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*Feeding the Planet and Greening Agriculture: Challenges and opportunities for the bio-economy*

# Regional Disparity of Vulnerability to Food Insecurity in China


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# *Background*

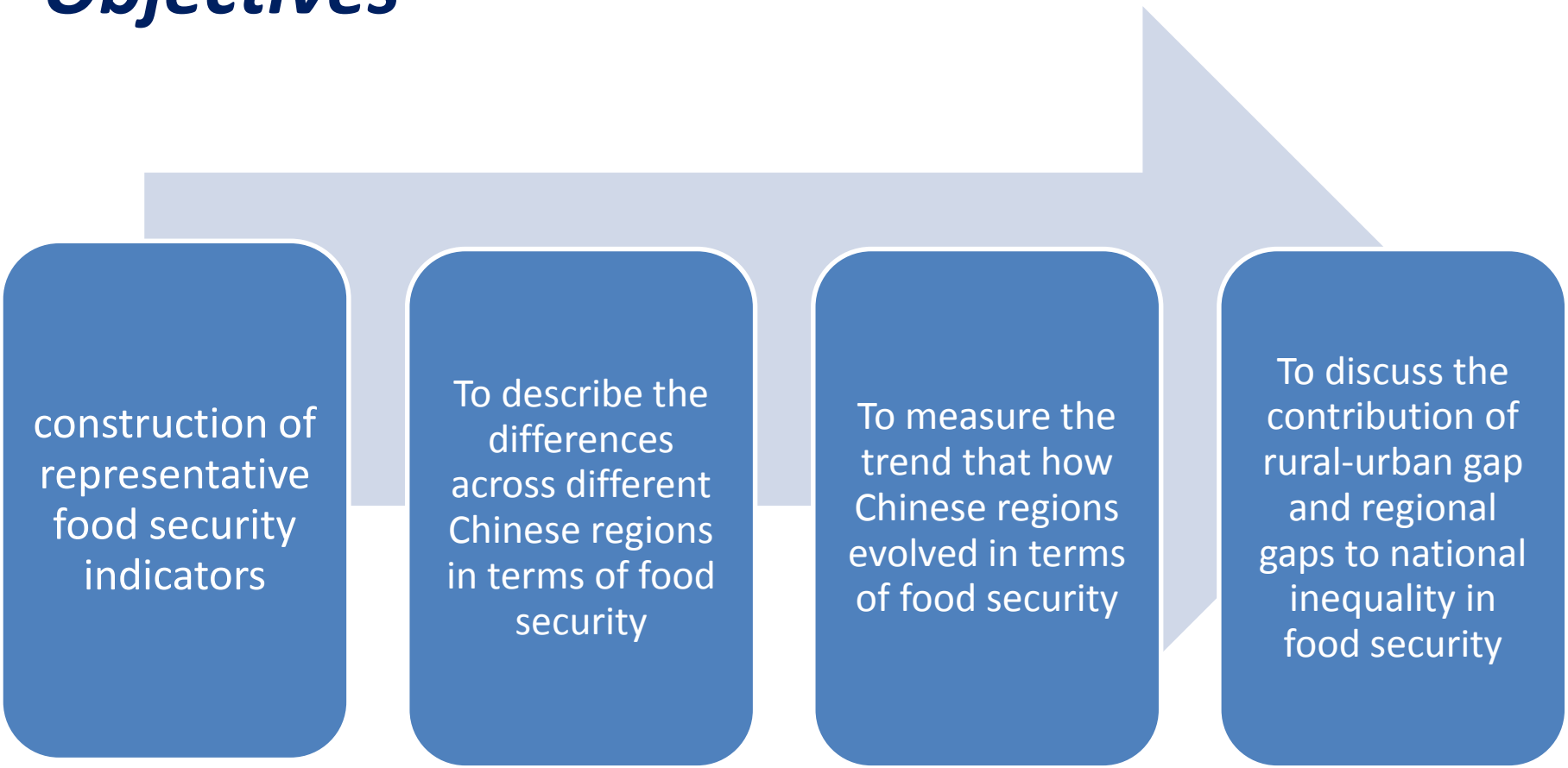
**Unequal development**

- Various literature: general geographic "inequity" in China
- Lack of attention: the relation between food security and regional inequality

**Significance of food security**

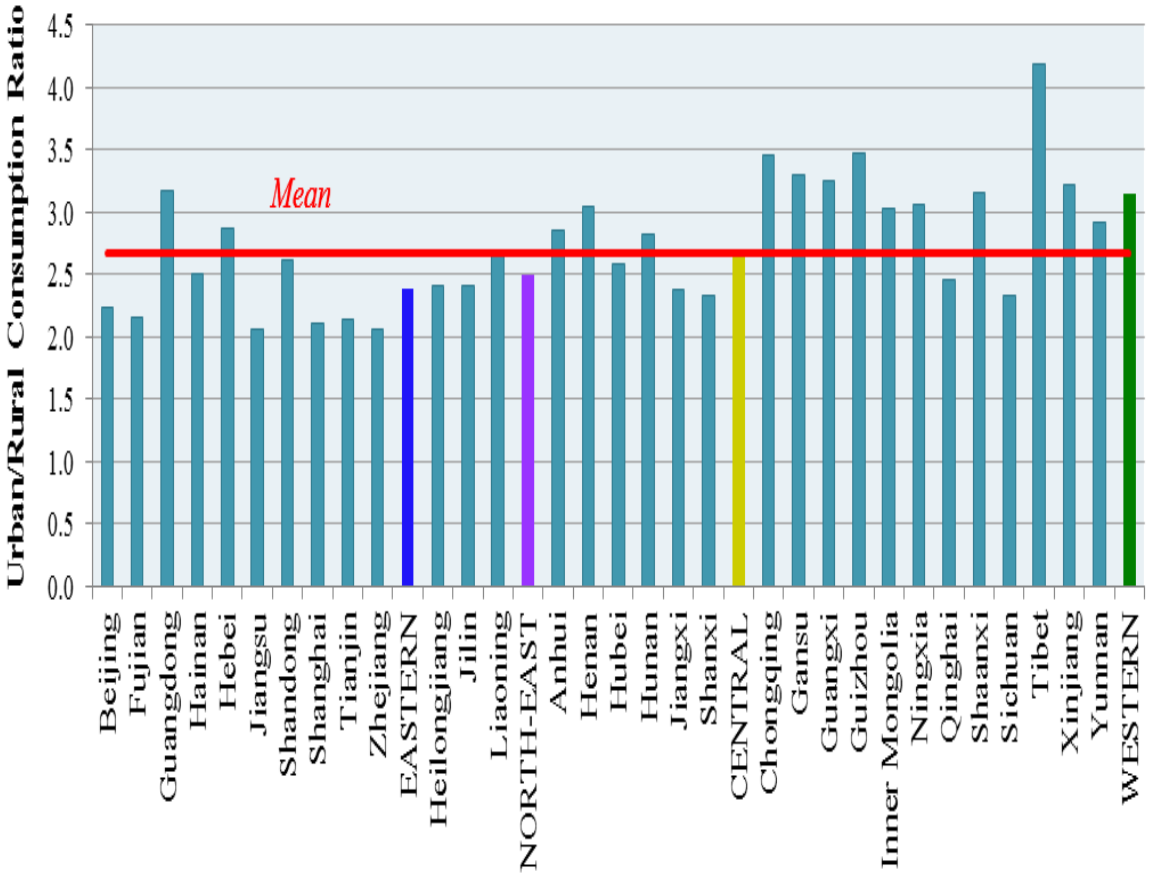
- Food security: quantity as "feeding people"; quality as health, nutrition, and combination.
- This study defines food security within the socio-economic aspects.

# *Objectives*


construction of representative food security indicators
To describe the differences across different Chinese regions in terms of food security
To measure the trend that how Chinese regions evolved in terms of food security
To discuss the contribution of rural-urban gap and regional gaps to national inequality in food security

# *Prelude - China's macro-economic regions (official classification)*

# *Regional inequalities – Consumption*



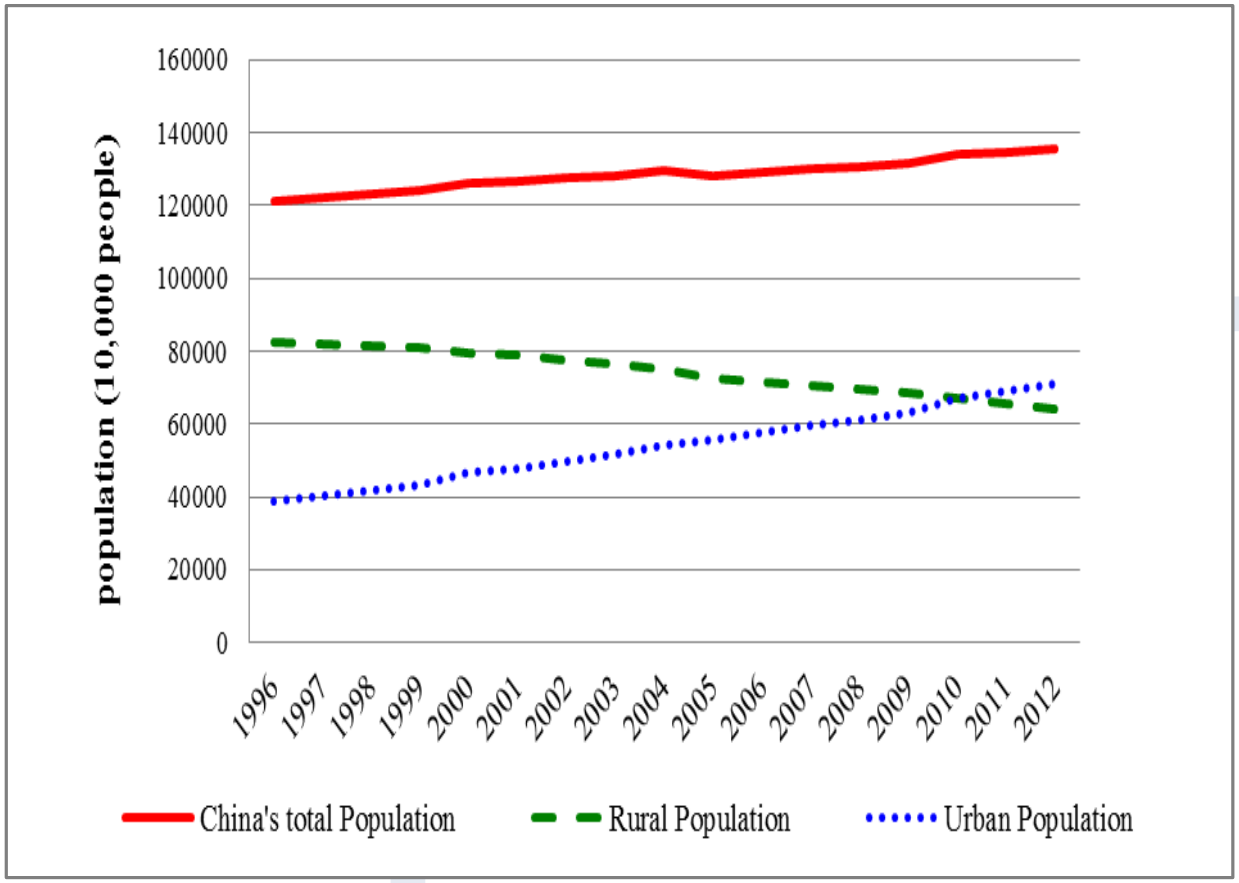

The urban-rural consumption rate shows:

***Western*** - the major inequalities;

***Eastern*** – the lowest gap of urban-rural consumption (e.g. Jiangsu, Shanghai, Beijing).

***Consumption gap between rural-urban households by region (2012)***

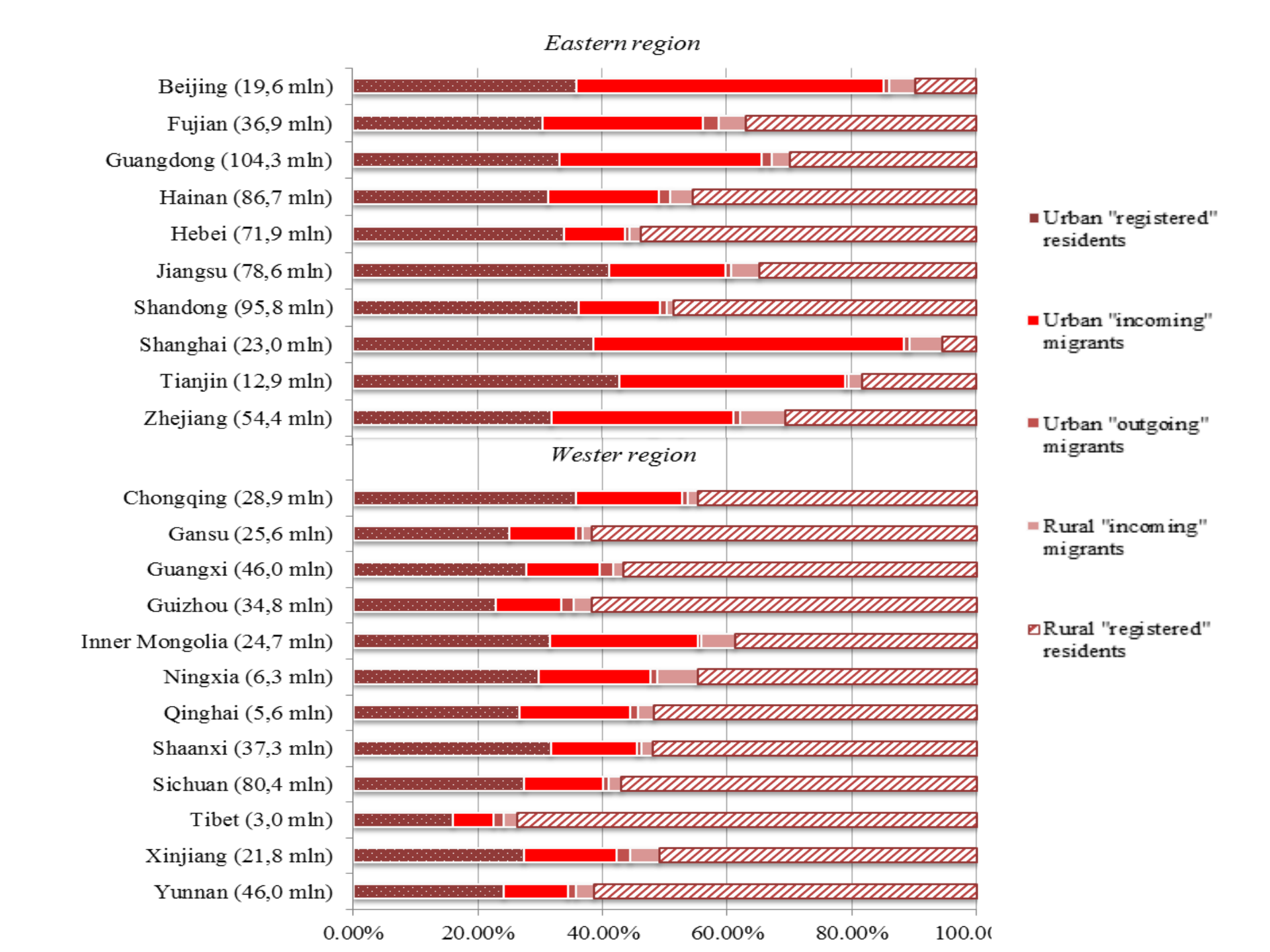
# *Spatial demographic challenge*



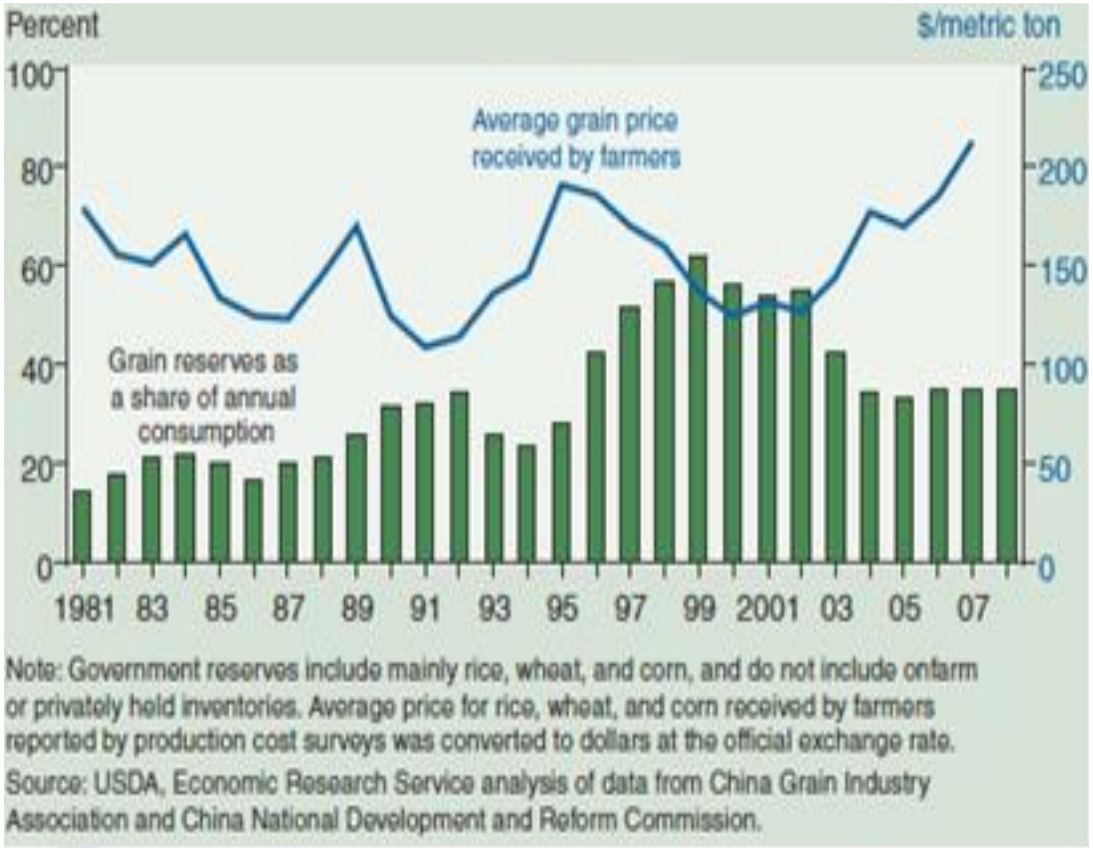

Not only China needs to feed about 20% of the world's population, the bulk of the issue relates to the share of its population living in rural and urban areas.

2010 a shift happened: urban population have outnumbered rural ones.

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


Eastern region
Beijing (19,6 mln)
Fujian (36,9 mln)
Guangdong (104,3 mln)
Hainan (86,7 mln)
Hebei (71,9 mln)
Jiangsu (78,6 mln)
Shandong (95,8 mln)
Shanghai (23,0 mln)
Tianjin (12,9 mln)
Zhejiang (54,4 mln)
Wester region
Chongqing (28,9 mln)
Gansu (25,6 mln)
Guangxi (46,0 mln)
Guizhou (34,8 mln)
Inner Mongolia (24,7 mln)
Ningxia (6,3 mln)
Qinghai (5,6 mln)
Shaanxi (37,3 mln)
Sichuan (80,4 mln)
Tibet (3,0 mln)
Xinjiang (21,8 mln)
Yunnan (46,0 mln)
0.00%
20.00%
40.00%
60.00%
80.00%
100.0
Urban "registered" residents
Urban "incoming" migrants
Urban "outgoing" migrants
Rural "incoming" migrants
Rural "registered" residents

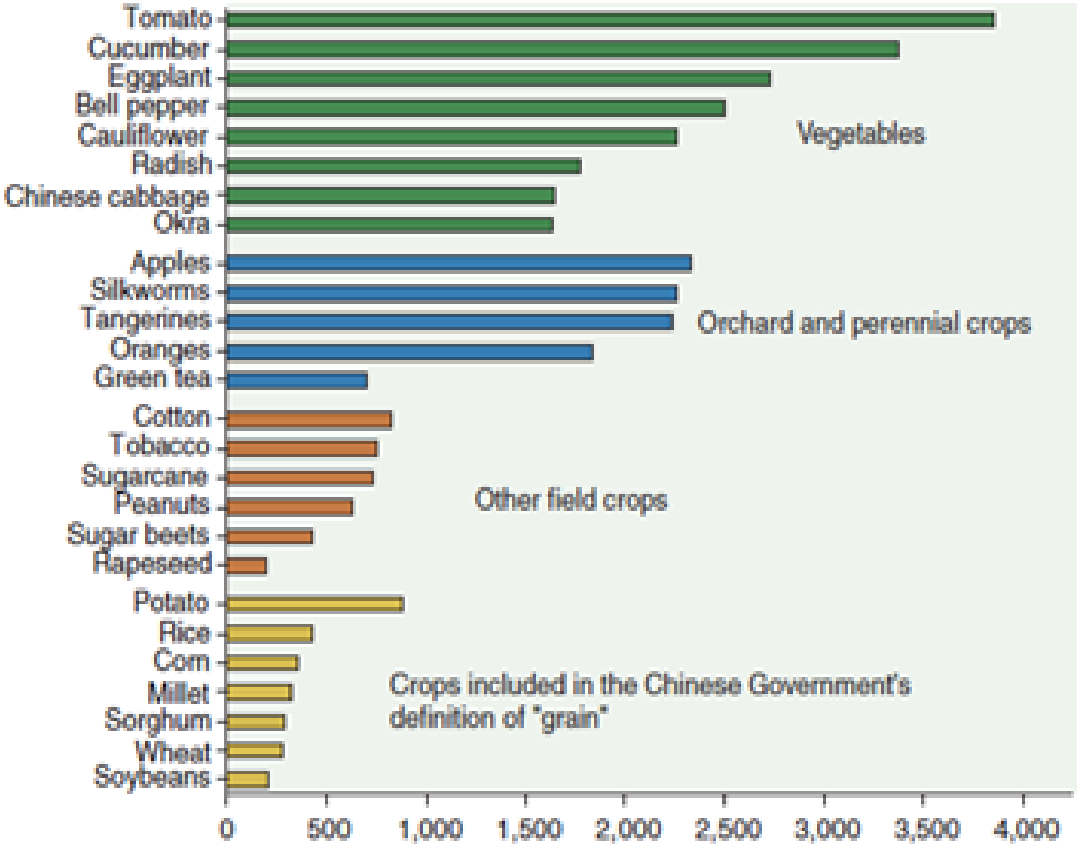
# *China's food security policy approach*




***Grain reserves and prices (1981-2007)***

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

# *China's food security policy approach*




***Net cash returns per acre by product ($/acre), 2006***

Grain subsidy protected farmers' benefit from the grain price stabilizing from the market shock on one hand, but its effects on grain security was ambiguous as the net return of grain was much less than economical plants.

# *Data*

**Data collection**

National Bureau of Statistics (NBS)

random sampling method (e.g. 2007):

59,000 urban HHS;

68,000 rural HHS

**Measuring bias**

urban migrants:

2% after 2002

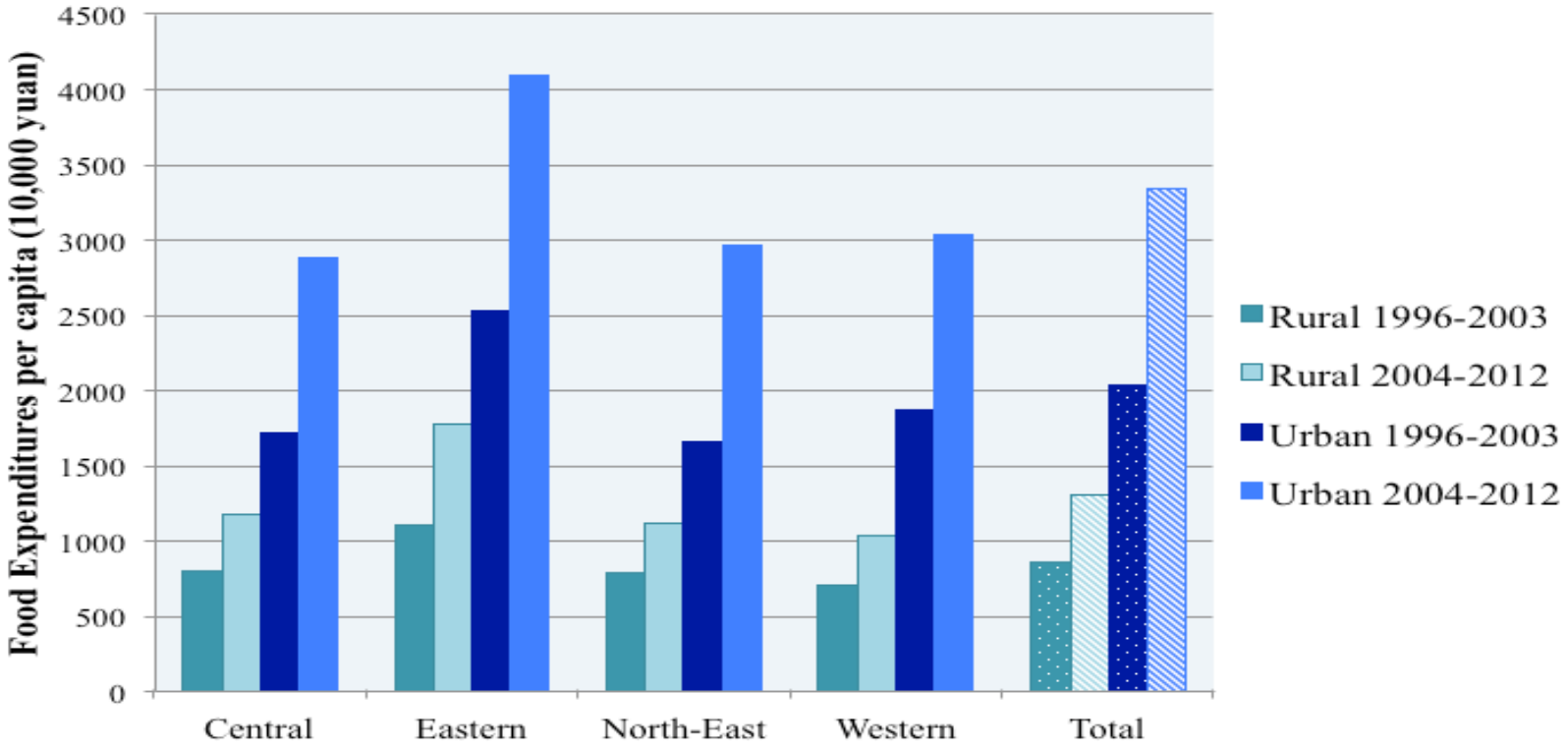
May affect our estimation of the rural-urban contribution to the overall disparity

# *The Construction of Food Security Indicators*

***"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)***

| 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 |

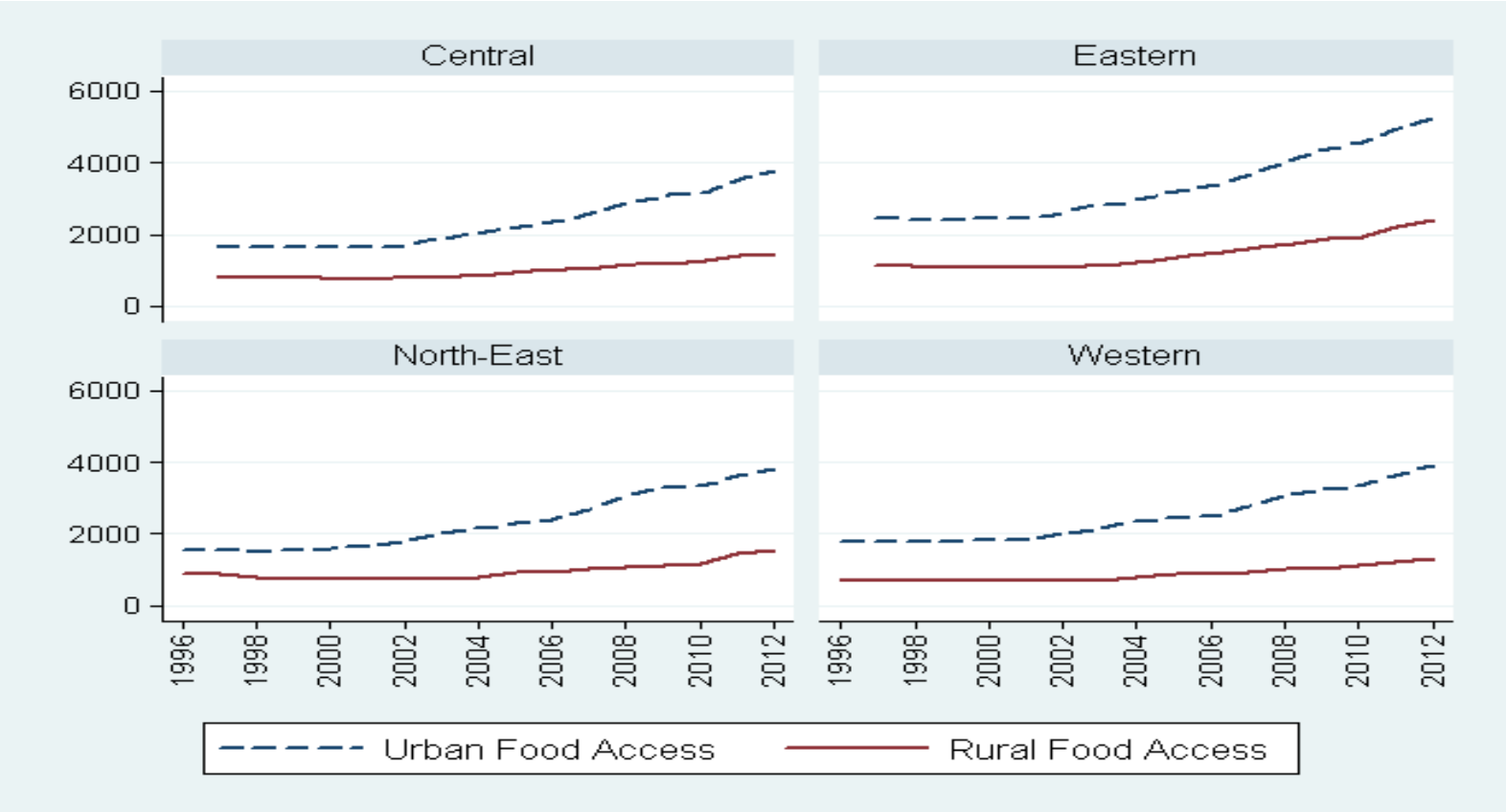
# *Basic analysis – Food access*




***Food Access in rural and urban areas by macro-region***

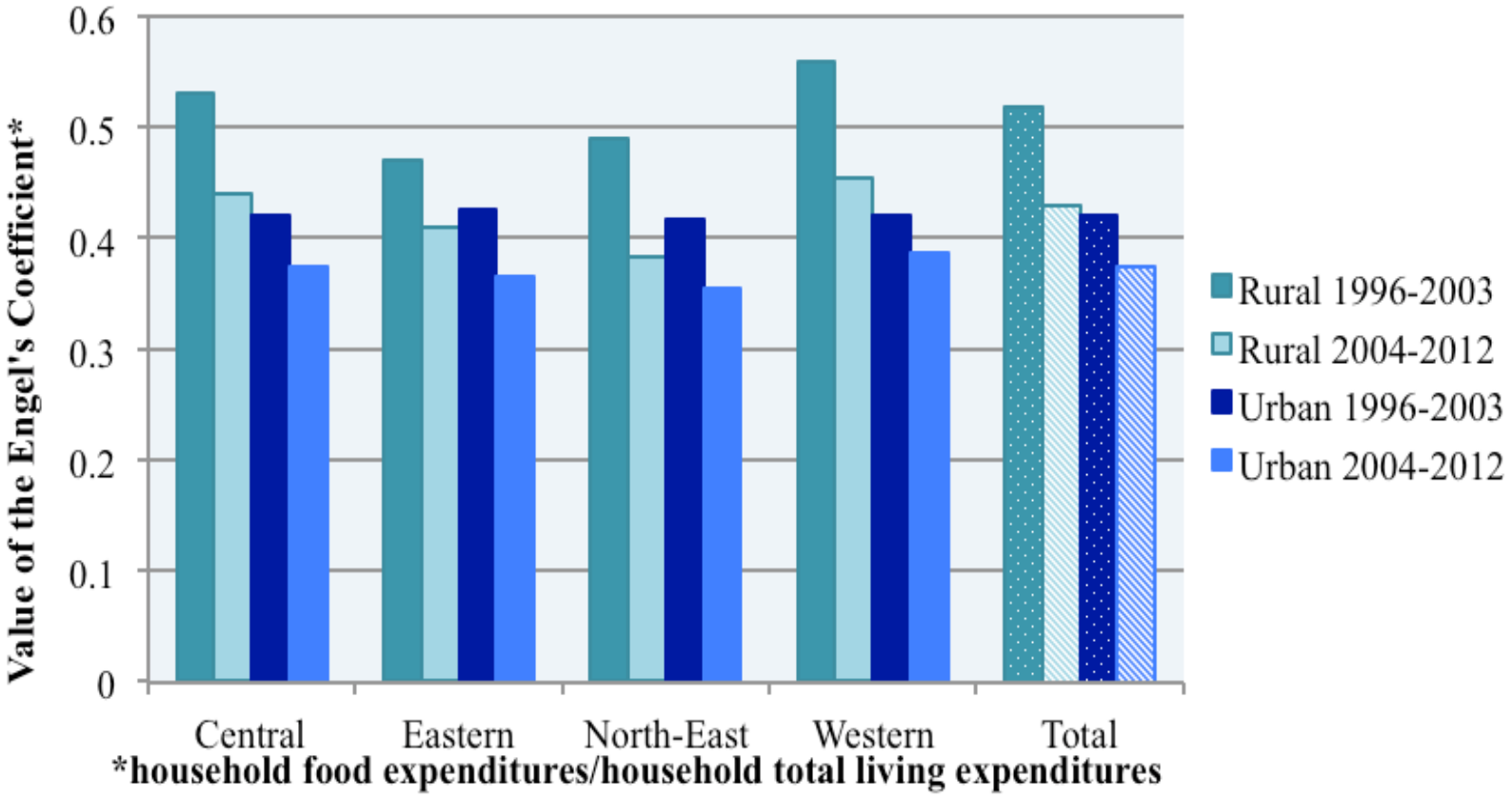
*Eastern region recorded was with much higher levels than other regions.*
*Differences were not large among the other three regions neither in rural nor urban areas.*
*Total: The increase of food expenses by urban households is much larger than the increase of rural families.*

# *Basic analysis – Food access*



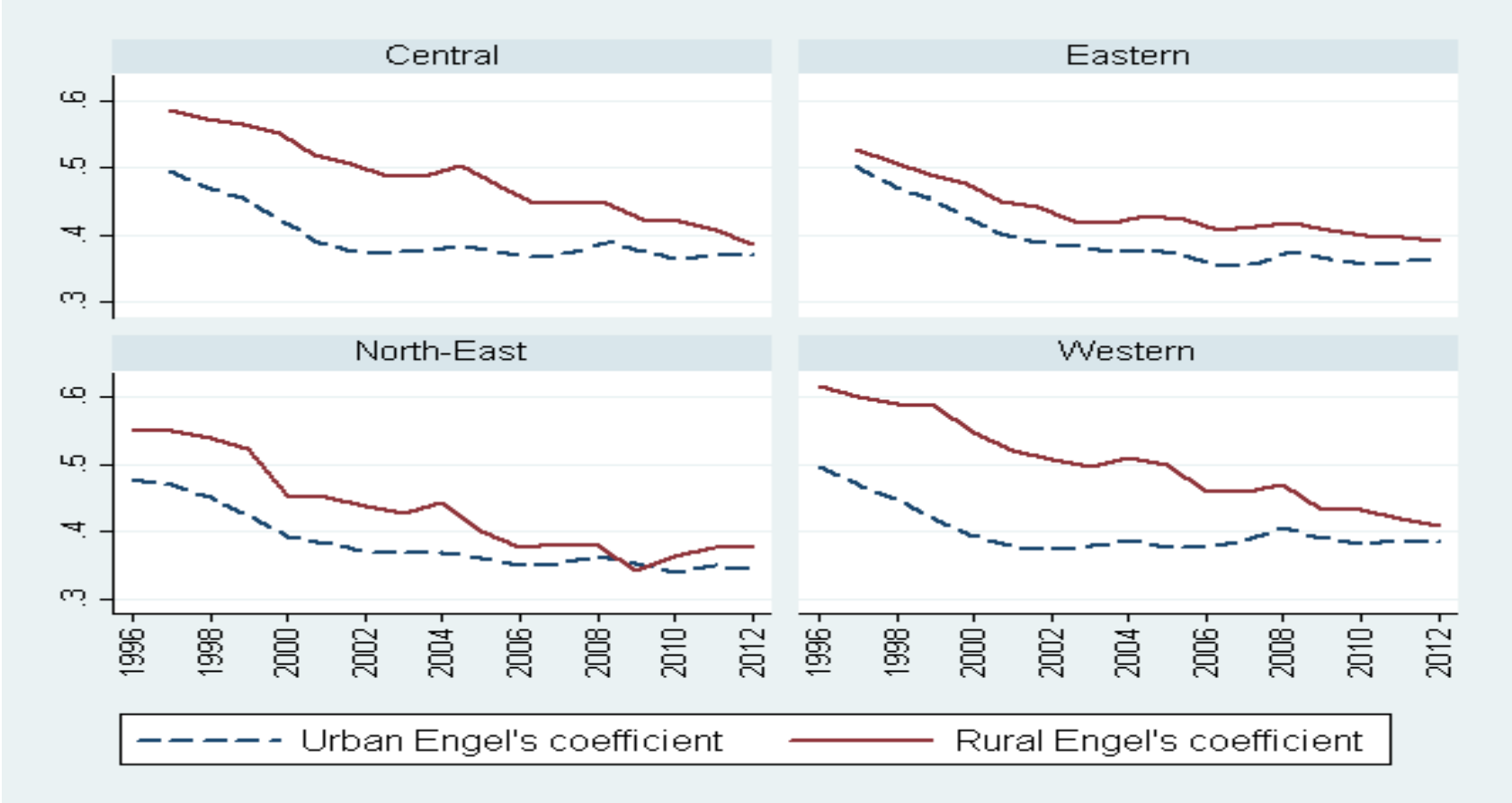

*Year by year: It reveals a common upward trend in food consumption all over China.*
***Urban (blue dash) :*** *The upward trend starts in the early years of 2000s, the eastern develops with a steeper slope.*
***Rural (red line):*** *The situation is similar, yet the expense is half of the urban and that the gap follows the same widening path in the four regions. The western develops the least.*

# *Basic analysis – Economic vulnerability*




*The rural-urban gaps of the consumption behaviors are getting smaller.*
*The greatest improvement of the indicator is in rural areas and especially in the poorest provinces of the Western area.*

# *Basic analysis – Economic vulnerability*



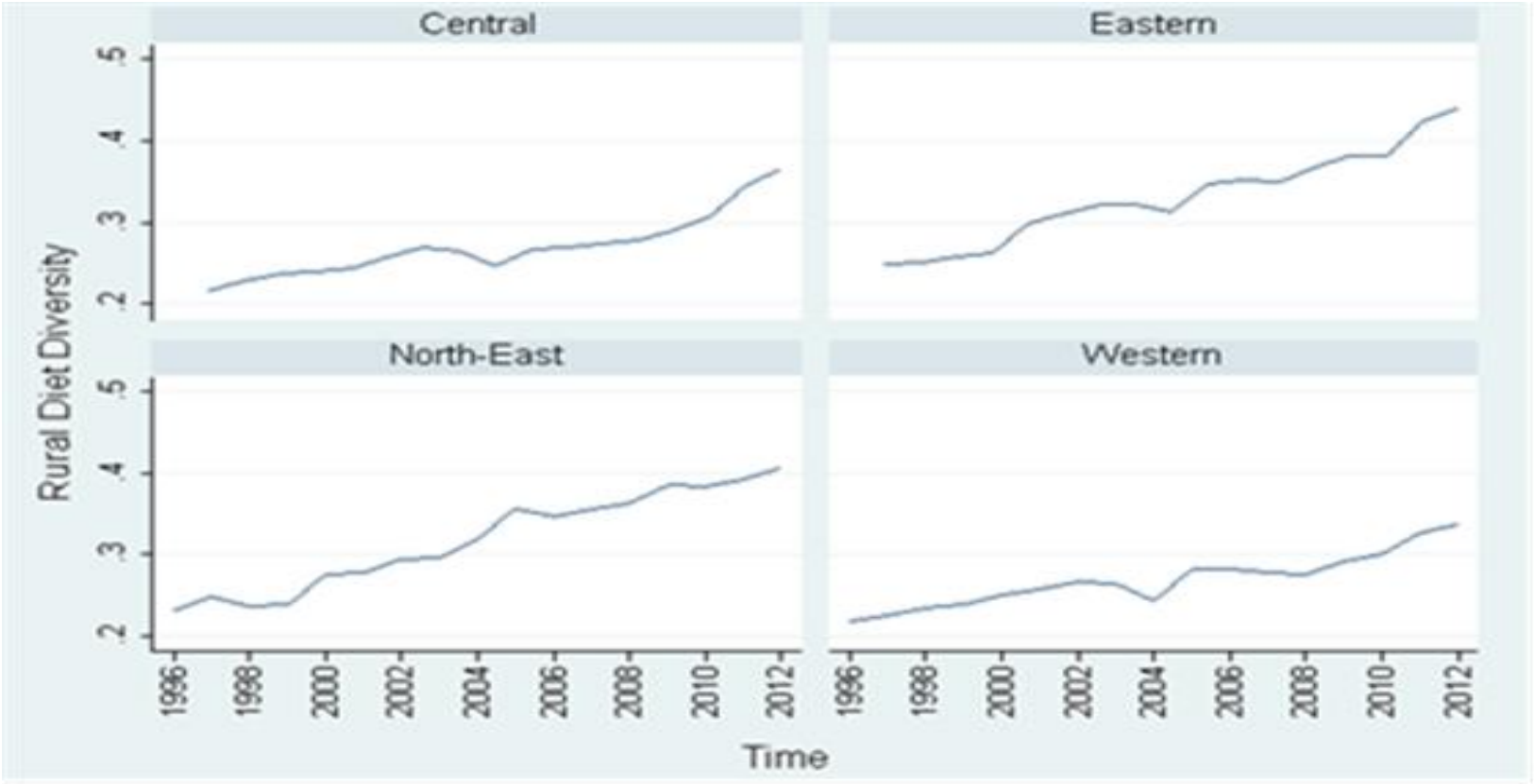

*The trends show large differences:*

***Eastern*** *– the rural-urban gap persists, yet smaller;*

***Central and Western*** *– show convergence that rural-urban gap was decreasing;*

***North-Eastern*** *– it was converging till 2009 and then the gap widens again slightly.*

# *Basic analysis – Diet diversity (Rural)*




*It shows low level across all rural China.*

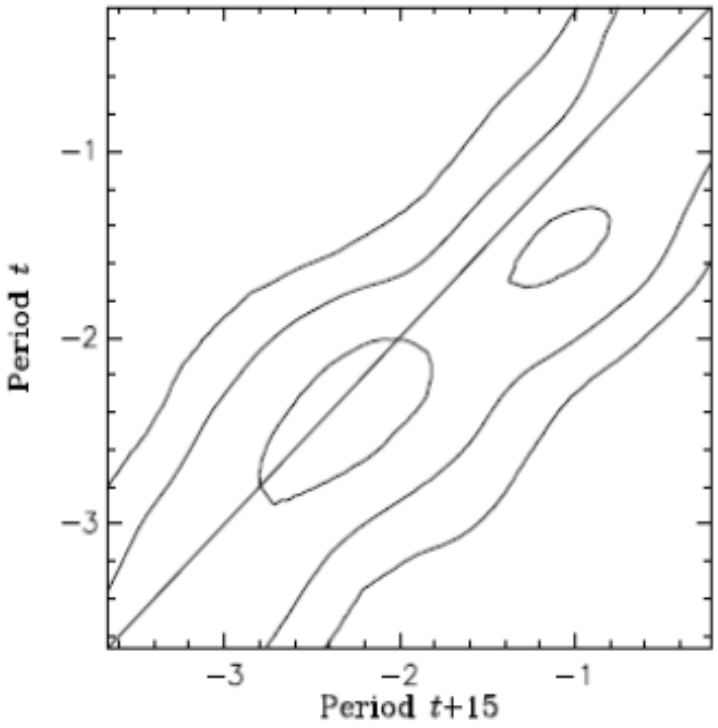
***Rural Eastern and North-eastern****: with greater dynamism and higher values*

***Rural Central and Western****: their trends were increasing at a much slower pace, speeding up only in recent years (2010-2012).*

# *Basic analysis – Diet diversity (Urban)*


*The urban varies little across the four regions over the whole 1996-2012.*
***Urban Northeast*** *shares the highest diet diversity;*
***Urban Western*** *shares the lowest.*
***Urban Eastern*** *shows slightly lower than northeast as the dining out cannot be observed.*

# *Convergence trajectory estimation – Stochastic Kernel*




*Quah (1995): The stochastic kernel operator (M) 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:*

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

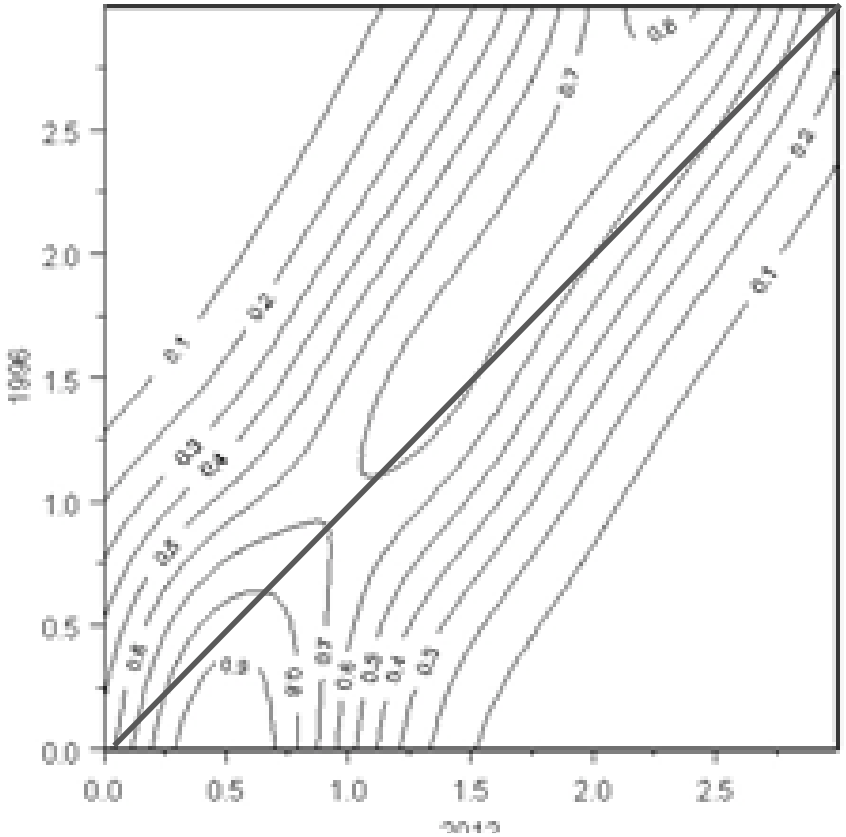
*Y-axis: density distribution of variable in the initial year;*

*X-axis: density distribution in final year.*

*Persistence: if the kernel surface gathered around the positive-sloped diagonal*

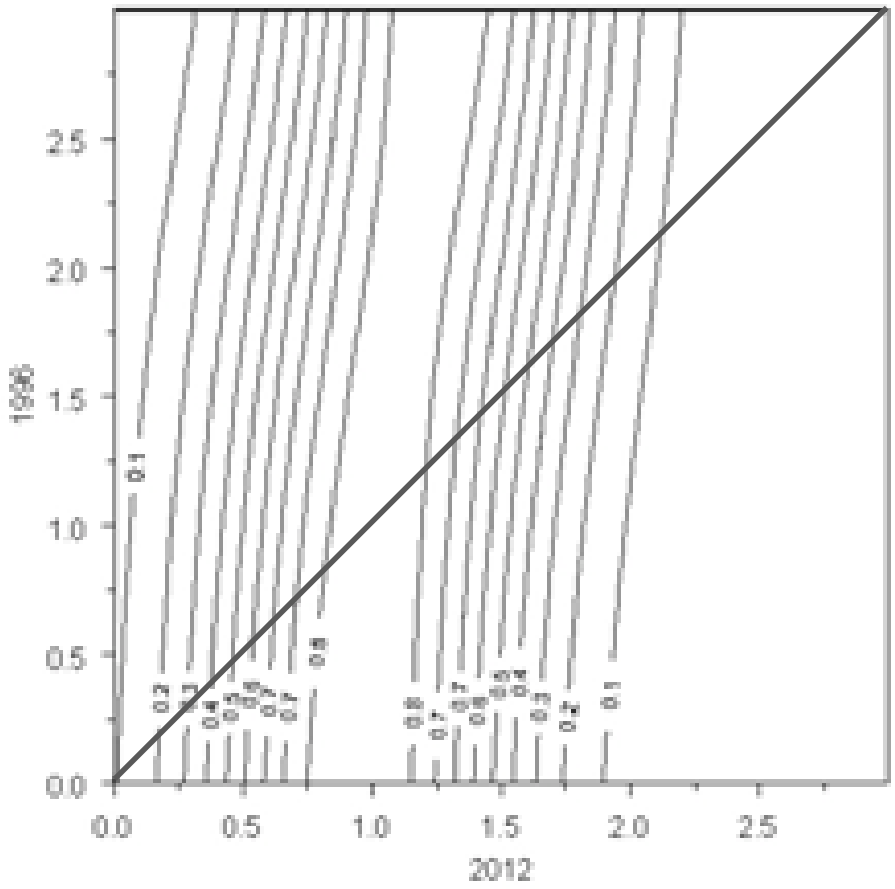
*Convergence: if the kernel surface moved counterclockwise along with positive-sloped diagonal*

# *Trajectory estimation – Convergence of food access*




There is a club convergence: one club with a value about half of the average, which probably collects all the rural areas with values of the food access lower than the average. For the rest of the observations it is possible to identify a very slow process of convergence in progress to catch up those observations reporting a value higher than 1.5 the average.

# *Trajectory estimation – Convergence of vulnerability*




It shows a clear tendency to unitary modal convergence around the mean value, which means the “economic vulnerability to food security” of rural and urban households in different regions have been getting similar in the long run.

## *Convergence trajectory estimation - Sigma Convergence of Diet Diversity*

- This hypothesis displayed in the following equation would reveal the presence of the *σ-convergence*:
  - $\sigma^2_{\log y,t} > \sigma^2_{\log y,t+s}$
- A series of three tests has been proposed in the literature to test the hypothesis of *σ-convergence*:
  - $\mathrm{T}_1 = \hat{\sigma}_1^2 / \hat{\sigma}_0^2$
  - $\mathrm{T}_2 = (\mathrm{N} - 2{,}5) ln \left[ 1 + \frac{1}{4} \frac{\hat{\sigma}_0^2 \hat{\sigma}_1^2}{\hat{\sigma}_0^2 \hat{\sigma}_1^2 - \hat{\sigma}_{0,1}^2} \right]$
  - $\mathrm{T}_3 = \left[ \frac{\sqrt{N}(\hat{\sigma}_0^2 / \hat{\sigma}_1^2 - 1)}{2\sqrt{1 - \hat{\pi}^2}} \right]$
- To have $\hat{\pi}^2 < 1$ it is a necessary condition for convergence. Then if $\mathrm{T}_1$ $\mathrm{T}_2$ and $\mathrm{T}_3$ 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 $\mathrm{T}_3$ cannot be computed and the validity of $\mathrm{T}_2$ concludes for the hypothesis of *divergence*.

# *Trajectory estimation – Convergence of diet diversity*

## *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*** |

## *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*** |

# *Rural-Urban contribution to regional gap – Theil Index*

- 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 the contribution to inequality coming from the within or between group components. The formula to be used to calculate the Theil Index is:

$$T = \underbrace{\sum_{k=1}^{m}\left(\frac{n_k}{n}\frac{\bar{y}_k}{\bar{y}}\right)T_k}_{\text{WITHIN}} + \underbrace{\sum_{k=1}^{m}\frac{n_k}{n}\left(\frac{\bar{y}_k}{\bar{y}}\right)\ln\left(\frac{\bar{y}^k}{\bar{y}}\right)}_{\text{BETWEEN}}$$

- where the Theil Index - within component (T-Within) is the average of Tk, 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.

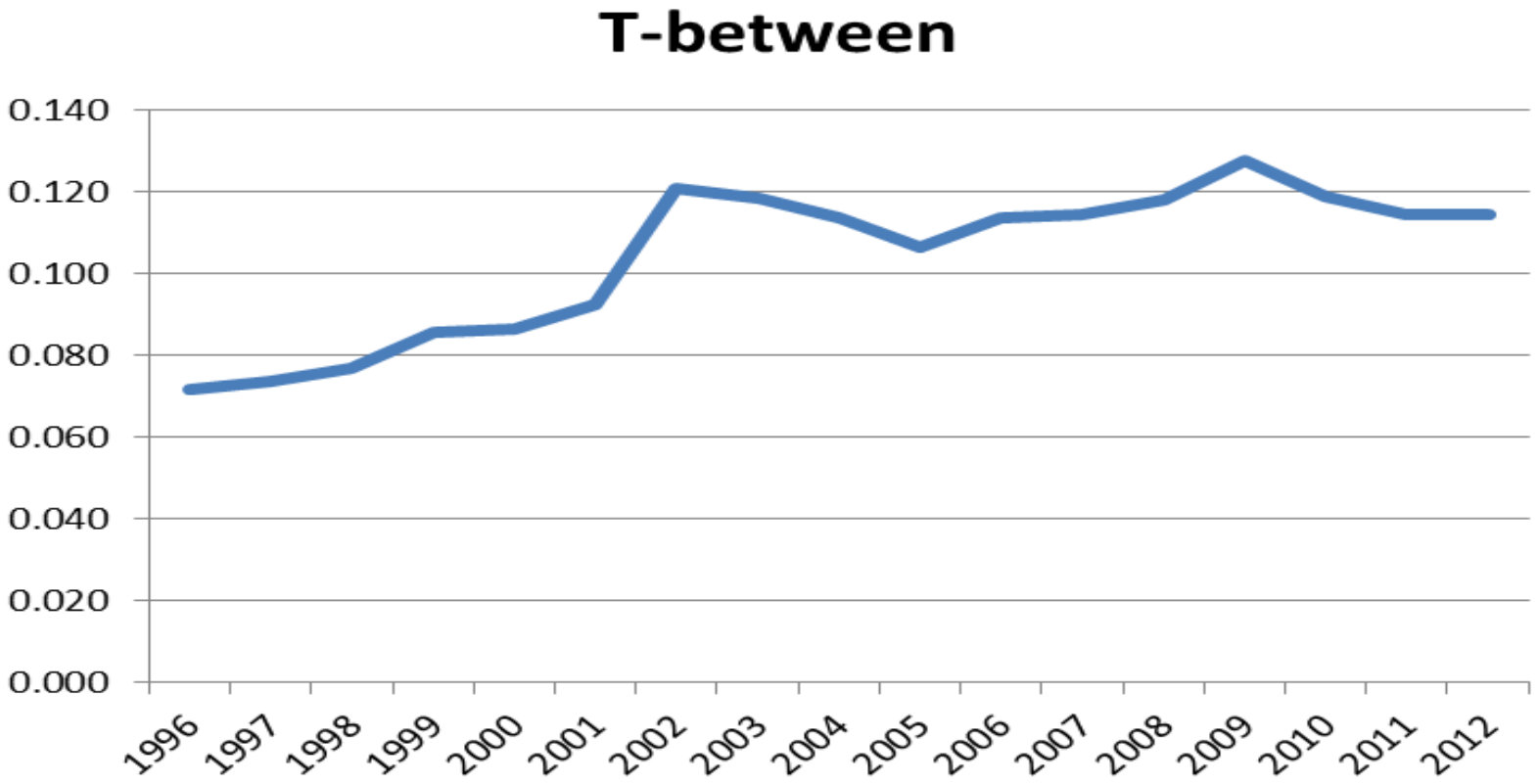
# *Theil Index – Food Access*

***Theil Index calculated on Food Access***

| 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 |

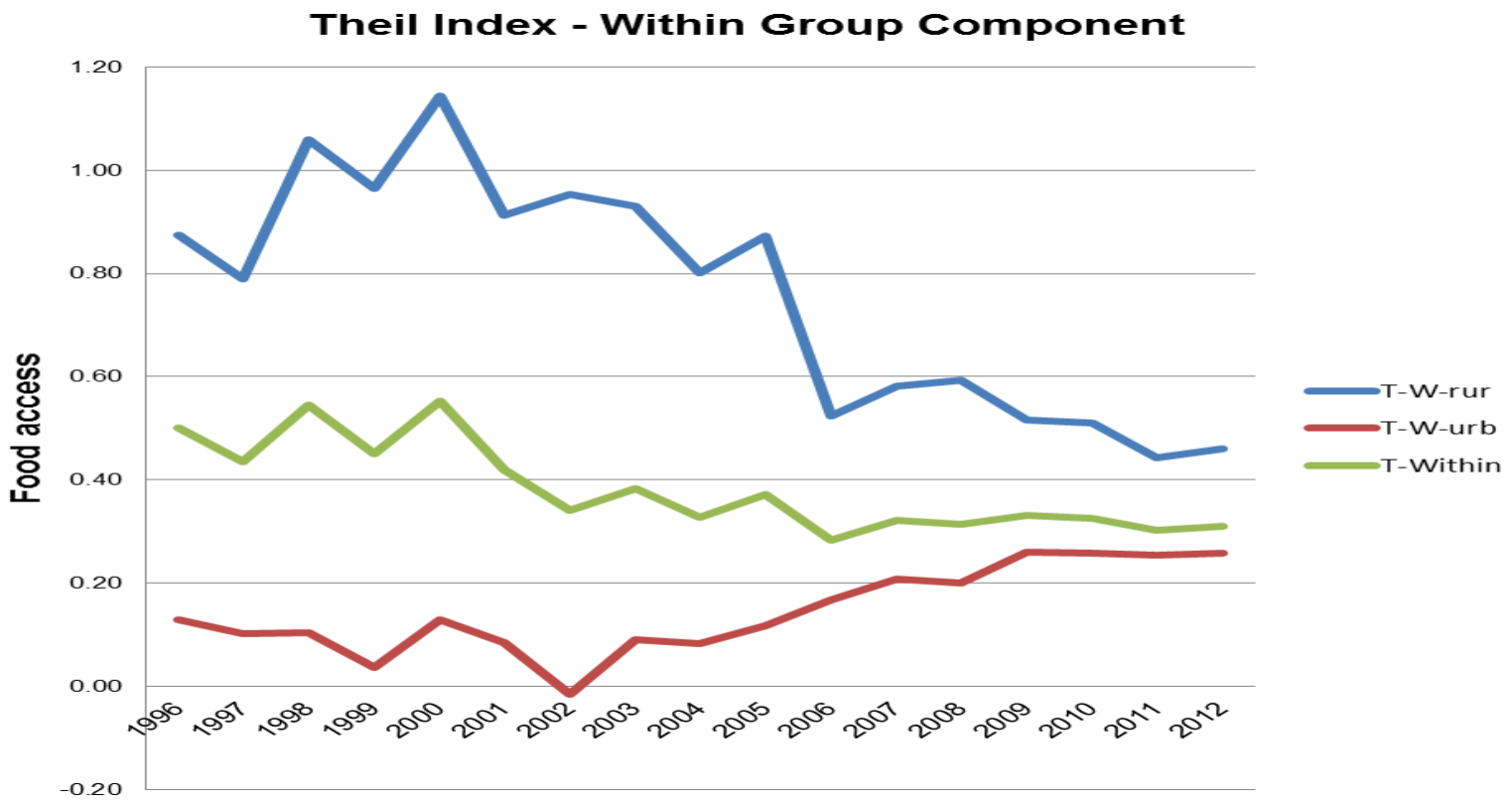
*Disparity in Food access has gradually reduced across China. The contribution of the T-Between component (- the inequality between the rural and urban groups), is almost irrelevant;*
*while the T-within component (- the inequality within the rural and urban groups respectively) explains the majority of the disparity.*

# *Theil Index: T-Between in Food Access*




The T-between component shows a constant increase over the whole time period, so the rural-urban gap has slowly widened up during 1996 – 2012.

# *Theil Index: T-Within in Food Access*




Rural T-Within (Blue): shows the disparity of food access in different rural areas decreases in the time period;
Urban T-Within (Red): shows a increasing trend;
Regional T – Within (Green): shows a more constant trend.

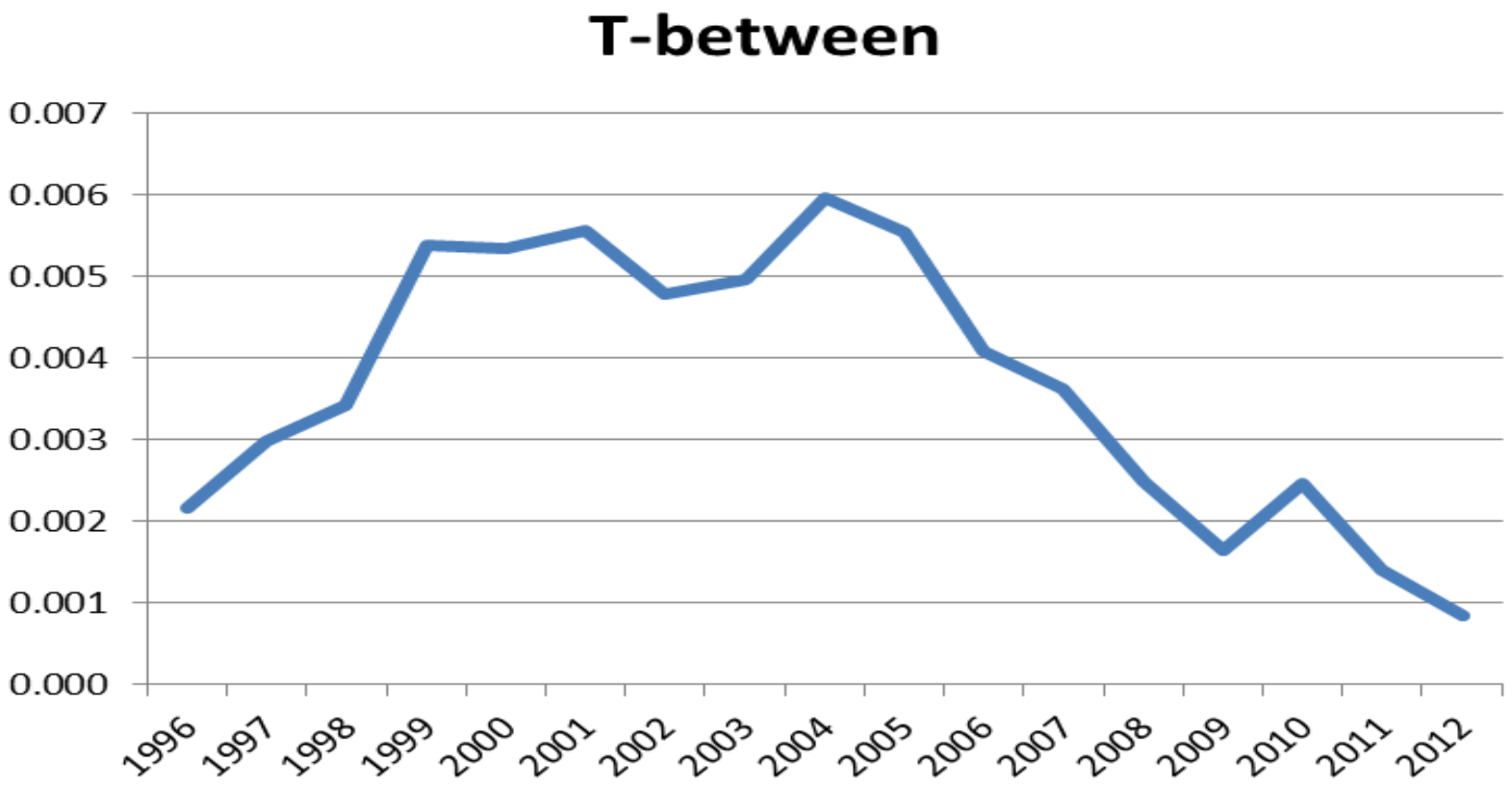
# *Theil Index – Economic Vulnerability*

***Theil Index calculated on Economic Vulnerability***

| 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 |

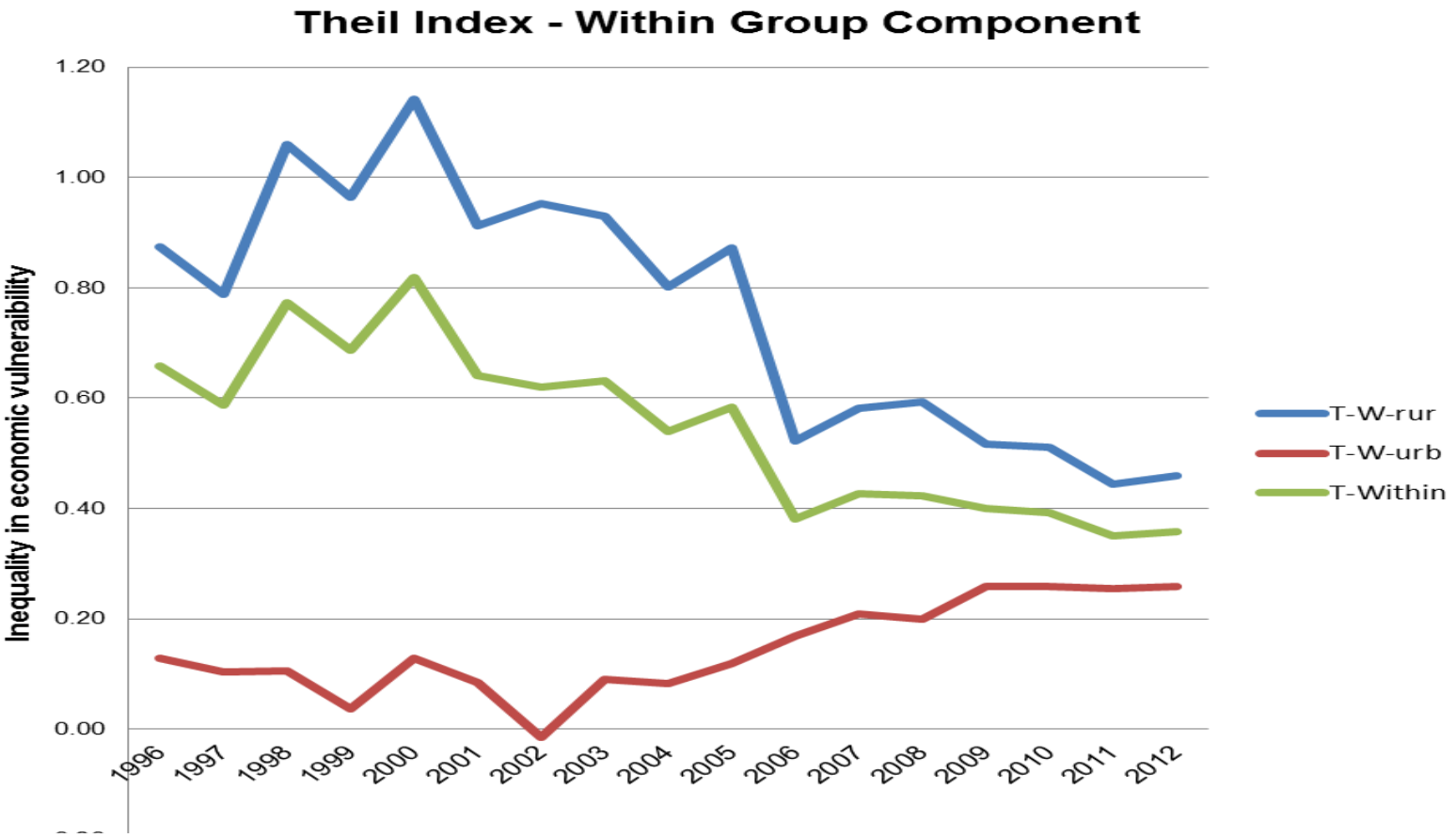
*The Theil Index displayed an obvious decreasing trend during the 1996-2012 period, as its value almost halved. T-Within component represents the majority of the entire regional disparity of the country; Whereas the T-between component is close to zero.*

# *Theil Index: T- Between in Economic Vulnerability*




Even though the small proportion of Inequality is explained by the T-between, it is interesting to note that, the urban-rural gap of economic vulnerability has been closing down since the year 2004.

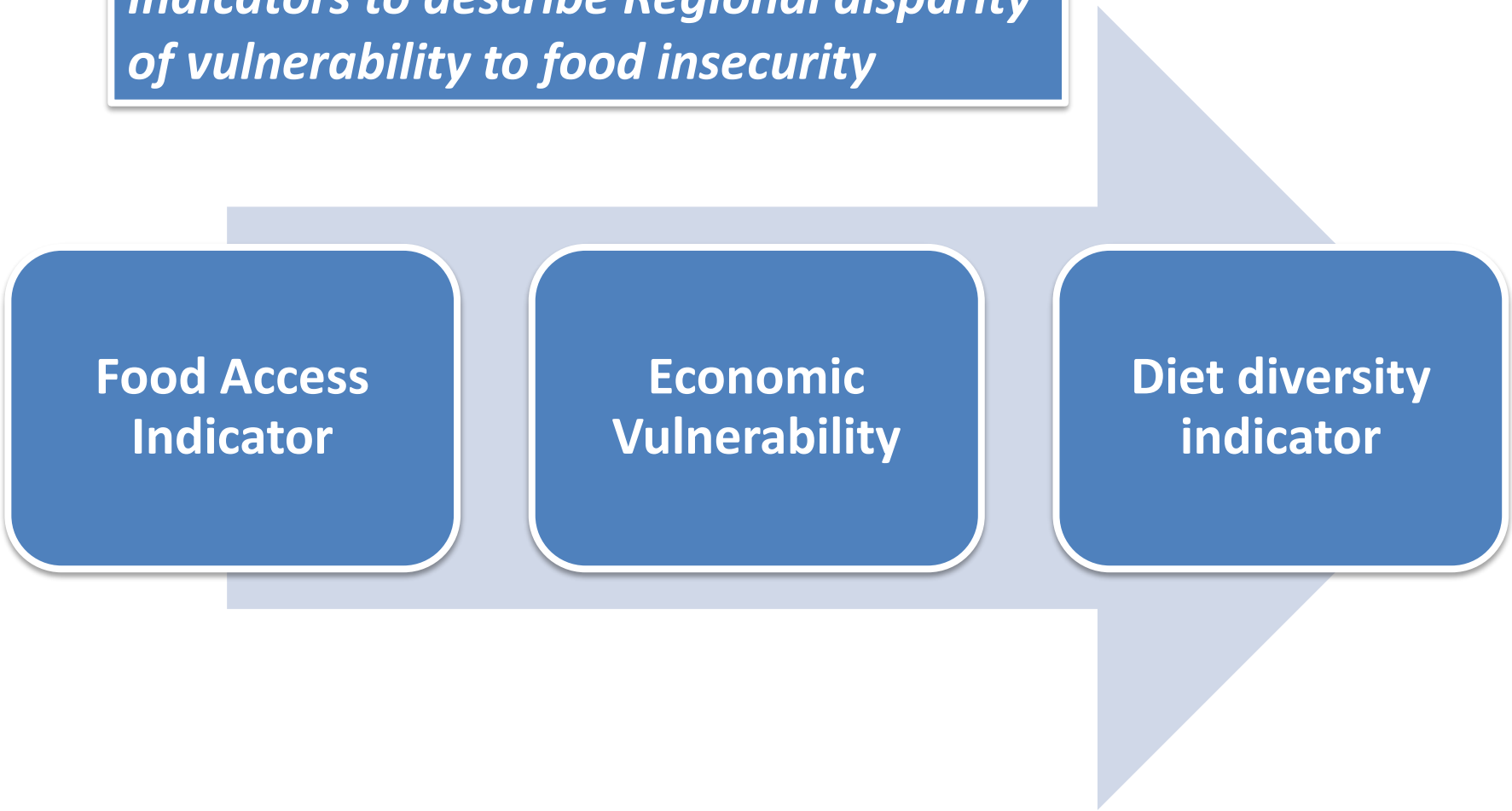
# *Theil Index: T-Within in Economic Vulnerability*




Inequality have been largely driven by the T-within rural component. Rural T-within decreased generally, while urban increased.

# *Conclusions*

***Indicators to describe Regional disparity of vulnerability to food insecurity***



# Conclusions [1]

Food Access

- Eastern region is much higher than other regions, and 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.
- The convergence process shows club convergence existing in China and a persistent situation of disparities is showing up between the extremes of the distribution.

# *Conclusions* [2]

**Economic Vulnerability**

- The greatest improvement of the indicator was demonstrated 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 behaviors.
- 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 households' preferences with respect to food have been converging in the long run.

# *Conclusions* [3]

**Diet Diversity**

- In rural areas, the largest contributors to this trend was the Eastern provinces and the North-Eastern region. The time series of the rural diet diversity indicator also showed greater dynamic trends of the Eastern and North-eastern region compared the other regions, whose trends were increasing at a much slower rate, speeding up only in recent years.
- In urban areas, while no changes could be measured if took the average for the four macro regions; however, justified if we would take into account dining out component, different considerations could be made in this indicator.

# Conclusions [4]

Food Access – Theil Index

It showed that over time disparity had gradually reduced across China. The contribution to regional disparity from T-between rural and urban groups was almost irrelevant, while the majority of the inequality was explained by the T-within rural and urban regions.

It shows that the inequality reduced dramatically over time, as its value almost halved during 1996-2012. Similarly, this disparity in economic vulnerability was largely driven by the T-within component (- disparity inside rural and urban regions), rather than the T-between rural and urban groups.

Eco Vulnerability – Theil Index

***The End***

***Thank you very much for your attention!***