INDEX NUMBERS IN THE CHINESE NATIONAL ACCOUNTS AND THEIR FURTHER DEVELOPMENT

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ABSTRACT

The paper introduces price indexes and methods of compiling them for Chinese GDP accounts at constant prices. The paper compares Chinese indices and national accounts results as they are released in the *China Statistical Yearbook*, with corresponding standard international terms, and discusses differences in their interpretation. In addition, the paper discusses some specific issues related to the current system of deflation methods of the National Bureau of Statistics, and makes some proposals for improved methods for measuring GDP at constant prices via the production approach, thereby increasing the international comparability of national accounts data and price statistics.

The paper comprises four sections: section one provides the background; section two describes price indexes as released in the *China Statistical Yearbook*, and analyses their relation to the corresponding indexes used internationally; section three introduces methods of compiling price indexes for the Chinese national accounts; section four discusses some of the problems associated with deriving GDP at constant prices via the production approach, and outlines the direction of future developments.

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1. Introduction

The growth rate of China's real GDP is an important indicator of the dynamics of the Chinese economy, and receives considerable attention. Although it is clear that the growth rate of real GDP can be derived from comparing GDP of adjacent years at constant prices, the derivation of GDP at constant prices or, more generally, the derivation of a volume index of GDP can be calculated with different methods. Hence, in order to understand the meaning of GDP at constant prices and to judge data quality and international comparability, it is very important to understand how price indexes are compiled and which index number formulae are used to deflate the national accounts.

As the production approach is the main accounting tool for levels and growth rates of the Chinese national accounts, this paper focuses on deflation methods for the production side of the accounts which dates back to 1985. Although the national accounts have become more detailed and comprehensive over time, the basic approach towards accounting and deflation was kept unchanged until 2004. In 2004, there was a significant change in the accounting method of industrial and agricultural value added at constant prices – two sectors that account for about 70 percent of GDP in China. For agriculture, single-indicator deflation methods is used to replace the former double-indicator combination method[1]. For industry, a single-indicator deflation method replaced the original extrapolation method with a single volume indicator. The comparison of results for agriculture and industry for the years 2001 to 2003 shows that changing the accounting method can greatly affect the growth rate of value added by up to 10 percentage points of the growth rate in some areas. In order to benchmark data obtained by new methods to historical data, the NBS decided that the revised data would be made available on a provisional basis but that the whole series of constant price data would be adjusted after the data from the 2004 economic census have become available.

Production-side GDP at constant prices is derived by separately deflating data for each industry and then aggregating these data. The industry classification follows the new edition of *The Standard Classification of National Economic Industry* (GB/T4754-2002). More details on the structure and contents of the production accounts are available from the *Handbook of GDP Accounting of China.*. The price indexes used for deflation come from various price indexes, which are compiled according to price statistics investigation designs from the Urban Survey Organization of NBS (USO) and the Rural Survey Organization of NBS (RSO). The designs in line with USO include the *Prices Investigation Design of Industrial Products, the Prices Investigation Design of Currency and Consumption, the Prices Investigation Design of Real Estate, and the Prices Investigation Design of Investment in Fixed Assets*. The frame in line with the RSO is the *Prices Investigation Design of Agricultural Produce (Table 1).*

The history of compiling price indexes in China is very short, except for consumer price indexes. Work on price indexes of agricultural means of production (by product) and of purchase price indexes of agricultural products (by product) began in 1995; work on producer price indexes of agricultural products (by industry) began in 2002; work on ex-factory price indexes of industrial products (by product and by industry) and work on purchase price indexes of raw material, fuel and power (by product) began in 1985; work on price indexes of investment in fixed assets (by product) began in 1994; work on real estate price indexes (by product) began in 1997. The availability and quality of Chinese price indexes is related closely to the introduction of a market economy in China. Before 1984, various prices of important materials were set by administrations and these prices were held unchanged for a long time, which severely limited the usefulness of price indexes. After 1985, the working of the price mechanism improved with the introduction of the dual-price system, where a commodity was transacted at both a market price and a central-planned price. Since then the functioning of price mechanism in allocating resource has become

[1] Former double-indicator combination method refers to that the output at constant prices is derived by using a volume indicator to do the extrapolation, while the intermediate consumption at constant prices is derived by using a price indicator to do the deflation.

more and more important, with the public paying increasingly attention to price changes and economic decisions about production and investment being increasingly governed by price trends and price changes.

Table 1 provides an overview of the key price indexes published in the China Statistical Yearbook:

Table 1 Price indexes released in *China Statistical Yearbook*

Price index	Break-down by
Price indexes of agricultural mean of production	Product
Ex-factory price indexes of industrial products	Poduct and by industry
Purchase price indexes of raw material, fuel and power	Product
Price indexes of land trade	Type of land
Price indexes of house sales	Type of house
Rental price indexes for houses	Type of house
Price indexes of investment in fixed assets — construction and installation —equipment, instruments and implementation —construction material costs and installation —price indexes of labour —price indexes of machine —price indexes of other investment expenditure	
Consumer price indexes —urban consumer price indexes —rural consumer price indexes —retail price indexes	 Product Product Product

2. Price Indices for deflation - overview

The discussion about price indices for deflation of national accounts is best conducted at three distinct levels. The first and most detailed level is the elementary level of the producer price indices that make up the basic deflators for the production side of the national accounts in China. We call elementary level the level of detail for price collection that does not comprise explicit weighting. The second, intermediate level is higher-level producer price indices. The main feature of this level is that it makes explicit use of weights in the construction of the price index. There are different ways how to construct weights and there are different index number formulae when it comes to using the weights in constructing the price index for a group of commodities. The result of levels one and two, established by price statisticians, is the set of price indices that national accountants then use, along with other information, to deflate current-price values of production and expenditure. This is the third level of aggregation and again there are different options for deflation of current-price values. In discussions about the index number formulae used in national accounts, this third level of aggregation is at stake. Index number formulae for the third level of aggregation may, or may not be the same as index number formulae for the second or first level of aggregation. For example, a country may be using a chain Fisher index formula for its price and volume indices in the national accounts, i.e. for the third level of aggregation. This does not imply that all the detailed price or volume indices that enter the process of deflation are themselves based on a Fisher index formula.

Our discussion of price indices and constant-price national accounts in China will make the distinction between the three levels of aggregation. We start out by looking at the intermediate level where the index number formulae for the producer price indices are discussed that enter the third level of aggregation. This is followed by a more detailed look at each of the price indices, including at the elementary level. Finally, we will jump to the third level and discuss how these indices feed into the deflation and which index number formulae are used for deflation.

3. Higher level price indices: index number formula

In the *China Statistical Yearbook*, price indexes appear in two forms: “Previous year = 100” and “Fixed base”. These two labels give sometimes rise to misinterpretation because they may be used differently in other countries. We therefore introduce the precise meaning of the concepts as they are used in Chinese statistics (‘Chinese style price indexes’ in what follows) and compare them to the index number formulae that are typical in the statistics of OECD countries.

Annual year-to-year price indexes in the *China Statistical Yearbook* are labeled as “Previous year = 100”. They are based a year-on-year monthly Young index that is averaged over every 12-months period. More specifically, the index is computed along the following formulae:

$$PY_{t/t-1} = \sum_{m=1}^{12} PY_{m,t} \,/12 \qquad (1a)$$

$$PY_{m,t} = \sum_{i=1}^{N} w_{t_b}^{i} \frac{PY_{m,t}^{i}}{PY_{m,t-1}^{i}} \qquad (1b)$$

$$w_{t_b}^{i} = \frac{P_{t_b}^{i} Q_{t_b}^{i}}{\sum_{i=1}^{N} P_{t_b}^{i} Q_{t_b}^{i}} \qquad (1c)$$

In expression (1a), $PY_{t/t-1}$ is the annual price change between year t and year t-1. This annual price change is an arithmetic average of the 12 monthly, year-on-year price indices $PY^{i}_{m,t}$ during the year t.

This monthly, year-on-year price index $PY^{i}_{m,t}$ in expression (1b) is a Young-type[2] index, i.e., a weighted average of price ratios $PY^{i}_{m,t} \big/ PY^{i}_{m,t-1}$ for i=1,2,….N products in the sample. The price ratios compare the price level of product i in month *m* and year *t* to the price level of the same product in the same month one year earlier. It is thus a year-on-year monthly index.

Expression (1c) defines the weights: they are the average annual value share of product in during the weight reference period t_b.

The *China Statistical Yearbook* also presents cumulative values of the year-on-year indexes in expression (1a). They appear under the heading *Fixed-base price indexes* and are computed in the following manner:

$$PY_{t/t_0} = \prod_{s=t_0}^{t-1} PY_{s+1/s} \qquad (1d)$$

The 2005 edition of the *China Statistical Yearbook* uses 1985 as the index reference year t_0. In general, t_0 will be different from the weight reference year t_b which, in the case of producer price indexes, is the year of the latest 5-yearly industrial census.

Several features distinguish this price index from the index number formulae that are typically used for producer price indices in OECD countries:

- the index number formula is based on an average of price ratios (the 'Young'-type);

- price relatives are measured between the same months of consecutive years and not between consecutive months of the same year as is typically the case elsewhere.

One notes also that the label *fixed-base price index* that is used by the Chinese National Bureau of Statistics to describe the cumulative price changes with regard to a reference year (expression (1d)) has quite a different meaning from the notion of fixed-base indexes that is commonly employed to describe Laspeyres or Lowe-type indices in OECD countries.

For comparison, consider the formula below which shows the index number formula that is most frequently used in OECD countries' producer price indexes. In general terms, a Lowe index between month *m* and month *m-1* of year *t* is a fixed basket index where the basket of goods or services is defined for period t_b (the weight reference period):

$$PL_{m,t/m-1,t} = \sum_i \frac{P^i_{m,t} Q^i_{t_b}}{P^i_{m,t-1} Q^i_{t_b}} \qquad (2a)$$

With a few transformations, the index number formula (2a) can be written in a form that resembles the Young index in (1b) where price relatives are weighted by their base-period share. Note, however, that the weights in this case are hybrid weights, where quantities of the reference period t_b are valued with the prices of period t-1 (expression 2c) and not with the prices of the reference period itself as in the case of expression (1c). One could also say that in (2c) weights have been price updated and in (1c) they have not

[2] For a more complete discussion of the Young index, see IMF et al. (2004).

been price updated.

$$PL_{m,t/m-1,t} = \sum_{i=1}^{N} v_{t-1,t_b}^{i} \frac{PL_{m,t}^{i}}{PL_{m-1,t}^{i}} \qquad (2b)$$

$$v_{t-1,t_b}^{i} = \frac{P_{t-1}^{i} Q_{t_b}^{i}}{\sum_{i=1}^{N} P_{t-1}^{i} Q_{t_b}^{i}} \qquad (2c)$$

On this topic, the International Producer Price Index Manual (IMF 2004) says:

> "Conceptually, a typical PPI may be viewed as a Lowe index that measures the change from month to month in the total revenue of an annual basket of goods and services that may date back several years before the price reference period. Because it uses the fixed basket of an earlier period, it is sometimes loosely described as a "Laspeyres-type" index, but this description is unwarranted. A true Laspeyres index would require the basket to be that purchased in the price reference month, whereas in most PPIs the basket not only refers to a different period from the price reference month but to a period of a year or more. When the weights are annual and the prices are monthly, it is not possible, even retrospectively, to calculate a monthly Laspeyres price index." (IMF, 2004, p. 232)

We conclude that neither the Chinese nor the typical OECD PPI is a true Laspeyres index. Both can be described as indices of the Young type but with the difference (i) that weights are not price-updated in one case and are price-updated in the other case and (ii) that one is a year-on-year monthly index whereas the other is a month-on-month index.

4. Price indices for national accounts in detail

At present, the price indices that are used to deflate the production side of the Chinese GDP include PPIs of agricultural products, ex-factory price indices of industrial products, price indices of house sales, price indices of investment in structures and installation, price indices of investment in other fixed assets, retail price indices, and consumer price indices. The methods of compiling price indices are introduced in this part of the document.

4.1 Price indices for agricultural produce

4.1.1 General

Statistical work on prices for agricultural products began in 1994, and the national RSO is in charge of compiling price indices. They are producer prices of agricultural products broken down by type of product and by industry. Producer price indices of agricultural products are year-on-year quarterly indices. Year-on-year quarterly price indices and cumulative quarterly price indices (from Q1 to current quarter) are compiled at the same time. The weights used in the process of compiling indexes are calculated by the sales of agricultural products in the weight reference period which is changed every five years. At present, the weight reference period is 2001.

Original data and cumulative data is reported from the regional RSO to the national RSO, with reporting time before the 25th day of last month of every quarter. Quarterly indices are published on the 25th day or 26th day of the month after the corresponding quarter, and annual indices are published on the 25th day or on the 26th day of the month after the corresponding year. At present, neither the *China Statistical Yearbook* nor the *China Monthly Economic Indicators* publish PPIs for agricultural products.

The survey covers wholesalers and retailers of agricultural products. The source for price data is records kept by farmers and interviews. The survey relates to quantities produced and sold of the main products of each unit. Main agricultural products are identified by way of a *Reference Catalogue of Agricultural Produce* that is benchmarked to The *Standard Classification of National Economic Industry* (GB/T4754-2002). The prices used in price collection are the value per product unit for agricultural producers when they sell their product directly.

4.1.2 Compilation process

The compilation process for PPIs for agricultural products is as follows:

First, representative products for investigation are selected according to the Reference Catalogue of Agricultural Products: in the latest version of the *Standard Classification of National Economic Industry* (GB/T4754-2002), there are 4 divisions at the 2-digit level, i.e. farming, forestry, animal husbandry and fishery, 14 groups at the 3-digit level and 31 classes at the 4-digit level. The *Reference Catalogue of Agricultural Produce* is linked by national RSO to the industry classification. Then, representative products can be selected from *Reference Catalogue of Agricultural Produce*. Representative products should cover 90 percent of all Classes so that PPIs of agricultural produce are representative for all kinds of agricultural products. Besides the coverage, other factors such as the importance for the national economy and for people's livelihood, the volume of output of products, the sales volume, stability, forecasting, and characteristics of region, should be taken into account in the selection of products. Once selected, the set of representative products is kept stable for five years. If there are special circumstances, such as a rapid change in the structure of products on the market, the set of representative products can be modified ahead of schedule, although representative products should at least be retained for one year. There are 180 representative products at the national level, and sales of these products account for more than 70 percent of total sales of agricultural products. When PPIs for agricultural products are compiled in every region, representative products are selected according to *Reference Catalogue of Agricultural Produce* but also with consideration of the local conditions. If some important products for local area are not included in Reference Catalogue of Agricultural Produce, these products should be reported to national RSO and can be used after obtaining uniform codes.

Second, a sample of units is selected in line with the Sampling Methods for Prices of Agricultural Products Survey.

Third, the actual calculation of the PPI for agricultural products takes place, along the following process:

Step 1: calculating price indexes of individual products for each unit

The price index between quarter q of year t and the same quarter of year t-1 of the representative product i in sample unit j, $PI^{ij个}_{q,t/q,t-1}$, is computed as follows:

$$PI^{ij个}_{q,t/q,t-1} = \frac{\overline{P}^{ij}_{q,t}}{\overline{P}^{ij}_{q,t-1}} \qquad (3a)$$

In expression (3a), $\overline{P}_{q,t}^{ij}$ is the average sales price of product i in unit j during quarter q of year t. The average price during the quarter is computed as the average unit value of the quarter, i.e., as the ratio between the value of sales and the total quantity sold during the quarter. Thus, if $V_{q,t}^{ij次}$ stands for the total value of sales of product i in unit j during quarter q, and $Q_{q,t}^{ij}$ is the total quantity of product i, the average price is given by $\overline{P}_{q,t}^{ij} = V_{q,t}^{ij次} / Q_{q,t}^{ij}$.

Step 2：calculating price indexes of individual products across units

The next step involves averaging across sample units. We call $PI_{q,t/q,t-1}^{i j次 j次}$ the average price index of product i across n sample units and compute it as an un-weighted geometric mean:

$$PI_{q,t/q,t-1}^{i j次 j次} = \sqrt[n]{\prod_{j=1}^{n} PI_{q,t/q,t-1}^{ij个}} \qquad (3b)$$

Step 3: aggregation of price indexes in the same class of products

To construct a price index of a class of products $PI_{q,t/q,t-1}^{小类}$, the price indexes of individual products are weighted by their respective shares in total sales:

$$PI_{q,t/q,t-1}^{小类} = \sum_{i} w_{t_b}^{i j次 j次} PI_{q,t/q,t-1}^{i j次 j次} \qquad (3c)$$

The weights for each type of product, $w_{t_b}^{i j次 j次}$ are calculated as the product share in total sales of the class of products during the weight reference year t_b. Appendix 2 shows how weights based on sales are derived and aggregated for divisions, groups, and classes.

Steps 4-6: aggregating price indexes to the level of group, division and total price index of agricultural products

The computation formulae of price indexes of group, price indexes of division, and total price indexes are same to that of price indexes of a class.

4.2 Prices Index of Industrial Products

4.2.1 General

Preliminary work on price indexes for industrial products began in 1984, and formal compilation started in 1985. From 1985 to present, the development process of works can be divided into three phases: 1985 to 1995, 1996 to 2000, and 2000 to present.

During phase I (1985-1995), the number of units supplying data increased and the scope of the prices collected was broadening. In 1985, there were 78 cities, 3000 corporations and more than 400 products (780 specifications), and in 1995, there were 114 cities, more than 5000 corporations and more than 400 products (1500 specifications). The frequency of investigation was monthly rather than quarterly. Collected prices were unit value prices. Data collection was based on a reporting system where corporations sent data to local statistical bureaus by way of report forms, and then aggregated report forms of corporations were sent to national USO by regional USO. The national USO is in charge of compiling price indexes of industrial products.

During phase 2 (1996-2000), the third edition of *Prices Investigation Design of Industrial Products* was accomplished. The number of units and the scope of investigation increased further: the number of products rose to 1,140 (3,120 specifications), the number of cities covered rose to 200 and the number of corporations involved rose to 10,000. Some adjustments for price indexes of industrial products were made following information from the third industry census in 1995. National USO had compiled the first edition of *Prices Investigation Design of Industrial Products* in order to standardize and improve statistical work about price indexes of industrial products. Main progress of phase 2 with regard to compilation methods was: (i) original data was sent by long-distance transmission, instead of report forms; (ii) the categories of centrally-planned prices, floating prices and market prices were cancelled from report forms, and unit value prices were sent directly; (iii) average price method was cancelled in the process of compiling price indexes of specification, and indexes method was adopted.

Phase 3 (2000-present): in 2001, the fourth edition of Prices Investigation Design of Industrial Products was accomplished. Some important technical modifications and improvements were made, and investigated products increased to 2,700 (6,000 specifications), the number of cities covered rose to 410 and the number of corporations involved rose to 50,000. At present, the new design covers 186 industrial groups, so the proportion of coverage reaches 94 percent of a total of 197 industrial groups and the proportion of production value reaches 95 percent of the total production value. Price indexes of industrial products are calculated before the 3rd day after the reporting month. Main progress of phase 3 includes: (i) the investigation of unit value prices for every month have been cancelled, and the investigation of time spot price at two time spot in a month has been adopted; (ii) weighted average method is not used to calculate price indexes, instead of geometric average method, which is to geometrically average all ex-factory price indexes of same specification (unweighted geometric average); (iii) the new edition of Prices Investigation Design of Industrial Products is put into practice from 2003; (iv) in 2002, China joined formally the GDDS data dissemination system of IMF. Some related information is sent to Dissemination Standard Bulletin Board (DSBB) of IMF.

Indexes compiled according to the Prices Investigation Design of Industrial Products include ex-factory price indexes of industrial products (by category and by industry) and purchase price indexes of raw material, fuel and power (by category). Ex-factory price indexes of industrial products are year-on-year monthly indexes, and at the same time year-on-year quarterly indexes and cumulative monthly and quarterly indexes are compiled (from M1 to current month or from Q1 to current quarter). Quarterly indexes (year-on-year annual indexes) are the simple average of monthly indexes of 3 month; annual indexes (year-on-year annual indexes) are the simple average of monthly indexes of 12 months. Weights are calculated in terms of sales of industrial productions during the weight reference period which is changed every five years. Up to present, weight reference periods have been 1985, 1990, 1995 and 2000. Initial weights are data from the second industries census in 1985. Because the frequency of industries censuses is once every 10 year, it is necessary to adjust weights with the help of special statistical data between 1985 and 1995. The second general adjustment for weights was made in 1995, which are based on the data of the third industries census. The adjustment of weights will be reconciled with the years of economy censuses in the future.

The price indexes of industrial products cover all industrial activities. The time of price collection is the 8th and 18th of each month, and prices used during price collection are selling prices per unit on the collection day. Price indexes of industrial products are monthly indexes, and the time of dissemination is on the 20th day after the corresponding month. The time of dissemination for annual data is on the 30th day after the corresponding year. The publications where producer price indexes of industrial products are released include *China Information*, *China Monthly Economic Indicators* and *China Statistical Yearbook.*

4.2.2 Computation

The compilation process of ex-factory price indexes for industrial products starts out with the selection of representative products and their specification. They are selected according to the Investigation

Catalogue of industrial Production, and corporations of investigated cities are sampled by probability proportional to size. In the latest survey designs, there are 2714 investigated products with 5,751 specifications, 415 investigated cities and 50000 investigated corporations. The survey sample will be updated every five years, and during the period, some adjustment may be made. The survey sample covers 186 groups of The Standard Classification of National Economic Industry (GB/T4754-2002), so the proportion of coverage reaches 94 percent of total 197 industry groups and the proportion of production value reaches 95 percent of total value.

Data are reported gradually from bottom to top and ex-factory price indexes of industrial products for Class, Group, Division and Section can be compiled respectively. This involves a number of steps.

In the first step, the average price during month m of year t, $\overline{P}_{m,t}^{ixj}$, of specification x of product i in unit j, is computed, based on two observations $P_{m,t,1}^{ixj}$ and $P_{m,t,2}^{ixj}$ of the ex-factory price:

$$\overline{P}_{m,t}^{ixj} = \frac{P_{m,t,1}^{ixj} + P_{m,t,2}^{ixj}}{2} \qquad (4a)$$

The month-to-month yearly index of the price of specification x of product i in unit j, $PI_{m,t/m,t-1}^{\text{ixj个}}$ is then:,

$$PI_{m,t/m,t-1}^{\text{ixj个}} = \frac{\overline{P}_{m,t}^{ixj}}{\overline{P}_{m,t-1}^{ixj}} \qquad (4b)$$

In a second step, prices of specification x of product i are aggregated across surveyed corporations by way of an un-weighted geometric average. This results in the average price change of specification x of the representative product i across *n* surveyed corporations, $PI_{m,t/m,t-1}^{ix,S}$:

$$PI_{m,t/m,t-1}^{ix,S} = \sqrt[n]{\prod_{x=1}^{n} PI_{m,t/m,t-1}^{\text{ixj个}}} \; . \qquad (4c)$$

Next, price indices for each product i are aggregated across specifications to yield the average price change of product i, $PI_{m,t/m,t-1}^{i,p}$:

$$PI_{m,t/m,t-1}^{i,p} = \frac{\sum_{x=1}^{X^i} PI_{m,t/m,t-1}^{ixs}}{X^i} \qquad (4d)$$

i.e. the price index of the representative product i is the arithmetic mean across the price indices of all X_i specifications of product i. Index computation continues with aggregating product-specific indices to price indices of an industry class, $PI_{m,t/m,t-1}^{c}$:

$$PI_{m,t/m,t-1}^{c} = \sum_{i} w_{t_b}^{i,p} PI_{m,t/m,t-1}^{i,p} \qquad (4e)$$

where $w_{t_b}^{i,p}$ is the share the representative product i in the sum of sales of all representative products in class c. The detailed methods for computing these weights are same as the methods for price indexes of

agricultural products. Further aggregation from class to group, from group to division, from division to section and from section to the total of the industry classification follows the same principle as aggregation to classes: price indices are weighted arithmetic averages where the respective shares in total sales constitute the weights.

4.3 Real Estate Prices Index

4.3.1 General

Statistical work on real estate prices began 1997, and the national USO is in charge of compiling these price indexes. In line with the *Statistical Prices Investigation Design of Real Estate*, price indexes of land transactions, price indexes of house sales and price indexes of renting houses are compiled. Collected prices are transaction prices of house property and land of activities units (real estate management organs of all levels, real estate developers, real estate agents, related corporations and corporations, governments and social organizations, and partial households). Prices of real estate are collected by combining key-point investigation and representative investigation. The manners of investigation are interview and report form. The frequency of investigation is once per month. Quarterly data are the sum of monthly data. Quarterly volume and sales can be obtained by summing up real trade numbers for three month of one quarter, and quarterly prices are the arithmetic average for sample prices of three month. The price indexes of real estate is compiled quarterly[3]. Original data and cumulative results are reported on the 5th after the corresponding quarter from local USO to national USO. The release time of quarterly data is on the 25th after the corresponding quarter and the release time of annual data is on the 30th after the corresponding year. At present, price investigations are only made in 35 cities, and the activities of real estate development and management in rural areas are not calculated. Investment in real estate of the 35 cities accounts, however, for more than 70 percent of total countrywide investment in real estate.

Prices indexes of real estate are divided into three sets of price indexes, i.e. price indexes of house sales, price indexes of house rents and price indexes of land transactions. The methods of compiling these sets of price indexes are similar because methods such as computation and accumulation gradually from bottom to top are also adopted. The computation process is from investigation item (specification) to basic classification (basic heading / product, Class, Group, Division) and finally to total indexes. Price indexes at the Group level are weighted harmonic averages of price indexes (item price indexes, Class price indexes, Group price indexes) of the corresponding level, and weights are based on sales of the corresponding level of aggregation at the current period. Division indexes and total indexes can be calculated by weighted arithmetic average formula with fixed weights. The detailed compiling methods will be introduced in next part with taking price indexes of selling houses for example.

4.3.2 Computation

Calculation starts out with the price index for an individual item, $PI^{i,s}_{q,t/q,t-1}$ computed as the ratio of the price of object i in quarter q of year t to its price in quarter q of year t-1:

$$PI^{i,s}_{q,t/q,t-1} = \frac{P^{i}_{q,t}}{P^{i}_{q,t-1}} \qquad (5a)$$

The price index for the basic heading of the classification $PI^{b}_{q,t/q,t-1}$ is a weighted harmonic mean of the price indices of all items in the same basic heading. The weights attached to each component,

[3] This is the case in 2004 when this paper is first written. However, since July of 2005, the price index of real estate started to be compiled monthly.

$W_{t-1}^{i} / \sum_{i} W_{t-1}^{i}$ constitute the share of each item in the total value of sales of last year.

$$PI_{q,t/q,t-1}^{b} = \frac{1}{\sum_{i} \frac{W_{t-1}^{i}}{\sum_{i} W_{t-1}^{i}} / PI_{q,t/q,t-1}^{i,s}} \qquad (5b)$$

Basic heading price indices are aggregated to class price indices $PI_{q,t/q,t-1}^{c}$ by forming a harmonic average, again with shares of each basic heading in total sales of the class of last year as weights:

$$PI_{q,t/q,t-1}^{c} = \frac{1}{\sum_{b} \frac{W_{t-1}^{b}}{\sum_{b} W_{t-1}^{b}} / PI_{q,t/q,t-1}^{b}} \qquad (5c$$

Similarly, the group price index PI_{i}^{g} is derived as a harmonic mean of the class price indices with shares of each class in total sales of the group of last year as weights:

$$PI_{q,t/q,t-1}^{g} = \frac{1}{\sum_{c} \frac{W_{t-1}^{c}}{\sum_{c} W_{t-1}^{c}} / PI_{q,t/q,t-1}^{c}} \qquad (5d)$$

Aggregation from group to division level is based on an arithmetic average:

$$PI_{q,t/q,t-1}^{d} = \sum_{g} \frac{W_{t-1}^{g}}{\sum_{g} W_{t-1}^{g}} PI_{q,t/q,t-1}^{g} \qquad (5e)$$

The above steps are identical for the division house sales, house rents, and land transactions. We shall label these three price indices at the Division level as $PI_{q,t/q,t-1}^{HS}$ (for house sales), $PI_{q,t/q,t-1}^{HR}$ (for house rents) and $PI_{q,t/q,t-1}^{LT}$ (for land transactions). The total quarterly, year-on-year price index for real estate $PI_{q,t/q,t-1}$ is obtained by forming an arithmetic average of the three component indices, each weighted by its share in total sales of last year:

$$PI_{q,t/q,t-1} = \frac{W^{HS} PI_{q,t/q,t-1}^{HS} + W^{HR} PI_{q,t/q,t-1}^{HR} + W^{LT} PI_{q,t/q,t-1}^{LT}}{W^{HS} + W^{HR} + W^{LT}} \qquad (5f)$$

The annual price index of real estate $PI_{t/t-1}$ is the simple arithmetic average of quarterly indexes, i.e.:

$$PI_{t/t-1} = \frac{PI_{1,t/1,t-1} + PI_{2,t/2,t-1} + PI_{3,t/3,t-1} + PI_{4,t/4,t-1}}{4}. \qquad (5g)$$

4.4 Prices Indices of fixed assets

4.4.1 General

Statistical work on fixed asset investment prices began in 1990, and USO of NBS are in charge of compiling these indexes. In line with the *Statistical Prices Investigation Design of Investment in Fixed Assets*, price indexes of investment in fixed assets, price indexes of construction and installation, price indexes of equipment and instruments, and price indexes of investment in other expenditure are compiled. Price indexes of investment in fixed assets are year-on-year Paasche indexes. They are compiled every quarter. The frequency of price collection is once per month. Quarterly data are cumulative data of corresponding months. The quarterly amount and value can be derived from the sum of the real exchange amount of the three months. Quarterly prices are the arithmetic average of sample prices of the three months of the quarter. The original data and collected results are transmitted to the USO of NBS from the regional USO on the 1st after the corresponding quarter. Quarterly indexes are released on the 25th day after the corresponding quarter, and annual indexes are released on the 30th day after the corresponding quarter.

Price investigation of investment in fixed assets begins with the corporations of construction, installation and decoration. For construction and installation, the price investigation includes the prices of main construction material, such as steel, wood, cement, electrical material, chemical material etc., which are bought in the current year and used for completed project and project under construction. These prices refer to purchase prices or settlement prices. Generally speaking, the sum of production value of the corporations in the sample accounts for 50 percent of the production value of construction and installation of the local region. For sample selection, in order to ensure the representativeness of price indexes of investment in fixed assets, one needs to consider the sampling coverage, the type of project, economic types of corporations, the importance of investment activity, the representative of investment activity and etc. For other fees, the content of price investigation includes the residual between the production values of construction projects under construction of sample corporations at current period and production values of construction and installation projects, i.e. 24 items of fees in the financial system. The selection of spots and prices for the construction and installation and the selection of spots and prices for other fees are conducted respectively.

For price investigation of fixed assets investment, the processes of sample selection from construction and installation corporations are: firstly, to find construction corporations (partner A) based on the catalogue of national and regional important projects, and then to select construction units (partner B). For fixed assets investment price investigation, the principle and process of selecting sample spots for the other fees is generally the same as the sample corporations' selection of construction and installation. But in practice, as it is not easy to obtain the data of other fees, it is necessary to use key-point investigation and specific investigation or to obtain data from corporations' accounting departments.

The method of compiling price indexes of fixed assets investment is as follows: the price index is decomposed into three kinds of price indexes, i.e. price indexes of construction and installation (investment), price indexes of equipment and instruments (investment), and price indexes of other fees, and then the total price indexes of investment in fixed assets can be derives by taking the average of the three indexes. The detailed methods of compiling the three decomposed price indexes of the fixed assets investment are introduced below.

4.4.2 Computation of price index of construction and installation

For construction and installation, material, labour and machine usage account for over 90 percent of all costs, so the average of corresponding price indexes of the three fees can be looked at as a price index of construction and installation. The methods of calculating the three fees are similar, which are calculated by gradually aggregating data from bottom to up. As an example, the methods of calculating price index of material fee will be introduced in the next part.

The process starts with price indices for a specification of some kind of material, $PI^{i,s}_{q,t/q,t-1}$. They are computed as the harmonic average of the price indices of a specification in all projects that are surveyed ($PI^{ij,s}_{q,t/q,t-1}$). Current weights for each project are based on the purchase value of a particular material with specification i in surveyed project j, $W^{ij}_{q,t}$:

$$PI^{i,s}_{q,t/q,t-1} = \frac{1}{\sum_j \frac{W^{i,j}_{q,t}}{\sum_j W^{i,j}_{q,t}} / PI^{ij,s}_{q,t/q,t-1}} \qquad (6a)$$

Aggregation across specifications for a particular type of material is carried out by way of an un-weighted arithmetic average across the price indices of the *n* different specifications. The formula for this price index at the basic heading level is:

$$PI^{b}_{q,t/q,t-1} = \frac{1}{n}\sum_i PI^{i,s}_{q,t/q,t-1} \qquad (6b)$$

The price index of material $PI^{c}_{q,t/q,t-1}$ is the weighted harmonic average of the price indices of all kinds of materials. Weights are based on the purchase value $W^{b}_{q,t}$ of all kinds of materials in the surveyed projects during the current period.

$$PI^{c}_{q,t/q,t-1} = \frac{1}{\sum_b \frac{W^{b}_{q,t}}{\sum_b W^{b}_{q,t}} / PI^{b}_{q,t/q,t-1}} \qquad (6c)$$

There are many kinds of material, which are consumed in the construction and installation, so it is impossible to calculate one by one. In practice, the main materials are selected, such as steel, wood, cement, electrical material and chemical material that also have great values. The total value of selected material should amount for more than 70 percent of all the expenditure on material. The unit price of the material includes transportation fee and commission charge of the distribution department. The type of weights used in price indexes of investment in construction and installation is direct weight, and there is no distributed proportion process such as the one shown in appendix 2.

The same principle as for material can be applied to calculate the price index of manpower and the price index of machine fee. After separately getting the price index of material fee, the price index of manpower fee and the price index of machine fee, the total price index of construction and installation $PI^{建安}_{q,t/q,t-1}$ can be calculated by a weighted arithmetic average. The formula is:

$$PI^{\text{建安}}_{q,t/q,t-1} = \frac{W^C_{q,t} PI^C_{q,t/q,t-1} + W^H_{q,t} PI^H_{q,t/q,t-1} + W^M_{q,t} PI^M_{q,t/q,t-1}}{W^C_{q,t} + W^H_{q,t} + W^M_{q,t}} \qquad (6d)$$

where $PI^C_{q,t/q,t-1}$ is the price index of material, $PI^H_{q,t/q,t-1}$ is the price index of labour, and $PI^M_{q,t/q,t-1}$ is the price index of machine usage.

5. GDP at constant prices: problems and further improvements

There are several issues associated with the price indices above when they are used to deflate national accounts. Problems include differences in index number formulae between China and other countries, a product catalogue that needs updating, as well as weights that may need more rapid updating to reflect substitution processes; there is little quality adjustment and seasonal adjustment. Partly this is due to a shortage of statistical personnel in China who have to deal with a heavy burden from sampling, price collection, investigation, reporting and etc. Of particular concern is the use of judgmental samples instead of random samples which is at variance with principle of statistical inference, and could generate biased results.

Secondly, the coverage of the indices compiled is not perfect. At present, there is a large gap in China's price index system. For example, producer price index of services industry (output), and price index of services of foreign trade are not compiled.

Thirdly, the process of compiling price indexes does not match with the national accounts. There is some difference between the prices collected for indices and producer price and the prices defined in the national accounts. So GDP at constant prices by production approach and GDP at constant prices by expenditure approach that are calculated based on such price indices may not meet conceptual requirements for deflation.

For GDP accounts at constant price, the following problems exist:

The level of aggregation at which national accounts are deflated is relatively high, and the price indices used for that purpose may not be adequate, especially in the services industry. There, producer price indexes are substituted by the respective components of the consumer price indexes, and the price indexes are not adjusted for the differences in valuation, taxes etc. All these problems will affect the accuracy of GDP at constant price by a great extent.

Furthermore, there is only limited time consistency in series of GDP at constant price. During the last 20 years, the system, the scope and classification standard of national accounts and especially base data have improving constantly. Sometimes, the introduction of changes in accounting methods led to large fluctuations in real growth rates, reflecting breaks in series due to methodology changes. For example, in 2004, the transformation in the accounting methods of industrial and agricultural value added at constant prices by the production approach resulted in a great difference in growth rates between new and old methods. Before 2004, industrial value-added at constant prices by production approach had been calculated by a single-volume index extrapolation method, and volume index used in extrapolation method had been a fixed-base Laspeyres output index. According to index number theory, because of the substitute effect, Laspeyres output index will underestimate the growth rate of industry output as time passes. And the price index used in the new method is similar to a Laspeyres price index with a fixed base, so there is a possibility of overestimating the growth rate of industry value-added obtained indirectly. On the other hand, under the situation that intermediate consumer price index is far above output price index, the use of single-indicator deflation method will increase the overestimated extent of industrial growth rate. Therefore, from this point of view, the transformation of the accounts method of industry value-added at constant price will lead to the great change of growth rate. Because of the change of accounts method, the incompatibility of historical data should be taken into account when historical GDP data are revised.

In addition, there is potential mixed base period problem for GDP at constant price by production approach. GDP at constant price by production approach is calculated by departments, and the accounts methods used by different section are also different. These methods include extrapolation, deflation， and mixed methods. Under this situation, the base periods of different indexes will affect the data of GDP at constant price. Therefore, once base periods used by different indices are different, the aggregated GDP at constant price becomes mixed base period data. The real meaning of constant prices becomes unclear. So the reform of different price indexes must match with each other in order to reduce the influence of mixed base period. In addition, the updating frequency for base period of GDP at constant price (once per 10 year) and price statistics (once per 5 year) is different. How to link this is also a problem that should be considered.

Thirdly, international comparability of GDP at constant price is limited. This is caused partly by the problems that exist in the process of calculating GDP at constant price by production approach, and partly by price indexes used in the accounts at constant price that can't be compared internationally. In addition, during the compiling process, the adjustments about quality of price indexes are made, which will lead to overestimate growth rate of GDP.

Fourthly, the use of single-indicator price index deflation method predicates that the fluctuation trend and range of the output prices and intermediate input prices is same. In practice, the assumption above is not correct. Hence, in order to improve the credibility of GDP at constant price, a double-deflation method should be used. If price indices cannot meet the qualification, single volume index extrapolation should be used, because it is a reasonable assumption that the structure of output at constant price is relatively stable.

In order to solve the problems above, some improvement should be made in GDP accounts and price statistics:

- GDP accounts at current price have to be improved in terms of their scope and in terms of the quality of current price calculations in order to reform statistics system. The national accounts and specialty accounts should be considered as a single entity in terms of methods and design. Specialty system improvement should be made with the condition of consistency with the whole national accounts system, and the problems on specialty statistics should be solved in order to provide a stable base for current price calculation.

- Dividing GDP accounting at current price, and designing the frame system of GDP accounts and input-output accounts. Price indices that match with the national accounts should be compiled, and especially, the work of compiling price index of services production and price index of foreign trade should be improved. The method of compiling price indexes should meet the international standard as soon as possible. It is necessary to compile fixed base index， annual change index calculated indirectly, and chain indices, and these indices should be consistent with the meanings of standard term. At the same time, the research on index theory should be strengthened, and the achievements of index number theories and the experience of other countries should be absorbed as much as possible. At the same time, methods have to be adapted to the Chinese situation. Under the situation that China's production and consumption structures change rapidly and that prices fluctuate greatly, it is reasonable for these ideas that fixed base price index be compiled first and then are replaced by chained price index with adequate comparability and research.

- Price indices should be reformed consistently. Otherwise the problems of mixed base period will be amplified when price indices are used to deflate GDP. If some indices change their base period every 5 years, and others once per year, if some indices are compiled according to internationally recommended methods, and some indices are not, this will have negative effects on real GDP measures.

- More attention should be paid to breaks in series of real GDP so as to better capture the development of the national economy.

- Documentation of national accounts at constant prices and methods of compiling related indices should be strengthened to ensure that metadata are precise, timely and comprehensive.

Appendix 1

Estimation Method for Production-Oriented GDP at Constant Prices by Industry

Industry	Estimation methods	Price index or volume index
Farming, Forestry, Animal Husbandry and Fishery	single-indicator deflation method	Output Price index.
Industry	single-indicator deflation method	Output price index, adjusted by the price change of raw materials.
Construction	single-indicator deflation method	Based on "price index of construction and installation" in the price index of investment of fixed assets，and adjusted to the difference of price index of manpower fee and material fee.
Services for Farming, Forestry, Animal Husbandry and Fishery	single-indicator deflation method	Service price index of consumer price index
Geological prospecting and water conservancy	single-indicator deflation method	Service price index of consumer price index
Transport, Storage, Post and telecommunication Services	Single-indicator extrapolation method	Transport and Storage： index of turnover for passenger and freight transportation; Post and telecommunication services： index of total amount of post and telecommunication services.
Wholesale and Retail Trade and Catering Services	single-indicator deflation method	Retail price index
Finance and Insurance	single-indicator deflation method	Weighted average of consumer price index and fixed assets investment index， weighted by the proportion of final consumption expenditure and gross capital formation
Real Estate	single-indicator deflation method	Value-added of real estate: price index of sales of dwellings; Value-added of real estate management: consumer price index; Depreciation of new owner-occupied dwellings: price index of investment; Depreciation of old owner-occupied dwellings: derived by adjusting the depreciation of owner-occupied dwellings at constant prices of the previous year.

Social Services	single-indicator deflation method	Net value-added: service price index of consumer price index, especially focusing on bus ticket, hairdressing fee, repairing and other service fees; Consumption of fixed capital for "old" assets: derived by adjusting the consumption of fixed capital at constant prices of the previous year; Consumption of fixed capital for newly increased fixed assets in the accounting period: price index of investment of the accounting year.
Health Care, Sports and Social Welfare	single-indicator deflation method	Net value-added: price index of service in consumer price index (especially price index of health care), Consumption of fixed capital for "old" assets: derived by adjusting the consumption of fixed capital at constant prices of the previous year; Consumption of fixed capital for newly increased fixed assets in the accounting period: price index of investment of the accounting year.
Education, Culture and Arts, Radio, Film and Television	single-indicator deflation method	Net value-added: price index of service in consumer price index, especially price index of culture, entertainment, education expenses etc.; Consumption of fixed capital for "old" assets: derived by adjusting the consumption of fixed capital at constant prices of the previous year; Consumption of fixed capital for newly increased fixed assets in the accounting period: price index of investment of the accounting year.
Scientific Research and Technological Services	single-indicator deflation method	Net value-added: price index of service in consumer price index; Consumption of fixed capital for "old" assets: derived by adjusting the consumption of fixed capital at constant prices of the previous year; Consumption of fixed capital for newly increased fixed assets in the accounting period: price index of investment of the accounting year.

Government Agencies, Parties and Social Organizations	single-indicator deflation method	The same as above
Others	single-indicator deflation method	The same as above

Source：

1. Xu, Xianchun, China's Gross Domestic Product Estimation, *Economics (Quarterly)*, volume 2 NO.1, October, 2002.
2. Xu, Xianchun, Research on Service Estimation and Current Issues, *Statistical Research*, July, 2004.

Appendix 2:

Illustrative Description of Weights Estimation for Producer Price Indices of Agricultural Products

Classification and items	Code	Sales (10 thousand yuan)	Weight of division	Ratio of group in division‰	Weight of group	Ratio of Class in group‰	Weight of class	Ratio of product in class‰	Weight of product
		1	2	3	4	5	6	7	8
Farming, Forestry, Animal Husbandry and Fishery	A	10,372,675							
(Sum of division)	B	10,372,675	1000						
1 Agriculture	C	4,209,775	405.85						
(Sum of group)	D	3,541,643		1000					
1.1 Cereal and other crops	E	1,369,544		386.7	156.94				
(Sum of class)	F	1,368,891				1000			
1.1.1 Cereal	G	872,566				637.43	100.4		
(Sum of production)	H	859,569						1000	
1.1.1.1Wheat	I	11,749						13.67	1.37
1.1.1.2 Rice	J	840,589						977.92	97.83
1.1.1.3 Corn	K	7,231						8.41	0.84
1.1.2 Tubers	L	227,121				165.92	26.04		
1.1.3 Oil-bearing crops	M	85,877				62.73	9.85		
1.1.4 Beans	N	71,648				52.34	8.21		
1.1.7 Sugar	O	28,331				20.7	3.25		
1.1.8 Tobacco	P	83,348				60.89	9.56		
1.2 Vegetable, gardening	Q	1,039,272		293.44	119.09				
1.3 Fruit, nut, drink, spicy	R	1,132,827		319.86	129.81				
2 Forestry production	S	822,932	79.34						
3 Animal Husbandry production	T	2,081,790	200.7						
4 Fishery production	U	3,258,178	314.11						

B1=C1+S1+T1+U1 C2=(C1/B1)*1000 G6=(E4*G5)/1000

D1=E1+Q1+R1 E3=(E1/D1)*1000 I7=(I1/H1)*1000

F1=G1+L1+M1+N1+O1+P1 E4=(C2*E3)/1000 I8=(I7*I6)/1000

H1=I1+J1+K1 G5=(E1/F1)*1000

Source: *Price Survey Plan of Agricultural Products*, Rural Survey Organization of NSB, August 2003.

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