Internal Spatial Differences in a Large Country: Consumer Price and Inequalities

Song Ze (宋泽)[1], Liu Zilan (刘子兰)[2] and Zou Hong (邹红)[*3]

[1] School of Economics, Nankai University, Tianjin, China
[2] Business School, Hunan Normal University, Changsha, China
[3] School of Economics, Southwestern University of Finance and Economics (SWUFE), Chengdu, China

Abstract: *Unbalanced price changes across regions cause consumption inequalities within a large country. With consumer demand system model, this paper estimated the dynamic changes of the true-cost-of-living index (TCLI) and consumption inequalities in China. Results indicate urban households experienced a rising TCLI from 2002 to 2014, among which, Liaoning increased the most and Guangdong the least. Beijing's TCLI was the highest and Sichuan the lowest over the same period. Since 2008, the unbalanced rise of consumer price has gradually diminished, and gaps between real and nominal consumption inequalities have narrowed. However, real consumption inequalities continue to rise, and low-income groups are affected the most by inflation.*

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1. Introduction

There are striking differences in price change and consumption inequalities within regions across China.[1] In 2015, Beijing's food consumer price index (CPI) rose by 1.7% while those of Hebei and Yunnan provinces went up by 0.8% and 3.4%, which amount to 50% and 200% of Beijing' level, respectively. While Beijing's household per capita consumption was 33,804 yuan, those of Hebei and Yunnan provinces were 13,031 and 11,005 yuan, which amount to 38.5% and 32.6% respectively. Over the period from 2002 to 2014, Beijing's food CPI and household per capita consumption increased by 103.4% and 227.8%, respectively; the same figures were 127.8% and 179.1% for Yunnan Province, respectively.[2]

Consumption inequalities cause mainly price differences across geographical space. Within large countries, economic development is unbalanced and demographic structure varies across regions. These regional differences affect household consumption levels and preferences, and result in structural changes in categorized consumer prices, giving rise to consumption inequalities (Mishra and Ray, 2014; Majumder *et al.*, 2015 (a, b)). Most studies focused on international comparison (Hill, 2004; Neary, 2004; Feenstra *et al*., 2009), and assumed spatial homogeneity, which overlooked differences in the size of countries. Some studies found the spatial homogeneity assumption is not inappropriate if economic disparities are huge and consumer preferences heterogeneous within and across regions (Coondoo *et al*.,

* CONTACT: Zou Hong, email: zouhong@swufe.edu.cn.

[1] Since "income inequalities" are synonymous to "income gaps" in most contexts, "consumption inequalities" are also referred to as "consumption gaps" in this paper.

[2] Data sources include the website of the National Bureau of Statistics (NBS) and *China Statistical Yearbooks*.

2011; Deaton and Dupriez, 2011).

The true-cost-of-living index (TCLI) reflects not only the impact of inflation on household consumption inequalities in a country (Ray, 1985; Nicola *et al*., 2010; Mishra and Ray, 2011; Ray, 2017) but inequalities within regions of the same country as well. Using CPI, Koo *et al.* (2000) corrected the cost-of-living index in 32 regions of the United States but took no account of heterogeneous preferences between regions. Mishra and Ray (2014) and Majumder *et al.* (2012) found that price differences between Australian states had widened since 1988. Meanwhile, differences in the CPI level across states have significantly increased over the past two decades.

Most Chinese studies on consumption inequalities have focused on the decomposition of inequalities. Following Deaton and Paxson (1994), Qü *et al.* (2008) ascribed consumption inequalities among rural households in China in 1988-2002 to intra-age-group differences. Yu (2015) found that the consumption inequalities among urban households had stemmed from intergenerational differences. Having analyzed the consumption inequalities of durable goods using the China Health and Nutrition Survey (CHNS) data, Zou *et al.* (2013) identified income inequalities as a major cause of consumption inequalities. Unlike the above decomposition research, Cai *et al.* (2010) described changing trends in household consumption inequalities among urban households in China from 1992 to 2003, attributing rising urban household inequalities to SOE reform, urbanization, and structural change in globalization. Based on China urban household survey data, Chamon and Filho (2014) found that the cost-of-living index was about one percentage point smaller than CPI during 1993-2005, but did not consider the differences in an inter-regional price change. Brandt and Holz (2006) defined a basket of daily expenses and their amount in the base period (1990) to compare changes in inter-provincial price level between 1990 and 2000, and constructed the province-level CPI index. In comparing changing income inequalities using the inter-provincial CPI-deflated price level, however, they overlooked changes in consumption structure. All in all, there is limited work to exam the impact of spatial price differences in China on consumption inequalities.

Understanding the effect of spatial price differences on the consumption inequality is of great significance. In the economic new normal, the Chinese government has adjusted urban and demographic planning to bring new force into economic growth. It elevated Chengdu, Wuhan and Zhengzhou into "National Central Cities" in 2016, and later Xi'an. Shenyang and Changsha are striving to join the list. This study helps government plan the development of "central cities" and promote rational population mobility, reduce consumption inequalities, and raise household welfare.

This paper offers the following contributions: First, based on the assumption of consumption utility equivalence, it employed consumer demand system to analyze differences in TCLI arising from a unbalance change in consumption price across regions. Unlike other methods, the TCLI contains information about consumption level and structure, which may control the differences in regional and household consumption preferences. It will reflect the real picture of inflation. Second, it estimated the real consumption inequality and nominal consumption inequality, and found a narrowing difference between the two since 2008 but inequality still kept on the rise. The low-income group suffered the most from the rising price. This study also offers empirical evidence for macroeconomic regulation to protect household welfare.

The remainder of this paper is structured as follows: Part 2 elaborates the theoretical model and econometric strategy; Part 3 explains data used in this paper; Part 4 performs an empirical analysis based on data and model; Part 5 is conclusions.

2. Models and Methods

The consumer demand system is an important instrument in consumption welfare analysis, and is the basis to decribe Engel's curve. Based on Lewbel and Pendakur's (2009) exact affine stone index

(EASI), this paper creates a consumer demand system model, in which the cost function is as follows:

$$C(p, u, z, \varepsilon) = u + \acute{p}m(u, z) + \acute{p}\varepsilon \quad (1)$$

Where, z is gender, age and education of household head, as well as the numbers of underage children and adults in the household, p is price index of each kind of commodities, and u is utility level. ε is the attribute of j-dimension unobservable preferences, which satisfies $\acute{\imath}_j\varepsilon=0$, where $\acute{\imath}_j$ is j-dimension vector.

According to Shephard's lemma, the Hicks compensation constraint of the cost function is:

$$w = \nabla_p C(p, u) = \omega(p, u, z, \varepsilon) = m(u, z) + \varepsilon \quad (2)$$

Where, $m(u, z)$ is an additively separable j-dimension value equation, and $\acute{\imath}_j m^j(u, z)=1$.

This paper introduces the time effect t and spatial effect s:

$$m^j(u, z, t, s) = \sum_{r=1}^{R} b_r^j u^r + \sum_{t=1}^{T} g_t^j z_t + \sum_{i=1}^{l} \theta_i^j t_i + \sum_{d=1}^{D} \delta_d s_d \quad (3)$$

According to the vector of $m^j(u, z, t, s)$, the model's Engel's coefficient can be obtained.

EASI parametric cost equation is:

$$C(p, u, z, \varepsilon) = u + \acute{p}(\sum_{r=1}^{R} b_r^j u^r + \sum_{t=1}^{T} g_t^j z_t + \sum_{i=1}^{l} \theta_i^j t_i + \sum_{d=1}^{D} \delta_d s_d) + \acute{p}\varepsilon \quad (4)$$

According to Shephard's lemma, the constraint form of Hicks supplementary budget of cost equation (4) is:

$$w^j = \sum_{r=1}^{R} b_r^j u^r + \sum_{t=1}^{T} g_t^j z_t + \sum_{i=1}^{l} \theta_i^j t_i + \sum_{d=1}^{D} \delta_d s_d + \sum_{k=1}^{T} \sum_{t=1}^{T} a_{jkt} z_t \ln p^k + \varepsilon_j \quad (5)$$

Where, j is the number of kind of commodities .

Using the Stone logarithmic price index (Stone 1954), we converted the nominal index to arrive at the logarithmic real expenses as:

$$y = u = g(w, p, x, z) = x - \acute{p}w \quad (6)$$

Where, y is the logarithmic actual spending that contains various consumption propensities. It is the cardinal form of utility level u and the mapping of nominal spending x on cardinal utility.

By substituting u in equation (5) with equation y, we obtained the structural equation for the benchmark regression (simultaneous equations for indirect Marshallian budget constraint):

$$w^j = \sum_{r=1}^{R} b_r^j y^r + \sum_{t=1}^{T} g_t^j z_t + \sum_{i=1}^{l} \theta_i^j t_i + \sum_{d=1}^{D} \delta_d s_d + \sum_{k=1}^{T} \sum_{t=1}^{T} a_{jkt} z_t \ln p^k + \varepsilon_j \quad (7)$$

Where, w^j is the share of spending on commodity j, and r is the order of the polynomial of household per capita spending. The endogeneity of Structural Model (7) derives from two sources: First, the share of spending w^j is used to create y^r, causing endogeneity in y and its polynomial; second, the missing variables and estimation errors of price data may also cause endogeneity. To address the problems of endogeneity, parametric nonlinearity and the heteroscedasticity of ε_j, Lewbel and Pendakur (2009) specified q as a variable of M-dimension vector and unrelated to ε. If $E(\varepsilon | x, p, z)=0_j$, q is a bounded function that contains x, p, z. θ is specified as the vector of all parameters in Model (7), under the assumption that $E(\acute{\varepsilon} q_m)=0_j$, they used q as the instrumental variable to estimate equation (7) and obtained $\hat{\theta}=\Theta_n(y_1,\ldots y_n)$ through the three-stage least square method, where n is the number of samples. For sample i, we have $\hat{y}_i=g(w_i, p_i, x_i, z_i, \hat{\theta})$. By specifying the initial value of $\hat{\theta}$, substituting $\hat{\theta}$ into g in the three-stage least square to estimation to obtain $\hat{y}_1,\ldots\hat{y}_n$, and then estimating θ using $\hat{y}$ as data, we obtained $\vec{\theta}=\Theta_n(\hat{y}_1,\ldots\hat{y}_n)$, and this process is repeated until iterative convergence. Referencing Dominitz and Sherman (2005), we specified the convergence dimension of iterative regression to be 0.0000001. Lewbel and Pendakur (2009) and Zhen *et al*. (2014) found that this estimation method had minimized endogeneity, we also follow Lewbel and Pendakur (2009) to set estimation.

Assuming that the utility-equivalent spending is $e_{c,h}$, the equivalence of utility at different price

levels is guaranteed, i.e.:

$$u(p_c, x_{c,h}) = u(p_r, e_{c,h}) \tag{8}$$

Where $u(\cdot)$ is the indirect utility equation, p_r is the base-period price level, p_c is the comparative-period price level, and $x_{c,h}$ is household per capita spending.

Transforming the indirect utility function as:

$$e_{c,h} = e(p_r, p_c, x_{c,h}) \tag{9}$$

Where $e_{c,h}$ is the price level p_c for household h, i.e. utility-equivalent spending during period c under household per capita nominal spending $x_{c,h}$.

Based on equation (2) with cardinalized utility, where y=u, we allow for new price adjustment under the given utility level:

$$m^j(u, z) = w^j(p, u, z) - \sum_{t=1}^{J} a_{jk} \ln p^k - \sum_{t=1}^{J} b_{jk} \ln p^k u \tag{10}$$

Substituting the above equation into cost equation (1) gives us its logarithmic form:

$$\begin{aligned} \ln C(p, u, z) = u(1 - \textstyle\sum_{j=1}^{J}\sum_{k=1}^{J} b^{jk} \ln p^j \ln p^k) + \sum_{j=1}^{J}(w^j(p, y, z, t, s) - \\ \textstyle\sum_{k=1}^{J} a^{jk}(z) \ln p^k) \ln p^j + \frac{1}{2}\sum_{j=1}^{J}\sum_{k=1}^{J} a^{jk}(z) \ln p^j \ln p^k \end{aligned} \tag{11}$$

The given configuration utility is:

$$\bar{u} = \frac{\ln x_{c,h} - \sum_{j=1}^{J} w^j \ln p_c^j + \frac{1}{2}\sum_{k=1}^{J} a^{jk}(z) \ln p_c^j \ln p_c^k}{1 - \frac{1}{2}\sum_{k=1}^{J} a^{jk}(z) \ln p_c^j \ln p_c^k} \tag{12}$$

The iso-utility logarithmic equation is:[3]

$$\begin{aligned} \ln C(p_r, u, z) = \ln e_{c,h} = \bar{u}\,(1 - \tfrac{1}{2}\textstyle\sum_{k=1}^{J} b^{jk}(z) \ln p_c^j \ln p_c^k) + \\ \textstyle\sum_{j=1}^{J}(w^j(p, u, z) - \sum_{k=1}^{J} a^{jk}(z) \ln p_r^k) \ln p_r^j + \frac{1}{2}\sum_{j=1}^{J}\sum_{k=1}^{J} a^{jk}(z) \ln p_r^j \ln p_r^k \end{aligned} \tag{13}$$

Substituting equation (11) into equation (12) gives the utility-equivalent spending:

$$e_{c,h} = \exp(\ln x_{c,h} + \textstyle\sum_{j=1}^{J} w^j \ln p_c^j - \sum_{j=1}^{J} w^j \ln p_r^j + \frac{1}{2}\sum_{k=1}^{J} a^{jk}(z) \ln p_c^j \ln p_c^k - \frac{1}{2}\sum_{k=1}^{J} a^{jk}(z) \ln p_r^j \ln p_r^k) \tag{14}$$

Meanwhile, the true cost-of-living index (TCLI) is:

$$\begin{aligned} P(p_c, p_r, \bar{u}, z, \varepsilon) = \exp\Big(\sum_{j=1}^{J} w^j \ln p_c^j - \sum_{j=1}^{J} w^j \ln p_r^j + \\ \tfrac{1}{2}\textstyle\sum_{k=1}^{J} a^{jk}(z) \ln p_c^j \ln p_c^k - \frac{1}{2}\sum_{k=1}^{J} a^{jk}(z) \ln p_r^j \ln p_r^k\Big) \end{aligned} \tag{15}$$

3. Data

This paper employs the Urban Household Survey (UHS) data from the National Bureau of Statistics (NBS), which selects surveyed household samples through stratified sampling to collect comprehensive information about demographics, income, and consumption. We only use data of the six provincial-level regions of Beijing, Liaoning, Zhejiang, Guangdong, Sichuan and Shaanxi in 2002, 2004, 2006 and 2008.[4] In addition, we have combined the urban household sample of the above six regions in 2010, 2012 and 2014 from the China Family Panel Studies (CFPS). We set householders' demographics to

[3] Calculation of iso-utility level is predicated upon constant household demographic characteristics. In this paper, the benchmark household characteristics are male householder aged above 40 years and with high school education or above, and it consisted of two adults and one child.

[4] Based on UHS data of the six provincial-level jurisdictions, this paper also references the provincial-level data of urban samples in CFPS. Samples of the six provincial-level jurisdictions in UHS data are representative of China's nationwide conditions. After 2010, UHS data ceases to be available, so the only practical solution is to combine with CFPS data in the empirical research. Some Chinese studies have followed changes in CFPS research. Our estimation process does not involve sample representativeness and will not cause any serious impact on the estimated results.

Table 1: Descriptive Statistics

Variable	Sample size	Mean	Standard deviation	Min.	Max.
Share of consumption category					
Food	43,056	0.431	0.142	0	1
Clothing	43,056	0.102	0.070	0	0.761
Housing	43,056	0.097	0.084	0	0.925
Household equipment & articles	43,056	0.053	0.062	0	0.900
Education, culture & entertainment	43,056	0.136	0.124	0	0.908
Transportation & communication	43,056	0.114	0.087	0	0.973
Healthcare	43,056	0.066	0.086	0	0.986
Logarithmic price					
Food	43,056	1.154	0.213	0.896	2.013
Clothing	43,056	0.897	0.07	0.694	1.048
Housing	43,056	0.888	0.051	0.821	1.049
Household equipment & articles	43,056	1.064	0.141	0.878	1.475
Education, culture & entertainment	43,056	1.049	0.079	0.909	1.265
Transportation & communication	43,056	0.841	0.079	0.669	0.991
Healthcare	43,056	1.262	0.148	1.019	1.748
Demographic characteristics					
Women	43,056	0.316	0.465	0	1
40 years or above	43,056	0.739	0.439	0	1
High school and above	43,056	0.652	0.476	0	1
Number of children	43,056	0.409	0.543	0	5
Number of adults	43,056	2.608	0.768	1	13
Year	43,056	2005	2.595	2002	2014
Provincial-level regions					
Beijing	43,056	0.14	0.347	0	1
Liaoning	43,056	0.262	0.44	0	1
Zhejiang	43,056	0.184	0.387	0	1
Guangdong	43,056	0.146	0.353	0	1
Sichuan	43,056	0.154	0.361	0	1
Shaanxi	43,056	0.113	0.317	0	1

represent household for UHS data, and the primary respondent on financial matters for CFPS data. This study selects household samples in the age group of 16 to 60 years, and consumption data includes the spending on the seven kinds of commodities of food; clothing; housing; household equipment & articles; education, culture & entertainment; transportation & comunication; and healthcare. Samples with missing food consumption and demographic characteristics are deleted.

As for price data, this paper selects the CPIs of the seven kinds of commodities as consumption data, which are converted based on national kind CPIs in 2002 into the price index of 2002-2014 (Lewbel and Pendakur, 2009; Li *et al*., 2015). See Table 1 for descriptive statistics of key variables.

4. Empirical Analysis

This paper first tested the EASI structure equation's optimal form for equation (7) and thus estimated the effects of year and space. Then, we simulated the benchmark utility level and specified changes in the price and spending levels to estimate the dynamic change in TCLI. Lastly, we performed a price deflation using regional TCLI to analyze changes in real consumption inequality and welfare level.

4.1 EASI Demand System

There is a trade-off mechanism between the rank of Engel Curve (the degree of income polynomials, y^r) and preference heterogeneity. First, we compared the regression results of the y^3 model set and the y^4 model set,[5] and found that all coefficients in the y^4 model set were more significant than those in the y^3 model set.[6] Then, we do a concavity test for the y^4 model set to fit utility maximization. Following Li *et al*.'s (2015), there are more than 90% of samples meeted the test and satisfied local concavity.[7] The test reveals that both the joint test of y^4 terms in various simultaneous sub-equations and the non-quadratic term test in the sub-equations significantly reject the null hypothesis, which indicates that the y^4 model set is optimal. Meanwhile, the joint test of the variable of year and the variable of province also rejects the null hypothesis, respectively, which indicates that both the effect of time and the effect of space have been estimated efficiently.

Table 2 reveals that most regression coefficients are significant at 1%. The coefficients of y^4 in all sub-equations of food, clothing and home devices are significant at the 5% level, which suggests that the inclusion of y^4 into the model better reflects the relationship between the share of spending on each item and total spending. The prices of all sub-equations and the regression coefficients of household composition all significantly influence the share of budget constraint, which explains that the relative price level and household consumption preference have significant effects on consumption structure. The reference province and reference year is Shaanxi and 2002. The coefficients of both province and year are highly significant, suggesting that the differences of period and spatial in household consumption preferences also significantly affect the composition of household spending.

Table 2: Regression Results of Demand System

	Food	Clothing	Housing	Home devices and maintenance	Education, culture and entertainment	Transportation and communication
y^1	-1.243**	-1.555***	4.947***	-0.714**	1.028*	-2.638***
	(0.455)	(0.257)	(0.327)	(0.242)	(0.468)	(0.318)
y^2	0.284***	0.250***	-0.841***	0.119**	-0.271***	0.517***
	(0.078)	(0.044)	(0.056)	(0.042)	(0.080)	(0.055)
y^3	-0.027***	-0.017***	0.062***	-0.009**	0.028***	-0.045***
	(0.006)	(0.003)	(0.004)	(0.003)	(0.006)	(0.004)
y^4	0.001***	0.001***	-0.002***	0.001**	-0.001***	0.001***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Female	-0.0050	0.009***	-0.012.	-0.0020	0.009**	-0.0020
	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)
40 years and above	0.014***	-0.019***	0.003**	-0.003***	0.010***	-0.012***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
High school and above	-0.025***	0.018***	-0.012***	-0.002*	0.022***	0.010***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Number of children	-0.033***	0.002**	-0.009***	0.0010	0.039***	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

[5] The y^5 model cannot converge under the multiple demographic attribute dimensions specified in this paper and thus is not used.

[6] After taking convergence and the importance of demographic characteristics into account, this paper has specified the interaction term between gender and price.

[7] Regression using data of fast-developing economies hardly satisfies global concavity. Li *et al*. (2015) consider that regional concavity is more appropriate for current data research for China.

(Continued)

	Food	Clothing	Housing	Home devices and maintenance	Education, culture and entertainment	Transportation and communication
Number of adults	-0.027***	-0.003***	-0.005***	0.002***	0.021***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
2004	-0.042***	0.009***	0.0030	-0.0010	0.018***	-0.008*
	(0.006)	(0.002)	(0.005)	(0.003)	(0.003)	(0.003)
2006	-0.056***	0.025***	0.0060	0.0020	0.008.	-0.0060
	(0.008)	(0.003)	(0.006)	(0.004)	(0.004)	(0.005)
2008	-0.133***	0.057***	0.035**	0.0070	0.029**	-0.040***
	(0.017)	(0.007)	(0.012)	(0.008)	(0.009)	(0.010)
2010	-0.204***	0.031***	0.0070	0.0070	0.092***	-0.024*
	(0.022)	(0.009)	(0.015)	(0.010)	(0.012)	(0.012)
2012	-0.225***	0.055***	0.051**	0.055***	0.075***	-0.088***
	(0.027)	(0.011)	(0.018)	(0.012)	(0.015)	(0.015)
2014	-0.172***	0.049***	0.080***	0.033**	0.053***	-0.115***
	(0.029)	(0.011)	(0.019)	(0.013)	(0.016)	(0.016)
Beijing	0.074***	-0.023***	-0.060***	-0.0010	-0.022***	0.0060
	(0.006)	(0.003)	(0.006)	(0.004)	(0.004)	(0.004)
Liaoning	0.021***	0.014***	0.019**	-0.026***	-0.018***	-0.0060
	(0.006)	(0.003)	(0.005)	(0.004)	(0.004)	(0.005)
Zhejiang	0.054***	-0.0010	0.0110	-0.040***	-0.0050	-0.0030
	(0.005)	(0.002)	(0.004)	(0.003)	(0.004)	(0.003)
Guangdong	0.131***	-0.060***	0.048***	-0.039***	-0.056***	0.019***
	(0.006)	(0.003)	(0.005)	(0.004)	(0.004)	(0.005)
Sichuan	0.082***	-0.011***	0.004*	-0.027***	-0.025***	0.0050
	(0.007)	(0.003)	(0.006)	(0.004)	(0.005)	(0.005)
Food price	0.533***	-0.164***	-0.143***	-0.0010	-0.223***	0.110***
	(0.049)	(0.017)	(0.032)	(0.021)	(0.023)	(0.025)
Clothing price	-0.164***	0.086***	0.029.	-0.023*	0.070***	-0.051***
	(0.017)	(0.012)	(0.015)	(0.010)	(0.011)	(0.012)
Housing price	-0.143***	0.029.	-0.160***	0.088***	0.069***	-0.0070
	(0.032)	(0.015)	(0.040)	(0.019)	(0.017)	(0.022)
Prices of home devices and maintenance	-0.0010	-0.023*	0.088***	-0.0150	0.0130	0.0210
	(0.021)	(0.010)	(0.019)	(0.018)	(0.012)	(0.016)
Prices of education, culture and entertainment	-0.223***	0.070***	0.069***	0.0130	0.075***	-0.045**
	(0.023)	(0.011)	(0.017)	(0.012)	(0.022)	(0.015)
Prices of transportation and communication	0.110***	-0.051***	-0.0070	0.0210	-0.045**	0.0020
	(0.025)	(0.012)	(0.022)	(0.016)	(0.015)	(0.023)
Constant term	2.573**	3.563***	-10.516***	1.623**	-1.2230	5.019***
	(0.985)	(0.557)	(0.708)	(0.523)	(1.011)	(0.688)
N	43,056	43,056	43,056	43,056	43,056	43,056

Note: ***, ** and * respectively denote significance at 0.1%, 1% and 5% levels.

4.2 True-Cost-of-Living Index (TCLI)

From 2002 to 2014, household consumption spending in China increased by 231.1%. The increase in consumption spending not only reflects an improvement in living standards but a rise in the cost of living as well. According to equation (15), we calculated the dymamic changes of true-cost-of-living index (TCLI) based on the 2002 levels of China and each provinces (see Table 3). CPI also can show the change of the cost of living. From 2002 to 2014, China's CPI rose by 37.4% while TCLI jumped by 166.4% (= 2.664-1), which is four times higher than CPI growth. CPI has gravely understated the rise in China's cost of living. Data suggests that China's M2 money stock increased from 18,500.7 billion yuan to 122,837.4 billion yuan, up by 564%, while GDP increased by 299% from 16,141.5 billion yuan to 64,479.1 billion yuan. The difference between these two indicators was 265%, which is far greater than CPI growth. CPI's under-estimation stems from its design framework. CPI is a Laspeyres index adjusted by the weights of different kinds of commodities, which were calculated by the previous cycle. The adjustment weight of CPI is every five years, and the lastest adjustment occurred in January 2016, involving the categories and weights of consumer goods. The too long adjustment cycle and invariant commodities and its weights, which cannot reflect consumption preferences, will lead to serious bias in estimating the cost of living (Beatty and Larsen, 2005). Hence, it will avoid this bias by using the consumer demand system with information of consumption preferences and consumption structure.

China's vast geographical space cause disparate levels of economic development. Apart from differences in regional climate and household demographics, it cause the unbalance of supply and demand for commodities, and heterogeneous preferences, which result in disparate gaps in TCLI growth across regions. Table 3 reveals that compared with 2002, TCLI growth was the highest for Liaoning (3.269) and the lowest for Guangdong (2.227) in 2014. The question is why did TCLI increase the least in Guangdong and the most in Liaoning? While consumer spending increased only by 163% in Guangdong during the same period, the absolute increase still amounted to 23,612 yuan in 2014, which was only less than in Beijing and Zhejiang. The share of food spending in Guangdong equalled to the national average level, and the growth of food CPI was smaller than the national average and in other parts of the country. With a warm climate, the share of cloth consumption in Guangdong is much smaller than in other parts of China, and clothing CPI rose gently. Despite the medium-high level of consumption on housing by national standards, the growth of housing CPI in Guangdong was higher only than in Beijing and slower than in other regions. In addition, there was no significant rise in CPI for education and entertainment in Guangdong. Benefiting from unique geographical environment, moderate price rising and relatively high household spending, the growth of Guangdong's TCLI was smaller than other regions. While Liaoning's consumption spending increased by a maximum of 284% during the same period, the shares of housing and healthcare consumption was higher than in other regions, and both types of CPI increased by a greater margin, causing Liaoning's TCLI to be higher than in other regions.

The uneven rise of commodites' CPI may have led to disparate TCLI growth rates across regions. We found that during 2006-2008, the growth rate of Liaoning's TCLI was 34.5%, which was significantly higher than its other periods and other regions in the same period, while the growth rate of Beijing's TCLI was only 5.8%, the lowest ever. The possible reason is that healthcare CPI rose by 5% in Liaoning, which was far higher than other regions. In 2010-2012, Shaanxi and Liaoning reported TCLI growth rates by 24.1% and 20.1%, respectively. A key contributor to such growth is a rising share of household spending on clothing in both provinces, where clothing CPI rose sharply, especially in Shaanxi. In 2012-2014, the growth rate of Beijing's TCLI reached by 34.2%, which was much higher than other regions during the same period. Through a generally sharp increase in the share of housing consumption in all regions, Beijing increase highest. Among all regions, household spending and CPI of education, culture & entertainmentent rose highest in 2012-2014.

Table 3: True-Cost-of-Living Index (The reference period is 2002 for nation and provinces)

	Nationwide	Beijing	Liaoning	Zhejiang	Guangdong	Sichuan	Shaanxi
2002	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	——	——	——	——	——	——	——
2004	1.143	1.171	1.182	1.154	1.162	1.122	1.114
	(0.143)	(0.171)	(0.182)	(0.154)	(0.1620	(0.122)	(0.114)
2006	1.344	1.387	1.403	1.426	1.311	1.278	1.315
	(0.176)	(0.185)	(0.187)	(0.236)	(0.128)	(0.138)	(0.181)
2008	1.635	1.468	1.887	1.740	1.569	1.546	1.584
	(0.217)	(0.058)	(0.345)	(0.220)	(0.196)	(0.209)	(0.204)
2010	1.954	1.813	2.259	1.806	1.889	1.905	1.887
	(0.195)	(0.235)	(0.197)	(0.038)	(0.204)	(0.233)	(0.192)
2012	2.319	2.078	2.712	2.101	2.189	2.264	2.342
	(0.187)	(0.146)	(0.201)	(0.163)	(0.159)	(0.188)	(0.241)
2014	2.664	2.789	3.269	2.554	2.227	2.584	2.612
	(0.149)	(0.342)	(0.205)	(0.216)	(0.017)	(0.141)	(0.115)

Note: Numbers in parentheses are growth rates over the previous period.

Consumption gaps and uneven commodities'CPI have led to TCLI differences across regions. Referencing the current-year national price level, this paper compares differences in the cost-of-living index across regions in the same periods. An index higher than 1 suggests that a region's cost of living is above the national level, and vice versa. Table 4 revealed that TCLI was the highest in Beijing, and the second highest were Guangdong and Zhejiang. Sichuan and Shaanxi were the lowest. The widest gap occurred in 2006, when Beijing's TCLI was higher than Sichuan's by 0.79 (= 1.501-0.715). The seond widest gap was in 2014, when Beijing's TCLI was higher than Sichuan's by 0.774 (=1.498-0.724). We also found that the gap between Beijing and Zhejiang was the second-highest 0.344 (=1.498-1.154). The smallest gap is 0.147 (=1.293-1.146) occurred between these two provinces in 2008. A key driver of the widening gap is spending on housing in Beijing growing at a much faster pace than in other regions in 2013-2014, which coincided with a sharp rise in Beijing's housing price. The rise of housing price pushed up rents, causing fast rises in the share of house rents and cost of living.

We also calculated the coefficient of variation (CV) to reflect TCLI differences across regions and years. Results indicate that the CV was the smallest for Shaanxi (0.016) and the highest for Beijing (0.076). Beijing's CV was alwasy far greater than other regions, which played a key role in regional gaps. On the period dimension, the CV was the highest in 2006 (0.326) and the smallest in 2012 (0.231) with an N-shaped pattern. It increased in 2002-2006, and then decreasd in 2006-2012, but increased again in 2012-2014. Overall, TCLI's regional gaps have decreased, and the reason of increasing in 2012-2014 is that the fast increase of housing CPI caused consumption structural change.

2.3 Consumption Inequalities

In comparing the period differences of consumption, researchers need to deflate price level by CPI. The previous section has explained the defects of CPI. And the differences of homogeneous commodities' price across regions cause consumption inequalities to be overestimated or underestimated (Attanasio and Pistaferri, 2016). With the regional TCLI for price deflation, we calculated the gap between real consumption inequality (quantile weighted Gini coefficient) and nominal consumption inequality. As shown in Table 5 and Table 6, except for 2006-2008, consumption inequalities have been

Table 4: True-Cost-of-Living Index (Referencing national level in the current period)

	Nationwide	Beijing	Liaoning	Zhejiang	Guangdong	Sichuan	Shaanxi	CV
2002	1.000	1.452	0.749	1.217	1.262	0.752	0.752	0.307
		(1.430)	(-0.793)	(0.686)	(0.827)	(-0.785)	(-0.783)	
2004	1.000	1.488	0.768	1.236	1.282	0.734	0.733	0.322
		(1.458)	(-0.694)	(0.704)	(0.844)	(-0.796)	(-0.798)	
2006	1.000	1.505	0.784	1.306	1.237	0.715	0.746	0.326
		(1.479)	(-0.634)	(0.896)	(0.694)	(-0.833)	(-0.745)	
2008	1.000	1.293	0.855	1.146	1.201	0.703	0.734	0.259
		(1.147)	(-0.569)	(0.571)	(0.786)	(-1.161)	(-1.040)	
2010	1.000	1.310	0.848	1.116	1.198	0.722	0.730	0.257
		(1.225)	(-0.598)	(0.457)	(0.780)	(-1.096)	(-1.066)	
2012	1.000	1.269	0.858	1.087	1.162	0.725	0.763	0.231
		(1.191)	(-0.631)	(0.387)	(0.716)	(-1.216)	(-1.050)	
2014	1.000	1.498	0.901	1.154	1.033	0.724	0.739	0.290
		(1.706)	(-0.339)	(0.528)	(0.114)	(-0.945)	(-0.893)	
CV		0.076	0.068	0.065	0.069	0.021	0.016	

Note: Numbers in parentheses are t statistics, which equal (SCLI-1)/the standard deviations of SCLI across regions.

Table 5: Nominal Consumption Inequalities (Gini Coefficient)

	Beijing	Liaoning	Zhejiang	Guangdong	Sichuan	Shaanxi	National
2002	0.276	0.274	0.292	0.350	0.304	0.309	0.344
2004	0.286	0.282	0.331	0.371	0.333	0.295	0.362
2006	0.297	0.300	0.365	0.381	0.326	0.314	0.373
2008	0.350	0.363	0.345	0.360	0.313	0.317	0.371
2010	0.404	0.389	0.329	0.408	0.346	0.282	0.415
2012	0.352	0.446	0.312	0.403	0.365	0.343	0.404
2014	0.513	0.345	0.506	0.369	0.334	0.383	0.458

rising across China, and real inequality has exceeded nominal inequality (Figure 1).[8] After 2008, the gap has narrowed. We believe that improving transportation infrastructure and rapid development in e-commerce have allowed commodity circulation effective across regions, reducing the unbalanced increase of commodities' price.

On period and spatial dimensions, real consumption inequality has exceeded nominal consumption inequality,[9] but the degree of inequality has changed over time. From 2000 to 2006, Guangdong had the highest consumption inequalities in China, which slightly decreased in 2008, then rising again. Consumption inequalities increased from 2002 to 2012 in Liaoning. Consumption inequalities continuously increased from 2002 to 2010, then decreased gently in 2010-2012, peaked at 0.513 (nominal)

[8] Major adjustments to the CFPS consumption questionnaire after 2012 have affected the consumption inequality coefficient for 2010.

[9] CPFS is nationally representative data, but in this paper, its provincial-level representativeness is limited to Liaoning and Guangdong, and there were only 34 urban samples for Beijing in 2012, which is smaller than the 53 samples for 2010 and 60 samples for 2014. There may be some deviations in Beijing's consumption inequality coefficient for 2012. In addition, similar problems may also exist for the urban samples of Zhejiang Province.

Table 6: Real Consumption Inequalities (Gini Coefficient)

	Beijing	Liaoning	Zhejiang	Guangdong	Sichuan	Shaanxi	National
2002	0.327	0.330	0.329	0.410	0.344	0.333	0.372
2004	0.369	0.337	0.420	0.452	0.364	0.355	0.389
2006	0.362	0.346	0.442	0.414	0.379	0.385	0.414
2008	0.375	0.423	0.396	0.380	0.386	0.357	0.391
2010	0.305	0.408	0.250	0.342	0.364	0.283	0.404
2012	0.293	0.452	0.284	0.402	0.316	0.423	0.407
2014	0.433	0.362	0.326	0.412	0.328	0.287	0.477

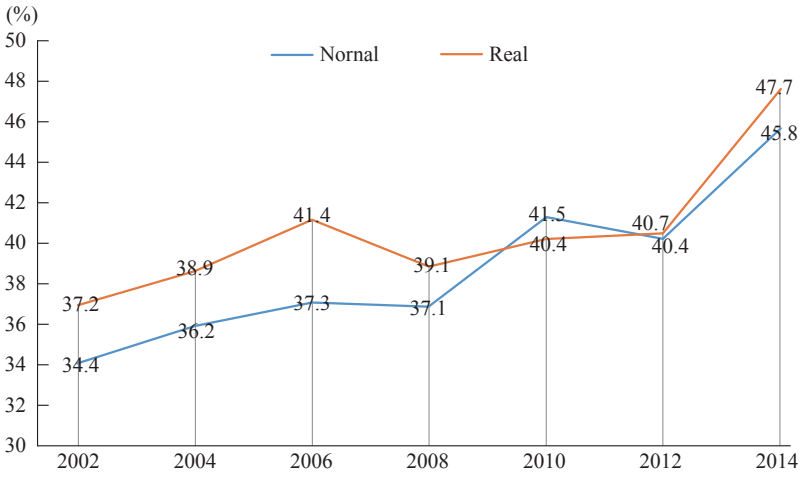

Figure 1: Change in Consumption Inequality

and 0.433 (real) in 2014 for Beijing. Consumption inequalities rose sharply in 2014, but real inequality was far smaller than the nominal value in Zhejiang. Consumption inequalities in Sichuan and Shaanxi remained at relatively low levels.

4.4 Welfare Level

Unbalance changes in interregional consumption and price levels will cause regional welfare imbalances. We estimated dynamic changes in welfare levels of each regions (Table 7). Results suggest that Sichuan and Shaanxi are in the highest welfare levels due to modest cost of living (except for the high estimated values for Liaoning Province in 2014). Since 2010, Beijing, Zhejiang and Guangdong have experienced faster consumption welfare growth than Sichuan and Shaanxi. A possible reason is that with higher levels of economic development, household disposable incomes increasd fast in Beijing, Zhejiang and Guangdong, which boosted household consumption.

The redistribution effect of price inflation is regressive, i.e., the rising cost of living affects the low-income group the most. According to regional statistical yearbooks, we have calculated changes in the disposable income and consumer spending of those for the bottom and top 20% income groups. As data revealed, the disposable income and consumption spending of the lowest-income group in Beijing increased by 209.7% and 176.4% in 2002-2014, respectively, and those of the highest-income group rose by 405.8% and 94.4%, respectively. In the same period, the true cost of living in Beijing rose by 178.9% (=2.789-1 (Table 3)). In Sichuan Province, the disposable income and consumption spending

Table 7: Welfare Index

	National	Beijing	Liaoning	Zhejiang	Guangdong	Sichuan	Shaanxi
2002	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	——	——	——	——	——	——	——
2004	1.191	1.186	1.225	1.22	1.190	1.558	1.548
	(0.191)	(0.186)	(0.225)	(0.221)	(0.190)	(0.558)	(0.548)
2006	1.442	1.387	1.495	1.532	1.383	1.777	1.833
	(0.211)	(0.169)	(0.221)	(0.255)	(0.162)	(0.140)	(0.184)
2008	1.865	1.600	2.102	2.050	1.728	2.193	2.259
	(0.293)	(0.154)	(0.406)	(0.338)	(0.249)	(0.234)	(0.232)
2010	2.234	1.938	2.486	2.050	2.057	2.721	2.719
	(0.198)	(0.211)	(0.182)	(0.001)	(0.191)	(0.241)	(0.204)
2012	2.765	2.338	3.106	2.473	2.492	3.275	3.421
	(0.554)	(0.622)	(0.503)	(0.589)	(0.589)	(0.442)	(0.463)
2014	3.311	3.278	3.841	3.127	2.627	3.756	3.843
	(0.197)	(0.402)	(0.237)	(0.264)	(0.054)	(0.147)	(0.123)

Note: Numbers in parentheses are growth rates compared with the previous period.

of the lowest-income group grew by 171.3% and 286.7%, respectively, and those of the highest-income group rose by 236.5% and 221.5%, while the true cost of living swelled by 158.4% (=2.584-1 (Table 3)). Compared with the high-income group, the low-income group is more vulnerable to price rise due to their spending constraint, especially in high cost of living regions. The low-income group has suffered the most from the sharp increase in food prices. Therefore, imbalance economic growth in various parts of China will intensify price disparities across regions, which cause a more severe reverse distribution effect by inflation that intensifies consumption inequalities, and reduces the welfare level of the low-income group.

5. Conclusions and Implication

Like other large developing countries, China's huge social, economic, and cultural differences across regions have led to different consumer preferences, giving rise to structural differences in the relative price level. It will cause real consumption inequality to be greater than nominal consumption inequality. Based on micro household data of the six provincial-level regions, this paper analyses the dynamic changes of price of and spending on commodities, and the differences in the true cost of living across regions. Results indicate that the optimal order of the EASI demand system is the , which is higher than Li *et al.*'s (2015) specification. The variables of year and province significantly influence household budget constraint. From 2002 to 2014, China's urban households experienced the fast rise of true cost of living , which is much higher than the increase of CPI. But risng levels of TCLI were heterogenous across regions. While Beijing's TCLI was far higher than in other regions, TCLI remained relatively low in Sichuan and Shaanxi provinces. Compared with 2002, TCLI increased the most for Liaoning (226.9%) and the least for Guangdong (122.7%) in 2014. China's TCLI increased the most by 21.7% in period of 2006-2008. Among this period, the biggest increase was in Liaoning (34.5%) and the smallest increase in Beijing (5.8%). Imbalcance increases in income and price levels have contributed the most to the widening gaps in the true cost of living across regions.

As the rising cost of living has increased real consumption inequality, real consumption inequalities

should be higher than nominal inequality. Overall, consumption inequality increased sharply in the two periods of 2004-2006 and 2012-2014, and peaked in 2014 (real consumption was 0.477). With falling unbalance change in the interregional price level after 2008, the gap between real and nominal consumption inequalities has narrowed. Moreover, consumption inequality was higher in Guangdong and Zhejiang in 2002-2006 than in other regions. Liaoning's consumption inequality rose since 2008, and the gap between real consumption and nominal consumption was the largest in China. Due to skyrocketing housing prices in 2013-2014, Beijing exceeded Liaoning to be the greatest consumption inequality region in China.

China is a vast country with huge regional disparities. In developing national central cities, we should attach great importance to the basic needs of low-income urban groups and migrants. In order to raise welfare levels of urban households ,we need to promote accelerating commodity circulation across regions to reduce relative price differences, offer living allowances and price subsidies for targetted groups to ensure basic needs. Moreover, reducing consumption inequality will benefit the reform of socioeconomic structure in long term.

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