DEMAND ELASTICITY FOR NUTRIENTS

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Abstract

Using data from the Household Socio-Economic Survey 2007-08, this study investigates the relationship between nutrient consumption and poverty in Mongolia. The nutrient consumption, I use here, is defined in terms of energy(calorie) and other macro nutrients such as fat, protein and carbohydrates.

I examine how nutrient intake responds to changes in household welfare using an instrumental variable (IV) approach. My preferred estimates (consumption demand elasticity using an unemployment rate as an IV for per capita consumption) gave statistically significant elasticities of 0.33 for total energy, 0.32 for protein and 0.58 for fat. I explored nonlinearities in the relationship between the per capita consumption and nutrientsand found that a significant and positive elasticity for total energy (0.26-0.49) across the all households. The results are consistent with the idea that poorly nourished persons make larger nutritional responses to changes on income than do well nourished persons. The relationship between per capita calorie and some macro nutrient consumption (except carbohydrates) and household welfare in Mongolia is not consistent with the view that income changes have negligible effects on nutrient intakes.

The contribution of this study is based on both --household income and consumption data adjusted for cost-of-living differences over time and space-- thus gives us a rare opportunity to examine the nature of the relationship. This paper hopes to provide some of the first estimates of the demand elasticity for nutrients in Mongolia.

Key words: HSES, Nutrient consumption, Energy, Fat, Protein, Carbohydrates, Household welfare-calorie relationship, Ordinary least squares (OLS), Instrumental variables (IV), Nutrient-household welfare elasticity, Linear regression approach

1. Introduction

Nutrient and calorie consumption can play a significant role in the definition of welfare concepts such as health and labor productivity[42]. Economic analysis of nutrient consumption might offer invaluable input in the design of better development policies.

There is an intimate connection between poverty and malnutrition, especially in developing countries. It is difficult for individuals who are poor to acquire adequate levels of food and thus of nutrient consumption for themselves and their families (Development economics, Debraj Ray).

The percentage of the population that is poor in Mongolia has been around 35 percent in the last decade and the analysis of the determinants of poverty and its relationship to food security and nutritional outcomes have become an important issue and area of research. Moreover, the relationship of nutrient consumption and poverty in Mongolia has not been investigated even though the Living Standard Measurement Surveys and National Nutrition Surveys have been separately conducted.

In 2009, the government of Mongolia announced the National Food Security Program. The initial task of the program is to describe the pattern of food consumption and food security indicators in order to implement policies successfully.

Keeping in mind these motivations, the principal aim of this study is to assess the extent to which nutrient consumption responds to change in household welfare.

However the relationship between the changes in household welfare and nutrient consumption may or may not be strong, thus I explore this relationship in the analytical

[42] See Stigliz (1976) for a detailed discussion of the efficiency wage hypothesis, which provides the theoretical framework for understanding the link between productivity and calorie intake.

part of the study. Evidence on increases in household welfare and increases in nutrient is mixed and varies between strong and weak nutrition responses to household welfare changes with these differences depending on the estimation method, type of survey, and geographic area of interest. These estimates also are affected by whether the calories measured are those actually consumed (intake) or just those available to the household, and whether household resources are measured **by income** or **by expenditure** (J.Gibson and S.Rozelle, 2000).

R.O. Babatunde (2010) noted that divergent opinions on the nature of the relationship call for more empirical research to analyze the income-calorie relationship in specific setting and provide plausible results that could be use to generate appropriate policy responses. The analysis in this study in based on both **household income** and **consumption** data adjusted for cost-of-living differences over time and space and thus gives us a rare opportunity to examine the nature of the relationship. This paper hopes to contribute to the growing literature on determinants of the relationship between the changes in household welfare and nutrient consumptionand provide some of the first estimates of the demand elasticity for nutrients in Mongolia.

The structure of the paper is as follows: the next chapter introduces the conceptual framework, while Chapter 3 reviews the literature on the topic. Chapter 4 describes the household surveys and the data employed in the analysis. Chapter 5 presents and discusses the results from empirical analysis and Chapter 6 concludes.

Conceptual framework

Although the incidence of poverty and incidence of undernutrition may be ordinally related, in the sense that poor person is more likely to be undernourished than her richer counterpart, the relationship between increases in income or in expenditure and increase in nutrition may or may not be strong. The relationship is best determined in terms of elasticities which can reveal what is the percentage change in the consumption of nutrients when household welfare (income or consumption) change by one percentage point. In theory, the elasticities between 0.6 and 0.8 may be good evidence that individuals strongly adjust nutrition to income. (Development economics, Debraj Ray)

To check the relationship, a standard model is drawn from the traditional consumption model. Although consumer theory is developed from the decision perspective of an individual consumer or consuming household, it is usually applied empirically in per capita or per household terms to aggregate market data (Timmer and Alderman, 2002). Determining a specific functional form from the general standard function is a matter of judgment and empirical fit. Equation as the below shows the general form used throughout this analysis.

$$Y_{i,v,t} = \alpha_0 + \alpha_1 FE_{tv} + \alpha_2 Z_{i,v,t} + \gamma X_{i,v,t} + \varepsilon_{i,v,t}$$

Where:

Y is per capita nutrient consumption in household *i* in stratum *v* at season *t*.

FE is a vector of binary variables summarizing stratum and season-specific fixed effects.

Z is a vector of other control variables such as household characteristics, includes age-sex household composition ratios, age, and educational level of the household head and spouse, and electricity type of household; food prices etc.

X is a per capita income/consumption, proxy of household welfare

$\varepsilon$is an error term.

The method of ordinary least squares (OLS) and instrumental variables (IV) is used for estimating the parameters of the model. [43]

At first, I estimated the nutrient-household welfare elasticity with a linear regression approach. Some of the benefits of the linear regression model include the ability to control for a large set of control variables, including area and time-specific fixed effects, and to take into account with standard econometric methods the possible biases due to measurement error and endogeneity issues.

[43] For details on the techniques can see, Introductory Econometrics. J.Wooldridge.

Then I adopt nonlinear specification, still linear in parameters but that allow elasticity to change with household welfare.

Given the multi-stage random sampling approach of selecting respondents of the HSES, where household's observations are clustered by administrative unit of city or villages, the estimate could lead to be biased. In other words, there could be potential intra-cluster correlation of the error term. To eliminate this problem, I employed a cluster correction approach and the standard errors of estimated coefficients are corrected robust to heteroskedasticity and clustering.

Literature review

In the development literature, studies on the relationship between income and nutrient consumption receive considerable attention. In addition, the debate regarding the relationship between nutrient intake and income has high prominence in the development literature (Salois, Matthew, 2010). Historically, the "conventional wisdom" of the World Bank and other institutions in the development arena was that deficient energy intake and hunger can be assuaged through income growth (World bank 1980, 1981). However, a series of articles emerged in the 1980s casting doubt on the role of income (Wolfe and Behrman 1983; Behrman and Wolfe 1984; Behrman and Deolalikar 1987). Moreover, R.O. Babatunde (2010) argued that from this debate on the relationship emerged two groups. The first group is the opinion that the level of per capita calorie intake has a strong positive but non-linear relationship with income, and that increases in income will lead to substantial increase in calorie intake (Grimard, 1996; Subramanian and Deaton, 1996). On the contrary, the second group of literatures suggests that the linkage between income and calorie intake is weak and therefore, increase in income will not result in substantial improvement in calorie intake (Behrman and Deolalikar, 1987; Boius and Haddad, 1992). So, it can be stated that the role of income in nutrition continues to spawn serious investigation, with contrasting results appearing throughout the literature.

However, there is an abundance of estimates of the demand for calorie intakes while for other nutrients are scarce. Skoufias (2009) claimed that unfortunately, irrespective of the size of the estimated elasticity for calories, there is nothing that can be inferred about the consumption about essential nutrients. Even if a reasonably sized and statistically significant income-calorie is found, the role of income in nutritional status is still unclear since people may shift the composition of their nutrient consumption as income changes (Behrman and Deolalikar 1989). As incomes rise, expenditure on food may increase because more expensive food being purchased but the nutrient content of these foods may not increase proportionately (Pitt 1983; Behrman, dealalikar, and Wolfe 1988). Improvements in income can trigger increases in food expenditures or total calorie intake, but this may not coincide with a diet more rich in nutrients (Brinkman et.al 2010; Behrman and Deolalikar 1987). Households tend to increase the variety of their diet based on features other than nutrient content, such as taste and quality, as they substitute away from cheaper sources of calories towards more expensive ones. It means that significant positive estimates on the relationship do not necessarily imply a higher consumption of other macro and micro nutrients. Conversely, studies that uncover a small or zero elasticity do not necessarily also prove that a change in income does not affect nutrition. For example, a drop in income may result in unchanged calorie intake, but the consumption of vital nutrients may fall as household substitute towards cheaper and less nutritious foods.

Regardless of the size of there calories, there is little room for conclusions regarding the consumption of important nutrients, such as proteins, fats, and carbohydrates (Skoufias 2009)

I summarize the result of the most resent studies as the below.

Gibson et.al (2002) found the demand elasticity is approximately 0.6 using parametric and semiparametric method. And they argued that the relationship between per capita calorie consumption and per capita expenditure in urban areas of Papua New Guinea is not consistent with the view that income changes have negligible effects on nutrient intakes.

Skoufias (2003) examined the relationship in Indonesia using nonparametric and parametric methods and found positive, significant elasticities as 0.32-0.45.

Skoufias et.al (2009) estimated the income (total expenditure was used as proxy of income) elasticity for a variety of macro- and micronutrients in poor rural households in Mexico using both parametric and semiparametric methods. They had a special focus on nonlinearity of the relationship. Their major finding is that while some nutrients, namely fats, vitamin A and C, calcium and heme iron have a sizeable positive elasticity, the elasticity for calorie is close to zero.

Babatunde et.al (2010) relooked at the relationship in Rural Nigeria using parametric and nonparametric techniques. They found that income has a significant positive relationship with calorie intake. However they concluded that the estimated elasticity (0.181) suggests calorie intake does not increase substantially with increases in income.

Aromolaran (2010) addresses the question of how calorie consumption in Afriacn low-income households would respond to intrahousehold redistribution of income from men to women. He use survey data from semirural areas of south-western Nigeria and found calorie income elasticity is small and close to zero.

2. Data and sampling

Data collection

The data used for this study is obtained from a comprehensive survey of households in Mongolia, called as Household Socio-Economic Survey, 2007-08. /HSES 2007-08/. The HSES 2007-08 is a nationally representative survey, whose main objectives are to evaluate and monitor the income and expenditure of households and to define a poverty profile of the country. The HSES is a permanent survey carried out by the NSO of Mongolia and for this study 12 months of fieldwork is used, that is, from July 2007 to June 2008. The HSES was conceived as an improved version of the Household Income and Expenditure Survey (HIES) because several modules from a typical Living Standards Measurement Survey were merged to the HIES which was conducted since 1966. It contains 16 major modules: basic socio-economic information about the members of the household, education, health, reproductive health, migration, employment, wage jobs, job search, agriculture and herding, non-farm family businesses, other income, savings and loans, housing and energy, durable goods, non-food expenditures and food consumption.

Food consumption data that consumed by household members was collected at the household level with the Classification of individual consumption by purpose/COICOP/ and covering 122 items, organized in 13 categories: flour and flour products; meat and meat products; fish and seafood; milk, cheese and eggs; oils and fat; fruits; vegetables; sugar and jam; other food; tea and coffee; mineral water and soft drinks; alcoholic beverages; and tobacco and cigarettes. The method to collect these data and the reference period vary across urban and rural areas. In the capital and in prefecture centers, information is captured through a diary, which is compiled by an enumerator every ten days, three times during a month. In other words, the reference period is one month. In village centers and in the countryside, a recall period for the last week is employed. Moreover, all possible sources of food consumption are included. This means that the food information comprises not only consumption on purchases in the market or on meals eaten away from home but also food that was own produced or received as a gift.

As in the case of food, data on an expensive range of non food items are available, 371 items arranged in 38 different groups such as clothing and footwear for men, women and children, jewelry and souvenirs, clothing materials, education, health recreation, beauty and toilet articles and services, cultural expenses, household goods, durable goods, housing expenditures, transportation, communication, insurance and taxes with COICOP classification. The HSES does not gather information on quantities consumed because most non food items are too heterogeneous to try to calculate unit values.

With regard to household total income, the information with different source is available from the survey. The information on farm and non farm activity of household covers sold production and total expenditure at household level. Wages and remittance were recorded separately for all household members. There is also information about other incomes such as non labor incomes which were recorded at household level. All incomes were covering a 12-months period in order to avoid a seasonality bias.

Variables and their measurements

The analysis reported here are used three main variables such *us per capita nutrient consumption, per capita income* and *per capita consumption.*[44] The latter two variables are estimated to proxy for household welfare.

Per capita nutrient consumption:

Food consumption collects on the quantity consumed (including from own production and free meal) at the household level. Skoufias (2009) supports that since consumption of nutrients determined by what foods and how much of those foods are consumed, good estimates of the demand system parameters for food can be used, by applying food-to-nutrient conversion factors (as sited in Pitt, 1983; Strauss, 1984). I use a food composition table compiled by the Ministry of Health of Mongolia in 2008 that contains information on the nutrient content per 100 grams of all the major food items in Mongolia to convert the quantity consumed of each of the hundred food items by each household into its equivalent content of calories, protein, fat and carbohydrates. Tobacco and residual categories are excluded from this calculation. It means household nutrient intake *HNUT* is computed through the formula:

$$HNUTi = \sum_{j=1}^{n} Fij$$

Where: *Fij* is the weight in 100 grams of the average daily intake of food item j by household i.

Nj is the standard measure of nutrient found in each type of food item *Fj*.

A total number of food items is n=100.

Then per capita nutrient consumption is estimated converting household nutrient consumption to per capita using equivalent adult ratio.

$$NUTi = \frac{HNUTi}{ADEi}$$

Finally, calorie of meals eaten outside the household is added to this calculation in order to estimate total calorie income at household level. For that I use average price of calorie at household level and average expenditure of meals eaten outside.

I try to have a welfare indicator, both measurable and acceptable, to rank all population accordingly.

Per capita consumption:

Creating consumption aggregate is guided by theoretical and practical considerations. First, it must be as comprehensive as possible given the available information. Omitting some components assumes that they do not contribute to people's welfare or that they do no affect the rankings of individuals. Second, market and non-market transactions are to be included, which means that purchases are not the sole component of the indicator. Third, expenditure is not consumption. For perishable goods, mostly food, it is usual to assume that all purchases are consumed. But for other goods and services, such as housing or durable goods, corrections have to be made. Lastly, the consumption aggregate comprises five main components: food, non-food, housing, durable goods and energy.

As in the case of food, non-food consumption and energy consumption is a simple and straightforward calculation. Again, all possible sources of consumption is included[45] and normalized to a common reference period.

However, for those components as housing and durable goods there is more imputations were employed.

Mongolia shows remarkable seasonal and spatial price differences, especially for food items. Therefore, in order to properly measure living standards, expenditure values need

[44] Distribution of calorie, income and consumption is in Figure A.1 and in Table A.1 in the Appendix

[45] Self produced and in-kind consumption is included with same way of total income.

to be corrected for such differences using price indices. The household survey provides information on budget shares for all items but information on average prices paid by the household only for food items. A Paasche price index at the cluster level was constructed combining information from the HSES and the national consumer price index. Clusters are comprised by 10 households in urban areas and 8 households in rural areas. Households within a cluster are likely to face similar prices and have similar consumption patterns. The Paasche price index for the primary sampling unit i is obtained with the following formula:

$$p_i^P = \left[\sum_{k=1}^{n} w_{ik}\left(\frac{p_{ik}}{p_{0k}}\right)^{-1}\right]^{-1}$$

Where:

k is one of the n goods considered for the index,

w_{ik} is the budget share of good k in the primary sampling unit i,

p_{ik} is the median price of good k in the primary sampling unit i, and

p_{0k} is the national median price of good k.

Overall, the final price index considers both food and non-food items for the temporal and spatial adjustment.

The final step in constructing consumption for the welfare indicator involves going from a measure of standard of living defined at the household level to another at the individual level. Consumption data are collected typically at the household level (usual exceptions are health and education expenses), so computing an individual welfare measure generally is done by adjusting total household consumption by the number of people in the household, and assigning that value to each household member. Common practice when doing this is to assume that all members share an equal fraction of household consumption. The final step in constructing consumption for the welfare indicator involves going from a measure of standard of living defined at the household level to another at the individual level. Consumption data are collected typically at the household level (usual exceptions are health and education expenses), so computing an individual welfare measure generally is done by adjusting total household consumption by the number of people in the household, and assigning that value to each household member. Common practice when doing this is to assume that all members share an equal fraction of household consumption.

Per capita income:

My estimated monetary income includes wage income and remittances as well as non labor income received by individuals. However, estimating income for agricultural household and those who are involved in non farm activities is problematic due non availability of actual income data. Therefore, I try to estimate their income data from their total sold production. Net income is estimated by subtracting cost of production from value of production sold.

Moreover, self produced and in-kind consumption is valued and included in the household total income. The HSES collects average prices for food purchases, whereas for all other sources quantities are recorded. Using those prices, median prices are computed at several levels: by household, cluster, prefecture and stratum. Hence if a household purchased a food item, the same price would be used to value its self-produced and in-kind consumption. If the household did not make any purchase but consumed a food item, the average price from the immediate upper level is used to estimate the value of that consumption.

Finally total household income is converted to individual level and adjusted by seasonal and spatial price in order to get real value of per capita income.

Sampling design

The sampling frame of the HSES was developed by the NSO based on population figures for 2005 from local registration offices. The design of the survey recognizes three explicit strata: Ulaanbaatar-capital, aimag-prefecture centers, and rural areas and small towns/villages. The selection strategy was different in each stratum: a two-stage process in urban areas and a three-stage process in rural areas. All 1,248 primary sampling units or clusters were selected with probability proportional to size and were randomly allocated into the 12 months of survey fieldwork. Thus the survey visited a random sub-sample of 104 clusters each month. The 8 or 10 households were selected randomly from the cluster and total sample of 11232 households was also allocated into the 12 months.

3. Empirical analysis and results

3.1 Demand elasticity for nutrients

The behavior-related issues, such as the response of nutrient consumption to changes in household welfare, are analyzed in this section. I try to explore the nature of the relationship between household welfare and nutrient consumption in Mongolia using parametric techniques which allow us to control properly for biases due to measurement error and endogeneity issues.

In particularly, I study whether, and to what extent or degree an elasticity of nutrient consumption with respect to income and consumption is in Mongolia.

The main hypothesis to be tested in this study is that, increase in per capita income or per capita consumption would increase per capita nutrient intake among the sampled households.

Choosing the Covariates:

Household size and demographic composition variables may be important if there are difference in nutrient consumption according to number of household member and their age and gender. The age and gender of household head and education levels, especially for women, may affect nutrient intake (Behrman and Wolfe, 1984). Food prices might be important to include as a way of ensuring that non-linearities are not just due to excluded price effect, because low-income consumers may have the largest nutrient response to price changes (Alderman, 1986). Stratum level and time level fixed effect are also candidates for inclusion because there may be community and seasonal influences on eating patterns that are not captured by the household and individual level variables. Mongolia is one of cold counties with the composition of food consumption changes drastically by season. Therefore a temperature may have effect on decision to nutrient consumption because the foods with more calorie and fat intake tend to be consumed more.

3.2 Linear specification

I estimate the demand (income and expenditure) elasticity for nutrients with linear regression approach. First, I use per capita income proxy of household welfare and specify a model represented as:

$$\ln NUT_{i,v,t} = \alpha_0 + \alpha_1 FE_v + \alpha_2 FE_t + \beta Z_{i,v,t} + \gamma \ln PCI_{i,v,t} + \lambda P + \omega T + \varepsilon_{i,v,t} \quad (1)$$

Where:

NUT is per capita nutrient consumption in household *i* in stratum *v* at season *t*.

FE is a vector of binary variables summarizing stratum and season-specific fixed effects. This variable can be intended to control for stratum or area and season-specific characteristics that may have also a direct impact on nutrient.

Z is a vector of household characteristics, includes age-sex household composition ratios, age, and educational level of the household head and spouse, and electricity type of household.

PCI is per capita real income and it is corrected by seasonal and spatial price adjustment.

P is the price for food items as recorded in the prefecture level

T is the annual average temperature as recorded in the prefecture level

$\varepsilon$is an error term.

In this model the main parameter of interest is γ in terms of the sign and magnitude. The coefficient will report what is the percentage change in the nutrient when household income change by one percentage point.

The results of the OLS estimation of (1) are presented in Table 1 (in the first column). One general pattern is that the estimated elasticities are all positive and significant for all nutrients. The total calorie income elasticity is 0.17 and implies that a 100 % increase in income is result in an increase of 17% in the calorie. The nutrient with highest income elasticity is fat (0.22) and with lowest is carbohydrates (0.08).

Table 1: **The elasticity of nutrients with respect to income**

Nutrients	OLS	IV
Energy	0.14*** (0.0071)	0.16* (0.0988)
Total energy	0.16*** (0.0070)	0.23** (0.0979)
Proyein	0.17*** (0.0076)	0.22** (0.0963)
Fat	0.22*** (0.0098)	0.40*** (0.1415)
Carbohydrates	0.08*** (0.0070)	-0.04 (0.1023)
F-test instrument		25.23
Observations	10871	10871

*Significant at 10%,**significant at 5%, ***significant at 1%; cluster-robust standard errors are in parentheses

The results of the OLS presented here have been based on estimators that assume zero correlation between per capita income and the error term. However this may not be the case in this model because income variable is endogenous. Thus the OLS estimation would have omitted variable bias. There is also the problem with possibility of reverse causality between nutrient consumption and income.

With this in mind, I estimate model (1) also with an instrumental variable (IV) approach. For the IV, I would like to have a variable that is correlated with per capita income but not with unobserved variables that drive nutrient consumption. I use unemployment rate[46] at city or village level as an instrument for per capita income. Unemployment rate is the proportion of the number of registered unemployed persons to the economically active population. I assume that this rate can describe socio economic situation of the area where household live that can have impact on household welfare as well as income.

In Table 5.1, in the last, I report the results with unemployment rate variable as instrument which has high power as the F- test (25.23). One general pattern from the IV results is that most of the estimated elasticities are much higher than those from OLS. The estimated elasticities are all positive and significant for the energy, the protein and the fat. It illustrates that a 100% increase in income is result in an increase of 16% in the energy, 23% in the total energy, 22% in the protein and 40% in the fat. On the contrary, negative and not significant elasticity (-0.04) is displayed by the IV estimate for carbohydrates. However, the reduced form result reports that the IV is not robust to carbohydrates.

Secondly, I use per capita consumption proxy of household welfare. Even though I rely on per capita income could capture household welfare because I included all potential sources, in general, consumption is preferred measure. This preference of consumption over income is based on both theoretical and practical issues.[47]

A model I use is represented as:

$$lnNUT_{i,v,t} = \alpha_0 + \alpha_1 FE_v + \alpha_2 FE_t + \beta Z_{i,v,t} + \gamma \ln PCC_{i,v,t} + \lambda P + \omega T + \varepsilon_{i,v,t} \quad (2)$$

Where:
NUT is per capita nutrient consumption in household *i* in stratum *v* at season *t*.

[46] I estimated the rate using the information from the NSO which was prepared by local government office

[47] See Deaton and Zaidi (2002); Hentschel and Lanjouw(1996)

FE is a vector of binary variables summarizing stratum and season-specific fixed effects. This variable can be intended to control for stratum or area and season-specific characteristics that may have also a direct impact on nutrient.

Z is a vector of household characteristics, includes age-sex household composition ratios, age, and educational level of the household head and spouse, and electricity type of household.

PCC is per capita consumption and it is corrected by seasonal and spatial price adjustment.

P is the price for food items as recorded in the prefecture level

T is the annual average temperature as recorded in the prefecture level

$\varepsilon$is an error term.

The results of the OLS estimation of (2) are presented in Table 5.2 (in the first column). The estimated elasticities are all positive, quite high, and significant for all nutrients. One clear pattern from this OLS results is that all of the estimated elasticities are higher than those from OLS in the model with per capita income in table 5.1. This can support the story of low elasticity when income variable is used the proxy of household welfare. That means that the classical measurement error bias which is referred to as attenuation bias was a result in downward bias of the estimation. The total calorie income elasticity is 0.36 and implies that a 100% increase in income is result in an increase of 36% in the calorie. The elasticities for calories are remarkably similar to 0.35 calorie income elasticity of Subramanian and Deaton (1996) for India, and the 0.31 estimate of Tiffin and Dawson (2002) for Zimbabwe. The nutrient with highest income elasticity is fat (0.47) and with lowest is carbohydrates (0.21).

However, the OLS estimation would have still omitted variable bias because consumption is also endogenous. Another potential source of bias in the OLS is the non classical measurement error bias which is result in upward bias of the OLS.[48] Therefore, I estimate model (2) with the same instrument variable as unemployment rate for per capita consumption. Results are presented in Table 2, in the last column.

Table 2: **The elasticity of nutrients with respect to total consumption**

Nutrients	OLS	IV
Energy	0.31 ***	0.24 *
	(0.0094)	(0.1339)
Total energy	0.36 ***	0.33 **
	(0.0090)	(0.1281)
Protein	0.37 ***	0.32 **
	(0.0097)	(0.1267)
Fat	0.47 ***	0.58 ***
	(0.0128)	(0.1905)
Carbohydrates	0.21 ***	-0.06
	(0.0096)	(0.1524)
F-test instrument		15.82
Observations	10871	10871

*Significant at 10%, ** significant at 5%, ***significant at 1%; cluster- robust standard errors are in parentheses.

The estimated elasticities (except the fat) are lower than the OLS, with supporting the story of upward bias in the OLS. The estimated elasticities are all positive and significant for the energy, the protein and the fat. It illustrates that a 100 % increase in income is result in an increase of 24 % in the energy, 33 % in the total energy, 32 % in the protein and 58 % in the fat. The same pattern as in income in Table 5.1 appears for the carbohydrates which displays not significant and negative elasticity.

The elasticity for calorie energy is also similar to the 0.19 estimate of Dawson (2002) for Pakistan and Aromolaran (2004) for Nigeria. Moreover, the elasticities for the fat and the carbohydrates are remarkably similar to the 0.51 estimate and -0.06 of Skoufias (2009) for Mexico.

One general pattern of the IV results in the both income and consumption specification is that the estimated elasticities are significant for the nutrients (except carbohydrates) and it can imply increase in household welfare seems to be effective for calorie, protein and fat consumption. One another finding is the estimated elasticities are not much associated with most deficient nutrient such as carbohydrates.

48 Non classical measurement error and aggregation bias could be less in the study because nutrient intake quantity data were obtained directly from food quantity data and not from food expenditure data

3.3 Non linear specification

Since a log-linear specification of per capita income would restrict the elasticity coefficient to be constant across income levels and theory suggests that this elasticity is likely to decline as income increases (Aromolaran, 2010). For a quick look at the relationship I employ curve-fitting approach. This is usage of nonparametric methods that fit a local relationship between variables. The result of the curve-fitting approach indicates that a quadratic relationship may be appropriate.
I then try to explore potential nonlinearities in the relationship between nutrients and household consumption with quadratic specification. [49]

$$\ln NUT_{i,v,t} = \alpha_0 + \alpha_1 FE_v + \alpha_2 FE_t + \beta Z_{i,v,t} + \gamma_1 \ln PCC_{i,v,t} + \gamma_2 (\ln PCC_{i,v,t})^2 + \lambda P + \omega T + \varepsilon_{i,v,t} \quad (3)$$

Where per capita consumption is proxy of household welfare and other variables in the model (3) are still the same as in the original model (2).

A positive the parameter of γ would imply that increase in income would result in increased nutrient consumption while a negative γ would imply that increase in income would result in decreased nutrient consumption. Both the OLS and IV ((using as instrument unemployment rate and its square) regressions are done. The result with OLS suggests that the elasticities for all nutrients are inversely related to household welfare level.

However, I am interested in looking at a summary effect on nutrients and then the elasticity for nutrients will be as in (4)

$$\frac{\partial LnNUT}{\partial LnPCC} = \gamma_1 + 2\gamma_2 \ln PCC \quad (4)$$

[49] Aromolaran (2004) noted that Timmer and Alderman (1979) found quadratic specification to have the best fit out of all the different forms of Engel specification.

Table 3: **The elasticity of nutrients with respect to total consumption, Quadratic specification**

Nutrients	Poor		National		Non poor	
	OLS	IV	OLS	IV	OLS	IV
Total energy	0.51***(0.0456)	0.49***(0.0603)	0.39***(0.0340)	0.33**(0.1420)	0.33***(0.0818)	0.26***(0.1081)
Protein	0.52***(0.0492)	0.73***(0.1518)	0.39***(0.1160)	0.33 (0.3578)	0.34***(0.0883)	0.15(0.2724)
Fat	0.72***(0.0801)	0.98***(0.1501)	0.51***(0.1887)	0.58 (0.3536)	0.42***(0.1437)	0.41(0.2693)
F-test instrument log PCC			12.63			
F-test instrumentlog PCC			13.02			
Observations			10871			

*Significant at 10%,**significant at 5%, ***significant at 1%; cluster-robust standard errors are in parentheses

The elasticity coefficients are shown in Table 3. I report the elasticity for energy, protein and fat computed at three mean point of the per capita consumption distribution. It means that coefficients are estimated at the mean value of per capita consumption of all households, and poor and non poor households as well. If we focus on IV results some interesting patterns arise: for energy/ calorie (0.40-0.49), protein (0.73) and fat

(0.98) the elasticities are high and positive at poor households; in particular total energy remains sizable magnitude (0.26-0.49) across the entire households. Main finding is that poor households have significant and positive elasticity for all nutrients while non poor households have positive and significant elasticity only for total energy.

4. Conclusion

The analysis of the impact of the household welfare on nutrition status provides essential insights for creating appropriate and effective policies and programs to address these issues.

In order to obtain a description of the situation, I explored the relationship between household welfare and nutrient consumption. The study provided estimates of the extent to which nutrient consumption at household level increases in response to changes in household income and consumption.

As discussed in the literature review section, the estimated elasticities for calorie and macro-nutrients display a very large range: going from zero to quite sizeable positive numbers.

Here, I found that the elasticities for energy/calorie, protein and fat are positive and significantly different from zero. My preferred estimates (consumption demand elasticity, IV with unemployment rate) gave statistically significant elasticity of 0.33 for total energy, 0.32 for protein, 0.58 for fat (see Table 5.5). However, estimated elasticity for carbohydrates is negative, small and not statistically significant (-0.06). The one explanation could be here that when household welfare increase households tend to substitute flour and rice, which contains more carbohydrates, with other food.

I also found some support that the estimated elasticity varies inversely with household level when the model incorporates quadratic terms. However, an IV result suggests that a poor household has significant, positive elasticity for all nutrients. One clear pattern from the non linearity is that the significant, positive elasticity (0.26-0.49) for total energy is founded across the entire households. The results also are consistent with the idea that poorly nourished persons make larger nutritional responses to changes on income than do well nourished persons.

In terms of methodology, the results imply that the nutrient–household welfare relationship may be revealed differently when a proxy of household welfare is either the consumption or income. In other words, if measurement error is the dominant source of bias, then the estimate would be downward bias of true estimation. However, when I control endogeneity issues in the model, the range of the difference of estimated elasticities was reduced.

Finally, the relationship between per capita calorie and some macro nutrient consumption (except carbohydrates) and household welfare in Mongolia is not consistent with the view that income changes have negligible effects on nutrient intakes. Thus, increase in income does seem to be policy tool that can remedy the deficiency in nutrients for poor households.

To conclude, the best way to fight the food security problem in the country could be the combination of policies that increase household incomes and that provide information on how to obtain a balanced and healthy diet.

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