relationship between income and food consumption as well as other factors through multiple linear regressions. Conclusions and corresponding policy recommendations are put forward.

1.7 Hypothesis

The main hypothesis is that food consumption, as a form of investment in health, leads to higher income, all else being equal.

1.8 Possible Benefits

If income is significantly affected by food intake in China, the government should implement some interventions to help poor people to improve their food intake. In recent years, housing, medical care, education and other expenses have increased rapidly as a proportion of household expenditures. As a result, low-income groups cannot be guaranteed food consumption. The government should implement sustainable food aid policies, which will in turn raise the income of poor people and increase their food intake.

If food intake has a positive effect on income, the government should give people knowledge of dietary nutrition and food intake. The government should use various means to strengthen education such that reasonable food intake and dietary nutrition structure can be achieved. At the same time, special policies may be implemented for impoverished areas, e.g. food aid and nutritional subsidy programs, in order to safeguard the most basic food intake and nutritional needs, which would then increase income levels.

CHAPTER 2
LITERATURE REVIEW

This section reviews relevant studies on food intake and income based on China and other countries. It shows that health impacts income, and food intake, as a form of health investment, also impacts income.

2.1 Impact of health of income

Several studies identify the impact of health (as an outcome) on income levels. Case, Fertig and Paxson (2005) used birth queue data from birth to middle age to quantify long-term effects of child health and economic conditions on adult health, employment, and socio-economic conditions (e.g. income, education and social class). This study used all children born in Great Britain (Scotland, England and Wales) in the week of March 3, 1958 from birth through to age 42. The study found that children with poor health are predicted to have a lower level of income and social status as they become adults. Members of the cohort born to poorer families also experience poor child health, lower human capital investment and lower health status, making their incomes lower as they grow older. In general, the results of this study show that health has an important impact on economic conditions.

L. Zhang (2012) studied the impact of healthy human capital on residents' income from an important aspect of human capital - health. This article used the China Health and Nutrition Survey (CHNS) data from 2004 to 2009 on the basis of Mincer income function. Nutrition and smoking variables were selected as indicators of the health of workers. The results of ungrouped population models showed that individual health was an important factor in determining the income of workers. In the case of controlling other variables, workers with reasonable nutrient intake have highest income.

L. Zhang and Li (2003) used data from poor rural areas in China to study the effects of nutrition and health on labor productivity or income. The results indicated that nutrition and health status played an important role in rural labor productivity.

The most significant predictor was the influence of nutrient intake and presence of disease on labor productivity. As the average number of calorie possession increased by 1%, the farmer's income would increase by 0.57%. The results suggested that if farmers were to be freed from poverty, an investment in nutrition and health had a crucial role.

Wei (2004) used data from the 1993 China Health and Nutrition Survey to investigate the impact of health in rural China on non-agricultural employment and wage decisions. It was discovered that there was a significant relationship between health and income in rural China, as well as labor participation and non-agricultural employment opportunities. Health status had a significant impact on non-agricultural employment and wages.

Through existing studies, we can find that health status has a significant effect on labor productivity or wages.

2.2 Food intake as a form of health investment: Impact of food intake on health

Health is considered a complex concept. As it cannot be obtained directly by observation in many empirical analyses, health status measurement requires a series of indicators. In the literature, indicators for health include, for example, nutritional intake, calorie intake, and physical characteristics (such as height, weight and body mass index (BMI)). There are also other measures, e.g. subjective health and functional health. Nevertheless, food intake is an important process that impacts health and can be considered as an investment in health. This section shows that food intake and health are closely and non-linearly linked, positive for low food intake, but negative for excessive food intake.

Guo, Popkin and Zhai (2000) examined food supply in 8 provinces in China in 1989, 1991 and 1993. They found that changes in food consumption, population structure and health care services have changed the population structure, health care services, as well as the population's health conditions. The results show that, with economic development, people's dietary structure changed. Cereal food intake decreased and meat foods increased, especially in cities. However, food intake in the

suburbs, counties and rural areas were still far apart, reflecting the huge imbalance. In particular, intake of fat was on the rise with the increase of economic income. The results suggest that food intake has a significant impact on health of individuals.

Ali, Muis and Suhartono (2016) analyzed the correlation between food intake and health status and nutritional status in 9- to 11-year-old children in Semarang. Using the descriptive analysis and Spearman correlation methods, the results showed that, food intake was normal in 9-11 years old children in Semarang, and that their health was satisfactory. The results also showed that there is a positive correlation between food intake and health, with children's food intake being related to all nutritional conditions.

Ridoutt et al. (2016) used data from the National Nutrition Survey of Australia in 1995 and 2011. The data involved more than 12,000 people and more than 4,500 different types of food. It was found that there were several positive changes among Australians, who were found to eat more whole fruits, more kinds of vegetables and more beans. They also increased their intake of whole grains, nut and seed intake. The results of the study found that there is a clear relationship between different food intake structures and health status.

Cerda and Estrada (2014) focused on whether food intake was a major cause of under-nutrition in children in Yucatan, Mexico. This article used data from the Federal Poverty Alleviation Program in Yucatan, Mexico, and the database of 111 children from 1 to 4 years old, named Oportunidades. The results showed that there is a significant correlation between height and weight of children and total food intake. For children with inadequate food intake, lower height and lighter weight are common.

Vozoris and Tarasuk (2003) examined food insecurity prevalence in Canadian families. Investigating the relationship between food insufficiency and physical, psychological and social health, through the analysis of the 1996-1997 national population health survey data, the authors found that 4% of Canadians, 1.1 million people, were found living in food-poor families. The study found that individuals with poor food intake had poor personal health, higher likelihood of having severe depression and were more likely to report heart disease, diabetes, high blood pressure and food allergies.

The impact of food intake was found to be non-linear. Lack of calories and excessive intake can negatively affect health status. Tang (2005) investigated the nutritional status of Guangxi residents and the distribution of chronic non-communicable diseases associated with them. A multi-stage cluster random sampling method was adopted and residents' dietary surveys, questionnaire surveys, medical examinations and laboratory tests were conducted. The 2002 results were compared with 1992. The medical examination and laboratory tests showed that the malnutrition rate of Guangxi residents was 12.9%. Anemia rate was 16.8%. The prevalence of obesity was 9.1% and the overweight rate was 4.4%. The results showed that nutrient intake has a crucial effect on health status.

2.3 Impact of food intake on income

Food intake is a significant determinant for income. It represents a form of health investment, impacting health, which then impacts income. Through existing research, it is found that food intake has a very important impact on people's income, especially among rural households in the agricultural sector. Farmers need energy to engage in agricultural production. The body's energy is mainly derived from food intake; workers with high food intake and healthy nutritional status have high labor productivity.

Bouis (1994) examined the effect of food intake on income in poor countries. The results indicated that food intake affects people’s labor productivity, especially in the agricultural sector. People with high food intake have high calories and there is more energy to work, so they can get higher income.

Yin and Yin (2009) examined the relationship between food intake and peasant income using data from the China Health and Nutrition Survey. To overcome the bias caused by the endogenous food intake, this paper uses the fixed effect model and dynamic panel data model. The results show that there is a significant positive relationship between calorie intake and farmers' income. Calorie intake has a greater impact on male income than female income. This research also finds that protein intake has a significant positive impact on farmers' income. Carbohydrate and fat intake have no significant effects on farmers' income. Therefore, the improvement of the

nutritional structure can significantly promote the increase of farmers' income. The results not only confirm the validity of the nutrition-based efficiency income model. At the same time, it also shows that the accumulation of healthy human capital has made important contributions to the growth of Chinese farmers' income.

Croppenstedt and Muller (2013) examined the health and nutritional status of Ethiopian farmers on their productivity and efficiency. A survey of farmers' food intake and nutritional status was found. The food intake and nutritional status of farmers have an important effect on their labor productivity. Farmers with more food intake generally have higher labor productivity and efficiency.

Thomas and Strauss (1997) examined the relationship between health status and wages. The subjects studied were men and women in Brazilian cities. The results of the study show that the impact of health status on wages is very important. Health status is represented by independent variables such as height, food intake and protein. The dependent variable is wages.

Strauss (1986) used Sierra Leone's family-level data to test whether higher calorie intake can increase labor productivity on family farms. The study found that for a rural family, the increase in caloric levels can indeed affect the family's labor productivity. And calorie intake and labor productivity are positively correlated.

Haddad and Bouis (1991) investigated the impact of the individual nutritional status on agriculture income rates in a southern Philippines province. The result showed a positive relationship between nutritional statues and labor productivity.

2.4 Impact of income on health and food intake: bidirectional relationships

While health and food intake affect income, the literature shows that income also affects health and food intake, implying that the relationships are bidirectional.

Ettner (1996) used national household survey data from 1987 to 1988 in America, labor participation surveys and national health interviews data to estimate the structural impact of income on the following health conditions: self-assessed health status, work and functional limitations, bed time, average daily alcohol consumption, depressive

symptoms and alcohol behavior scale. Ordinary and IV estimates show that increased income can significantly improve mental and physical health.

Fritzell, Nermo and Lundberg (2004) examined the relationship between adult income and health, using data from the survey of Swedish living conditions from 1996 to 1997, including individuals 25-64 years old. Using logistic regressions, including polynomial terms for various income variables, the results show that income and disposable household income are closely related to health. This finding applies to both men and women. There are also clear links between income and health when controlling other structural variables.

HM, A, C, PS and RC (2007) used data from Canada and the United States and found that there is a positive correlation between household income and child health. Family income is a major determinant of child health. This study provided some evidence that nutritional and family lifestyle choices play an important role in determining child health.

Frijters, Haisken-DeNew and Shields (2005) investigated whether there is a causal relationship between income changes and the health satisfaction of East Germans and West Germans. The data source for this study was the German Social and Economic Experts Group (GSOEP) from 1984 to 2002. Using fixed effect models, the results of the study showed that income changes have an important positive effect on health satisfaction.

A similarly large body of studies also considers the impact of income on food intake, consistent with the demand theory. Panikar (1979) investigated employment, income and food intake among selected agricultural labor households. This article focused on the relationship between employment rates, income and food intake in farming families. Using employment rate indicators and household food expenditure indicators, the study compared food expenditures of households with different income and employment rates. The results show that households with lower incomes and employment rates have lower food expenses. For agricultural households with high employment rates and income, the family's food expenditure is higher. This study showed that income and food intake have a bidirectional relationship.

Du, Mroz, Zhai and Popkin (2004) study the impact of income change specifically rapid income growth on diet behavior over time and by socioeconomic level. They used data from a prospective study of China in 1989, 1991, 1993 and 1997. The sample included 5783 subjects aged 20–45 years old from 3129 households. Detailed income and price data were collected and predicted household per capita income was used in multivariate longitudinal random effects models that described the consumption of several food groups and nutrients.

Sausenthaler et al. (2006) analyzed the association between socio-economic indicators and diet among 2-year-old children. Assessing the contribution of parental education and income to children's food intake, the analysis was based on data from a prospective birth cohort study. Information on diet was obtained using a semi-quantitative food frequency questionnaire. Subjects were 2637 children at the age of 2 years, whose parents completed questionnaires gathering information on lifestyle factors, including parental socioeconomic status, household consumption frequencies and children's diet. Using logistic regression, the authors found that both low parental education and low equivalent income were associated with a low intake of fresh fruit, cooked vegetables and olive oil, and a high intake of canned vegetables or fruit, margarine, mayonnaise and processed salad dressing in children. Children with a low intake of milk and cream, and a high intake of hardened vegetable fat, were more likely to have parents with lower education. Low butter intake was associated with low equivalent income only. The key findings of this study highlight that the impact of socio-economic determinants on food intake exists even among very young children. Not all foods seem to be influenced by both parental education and income level. Thus, it would be profitable to further investigate the association between more foods consumed by children and socio-economic factors.

Shariff et al. (2015) consider the relationship between household income and dietary intakes of 1-10 years old urban Malaysians. Diet plays an important role in the growth and development of children. However, dietary intakes of children living in either rural or urban areas can be influenced by household income. This study examined energy, nutrient and food intakes of 749 urban children (1-10 years old). Children's dietary intakes were obtained using food recall and record for two days.

Diet adequacy was assessed based on recommended intakes of energy and nutrients and food group servings. A general linear model (One-Way Analysis of Covariance) was used to test differences in energy, nutrient and food intakes according to income levels within each age group, adjusting for sex, ethnicity and body mass index. Data are presented as mean, standard error of the mean and percentages. Significant differences between income groups were determined using Bonferroni post-hoc test. Statistical significance was set at $P < 0.05$. The authors found that low socioeconomic status, as indicated by low household income could limit access to adequate diet, particularly for older children.

Qian (2011) studied factors that affected people's main food consumption needs in rural areas in China. Using a multiple linear regression model and a Binary Logit regression model to measure the effect of variables such as income on nutrient intake, the results showed that: (1) with the development of a regional economy and the increase of rural residents' income level, food consumption levels continued to increase; (2) there were significant regional differences in the nutritional intake of rural residents in China; (3) it was found that the higher the income level, the higher the nutritional intake of residents.

Chang (2000) used data on per capita disposable income, consumption expenditure and food consumption expenditures of people in urban and rural areas in China from 1990 to 1998. Based on a linear regression, the study showed that there is a strong positive correlation between income levels, consumer expenditure levels and food consumption expenditures at the current stage in China. The correlation coefficient is around 0.99. The effect of income level on food consumption expenditure is significant. The coefficient of determination is above 0.97. It can be seen that the level of income has a great influence on food consumption expenditure.

SAHN (1988) focused on the impact of changes in income and prices in Sri Lanka on residents' food energy intake. He used consumption and expenditure data from 1980 to 1981. By comparing food consumption expenditures of each household before and after price and income changes, the impact of price and income changes on food energy intake was calculated. It was found that the government's implementation of food price policy had a great influence on food consumption expenditure of each

household. There was also a positive correlation between income and household food energy intake.

Liang, Liu, Du and Qiu (2014) used data from the 1991-2009 China Health and Nutrition Survey (CHNS). The relationship between per capita household annual income and nutritional intake as well as health was studied. Rural residents and urban residents were compared. This research used a linear regression model, gathering data from CHNS, the Food and Agriculture Organization of the United Nations and the World Bank. The relationship between per capita GNI and nutrient intake in high-income and low-income countries in 1992 and 2007 was studied and compared with China. This research drew the following conclusions. First, for rural and urban residents, the per capita household income had a significant positive impact on nutrient intake. Second, compared with 1992, high-income countries and low-income countries had corresponding increases in per capita gross national income and nutritional intake. Compared with high-income countries, the nutritional level of Chinese residents had a certain gap.

Y. Li (2012) used the China Nutrition and Health Survey (CHNS) data to analyze the impact of income risk on rural residents' food consumption and nutritional intake. The two-stage Generalized Method of Moments (GMM) estimation results showed that higher income risk had a significant negative effect on the average daily calorie intake of residents. This was mainly because the increased income risk led to reduced intake of protein and fat by residents. The research showed that in the absence of social security and lower income levels, rural residents could not effectively avoid the impact of income risk on basic living consumption.

In summary, so far, the literature has suggested that that income has an important impact on food intake and food intake has also a very important impact on people's income. This is true especially in the agricultural sector. Farmers need energy to engage in agricultural production to earn wages, and the body's energy is mainly derived from food intake.

2.5 Literature Gap

Based on a large number of existing literatures, it can be seen that relatively few studies examine the impact of food intake on income. Most studies examine the effect of income on food intake or nutritional status and health status. This study contributes to the literature by investigating the impact of food intake on income in China. A summary of similar studies in the literature is provided in the table below.

Table 4: Summary of Existing Studies

Details	Haddad et al.(1991)	Fahima Aziz (1995)	Anil B. Deolalikar (2008)	David E.Sahn (1988)	Strauss et al. (1986)	Wang Yin et al.(2009)	Zhang et al. (2003)
Y (Dependent Variable)	wage	wage	income	wage	productivity	income	wage
X (Explanatory Variable) Food intake	√	√	√	√	√	√	√
Age	√	√	√	√	√	√	√
Gender	√	√	√	√	√	√	√
Education	√	√	×	√	√	√	√
Occupation	√	√	√	×	×	×	×

Experience	√	×	×	√	×	×	×
Family size	√	√	×	√	√	×	√
Model	OLS	2SLS	OLS	OLS	2SLS	2SLS	OLS
Data	Philippines (1987)	India (1976-1977)	South India (1980)	Sri Lanka (1980)	Sierra Leone (1980)	China (1989-2006)	China (2000)

CHAPTER 3

CONCEPTUAL FRAMEWORK

Figure 1: Conceptual Framework

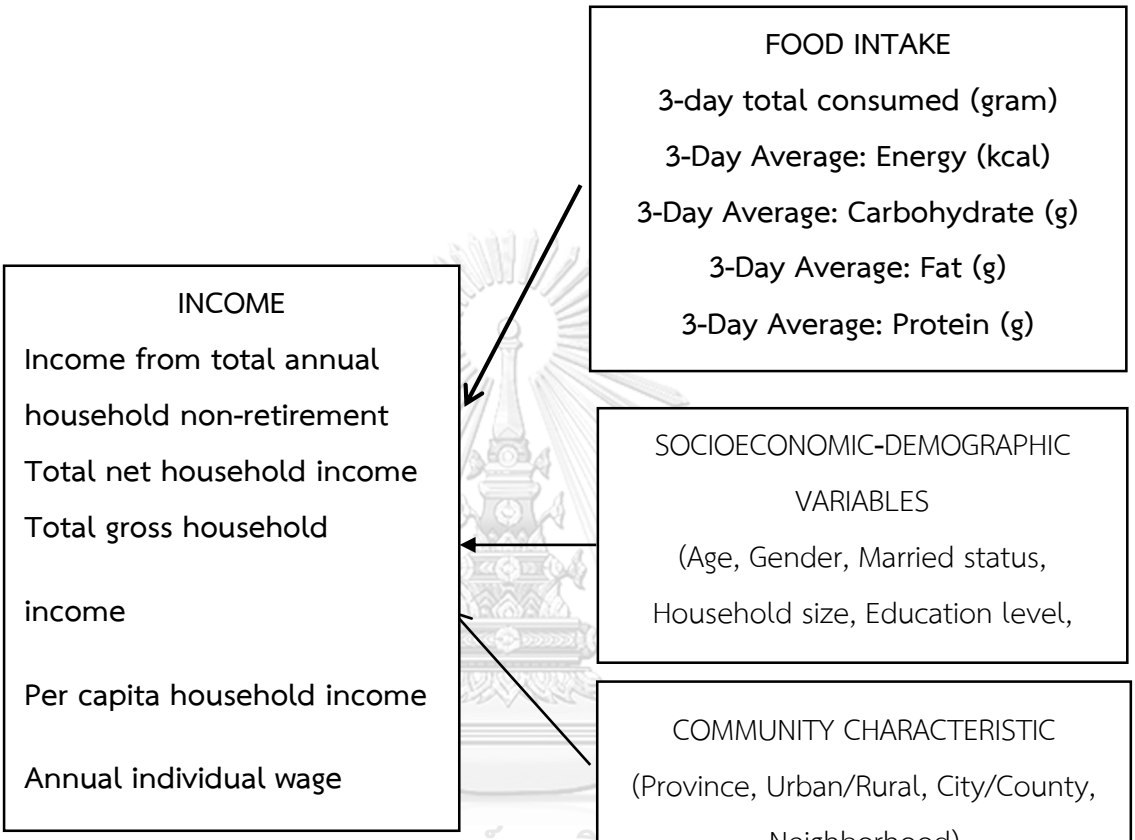


Figure 1 shows the conceptual framework of this study. The variables in Figure 1 above are expected to have an impact on income, based on the above literature review. Food intake categories are expected to be positively related to income because more food intake can give people more energy to work and get more income. The energy, carbohydrate, fat and protein intakes are very important for people's health and it is expected that there will be a positive correlation between food intake and income levels. There are six main dependent variables in this study. It includes different types of income, such as income from total annual household non-

retirement, total net household income, total gross household income, per capita household income, annual individual wage and total net individual income.

Although the dataset contains a lot of other measures of income e.g., farming household income, fishing household income, small business household income and so on, this study only considers the afore-mentioned six measures for two reasons. First, the chosen income measures are general measures of income, not specific to any occupation or profession, and therefore can be considered as a more general approximation of productivity. Second, the chosen income measures contain more observations and therefore allow for a more robust statistical analysis, compared to other types of income that are not included in the analysis and contain only a limited number of observations (in some cases, less than 500).

Socioeconomic-demographic factors, such as age and gender are expected to affect income. The effect of age on income is difficult to predict -- it could be positive or negative. If a person's age increases, his education, experience and ability may also increase and his income can be increased. However, for some farmers, when they grow older, their energy and health status become worse, perhaps leading to a decrease in their income. The relationship between gender and income is also difficult to predict. It could be positive or negative, but generally speaking, males' income is higher than females. According to the human capital theory, education is expected to be positively related to income because higher education can improve people's ability and they can get higher income. The choice of occupations will also affect income, as income of different occupations will be differently set; for example, professional workers tend to receive more income than manual workers.

This research covers nine different Chinese provinces. The economic development level of each province is different and can impact income at the individual level. When people live in a higher GDP province, they should, in general, be able to receive higher income, even when doing the same job. Therefore, it is expected that GDP per capita of province and individual income will have a positive correlation. People living in urban areas are expected to have higher income because the people living in urban areas have occupations and economic environment that are more rewarding to labor than rural areas.

CHAPTER 4
METHODOLOGY

4.1. Variables

This section provides definitions of the variables in the statistical analyses.

4.1.1 Dependent Variables

Two groups of outcomes are considered in this research: household and individual income, and they are represented/ operationalized as six dependent variables. Details are shown in Table 5 below. It includes four different types of household income and two types of individual income. This study investigates how food intake affects different types of household income, individual wage and individual income.

Table 5: Details of Dependent Variables

Dependent Variables	Description
Non-retirement household income	Annual household income from non-retirement sources in 2011.
Net household income	Annual net household income in 2011. This is equal to annual gross household income from all sources combined minus any outstanding household debts.
Gross household income	Annual gross household income in 2011. This is the annual household income from all sources combined before debts.

Per capita household income	Annual per capita household income in 2011. This is the net household income divided by the number of household members.
Annual individual wage	Annual individual wage in 2011. This measure combines wages from all sources combined.
Net individual income	Annual net individual income in 2011. This variable represents the individual's income minus all outstanding expenses.

The dependent variables are all continuous measures and they are converted into log values. There are certain benefits to logging the dependent variables. It can make the skewed distribution (non-normality) of the dependent variables less skewed and tend to normal distribution, which then helps to satisfy the normality assumption of inferential statistics. (https://www.zhihu.com, website) In fact, it should be noted that Box-Cox tests were performed to identify the more appropriate functional form for the dependent variable: whether it is "log income" or "income". It was found that "log income" was more appropriate than "income".

4.1.2 Independent Variables

Table 6 shows details of independent variables used in this study. It shows the expected signs of the independent variables and provides supporting reasons. The occupation includes professional occupation, office staff, farmer, skilled worker, soldiers and police and other occupations. In this study, other occupations are omitted category. Education level includes primary school, middle school and bachelor's degree or above. In this study, primary school is omitted category.

Table 6: Details of Independent Variables

Variable	Description	Expected Sign	Reasons
3-day total consumed (gram)	Total food consumption in three days in grams.	+	Food intake and income are positively correlated. (Bouis, 1994)
3-Day Average: Energy (kcal)	Average three-day caloric intake.	+	More energy intake maybe can lead to higher income. (SAHN, 1988)
3-Day Average: Carbohydrate (g)	Average three-day carbohydrate intake.	+	Carbohydrate intake affect health status. (Friel, Kelleher, Nolan, & Harrington, 2003)
3-Day Average: Protein (g)	Average three-day protein intake.	+	More protein intake maybe can leads to more income.(Grigg, 1995)
3-Day Average: Fat (g)	Average three-day fat intake.	+	Fat intake is important for energy intake, maybe more fat intake can leads to more income, especially for farmers.
Gender	Male/ Female Male=1Female=0.	+	In general, males have higher income.
Household size	The total number of members of each household. The household size from 1 to 13.	+	As a larger household size implies there will be more labor, then more income is expected.

Occupation	The occupation of the head of household, it includes professional occupation, office staff, farmer, skilled worker, soldiers and police and other occupations. (converted into several dummy variables in the regression)	+/-	Different career types have different income.
Education	Education level of the head of the household member, it includes primary school, middle school and bachelor's degree or above. (converted into several dummy variables in the regression)	+	The higher the level of education, the more income, following the human capital theory. (https://econ.lse.ac.uk/staff/spischke, 2000)
Age in years	Mean Age (for all household members)	+/-	Age may be positively correlated and may be negatively related with income.

Marital status	1=never married 2=married3=divorced 4=widowed 5=separated (converted into several dummy variables in the regression)	+/-	The relationship between marital status and income is not confirmed in the literature.
Province	Nine different provinces. 21=Liaoning23=Heilongjiang32=Jiangsu37=Shandong41=Henan42=Hubei43=Hunan45=Guangxi52=Guizhou (converted into several dummy variables in the regression)	+/-	High-income provinces have high residents' income.
Urban or rural site.	The location of the surveyed person. 1=urban, 2=rural	+/-	Urban areas may have higher income than rural areas.
City or county site.	city: 1=fist city 2=second city. county: 1=first county 2=second county 3=third county 4=fourth city (converted into several dummy	+/-	City areas may have higher income than county.

	variables in the regression)		
Neighborhood/village	Different types of neighborhood. Neighborhood:01=First[urban]neighborhood02=Second [urban] neighborhood03=Third suburban village (neighborhood)04=Fourth suburban village (neighborhood)05=Fifth [urban] neighborhood06=Sixth [urban] neighborhood07=Seventh suburban village (neighborhood)08=Eighth suburban village (neighborhood)09=Ninth [urban] neighborhood10=Tenth [urban] neighborhood11=Eleventh suburban village (neighborhood)12=Twelfth suburban village (neighborhood)	+/-	The fixed effect of the type of neighborhood on the income.

	(converted into several dummy variables in the regression)		

4.2 Models

4.2.1 Multivariate Linear Regression (OLS)

This study uses OLS multivariate linear regression models, as the dependent variables are all continuous. There are several explanatory variables in this study, as explained above.

Different specifications are explored to identify the best set of explanatory variables. The specifications correspond to the literature review. They are shown below:

Model 1: Y_i (Income) $=\beta_0 + \beta_1$Age $+ \beta_2$Male $+\beta_3$Marital status$+ \beta_4$HHsize$+ \beta_5$Middle school $+\beta_6$Bachelor degree or above $+\beta_7$Professional occupation $+\beta_8$Office staff $+ \beta_9$Farmer $+ \beta_{10}$Skilled worker $+ \beta_{11}$Soldiers and police $+ \varepsilon_i$

Model 2: Y_i (Income) $=\beta_0 + \beta_1$Age $+ \beta_2$Male $+\beta_3$Marital status$+ \beta_4$HHsize$+ \beta_5$Middle school$+\beta_6$Bachelor degree or above $+\beta_7$Professional occupation $+\beta_8$Office staff $+ \beta_9$Farmer $+ \beta_{10}$Skilled worker $+ \beta_{11}$Soldiers and police $+ \beta_{12}$3-day total consumed (gram) $+ \varepsilon_i$

Model 3: Y_i (Income) $=\beta_0 + \beta_1$Age $+ \beta_2$Male $+\beta_3$Marital status$+ \beta_4$HHsize$+ \beta_5$Middle school$+\beta_6$Bachelor degree or above $+\beta_7$Professional occupation $+\beta_8$Office staff $+ \beta_9$Farmer $+ \beta_{10}$Skilled worker $+ \beta_{11}$Soldiers and police $+ \beta_{12}$3-day average: energy (kcal) $+ \beta_{13}$3-day average: carbohydrate (g) $+ \beta_{14}$3-day average: fat (g) $+ \beta_{15}$3-day average: Protein (g) $+ \varepsilon_i$

Model 4: Y_i (Income) $=\beta_0 + \beta_1$Age $+ \beta_2$Male $+\beta_3$Marital status$+ \beta_4$HHsize$+ \beta_5$Middle school$+\beta_6$Bachelor degree or above$+\beta_7$Professional occupation $+\beta_8$Office staff $+ \beta_9$Farmer $+ \beta_{10}$Skilled worker $+ \beta_{11}$Soldiers and police $+ \beta_{12}$3-day average:

energy (kcal + β_{13}3-day average: carbohydrate (g) + β_{14}3-day average: fat (g) + β_{15}3-day average: Protein (g) + β_{16}3-day total consumed (gram) + ε_i

The main explanatory variables are 3-day total consumed (gram), 3-day average: energy (kcal), 3-day average: carbohydrate (g), 3-day average: fat (g) and 3-day average: protein (g). Adjusted R-square values would be used to compare between the above specifications.

CHAPTER 5
DATA

5.1. Data source: China Health and Nutrition Survey (CHNS)

This study used data from the 2011 China Health and Nutrition Survey (CHNS). This survey is conducted by scholars from University of North Carolina and experts from the Chinese Center for Diseases Control and Prevention. The CHNS is not designed to represent the whole of China. Instead, it aims to offer economic and demographic data from randomly selected households and individuals from nine provinces. Demographic data include gender, age, education level, household income, working status and so on.

This survey includes nine provinces: Guangxi, Guizhou, Heilongjiang, Hubei, Henan, Hunan, Shandong, Jiangsu and Liaoning. The survey uses a multistage, random cluster sampling process to choose the sample from each province. The counties and cities in each province are divided as low-income, middle income and high income. Then one low-income county, two middle-income counties and one high-income county would be randomly chosen along with a provincial capital and a low-income city. In addition, villages and townships within the counties and urban and rural neighborhoods within the cities would be randomly selected. Twenty households are chosen from each community, and all members of each household are interviewed.

This study used the 2011 wave. There are three reasons as follows: firstly, it is the latest available data. Secondly, it contains the most complete set of variables. Finally, there are several exciting new developments in 2011 dataset. For example, three mega cities have joined this survey since 2011. Compared to the previous surveys, the 2011 data is more representatives and the survey is more extensive. It includes nine provinces and three municipalities (Beijing, Chongqing and Shanghai).

5.2. Data management process and final sample

This study dataset includes 11 files of household level data and 12 files of individual level data. For each of the household-level variable, there are multiple data entries, with each entry referring either to an individual level response or the fact that there are several responses by the same person (e.g. 3 days of caloric intake data). The household level data are averaged and merged with individual level data, using household unique identifiers.

The final dataset is individual level. It includes individual characteristics and household-average characteristics. The total number of observations is 42870. We drop 2 observations with a negative age.

5.3 Descriptive Statistics of Dependent Variables

Table 7 shows summary statistics for the dependent variables. There are six main dependent variables in this study. For the sample, the mean for annual household non-retirement income was 37,310.01 with the 17,728 observations (41.35%). The mean of log income from total annual household non-retirement was 9.785895 with 17,728 observations (41.35%). The mean of net household income was 43,206.64 with 31,919 observations (74.46%). The mean of log net household income was 10.19055 with 31,457 observations (73.38%). The mean of gross household income was 47,622.28 with 31,819 observations (74.22%). The mean of log gross household income was 10.27402 with 31,607 observations (73.73%). The mean of per capita household income was 13,711.38 with 31,898 observations (74.41%). The mean of log per capita household income was 10.23013 with 31,457 observations (73.38%). The mean of annual individual wage was 24,882.3 with 2,630 observations (6.13%). The mean of log annual individual wage was 9.457555 with 2,630 observations (6.13%). The mean of total net individual income was 23,099.63 with 5,249 observations (12.24%). The mean of log total net individual income was 9.598977 with 5,209 observations (12.15%).

Table 7 shows that there is also information on other sources of household income available in the dataset. However, due to the limited number of observations involved, this study focuses on the six main dependent variables only.

It should be noted that, in this study, log values of different types of income were used, instead of the actual values. The use of the log form is consistent with the Box-Cox tests discussed below. The number of observations for the logged values and the linear values of the dependent variables are different. This is because households with negative or zero net income were dropped in the process.

Table 7: Descriptive Statistics of Dependent Variables

Dependent Variable	Number of observations	Mean	Standard Deviation
Sources of income that are considered in this study			
Income from total annual household non-retirement	17728	37310.01	47061.86
Log income from total annual household non-retirement	17728	9.785898	1.514644
Total net household income	31919	43206.64	49088.24
Log total net household income	31457	10.19055	1.166898
Total gross household income	31819	47622.28	56715.55
Log total gross household income	31607	10.27402	1.157919
Per capita household income	31898	13711.38	16201.96
Log per capita household income	31457	10.23013	1.134551
Annual individual wage	2630	24882.3	31411.18
Log annual individual wage	2630	9.457555	1.456808

Total net individual income	5249	23099.63	28740.35
Log total net individual income	5209	9.598977	1.105023
Other sources of income that are not considered in this study			
Income from household business	4381	29927.15	57775.02
Log income from household business	4224	9.849859	1.069354
Income from household farming	12029	6872.035	9883.716
Log income from household farming	11942	8.273653	1.085401
Income from household fishing	535	4561.234	10388.02
Log income from household fishing	425	7.711434	1.393068
Income from household gardening	11910	12680.33	11485.28
Log income from household gardening	11883	9.093044	.9066424
Income from household livestock	6806	2607.925	10433.82
Log income from household livestock	5113	6.789844	1.564094
Income from household other income	18702	5981.219	11568.09

Log income from household other income	18702	7.635368	1.448073
Income from household subsidy	6818	549.5666	718.7333
Log income from household subsidy	6818	5.65945	1.207279
Total household income from retirement	27778	7813.601	16217.67
Log total household income from retirement	7455	10.06782	.6958959
Individual business income	401	23784.28	49303.36
Log individual business income	391	9.38995	1.223406
Individual farming income	1252	5018.229	8167.904
Log individual farming income	1164	7.964326	1.142735
Individual fishing income	44	5685.863	11059.96
Log individual fishing income	38	7.671938	1.540054
Individual gardening income	1547	8193.396	8400.566
Log individual gardening income	1425	8.666666	1.028057
Individual livestock income	672	1939.816	7411.368
Log individual livestock income	502	6.381953	1.685843
Individual retirement income	1202	21431.17	11639.02
Log individual retirement income	1202	9.83441	.5588601

5.4 Descriptive Statistics of Independent/Explanatory Variables

Table 8 shows summary statistics of the independent variables for the total sample. There are five main independent variables. The mean amount of food consumed in 3 days was 95.37029 grams with 32,062 observations (74.79%). The average amount of energy consumed in 3 days was 1,802.068 kilocalories with 8,422 observations (19.65%). The average amount of carbohydrate intake consumed in 3 days was 226.2352 grams with 8,422 observations (19.65%). The average amount of fat consumed in 3 days was 69.45393 grams with 8,422 observations (19.65%). The average amount of protein consumed in three days was 63.41728 grams with 8,422 observations (19.65%).

The main independent variables on food intake were derived from several questions in the questionnaire. The instrument asked each respondent to put together a diary/ log of what they consumed for three days, with specific details on the weight of the 3-day food consumption and the types of food consumed. The information here was converted into total food consumption in 3 days in grams. Given information on the types of food consumed, intake of energy in kilocalories, carbohydrate in grams, fat in grams and protein in grams in 3 days could be calculated. These variables were averaged to become average daily intakes prior to the analysis.

Personal characteristics are also included in the model. Educational level is divided into three categories, including primary education, middle school education and bachelor's degree or above education. This variable has 10,927 observations. Here, primary school is omitted category. Occupation is divided into six categories, including professional occupation, office staff, farmer, skilled worker, soldiers and police and other occupations. It has 18,628 observations. Here, "other occupations" is the omitted category. The mean age was 36.15034 and with 42,869 observations (99.99%). The mean value of the male variable was 0.4827631 and with 42,869 observations (99.99%), showing that 48.28% of the sample were male. The average household size was 3.576695 with 31,899 observations (74.41%). The average ratio of married respondents was 0.4795374 with 32,425 observations (75.64%), showing that 47.95% of the sample were married.

All the “location” variables, including province, urban or rural residence, city or county and neighborhood are treated as fixed effects and are included in this study. The 3-day total food consumed in gram is individual data.

Table 8: Descriptive Statistics of Explanatory Variables

Explanatory Variable	Definition	Number of observations	Mean	Standard Deviation
3-day total food consumed (gram)	Total food consumption in three days	32062	95.37029	273.0945
3-Day Average: Energy (kcal)	Average calorie intake for three days	8422	1802.068	647.7382
3-Day Average: Carbohydrate (g)	Average Carbohydrate intake for three days	8422	226.2352	85.63736
3-Day Average: Fat (g)	Average Fat intake for three days	8422	69.45393	51.0916
3-Day Average: Protein (g)	Average Protein intake for three days	8422	63.41728	23.91831
Age	Mean age	42869	36.15034	11.76369
Male	Mean male	42869	.4827631	.1492005
Married	Mean married status	32425	.4795374	.4995888
Household Size	Mean household size	31899	3.576695	1.649704

Primary Education (Omitted Category)	The highest level of education is primary school	10927	.2965132	.4567409
Middle School Education	The highest degree is high school	10927	.5333577	.4989089
Bachelor's Degree or Above Education	Bachelor's Degree or Above	10927	.170129	.3757633
Professional Occupation	The people with professional skills	18628	.0861606	.2806086
Office Staff	People work in government or offices	18628	.1028559	.3037788
Farmer	The profession is farmer	18628	.5407988	.4983461
Skilled Worker	A worker with special skills	18628	.2186493	.4133412
Soldiers and Police	The soldier or policeman	18628	.0025231	.0501682
Other Occupation (Omitted Category)	Other occupations other than those listed	18628	.0490122	.2158994
Province	Different Province	42868	37.68702	11.14137

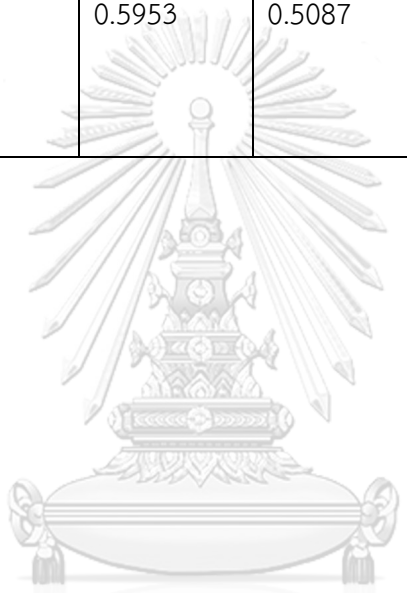
Urban/Rural	Urban or rural site	42868	1.621862	0.4849279
City/County	City or county	42868	2.142531	1.052732
neighborhood/village(town)	The neighborhood information	42558	2.720288	1.39005

Since the main independent variables on food intake are derived from the same log of food consumption over the period of 3 days, including all of the variables in the same regression may cause multicollinearity problems. To test for multicollinearity, Table 9 is provided. It shows a correlation matrix of the main independent variables, with some correlations having the value of more than 0.5, but all lower than 0.8. This is taken as evidence for the fact that there is a potential for some multicollinearity. A more format test of multicollinearity (Variance Inflation Factor) is provided in Appendix A, which provides a consistent conclusion that evidence of multicollinearity is confirmed, but the severity of the problem is likely to be limited.

Table 9: Correlation Matrix of the Main Independent Variables

Variable	3-day total food consumed (gram)	3-Day Average: Energy (kcal)	3-Day Average: Carbohydrate (g)	3-Day Average: Fat (g)	3-Day Average: Protein (g)
3-day total food consumed (gram)	1.0000				
3-Day Average: Energy (kcal)	0.4322	1.0000			

3-Day Average: Carbohydrate (g)	0.0324	0.6550	1.0000		
3-Day Average: Fat (g)	0.5824	0.7753	0.0574	1.0000	
3-Day Average: Protein (g)	0.0241	0.5953	0.5087	0.2443	1.0000



CHAPTER 6
RESULTS

This section contains regression results.

6.1 Regression results for non-retirement household income

Table 10 shows four regressions with different specifications for log non-retirement household income. The nested-model F-tests were also performed and reported at the end of the table. Here it can be seen that Model 4 is preferred, as the R^2 is higher here, and the F- tests show that Model 4 outperforms the other models (with the exception of Model 3).

Model 4 suggests that the total amount of food consumed over 3 days is an insignificant predictor of non-retirement household income. Based on Model 4, the coefficients of the 3-day average fat intake and the 3-day average protein intake for non-retirement household income are of the expected positive sign and are statistically significant at the 1 percent level. If the 3-day average fat intake increases by 1%, the non-retirement household income will increase by 0.675%. If the 3-day average protein intake increases by a 1%, the non-retirement household income will increase by 1.23%. However, the coefficient of the 3-day average energy (kcal) intake is negative and statistically significant at the 1 percent level. If the 3-day average energy intake increases by 1%, the non-retirement household income will decrease by 0.0683%. The results are consistent with Aromolaran (2004), which finds a small and negative effect of women's income share on per capita calorie intake, -0.04, which is a rejection of the hypothesis that increases in women's calorie intake can increase income.

The coefficient of the age variable is of the negative sign and significant at 10 percent level. With the age increase, non-retirement household income is expected to decrease, with lower productive capacities. The coefficient of the male variable is as expected of the positive sign and significant at 5 percent level. Generally speaking, male income is higher than female income. The coefficient of the married status and

household size are found to be positive and significant at 1 percent level. The more people in a household, the higher non-retirement household income.

The coefficients of the education variables are of the positive sign and significant at 1 percent level. This is consistent with the human capital theory. Higher education implies more human capital accumulation, which in turn increases productivity and finally wage. The coefficients of professional occupation, office staff, skilled worker and soldiers and police are found to be positive and significant at 1 percent level. However, compared to the reference occupation category, the coefficient of farmer is negative and significant at 1 percent level. This implies income differences across occupations.

To further investigate the differences between males and females in model 4, sub-sample analyses were performed. The results are shown in Appendix B, showing that the results are consistent with the full sample.

Table 10: Four regressions with different specifications for log non-retirement household income

Explanatory Variables	Model 1 (1)	Model 2 (2)	Model 3 (3)	Model 4 (4)
3-day total consumed (gram)	×	-1.00e-05 (.0002)	×	-.0001591 (.0002203)
3-Day Average: Energy (kcal)	×	×	-.000682*** (.0002312)	-.000683*** (.0002312)
3-Day Average: Carbohydrate (g)	×	×	.000811 (.0009864)	.0008138 (.0009865)

3-Day Average: Fat (g)	×	×	.0066304*** (.0020962)	.0067548*** (.0021034)
Day Average: Protein (g)	×	×	.0123708*** (.0012008)	.0122834*** (.0012069)
Age	.0009078 (.0016432)	.0009123 (.0016458)	-.0027197* (.0016358)	-.0026404 (.0016396)
Male	.2535732*** (.0934088)	.2535456*** (.09342)	.1972508** (.0917474)	.1972517** (.0917519)
Married	.1492383*** (.0292438)	.1492353*** (.0292469)	.1318501*** (.0287412)	.1316908*** (.0287435)
Household Size	.2675571*** (.0126172)	.2677016*** (.0129454)	.2590772*** (.0124922)	.2616815*** (.0130032)
Primary Education (Reference category)	×	×	×	×
Middle School Education	.481655*** (.0407536)	. .4816255*** (.040762)	.4031554*** (.0404391)	.4027928*** (.04044429)
Bachelor Degree or Above Education	.9283008*** (.0566966)	.9282322*** (.056719)	.7904111*** (.0565539)	.7889286*** (.056594)
Professional Occupation	.3611019*** (.0727459)	.3612014*** (.0727807)	.4112536*** (.0714747)	.4124042*** (.071496)
Office Staff	.3062967*** (.069544)	.3062293*** (.0695642)	.3195642*** (.0682817)	.3192227*** (.0682867)

Farmer	-.6680488*** (.0680727)	-.6680243*** (.0680815)	-.5492658*** (.0674098)	-.547992*** (.0674362)
Skilled Worker	.1231356* (.0668995)	.1231057* (.0669091)	.1936626*** (.0658183)	.1938458*** (.065822)
Soldiers and Police	.3546828** (.1639697)	.354344** (.1641265)	.4621144*** (.1610556)	.4577529*** (.1611768)
Other Occupation (Reference category)	×	×	×	×
Provincial fixed effects/ urban-rural fixed effects/ city and county fixed effects	Yes	Yes	Yes	Yes
Number of observations	4867	4867	4867	4867
Adjusted R- squared	0.2960	0.2959	0.3232	0.3231
F-test comparing (4) V. (1)	F = 337.413***			
F-test comparing (4) V. (2)	F = 421.943***			

F-test comparing (4) V. (3)	F = 0.701

*= Significant at 10% **=Significant at 5% ***=Significant at 1%

6.2 Regression results for log net household income

Table 11 shows four regressions with different specifications for log total net household income. The nested-model F-tests were also performed and reported at the end of the table. Here it can be seen that Model 4 is preferred, as the R^2 is higher here, and the F- tests show that Model 4 outperforms the other models.

Model 4 suggests that the total amount of food consumed over 3 days is an insignificant predictor of total net household income. Based on Model 4, the coefficient of 3-day average protein intake for total net household income is of the expected positive sign and is statistically significant at 1 percent level. If the 3-day average protein intake increases by a 1%, the total net household income will increase by 0.718%. The coefficient of the age variable is of the positive and significant at 1 percent level. With the age increase, total net household income is expected to increase with more work experiences. The coefficient of the male variable is as expected of the positive sign and significant at 10 percent level. Generally speaking, male income is higher than female income. The coefficient of the married status and household size are found to be the positive sign and significant at 1 percent level. The more people in a household, the higher total net household income.

The coefficient of the education variables are of the positive sign and significant at 1 percent level. This is consistent with the human capital theory. Higher education implies more human capital accumulation, which in turn increases productivity and finally wage. The coefficients of professional occupation, office staff, skilled worker and soldiers and police are found to be positive and significant at 1 percent level. However, compared to the reference occupation category, the coefficient of farmer is negative and significant at 1 percent level. This implies income differences across occupations.

The coefficient of the education variables of the positive sign and significant at 1 percent level. This is consistent with the human capital theory. Higher education implies more human capital accumulation, which in turn increases productivity and finally wage. The coefficient of professional occupation, office staff, skilled worker and soldiers and police are found that to be positive sign and significant at 1 percent level. However, compared to the reference occupation category, the coefficient of farmer is negative and significant at 1 percent level. This implies income differences across occupations.

Table 11: Four regressions with different specifications for log total net household income

Explanatory Variables	Model 1 (1)	Model 2 (2)	Model 3 (3)	Model 4 (4)
3-day total consumed (gram)	×	.0000415 (.0001212)	×	.0001664 (.0001277)
3-Day Average: Energy (kcal)	×	×	-.0001069 (.0001533)	-.0001028 (.0001533)
3-Day Average: Carbohydrate (g)	×	×	-.0010027 (.0006431)	-.0010212 (.0006432)
3-Day Average: Fat (g)	×	×	.0004232 (.0013906)	.000276 (.0013952)
Day Average: Protein (g)	×	×	.0070997*** (.0008463)	.0071799*** (.0008485)

Age	.004601*** (.0010833)	.0045882*** (.001084)	.0028773*** (.0010838)	.0028191*** (.0010847)
Male	.1452892** (.0634181)	.1447901** (.063439)	.1178152* (.0629449)	.1153267* (.0629706)
Married	.1207673*** (.0197336)	.1205882*** (.0197418)	.1102131*** (.0195791)	.1096263*** (.0195832)
Household Size	.1998974*** (.0081709)	.1994156*** (.0082916)	.190208*** (.0082271)	.1879849*** (.0084017)
Primary Education	×	×	×	×
Middle School Education	.2499606*** (.0245438)	.2502361*** (.0245586)	.2203323*** (.0245416)	.2215128*** (.024557)
Bachelor's Degree or Above Education	.5444424*** (.0397901)	.5448997*** (.0398151)	.4866098*** (.0398846)	.4891*** (.0399283)
Professional Occupation	.4067029*** (.0541124)	.4066229*** (.0541165)	.4272481*** (.0536238)	.4272802*** (.053621)
Office Staff	.3899771*** (.0517748)	.3905041*** (.0518011)	.3803511*** (.0513276)	.3817499*** (.0513361)
Farmer	-.2574887*** (.0474283)	-.257263*** (.047436)	-.1862292*** (.0475333)	-.185970*** (.0475313)
Skilled Worker	.1796036*** (.0485757)	.1800357*** (.0485953)	.2059308*** (.0481916)	.2069394*** (.0481953)
Soldiers and Police	.2861917** (.1290413)	.2878238** (.1291378)	.3318898*** (.1278664)	.3374437*** (.1279308)

Other Occupation	×	×	×	×
Provincial fixed effects/ urban-rural fixed effects/ city and county fixed effects	Yes	Yes	Yes	Yes
Number of observations	6698	6698	6698	6698
Adjustment R- squared	0.2544	0.2543	0.2691	0.2692
F-test comparing (4) V. (1)	F = 102.786***			
F-test comparing (4) V. (2)	F = 128.461***			
F-test comparing (4) V. (3)	F = 4.543**			

*= Significant at 10% **=Significant at 5% ***=Significant at 1%

6.3 Regression results for log gross household income

Table 12 shows four regressions with different specifications for log total gross household income. The nested-model F-tests were also performed and reported at the end of the table. Here it can be seen that Model 4 is preferred, as the R^2 is higher here, and the F- tests show that Model 4 outperforms the other models.

Model 4 suggests that the total amount of food consumed over 3 days is an insignificant predictor of total net household income. Based on Model 4, the coefficient of 3-day average protein intake for total gross household income is of the expected positive sign and is statistically significant at 1 percent level. If the 3-day average protein intake increases by a 1%, the total gross household income will increase by 0.637%. The coefficient of the married status and household size are found to be the positive sign and significant at 1 percent level. The more people in a household, the higher total gross household income.

The coefficient of the education variables are of the positive sign and significant at 1 percent level. This is consistent with the human capital theory. Higher education implies more human capital accumulation, which in turn increases productivity and finally wage. The coefficient of professional occupation, office staff and skilled worker are found to be positive sign and significant at 1 percent level. The coefficient of soldiers and policeman is found to be positive sign and significant at 5 percent level. However, compared to the reference occupation category, the coefficient of farmer is negative and significant at 1 percent level. This implies income differences across occupations.

Table 12: Four regressions with different specifications for log total gross household income

Explanatory Variables	Model 1 (1)	Model 2 (2)	Model 3 (3)	Model 4 (4)
3-day total consumed (gram)	×	.0000629 (.0001186)	×	.0001857 (.0001251)
3-Day Average: Energy (kcal)	×	×	-.000064 (.0001496)	-.0000593 (.0001497)

3-Day Average: Carbohydrate (g)	×	×	-.0009845 (.0006281)	-.0010054 (.0006282)
3-Day Average: Fat (g)	×	×	.0000571 (.0013581)	-.0001079 (.0013625)
3-Day Average: Protein (g)	×	×	.0062784*** (.000827)	.0063677*** (.0008291)
Age	.0033189*** (.001059)	.0032996*** (.0010597)	.0017929* (.0010612)	.0017281 (.001062)
Male	.0856808 (.0619802)	.0849246 (.062)	.0602484 (.0616129)	.0574842 (.0616355)
Married	.1110812*** (.0192778)	.1108116*** (.0192855)	.101343*** (.0191576)	.1006989*** (.0191608)
Household Size	.1971649*** (.0079768)	.1964331*** (.0080956)	.1892473*** (.0080441)	.1867625*** (.0082155)
Primary Education	×	×	×	×
Middle School Education	.2110777*** (.0239495)	.2114943*** (.0239636)	.1838939*** (.0239863)	.1852217*** (.0240008)
Bachelor Degree or Above Education	.4645768*** (.0388422)	.4652659*** (.038866)	.4123431*** (.0389947)	.4151218*** (.039036)
Professional Occupation	.385663*** (.0529122)	.3855423*** (.0529155)	.4030994*** (.052519)	.4031373*** (.0525142)

Office Staff	.3479836*** (.0505898)	.3487916*** (.0506155)	.3379486*** (.0502323)	.339539*** (.0502392)
Farmer	-.2098325*** (.0463784)	-.2094888*** (.0463854)	-.1482961*** (.0465586)	-.148001*** (.0465549)
Skilled Worker	.1694821*** (.047493)	.1701331*** (.0475114)	.1931336*** (.0471956)	.1942469*** (.0471973)
Soldiers and Police	.2402694* (.1261927)	.2427425* (.1262856)	.2801322** (.1252485)	.2863379** (.125307)
Other Occupation	×	×	×	×
Provincial fixed effects/ urban-rural fixed effects/ city and county fixed effects	Yes	Yes	Yes	Yes
Number of observations	6714	6714	6714	6714
Adjustment R- squared	0.2228	0.2227	0.2357	0.2358
F-test comparing (4) V. (1)	F =114.263***			
F-test comparing (4) V. (2)	F = 143.008***			

F-test comparing (4) V. (3)	F = 4.528**

*= Significant at 10% **=Significant at 5% ***=Significant at 1%

6.4 Regression results for log per capita household income

Table 13 shows four regressions with different specifications for log per capita household income. The nested-model F-tests were also performed and reported at the end of the table. Here it can be seen that Model 4 is preferred, as the R^2 is higher here, and the F- tests show that Model 4 outperforms the other models.

Model 4 suggests that the total amount of food consumed over 3 days is a significant predictor of total net household income. The coefficient of the total amount of food consumed over 3 days is of the expected positive sign and is statistically significant at 5 percent level. If the total amount of food consumed over 3 days is increases by 1%, the per capita household income will increase by 0.028%. The coefficient of 3-day average protein intake for per capita household income is of the expected positive sign and is statistically significant at 1 percent level. If the 3-day average protein intake increases by 1%, the per capita household income will increase by 0.437%. However, the coefficient of 3-day average carbohydrate intake for per capita household income is of the negative sign and is statistically significant at 5 percent level. If the 3-day average carbohydrate intake increases by 1%, the per capita household income will decrease by 0.14%. The coefficient of the male variable is as expected of the positive sign and is statistically significant at 10 percent level. Generally speaking, male income is higher than female income. The coefficient of the married status and household size are found to be positive and significant at 1 percent level. The more people in a household, the higher per capita household income.

The coefficients of the education variables are of the positive sign and significant at 1 percent level. This is consistent with the human capital theory. Higher education implies more human capital accumulation, which in turn increases productivity and finally wage. The coefficient of professional occupation, office staff and skilled worker are found to be positive sign and is statistically significant at 1

percent level. The coefficient of soldiers and policeman is found to be positive sign and is statistically significant at 5 percent level. However, compared to the reference occupation category, the coefficient of farmer is negative and significant at 5 percent level. This implies income differences across occupations.

Table 13: Four regressions with different specifications for log per capita household income

Explanatory Variables	Model 1 (1)	Model 2 (2)	Model 3 (3)	Model 4 (4)
3-day total consumed (gram)	×	.0001072 (.0001205)	×	.0002816** (.0001274)
3-Day Average: Energy (kcal)	×	×	.0000356 (.000153)	.0000425 (.000153)
3-Day Average: Carbohydrate (g)	×	×	-.0013357** (.0006419)	-.001367** (.0006418)
3-Day Average: Fat (g)	×	×	-.0010565 (.0013881)	-.0013056 (.0013922)
3-Day Average: Protein (g)	×	×	.004228*** (.0008447)	.0043637*** (.0008467)
Age	.0023293** (.0010767)	.0022963** (.0010773)	.0010488 (.0010818)	.0009504 (.0010824)
Male	.1180405* (.0630282)	.1167524* (.0630459)	.1106178 * (.0628277)	.1064064* (.0628383)

Married	.0898664*** (.0196123)	.0894041*** (.0196195)	.0869977*** (.0195426)	.0860046*** (.0195421)
Household Size	.1934982*** (.0081207)	.192255*** (.0082403)	.1817605*** (.0082118)	.1779982*** (.0083841)
Primary Education	×	×	×	×
Middle School Education	.1867613*** (.0243929)	.1874723*** (.0244064)	.176911*** (.0244958)	.1789088*** (.0245054)
Bachelor's Degree or Above Education	.3738428*** (.0395455)	.375023*** (.0395684)	. 3513669*** (.0398103)	.3555812*** (.0398444)
Professional Occupation	.4271788*** (.0537798)	.4269722*** (.0537811)	.4462422*** (.0535239)	.4462966*** (.0535084)
Office Staff	.3792216*** (.0514566)	.3805815*** (.0514801)	.3789673*** (.051232)	.3813346*** (.0512283)
Farmer	-.1588001*** (.0471368)	-.1582176*** (.0471421)	-.1037585** (.0474448)	-.1033203** (.0474314)
Skilled Worker	.2212872*** (.0482771)	.2224023*** (.0482942)	.233363*** (.0481018)	.2350698*** (.048094)
Soldiers and Police	.2432645* (.1282482)	.2474765* (.1283376)	.2736238** (.1276282)	.2830231** (.127662)
Other Occupation	×	×	×	×
Provincial fixed effects/ urban-rural	Yes	Yes	Yes	Yes

fixed effects/ city and county fixed effects				
Number of observations	6698	6698	6698	6698
Adjustment R- squared	0.1948	0.1947	0.2039	0.2043
F-test comparing (4) V. (1)	F = 132.787***			
F-test comparing (4) V. (2)	F = 166.635***			
F-test comparing (4) V. (3)	F = 8.213**			

*= Significant at 10% **=Significant at 5% ***=Significant at 1%

6.5 Regression results for individual wage

Table 14 shows four regressions with different specifications for log annual individual wage. The nested-model F-tests were also performed and reported at the end of the table. Here it can be seen that Model 4 is preferred, as the R^2 is higher here, and the F- tests show that Model 4 outperforms the other models (with the exception of Model 3).

Model 4 suggests that the total amount of food consumed over 3 days is a significant predictor of total net household income. The coefficient of the total amount of food consumed over 3 days is of the negative sign and is statistically significant at 5 percent level. If the total amount of food consumed over 3 days increases by 1%, the individual wage will decrease by 0.11%. The coefficient of the age variable is of the

negative sign and significant at 5 percent level. If age increases by 1%, the individual wage will decrease by 0.74%. With the age increase, annual individual wage is expected to decrease, with lower productive capacities. The coefficient of household size is found to be positive sign and is statistically significant at 5 percent level.

The coefficients of the education variables are of the positive sign and significant at 1 percent level. This is consistent with the human capital theory. Higher education implies more human capital accumulation, which in turn increases productivity and finally wage. The coefficient of professional occupation is found to be positive sign and is statistically significant at 1 percent level. The coefficient of office staff is found to be positive sign and is statistically significant at 5 percent level. However, compared to the reference occupation category, the coefficient of farmer is negative and significant at 5 percent level. This implies income differences across occupations.

Table 14: Four regressions with different specifications for log annual individual wage

Explanatory Variables	Model 1 (1)	Model 2 (2)	Model 3 (3)	Model 4 (4)
3-day total consumed (gram)	×	-.0007634** (.0003882)	×	-.0011327** (.000451)
3-Day Average: Energy (kcal)	×	×	.0002045 (.0005132)	.0001812 (.0005118)
3-Day Average: Carbohydrate (g)	×	×	-.0014881 (.0021894)	-.0013734 (.0021834)

3-Day Average: Fat (g)	×	×	-.0018041 (.0046426)	-.0007771 (.0046469)
3-Day Average: Protein (g)	×	×	.0043468* (.0025955)	.0038985 (.002594)
Age	-.0064155 * (.0035503)	-.0059529* (.0035524)	-.0081874** (.0035805)	-.0074104** (.0035833)
Male	.0534447 (.1970477)	.0570818 (.1967431)	.0331731 (.1962954)	.0387985 (.1957288)
Married	.0314418 (.0654962)	.0334168 (.0653998)	.0125602 (.0654194)	.0128975 (.0652264)
Household Size	.057191* (.0344436)	.066857* (.0347384)	.0557603 (.0344783)	.0748337** (.0352055)
Primary Education	×	×	×	×
Middle School Education	.438866*** (.1033884)	.434111*** (.1032523)	.3840551*** (.104492)	.3724082*** (.1042867)
Bachelor's Degree or Above Education	.7494888*** (.1322344)	.7505599*** (.1320252)	.6685823*** (.133925)	.6607409*** (.1335662)
Professional Occupation	.3950427** (.1547365)	.3963456*** (.1544919)	.4321541*** (.1543531)	.4333908*** (.1538983)
Office Staff	.3407737** (.1487)	.3294095** (.148576)	.3564562** (.1481165)	.3481645** (.1477162)
Farmer	-.4524881*** (.1524928)	-.4532032*** (.1522508)	-.3781124** (.1534481)	-.36873** (.1530408)

Skilled Worker	.1219045 (.1457806)	.1203693 (.1455509)	.1723933 (.1456734)	.1798691 (.1452739)
Soldiers and Police	.4643879 (.3457624)	.4299291 (.3456572)	.5306054 (.3446634)	.4911089 (.3440057)
Other Occupation	×	×	×	×
Provincial fixed effects/ urban-rural fixed effects/ city and county fixed effects	Yes	Yes	Yes	Yes
Number of observations	911	911	911	911
Adjustment R- squared	0.2089	0.2114	0.2178	0.2224
F-test comparing (4) V. (1)	F = 121.487***			
F-test comparing (4) V. (2)	F = 156.948***			
F-test comparing (4) V. (3)	F = 1.855			

*= Significant at 10% **=Significant at 5% ***=Significant at 1%

6.6 Regression results for net individual income

The table 15 shows four regressions with different specifications for log total net individual income. The nested-model F-tests were also performed and reported at the end of the table. Here it can be seen that Model 4 is preferred, as the R^2 is higher here, and the F- tests show that Model 4 outperforms the other models.

Model 4 suggests that the total amount of food consumed over 3 days is an insignificant predictor of total net household income. Based on Model 4, the coefficient of 3-day average protein intake for total net individual income is of the expected positive sign and is statistically significant at 10 percent level. If the 3-day average protein intake increases by 1%, the net individual income will increase by 0.36%. The coefficient of the age variable is of the negative sign and significant at 5 percent level. With the age increase, total net individual income is expected to decrease, with lower productive capacities.

The coefficients of the education variables are of the positive sign and significant at 1 percent level. This is consistent with the human capital theory. Higher education implies more human capital accumulation, which in turn increases productivity and finally wage. The coefficient of office staff is found to be positive sign and is statistically significant at 1 percent level. However, compared to the reference occupation category, the coefficient of farmer is negative and significant at 5 percent level. This implies income differences across occupations.

To further investigate the differences between middle school education and bachelor's degree or above education in Model 4, sub-sample analyses were performed. The results are shown in Appendix B, showing that the results are consistent with the full sample.

Table 15: Four regressions with different specifications for log total net individual income

Explanatory Variables	Model 1 (1)	Model 2 (2)	Model 3 (3)	Model 4 (4)
3-day total consumed (gram)	×	-.0004131 (.0002632)	×	-.0003831 (.0002838)
3-Day Average: Energy (kcal)	×	×	.0003246 (.0003633)	.0003109 (.0003634)
3-Day Average: Carbohydrate (g)	×	×	-.0025219 * (.0015245)	-.0024568 (.0015248)
3-Day Average: Fat (g)	×	×	-.0032532 (.0032888)	-.0028707 (.0033)
3-Day Average: Protein (g)	×	×	.0037614* (.0019583)	. 0036231* (.0019603)
Age	-.0046471* (.0024347)	-.0045188* (.0024348)	-.0060728** (.0024498)	-.0059304** (.0024514)
Male	.1284185 (.1455001)	.1336009 (.1454611)	.1246043 (.1451199)	.1301125 (.1451343)
Married	.0142709 (.0470501)	.0169013 (.0470552)	.0091338 (.0469546)	.0109542 (.04696)
Household Size	-.0141126 (.0219625)	-.0097502 (.0221262)	-.0225873 (.0221404)	-.0174657 (.0224567)

Primary Education	×	×	×	×
Middle School Education	.234832*** (.0611931)	.2309336*** (.0612114)	.214986*** (.0615232)	.2108762*** (.0615803)
Bachelor's Degree or Above Education	.522739*** (.0933441)	.5204731*** (.0933062)	.4828667*** (.0940909)	.4787648*** (.0941121)
Professional Occupation	.357593*** (.1244723)	.3563378*** (.1244095)	.384173*** (.1241351)	.382207 (.1241069)
Office Staff	.325182*** (.1192516)	.3180768*** (.1192748)	.3305078*** (.1188887)	.3260106*** (.1189002)
Farmer	-.352630*** (.112459)	-.3540705*** (.1124036)	-.2833535** (.1136904)	-.2826866** (.1136579)
Skilled Worker	.0717038 (.1138554)	.0677413 (.1138236)	.0975918 (.1136991)	.0965985 (.1136679)
Soldiers and Police	.3328822 (.2906914)	.3148608 (.2907653)	.3833527 (.2897544)	.3695577 (.2898488)
Other Occupation	×	×	×	×
Provincial fixed effects/ urban-rural fixed effects/ city and county fixed effects	Yes	Yes	Yes	Yes

Number of observations	1404	1404	1404	1404
Adjustment R- squared	0.2047	0.2119	0.2119	0.2124
F-test comparing (4) V. (1)	F = 10.074**			
F-test comparing (4) V. (2)	F = 3.198**			
F-test comparing (4) V. (3)	F = 4.995**			

*= Significant at 10% **=Significant at 5% ***=Significant at 1%

Table 9 - Table 14 showed four regressions with different specifications for six different dependent variables. Model 4 was considered the best model, as the adjusted R^2 was generally the highest in the table. The coefficients of 3-day average protein intake and 3-day average fat intake for different kinds of income were significant. The coefficient of age was generally of the negative sign. With age increase, income was expected to decrease, with lower productive capacities. The coefficient of the male variable was as expected of the positive sign. Generally speaking, male income is higher than female income. The coefficient of the married status and household size were found to be positive. The more people in a household, the higher income.

The coefficients of the education variables were of the positive sign. This is consistent with the human capital theory. Higher education implies more human capital accumulation, which in turn increases productivity and finally wage. Finally, we also can find that income differences across occupations.

CHAPTER 7
CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

This research attempts to identify the impact of food intake and socioeconomic-demographic factors on income in China. Data used for estimation come from the 2011 wave of China Health and Nutrition Survey. Using ordinary least squares models with location fixed effects based of different regression specifications, it is found that food intake variables have very strong effects on income in China.

There are six dependent variables. The impact of food intake on income is quite similar across all outcomes. The summary is as follows. Firstly, the coefficients of the 3-day average fat intake and the 3-day average protein intake for non-retirement household income are of the expected positive sign and are statistically significant at the 1 percent level. Secondly, the coefficient of 3-day average protein intake for total net household income is of the expected positive sign and is statistically significant at 1 percent level. Thirdly, the coefficient of 3-day average protein intake for total gross household income is of the expected positive sign and is statistically significant at 1 percent level. Fourth, the coefficient of the total amount of food consumed over 3 days is of the expected positive sign and is statistically significant at 5 percent level. The coefficient of 3-day average protein intake for per capita household income is of the expected positive sign and is statistically significant at 1 percent level. However, the coefficient of 3-day average carbohydrate intake for per capita household income is of the negative sign and is statistically significant at 5 percent level. Fifth, the coefficient of the total amount of food consumed over 3 days is of the negative sign and is statistically significant at 5 percent level. Maybe some endogeneity problems exist. Finally, the coefficient of 3-day average protein intake for total net individual income is of the expected positive sign and is statistically significant at 10 percent level.

The results are consistent with existing studies. Haddad & Bouis (1991) examine the impact of individual nutrition status on wages and find a positive relationship. Other

empirical investigations have also shown a positive relationship between nutrition status and labor productivity as measured by wages, e.g. Strauss (1986). As food intake translates into better health, food intake leads to an improvement in income.

Consistent with the human capital theory, education has a significant impact on income. Qingcai Zhong (2000) examine the impact of education on income and find a positive relationship between education and income. This study also shows a positive and significant relationship between education and income, mostly at the 1 percent level.

Other socioeconomic-demographic variables also have an impact on income. Age, being male, and being married always show a statistically strong impact on all dependent variables. It is possible that older people have more work experiences than young people, and therefore receive higher income. Males typically have higher incomes; Edward P. Lazear et al. (1990) discuss male-female wage differentials in job ladders, and like this study, they find a positive relationship between being male and income. Being married status also always shows a strong positive impact on income. The impacts of occupations on income vary. Being professional, office staff, skilled worker and soldiers and police usually show a positive and significant impact on income. Farmers are associated with a negative impact on income. Compared with other occupations, farmers' income is lower on average.

The results can also be explained by policy shifts in China. Since 2011, in order to ensure adequate protein intake for residents, the government has implemented a nutritional meal policy. The government has invested a lot of money to buy nutritional meals to improve the nutritional status of students (Ministry of Finance of the People's Republic of China, 2011; Ming Fen, 2014). The government has also implemented a nutritional diet subsidy, allocating funds to launch a nutrition improvement plan for rural compulsory education students in concentrated areas. According to the relevant statistics of the Ministry of Education, as of the end of 2013, 699 counties in 22 provinces in China carried out national pilot work on rural student nutrition improvement programs and nearly 23 million students benefited. In another 529 counties in 19 provinces, local pilot projects were carried out, covering nearly 40,000 schools. Students protein intake has since improved significantly.

7.2 Recommendations

Following the conclusions of the study, policy recommendations can be made. The results suggest that the government should improve the nutritional status of the people in order to increase their income.

a. The government may implement some interventions to help poor people to improve their food intake and nutrition status. For example, the government should implement sustainable food aid policies.

b. More TV advertisements about the importance of healthy diets may be made. The purpose is to provide people with knowledge about nutrition and balanced diet, which are good for health, and in turn increase income.

c. Given that farmers' income is lower than other occupations on average, the government should implement some nutrition subsidy programs in rural areas, where farmers reside, in order to improve their nutrition status and their income.

7.3 Limitations

There remain major limitations of the research. As the literature review suggests, while food intake impacts income, income also affects food intake. The regressions certainly face endogeneity problems. However, since the data are limited, appropriate instrumental variables cannot be found to solve the problems. Lin-lin and Yong (2017) this paper evaluates the effects of health on the income of rural residents in China with the micro panel data from China Health and Nutrition Survey. To get reliable results, the paper controls the endogenity of health by using simultaneous equation model and solves the parameters by using the three-stage least squares method. The study found that health has significantly positive effects on the income of rural residents in China, a conclusion which is in conformity with the economic effects of health. The relationship between income and health status has endogenity problems. Stronks, Mheen, Bos and Mackenbach (1997) this study was to test the hypothesis that the relatively strong association between income and health compared to that between education/occupation and health, can partly be interpreted in terms of an association between employment status and health. They

control for differences in other socioeconomic indicators, the association between income and health was found to be stronger than that between occupation or education and health. But it does not address the endogenous issue between health and income. The issue of endogeneity bias can be seen here. The 3-day total amount of food consumption, the 3-day average energy intake and the 3-day average carbohydrate intakes have been found to be strong predictors of income in prior research. However, this study shows that the variables are not statistically significant, which might be a result of endogeneity problems.

There is also another limitation. This study does not account for household composition. The dataset does not contain information on how many older people or young people live in a household, and therefore it is not possible to adjust the dependent variables (which are measures of income) by household composition. The lack of data here can bias the results.

REFERENCES

APPENDIX

APPENDIX – A

Multicollinearity Problem

This section investigates whether there are multicollinearity problems in the specification. The Variance Inflation Factor tests (VIF tests) were used to test if multicollinearity existed in the following four models. The results suggest that Model 3 and Model 4 may be subjected to multicollinearity but the evidence is weak, with the VIF values being just above 10.

Model 1: Y_i (Income) $=\beta_0 + \beta_1$Age $+\beta_2$Male $+_+\beta_3$Marital status$+ \beta_4$HHsize $+\beta_5$Middle school $+\beta_6$Bachelor degree or above $+\beta_7$Professional occupation$+ \beta_8$Office staff $+$ β_9Farmer + β_{10}Skilled worker + β_{11}Soldiers and police + ε_i

Model 2: Y_i (Income) $=\beta_0$ + β_1Age $+\beta_2$Male $+_+\beta_3$Marital status+ β_4HHsize $+\beta_5$Middle school+β_6Bachelor degree or above $+\beta_7$Professional occupation+ β_8Office staff + β_9Farmer + β_{10}Skilled worker + β_{11}Soldiers and police + β_{12}3-day total consumed (gram) + ε_i

Model 3: Y_i (Income) $=\beta_0$ + β_1Age $+\beta_2$Male $+_+\beta_3$Marital status+ β_4HHsize $+\beta_5$Middle school+β_6Bachelor degree or above $+\beta_7$Professional occupation+ β_8Office staff + β_9Farmer + β_{10}Skilled worker + β_{11}Soldiers and police + β_{12}3-day average: energy (kcal) + β_{13}3-day average: carbohydrate (g) + β_{14}3-day average: fat (g) + β_{15}3-day average: Protein (g) + ε_i

Model 4: Y_i (Income) $=\beta_0$ + β_1Age $+\beta_2$Male $+_+\beta_3$Marital status+ β_4HHsize $+\beta_5$Middle school+β_6Bachelor degree or above+β_7Professional occupation+ β_8Office staff + β_9Farmer + β_{10}Skilled worker + β_{11}Soldiers and police + β_{12}3-day average: energy (kcal + β_{13}3-day average: carbohydrate (g) + β_{14}3-day average: fat (g) + β_{15}3-day average: Protein (g) + β_{16}3-day total consumed (gram) + ε_i

Table A-1. Summary of the VIF from Model 1-Model 4 for log non-retirement household income

Model	Mean VIF
Model 1	2.53
Model 2	2.41
Model 3	13.04
Model 4	12.36

For log non-retirement household income, the model 3 and model 4's mean VIF are higher than 10, suggesting that Model 3 and Model 4 may be subjected to multicollinearity.

Table A-2. Summary of the VIF from Model 1-Model 4 for log net household income

Model	Mean VIF
Model 1	2.54
Model 2	2.42
Model 3	11.89
Model 4	11.25

For log net household income, the model 3 and model 4's mean VIF are higher than 10, suggesting that Model 3 and Model 4 may be subjected to multicollinearity.

Table A-3. Summary of the VIF from Model 1-Model 4 for log gross household income

Model	Mean VIF
Model 1	2.55
Model 2	2.42
Model 3	11.85
Model 4	11.21

For log gross household income, the model 3 and model 4's mean VIF are higher than 10, suggesting that Model 3 and Model 4 may be subjected to multicollinearity.

Table A-4. Summary of the VIF from Model 1-Model 4 for log per capita household income

Model	Mean VIF
Model 1	2.54
Model 2	2.42
Model 3	11.89
Model 4	11.25

For log per capita household income, the model 3 and model 4's mean VIF are higher than 10, suggesting that Model 3 and Model 4 may be subjected to multicollinearity.

Table A-5. Summary of the VIF from Model 1-Model 4 for log annual individual wage

Model	Mean VIF
Model 1	2.62
Model 2	2.49
Model 3	16.74
Model 4	15.85

For log annual individual wage, the model 3 and model 4's mean VIF are higher than 10, suggesting that Model 3 and Model 4 may be subjected to multicollinearity.

Table A-6. Summary of the VIF from Model 1-Model 4 for log total net individual income

Model	Mean VIF
Model 1	2.62
Model 2	2.49
Model 3	13.86
Model 4	13.12

For log total net individual income, the model 3 and model 4's mean VIF are higher than 10, suggesting that Model 3 and Model 4 may be subjected to multicollinearity.

APPENDIX – B.

Sub-sample analysis

Table B – 1. Regression of preferred specification model 4 for log non-retirement household income (female)

Explanatory Variables	Model 4 (4)
3-day total consumed (gram)	.0003664 (.0004552)
3-Day Average: Energy (kcal)	-.0013046*** (.0003146)
3-Day Average: Carbohydrate (g)	.0014242 (.0014113)
3-Day Average: Fat (g)	.0087006*** (.0029243)
3-Day Average: Protein (g)	.0253895*** (.0018427)
Age	.0057548** (.0028153)
Male	.7811309* (.4166088)
Married	.1347469*** (.0430632)
Household Size	.1476306*** (.023665)
Primary Education	×

Middle School Education	.4216372*** (.0700011)
Bachelor's Degree or Above Education	.7444001*** (.0866413)
Professional Occupation	.329113*** (.0941613)
Office Staff	.2323091** (.0908852)
Farmer	-.3247246*** (.0966836)
Skilled Worker	.2385527*** (.0884893)
Soldiers and Police	.6190743** (.2475131)
Other Occupation	×
Provincial fixed effects/ urban-rural fixed effects/ city and county fixed effects	Yes
Number of observations	1505
Adjustment R- squared	0.4024

Table B – 2. Regression of preferred specification model 4 for log non-retirement household income (male)

Explanatory Variables	Model 4 (4)
3-day total consumed (gram)	-.0008244 (.0005347)
3-Day Average: Energy (kcal)	-.0003073 (.0003513)
3-Day Average: Carbohydrate (g)	.0003453 (.00144)
3-Day Average: Fat (g)	.0062149* (.003248)
3-Day Average: Protein (g)	.0045331** (.0019457)
Age	-.0055077* (.0029927)
Male	-3.355188*** (.5527945)
Married	.202373*** (.0470681)
Household Size	.2300766*** (.0292779)
Primary Education	×
Middle School Education	.4751989*** (.0766031)
Bachelor's Degree or Above Education	.844114*** (.0994117)

Professional Occupation	.7688913*** (.1227645)
Office Staff	.5163088*** (.1169822)
Farmer	-.1401739 (.1208248)
Skilled Worker	.424348*** (.1183469)
Soldiers and Police	.6483155*** (.1981085)
Other Occupation	×
Provincial fixed effects/ urban-rural fixed effects/ city and county fixed effects	Yes
Number of observations	1571
Adjustment R- squared	0.3112

Table B – 3. Regression of preferred specification model 4 for log total net individual income (education level-Middle School Education)

Explanatory Variables	Model 4 (4)
3-day total consumed (gram)	-.0013312 (.0008342)
3-Day Average: Energy (kcal)	.0003193 (.0005808)
3-Day Average: Carbohydrate (g)	-.0049486 (.0034728)
3-Day Average: Fat (g)	-.0083864 (.0076128)
3-Day Average: Protein (g)	-.0001971 (.0039994)
Age	.0038565 (.0045003)
Male	.4136748 (.2570186)
Married	-.1573595* (.0857517)
Household Size	.0067998 (.0516162)
Professional Occupation	.2057155 (.1868558)
Office Staff	.0817595 (.169524)

Farmer	-.4648768*** (.1623221)
Skilled Worker	-.1451124 (.1599414)
Soldiers and Police	.0871552 (.5362097)
Other Occupation	×
Provincial fixed effects/ urban-rural fixed effects/ city and county fixed effects	Yes
Number of observations	613
Adjustment R- squared	0.0957

Table B – 4. Regression of preferred specification model 4 for log total net individual income (education level- Bachelor's Degree or Above Education)

Explanatory Variables	Model 4 (4)
3-day total consumed (gram)	-.0000255 (.0004555)
3-Day Average: Energy (kcal)	.0008978 (.0008427)
3-Day Average: Carbohydrate (g)	-.0049486 (.0034728)
3-Day Average: Fat (g)	-.0083864 (.0076128)
3-Day Average: Protein (g)	-.0001971 (.0039994)
Age	.0038565 (.0045003)
Male	.4136748 (.2570186)
Married	-.1573595 (.0857517)
Household Size	.0067998 (.0516162)
Professional Occupation	.8860351*** (.2045127)
Office Staff	.8263172*** (.2045003)

Farmer	.1168728 (.5187459)
Skilled Worker	.7573544*** (.2695253)
Soldiers and Police	.8939884*** (.3243056)
Other Occupation	×
Provincial fixed effects/ urban-rural fixed effects/ city and county fixed effects	Yes
Number of observations	294
Adjustment R- squared	0.0582

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