An Index Approach to Assess the Reliability of Purchasing Power Parities in China

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Paper Prepared for the IARIW 33rd General Conference

Rotterdam, the Netherlands, August 24-30, 2014

Session 6A

Time: Thursday, August 28, Afternoon

Session 6A: Measuring the Size and the Structure of the World Economy I

Time: Thursday, August 28, 2014 PM

Paper Prepared for the 33nd General Conference of

The International Association for Research in Income and Wealth

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ABSTRACT

The introduction of representative products in International Comparison Program makes the purchasing power parities (PPPs) become a computable concept. The representative extent of the product list for the participating countries has important impacts on the reliability of PPPs and the global results. However, the measurement of representativeness and its induced biases in the estimated PPPs has not been carried out to our knowledge. Therefore, the paper designs a new index approach——Intra-national Assessment, to assess the reliability of PPPs via representativeness. First, there exits the common products in the basket of goods in each country's consumer price index (CPI) and the international baskets used in the ICP and thus we use the common food products both in CPI and ICP to measure the basic missing degree of representativeness in ICP. Then we add other household consumption expenditures and fixed capital formation to calculate the full missing degree of representativeness in ICP. Because of the full participation of China and its significant role in ICP, we apply this new index approach to empirical assess the reliability of China's PPPs in 2011 ICP. Reliability implications in this study would be helpful for measuring the real size of the world economy.

1.Introduciton

1.1Background

On June 20, 2014, World Bank issued the results of the 2011 International Comparison Program (ICP) (World Bank 2014), again raising the hot debate on the real size of the world economy. In particular, China, as the largest developing country and second largest economy in the world, is full of participation in this round with urban and rural survey around the nation, and thus has better representative for China(Asian Development Bank 2014). Although the full participation of China can improve the representative of the global results, the methodology of purchasing power parity (PPP) originating from OECD, are more suitable for the marketized and highly homogeneity economies. As the world's largest developing country and the world's second largest economy, China's marketized development is not perfect, and thus the prices of some products can not well reflect their real price levels. Moreover, China has significant regional differences and urban-rural differences, such as on the level of development, living standards and consumption mode. For example, east coastal areas have reached the level of developed countries, while the living standards of the central and western regions are just above the poverty line. Therefore, great quality differences of the surveyed products among regions and urban-rural exist, and it is hard to guarantee the representatives of the average prices.

The introduction of representative products in International Comparison Program makes the purchasing power parities (PPPs) become a computable concept. The representative extent of the product list for the participating countries has important impacts on the reliability of PPPs and the global results. However, the measurement of representativeness and its induced biases in the estimated PPPs has not been carried out to our knowledge. Therefore, the paper designs a new index approach——Intra-National Assessment (INA), to assess the reliability of PPPs. First, there exits the common products in the basket of goods in each country's consumer price index (CPI) and the international baskets used in the ICP and thus we use the common food products both in CPI and ICP to measure the basic missing degree of representativeness in ICP. Then we add other household consumption expenditures and fixed capital formation to calculate the full missing degree of representativeness in ICP. Because of the full participation of China and its significant role in ICP, we apply this new index approach to empirical assess the reliability of China's PPPs in 2011 ICP. Reliability implications in this study would be helpful for measuring the real size of the world economy.

1.2Review

As a method to measure the differences of regions within a country and its effects, Sub-National PPP (Dikhanov, Palanyandy and Capilit 2011) cannot be used to judge the reliability of the PPP with whole economies, as it's result is the PPP in each area be obtained.

Some methods can make judgments on whole economies or main classification but did not consider the differences in regions or urban-rural. For instance, Hajargasht and Rao advanced a stochastic approach—the country-product-dummy(CPD) method, to derive standard errors of Geary-Khamis PPP(Hajargasht and Rao 2010). The approach mainly focuses on the second step of PPP compilation involving the aggregation above the basic heading level where weights for each basic heading are available for all the countries. In the Asia Pacific region, ICP in 2011 adopts this method, so we can largely determine the reliability by China's standard deviation. But as an overall evaluation, its requirements of the data are relatively high. It cannot draw any conclusions on the survey framework of ICP and the quality of the data itself, as well as PPP is overvalued or undervalued. Angus Maddison used comparative level of performance revised 1990 PPP to convert GDP of 30 economic entities or so over a longer period, found that China's GDP was about 81% of the United States in 2005, as well as thought that China's GDP is about half of the level that the results of World Bank ICP in 2005(Maddison 2009). Feenstra et al. reviewed possible sources of this puzzle including substitution bias in consumption, reliance on urban prices, which are estimated higher than rural ones, and the use of an expenditure-weighted rather than an output-weighted measure of GDP. Taking all these together, they estimate that Chinese real per capita GDP was 30% higher in 2005 than the World Bank estimations, lower than previous ones as the ICP 2011 shown(Feenstra et al. 2013).

Some other scholars proposed the opposite views on regional differences affect the results of large developing countries' ICP. Hill and Syed shows how the results can be adjusted to take account of unrepresentative products, urban-rural price differences and differing outlet-type mixes across countries by introducing some innovations into CPD model such as inserting representative ang urban dummies and using individual price quotes(Hill and Syed 2012). They consider the plausibility that China came out 40% smaller than previously thought in ICP 2005 and attributed part of discrepancy to excessive sampling in China of unrepresentative products in urban location. Majumder et al. proposed a demand system based methodology, which is different from traditional method in previous ICP, for calculating the PPP between the Indian Rupee and the Vietnamese Dong, allowing for regional variation in preference and price changes both inside the country and between countries(Majumder, Ray and Sinha 2013).

Through the above literature review we can see, considering domestic regional differences or urban-rural differences of China probably has a significant effect on the result of ICP, which helps to make a reliability judgment of the result of ICP of China. As Hill and Syed did, bringing domestic regional differences or urban-rural differences into establishment of basic price is a worthwhile direction of thinking(Hill and Syed 2012). We can trace the process of producing PPP. Under a framework of considering the frequency of investigation, or may be setting a fixed proportion of rural and urban survey spot, initial price data are gotten. Then validation of data was undertaken to ensure the quality of prices at the national level, price quotations were checked for the presence of outliers to ensure pricing of comparable products across

different outlets and regions, and between quarters within the economy. We can see this do no help to revise simple averages of price quotations by considering the weight of items and the rural-urban consumption structure of items. As it is usually difficult to compute weighted averages of price quotations collected, where feasible the price surveys must use self-weighted designs so that simple averages of price quotations would provide reliable estimates of national average prices.

The reliability of PPPs and volume measures based on them depends on the level of detail. At higher aggregated levels, PPPs are likely to be more reliable(Asian Development Bank 2014). This provides an inspiration by a bottom-up approach to judge the reliability of the main classification of PPP :Standard Products of the ICP are divided into groups mainly according to "Classification of Individual Consumption According to Purpose Classification" of the United Nations. Categories of consumption expenditure of Chinese residents include eight categories of 24 in class with 82 subcategories, which is consistent with international standards(Research Group on "The Index Method and Application for Regional of Price Difference" 2014). It provides some convenience of data for gathering the weight of price and weighted deviation, and then getting a higher level of PPP reliability. Because a bottom-up approach level by level is infeasible, an alternative method is leapfrog summary. Because of availability of the data, only China's data is used in this process. Underlying assumptions is are that the reliability of GDP and one level of the main category is equal to the reliability of PPP.

2.Methods and Data

2.1 The new index approach——Intra-National Assessment

The index method with which to assess China's PPP reliability, is called Intra-National Assessment, INA. The method above is based on the representative of ICP specifications products' prices and weights measuring GDP and the reliability of main classification level PPP in ICP. "Reliability" here reference to the Engineering ideas "inspecting component failure affect overall mechanical failure's probability", investigating when specification products' prices and summary weights appear deviation, how does them affect ICP main classification of PPP.

In this paper, exponential model about the main classification reliability which considers the regional differences are as follows:

$$ina(p_i^I) = \frac{S\,\bar{p}_i^S + D_1\bar{p}_i^D}{J_1\bar{p}_i^J} \bigg/ \frac{S\,\bar{p}_i^S + D_2\bar{p}_i^D}{J_2\bar{p}_i^J} \tag{1}$$

Formula (1), i represents the collection of specification products, I represents the number of species about the collection of specification products in a higher level. S represents the number of Capitals or the number of deputy provincial cities, D represents the number of other prefecture-level cities, $J_1 = S + D_1$, $J_2 = S + D_2$,。

$$ina(P) = \frac{\sum_{i=1}^{I} w_i ina(p_i)}{\sum_{i=1}^{I} w_i} \qquad (2)$$

In formula (2), P represents the price level of the higher level, w represents expenditure. p represents specification product or weights of a lower level.

Models in this paper which considered Urban-rural differences are as follows:

$$ina(p_i^I) = \frac{u_1 p^u + r_1 p^r}{per * u_2 w^u + r_2 w^r} \qquad (3)$$

In formula (3), u represents the number of points for urban survey in each ICP survey area, r represents the number of points for rural survey in each ICP survey area, subscript 1 indicates the range of each ICP survey area, subscript 2 indicates all ranges of ICP survey areas. w represents the proportion of expenditure. per represents the ratio of urban per capita expenditure and rural per capita expenditure of rural.

$$ina(P) = \sum_{i=1}^{I} (\frac{p_i}{\sum_{i=1}^{I} p_i}) ina(p_i) \qquad (4)$$

In formula (4), P represents the price level of the higher level, p represents or weights of a lower level.

GDP reliability index in this paper are as follow:

$$ina(GDP) = \sum_{i=1}^{I} \frac{w_i}{\sum_{i=1}^{I} w_i} ina(P_i) \qquad (5)$$

In formula (5), ina（P）represents the main classification reliability of price, w represents the main classification of expenditures right in GDP weights.

2.2 Data sources

Although 82 cities from 30 provinces, autonomous regions and municipalities (excluding Tibet) in China participated in 2011 International Comparison Program(ICP), only 55 cities (4 municipalities of Beijing, Tianjin, Shanghai, Chongqing, 26 capital cities, and 25 non-capital cities as shown in Table A1) are included in this study due to the data available.

ICP product specifications considered in this study are divided into three categories: food, other household consumption expenditures, and other expenditures (government public spending and gross fixed capital formation).

The shares of household consumptions, calculated by per capita annual cash consumption expenditure of urban household by region and per capita annual cash consumption expenditure of rural household by region expenditure , and the shares of individual consumptions and government spending are both from *China Statistical Yearbook* 2012 (National Bureau of Statistics of China 2012).

2.2.1Food expenditures

There are 24 specifications of food price, such as rice, strong flour, prosperous and powerful powder flour, and bean curd (unit in RMB/500 grams) are collected. The prices of the 31 capital cities and 4 municipalities are from *China Urban Life and Price Yearbook 2012*(Department of Urban Society China 2012). The prices of the rest 20 cities, such as Mianyang, Leshan, Guilin, are from various bureau websites or Development and Reform Commission (NDRE) websites. The national urban weights of food come from *China Statistical Yearbook 2012*(National Bureau of Statistics of China 2012), including grain, starch and potatoes, dry beans and soy products, fats and oils, meat and products, eggs, aquatic products, vegetables, spices, sugar, tobacco, wine and beverages, dry fresh fruits, cakes, milk and dairy products, other foods, eating out, food processing, and service charges.

Other household consumption expenditures mainly consist of clothing, housing, household equipment and supplies (including consumer durables, telephone, computer), transport and communications, catering and tourism. Therefore, we select the weights of apparel consumption, housing (including per capita housing area of urban residents and real estate business houses completed cost), furniture market turnover, durable goods, transportation and communications, catering, and domestic tourists per capita spending of urban and rural residents, and other indicators, of which reflect these residential consumer spending.

Urban and rural clothing consumption are from *China's Economic and Social Development Database* (http://tongji.cnki.net/kns55/index.aspx), we take per capita cloth consumption of urban and household residents as the weight. The prices of garment exports are from the statistics of the Customs of China. The imputed rents are calculated from the per capita housing areas of urban residents and the completed house costs of real estate (housing areas divided by the value of completed buildings). These data are mainly from various statistical yearbooks of cities or provinces. Furniture market turnover of 2011 provincial data comes from *China's Economic and Social Development Database*. Durable goods, transportation and communications contain two parts: 1) the quantities are from the *China Yearbook of Household Survey* (Department of Household Surveys National Bureau of Statistics of China 2012); 2) the prices of camcorders, computers, fixed phones, motorcycles, cars are calculated by volumes and values from Customs of China, and the rest come from *the Price Yearbook of China* (Department Of Urban Society Economic Statistics National Bureau of Statistics of China 2012). Tourism data comes from *The Yearbook of China Tourism* (National Tourism Administration of China 2012).

2.2.2 Other household consumption expenditures

Government employees compensation uses average wage of Public Administration and Social Organization, which sectoral average wages are from the statistical yearbook of provinces. Nearly half of the cities miss the data.

2.2.3 Gross Fixed Capital Formation

Indicators of the construction industry are housing construction areas and commercial housing prices. Housing construction areas are computed by the sub-regional data in statistical of provinces. Commercial housing price is from National Bureau of Statistics of China. Construction cost margin ratio is obtained from calculating the relevant indicators.

Machinery and equipment spending is calculated by the difference between gross fixed capital formation and the value added of construction. The data of gross fixed capital formation and value added of construction are mainly from the statistical yearbooks of cities.

3.Results

In 2011，the reliability index of PPP on GDP level is 1.007 corresponding that PPP of ICP which is overestimated by 0.67%. As it shows, the ICP results of China at GDP level are very reliable.

3.1 PPP reliability index of GDP level and main category level

The reliability index of residents consumer expenditure (including housing) PPP is 0.96, which is very high. The reliability index of government public consumption PPP is 1.09, which is overvalued by 8.8%. The reliability index of fixed capital formation PPP is 0.99 and the reliability index of mechanical device PPP is 1.32, which is overvalued by 31.5%. PPP of construction is 0.85, which is undervalued by 15.1%.

Table 1. Reliability of PPP of GDP level and main category level

	Residents consumer spending (including housing)	Government public consumption	Fixed capital formation	Mechanical equipment	construction industry
Reliability of PPP	0.96	1.09	0.99	1.31	0.85

The reliability index of residents consumer spending (including housing) PPP is 0.96, which is very reliable. This is decided by the strict survey system and easy identification of product characteristics. The reliability index of government public consumption PPP is 1.09, which is overvalued by 8.8%. This means that the per capital share of collective government consumption expenditure of Chinese government consumption is lower than other countries, which is seemly in accordance with the China situation. The reliability index of fixed capital formation PPP is 0.99 and the reliability index of mechanical device PPP is 1.31, which is overvalued by 31.5%. PPP of construction industry is 0.85, which is undervalued by 15.1%. This shows that it has a high reliability index overall,although the internal price of fixed capital formation varies significantly. We also investigated the price of commercial

housing to replace the input cost method of building to measure the representative product price and results showed that the PPP reliability index index of construction industry is 0.76 with a more serious underestimated situation. Although we cannot judge whether it is helpless to what kind of method, but the compromise of two reliability index should be more reasonable.

3.2 PPP reliability index of household consumer expenditure levels

The reliability index of household consumer spending (including housing) PPP is 0.96 with a reliability index of foods PPP 1.05, which is relatively reliable. Non-food consumption expenditure is 0.90, excluding housing virtual rents consumer spending PPP reliability index is 1.08, household consumption expenditure without housing make the reliability index of consumer spending decreased 0.12, which is because the reliability index is 0.29 of housing is low indicating that this may be due to the rapid commercialization of Chinese housing, per capita of commercial housing construction area increases rapidly, so high prices, real rents rising faster. Non-food consumer spending reliability index is slightly low, mainly due to family equipment reliability index is underestimated, in other words, domestic prices reflected in the ICP PPP is comparatively high. Although PPP of Transport and Communications are overvalued by as much as 70%, this may be due to: public transport fares in China is low and cannot be comparable with abroad; supply of electronic products market is adequate, which restrain the price. Clothing PPP is undervalued by 22.7% indicating that the domestic price is actually high, mainly of garment exports accounted for a larger proportion with lower price. Cultural and educational entertainment PPP is relatively reliable, the reliability index index is 1.04. PPP under the classification of household consumption expenditure are shown in table 2:

Table 2. Reliability of PPP of Household Consumption Expenditure

Food	Housing	Household consumption expenditure by households with housing	Household equipment and maintenance	Transport and communication	Clothing	Education and entertainment
10.49	0.29	1.08	0.71	1.72	0.79	1.04

3.3 The reliability index of PPP of Food Consumption Expenditure
Food contains 8 categories, and the reliability index of PPP shown in Table 3.

Table 3. Reliability index of PPP of Food Consumption Expenditure

	Reliability index of PPP
Grain	1.07
Bean and Its Products	1.01
Oil and Fat	1.02
Meal, Poultry and Their Products	1.01
Eggs	0.96

Aquatic Products	1.01
Vegetables	1.01
Dried and Fresh Melons and Fruits	1.00

The reliability index of PPP of food categories are most in 5% for most of production specifications are calculated by the prices of high frequency survey. The reliability index of PPP of grain is relatively high, 1.07, and the price is overvalued. It may be due to Asia-Pacific region is rich of rice, and the quantity of Chinese rice is better in the region, and the quality is more higher than Southeast Asia.

4.Discussion

From the above analysis, the results of the reliability index in this paper comply with Chinese conditions situation basically., Overall, the results of reliability index show the following characteristics:

i.The reliability index of summary category level PPP is close to 1. This is because the weighted method counteract the variation of the following summary classification of the following levels. But this does not mean the reliability of the levels below aggregation category level are all big, at least the reliability index of food categories is close to 1, indicating that the level of detailed survey has a significant impact on reliability.

ii.As the result of reliability index of Transport and communications categories, housing, construction industry, household euipment, machinery and equipment categories show more derivatation from 1 than other categories. The reliability index of four kinds are 1.7178, 0.2908,0.7111, 0.8488, 1.315 which shows that the products of these categories may exist difficulty in ICP survey or ICP outlet is not representative in China. Transport and communication as an example, this paper selects the telephone, mobile phone, computer ,motercycle and family car as representative products of China . They have the certain representation, but the global ICP survey catalogue includes computer in China, and includes a lot of public transportation, on the contrary, the developed countries have more international flights specifications, although they are investigated in China, but not involved in comparision.

iii.According to the degree of reliability, the Chinese PPP of GDP level is more reliable, but the variability between main classifications is relatively larger. Using it in the PPPs of construction industry, and machinery and equipment, and housing needs to be cautious. The PPPs of residents consumer, gross fixed capital formation, and public consumer are more reliable. And the PPPs of food and recreation, education and culture articles under residents consumer are .reliable.

iv.Compared with other categories, the reliability of PPP of costume deviation is far from 1, this may due to the export price we chose can not reflect the domestic reality, which need further study.

The above features can not fully explain the disparity between urban and rural areas,

further discussion of ICP are as follows:

i.ICP catalog representation

For the large economic entities in internal areas which have large differences between regions, it is difficult to guarantee the   representative of national average price effectively. Underdeveloped market economy as well as inadequate   circulation of economic factors and commodities ,diversity of expenditure,all of these will increase the differences between the various regions in economic entities resulting the weaken of representation of average price probably .The average price has poor representation, its conclusions draw from that relatively are easy to produce bias. Although this paper includes some products do not belong ICP catalog, but did not really consider the impact of a representative of the ICP PPP results.Even taking into account the representation of a product in China, it is only done to determine the product should be included in the directory, and can not determine the impact on average prices.

ii.The comparability of expenditure items. ICP focus on the comparable parts of all expenditure items, and calculate the parity, and assume that the parity of non-representative products is equal to representative products. Because of the division of expenditure category, the difference between each two subcategories seems to be limited, and non-representative products do not overly deviate representative products. However, the non-comparable part of expenditure is a directly reflect of different economic structures. Therefore, I suggest that to calculate the degree of differences of the basket of goods between countries could use variety or expenditure to reflect the reliability of international comparison. The assumption of product comparability is the comparability of expenditure items.

iii. Weight problem

Weighting has effects on different levels of PPP. Hill (2012) believes weighting on product specifications can improve the results. World Bank(2014) investigates the effects of importance weights on the results and methods of ICP. Weighting on product specifications should take various factors into fully validated, to determine the guiding weight by regions. It should be convenient to specify the importance and to investigate the effect of the weight.

iv.Other problems that impact representative of products , regional division and regional problem relates to the countries of the region to participate in another area of cross comparison, will change the constitution expenditure structure remaining in the region, which may affect representative of some products in the remaining area.

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Appendix

Table A1. The list of Chinese cities in this study

No.	Major Cities	No.	Non Major Cities
1	Beijing	1	Tangshan
2	Shanghai	2	Shuozhou
3	Tianjin	3	Datong
4	Chongqing	4	Alashan
5	Shijiazhuang	5	Jilin
6	Taiyuan	6	Yanji
7	Hohhot	7	Qiqihar
8	Shenyang	8	Wenzhou
9	Changchun	9	Xiangyang
10	Harbin	10	Xiangtan
11	Nanjing	11	Yueyang
12	Hangzhou	12	Sanya
13	Hefei	13	Liuzhou
14	Fuzhou	14	Guilin
15	Nanchang	15	Mianyang
16	Jinan	16	Leshan
17	Zhengzhou,	17	Dali Prefecture
18	Wuhan	18	Haixi Prefecture
19	Changsha	19	Karamay
20	Haikou	20	Ili Kazak Autonomous Prefecture
21	Guangzhou		
22	Nanning		
23	Chengdu		
24	Guiyang		
25	Kunming		
26	Xi'an		

27	Lanzhou
28	Xining
29	Yinchuan
30	Urumqi
31	Dalian
32	Ningbo
33	Xiamen
34	Qingdao
35	Shenzhen