Regional Disparity of Vulnerability to Food Insecurity in China

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Summary

Paraphrasing the 1996 World Food Summit definition, "food insecurity" exists when "not" all people, "not" at all times, have physical and economic access to sufficient safe and nutritious food. In this perspective, our study examines the relation between spatial inequality and vulnerability to food insecurity from a socioeconomic perspective. A longitudinal analysis is applied to estimate the regional food vulnerability at provincial and sub-provincial level and the rural and urban contributions to the integral regional vulnerability are underlined. Theil Index and Herfindahl Index are used to quantify the basic factors for the evaluation of economic vulnerability to food consumption and diversity of food structure, which we also based on to proceed further studies and benchmark 31 Chinese provinces and municipalities by their vulnerability to food insecurity. Our main aim is to fill up the gap of analysing regional food vulnerability in a socioeconomic point of view in China, and hence to better depict the regional disparity in food vulnerability and try to provide useful information on the reality of food insecurity.

Keywords: food insecurity, economic vulnerability, regional disparity, convergence

JEL Classification codes: Q180, O130, O180

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1. INTRODUCTION

China's impressive economic performance over the last thirty years has been accompanied by remarkable social and poverty reduction achievements, as China halved by early 2005 the number of those living with less than $1.25 a day, dragging over 600 million people out of absolute poverty. Nevertheless, progress in development has spread unevenly across the country. Both the Chinese and international literature document widely this lack of "equity" in the geographical distribution of economic gains across the Chinese provinces and regions. While the majority of the studies mentioned attempted to infer on geographical, historical, and political factors behind China's large spatial disparities (Xu, 2002; Fan, Sun 2008; Maasoumi, Le Wang 2006; Lohmar et al. 2009), the relation between food security and regional inequality has so far been poorly addressed. This is a serious shortcoming given that some of the most pressing domestic issues for China nowadays are rooted in its rampant spatial inequality, where the rural-urban dichotomy plays a major role - among others, the trade-off between the use of land for farming and for urban-use, the social and environmental "unsustainability" of urban growth, the social and economic pressure of the urban workers registered in the rural areas. Some of these issues affect China's Food security directly and we will introduce these topics in the following paragraphs of this introduction.

The focus of this paper is the relation existing between regional inequality and food security. We will use a set of indicators to determine the degree of food insecurity of the various regions of China and measure their changes over time. The study takes also into account also the rural-urban component of regional inequality in relation to food security. In Section 2, our study starts with the construction of representative food security indicators, making use of the available household expenditures survey data compiled by the national statistical office for both rural and urban areas. The time period we considered is represented by the years from 1996 to 2012. In section 3 we will describe the differences across the Chinese macro-regions in terms of food security and look at their evolution over time. We will complement this analysis by addressing the issue of convergence towards similar levels of the indicators (Section 4). Different methodologies will be employed with the aim of uncover whether a process of homogenisation of all areas of China exist and if so, how is taking place. Finally we will discuss the contribution of rural-urban disparities and regional disparities to the overall China's inequality in food security. We will carry out a longitudinal analysis of the economic vulnerability to food insecurity (Engel's coefficient) and the inequality in food access (per capita household food expenditures) at provincial and sub-provincial level. The analysis will be based on the construction of a decomposable general entropy measure of inequality, the Theil Index by group. This method allows decomposing inequality into the contribution of different sub-groups of the population. In our case, we will decompose China national spatial inequality into the separate contributions given by its rural and urban areas as well as by each of its macro-regions. This analysis will estimate the spatial differences and map the phenomenon across the whole country. While this study does not have the ambition of assessing the comprehensive nature of the vulnerability to food insecurity in China, it aims at capturing some highlights regarding the relation between regional inequality and food insecurity. It does so by adopting a narrow definition of vulnerability to food insecurity that is confined within the socio-economic aspects of household food consumption, leaving the assessment of the nutritional aspects of food security to future analysis. Before starting our assessment of regional Food security in China it is however important to set the

context of this analysis by introducing three major themes that directly and indirectly affects regional development and food security in China, namely (i) the existing regional economic inequalities in China, (ii) the spatial demographic challenges and finally, (iii) the policy approach to food security adopted by the Chinese government.

1.1. Regional Inequalities

Both the Chinese and international literature documented widely the lack of "equity" in the geographical distribution of gains arising from the impressive Chinese economic performance and the resulting rise of spatial disparities between and within the Chinese provinces since the adoption of 1978 market reforms (Kanbur and Zhang, 2005; Yao and Zhang 2001; Herd 2010; Wan, 2001; Zhang et al., 2012; Liu et al., 2013; Chen et al., 2010). The majority of the quantitative studies taking a longitudinal perspective on China's spatial inequality demonstrated the increase in spatial disparities by focussing on one representative variable (either per capita income or consumption) (e.g. Kanbur and Zhang 2005). Some other studies broadened the perspective on inequality, so that to include more elements in the analysis and, for instance constructed multidimensional indicators to document spatial disparities in China (Barone et al. 2013; Li et al. 2013; Liu et al. 2013; UNDP China 2005). In 2005, the China Human Development Report - written by a Chinese team of experts coordinated by the China Development Research Foundation – decided to address the issue of "development with equity" (UNDP CHINA 2005) proposing the measurement of the HDI not only for each Chinese province but also for the respective sub-provincial rural and urban parts. This work greatly contributed to the understanding of rural-urban divide and how this differs across provinces. At support of this strand of these results, a further strand of the literature concentrated on disparities in living conditions in rural areas, providing an alternative regional mapping of China, based on the rural clustering of the Chinese provinces (Fanfani, Brasili, 2003; Fanfani, Calò 2011).

In the literature there are also examples of comparison of life conditions in rural and urban areas. Some authors directly examined the rural-urban interactions introducing the concept of urban-rural equalized development (URED) to the analysis of China's regional development (Liu et al. 2013). They calculated a URED multidimensional indicator for all Chinese provinces to evaluate the magnitude and concentration of spatial disparities during the period 1996-2009 (for selected years). Among their results, the authors highlighted that the richest areas, such as those Eastern region also have the highest levels of integrated urban-rural development (Liu et al 2013), with the western provinces lagging behind in that. To similar conclusions arrived other authors that analysed the convergence process in rural and urban areas of China and identified a process of urban-to-rural contagion within one province, so that in high-developed areas (e.g. Beijing, Shanghai, Tiajin, Fujian), rural economic development follows the urban one (Barone et al 2013). The drivers of spatial disparities in China have been also widely investigated. Some studies focused on the relationship between uneven social and economic conditions and migration and earnings (Zhao, 1999), while some pointed out the correlation between average growth rate and education levels (Cai, et al. 2002), and some others found regional inequality depended on globalization, uneven domestic capital accumulation, and privatization (Wan, Lu, and Chen 2007).

A common consideration arising from the review of the literature is that different clusters of development can be identified and within those clusters, all provinces tend to converge to similar degrees of development. The direction of development also follows the pattern coast-interior, moving inwards from the coastal part of China to the interior. The macro-regions of China, as identified by the official regional classification (Fig.1) allow ranking the Chinese provinces into macro-regions reflecting a common level of socio-economic development. The Eastern region collects the Chinese provinces located on the coast and

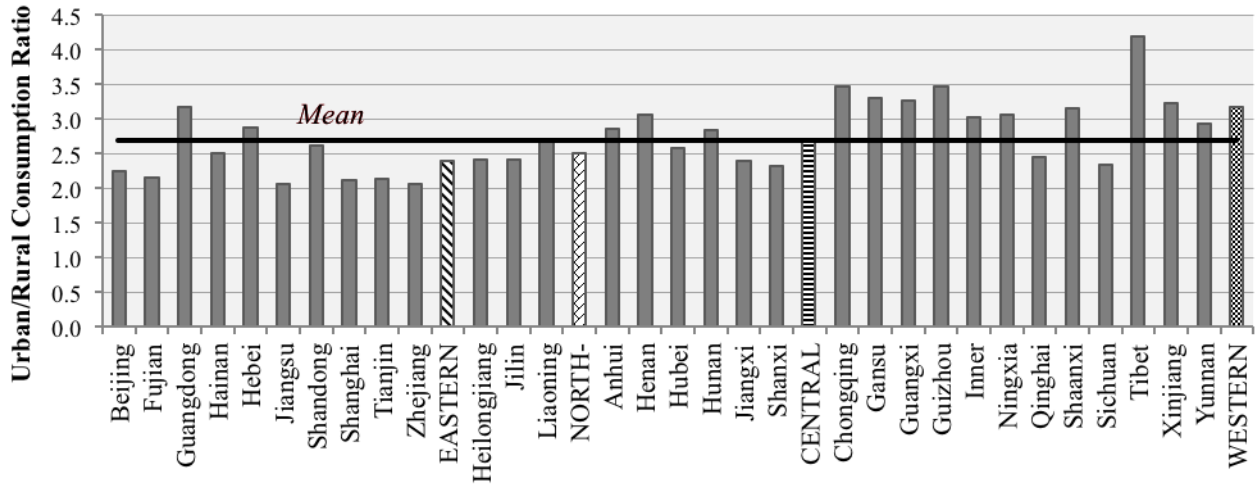
with a higher degree of socio-economic development. Progressively, as one moves from the coast to the interior the degree of development decreases. The Western region is the least developed area of China.

Figure 1: China's macro-economic regions by official classification

Note: authors' own work based on Chinese statistical yearbook

Looking at the consumption gap between rural and urban areas within each province (Fig.2), it is clearly visible that the Western region holds the major contrasts, with peaking values for Tibet, Chongqing, Tibet, Guizhou. The Eastern provinces instead score the lowest values of the urban-to-rural consumption ratio (e.g. Jiangsu, Shanghai, Beijing), although provinces such as Guangdong, Hebei still overpass the national average of this indicator.

Figure 2: Consumption Gap between Urban and Rural Households by region (2012)

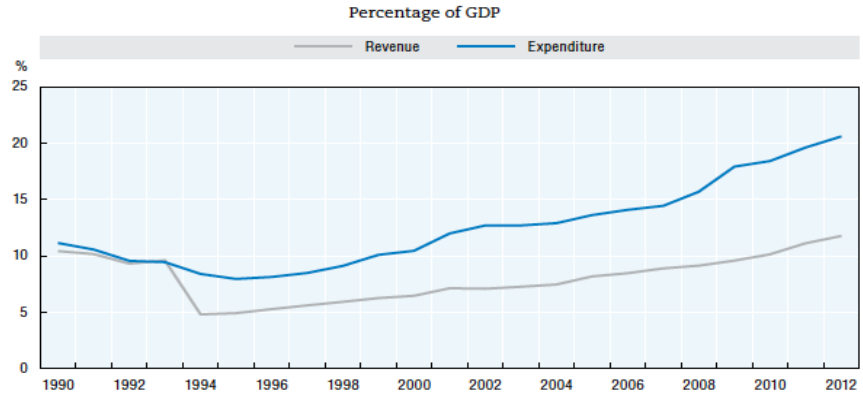


Note: authors' own work based on Chinese statistical yearbook 2013

The problem of regional inequality is fuelled by the increasing financing shortfalls of local governments (Fig. 3). Since the mid'90s in fact the local government expenditures have been growing more than the revenues. The problem has worsened due to the implementation of 1994 budget reform approved by the Chinese central government that forbade local governments from running deficits and selling bonds (Sanderson, Forsythe 2013, p.4). This situation put under pressure local government administrations that needed funds to support the development of infrastructure, mostly at support of the urbanisation process of China. Lacking other forms of financing, local government accumulated large debts and used the transfer of land from rural to urban use as a source of extra-budget revenue. Therefore the increasing debt of the local governments is proportional to the needs of the territory under their jurisdiction, making local government debt varying widely both within and between regions. The Western region collects the provinces with the largest financing gap on average and with the two provinces with the highest values of debt per capita, i.e.

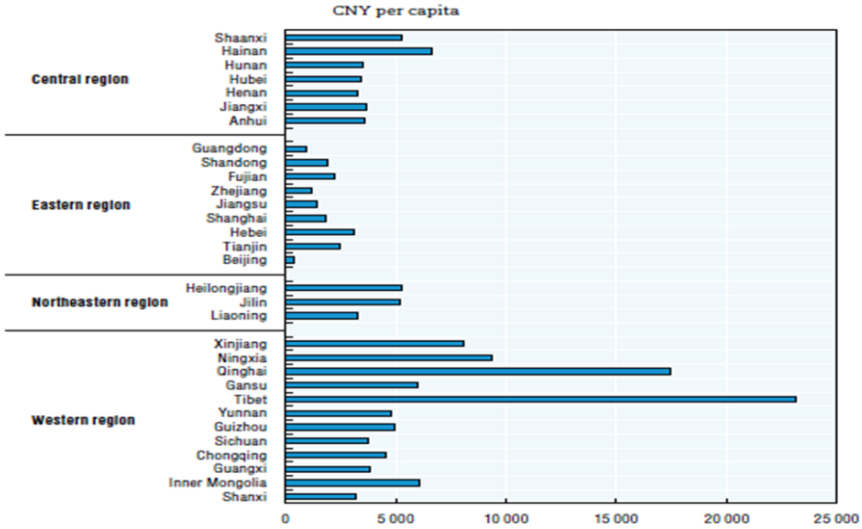
Tibet with about 24000 yuan and Qinghai 17000 yuan (Fig. 4). The Eastern region as expected displays much lower levels of debt per capita. The local government-financing problem is therefore a self-sustaining aspect of regional inequality in China.

Figure 3: Local government revenue and expenditure in China, 1990-2011



Source: CEIC (OECD 2013, p. 252)

Figure 4: Financing gaps in China, by province (before transfers), 2012

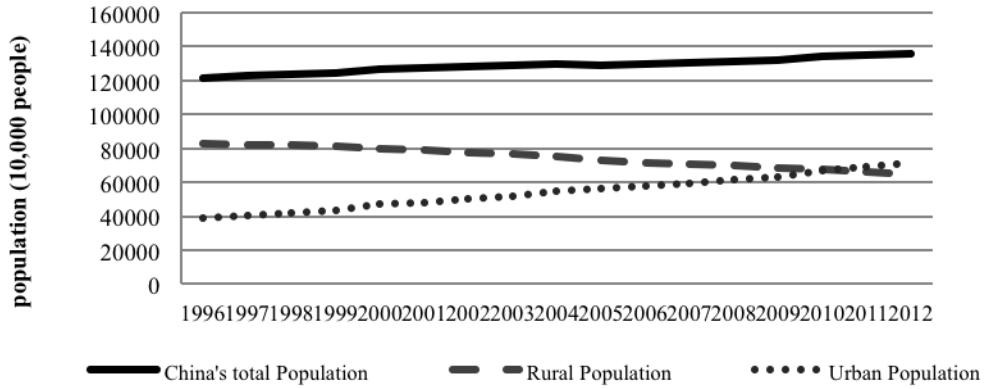


Source: CEIC and OECD Development Centre calculation (OECD 2013, p. 251)

1.2. Spatial demographic challenge

One of the major issues for China stays in its demographic growth and dynamics. Not only China needs to feed about 20% of the world's population, characterised by constantly increasing demographic growth rates. The bulk of the issue relates to the share of its population living in rural and urban areas. If historically the largest share belonged to rural, since 2010 in fact there has been a shift and urban residents have outnumbered rural ones (Fig. 5). This demographic dynamics has important implications in terms of food security as rural peasants move to the cities as migrant workers; there, they hold a status of "second class citizens" as recently labelled by the Economist (The Economist 2013) with limited access to urban social services (such as education, healthcare, housing, etc.).

Figure 5: China's demographic trends in rural and urban areas and total (1996-2012)

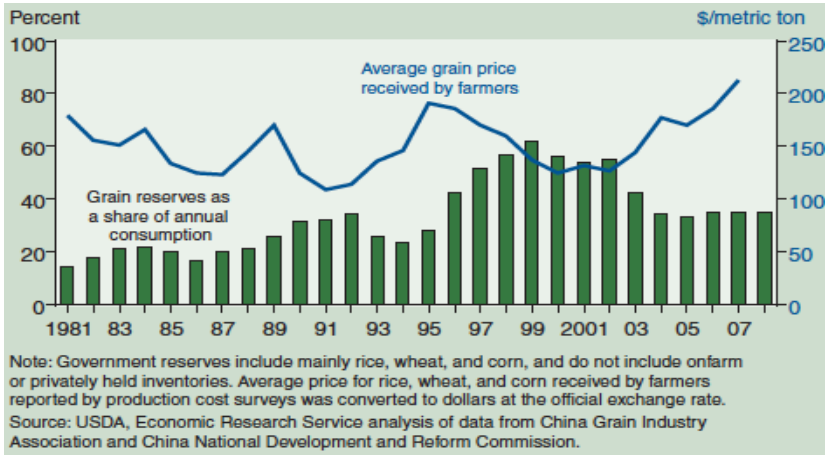


Note: authors' own calculation from China statistical yearbook 1997 to 2013

1.3. China's food security policy approach

Since 1981 China's grain reserves and prices have fluctuated, China's farmers receive relatively low returns from grain. Figure 6 showed us how the grain reserves and prices changed over years in China.

Figure 6: Grain reserves and prices (1981-2006/7)



Source: Gale et al. 2009, p. 34

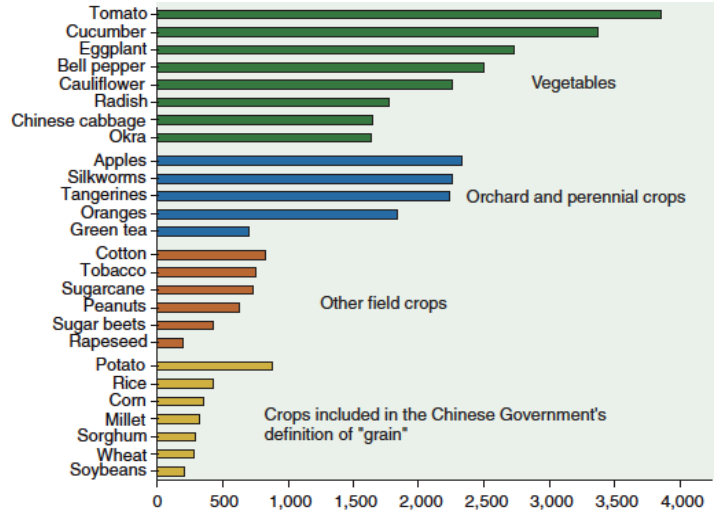
The grain price changes in China cannot be separated with the grain policy of central government. After the well-known 1978 reform, the central government started to make some adjustments on the quotas and prices of grain purchasing and marketing, a dual-track price system for grain was commenced in 1985 and the mandatory quotas were abolished, and this reform got deepened the marketization of grain circulation with the way of coexistence of supported purchasing price and market price for grain in early 1990s; however, due to the price increase and inflation, the grain supporting price has been regained and the grain purchasing price had been increased twice in 1994 and 1996; during 1998 – 2002, the reforms in grain circulation system was convened, which issued the reform principle of "four separations and one improvement"[1]; then the grain minimum purchasing price was launched in 2004 to protect farmers' benefits and stabilize grain market with governmental macro regulation and control, and a new direct subsidy for farmers was launched as a new green-box policy[2], this reform was enlarged in the whole country in 2006, and the agricultural taxes were totally cancelled.

[1] It includes separation of governmental functions from enterprise management, separation of grain reserve and operation, separation of central and local responsibilities, separation of new and old grain financial debts, and improvement of grain pricing mechanism

[2] During this period, a new supporting policy of direct aids for grain was executed in 2004, and the following-up aids for agricultural materials was added in 2006. In the meantime, the agricultural tax reform started: the main task were cancellation of institutional fees and governmental charges, taxes on animal slaughter, and voluntary labor service; adjusted the agricultural taxes, taxes on special

Diversification of food production and consumption has important reflections in terms of socio-economic conditions of the rural communities, disclaimer on migration and the indirect effect we can catch through the impact on income. Figure 7 showed us the net cash returns under Chinese governmental definition of grain just halved the economical plants such as vegetables and fruits. It protected the grain price stabilizing from the market shock on one hand, while on the other side, hindered the confidence of farmers to plant grain crops, and hence its influence on the food vulnerability was ambiguous.

Figure 7: Net cash returns per acre by product ($/acre), 2006



Source: USDA, Economic Research Service analysis of data from China National Development Reform Commission (Gale et al. 2009, p.35)

2. LONGITUDINAL ANALYSIS OF CHINA'S SPATIAL INEQUALITY IN FOOD SECURITY: AN ASSESSMENT THROUGH KEY FOOD SECURITY INDICATORS

Since 1955 China started to investigate on the people's living conditions in rural and urban areas by collecting data through annual sample surveys on households. In order to evaluate the evolution of food consumption patterns in rural and urban areas we considered the data coming from these official sources, which provided us with information on rural and urban food expenditures (in absolute terms, as a share of income and by main food product) and their regional differences.

2.1. On the data: the People's Living Conditions Household Surveys

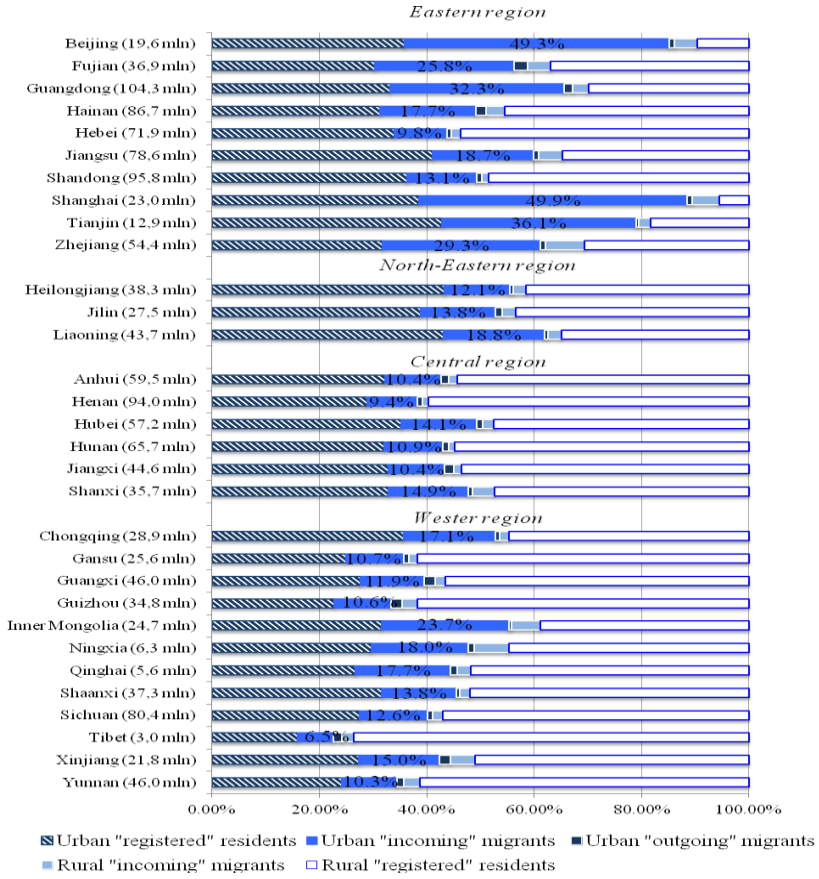
Data regarding life conditions in urban areas have been collected by the Department of Urban Social and Economic Survey of the National Bureau of Statistics (NBS) by using a stratified random sampling method that accounts for the population size of all cities and county towns on the Chinese territory. The national sample of urban households surveyed counted 59,000 households at the end of 2007. Similarly, data on living conditions of rural households have been collected by the Department of Rural Social and Economic Survey of the NBS through sample surveys on households located in villages. Data included in the rural surveys refer to a sample of 68,000 households selected from 7,100 villages across all China.

For the way the rural and urban surveys are structured they are subject to a number of measurement bias (Park 2008) that we need to acknowledge. Among the most relevant for our analysis are perhaps those related to the urban sampling method, which excludes urban residents living in townships as well as those living in suburban districts of province-level cities (Beijing, Chongqing, Shanghai, and Tianjin) and underrepresents the migrants living in urban areas (making just 2% of the sample after 2002; beforehand

agricultural products; and reform the village collection methods.

these were even completely excluded by the sampling). While the first of the measurement issues mentioned may introduce a slight upward bias in the computation of the average urban incomes, the second issue leaves out from our analysis a large part of the urban population. As discussed before, some of the Chinese provinces count more migrants in their cities with respect to others (see Fig.8)[3].

Figure 8: Resident Population by province, region and rural/urban residence (2010)



Source: authors' elaboration on the China's Sixth National Population Census

A striking case is that of Eastern provinces versus Western provinces: if cities in Beijing, Shanghai, Guangdong have a percentage of incoming migrants up to about 50% of their urban residents, in other provinces such as Tibet or Yunnan the proportion of these migrants is below 10%. Therefore the spatial heterogeneity of the bias introduced in our analysis will likely affect our ability to estimate thoroughly the rural-urban contribution to the overall inequality of the country. Despite we are unable to catch the direct effect of the urban immigrants on the rural-urban consumption gap, we certainly can assume to have catch their indirect effect. Just think to the remittances of the migrants and their positive impact on the living conditions of their families back home and you will understand how possibly urban migrants in rich provinces may raise the living standards of their community of origin. These ultimately may inflate our estimation of the contribution of regional disparities to the overall inequality of China.)

[3] This bias comes in part also from the policy of Hukou system. The Hukou is an ancient way to permanently register person and families to control the movement of Chinese population. In 1958 the distribution between rural and urban Hukou became more effective and the great process of urbanization of the last decades contribute to the growing disparities between rural and urban areas. The rural Hukou, even if migrant in urban areas, cannot take advantages of social security, medical care, school which reserved to urban Hukou. There are now restrictive conditions to become urban Hukou, who depend on the Cities rules, and they could introduce new discrimination in the access to urban areas [China Daily]. According to the "PRC regulations of the registered permanent residence", Hukou is defined as the people registered as permanent residences in the local authority, including registered foreigners and stateless. It is different with the permanent residence when we do statistics or researches: usually the latter is larger in developed areas, and vice versa.

2.2. The Construction of Food Security Indicators

As a starting point in our analysis we constructed a set of three food security indicators to be employed for the assessment of China's spatial disparities across space and over time. According to the food security definition adopted at the 1996 World Food Summit: "Food security (is achieved) when all people at all time, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life"(FAO 1996). Following this definition, scholars and policy researchers working on food security have tried to extract and measure the main aspects of food security to assess how spread is this human right across populations, deriving policy solutions to food insecurity and monitor progress in this field. As pointed out by IFPRI (2003) three main aspects derived by this definition of food security can be measured using household expenditure survey data, namely the "diet quantity", "diet quality" and "economic vulnerability". In line with this approach we employed China's rural and urban household survey data to measure the same three aspects. Within these three broad categories however a number of indicators could be chosen to measure each face of the food security. Our choice has been limited by the availability of data and the aim of this study. As our analysis intends to assess the relation between spatial inequality (considering both rural-urban and regional disparities) and food security and the changes occurred over the last two decades, we needed comparable data on rural and urban food consumption patterns for a time period relatively long. Our choice fell on the set of indicators presented in Table 1. Let's discuss them one by one.

Table 1. Food Security Indicators measured using People's living condition household survey data on rural and urban areas (China's Statistical Yearbook)

DIMENSION	INDICATOR	DESCRIPTION
Diet Quantity Access to food	Food consumption per capita	Per capita household expenditures devoted to food consumption at constant prices (year 1996)
Diet Quality Diet Diversity	Simpson Index of diet diversity	1 minus the sum of the square of each food product/group of products consumed over the total food consumption
Vulnerability Economic vulnerability	Engel's coefficient	Share of per capita household food expenditures over per capita income

Source: authors' own elaboration

2.2.1. Access to Food

The first main dimension highlighted by the definition of food security is certainly the "diet quantity" in a "sufficient" amount to live a healthy life. The issue is also related to that of "equal access to food" by all people at all times and justify our interest in understanding how in China the "right to food" is granted to all the people all over the country and whether things have changed over different times. The literature has measured the diet quantity using different indicators such as expenditures on each food, food quantities consumed, energy acquired, etc. In our study we decided to use the household food expenditures (in Yuan per capita) as this variable was available with yearly frequency for both rural and urban households in each of the 31 Chinese provinces. We used the time series of rural and urban food expenditures per capita deflated. For the deflation we used the retail price index enchained collected from the annual series of the Statistical yearbook for the 1996-2012 period. Then we converted the enchained series to series at constant prices 1996 and then deflated our data.

2.2.2. Diet Diversity

Within the range of the available indicators apt to describe the food security dimension "diet quality", we decided to concentrate of the diet diversity. A number of studies praised the diet diversity as a good indicator of food security (Hoddinott and Yohannes 2002; Hatloy et al. 1998, Lorenzana and Sanjur 1999). The first reason is that this indicator has been often associated to nutritious and health benefits, in the sense

that who eats more than one type of food products is less exposed to the risks of developing a nutrient deficiency/excess and is projected towards a more balanced diet (Ruel 2002). Also as noted by Hoddinott and Yohannes (2002) diet diversity has been found associated with higher birthweight (Rao et al. 2001), child anthropometric status (Allen et al. 1991; Hatloy et al. 2000; Onyango, Koski, and Tucker 1998; Taren and Chen 1993; Tarini, Bakari, and Delisle 1999), improved hemoglobin concentrations (Bhargava, Bouis, and Scrimshaw 2001), reduced incidence of hypertension (Miller, Crabtree, and Evans 1992), reduced risk of mortality from cardiovascular disease and cancer (Kant, Schatzkin, and Ziegler 1995).

Diet diversity is also associated to socio-economic gains, being a good indicator of the households' possibility to diversify the risks coming from an increase of specific food products. On the same time a diversified food consumption basket reflects a higher household income, revealing not only consumption preferences but also the socio-economic status of the consumer (Fanzo et al. 2013). Methodological difficulties characterise the measurement of diet diversity. The main issues are connected to the choice of the family products to be considered as "compulsory" for a healthy diet. Indeed a number of religious and ethical considerations affect food consumption preferences in China as in the rest of the world (food safety warns, vegetarian trends, traditional habits, etc.). The general practise in the literature to measure the diet diversity has been that of summing the number of food/food groups over a reference period (Ruel 2002), without however that an official recommendation exists on the number of different food products/groups that should enter an adequately diversified diet. If ones could access detailed data on individual food consumption, a possible solution is that to convert the food products consumed into nutrient intake to aggregate nutrient intakes and aggregate these values across all food entering a person's diet. Due to the unavailability of such data, we leave the nutritional aspects of the diet quality out of our analysis and follow a strand of the literature that applies indexes of corporate diversification to the measurement of the variety of food consumed (Doan 2013). For the computation of the Diet Diversity Index we used the formula of the Simpson Index - SI (Doan 2013). The SI is a diversification index is calculated according to the formula: $SI \quad 1 \quad \sum_{i=1}^{n} s_i^2$ where s_i^2 is the share of food consumption of each one food product consumed. The SI can be calculated using the consumption expenditures for the different types of food or any other variable measured in quantity (kg), energy (kcal), etc. The index ranges from 0 to 1-(1/n). A value close to 0 indicates that the consumption is concentrated over only one food product, while higher levels approaching 1 indicate a more equal share of products consumed.

For the rural and urban households we had different data made available by the national household surveys. In particular for the urban households we had the average total food expenditures by province (in yuan per capita) and the distribution of these expenditures across different food products. For the rural households instead we had the average total food expenditures by province (in yuan per capita) and the quantity (in kilograms) consumed of the main food products. As the data available for rural and urban areas are different we employ different methodology for the calculation of the SI index. For this reason it has to be kept in mind that our SI rural and SI urban are not directly comparable even if they are calculated over the same time-span and for the same 31 Chinese provinces. To make the analysis more consistent we keep constant the main food groups entering the analysis of both rural and urban areas (Grain, Vegetables, Edible Oil, Meat, Eggs and related products, Aquatic products) with the exception of "fruit", whose data were only available for urban areas; due to the importance of this food item we retained it in the urban calculations. The final computation of the SI index was done on 6 food groups for rural household consumption and on 7 groups for the urban household consumption. About the computation of the SI urban we proceeded to deflate the expenditure on each product with the retail price index of the correspondent products available for each province of China and for every year of the period considered. After the deflation we calculated the share of expenditures on each product over the total expenditures. For rural areas instead we converted the quantity in kcal using the "Crop primary equivalent" FAOSTAT conversion tables, which provided the food supply

quantity (g/capita/day) and (kcal/capita/day) for China for each of the food group products we analysed. We used the ratio of these variables to convert our data expressed in kilograms into kcal consumed by food products. Then we applied the SI formula and obtained the Diet Diversity Index for all rural areas.

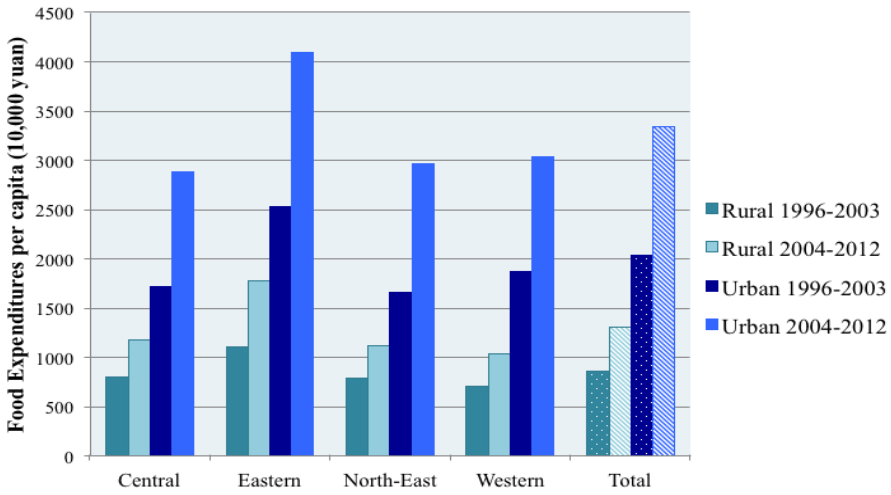
2.2.3. Economic Vulnerability

A third aspect of food security we are able to capture with our analysis on the rural and urban household food consumption behaviour is "vulnerability", in particular economic vulnerability. As mentioned in IFPRI (2003) economic vulnerability can be measured as the percentage of expenditure on food in the total household consumption expenditure. This indicator provided by the National Bureau of Statistics of China under the label "Engel's Coefficient" is readily available for both rural and urban households, at yearly frequency and for the whole time-period we intend to analyse (1996-2012). The Engel's coefficient obeys to the homonymous law according to which the share of food expenditures decreases as income increases. In the case of our assessment this indicator is of particular use as it is of immediate understanding its strong connection with food vulnerability. Think about an income shock and you will understand the possible effects of such shock on those households highly reliant on food. Having a small margin for other actions, such households will either reduce the food consumed (vulnerability to undernourishment) or reduce the quality of food consumed (vulnerability to malnourishment). Both examples clarify the issue embodied in the Engel's coefficient and its importance in our study of food security.

3. REGIONAL INEQUALITIES IN FOOD SECURITY AND ITS CHANGES OVER TIME

We adopted the official geographic divisions of China into four main groups - the Eastern coastal area, the Central area, the Western area and North-East area - to assess the food consumption behaviour of the rural and urban households in different regions of China. We compiled a table of descriptive statistics for two sub-periods: 1996-2003; 2004-2012. We also performed the analysis of variance (ANOVA) to test the differences between group means. The full statistics are available in Annex I. As revealed by the analysis of the Food Access Indicator, the Eastern region recorded already in 1996 much higher levels than other regions (Fig. 9 and Fig.10). On average in this region the household food expenditures per capita amounted to 11,070 Yuan in 1996 and 25,359 Yuan in 2006 against a national average of 8,618 Yuan in 1996 and 20,343 Yuan in 2012. Differences were not large between the remaining three regions neither in rural nor in urban areas for the whole time-period analysed. It is worth mentioning instead the striking increase recorded by the food expenses of urban households (Figure 9), certainly much larger than the food consumption increase of rural families.

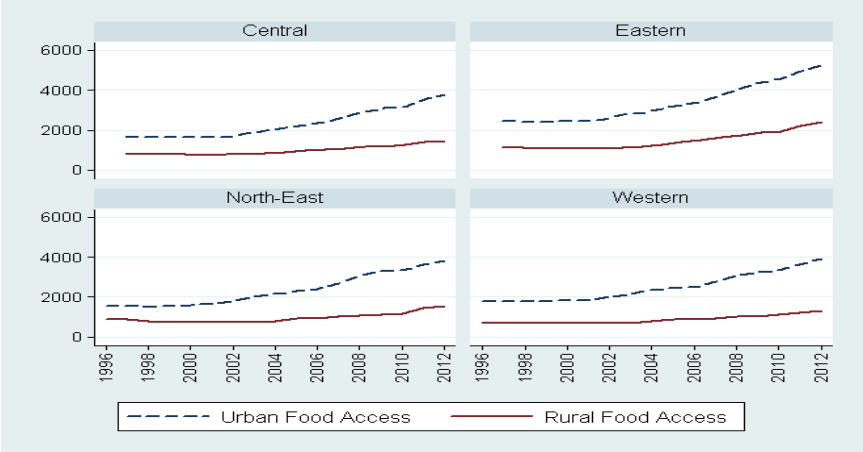
Figure 9: Food Access in rural and urban areas by macro-region



Note: calculated from the Chinese statistical yearbook as average over the 1st time-period (1996-2003) and the 2nd time-period (2004-2012)

The sharp increase has been more or less equal across the four regions, revealing a common upward trend in urban consumption all over China (Fig.10). The upward trend starts in the early years of 2000s, with a steeper slope for the provinces in the Eastern region. In rural China the situation is similar for the Eastern region, which records the highest values in all time period and the steepest increasing trend. The regional time series displayed in Fig.10 reveal that rural food access is on average the half of the urban and that the rural-urban gap follows the same widening path in all the four regions. This gap is explained in part by the different purchasing power in rural and urban areas, in part by the presence in urban areas of an increasing relevance of the "dining out" component. Regarding this last aspect in fact, in Beijing the dining out component of food consumption increased from 19% of the total in 1996 to 27% in 2012. This trend is even more pronounced in the Western region, the dining out component for household in Tibet for example was 4.6% in 1996 and reached 19.6% in 2012.

Figure 10: Urban and Rural Food Access by region

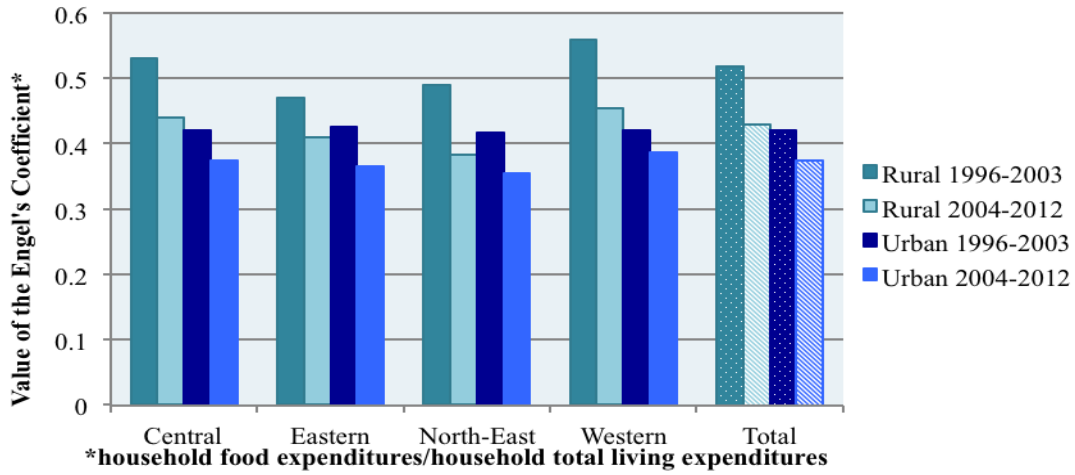


Note: based on the Chinese statistical yearbook and measured as Household Food Expenditure Yuan/per capita (1996-2012)

Looking at the economic vulnerability, as measured by the Engel's coefficient, the situation reverses. The greatest improvement of the indicator is registered in rural areas and in particular in the poorest provinces of the Western area (Figure 11). Considering the national average economic vulnerability of rural areas, the indicator decreased from 0.51 in 1996 to 0.43 in 2012, while in urban areas the indicator was 0.42

at in 1996 and reached now 0.37. There is a clear tendency of the rural and urban households to converge to similar behaviours (share of expenditures for food), which is now slightly below 0.4.

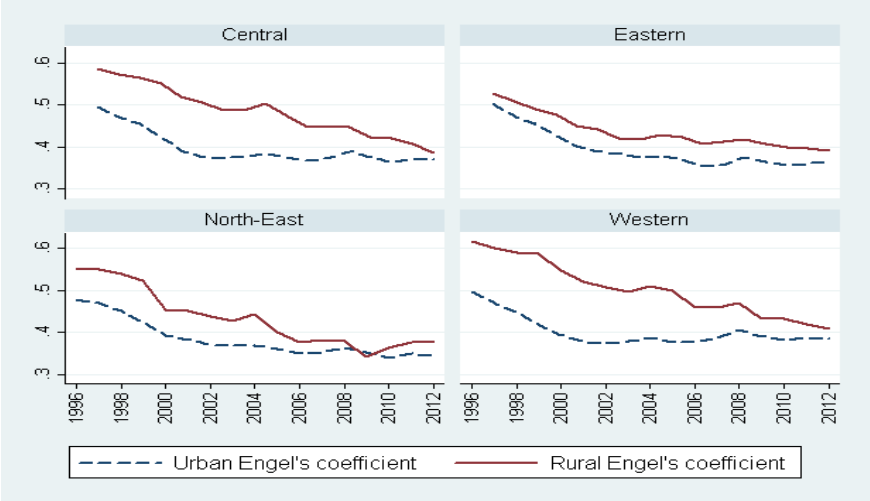
Figure 1: Economic Vulnerability to Food Insecurity by macro-region



Note: based on the Chinese statistical yearbook and calculated as average over the 1st time-period (1996-2003) and the 2nd time-period (2004-2012)

The trends of the regional time series plotted in Fig. 12 shows large differences across the four regions. In the Eastern provinces the rural-urban gap persists, while in the Central and Western provinces (those starting with the largest rural-urban gap) show convergence to similar values of the Engel's coefficient. In the North-Eastern region instead the values first converge in 2009 and then the gap widens again slightly.

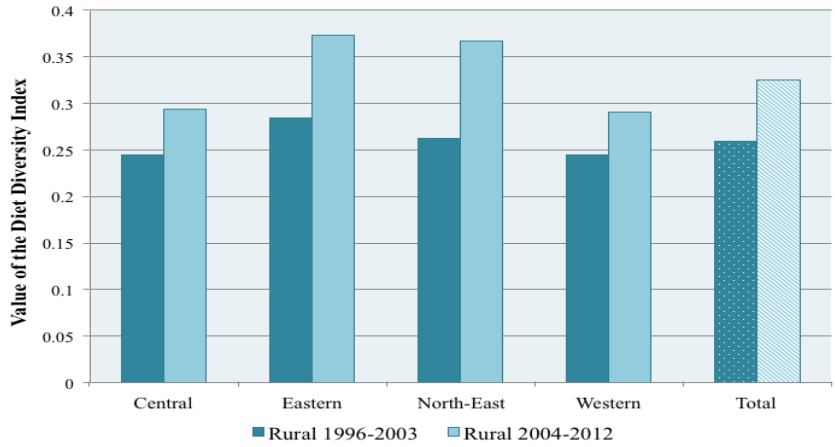
Figure 2: Urban and Rural Economic Vulnerability by region



Note: based on the Chinese statistical yearbook, proxy by the Engel's Coefficient (1996-2012)

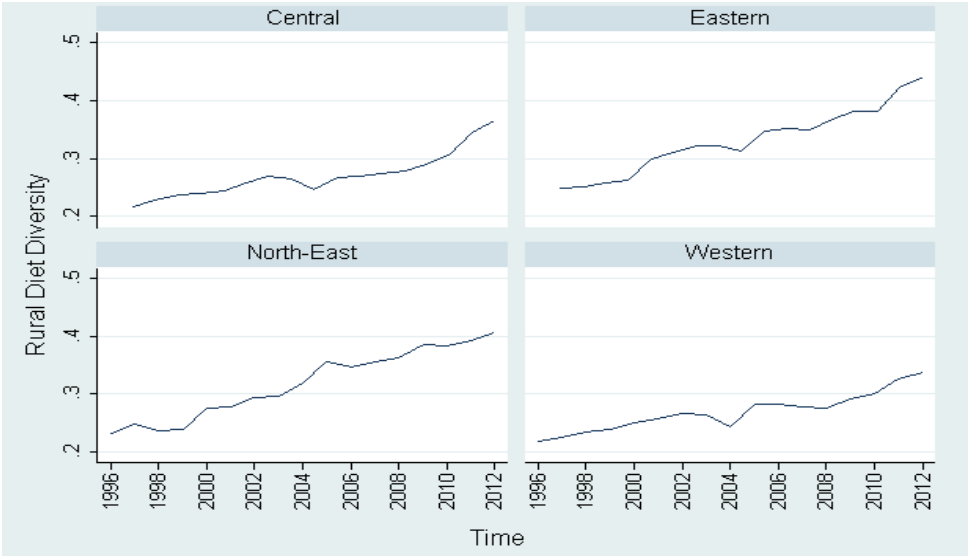
For the assessment of the diet diversity we need to keep the rural and urban analysis separate for the methodological reasons quoted earlier in this paper. Starting with rural areas the indicator shows very low level across all China. On average the value was a little above 0.25 in 1996 and it has improved to 0.33 nowadays (Fig.13). The largest contributors to this trend have been the Eastern provinces and the provinces in the North-Eastern region. There are the most exposed to foreign food supply (as are in prevalence located on the Coast), which may drive up the consumption standards and preferences. Looking at the time series of the rural diet diversity indicator (Fig.14), it is visible the greater dynamism of the Eastern and North-eastern region with respect to the other regions, whose trend was increasing at a much slower pace, speeding up only in recent years (2010-2012).

Figure 3: Diet Diversity of rural households by macro-region



Note: based on the Chinese statistical yearbook and calculated as average over the 1st time-period (1996-2003) and the 2nd time-period (2004-2012)

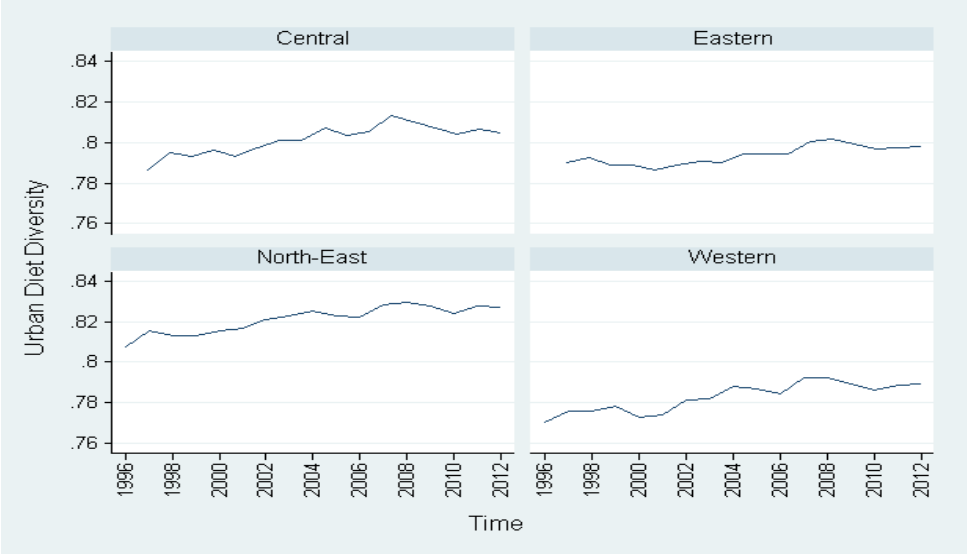
Figure 4: Diet Diversity in rural areas by macro-region (1996-2012)



Note: based on the Chinese statistical yearbook and measured as Simpson Index of household food consumption kcal (1996-2012)

About diet diversity in urban areas, while no changes can be measured if one takes the average over the 1st and 2nd time-period for the four macro-regions, different considerations can be made by observing the time-series of the indicator over the whole 1996-2012 period (Fig.15). We first have to acknowledge that the indicator varies little across the four regions. It ranges in fact from 0.78 in the Western region in 1996 to 0.83 in the North-Eastern region in 2012. This may be also due to the fact that we left out of our diet diversity indicator the dining out component. Despite that, the North-Eastern region displays at all times higher value of diet diversity indicator, while the contrary it is true for the Western region. Surprisingly, the Eastern region has rather modest values of this indicator. One possible explanation may be that due to the high-speed daily routine in the urban cities of the Eastern region, people tend to eat-out for working needs and we overlooked this component of household consumption, as we would be unable to assess the diet diversity of the meals consumed at restaurants.

Figure 5: Diet Diversity in urban areas by macro-region (1996-2012)



Note: based on the Chinese statistical yearbook and measured as Simpson Index of household food consumption Yuan/per capita (1996-2012)

A final conclusion on the assessment of the food security indicators for rural and urban Chinese households is that much of the differences catch by the analysis refer to the heterogeneity between the macro-regions rather than within. As reported in Annex I for almost all the indicators considered, the ANOVA revealed that the between group variance is larger than the one existing within group. As a consequence it has to be deduced that the macro-economic regions are quite homogeneous within their group, but strong differences still persist between those macro-regions. It makes an exception the indicator referring to urban economic vulnerability, for which it is the variance within the group that counts more.

4. CONVERGENCE ANALYSIS OF FOOD SECURITY INDICATORS

In order to investigate the process of convergence across rural and urban areas of China and its different regions we decided to perform a convergence analysis using non-parametric methods, taking the values of our food security indicators as variables of interest. Unfortunately, we could not perform this analysis on the diet diversity, as rural and urban data are not comparable. As we will see in section 2.3.3, for this analysis we used a different convergence methodology (the sigma-convergence).

Back to our non-parametric convergence analysis, we applied a methodology developed by Quah (Quah1993, 1995, 1995b, 1997) and based on observing the evolution of distribution of a variable over time. Each observation in our data was divided by the annual average, so that 1 represents the mean of the distribution. Unitary modal distributions centred in 1 would represent low levels of disparity across China. The stochastic kernel operator (M), the principal tool of this analysis, estimates the stochastic process, determining the evolution of a distribution (F) over time. M maps the current distribution (at time t) and its future distribution (at time t+1). The function describing this process is:

$$F_{t+1} = M \cdot F_t$$

By repeating this operation in subsequent periods one can obtain an estimate of the future distributions F_{t+m} defined as:

$$F_{t+s} = (M \cdot M \cdot \ldots \cdot M) \cdot F_t = M^s \cdot F_t$$

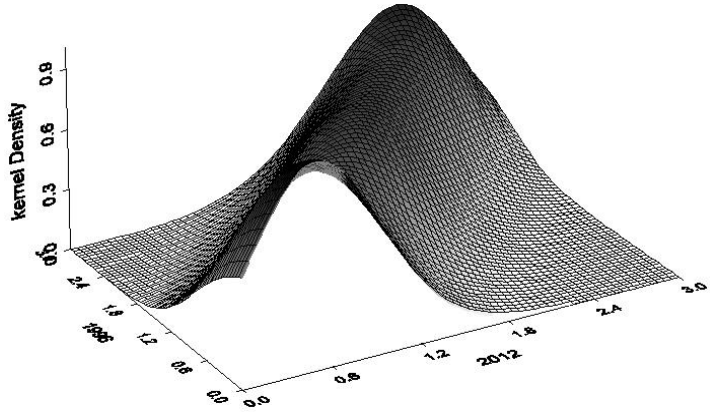
For s→∞ we obtain the long-term distribution of our variable of interest and explore the probability of distribution converging. The analysis will identify a process of value of "persistence" – where there are no expected changes in the relative positions of the observations within the cross-country distribution;

"convergence" - where all observations cluster around the same values, or finally; "polarization"- where the gap between the observations at the extremes of the distribution increases.

4.1. Access to Food

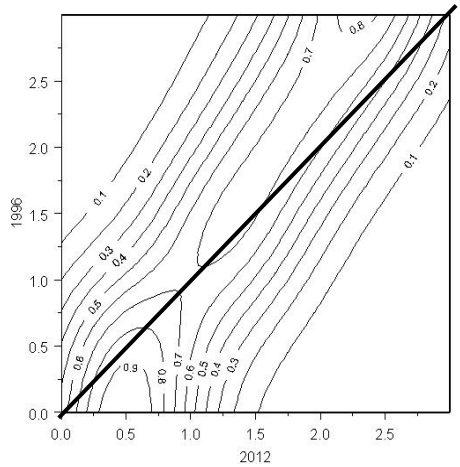
Our estimation of the stochastic kernel of the food access indicator (Fig.16) and (Fig.17) - calculated on a sample of 62 observations (31 rural, 31 urban) for the time-period 1996-2012 - revealed the presence of a process of club convergence in China and a persistent situation of disparities existing between the extremes of the distribution. There is a converging club with a value of the indicator below the national average, namely at about half of the average. This group of observations likely collects all the rural areas presenting values of the food access indicator lower than the average. For the rest of the observations it is possible to identify a very slow process of convergence in progress that starts for those observations reporting a value of the indicator higher than 1.5 the average. The Kernel surface above this value, as we better see in Fig. 17, is slightly rotated counter-clockwise and culminate in a second converging club around the value of 2.0-2.5.

Figure 6: Stochastic Kernel of Household Food Expenditures (1996-2012)



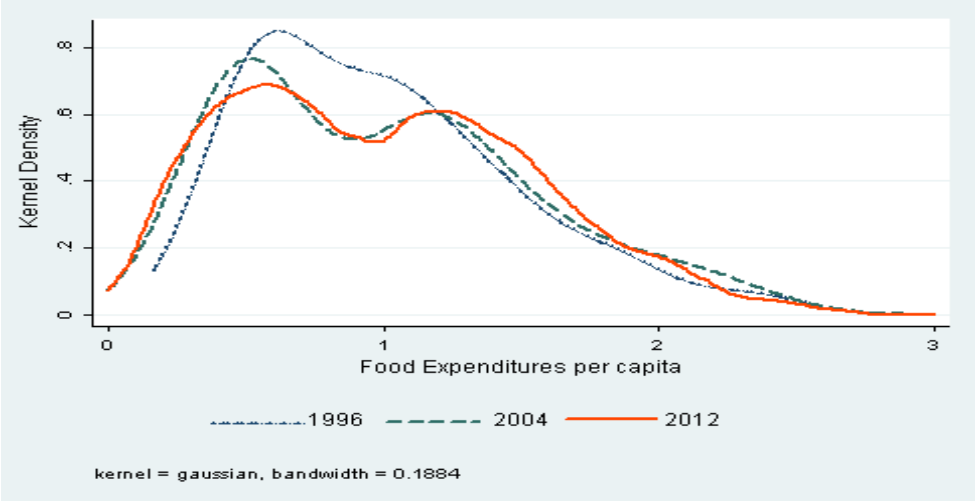
Note: authors' own calculation by software Gauss and S-Plus (1996-2012)

Figure 7: Contour Plot of Household Food Expenditures (1996-2012)



Note: authors' own calculation by software Gauss and S-Plus (1996-2012)

Figure 8: Marginal density function of the Household Food Expenditures (1996; 2004; 2012)



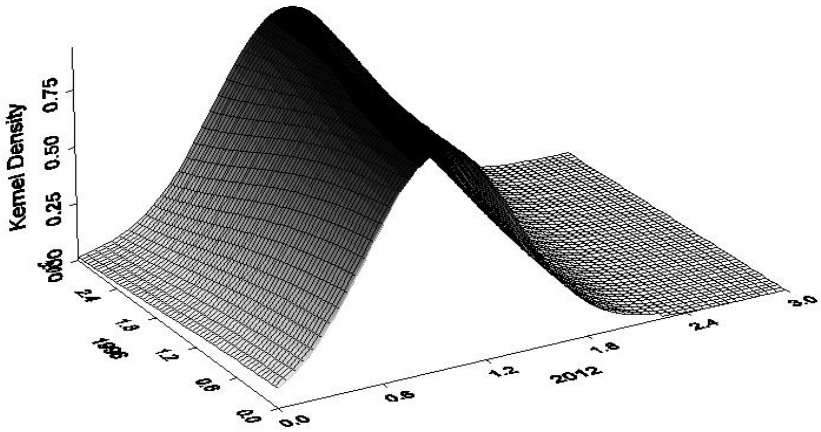
Note: authors' own calculation by software STATA (1996, 2004, 2012)

The result of the estimation of the marginal density function of the food access indicator (Fig.18), taken at three points in time (1996; 2004; 2012) clarifies our understanding on this convergence process. In fact the marginal distribution was uni-modal in 1996 and gradually moved to a bimodal (with modes of equal height) in 2004 and then in 2012. The convergence analysis on this indicator tells us that China's food access in the long run will be even more unequal as households will converge towards two different values of the indicator.

4.2. Economic Vulnerability

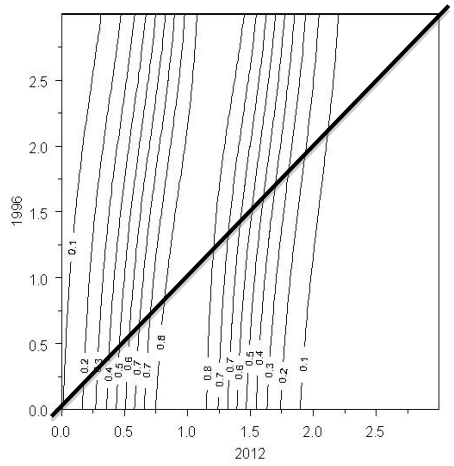
Moving to consumption behavior and looking at the share of household expenses devoted to food purchases, the situation changes. The Stochastic Kernel plotted in Fig.19 and its contour plot in Fig.20, show a clear tendency to unitary modal convergence around the mean value, supporting the consideration that rural and urban household allocation preferences with respect to food have been converging and will in the long run, irrespectively to regional economic inequalities.

Figure 9: Stochastic Kernel of the Engel's Coefficient (1996-2012)



Note: authors' own calculation by software Gauss and S-Plus (1996-2012)

Figure 10: Contour Plot of the Engel's Coefficient (1996-2012)



Note: authors' own calculation by software Gauss and S-Plus (1996-2012)

4.3. Diet Diversity

As for the Diet Diversity indicator, it has not been possible to perform a joint analysis of the rural and urban indicators. We therefore proceed to a convergence analysis targeting the two distributions separately. We tested the hypothesis that the variance of rural and urban diet diversity indicators reduced over time, measuring it only at two fixed points in time. This hypothesis displayed in the following equation would reveal the presence of the σ*-convergence*:

$$\sigma^2_{\log y,t} - \sigma^2_{\log y,t+x} > 0$$

A series of three tests has been proposed in the literature to test the hypothesis of σ*-convergence*. The first is the *Lichtenberg's Test* (1994) which takes the form of:

$$T_1 = \hat{\sigma}_1^2 / \hat{\sigma}_0^2$$

where $\hat{\sigma}_1^2$ is the variance of the per capita income at time 1 and $\hat{\sigma}_0^2$ at time 0. The T1 is distributed as F with (n-1;n-1) degrees of freedom. As the T_1 had been proved to be subject to "Type II error", thus failing to reject the false null hypothesis of *no-convergence*, other two tests have been later proposed by Caree and Klomp (1997) to complement the σ*-convergence* analysis. The two tests are described below:

$$T_2 = (N - 2,5)\ln\left[1 + \frac{1}{4}\frac{\hat{\sigma}_0^2\hat{\sigma}_1^2}{\hat{\sigma}_0^2\hat{\sigma}_1^2 - \hat{\sigma}_{0,1}^2}\right]$$

$$T_3 = \left[\frac{\sqrt{N}(\sigma_1^2/\sigma_1^2 - 1)}{2\sqrt{1-\hat{\pi}^2}}\right]$$

where $\hat{\sigma}_1^2$ and $\hat{\sigma}_0^2$ have been already defined and $\hat{\sigma}_{0,1}^2$ is the covariance of the variable between time 0 and time 1. T2 is distributed as a $\chi 2(1)$, while T3 is distributed as a N~(0,1). $\hat{\pi}^2$ is the estimated parameter from a general convergence regression:

$$y_1 = (1 + \beta)y_0 + u = \pi y_0 + u$$

where the variance of y_1 (the variable of interest as measured at final year), σ_1^2 is defined as:

$$\sigma_1^2 \quad (1 + \beta)^2\sigma_0^2 + \sigma_u^2$$

and σ_0^2 represents the variance of y_0 (the variable of interest as measured at initial year) . To have $\hat{\pi}^2 < 1$ it is a necessary condition for convergence. Then if T_1 T_2 and T_3 have a value over that one corresponding to the threshold of significance, then one can reject the null hypothesis of *no-convergence*. If instead $\hat{\pi}^2 > 1$, the T_3 cannot be computed and the validity of T_2 concludes for the hypothesis of *divergence*.

The tests of the *σ-convergence* on the Diet diversity indicator for rural areas excluded the possibility of convergence as $\hat{\pi}^2$ was always larger than one (Tab.2). For the whole 1996-2012 period, and the 1996-2004 period it has been possible to reveal the presence of a divergent process. This result seems consistent with previous findings on food access in rural and urban areas, where a polarization around two modes was in progress. In Tab.3 are reported the results of the *σ-convergence* tests on the diet diversity indicator. The tests are ambiguous. On one side it is rejected the hypothesis of convergence, on the other side it is also rejected the hypothesis of divergence. Perhaps in line with what seen in the Stochastic Kernel plot (Fig.11 and 12), there is prevalent persistence and on the same time a slow movement towards more converging diet consumption patterns in urban areas.

Table 2. Convergence of the Diet Diversity between provinces in rural areas

	π	T1	T2	T3		
1996-2004	1.19	0.42	12.16	-	π>1; T2 >3.84	Divergence
2004-2012	1.35	1.16	0.47	-	π>1; T2 <3.84	Non-convergence
1996-2012	1.63	0.48	5.68	-	π>1; T2 >3.84	Divergence

Table 3. Convergence of the Diet Diversity between provinces in urban areas

	π	T1	T2	T3		
1996-2004	1.017	0.79	1.17	-	π>1; T2 <3.84	Non-convergence
2004-2012	1.001	0.87	1.21	-	π>1; T2 <3.84	Non-convergence
1996-2012	1.018	0.69	2.28	-	π>1; T2 <3.84	Non-convergence

5. THE CONTRIBUTION OF RURAL AND URBAN AREAS TO THE OVERALL REGIONAL INEQUALITY IN FOOD SECURITY

The use of indicators measuring the unequal distribution of a phenomenon and the contribution of sub-groups or factors to the overall performance has a long history in the economic literature on inequality. The Gini Index is perhaps the most commonly used measure of statistical dispersion that has been adapted to various fields of economic analysis including that of spatial inequality. An alternative however exists to these types of dispersion indexes, which derives from the generalized entropy class of inequality measures and is characterized by fully additive decomposability of the Indexes produced. One well-known measure is the Theil Index (1967) that in its "by-group" formulation allows one computing the contribution of distinct sub-groups of the population to the overall measure of Inequality. The Theil Index measures also the contribution to inequality coming from the within or between group components. The formula to be used to calculate the Theil Index is:

$$T = \sum_{k=1}^{m} \left(\frac{n_k}{n}\frac{\overline{y_k}}{\overline{y}}\right) T_k + \sum_{k=1}^{m} \frac{n_k}{n}\left(\frac{\overline{y_k}}{\overline{y}}\right) ln\left(\frac{\overline{y_k}}{\overline{y}}\right)$$

T-Within ***T-Between***

where the Theil Index - within component (T-Within) is the average of T_k, the Theil inequality indexes of each *k* group (ranging from 1 to m) and weighted by the population share of each *k* group and their average intensity of the phenomenon (i.e. average income if we are measuring Inequality in income distribution). The T-Between components instead is calculated by using the mean of the *y* variable for each of *k* groups, instead

of the individual values of y. We calculated the Theil Index on two of our food security indicators in order to measure the contribution of the rural and urban groups to China's overall inequality in terms of food security. The two indicators considered are the Access to Food and the Economic Vulnerability.

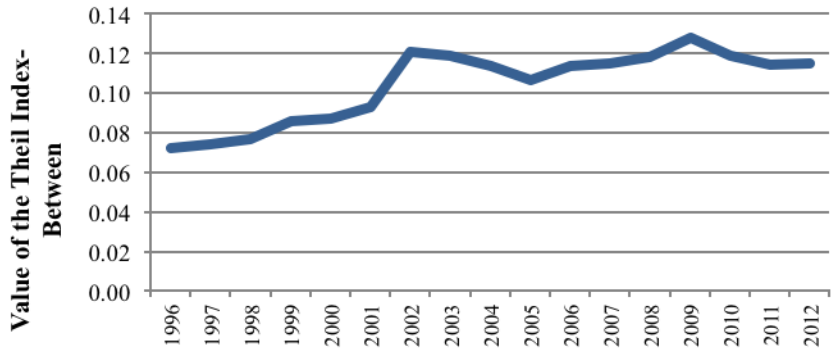
5.1. Access to Food

The Theil Index calculated on the food expenditures per capita for the 1996-2012 years shows that over time Inequality in Food access has modestly reduced across China, moving from a value of 0.57 in 1996 to 0.42 in 2012 (Tab.4). The contribution of the T-Between component, that is the inequality between the rural and urban group of provinces, is almost irrelevant; while the bulk of the inequality is explained by the T-within component - the inequality within the rural and urban groups taken separately. The time series of the T-between component shows a constant increase over the whole time period considered (Fig. 21). As we see in Fig. 22 the largest share of this T-Within Inequality is also attributable to the rural areas; that is to say that huge disparity characterizes the food access of rural households living in different geographic areas of the country. Looking now at the trends followed by the Theil Index components, it is worth noting that over time the rural-urban gap has slowly widened (it passed from 0.7 in 1996 to 0.11 in 2012). On the contrary the overall inequality measured by the Theil Index has decreased and great contribution has come in this direction by the rural areas, becoming more homogeneous in food access terms. Since 2002 it has been recorded also a slight increase in the disparities within the T-within urban group, which however kept staying below the value 0.4 (Fig. 22).

Table 4. Theil Index calculated on Food Access (1996-2012)

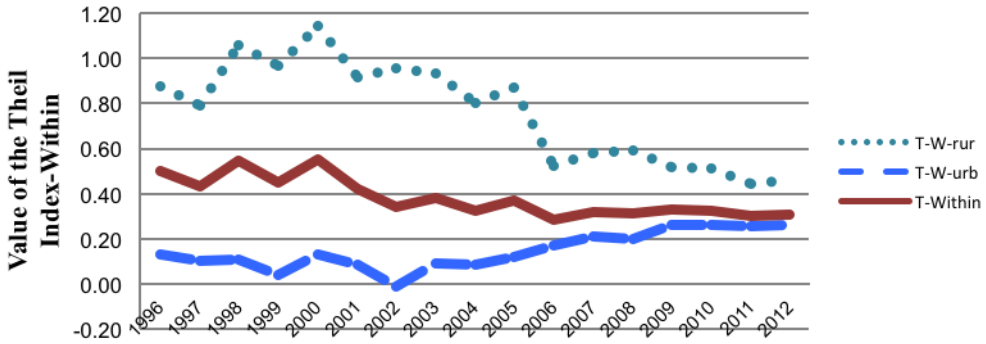
Year	T-Index	T-between	T-Within
1996	0.57	0.07	0.50
1997	0.51	0.07	0.43
1998	0.62	0.08	0.55
1999	0.54	0.09	0.45
2000	0.64	0.09	0.55
2001	0.51	0.09	0.42
2002	0.46	0.12	0.34
2003	0.50	0.12	0.38
2004	0.44	0.11	0.33
2005	0.48	0.11	0.37
2006	0.40	0.11	0.28
2007	0.44	0.11	0.32
2008	0.43	0.12	0.31
2009	0.46	0.13	0.33
2010	0.44	0.12	0.32
2011	0.42	0.11	0.30
2012	0.42	0.11	0.31

Figure 11: The Theil Index "Between Component" on Food expenditures per capita



Source: based on the Chinese statistical yearbook

Figure 12: The Theil Index "Within Component" on Food expenditures per capita



Source: based on the Chinese statistical yearbook

5.2. Economic Vulnerability

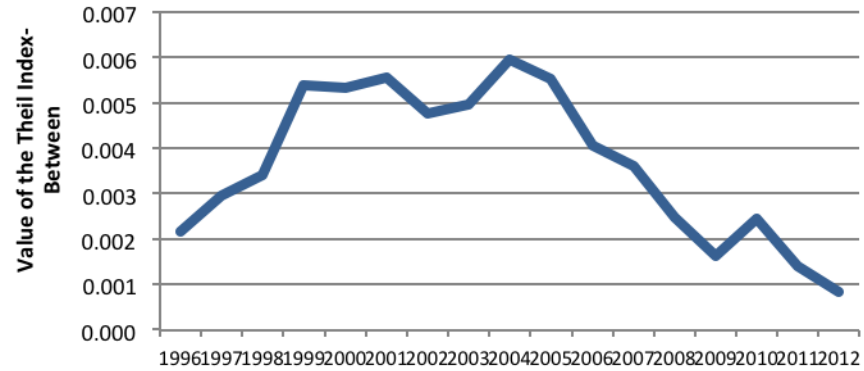
Another perspective can be acquired by measuring the Theil Inequality on the economic vulnerability of the rural and urban households to food insecurity. The Theil Index displayed a promising successful performance over the 1996-2012 period, as its value almost halved (going from 0.66 in 1996 to 0.36 in 2012) (Tab.5). Similarly what scored in terms of food access, inequality gains in economic vulnerability have been largely driven by the T-within rural component (Fig. 24). This latter first displayed a worsening trend until year 2000, but later sharply recovered and reached values slightly above 0.4. As in the previous case the T-Within component represents almost entirely the overall Inequality of the country, with the values of the T-between close to null (Tab.5). Despite the small proportion of Inequality explained by the T-between component, it is interesting to note that, contrary to what has happened in terms of food access, the urban-rural gap has been closing down since year 2004 (Fig.23).

Table 5: Theil Index calculated on Economic Vulnerability (1996-2012)

Year	T-Index	T-between	T-Within
1996	0.66	0.00	0.66
1997	0.59	0.00	0.59
1998	0.78	0.00	0.77
1999	0.69	0.01	0.69
2000	0.82	0.01	0.82
2001	0.65	0.01	0.64
2002	0.62	0.00	0.62
2003	0.64	0.00	0.63
2004	0.54	0.01	0.54
2005	0.59	0.01	0.58

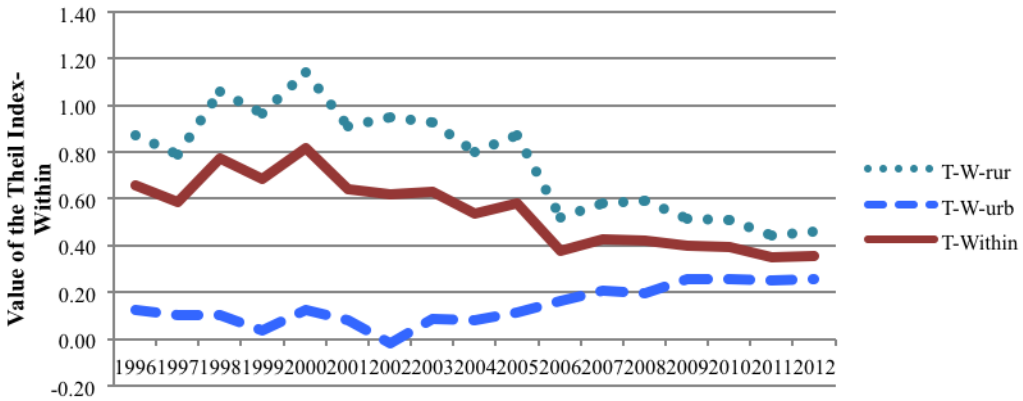
2006	0.39	0.00	0.38
2007	0.43	0.00	0.43
2008	0.43	0.00	0.42
2009	0.40	0.00	0.40
2010	0.40	0.00	0.39
2011	0.35	0.00	0.35
2012	0.36	0.00	0.36

Figure 13: The Theil Index "Between Component" on the Engel's Coefficient



Source: based on the Chinese statistical yearbook

Figure 14: The Theil Index "Within Component" on the Engel's coefficient



Source: based on the Chinese statistical yearbook

6. CONCLUDING REMARKS

In this study, we analyzed the regional disparity of vulnerability to food insecurity rural and urban sub dimension in China through three factors: access to food, economic vulnerability and diet diversity. Access to food highlighted the definition of food security by the food quantity as to obtain sufficient amount of food to sustain a healthy life; this "equal access to food" justify our interest in understanding how the "right to food" was granted to all the people all over China and whether things changed over different times. Economic vulnerability was used to capture the rural and urban household food consumption behavior, in particular measured as the percentage of expenditure on food in the total household consumption expenditure (Engel's Coefficient). Diet diversity, on the other hand, signified food security by the dimension of diet quality, within the range of the available indicators apt to describe how various food consumed by urban and rural households in China during the recent decades. We analyse 31 Chinese provinces considering rural and urban disparity inside from 1996 to 2012.

As revealed by the analysis of the Food Access Indicator, the Eastern region recorded much higher levels than other regions while the differences were not so dramatic among the remaining three regions neither in rural nor in urban areas for the whole time-period. The striking increase of food expenses

concentrated on urban households, much larger than the food consumption increase of rural families (which may because we cannot estimate the rural "dining out" component because of missing data). This indicator processed an upward trend starting in the early years of 2000s with a steeper slope for the provinces in the Eastern region, revealing that rural food access is on average the half of the urban and that the rural-urban gap follows the same widening path in all the four regions. The convergence process of the food access indicator shows club convergence existing in China and a persistent situation of disparities is showed up between the extremes of the distribution.

The dimension of Economic Vulnerability, shows a reversed situation. The greatest improvement of the indicator was registered in rural areas and in particular in the poorest provinces of the Western area, and there was a clear tendency of the rural and urban households to converge to similar behaviours. The trends of the regional time series showed large differences across the four regions in Economic Vulnerability: in the Eastern provinces the rural-urban gap persists, while in the Central and Western provinces (those starting with the largest rural-urban gap) shows convergence to similar values of the Engel's coefficient; in the North-Eastern region instead the values first converged in 2009 and then the gap widened again slightly. The convergence estimation of Economic Vulnerability shows a clear tendency to unitary modal convergence around the mean value, supporting the consideration that rural and urban household allocation preferences with respect to food had been converging in the long run, irrespectively to regional economic inequalities.

For the assessment of the diet diversity we need to keep the rural and urban analysis separate for the methodological reasons quoted earlier in this paper. In rural areas, the largest contributors to this trend was the Eastern provinces and the provinces in the North-Eastern region, which were the most exposed to foreign food supply that might drive up the consumption standards and preferences. The time series of the rural diet diversity indicator also showed greater dynamism of the Eastern and North-eastern region with respect to the other regions, whose trend was increasing at a much slower rate, speeding up only in recent years. In urban areas, while no changes could be measured if one took the average over the 1st and 2nd time-period for the four macro-regions (this trend is justify also because we would have to take in to account dining out component) different considerations could be made by observing the time-series of the indicator over the whole period. The convergence estimation of the reduction in variability of Diet diversity indicator for rural areas excluded the possibility decreasing gaps, which seemed consistent with previous findings on food access. In urban areas we cannot conclude anything about convergence, the gaps remain more or less the same in the three time period considered.

We also calculated the Theil Index on two of our food security indicators in order to measure the contribution of the rural and urban groups to China's overall inequality in terms of food security. We consider only two indicators: the Access to Food and the Economic Vulnerability. The Theil Index calculated on the food expenditures per capita showed that over time Inequality in Food access had modestly reduced across China. The contribution of the inequality between the rural and urban group of provinces was almost irrelevant, while the majority of the inequality was explained by the inequality within the rural and urban groups taken separately. The inequality on the economic vulnerability of the rural and urban households to food insecurity, displays the differences over 1996-2012 reducing dramatically, as its value almost halved. Similarly it happened in terms of food access, inequality gains in economic vulnerability have been largely driven by the inequality inside rural component.

A final conclusion on the assessment of the food security indicators for rural and urban Chinese households was that much of the differences caught by the analysis referred to the heterogeneity among different regions rather than between the rural and the urban reality.

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Annex I - Descriptive statistics

Table 6 . Descriptive Statistics and ANOVA of the six Food Security Indicators by (1996-2012)

Descriptive Statistics - 1st Time-period (1996-2003)						
Indicator		*Central*	*Eastern*	*North-East*	*Western*	*Total*
Food Access Rural	*Mean*	806.47	1107.77	793.73	701.72	861.88
	No. obs.	48	80	24	96	248
	Std. Deviation	159.913	319.457	82.388	114.945	271.699
*Diet Diversity Rural**	*Mean*	0.2448	0.2844	0.2623	0.2443	0.2591
	No. obs.	48	80	24	96	248
	Std. Deviation	0.04456	0.06515	0.04714	0.05121	0.05729
Vulnerability Rural	*Mean*	0.5312	0.4696	0.49	0.5593	0.5182
	No. obs.	48	80	24	96	248
	Std. Deviation	0.04652	0.06792	0.05626	0.08388	0.08012
Food Access Urban	*Mean*	1205.7862	1772.2087	1238.6992	1261.1842	1413.1327
	No. obs.	48	80	24	96	248
	Std. Deviation	134.51605	428.3842	154.68275	284.12065	396.81089
Vulnerability Urban	*Mean*	0.4204	0.4261	0.4171	0.4197	0.4217
	No. obs.	48	80	24	96	248
	Std. Deviation	0.0569	0.06299	0.04398	0.05535	0.05705
*Diet Diversity Urban **	*Mean*	0.7955	0.7897	0.8156	0.7763	0.7881
	No. obs.	48	80	24	96	248
	Std. Deviation	0.00894	0.02806	0.0055	0.02458	0.02532

Anova - 1st Time-period (1996-2003)						
		Sum of Squares	*df*	*Mean Square*	*F*	*Sig.*
Food Access Rural	*Between Groups*	7558206.72	3	2519402.24	57.58	0.000
	Within Groups	10680000	244	43751.54		
	Total	18230000	247			
Diet Diversity Rural	*Between Groups*	0.08	3	0.03	9.15	0.000
	Within Groups	0.73	244	0.00		
	Total	0.81	247			
Vulnerability Rural	*Between Groups*	0.38	3	0.13	25.46	0.000
	Within Groups	1.21	244	0.01		
	Total	1.59	247			
Food Access Urban	*Between Groups*	30950000	3	10320000	48	0.000
	Within Groups	52660000	244	215808		
	Total	83610000	247			
Vulnerability Urban	*Between Groups*	0.003	3	0.001	0.26	0.855
	Within Groups	0.801	244	0.003		
	Total	0.804	247			
Diet Diversity Urban	*Between Groups*	0.03	3	0.01	22.51	0.000
	Within Groups	.124	244	.001		
	Total	.158	247			

Descriptive Statistics - 2nd Time-period (2004-2012)						
Indicator		*Central*	*Eastern*	*North-East*	*Western*	*Total*
Food Access Rural	*Mean*	1172.37	1780.92	1122.85	1030.57	1308.99
	No. obs.	54	90	27	108	279
	Std. Deviation	268.742	652.741	243.026	254.487	538.361
Vulnerability Rural	*Mean*	0.2941	0.3731	0.3674	0.291	0.3255
	No. obs.	54	90	27	108	279
	Std. Deviation	0.05248	0.07758	0.03067	0.06364	0.07521
*Diet Diversity Rural**	*Mean*	0.4394	0.4097	0.3826	0.4547	0.4303
	No. obs.	54	90	27	108	279
	Std. Deviation	0.05332	0.06525	0.03591	0.06765	0.06629
Food Access Urban	*Mean*	2882.3263	4092.5462	2968.02	3035.0067	3340.1148
	No. obs.	54	90	27	108	279.00
	Std. Deviation	671.20644	1121.82953	714.11977	706.72285	1001.16
Vulnerability Urban	*Mean*	0.3748	0.3647	0.3537	0.3864	0.374
	No. obs.	54	90	27	108	279
	Std. Deviation	0.03628	0.03727	0.02256	0.04617	0.04113
*Diet Diversity Urban **	*Mean*	0.8072	0.7975	0.826	0.7885	0.7987
	No. obs.	54	90	27	108	279
	Std. Deviation	0.01143	0.02712	0.0054	0.0256	0.02535

Anova - 2nd Time-period (2004-2012)						
		Sum of Squares	*df*	*Mean Square*	*F*	*Sig.*
Food Access Rural	*Between Groups*	30360000	3	10120000	55.42	0.000
	Within Groups	50210000	275	182594.08		
	Total	80570000	278			
Vulnerability Rural	*Between Groups*	0.43	3	0.14	34.84	0.000
	Within Groups	1.14	275	0.00		
	Total	1.57	278			
Diet Diversity Rural	*Between Groups*	0.17	3	0.06	14.69	0.000
	Within Groups	1.05	275	0.00		
	Total	1.22	278			
Food Access Urban	*Between Groups*	76060000	3	25350000	34.42	0.000
	Within Groups	202600000	275	736673		
	Total	278600000	278			
Vulnerability Urban	*Between Groups*	0.04	3	0.01	7.50	0.000
	Within Groups	0.44	275	0.00		
	Total	0.47	278			
Diet Diversity Urban	*Between Groups*	0.04	3	0.01	22.62	0.000
	Within Groups	0.143	275	0.001		
	Total	0.179	278			

Annex II - Association between the Rural and Urban Food Security Indicators

Table 7. Correlations between the rural and urban Food Security Indicators by macro-region (1996-2003; 2004-2012)

1st Time-period (1996-2003)

	Urban Food Access	Rural Food Access	Rural Econ. Vulnerability	Urban Econ. Vulnerability	Urban Diet Diversity	Rural Diet Diversity
Urban Food Access	1					
Rural Food Access	0.9399''	1				
Rural Econ. Vulnerability	-0.7852''	-0.7006''	1			
Urban Econ. Vulnerability	-0.526''	-0.4095''	0.7729''	1		
Urban Diet Diversity	0.2652''	0.3196''	-0.5908''	-0.4081''	1	
Rural Diet Diversity	0.9018''	0.883''	-0.8724''	-0.6808''	0.4597''	1

2nd Time-period (2004-2012)

	Urban Food Access	Rural Food Access	Rural Econ. Vulnerability	Urban Econ. Vulnerability	Urban Diet Diversity	Rural Diet Diversity
Urban Food Access	1					
Rural Food Access	0.9435''	1				
Rural Econ. Vulnerability	-0.766''	-0.659''	1			
Urban Econ. Vulnerability	-0.5293''	-0.4222''	0.8175''	1		
Urban Diet Diversity	0.2661''	0.3161''	-0.6683''	-0.4495''	1	
Rural Diet Diversity	0.888''	0.8956''	-0.8657''	-0.6853''	0.568''	1

Table 8. Correlations between the rural and urban Food Security Indicators by province (1996-2003; 2004-2012)

1st Time-period (1996-2003)

	Rural Econ. Vulnerability	**Rural Food Access**	**Rural Diet Diversity**	**Urban Econ. Vulnerability**	**Urban Food Access**	**Urban Diet Diversity**
Rural Econ. Vulnerability	1					
Rural Food Access	-0.391"	1				
Rural Diet Diversity	-0.5513"	0.6941"	1			
Urban Econ. Vulnerability	0.7263"	-0.1848"	-0.4024"	1		
Urban Food Access	-0.4976"	0.9147"	0.7674"	-0.239"	1	
Urban Diet Diversity	-0.5493"	-0.1185'	0.0459	-0.4459"	-0.0773	1

2nd Time-period (2004-2012)

	Rural Econ. Vulnerability	**Rural Food Access**	**Rural Diet Diversity**	**Urban Econ. Vulnerability**	**Urban Food Access**	**Urban Diet Diversity**
Rural Econ. Vulnerability	1					
Rural Food Access	-0.3728"	1				
Rural Diet Diversity	-0.4304"	0.749"	1			
Urban Econ. Vulnerability	0.7652"	-0.2501"	-0.3722"	1		
Urban Food Access	-0.3818"	0.8902"	0.6845"	-0.1807"	1	
Urban Diet Diversity	-0.552"	0.0132	0.0802	-0.4659"	-0.0131	1

Note: ‘significance level at 0.1; “significance level at 0.05