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A Modified Consumer Price Index[*]

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Abstract

It is well known that the Consumer Price Index (CPI), as a Laspeyres-type index, attempts to measure the average change in the prices paid by urban consumers for a fixed market of goods and services, and new samples for most item categories are routinely introduced over time to keep the CPI sample representative of consumer spending patterns. The CPI normally overstates the true rate of increase of the cost of living. In this paper, our main objective is to propose a new measurement in the CPI which combines with the Gross Domestic Product (GDP). This new method will make the bias effectively decreased.

1. Introduction

The CPI is defined by

$$CPI = \frac{\sum P_t Q_b}{\sum P_{t-1} Q_b} \qquad (1)$$

where P_t is the price of an item in period t, P_{t-1} is the price in a base period b, and Q_b is an index of the quantity of an item in a base period b. The CPI can provide an approximation to a cost-of-living index (CLI), measuring the average change in the prices paid by urban consumers for a fixed market basket of goods and services has many limitations when interpreted relative to a true CLI. For example, consumers shift spending patterns in response to changes in relative prices, items and outlets available in the original or base period disappear, and new items and outlets enter the marketplace. To alleviate some of these problems, the CPI uses a modified Laspeyres approach, which allows for product substitution and introduction of new samples of outlets and items [1].

It is important to have an assessment of the magnitude of the bias in the CPI. First, the CPI is the most widely followed measure of inflation. Users of all types, including members of the general public, policy makers, and participants in financial markets, should have the best information available concerning the size of the bias. Second, knowledge about the sources and magnitude of the bias could be important in guiding efforts to improve the index. Among other things, this type of knowledge is es-

sential for judging the likely costs and benefits of investing additional resources in the index. Third, the CPI has a substantial effect on the Federal budget. This link between the CPI and the Federal budget has generated considerable political interest in the magnitude of the bias in the CPI.

Furthermore, price evaluations may be biased by perceptions of price unfairness [2], low purchase frequency and steep price changes of particular goods [3]. Although Kemp [4] to some extent dealt with general costs, the cognitive processes described typically comprise individual reactions to price changes of isolated goods and services, not to reactions of the general public to prices changes across consumption categories. At the aggregate level, the divergence between perceived and actual price changes cannot be fully explained from cognitive process. Economic data usually capture price changes by using price indices, which essentially reflect changes in aggregated prices, *i.e.*, weighted averages of a large number of price changes in different item categories. Hence, inflation perceptions may deviate from price indices due to differences between perception processes and statistical procedures in constructing the price indices.

Kemp [4] mentions the possibility that experience with purchases, *i.e.*, for frequently purchased items such as stamps, butter and telephone bills, tends to strengthen these effects. Experience may add to the availability bias [5], possibly resulting in greater weight of high-frequency purchases in perceived inflation judgments. Kemp [6] found almost correctly perceived inflation for the previous year but again under-estimated perceived inflation for the previous 15 years. Brachinger [7] assumes as-

ymmetric inflation perceptions for prices increases versus price decreases. Due to the asymmetric value function in the prospect theory (Tversky & Kahneman, 1991), price increases should influence perceptions more than price decreases. Hence, items associated with large price increases should influence general perceived inflation more heavily than items associated with minor prices increases or price decreases. This expectation may be qualified by distinguishing between absolute and relative price changes. In contrast, a one cent increase of gasoline prices may be evaluated as quite low (see [8]). Hoffmann, Leifer, and Lorenz [9] seem to favor the role of relative price changes in consumer price perception.

The GDP was introduced as a monetary measure of wartime production capacity during the World War II. Today, it is widely used by policymakers, economists, and the media as the primary scorecard of a nation's economic health and welfare. However, GDP has some unavoidable deficiencies as a measure of economic performance (see [10-12]), and is incapable of measuring peoples' well-being. The major problem is that GDP makes no distinction between economic transactions that add to welfare and those that diminish it [13]. It includes all expenditures, assuming that every monetary transaction adds to peoples' welfare. Real GDP is often used as a proxy of a country's real income, even though official statisticians warn against such a practice [14]. Thus, Prescott [15], who singles out Switzerland for its poor economic performance over the past three decades, focuses exclusively on real GDP. Yet, unlike a technological progress, the beneficial effect of an improvement in the terms of trade is not captured by real GDP, which focuses on production per se. In fact, if real GDP is measured by Laspeyres quantity index, as it is still the case in most countries, an improvement in the terms of trade will actually lead to a fall in real GDP [16]. Based on the nominal GDP(NGDP) and real GDP (RGDP), an index GDP deflator (GDPD) is defined by

$$GDPD = \frac{NGDP}{RGDP} \qquad (2)$$

which reflects the changes of all items in economics. Usually the GDPD tends to underestimate the inflation for consumer price [17].

Motivated by the above observations, we propose a new index which combines the CPI and the GDP to test inflation. This index will make the bias decreased effectively in the CPI. In the next section, motivation and method are stated. The data results are reported in Section 3. One conclusion is stated in the last section.

2. Motivation and Method

Many proposals have been forwarded to alleviate the bias caused by the rotation of new item and outlet samples in the CPI. In the interim, there are three ways that have been systematically investigated in which the current bias in the CPI sample rotation process may be alleviated [18]: 1) using geometric means to calculate basic item-area price relatives; 2) setting base period prices using pre-link month "initiation" prices; 3) pricing both the old and new samples for a period of time before introducing the new sample into the CPI.

It is well known that the CPI is one of the most important indexes of the inflation. Normally the CPI overestimates the inflation [17]. Many authors study this problem to decrease the CPI (see [18,19] etc.). From the definition of CPI (1), it is easy to see that the CPI only refers to the consumer items but other items. When we consider the CPI of some items, other items are omitted. In fact, this CPI will be influenced by other items. Then a reasonable idea is to consider the items' percent of the total property, *i.e.*, the GDP should be considered. Moreover, the authors [18,20-23] use geometric means to calculate basic item-area price relatives in CPI and get better results. Motivated by their ideas and the above discussions, we present the modified CPI formula as follows

$$MCPI = \frac{\dfrac{\sum P_t Q_b}{\sqrt[N_t]{GDP_t}}}{\dfrac{\sum P_{t-1} Q_b}{\sqrt[N_t]{GDP_b}}}, \qquad (3)$$

where GDP_t is the GDP in period t, GDP_b is the GDP in a base period b, and N_t is the number of all items, respectively. In practice, it is not difficult to compute (or estimate) the quantities N_t By (3), we have

$$MCPI = \frac{\dfrac{\sum P_t Q_b}{\sqrt[N_t]{GDP_t}}}{\dfrac{\sum P_{t-1} Q_b}{\sqrt[N_t]{GDP_b}}} = \sqrt[N_t]{\frac{GDP_b}{GDP_t}} CPI. \qquad (4)$$

In this paper we will use the index MCPI in (4) instead of CPI in (1). In the next section, we report the practical data to compare the given Formula (4) with the normal CPI Formula (1).

3. Data Results

Since reform and open policy, China has one of the highest rates of economic growth in the world, especially for GDP. In this section, we report the detail data to test our given method including GDP, CPI, all items of CPI since the year 1990 in China. We list them as the following tables.

The data of the **Table 1-2** is from National Bureau of Statistics of China (2008) or can be found at the Homepage:

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Table 1. The data of GDP, Per Capita GDP, CPI, Urban Household CPI, and Rural Household CPI.

Year	GDP(100 million Yuan)	Per Capita GDP (Yuan)	CPI(preceding year=100)	Urban Household CPI	Rural Household CPI
1990	18667.8223761059	1644	103.1	101.3	104.5
1991	21781.4994107882	1892.8	103.4	105.1	102.3
1992	26923.4764511214	2311.1	106.4	108.6	104.7
1993	35333.9247145462	2998.4	114.7	116.1	113.7
1994	48197.8564447092	4044	124.1	125	123.4
1995	60793.7292113314	5045.7	117.1	116.8	117.5
1996	71176.5916539871	5845.9	108.3	108.8	107.9
1997	78973.0349964914	6420.2	102.8	103.1	102.5
1998	84402.279768922	6796	99.2	99.4	99
1999	89677.0547509045	7158.5	98.6	98.7	98.5
2000	99214.5543084772	7857.7	100.4	100.8	98.5
2001	109655.170558159	8621.7	100.7	100.7	100.8
2002	120332.689274252	9398.1	99.2	99	99.6
2003	135822.756149557	10542	101.2	100.9	101.6
2004	159878.33791739	12335.6	103.9	103.3	104.8
2005	183217.4	14053	101.8	101.6	102.2
2006	211923.5	16165	101.5	101.5	101.5
2007	249529.9	18934	104.8	104.5	105.4

Table 2. Consumer Price Indices by Category (2007) (preceding year = 100).

Item	National Indice	Item	National Indices
Consumer Price Index	104.8	Health Care and Personal Articles	102.1
Food	112.3	Health Care	102.1
Grain	106.3	Medical Instrument and Articles	98.2
Rice	105.4	Traditional Chinese Medicine	107.9
Flour	107.3	Western Medicine	99.1
Starches and Tubers	106.2	Health Care Appliances and Articles	101.1
Beans and Bean Products	108.0	Health Care Services	102.2
Oil or Fat	126.7	Personal Articles and Services	102.1
Meal, Poultry and Processed Products	131.7	Cosmetics	100.1
Eggs	121.8	Sanitation Articles	100.3
Aquatic Products	105.1	Personal Ornaments	104.5
Vegetables	107.9	Personal Services	103.1
Fresh Vegetables	107.3	Transportation and Communication	99.1
Flavoring	104.1	Transportation	100.8
Carbohydrate	101.6	Transportation Facility	97.7
Tea and Beverages	101.5	Fuels and Parts	103.5
Tea	103.3	Fees for Vehicles Use and Maintenance	102.4
Beverages	100.7	In city Traffic Fare	101.3
Dried and Fresh Melons and Fruits	102.2	Intercity Traffic Fare	103.0
Fresh Fruits	100.1	Communication	97.1
Cake, Biscuit and Bread	103.6	Communication Facility	81.8
Milk and Its Products	102.7	Communication Service	100.6
Dining Out	107.3	Recreation, Education and Culture Articles	99.0
Other Foods and Manufacturing Services	104.2	Durable Consumer Goods for Cultural	93.1
Tobacco, Liquor and Articles	101.7	and Recreational Use and Services	99.6
Tobacco	100.8	Education	99.1
Liquor	103.5	Teaching Materials and Reference Books	99.6
Articles for Smoking and Drinking	100.1	Tuition and Child Care	101.0
Clothing	99.4	Cultural and Recreational Articles	99.5
Garments	99.4	Cultural Articles	100.7
Clothing Material	101.6	Newspapers and Magazines	102.7
Footgear and Hats	99.0	Expenditure on Culture and Recreation	102.3
Clothing Manufacturing Services	102.3	Touring and Outing	104.5
Household Facilities, Articles and Services	101.9	Residence	105.1
Durable Consumer Goods	101.6	Building and Building Decoration Materials	104.2
Furniture	101.9	Renting	107.0
Interior Decorations	100.3	Private Housing	103.0
Bed Articles	99.4		
Daily Use Household Articles	101.7		
Household Services and Maintenance and Renovation	107.2		

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In order to show these data of **Table 1**, we give the histogram of GDP and diagram of curves of CPI in **Figure 1** and **Figure 2**, respectively. From **Table 1** and **Figure 2**, we can see that the growth rate of GDP is about 10% every year. This growth rate is interesting and shows that the economy of China is healthy. From **Table 1** and **Figure 2**, it is easy to observe that the CPI from 1993-1995 are the highest in these years, and we can conclude that China was facing the inflation except for 1998, 1999, and 2002 years. It is not difficult to see that the urban house-hold CPI was larger than the rural household CPI from 1990 to 2000. However, the rural household CPI surpassed the urban household CPI from 2001 year to 2007 year, which shows that the inflation rate of the rural household was lager than the inflation rate of the urban household in this period. This case also shows that the living level of the rural household is becoming better in some situation and the speed is lager than the urban household does. Overall China is in the situation of inflation from these data. From 2005 year, the inflation is arising.
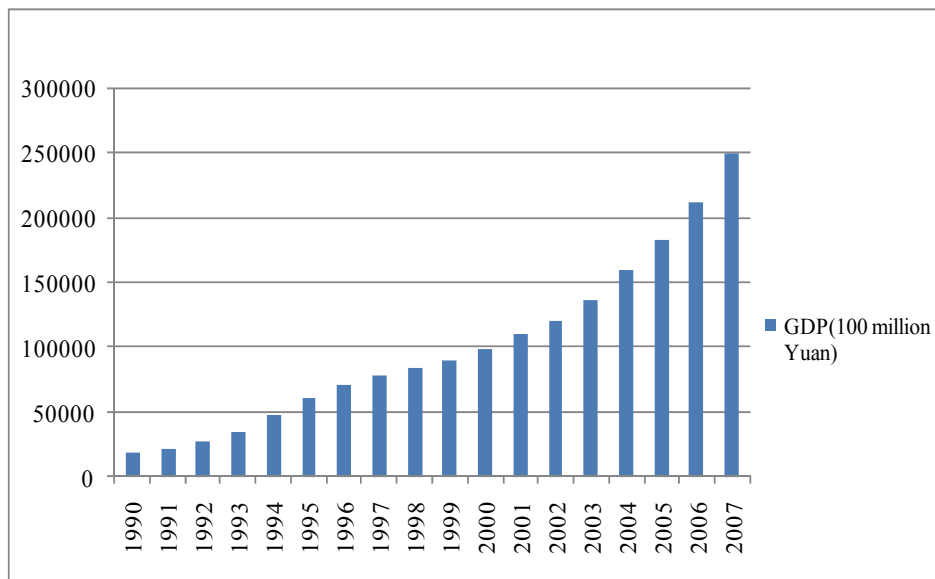

Figure 1. Sources of data: various years of the China Statistical Yearbook and China Data online (2008 year).
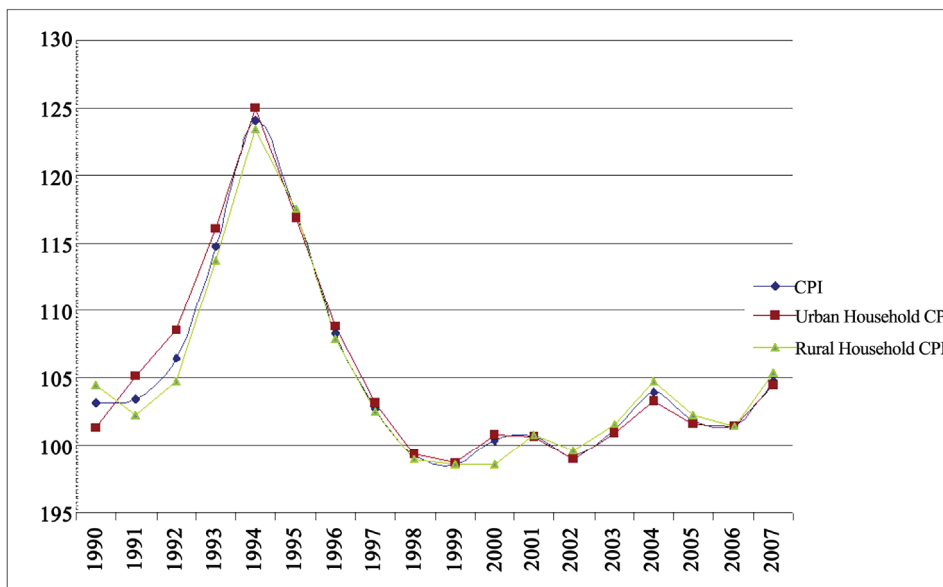

Figure 2. The data of GDP, Per Capita GDP, CPI, Urban Household CPI, and Rural Household CPI (preceding year = 100). Sources of data: Various years of the China Statistical Yearbook and China Data Online (2008).

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In the following, we will compute the inflation rate by the normal CPI Formula (1) and the modified Formula (4) according to the data in **Table 1**, respectively. From **Table 2**, it is easy to compute the number of all items is about sixty. Since it is this category of 2007 year, the number of the category may be less than sixty before 2007 year. So we set $N_t = 50$ by (4) in this paper. The numerical results of formulas (1) and (4) are listed in **Table 3** and **Figure 3**.

Michael, Ellen, Robert, Zvi, and Dale (1995) conclude that the CPI overestimates the inflation rate 0.8 ~ 1.6 percentage points, and the "best estimation" is 1.1 percentage points (see [17]). Then many modified CPI methods are presented (see [19]), but the CPI still overestimates the inflation. Table 3 provides the inflation rates of these two indices. Before 1998, relatively high inflation rates were observed, and the CPI overestimated the MCPI from 0.19 to 0.61 percentage points. In this period, the inflation is serious. In 1998, 1999, and 2002, when the deflationary pressure became stronger and the inflation rates became negative, the CPI understated the MCPI by –0.13, –0.12, and –0.19 percentage points, respectively. Since 2000, the inflation rates are positive except for 2002, and the CPI overestimated the MCPI from 0.2 to 0.33 percentage points. Overall, China is facing the pressure of inflation.

Table 3. Inflation rates and substitution bias.

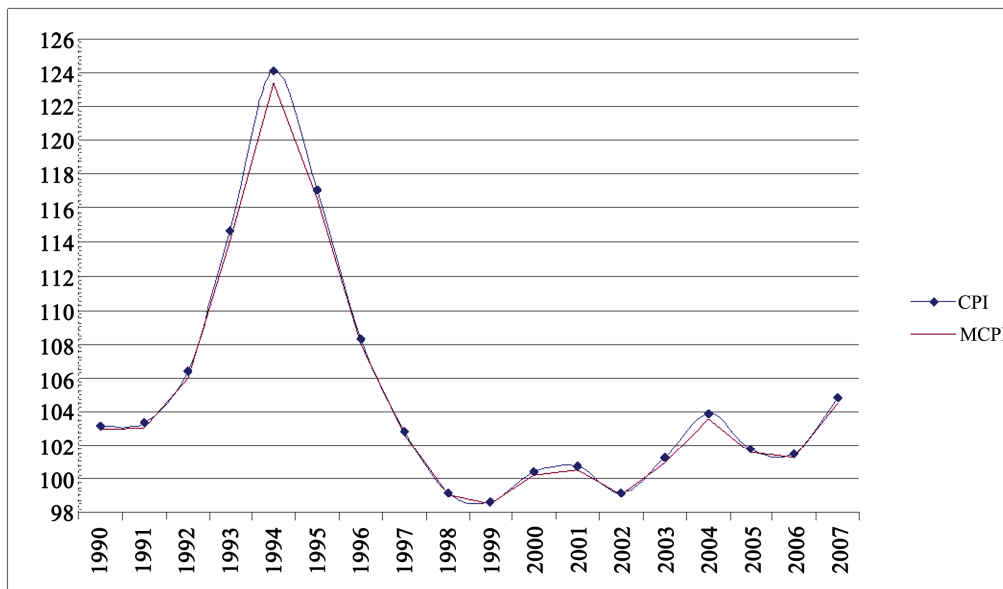| Year	CPI Inflation (%)	MCPI Inflation (%)	Bias (%)
1990	3.1	2.91	0.19
1991	3.4	3.1	0.3
1992	6.4	5.98	0.42
1993	14.7	14.16	0.54
1993	24.1	23.49	0.61
1995	17.1	16.64	0.46
1996	8.3	7.99	0.31
1997	2.8	2.6	0.2
1998	–0.8	–0.67	–0.13
1999	–1.4	–1.28	–0.12
2000	0.4	0.2	0.2
2001	0.7	0.5	0.2
2002	–0.8	–0.61	–0.19
2003	1.2	0.96	0.24
2004	3.9	3.57	0.33
2005	1.8	1.53	0.27
2006	1.5	1.21	0.29
2007	4.8	4.47	0.33

Figure 3. The CPI and the MCPI denote the consumer price index and the modified consumer price index, respectively.

Figure 3 presents the CPI and the MCPI. The higher inflation rate of the CPI than the MCPI is evident. From the results of **Table 3** and **Figure 3**, it is not difficult to see that the modified CPI method can make the bias decrease in certain extent.

4. Conclusions

In this paper, we only propose a modified CPI formula which combing with the GDP. This modified CPI formula can make the normal CPI decrease in certain extent. From the test results, we can see that this formula is interesting in some cases. Based on the model of this paper, we can get the following conclusions and extensions.

1) According to the data of National Bureau of Statistics of China (2008), it is not difficult to see that China is facing the pressure of inflation now although the Chinese government has drew up related policy.

2) The real GDP should be considered in this modified formula. The use of real GDP maybe make this method is more loser to the real inflation. We will also be very interested in researching conducted by other statistical agencies in this area.

3) The method of the CLI estimated should be studied, moreover the accordingly method is measured with the CPI and the MCPI.

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