Why Is Food Consumption Inequality Underestimated? A Story of Vices and Children*

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Abstract

Without data on individual consumption, inequality is invariably inferred by applying adult equivalence scales to household-level consumption data. To assess the effectiveness of these household-based measures of inequality, we exploit a rare opportunity in which individual food consumption data for each and all household members are available in China. We find that standard adult-equivalent measures understate cross-sectional individual inequality by 40%. The discrepancy is driven by the dispersion of "vices" consumption among adults—alcohol, tobacco, coffee and tea—and the dispersion of core food consumption among young children, which doubles that of adults. Our results suggest caution in the use of adult-equivalent scales to measure inequality.

Keywords: Food, Consumption, Inequality, Individual Data, Vices, Children
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1 Introduction

Consumption inequality is an important indicator of inequality in well-being (Deaton, 1992, Heathcote et al., 2010, Attanasio and Pistaferri, 2016). Not only is consumption a primary input to an individual's utility, which sums up to a measure of social welfare at a point in time, but also it correlates more closely with the permanent component of individual income, and therefore is a better proxy for the total amount of economic resource an individual commands over her life time (Deaton and Paxson, 1994, Attanasio and Weber, 1995, Krueger and Perri, 2006). Though economic theory requires making an individual the unit of analysis, consumption is typically measured by household-level expenditures on non-durable consumption goods. Economists then resort to adult-equivalent consumption measures that remove differences in household sizes and compositions, before making inferences on consumption inequality (Deaton and Muellbauer, 1980).[1] But how well does adult-equivalent consumption perform in capturing actual individual consumption inequality? Without actual individual consumption data, the answer remains elusive.

It is important to assess how reliable adult-equivalent consumption is in keeping track of individual inequality. For example, adult-equivalent consumption is almost invariably used to construct stylized facts which are used in disciplining macroeconomic models of cross-sectional and lifecycle inequality (Krueger et al., 2010, Kaplan, 2012, Aguiar and Hurst, 2013, Bick and Choi, 2013). In this paper, we take advantage of a rare individual consumption dataset, where food consumption is measured for each and all household members in a large sample of households, to answer this question. Our source is the China Health and Nutrition Survey (CHNS), which gives us an unbalanced panel of about 6,800 households from 1993 to 2011, who live in nine geographically diverse and densely populated provinces in China. The CHNS is designed for monitoring the health and nutritional status of the Chinese population during years of rapid economic transformation, but its rich information on the social and economic lives of its subjects proves to be useful for a variety of economic inquiries (Wang, 2011, Santaeulàlia-Llopis and Zheng, 2018). Using the demographic information on members of a household, we follow the standard procedure to adjust the household-level consumption by the household's age-sex structure to arrive at an adult-equivalent consumption measure for the household. We then compare food consumption inequality based on this adult-equivalent consumption measure and the inequality of individual food consumption based on the individual data.

We have three main findings. First, the cross-sectional inequality in adult-equivalent food consumption understimates individual food inequality by as much as 40%. Second, more than

[1] Adult-equivalent consumption is computed using scales that measures the cost of living of a household given its size and age-sex structure, relative to a reference household such as a single adult. See Section 3.

half of the missing inequality comes from the failure of the demographics-based adjustment to account for the inequality of the consumption of alcohol, tobacco, coffee and tea (or more conveniently the "vices") among demographically similar adults. Once we exclude the vices from the food consumption, adult-equivalent consumption inequality misses only about 17% of individual inequality. Third, the panel dimension of our dataset allows us to estimate the life cycle profile of consumption inequality for both the household-based adult-equivalent consumption and the individual consumption. Our analysis reveals that inequality in food consumption among small children aged between 0 to 5 roughly doubles that of adults, indicating that children of similar age and same gender consume very different amounts in different households. If we were to remove the vices component from food consumption as well as households with children from our sample, the amount of consumption inequality that adult-equivalent measures miss relative to the actual individual inequality is merely 5%. That is, the inequality of vices consumption and the inequality among small children account for almost 90% of the total missing inequality. These results hold for both our rural and urban samples.

Our findings suggest caution against inferring individual consumption inequality from household-based consumption measures combined with adjustment procedures that are based solely on the demographic composition of a household. How effective this adjustment procedure is depends on the particular consumption item under study—in our example, more effective, though still imperfect, when excluding the vices—and on the presence of young children. At the policy level, given that collecting consumption information is costly (Grosh and Deaton, 2000, Beegle et al., 2016), it may be worthwhile to survey in individual detail the consumption of vices in adults and the core food consumption of children to close this gap.

The sensitivity of life cycle (mean) consumption profiles to alternative adult-equivalent consumption measures has been previously studied in Fernández-Villaverde and Krueger (2007). In contrast, we focus on cross-sectional and life cycle consumption inequality. In particular, we directly compare the inequality measures produced by adult-equivalent consumption with the true individual-level inequality. We focus on food consumption, which in the context of China is the largest component of consumption representing roughly 65% of total non-durable consumption.[2,3] Indeed, due to the paramount importance of food and nutrition for the poor, individually surveyed diet data have been collected and studied for other developing economies (Behrman and Deolalikar, 1990, Pitt et al., 1990, Behrman, 1993, Haddad et al., 1997, Alderman et al.,

[2]Using the China Household Income Project, which surveys household expenditure patterns, we find that food expenditure accounts for about 63% of the total non-durable consumption expenditures (which includes food, clothing, transportation and communication, utility and fuel) for Chinese urban households from 1995 to 2007.

[3]This figure is similar for other growing economies. For example, in India and Pakistan a large proportion of households spends 75% of their expenditure on food (Deaton, 1997). In Malawi, Uganda and Tanzania food expenditure represents roughly two thirds of the total expenditure (De Magalhães and Santaeulàlia-Llopis, 2015).

2008). However, none of these studies analyzes the size of cross-sectional individual inequality and the ability of adult-equivalent consumption measures to capture it, which is the focus of our study. This is probably due to the fact that we draw from a survey of a much larger scale over an extended period of time compared with previous studies, which is an important advantage from an aggregate perspective.

Closely related to our work, Haddad and Kanbur (1990) use an individual diet survey from a village in rural Philippines in 1984-5 to find household-based calorie intake, adjusted for differential needs of household members, misses as much as 50% of inequality in individual calorie intake. In contrast, we find the adult-equivalent inequality in core food (i.e. food excluding the vices, which defines the source of calorie) misses only about 17% (14%) of individual core food inequality for the rural (urban) sample. We suspect that the larger missing inequality they report may due to their relative small sample and the timing of the survey in the Philippines that coincides with a period of high macroeconomic instability.[4] The fact that we have a span of 18 years of panel data gives us the option to control for time effects that capture aggregate shocks and to control for cohort effects that helps us isolate life cycle behavior. Indeed, our life cycle analysis helps identify the presence of children as driving the missing inequality in core food or calorie, which provides a new insight to the previous results in Haddad and Kanbur (1990) regarding calorie intake inequality.

An important approach to get at individual inequality is by using the structure of collective models. Lise and Seitz (2011) use a collective model to structurally recover individual consumption and show that the inferred individual consumption inequality is twice what household-level consumption data implies for the United Kingdom, which is a larger discrepancy than what we find for food consumption. Our focus, food consumption, captures a large part of (though not all) household consumption and is also arguably less subject to measurement error (Attanasio et al., 2014). We contribute to this literature by providing direct evidence from the individual-level data that the adult-equivalent household consumption inequality, a sufficient statistics for unitary models, masks substantially larger individual consumption inequality. Individual consumption data, where available, can also be a very valuable asset to identify the dynamics of intrahousehold re-

[4] Theirs is a sample of 448 households comprising 2,888 individuals in a rural southern Philippine province that were surveyed in four rounds over sixteen months in 1984-5. Following the assassination of opposition leader in August 1983, the Philippines experienced serious political and economic instability in the following years: "In September, industrial production fell for the first time in several years, and huge layoffs seemed imminent in the first quarter of 1984... the rate of inflation doubled following two devaluations of the peso in June and October... the country faced its worst liquidity crisis since 1945 due to an estimated $1 billion capital flight from late August to December," cited from "The Roots of the Philippines' Economic Troubles" prepared for the Heritage Foundation by Ramon H. Myers Hoover Institution on War, Revolution and Peace. The article is online at http://www.heritage.org/research/reports/1984/05/the-roots-of-the-philippines-economic-troubles (accessed December 9th, 2016).

source allocation (Lise and Yamada, 2014) as well as to study of poverty measures. Dunbar et al. (2013) use information about clothing expenditures across children and adults within households in Malawi to recover the structure of total consumption within a collective model and find that child poverty is underestimated with standard poverty indexes. Here, we show that among young children food inequality is twice as large as that for adults which, importantly, is not captured by standard adult-equivalent measures.[5]

It is important to note that while the measurement of consumption inequality is a step towards measuring welfare inequality, consumption inequality can also reflect heterogeneity in preferences (Mazzocco and Saini, 2012). Interpreting the welfare consequence of the missing consumption inequality is beyond the scope of this paper, but we provide suggestive evidence that preference heterogeneity likely plays a role. For example, we find that the consumption of vices may reflect different priorities among the teenagers: prioritizing popularity among peers and prioritizing good grades are positively and negatively correlated with the consumption of vices respectively.

Lastly, the difficulty of the identification of the equivalence scale is well recognized in the literature (Pollak and Wales, 1979, Blundell and Lewbel, 1991). There are modeling options that explicitly deal with the potential endogeneity issues such as family formation (Salcedo et al., 2012). Interesting identification strategies have been used to structurally estimate equivalence scales using individual life insurance purchases (Hong and Ríos-Rull, 2012) or collective models with economies of scale and intrahousehold sharing rules (Browning et al., 2013). Another compelling strategy to estimate equivalence scales is the use of the distributional patterns of welfare programs, in which case the scales are not determined by the household but by the community distributing aid (Olken, 2005). In our benchmark, we follow the regression-based approach that considers equivalence scales exogenous (Aguiar and Hurst, 2005, 2013) and focus on the consequence on the measurement of the inequality. It is important to note that our main messages are robust to the use of alternative equivalence scales (e.g. OECD scales) that take into account endogeneity.

The rest of the paper is organized as follows. In Section 2, we describe the data set. In Section 3, we introduce our benchmark equivalence scale to adjust the household consumption for the household structure. In Section 4, we quantitatively assess the effectiveness of adult-equivalent food consumption inequality in capturing actual individual food consumption inequality and investigate the sources of the discrepancy. Section 5 concludes.

[5] More recently, De Vreyer and Lambert (2016) study the unusual compound structure within households in Senegal to infer individual consumption. See also Lambert et al. (2014).

2 The Data

We use the China Health and Nutrition Survey (CHNS), a longitudinal study designed to track the health and nutritional status of the Chinese population since 1989.[6] We draw our baseline sample from the most recent seven waves of the survey, conducted in 1993, 1997, 2000, 2004, 2006, 2009, and 2011, and in the consistently surveyed provinces, Liaoning, Heilongjiang, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, and Guizhou, which involve a total of 25,761 individuals living in 6,809 households.

At the core of our food consumption measure is the food intake recorded in the Nutrition Survey, an integral part of the CHNS. It documents the quantity (in grams) of a variety of food items that each and all household members consume at and between meals, both at home and away from home, over a three-day window. The result is a highly detailed account of hundreds of types of food consumed during the day, whose precision is suitable for nutrition studies (Batis et al., 2014). This survey design minimizes recall and telescoping error and is considered close to a "gold standard" for measuring consumption (Deaton and Zaidi, 2002, Beegle et al., 2010). This constitutes what we call the core food component.

In addition, we construct a "vices" component of food consumption, which includes alcohol, tobacco, coffee and tea. The consumption of these items is consistently surveyed for all individuals age 14 and above since 1993, which defines the time frame of our study.[7] For cigarettes, coffee and tea, the respondent is asked the frequency of consumption in the last month as well as the quantity consumed per day. For alcohol, the respondent is asked the quantity consumed per week. We annualize and convert these quantity data to standard units of measure.[8]

We value the food intake at the local prices of the core component and the vices surveyed

[6] The CHNS is an on-going collaborative project between the Carolina Population Center at the University of North Carolina at Chapel Hill and the National Institute of Nutrition and Health at the Chinese Center for Disease Control and Prevention.

[7] The structure of the questions in the section on smoking, alcohol, coffee and tea consumption stays relatively constant with minor changes since 1993, though this section is included in different parts of the survey. In 1993 and 2000, it is found in the Physical Examination Survey. In 1997, it is part of the Household Survey, while after 2004 it is moved to the Adult/Child Survey. We include the consumption of cigarettes, tea, coffee, beer, wine, and liquor in our measure of "vices." We exclude pipes and tobacco usage, because it is surveyed only up to 2000. We also exclude sugared drinks, because it is not surveyed until 2004. Before 2000, information on vices consumption is collected from all members of a household, while in 2000 it is collected from members aged 14 and above and after 2004 from members aged 12 and above. To construct a consistent measure, we replace the quantity of vices for individuals under age 14 by missing values. This replacement does not have noticeable effect on measured inequality either in the cross section or over the life cycle.

[8] In the survey, coffee and tea are measured by the number of cups per day. We assume that each cup of coffee or tea contains 5 grams of grounded coffee beans or tea leaves. Other items are surveyed in standard units of measure.

in the Community Survey to arrive at the expenditures of the two components respectively.[9] To ensure comparability over time, we report expenditures in constant 2009 food prices. The step-by-step construction of food consumption, together with the issues of the harmonization of units of measure, the sub-category aggregation, and the external validation of our micro data with aggregate statistics are detailed in the online Appendix of Santaeulàlia-Llopis and Zheng (2018). In particular, we show there that the mean of a measure of household food expenditure, constructed from the CHNS according to the definition given by the Chinese Statistical Bureau, tracks remarkably well the average household food expenditure published in the China Statistical Yearbooks, by province and by rural or urban status. Finally, to isolate the price effects, we also construct the individual daily calorie intake from the quantity data. To convert food intake into calorie consumption, we follow the suggestion from the CHNS team and use the calorie conversion rates published in the China Food Composition Tables.

We trim the top 1% of the core food expenditure by wave and by urban status. We trim the top and bottom 1% of the calorie consumption of individuals age 14 and above by wave and gender. We drop 34 observations that have missing age or gender. We drop 66 observations that have missing calorie and core food expenditure. The household-level measures are aggregated from the individual data. We further keep individuals from the sixteen most common types of household compositions that range from 1-person households to 6-person households, which make up 95.4% of the remaining sample. Our analysis sample is an unbalanced panel of 25,094 individuals living in 6,771 households.[10]

The summary statistics from the analysis sample are found in Table 1. Due to the panel nature of our dataset, the average age increases from 32 in 1993 to 46 in 2011. The household size decreases by almost one person per household, from an average of 3.90 to 2.95 over the sample period. The average weak dependency ratio, i.e. the number of children (age less than 15) over the number of adults (age 15 and above), decreases from 0.44 to 0.19. The strong dependency ratio, i.e. the number of children (age less than 15) and old adults (age above 60) over the number of working age adults (age in between 15 and 60), decreases also, albeit to a lesser extent, from 0.65 to 0.49. These changes in household composition occur in both the rural and urban sample (Table 1).

[9] The CHNS staff collects the prices of a variety of consumption items from local supermarkets and free markets. We take the average of available prices from different local sources for a given food item and use it to compute the expenditure on that item. We do not distinguish consumption and expenditures in this study, but the two are not necessarily the same (Aguiar and Hurst, 2005).

[10] The most common household composition in 1993 consists of "two adults and two children," which takes up 18% of individuals in that wave. The most common household composition in 2000 consists of "two adults and one child," which takes up 20% individuals. By 2011, the most common household composition has evolved to consist of "two adults" and 35% of individuals reside in such a household.

3 The Household-Based Measure: Adult-Equivalent Consumption

Since consumption is typically measured at the household-level, to make a fair comparison of consumption across households and measure inequality, one must control for differences in consumption across households that are induced by differences in household size or composition. More generally, in studies on consumption inequality over time (e.g. Krueger and Perri (2006) and over the life cycle (e.g. Aguiar and Hurst (2013)), standard models often abstract from cohort effects or household formation and dissolution. Hence, to assess the models quantitatively, one needs to remove those effects from the consumption data. A common practice is to use equivalence scales to convert the household-level consumption into the consumption of a reference person of the household, usually its head.

Take the OECD modified equivalence scale as an example. The OECD scale stipulates that the ratio of the consumption of a household member other than the head and aged 14 or over to the consumption of the head is 0.5 and the ratio of the consumption of a child aged under 14 to the consumption of the head is 0.3. This implies, for a household with two adults and one child, the adult-equivalent consumption is the household consumption over the sum of 1 (for the head), 0.5 (for the second adult), and 0.3 (for the child).

More generally, one can define a linear scale $\theta_{g,a}$, which captures the ratio of the consumption of some non-head household member of gender g and age a to the consumption of the head. Then the consumption of a non-head member i with characteristics (g,a), $c^i_{g,a}$, relative to that of the head, c^h, is simply $\theta_{a,g}c^h$. This way, given household consumption C, we have

$$C = c^h + \sum_{i \neq h} c^i_{g,a}, \; = c^h + \sum_{i \neq h} \mathbf{1}_{i \in \{g,a\}} \theta_{g,a} c^h,$$

or

$$c^h = \frac{C}{1 + \sum_{i \neq h} \mathbf{1}_{i \in \{g,a\}} \theta_{g,a}}. \tag{1}$$

c^h is referred to as the adult-equivalent consumption. Note that only information on household-level consumption, C, and on the household composition are needed to define adult-equivalent consumption, c^h. Continuing our example, the OECD scale can then be expressed as $\theta_{g,a} = 0.5$ for g equal to either gender and a greater than or equal to 14 and $\theta_{g,a} = 0.3$ for g equal to either gender and a less than 14.[11]

[11] Non-linear equivalence scales are sometimes used to capture economies of scale within a household. For example, the square root scale requires the household consumption be divided by the square root of household size. While our focus is food consumption, a prime example of private good, economies of scale might still be

To compute our benchmark adult-equivalent food consumption, we proceed analogously to Aguiar and Hurst (2013). We regress logged household-level consumption on dummies for the number of adults and the number of children of different gender and age combinations:

$$\ln C = cons + \beta_{adults}\mathbf{1}_{\#adults} + \sum_{i \neq adult}^{I} \mathbf{1}_{i\in\{g,a\}}\beta_{g,a} \tag{2}$$

The dummies $\mathbf{1}_{i\in\{g,a\}}$ include the dummies for the number of boys between 0 and 2, the number of girls between 0 and 2, the number of boys between 3 and 5, the number of girls between 3 and 5, the number of boys between 6 and 13, the number of girls between 6 and 13, the number of boys between 14 and 17, and the number of girls between 14 and 17. The regression is run separately by area of residence (i.e. rural or urban) and by wave. Then we use the exponentiated predicted value of the regression, normalized by the value for singleton households (i.e. the exponentiated constant in the above regression), as the equivalence scale.

A benefit of this regression-based approach is that we obtain one set of equivalence scales for each measure of consumption, be it the total food consumption, the core food consumption or the vices consumption. Given the demographic information, this is arguable the best one can do to control for differences in household structures. The regression-based equivalence scale shows a marginal increase of consumption per additional adult that is slightly lower than one (and almost linear), whereas children always consume a fraction of what adults do (Figure 1). The implied decline in core food consumption per capita as the number of adults in the household increases resembles the results in Deaton and Paxson (1998) for a set of rich and poor economies.

4 Adult-Equivalent Consumption Inequality vs. Actual Individual Consumption Inequality

In this section, we examine whether adult-equivalent consumption measures are effective in capturing actual individual consumption inequality. We assess this effectiveness in the cross-section and over the life cycle. We explore the role of the vices and children.

present through the substitution with public goods (Deaton and Paxson, 1998). We follow the procedure in Aguiar and Hurst (2013) to compute equivalence scales which implicitly assumes an economies-of-scale parameter equal to one, as do the OECD modified scales. The separate identification of adult equivalence scales and economies of scale is beyond the scope of this paper; see Browning et al. (2013) for a detailed discussion.

4.1 The Cross-Section

We start by comparing the cross-sectional inequality of adult-equivalent food consumption with the cross-sectional inequality of individual food consumption. We measure inequality by the variance of log consumption and we do this exercise for the rural and urban sample separately. Note that adult-equivalent consumption measures are at the household-level, so each household contributes one data point at a time. This is consistent with how the empirical profiles of consumption inequality are usually computed using household-based data (Heathcote et al., 2010). On the other hand, when constructing individual consumption inequality, each individual contributes one data point at a time.[12]

The difference between the two inequality measures is striking (Table 2). The adult-equivalent consumption inequality is substantially lower than the individual consumption inequality. For the rural sample, averaged across years, the cross-sectional variance of individual food consumption is 0.781 and that of adult-equivalent consumption is 0.461, with the latter missing 41% of the individual-level inequality. Figure 2 shows that this gap between the two inequality measures remains wide throughout the sample period. Adult-equivalent consumption inequality misses 47% of the individual inequality in 1993 and 38% in 2011 for the rural sample. The picture is very similar for the urban sample, where on average the adult-equivalent consumption inequality misses 38% of the individual inequality (see panel (b) in Table 2 and Figure 2).

The cross-sectional consumption inequality is regarded as an important indicator of inequality in well-being (Jones and Klenow, 2016). To the extent that consumption is a direct input to the utility and it correlates more with the permanent component of income, consumption inequality is a less noisy measure of inequality of welfare than for instance income inequality. In the absence of individual consumption data, countries are usually ranked by inequality measures based on adult-equivalent consumption and their progress towards equitable growth monitored by comparing the reduction of those inequality measures over time. Haddad and Kanbur (1990) made the case that using calorie adequacy measured at the household level to rank sub-groups by the calorie adequacy inequality do not differ significantly from using individual calorie adequacy for a small sample of households in the rural Philippines. We provide additional evidence on this issue. We rank the nine provinces in our sample by the provincial consumption inequality (see, for example, the rankings of provinces for the year 2011 for the rural and urban sample under the header "Level (2011)" in Table 3). The correlation between the ranking using the adult-equivalent food consumption inequality and the ranking using the individual consumption inequality is roughly

[12] If we replace the consumption of each household member by its household's adult-equivalent consumption and compute the cross-sectional statistics from this sample, which essentially uses the household size as the weight when computing the adult-equivalent inequalities, we obtain very similar results; see Appendix ??.

0.8 for the rural sample and 0.9 for the urban sample. However, the ranking in terms of the growth of inequality is much more sensitive to the choice of data (see the rankings under the header "Growth (2000-11)" in the same table). There we compute the growth of inequality as the difference of the cross-sectional inequality measured in 2011 and 2000 by province and rank the provinces by the difference. Now the correlation of the rankings using different data is still around 0.8 for the rural sample, but it is as low as 0.3 for the urban sample. This highlights the potential importance of getting individual consumption inequality right to study the relationship between economic growth and welfare inequality.

4.2 The Role of Vices

Between the two components of food, one would expect the vices consumption to vary more across households with a similar demographic structure, either due to heterogeneity of preferences or due to its tighter relation with work. To evaluate how the vices affect the inequality measures, we re-conduct our inequality analysis using the core food component in isolation.

For the rural sample, averaged across years, the inequality of individual core food consumption is 0.314 and the inequality of adult-equivalent counterpart is 0.259, with the latter missing about 18% of the individual inequality (panel (b), Table 2). Compared with the 41% of missing inequality obtained using the total food consumption, removing vices alone reduces the gap by more than half. Similar insights emerge from the urban sample where the inequality of adult-equivalent measure on average misses 14% of the actual individual inequality (panel (b), Table 2). That is, removing vices reduces the missing inequality by more than 60% in the urban sample. The contrast between panels (a) and (c) and between panels (b) and (d) in Figure 2 confirms that the role of the vices is quantitatively important across years for both rural and urban areas.

To better understand the variation in the vices consumption within demographically similar groups, we turn to other parts of the survey for evidence. Since 2004, teenagers aged between 14 and 18 are asked about their priorities. More specifically, they are asked to rate how often do they care about "being liked by friends" and "getting good grades in school." The answer can range from "never", "sometimes", "often", to "usually." When we regress the log consumption of vices of these teenagers on these questions controlling for individual fixed effects, we find that the desire to be liked by friends strongly correlates with higher consumption of vices, while the desire for good grades correlates with lower consumption of vices (see Table 4). These effects of priorities, on the other hand, are absent on the consumption of core food. This suggests that heterogeneous preferences may be behind the differing vices consumption behaviors among the teenagers.

To evaluate the potential relation of vices consumption to work, we focus on a subsample of working age adults who are currently employed. We treat our data as if they are repeated cross sections and regress the logged vices and logged core food consumption on individual characteristics (age, sex, education, province of residence, and wave), the primary occupation, and the characteristics of the employer (e.g. the size and ownership type of the employer). We find that certain occupations are associated with higher levels of vices consumption. In particular, administrators, executives and managers consume more vices as well as core food items relative to average workers (Table 5). Interestingly, low skill workers also tend to consume more vices, though they consume less core food items. The self-employed with employees and those who work in small collective enterprises tend to consume more vices.[13] These patterns suggest that vices can serve important social functions for the executives and small business owners in China.

4.3 The Life Cycle

The cross-sectional data is collected from individuals living in households that are at different points in their life cycle. Therefore, the gap between the cross-sectional individual consumption inequality and its adult-equivalent counterpart can mask the potentially different ways in which the missing inequality is distributed over the life cycle (of the household head).

To obtain the measure of adult-equivalent consumption inequality over the life cycle, we regress the logged adult-equivalent food consumption on dummies of the cohort of the head and compute the variance of the resulting residuals by the age of the household head, as is commonly done using household-level data.[14] We then contrast this measure with its individual data counterpart, which is the true consumption inequality among all individuals who reside in households whose heads are of a given age. Namely, we regress the logged individual consumption on the cohort of the head of the household where this individual lives and compute the variance of the residuals by the age of the household head. The two inequality measures are plotted in solid curves in the top panels (a) and (b) of Figure 3 for rural and urban areas, where we fit a cubic spline on the age profile of the variances. Note that at each age, both inequality measures are constructed from the same set of households, i.e. all households with heads of the same age.

Our results show that the variance of adult-equivalent food consumption is relatively flat with an absolute growth of 0.1 log points from age 25 to 65, a feature shared by food consumption

[13] The small collective enterprises in China, often referred to as the township and village enterprises, are de facto rural privately owned businesses (Huang, 2012).

[14] Heathcote et al. (2005) show that the age-profile of inequality can look different depending on if one controls for time effects or for cohort effects. In our case, the age-profile of food consumption inequality remains largely invariant to the control for time or cohort effects. We report the results with cohort controls in the main text and relegate the results with time controls to Appendix **??**.

over the life cycle in the U.S.[15] The individual inequality exhibits growth over the life cycle by a comparable magnitude. Similar to our cross-sectional findings, the adult-equivalent consumption inequality misses roughly 35% of the individual inequality over the life cycle in both rural and urban areas.

When we exclude the vices, the adult-equivalent food consumption inequality over the life cycle is much closer to the individual inequality (panels (c) and (d) in Figure 3). On average, the vices close the gap between the adult-equivalent and the individual inequality by 60%. Interestingly, while the amount of missing inequality in core food consumption is roughly 11% at ages 25 to 30, it decreases with the head's age and entirely disappears in old ages. In other words, there is sizable within household core food consumption inequality not accounted for by the scales for younger households, but not for older households. This points to core food consumption inequality among children across households as a potential explanation, which we turn to next.

4.4 The Role of Children

To visualize the consumption inequality among children, we construct consumption inequality among individuals of the same age independent of the household membership, which we label as "Individual (own age)" inequality. We regress logged individual consumption on the individual's cohort, and compute the variance of the residuals from the resulting regression by the age of the individual. We do this for all individuals aged from 0 (i.e., less than 1 year old) to 80. This is the dashed black line in Figure 3. Without vices, the "individual (own age)" inequality for children aged 0 to 5 is roughly twice as high as that for adults aged 25 or over (see panels (c) and (d) in Figure 3). To the extent that younger households are more likely to have small children, among which the consumption is more unequally distributed, the missing individual inequality in core food consumption over the life cycle is likely driven by the presence of children.

One way to test this hypothesis is to restrict our attention to a sample of households without children.[16] The cross-sectional results are found in Table 6. Removing households with children reduces the missing inequality in food consumption from 41% to 30% in the rural sample and from 38% to 27% in the urban sample (recall panel (a) in Tables 2). Further removing the vices,

[15] For the US, Aguiar and Hurst (2013) documents an age profile for the cross-sectional variance of food at home that decreases by -0.04 log points between the ages of 25 and 45, and increases by 0.01 log points between the ages of 45 and 65. The cross-sectional variance of food away from home decreases by -0.08 log points between the ages of 25 and 45, and increases by 1.60 log points between the ages of 45 and 65. The cross-sectional variance of alcohol and tobacco shows a much larger rise over the life cycle, increasing by 1.61 log points between the ages of 25 and 45, and by 3.21 log points between the ages of 45 and 65.

[16] Our results are very similar if instead of restricting the sample to households without children, we remove all children from our analysis. That is, if we use all adults, independently of whether they have children or not, to construct individual inequality. See Appendix **??**.

we find the amount of missing inequality drops to a mere 5% in both rural and urban areas. In other words, out of the total 41% missing cross-sectional food consumption inequality in our rural sample, about 60% of it disappears after removing the vices component of food, and another 28% of it disappears after further removing households who have children under 18, leaving about 12% of the missing inequality unexplained.[17] For the urban sample, about 60% of the missing inequality can be attributed to vices and 27% to children, leaving 13% unexplained. Comparing Figure 3 to panels (c) and (d) in Figure 4, we find that after removing vices and households with children, the adult-equivalent inequality over the life cycle basically overlaps with its individual counterpart.

The high inequality of core food consumption among very young children may seem surprising. One wonders if it simply reflects the wide range of prices of special food items that are relevant for babies, toddlers and small children. Inspired by Aguiar and Hurst (2005), we verify that the inequality in caloric intake over the life cycle also features higher inequality among children, albeit the level of inequality is about one third of that of core food expenditures (see Figure 5). Admittedly, calorie is an imperfect, and conservative, measure of the quality of diet, however the fact that there is a large variation in calorie intake among small children of the same age in our data suggests that prices do not drive our results.

One also wonders if there may be more measurement errors when measuring food consumption for small children, since their food intake is likely reported by other adult members in the household on their behalf.[18] A piece of indirect supporting evidence on the high inequality among young children comes from the anthropometric measures collected by the survey team. The individual height and weight information is recorded under the Physical Examination Survey from the 1993 to 2000 wave and under the "Physical Measurements" section in the Child/Adult Survey from

[17] How big the role of vices and the role of children are in explaining the missing inequality is largely independent from whether one removes the vices first or households with children first. For the rural sample, removing vices reduces the missing inequality from 41% to 17% and further removing household with children reduces it to 5%. The relative contribution of vices and children are therefore $\frac{41\%-17\%}{41\%} = 59\%$ and $\frac{17\%-5\%}{41\%} = 29\%$, leaving 12% unexplained. Similarly, removing households with children directly from the full sample reduces the missing inequality to 30% and further removing vices reduces it to 5%. The relative contributions of vices and children are $\frac{30\%-5\%}{41\%} = 61\%$ and $\frac{41\%-30\%}{41\%} = 27\%$. By and large, we attribute 60% of the missing inequality to vices and 28% to children, for the rural sample.

[18] Possible concerns include under-measurement of small children's diet caused by constant snacking or breast-feeding. We have verified that "snacks" between meals are recorded as part of the diet in the Nutrition Survey, so our measure of food intake includes those. With regard to breast-feeding, we find from the 1993 wave to the 2000 wave, mother's milk as well as infant formula are among the main items in the diet for babies under 2. After the 2004 wave, however, only infant formula was surveyed, because the food coding is taken from a newer edition of China Food Composition Tables, which unfortunately does not include the nutritional statistics for mother's milk. This can potentially lower the food intake for babies who are mostly breast-fed in waves 2004, 2006, 2009 and 2011, though due to the aging of our sample, the number of babies under age 2 reduces from about 150 in the 1993 wave to about 80 in 2004 and 60 in 2011. That said, it can hardly rationalize the overall high levels of food inequality among kids between age 0 and 5.

the 2004 to 2011 wave. From height and weight, we construct the Body Mass Index (BMI) as an additional anthropometric outcome.[19] First, we regress the logged weight and logged height on logged calorie intake after controlling for dummies of age and wave for the rural and urban sample separately, and confirm that calorie intake does significantly translate into a heavier body and a taller build (Table 7). Then we construct the variance of logged weight, logged height and BMI over the life cycle the same way we construct the consumption inequality over the life cycle. We observe that there is a decline in the inequality in height and weight over the age range 0 to 20, after which it remains low for older ages, as well as a decline in the inequality in BMI over the age range 0 to 10, after which it picks up as one ages (Figure 6). Putting the two pieces of evidence together, we find that children in our sample do consume more varied amount of food, which corresponds to more dispersion in the anthropometric measures. However, we are not able to give any causal interpretation of these correlations.

The role of children is robust to further household structure controls. Let's focus on the consumption of core food and calorie among households with three members – a head, a spouse and their child (not necessarily under age 18). We construct the adult-equivalent inequality and the individual inequality by the age of the head in the same way we did in Figure 3. This produces the "Individual" line and the "Adult-equivalent" line in Figure 7. As before, we notice a visible gap between the individual inequality and the adult-equivalent inequality for younger households and the gap closes as the household ages. To understand what lies behind the gap, we further construct the inequality of all parents and the inequality of all children, controlling for cohort effects, in households of a given (head's) age. This produces the "Parent" and "Child" lines in Figure 7. As illustrated, the inequality among the parents across households largely overlaps with the adult-equivalent inequality, while the inequality among children across households is much higher for young households and declines as heads age. It shows strong evidence that, for the sample of three-member households, children explain most of, if not all, the missing core food consumption inequality.

5 Conclusion

Standard adult-equivalent measures of consumption underestimates total cross-sectional individual food consumption inequality by 40%. Our findings emerge from the study of a unique individual panel dataset on diet. The vices component of the diet (i.e. alcohol, tobacco, coffee and tea) accounts for close to 60% of the missing inequality, and the core food consumption of young children accounts for another 30% of the missing inequality. The importance of children for

[19] The BMI is a measure of body fat based on height and weight, which is often linked to obesity. It is computed as the weight (in kg) over squared height (in m).

the measurement of inequality is also highlighted by the fact the inequality in food consumption among small children aged between 0 to 5 roughly doubles that of adults.

Our results suggest caution in the use of adult-equivalent consumption to measure inequality, whose effectiveness strictly depends on the items in the consumption basket and the presence of young children. This provides a practical lesson for consumption data collection: To increase the accuracy in the measurement of food consumption inequality, household surveys might greatly benefit from collecting individual data on the vices from adults and on the core food items from children, while keeping the current practice of household-level data collection of core food items for adults. Obviously, the study of intrahousehold allocations between spouses would still benefit from separate individual consumption data for each spouse.[20] In this direction, we expect our data to be useful to identify the dynamics of intrahousehold allocations, as recently pioneered by Lise and Yamada (2014) using individual panel from Japan, in the context of a growing economy like China. We leave these important questions for future research.

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[20] See Case and Deaton (2003) for a discussion and alternatives that, in the absence of individual consumption data, link family expenditure patterns to the gender composition of the household.

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Table 1 Summary Statistics: A Cross-Sectional Snapshot, CHNS 1993-2011

	1993		2000		2011	
	Rural	Urban	Rural	Urban	Rural	Urban
Age	30.7	36.5	35.5	40.4	44.9	48.1
Household Size	4.0	3.7	3.6	3.2	3.0	2.8
Children < 15 (%)	61.8	53.6	49.3	41.2	26.8	19.8
Weak DR	0.5	0.3	0.3	0.2	0.2	0.1
Strong DR	0.6	0.7	0.5	0.5	0.5	0.4
Num. Households	7,322	3,170	8,476	3,850	6,839	3,364

Notes: This table shows the summary statistics of the demographics and the household structure from the analysis sample that satisfies the sample selection criteria (see Section 2).

Table 2 Missing Cross-Sectional Consumption Inequality, Averages over Waves

	Rural	Urban
(a) Food Consumption:		
Individual Inequality	0.781	0.598
Adult-Equivalent Inequality	0.461	0.370
Missing Inequality (%)	40.93	38.00
(b) Core Food Consumption (Excl. "Vices"):		
Individual Inequality	0.314	0.276
Adult-Equivalent Inequality	0.259	0.237
Missing Inequality (%)	17.66	14.03

Notes: Missing consumption inequality is defined as the share of actual individual consumption inequality not captured by adult-equivalent consumption inequality, that is, $100 \times \left(1 - \frac{var_t(\ln c^h)}{var_t(\ln c^i)}\right)$, where $var_t(\ln c^h)$ is the cross-sectional variance of logged adult-equivalent consumption and $var_t(\ln c^i)$ is the cross-setctional variance of actual individual consumption in year t. We report the averages across waves. See Section 4 for a discussion.

Table 3 Rankings of the Provinces by the Level and the Growth of Adult-Equivalent Consumption Inequality and of Actual Individual Consumption Inequality, from High to Low

(a) Rural

Level (2011)		Growth (2000-11)	
Adult-Equiv.	Individual	Adult-Equiv.	Individual
Liaoning	Liaoning	Liaoning	Liaoning
Shandong	Shandong	Guizhou	Henan
Jiangsu	Henan	Henan	Guizhou
Guizhou	Guizhou	Jiangsu	Guangxi
Henan	Jiangsu	Guangxi	Jiangsu
Hubei	Hubei	Shandong	Hunan
Hunan	Hunan	Hunan	Shandong
Guangxi	Guangxi	Heilongjiang	Heilongjiang
Heilongjiang	Heilongjiang	Hubei	Hubei
Corr. = 0.80		Corr. = 0.83	

(b) Urban

Level (2011)		Growth (2000-11)	
Adult-Equiv.	Individual	Adult-Equiv.	Individual
Shandong	Henan	Shandong	Guangxi
Henan	Shandong	Liaoning	Henan
Hubei	Hubei	Jiangsu	Jiangsu
Liaoning	Liaoning	Guangxi	Shandong
Hunan	Hunan	Hubei	Hunan
Heilongjiang	Guangxi	Guizhou	Liaoning
Guangxi	Heilongjiang	Heilongjiang	Guizhou
Guizhou	Guizhou	Hunan	Hubei
Jiangsu	Jiangsu	Henan	Heilongjiang
Corr. = 0.91		Corr. = 0.30	

Notes: We report the rankings of the nine provinces in the sample by the cross-sectional consumption inequality in 2011, based on household equivalent data (under "Adult-Equiv.") and based on individual data. We also report the rankings of the provinces by the growth of inequality, defined by the difference between the inequality in 2011 and that in 2000. The analysis is done for the rural and urban sample separately. The correlations however are the correlation between rankings from all waves. See Section 4.1 for a discussion.

Table 4 Regression of (Log) Vices Consumption on Priority Questions

	Vices	Core Food
Being praised by parents:		
Never	—	—
Sometimes	0.669	0.050
Often	-0.195	0.104
Usually	0.210	-0.022
Being liked by friends:		
Never	—	—
Sometimes	2.755*	0.040
Often	2.901**	0.052
Usually	1.710*	0.067
Looking cool:		
Never	—	—
Sometimes	-0.581	0.033
Often	0.201	0.102
Usually	0.017	0.036
Getting good grades:		
Never	—	—
Sometimes	-1.499	-0.051
Often	-1.883*	-0.171
Usually	-2.161*	-0.128
Observations	299	1,317
R^2	0.877	0.052

Notes: We regress logged vices consumption and logged core food consumption on categorical variables that describe a teenager's priorities, after controlling for indivdiual fixed effects, on the subsample of individuals aged between 14 and 18. Standardized beta coefficients. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. See Section 4.2 for a discussion.

Table 5 Regression of (Log) Vices Consumption on Work Characteristics

	Vices	Core Food
Sex		
male	—	—
female	-0.409***	-0.103***
Education		
no education	—	—
below (including) 9th grade	0.028*	0.071***
above 9th grade	-0.008	0.122***
Primary occupation		
junior professional or technical personnel	—	—
senior professional or technical personnel	0.012	0.011*
administrator or executive or manager	0.044***	0.037***
office staff	0.028***	0.023***
farmer, fisherman, hunter	0.044*	-0.104***
skilled worker	0.022**	0.018**
non-skilled worker	0.035***	-0.026***
army officer, police officer	0.006	-0.007
ordinary soldier, policeman	0.017***	-0.001
driver	0.028***	0.022***
service worker	0.025**	0.026***
athlete, actor, musician	-0.007	0.006
other	0.025***	0.014**
Size of employer		
permanent employee	—	—
self-employed with employees	0.022***	-0.002
self-employed with no employees(includes farmer)	0.020	-0.056***
contractor	-0.008	-0.007
temporary worker	0.017**	-0.042***
paid family worker	0.003	-0.010**
unpaid family worker	0.010	-0.000
other	0.000	0.001
Type of employer		
private enterprise	—	—
state	0.010	0.056***
small collective enterprise	0.030***	0.011*
large collective enterprise	0.013*	0.025***
family contract farming	-0.003	-0.041***
foreign or joint enterprise	-0.012*	0.011**
other	0.002	-0.004
Observations	20,196	33,637
R^2	0.223	0.318

Notes: We regress logged vices consumption and logged core food consumption on individual characteristics (such as sex, age education, province of residence and wave), primary occupation and characteristics of the employer for a sample of working adults aged 18 to 60. Standardized beta coefficients. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. See Section 4.2 for a discussion.

Table 6 Missing Cross-Sectional Consumption Inequality: Households without Children

	Rural	Urban
(a) Food Consumption:		
Individual Inequality	0.755	0.576
Adult-Equivalent Inequality	0.531	0.419
Missing Inequality (%)	29.71	27.22
(b) Core Food Consumption (Excl. "Vices"):		
Individual Inequality	0.2847	0.259
Adult-Equivalent Inequality	0.273	0.247
Missing Inequality (%)	4.79	4.77

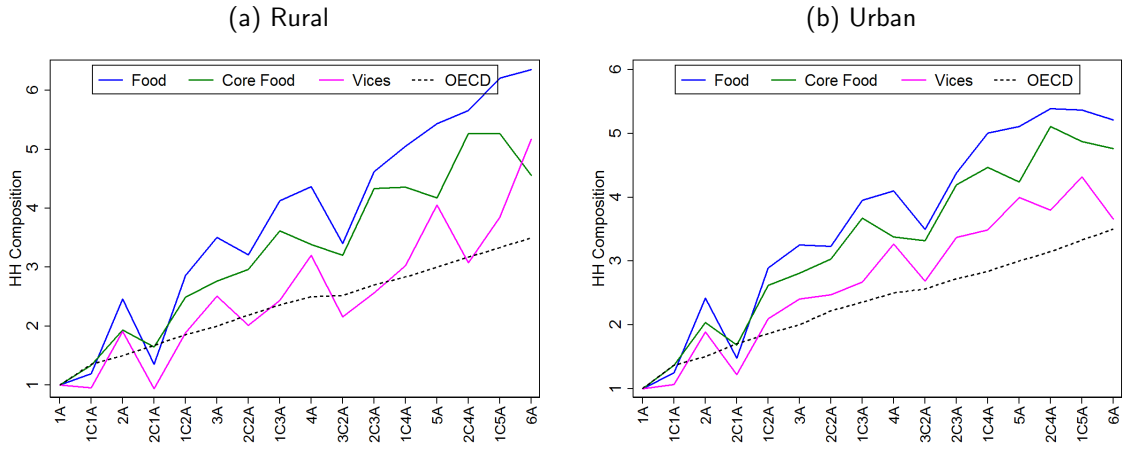
Notes: Missing consumption inequality is defined as the share of actual individual consumption inequality not captured by adult-equivalent consumption inequality, that is, $100 \times \left(1 - \frac{var_t(\ln c^h)}{var_t(\ln c^i)}\right)$, where $var_t(\ln c^h)$ is the cross-sectional variance of logged adult-equivalent consumption and $var_t(\ln c^i)$ is the cross-setctional variance of actual individual consumption in year t. We report the averages across waves. See Section 4 for a discussion.

Table 7 Regression of Height and Weight on Calorie Intake

	(a) Rural		(b) Urban	
	Height	Weight	Height	Weight
Calorie	0.0235^{***}	0.0466^{***}	0.0285^{***}	0.0877^{***}
	(31.74)	(18.85)	(25.14)	(22.54)
Observations	46,895	46,804	21,546	21,490
R^2	0.843	0.809	0.780	0.733

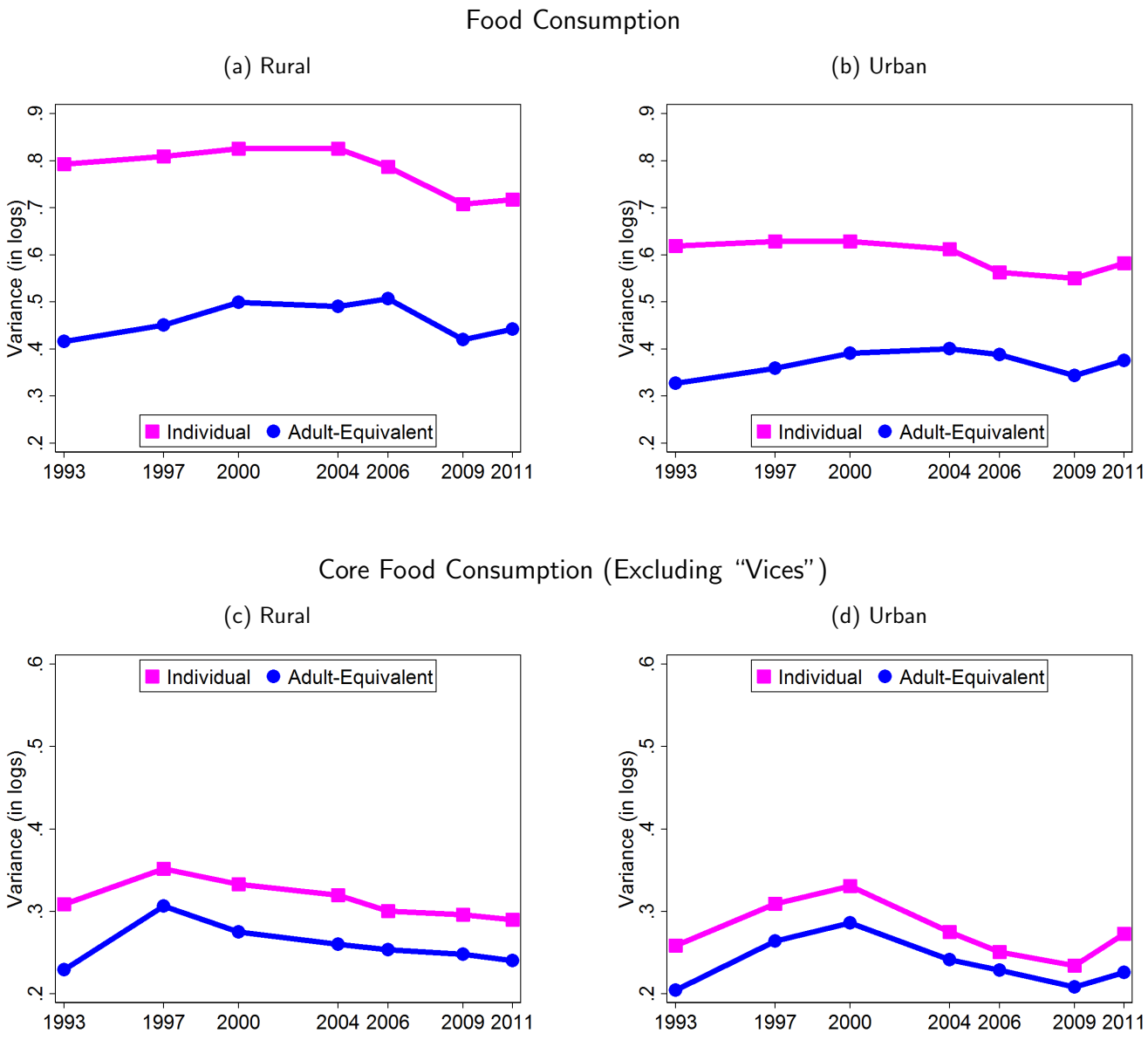
Notes: We regress logged height (logged weight) on logged calorie intake and dummies of age and wave, allowing for individual fixed effects. We do the analysis on the rural and urban sample separately. We show t statistics in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. See Section 4.4 for a discussion.

Figure 1 Regression-Based Adult-Equivalence Scale for Food, Core Food and Vices Consumption By Household Composition and By Area of Residence



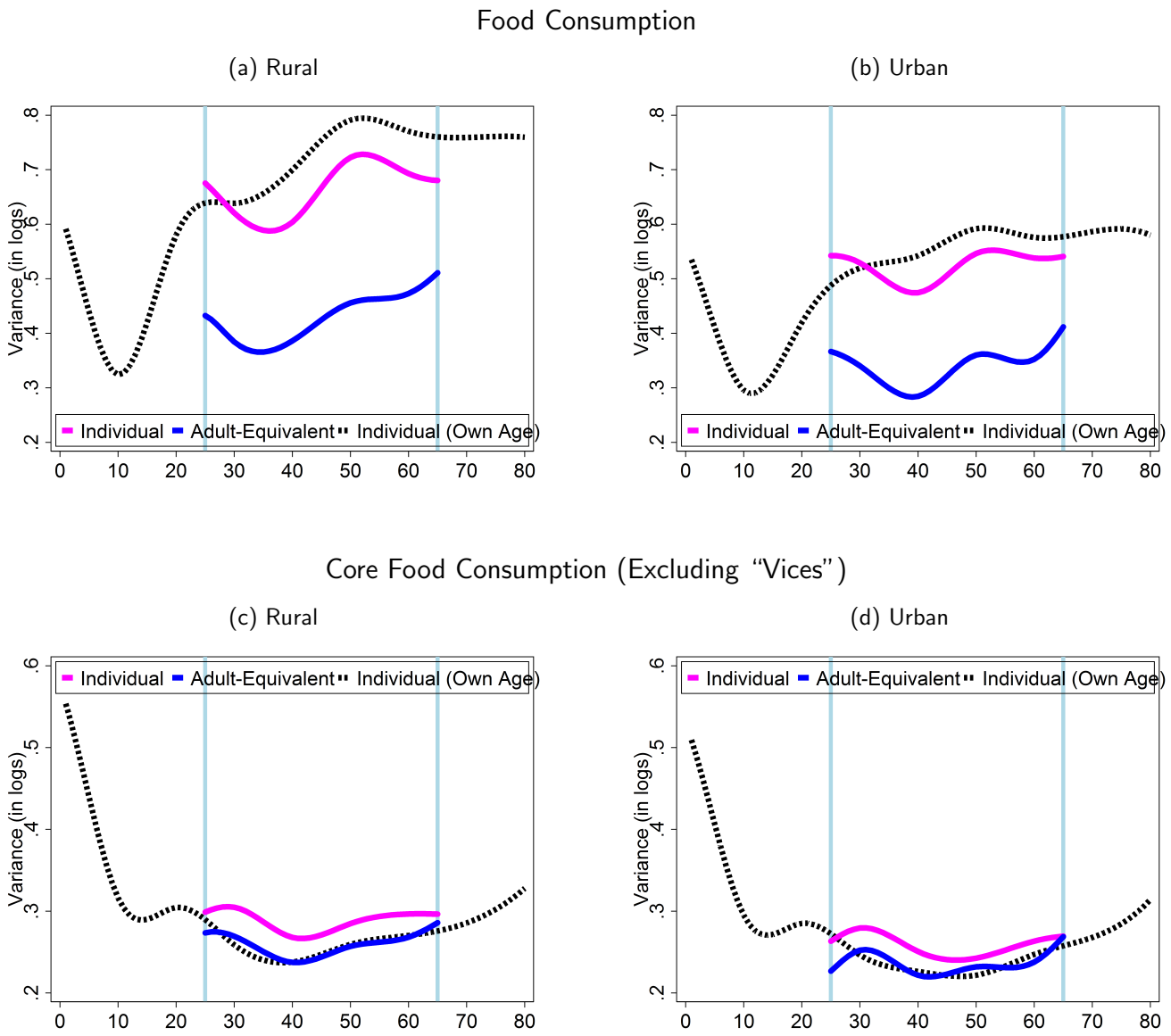
Notes: The adult-equivalence scales for each type of consumption good, the food, the core food and the vices, are estimated separately from household-level consumption of these goods. Consumption is normalized to one for the reference adult. In the horizontal axis "C" refers to a child, and "A" to an adult. See Section 3 for a discussion of computation and results.

Figure 2 Adult-Equivalent vs. Actual Individual Consumption Inequality: The Cross-Section



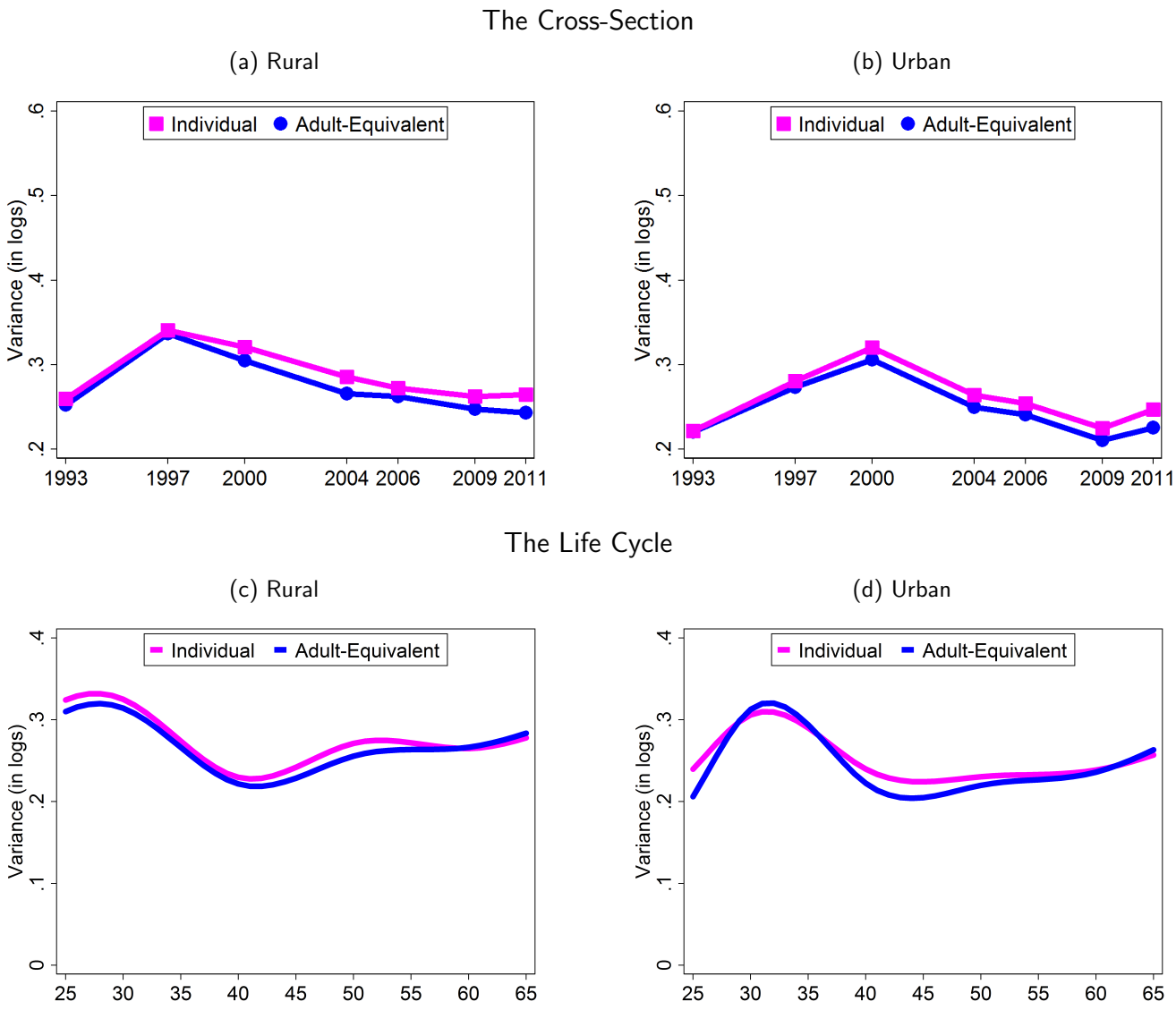
Notes: The measure of inequality is the variance of logged variables. The top panels focus on the cross-sectional inequality of food consumption from 1993 to 2011, and the bottom panels focus on the cross-sectional inequality of core food consumption (excluding alcohol, tobacco, coffee and tea) from 1993 to 2011. The left panels focus on rural areas, and the right panels on urban areas. See Sections 3 and 4 for computational details.

Figure 3 Adult-Equivalent vs. Actual Individual Consumption Inequality: The Life Cycle



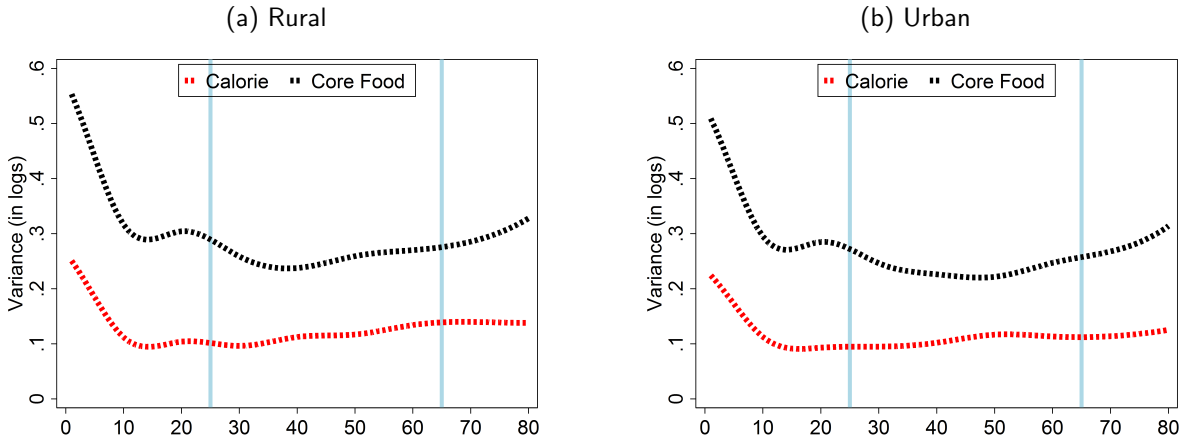
Notes: The measure of inequality is the variance of logged variables. The top panels focus on the life cycle inequality of food consumption, and the bottom panels focus on the life cycle inequality of core food consumption (excluding alcohol, tobacco, coffee and tea). The left panels focus on rural areas, and the right panels on urban areas. We use cohort controls. See Sections 3 and 4 for computational details.

Figure 4 The Role of Children: Households without Children, Inequality of Core Food Consumption



Notes: The measure of inequality is the variance of logged variables. Here we report the results from subsamples of households that don't have children under 18. The top panels focus on the cross-sectional inequality of core food consumption over time, and the bottom panels focus on the life cycle inequality of core food consumption over age. We use cohort controls to compute the life cycle inequality. See Sections 3 and 4 for computational details.

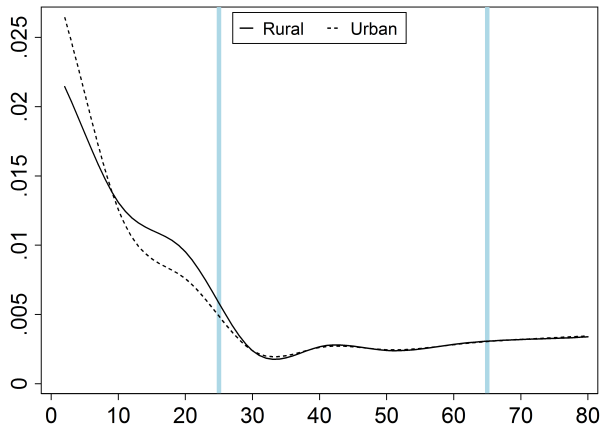
Figure 5 Individual (Own-Age) Calorie Inequality: The Life Cycle



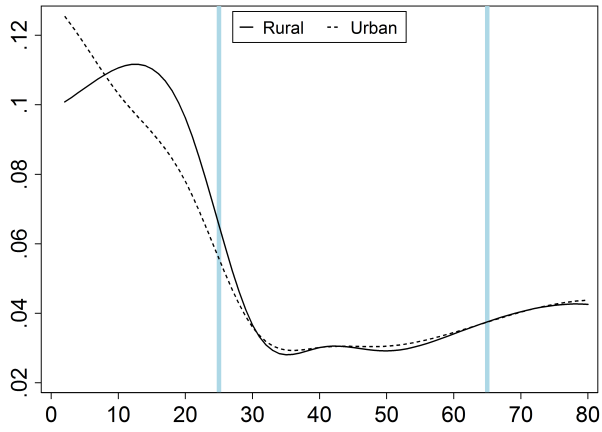
Notes: The measure of inequality is the variance of logged daily calorie. We use cohort controls. See Sections 3 and 4 for computational details.

Figure 6 The Inequality of Anthropometric Outcomes: The Life Cycle

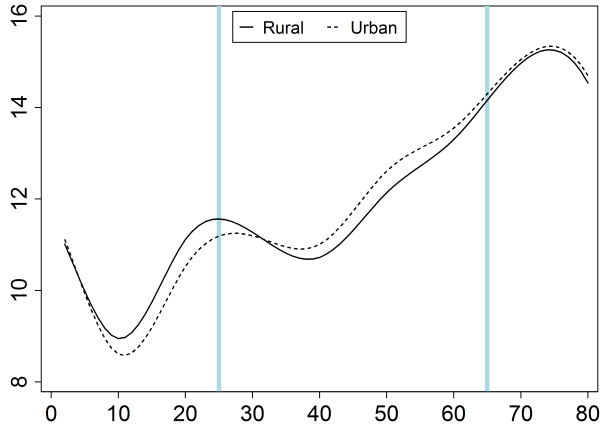
(a) Height



(b) Weight



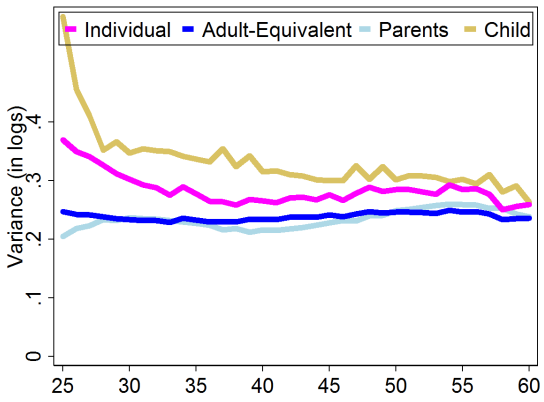
(c) BMI



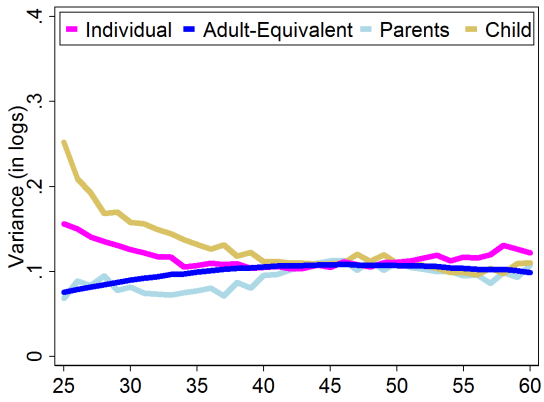
Notes: The measures of inequality are the variance of logged height, the variance of logged weight and the variance of BMI. We use cohort controls to compute the life cycle inequality. See Section 4.4 for a discussion.

Figure 7 Three-Member Households: The Life Cycle

(a) Core Food Consumption (Excluding "Vices")



(b) Calorie Intake



Notes: We use the rural subsample of households that consist of one head, one spouse and one child (not necessarily under the age of 18). The measure of inequality is the variance of logged variables. The left panel focuses on the inequality of core food consumption and the right panel focuses on the inequality of calorie intake over the household's life cycle. We use cohort controls. The "Individual" and "Adult-Equivalent" inequality over the household's life cycle is constructed as before, but for the restricted sample of three-member households. The "Parent" inequality depicts the evolution of inequality among the parents over the household's life cycle, while the "Child" inequality depicts the evolution of the inequality among the children over the household's life cycle. See Section 4.4 for a discussion.