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Abstract

Many scholars of the Chinese economy have concluded that official estimates of China's GDP growth rate are too high. Journalists have popularized this view, but we disagree. We use a method that examines several strategic indicators that are suggested by basic social accounting principles and conclude that principal components of these indicators reflect the movement of official estimates of the Chinese economy. This conclusion holds whether one uses annual, quarterly or monthly indicators. It cannot be claimed that we have proved that GDP as officially measured is correct. No one knows the correct estimate; that is the whole point of showing how different such estimates can be, depending on how they are calculated, and this is true the world over. Our estimates survive diagnostic tests, within-sample interpolations and outside-sample extrapolations in monthly, quarterly, and annual time frames. It is reasonable to expect that introduction of quality adjustments will justify higher estimates.

JEL Classification: C51, C82, O53

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1. Introduction

There is always uncertainty in connection with the estimation of a country's GDP and its rate of growth. There are problems of concept, missing data, incorrect reporting, sampling error where complete enumeration is not achievable, inconsistency of "mirror" statistics, and other pitfalls (Fixler and Grimm [1], Grimm and Parker [2], Young [22]). The focus of the present investigation is the estimation of the annual growth rate of China's GDP and response to various critics who claim that recent reports are too high.

Skepticism about official statistics is nothing new (Movshuk [11]). Rawski's highly controversial article generated heated debates over Chinese statistics. Rawski [14], based on decreasing energy consumption, makes the claim that GDP growth rates during 1997-2000 are overestimated and might even be negative in 1997-1998. Lardy [9] argues that even though energy consumption was declining there were substantial increases in government revenues and imports. Discussions are taken up by Rawski [15,16], Rawski and Xiao [17], and Meng and Wang [10]. Various aspects of Chinese statistics have been studied by researchers to understand possible deficiencies and sources of problems. Scharping [18] argues that population statistics are defective, largely due to the one-child policy and increasing mobility in the country. Sinton [19] states that energy statistics were probably relatively good in the early 1990s, but that their quality has declined since the mid-1990s. The major reason for this is the decline of the portion of economic activity within the control of government. This is especially the case for coal which is the dominant form of commercial energy. Wiemer and Tian [21] refer to increasing private ownership and indicate the requirement for relying on sample survey methods rather than comprehensive reporting, which was the system for a state-

dominated economy. Holz & Lin [4] warn about the 1997-1998 break in industrial statistics which was due to the scope of enterprises covered and the enterprise classification system. Kojima [8] deals with the problem of shifting from MPS to SNA, and the coverage of the services sector. Keidel [5] proposes having expenditure accounts to strengthen accuracy for national income statistics of China. The National Bureau of Statistics recognizes the need to improve the present statistical system and tries to make it internationally more comparable (Zheng [23]).

The goal of this paper is not to go into the discussion of reliability of Chinese statistics, but to present a method which uses several indicators and examines if these independent indicators and published GDP growth rates are mutually consistent or not. The paper is organized as follows: A brief discussion of national income and product accounts is given in the next section. The principal components methodology is discussed in section 3. Empirical results based on annual, monthly and quarterly data are presented in section 4. The following two sections deal with two important issues, namely GDP growth and level, and adjustment for quality change. Major conclusions are stated in the final section.

2. National Income and Product Accounts (NIPA)

First, let us consider some accounting issues, especially the facts that GDP measurement for any large and complex industrial economy is inherently difficult. There are at least three well-known accounting approaches to GDP measurement, and it is equally well-known (for several decades) that they rarely provide the same results.

Method 1. GDP is the sum of final purchases. This is known as demand-side estimation and happens to be the officially favored method for the USA, but not for all nations. It finds textbook expression in the accounting definition.

$$\text{GDP} = C(\text{consumption}) + I(\text{investment}) + G(\text{gov't purchases}) + X(\text{exports}) - M(\text{imports})$$

In input-output accounting, it is usually displayed in the form of column sums of a rectangular matrix at the right hand side of the square inter-industry delivery matrix.

Method 2. GDP is the sum of income payments to the original factors of production.

It also is expressed in textbooks as

$$\text{GDP} = W(\text{wages}) + IN(\text{interest}) + P(\text{profits}) + R(\text{rent/royalty}) + IT(\text{indirect tax}) - S(\text{subsidies})$$

In input-output accounting it is usually displayed as row sums of a rectangular matrix across the bottom of the square inter-industry matrix. In principle, this method can be implemented, sector-by-sector, in the I-O accounts, but for the US is computed for the macro economy every quarter.

Method 3. GDP is the sum of value-added across all sectors of production. Value-added is written as

$$\text{GP}(\text{gross production}) - \text{IP}(\text{intermediate production}) = \text{VA}(\text{value added})$$

If all statistical reports were accurate and if all economic agents were cooperative respondents or reporters, these three methods should give identical estimates. A very

recent discrepancy between Method 1 and Method 2 for the USA, 2001, fourth quarter has been estimated at -\$186 billion (seasonally adjusted annual rate). While this is a small percentage of the (unknown) total GDP of the USA, it is a very, very significant amount. It is as large as many important national policy initiatives that are meant to stabilize the economy. It does not go away, and it is not a random series. It has a well-established serial pattern and is closely correlated with important economic variables.¹ The nonrandom serial correlation found in data of the discrepancy between different measures of GDP for the USA has been found in other national data, but not always between Methods 1 and 2, but sometimes between 1 and 3. Some countries do not have full statistics for Method 2.

It should be noted that there are similarities between Methods 2 and 3; they both aim for estimates of value-added, but Method 2 could do this on an individual sector or industry basis, and Method 2 uses direct estimates of factor payments, while Method 3 derives factor payments (total or by sector) as a residual. It gets to value-added indirectly.

This digression into different methods is to show, and to emphasize, that perfectly sensible approaches can provide estimates of GDP that differ by 1 or 2 percentage points, and since the discrepancy fluctuates, these differences in levels can affect “spells” of movement in growth rates.²

¹ See L.R. Klein and J. Makino [6]. James Kilpatrick and Allen Shaw have made interesting and innovative use of the statistical discrepancy, by allocating it to particular entries in China’s national accounts in an unpublished paper. They estimate that Chinese figures overstate growth by somewhat more than 2 percentage points.

² In the 1997 Economic Report of the President, the Council of Economic Advisers pointed out that growth and labor productivity measurement were significantly more favorable from the income than from the expenditure side of the National Income and Product Accounts (NIPA).

China, at the time of early reform, 1978-1980, was just shifting from net material product to gross domestic product i.e. from Marxist to Western accounting. For their participation in Project LINK, Chinese econometricians made special efforts to estimate GDP as total values and not as refined constructs from input-output tables. Within LINK, we used the approximations to GDP that were given to us and also received guidance from Irving Kravis, who was gathering data for international comparisons in connection with the visit by the delegation of American economists under the auspices of the US National Academy of Sciences, American Council of Learned Societies, and the Social Science Research Council (the original sponsor of Project LINK). We had excellent rapport with statisticians from the Chinese Statistical Offices, who could fully appreciate the measurement needs for econometric analysis.

Since Project LINK encountered similar problems with Soviet data and also had to convert from the concept of NMP to GDP, it may be fruitful to consider an extension of the original work of Sovietologists who were very inventive in studying the quantitative dimensions of the USSR. The scholars of the economy of the USSR used many proxies to get at Soviet aggregative measures. For output, they used volumetric statistics on coal, electricity, transportation, agricultural yields, and similar magnitudes. LINK regularly received excellent and helpful harvest estimates for grains, well in advance of forecast calculations for world economic activity.

3. Methodology - Principal Components

The use of principal component analysis has figured prominently in this report. It is a technique that has been used a great deal in psychology and closely related social sciences to gain information on latent variables, such as intelligence measurement among individuals, based on identifiable characteristics and also for the purpose of data reduction. In econometrics, it has been used for reduction of large data collections into more manageable form, especially to deal with problems of multicollinearity and shortage of degrees of freedom.

The principal components are estimated linear functions of the whole set of indicators that we choose to represent the movement of the economy as a whole. They can be considered as a canonical form. There are potentially as many principal components as there are indicators that we select. The components are mutually uncorrelated, thus dealing with the possible indeterminate regressions on many (15 or more in our case) indicators that deal with highly interrelated features of the whole economy. These components are chosen to “explain” as much of the joint variation of the indicator variables as is possible, by maximizing the variances of the linear functions of the variables, in sequence, subject to their being mutually uncorrelated

If we write for the j-th principal component

$$PC_{jt} = \sum_{i=1}^{15} \gamma_i I_{it}$$

our procedure can be stated as one that estimates regression relationships between the specific economic variables that we want to project and the principal components, which, in turn, are based on the primary indicators.

$$G_t = \sum_{j=1}^n \alpha_j PC_{jt} + e_t$$

$n < 15$, is the subset of principal components that are found to be significantly related to G_t , a magnitude that we are trying to project (GDP growth rate).

e_t = random error.

Simultaneously, in estimating the coefficients in the above relationship we also represent e_t as an ARIMA process

$$e_t = \sum_{j=1}^k \rho_j e_{t-j} + \sum_{j=1}^k \lambda_j u_{t-j}$$

where both e_t and u_t are independent random variables. The “noise” in this process comes from e_t .

A very early use was introduced into econometric analysis by Richard Stone [20]. He used time series of separate group entries in the US NIPA of the 1940s, and earlier, covering both the expenditure and income sides of the accounts. He extracted the first three principal components identifying one as National Income (NI) (the contemporary aggregative concept), one as change in NI, and one as chronological trend. He made this identification by examining the relative sizes of coefficients and by empirical correlation of components with the explicit aggregates. The main aggregate was implicit in the analysis, as the sum of income components. He made no attempt to deal with the statistical discrepancy between total outlay and income.

Stone was able to make some inferences about headline aggregates, which are analogous to those that have been frequently examined in appraisals of the Chinese economy, namely, levels and rates of change of GDP, in line with the objectives of our present investigation. We, however, transformed all variables, both the headline

statistics; as well as the individual indicator statistics; these transformations helped to deal with trend problems in residual error. Our objective has been to isolate “white-noise” residual variation from the “signal”.

Another motivation for using principal component analysis is our general point of view that a country’s (any country’s) economic growth is highly multivariate. No single measured economic activity can account for anything as complex as a modern economy, especially one as large as China’s economy. We examined many time series, selected those that seemed to have a priori importance (leaving us with 15) and only 20 annual data points. In order to conserve degrees of freedom we narrowed the list of right hand side variables in the regression to no more than four (principal components). This has been an important motivation in adopting the principal component methodology. What is more, these components account for a high degree of variation of the total set. Also, by construction, the components are mutually uncorrelated; therefore we can handle the multicollinearity problem from a statistical point of view. Each component depends, in some way or another, on the whole set of indicators, yet their intercorrelation, which is naturally high, does not confound the interpretation of the regression estimates, and we have plausible associations between GDP growth and individual indicator growth, as shown by estimates in Table 1.

In a recent paper, the Indian statistician and econometrician, A.L. Nagar, with Sudip Ranjan Basu, has suggested the use of principal components to investigate human development, much as UNDP estimates its “Index of Human development”. Nagar and Basu [12] measures various indicators, beyond the UNDP listing, across countries, and extracts principal components. He then forms weighted averages of the components,

with weights being the eigenvalues of the principal component analysis. He then declares that this weighted value represents human development, different for each country because the country indicators are different. He does not have a measured quantity, such as GDP growth rate estimates, to correlate with the principal components. That is the meaning of the term latent variable analysis. To a large extent, we have followed the pathways laid out by Stone and Nagar, but we have adapted their methodology to the specific case of estimating China's economic growth rate.

4. Empirical Results³

To study Chinese GDP from a fresh angle and test the consistency of China's GDP estimates with independent information, we assembled annual statistical series for the following magnitudes (data are available in Klein and Özmucur [7]):

electricity (kwh)	employment share of tertiary sector (%)
coal (tons)	grain output (tons)
oil (tons)	exports (const. \$)
steel (tons)	imports (const. \$)
freight (ton * km)	government spending (deflated)
civil aviation (ton*km)	real wage
long distance telephone calls (mill)	inflation rate (cpi)
	livestock products (tons)

This gave us coverage of energy, transport, communications, labor, agriculture, trade, public sector, wage, inflation. Both the supply side, the demand side, and market mechanisms are featured in this array. In lieu of building a fresh macro model of the Chinese economy, we got very broad coverage in the form of a semi-reduced form. We estimated principal components (PC_{it}) from annual data, 1980-2000, for these 15 indicators.

The first three components account for 60.8% of the overall variance of the whole set. In addition, the 9th component accounts for another 2.6%, and has a large coefficient of oil in the corresponding eigenvector. A regression estimate of percentage change in GDP (the statistic in question) provides the following result (Equation 1, Figure 1). Each principal component is a linear combination of the 15 indicator variables listed above, each variable being expressed as an annual percentage change.

³ Eviews 4.1 by Quantitative Micro Software is used in calculations, QMS [13].

Equation 1: Annual growth in GDP, 1981 – 2000

$$\text{GDP} = 9.386 + 1.360 \text{ PC1} - 0.679 \text{ PC2} - 1.030 \text{ PC3} - 0.543 \text{ PC9} + 0.981 \text{ MA}(1)$$

(15.06) (4.11) (-3.42) (-3.88) (-2.27) (22.12)

Adjusted $R^2=0.766$, D.W.=2.15, F=13.4, SEE=1.56, Q (2)=2.24, LM(2)=2.26,
ARCH(1)=0.60, J-B=0.27, n=20

How can one interpret this numerical statistical finding? The principal components reflect, in a generalized sense, the movement of 15 broadly based measures of the Chinese economy, collected quite independently from diverse sources. The movements of these summary indicators, the principal components, are consistent with the movements of real GDP growth rate as officially estimated. It cannot be claimed that we have proved that GDP growth rate as officially measured is correct. No one knows the correct estimate; that is the whole point of showing how different such estimates can be, depending on how they are calculated, and this is true the world over.

Not only are the movements of GDP and the combination of PC values highly correlated, but the relevant regression estimate has serially uncorrelated errors (according to Durbin-Watson, Ljung-Box-Pierce Q statistics and Breusch-Godfrey LM tests). Also there is no apparent autoregressive conditional heteroskedasticity (ARCH) of residuals and the correlogram of residuals from the regression is confined to narrow bands. Residuals are also normally distributed according to a low Jarque-Bera statistic. There are no systematic errors (Figure 1a).

It should be noted that large error terms are estimated for 1989 and 1990, just as they should be, given the enormous halt in activity that was readily visible (on the scene and in the statistical data) following the civil disturbances of that period.

The coefficients of the regressions and in the eigenvectors are both positive and negative, but as we have calculated in Table 1, they are all positively related, at the margin, to GDP growth rate.

The equation may perform well in the sample period. The question is whether it performs as well in the post sample period. Therefore, the equation is estimated using 1981-1990 data, and the GDP growth rate is extrapolated to 1991; then this equation is estimated using 1981-1991 data, and GDP growth for 1992 is extrapolated. This is continued up to 1999, and an extrapolation for 2000 is obtained. Results are given in Figure 1b. In general errors are quite small with the exception of three years: 1996, 1998 and 1999. The difference between the actual GDP growth and that extrapolated by this model is 4.2% in 1996, and 3.5% in 1998. The difference is 4.3% in 1999, and only 1.5% in 2000.

It may be argued that 20 annual observations are too few. Others may argue that there is a structural break in the early 1990's, and a single equation estimated for the entire 1980-2000 period may not be an accurate representation. In order to respond to those criticisms, we have also used monthly and quarterly data.

There are twenty monthly indicators used in calculating principal components.

These indicators are:

- Real retail sales (year-on-year growth)
- Production of motor vehicles (year-on-year growth)
- Steel production (year-on-year growth)
- Output of steel products (year-on-year growth)
- Production of plate glass (year-on-year growth)
- Cement production (year-on-year growth)
- Natural gas production (year-on-year growth)
- Energy production (year-on-year growth)
- Electricity production (year-on-year growth)
- Crude oil production (year-on-year growth)

Coal production (year-on-year growth)
 Passenger traffic (year-on-year growth)
 Freight traffic (year-on-year growth)
 Real capital construction (year-on-year growth)
 Real investment in fixed assets by state-owned enterprises (year-on-year growth)
 Floor space completed of houses (year-on-year growth)
 Real government expenditures (year-on-year growth)
 Real government revenues (year-on-year growth)
 Real money supply (year-on-year growth)
 Export/Import ratio (year-on-year change)

These principal components are then used in the regression where the manufacturing growth rate is the dependent variable. The estimated equation based on 123 monthly observations from February 1992 to April 2002 (Equation 2) includes 6 principal components, as well as autoregressive and moving average processes of residuals.

Equation 2: Year-on-year growth in the monthly manufacturing index, 1992:02 – 2002:04

$$\begin{aligned}
 \text{Man} = & 12.333 \quad -1.679 \quad Z1 - 0.733 \quad Z3 - 0.902 \quad Z7 - 0.413 \quad Z9 + 0.874 \quad Z11 + 1.170 \quad Z13 \\
 & (5.04) \quad (-8.31) \quad (-2.74) \quad (-1.78) \quad (-2.09) \quad (2.67) \quad (2.88) \\
 & +0.961 \text{ AR}(1) - 0.581 \text{ MA}(1) \\
 & (18.81) \quad (-5.88)
 \end{aligned}$$

Adjusted $R^2=0.740$, D.W.=1.87, F=44.5, SEE=2.76, Q(12)=11.26, LM(2)=1.46,
 ARCH(1)=0.38,n=123

There is a close relationship between the growth in manufacturing and monthly principal components (Z's). The relevant regression estimate has serially uncorrelated errors (according to Durbin-Watson, Ljung-Box-Pierce Q statistics and Breusch-Godfrey LM tests). There is no apparent autoregressive conditional heteroskedasticity (ARCH) of residuals. There are no systematic errors (Figure 2). In conclusion, the movements of

principal components are consistent with the movements of the monthly manufacturing growth rate as officially estimated.

Since the primary goal is to study the growth rate in GDP, monthly principal components are averaged to obtain quarterly figures. Quarterly averages of monthly principal components are used in the prediction of quarterly GDP growth. The estimated equation (Equation 3), which is based on 37 observations, from the first quarter of 1993 to the first quarter of 2002, includes 3 principal components (ZQ1, ZQ3, and ZQ8), as well as autoregressive and moving average processes of residuals.

Equation 3. Year-on-year growth in Quarterly GDP, 1993:1 – 2002:1

$$\begin{aligned} \text{GDP} = & 4.495 - 0.326 \text{ ZQ1} - 0.204 \text{ ZQ3} + 0.346 \text{ ZQ8} \\ & (2.91) \quad (-3.91) \quad \quad (-1.81) \quad \quad (2.84) \\ & + 0.179 \text{ AR}(1) + 0.700 \text{ AR}(4) - 0.951 \text{ MA}(4) \\ & (3.22) \quad \quad (15.09) \quad \quad (-62.13) \end{aligned}$$

Adjusted R²=0.950, D.W.=1.86, F=115.1, SEE=0.50, Q(4)=1.01, LM(2)=0.07, ARCH(1)=0.26, n=37

where, ZQ's are quarterly averages of monthly principal components (Z's), i.e. $ZQ_t = (1/3) \sum Z_{ti}$, i=1,2,3 are months and t is the quarter.

The equation has a very high determination coefficient (0.95), and regression coefficients which are significant at the five percent level. This equation has serially uncorrelated errors (according to Durbin-Watson, Ljung-Box-Pierce Q statistics and Breusch-Godfrey LM tests). There is no autoregressive conditional heteroskedasticity (ARCH) of residuals. There are no systematic errors (Figure 3). In conclusion, the

movements of principal components are consistent with the movements of the quarterly growth rate in GDP as officially estimated.

Annual averages of monthly principal components are used in the prediction of annual GDP growth. The estimated equation (Equation 4), which is based on only 9 observations, from 1992 to 2000, includes 4 principal components (ZA1, ZA2, ZA3, and ZA6).

Equation 4. Annual growth rate in GDP, 1992 – 2000

$$\text{GDP} = 10.220 - 0.633 \text{ ZA1} + 0.546 \text{ ZA2} - 1.349 \text{ ZA3} + 1.258 \text{ ZA6}$$

$$(84.4) \quad (-5.30) \quad (7.96) \quad (-10.04) \quad (8.84)$$

Adjusted R²=0.983, D.W.=1.10, F=118.8, SEE=0.34, Q(1)=0.19, LM(2)=3.04, ARCH(1)=0.52, n=9

Where, ZA's are annual averages of monthly principal components (Z's), i.e..

$$\text{ZA}_t = (1/12) \sum Z_{ti}, \quad i=1,2,..12 \text{ are months and } t \text{ is the year.}$$

The equation has a very high determination coefficient (0.98), and regression coefficients which are significant at the one percent level. This equation has serially uncorrelated errors (according to Durbin-Watson, Ljung-Box-Pierce Q statistics and Breusch-Godfrey LM tests). Of course, it is the very small sample size that leads us to accept such a low Durbin-Watson coefficient. There is no autoregressive conditional heteroskedasticity (ARCH) of residuals. There are no systematic errors (Figure 4). In conclusion, the movements of principal components are consistent with the movements of the annual growth rate in GDP as officially estimated.

5. A Side Issue: GDP Growth and Level

When Irving Kravis first estimated the level of Chinese GDP per capita, at the beginning of the reform period, there was significant criticism, much of it coming from Chinese scholars. He collected just under 100 prices, over a short time span. The visiting team did, however, go to as many as six sites, both rural and urban. He also had some independent information about medical care and education costs from other visiting experts in those fields.

After a few years of reform, economists, statisticians and political people became aware of the significant growth achievements of China and great attention was paid to Kravis' figure, which placed China approximately equal to the Philippines (and double the Indian position) scaled as a percentage of the US per capita income level. Also, the returns of the 1980 Census, which was being taken at the beginning of reform, indicated that a modest per capita figure, when multiplied by a huge total population figure, placed China very high in the world ranking of total GDP.

At this time, in the mid-to-late-1980s, it was also found that China's growth rate (percentage change in either total or per capita GDP) was reduced if evaluated at world prices, i.e. using PPP conversion factors rather than market exchange rates. At the same time, when some international institutions were forming weighted averages of country growth rates, to get average world rate, the inclusion of developing countries, including China as one developing country, produced world rates that were larger than if weighted by shares in GWP (gross world product) that were evaluated at market rates.

Chinese growth at constant world prices is biased downwards in comparison with evaluation at market or official exchange rates. This bias was also found by Heston,

Nuxoll, and Summers [3] in a large cross-country sample that compared, for each country, two ways of computing growth – using base period world prices, or using base period “own” prices. They found that poorer developing countries grew more slowly, using world prices. China was not in their sample, but would, by inference, show lower growth when evaluated at base period world prices.

6. Adjustment for Quality Change

As long ago as World War II, economists and statisticians in Great Britain argued that the cost-of-living price index had a downward bias because it did not allow for the substitution effect of shifting towards relatively more unrationed goods in place of rationed goods in the household budget. The former (unrationed goods) were inferior to the latter (rationed) goods. There was a loss of real income by using a price index deflator that did not take rationing into account. After World War II we were quickly exposed to the opposite bias in the consumer price index because new goods that were built on the advanced technologies of the postwar era were of superior quality. One of the first major acknowledgments of this concept was in the estimation of the price of motor cars. A typical quality factor was the availability and rapid addition of the “automatic gear shift”. The method of hedonic index number construction made specific allowance for some types of quality change; this tended to reduce price index values below where they would have been, and provided adjusted real output calculations for faster growth.

On an increasing scale, quality improvements were introduced, and the Boskin Commission in the United States added up to approximately $\frac{1}{2}$ percentage point of growth to US GDP, by adjusting the consumer price index for improvements in computer and other quality changes. The higher speeds, enlarged capacity, and added friendliness of the computer made its adjusted price decline, in the midst of rising prices elsewhere.

In the China case there has been enormous quality change since 1978-80, when economic reforms were introduced. The diet is vastly improved; clothing is much better and varied; the motorcar fleet is remarkably improved; aircraft seat-miles are

modernized; education is far better at all levels; housing is improved; tourist facilities are closer and closer to world standards; communication is better; and one could go on, endlessly, describing the quality changes. In short, the Chinese “market basket” is of such far greater quality in comparison with the start of reform that there is surely a need for a major adjustment in price indexes – even larger than the quality improvements that have already been introduced in the US and other Western economies.

For anyone who has regularly visited China, year-by-year since the start of reform, the quality aspect of Chinese economic life is quite apparent and “crying out” for a major statistical investigation to measure its growth impact. The construction of relevant hedonic indexes, as well as complete expenditure systems, are needed in order to carry the investigation forward in a careful empirical mode.

Just as a “teaser” to show where quality adjustment of price deflators might take us in this examination of Chinese growth rates let us consider some key variables dealing with “quality of life”. On an overall basis, one might select life expectancy at birth. In the UNDP Index of Human Development, life expectancy figures prominently. In the twenty-five year span from 1970-75 to 1995-2000, China’s life expectancy increased from 63.2 years to 69.8 years providing an annual growth rate of 0.4%, not far from the amount by which the Boskin Committee raised the US growth rate as a result of reckoning quality in the CPI. The US life expectancy rose by 0.3% in the same period. Other quality issues such as clean tap water and household sanitation facilities have improved in China at impressive rates, while infant and child mortality improved a great deal. If one were to use the Nagar-Basu methodology, it would be possible to include more variables of this type in making an adjustment for quality change. It is a conjecture

to estimate that computation of a complete expenditure system, from which a “true” cost-of-living index can be computed, would result in an even larger adjustment, bringing Chinese methodology up to a world-class level.

7. Conclusion

No single indicator can fully explain the movements of a very broad magnitude such as real gross domestic product (GDP). Therefore, the principal components methodology is proposed in this paper. The principal components are estimated linear functions of the whole set of indicators that we choose to represent the movement of the economy as a whole. The principal components reflect the movement of broadly based measures of the Chinese economy collected quite independently from diverse sources. The movements of these principal components are consistent with the movements of real gross domestic product (GDP) as officially estimated. This conclusion holds whether one uses annual, quarterly or monthly indicators. It cannot be claimed that we have proved that GDP as officially measured is correct. No one knows the correct estimate; that is the whole point of showing how different such estimates can be, depending on how they are calculated, and this is true the world over.

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References

- [1] D.J. Fixler and B.T. Grimm, Reliability of GDP and Related NIPA Estimates, Survey of Current Business, 82 (January 2002), 9-27.
- [2] B.T. Grimm and R.P. Parker, Reliability of the Quarterly and Annual Estimates of GDP and Gross Domestic Income, Survey of Current Business, 78 (December 1998), 12-21.
- [3] A. Heston, D. A. Nuxoll, and R. Summers, Comparative Country Performance at Own-Price or Common International Prices, in: Economics, Econometrics, and the LINK, M. Dutta, ed., Amsterdam, Elsevier, 1995, pp. 345-61.
- [4] C. A. Holz and Yi-min Lin, The 1997-1998 break in industrial statistics, Facts and appraisal, China Economic Review, 12 (2001), 303-316.
- [5] A. Keidel, China's GDP expenditure accounts. China Economic Review, 12 (2001), 355-367.
- [6] L. R. Klein and J. Makino, Economic Interpretations of the Statistical Discrepancy, Journal of Economic and Social Measurement, 26 (2000), 11-29.
- [7] L. R. Klein and S. Özmucur, The Estimation of China's Economic Growth Rate. Project LINK Meeting, United Nations, New York, 22-24 April. 2002.
- [8] R. Kojima, On the Reliability of China's Economic Statistics with Special Reference to GDP, The Journal of Econometric Study of Northeast Asia, 4 (2002), 15-30.
- [9] N. R. Lardy, China will keep on growing, Asian Wall Street Journal, June 14, 2002.
- [10] L. Meng and X. Wang, A reevaluation of China's economic growth, China Economic Review, 12 (2001), 338-346.
- [11] O. Movshuk, The Reliability of China's Growth Figures: A Survey of Recent Statistical Controversies, The Journal of Econometric Study of Northeast Asia, 4 (2002), 31-45.
- [12] A.L. Nagar and S.R. Basu, Weighting Socio-Economic Indicators of Human Development (A Latent Variable Approach), National Institute of Public Finance and Policy, New Delhi, 1999.
- [13] Quantitative Micro Software (QMS), Eviews 4.1. Irvine, California, 2002. <<http://www.eviews.com>.>
- [14] T.G. Rawski, What is happening to China's GDP statistics? China Economic Review, 12 (2001), 347-354.

- [15] T.G. Rawski, Will investment behavior constrain China's growth? *China Economic Review*, 13 (2002), 361-372.
- [16] T.G. Rawski, Measuring China's recent GDP growth: where do we stand?, University of Pittsburgh, 2002, mimeo.
- [17] T.G. Rawski and W. Xiao, Roundtable on Chinese Economic Statistics, Introduction, *China Economic Review*, 12 (2001), 298-302.
- [18] T. Scharping, Hide-and-seek China's elusive population data, *China Economic Review*, 12 (2001), 323-332.
- [19] J. E. Sinton, Accuracy and reliability of China's energy statistics, *China Economic Review*, 12 (2001), 373-383.
- [20] J. R. N. Stone, On the Interdependence of Blocks of Transactions, Supplement to *Journal of the Royal Statistical Society*, VIII, pt 1 (1947), 1-32.
- [21] C. Wiemer and X. Tian, The measurement of small-scale industry for China's GDP accounts, *China Economic Review*, 12 (2001), 317-322.
- [22] A. Young, Reliability and Accuracy of the Quarterly Estimates of GDP, *Survey of Current Business*, 73 (October 1993), 29-43.
- [23] J. Zheng, China's official statistics growing with full vitality, *China Economic Review*, 12 (2001), 333-337.

Table 1

Approximate Partial Derivatives of DLOG (GDP) with Respect to

DLOG(ELECTRICITY)*100	0.542
DLOG(COAL)*100	0.649
DLOG(OIL)*100	1.078
DLOG(STEEL)*100	0.722
DLOG(FREIGHT)*100	0.423
DLOG(CIVIL)*100	0.163
DLOG(PHONECALLS)*100	0.524
D(EMPTERTIARY/(EMPSECONDARY+EMPTERTIARY))	0.424
DLOG(GRAIN)*100	0.278
DLOG(EXPORTS/PCPIUSA*100)*100	0.106
DLOG(IMPORTS/PCPIUSA*100)*100	0.265
DLOG(REALGOVEXP)*100	0.288
DLOG(WAGE/CPI)*100	0.510
DLOG(CPI)*100	0.326
DLOG(LIVESTOCK)*100	0.221

Figure 1a. Actual and Fitted Growth Rates in GDP (right scale) and Residuals (left scale)

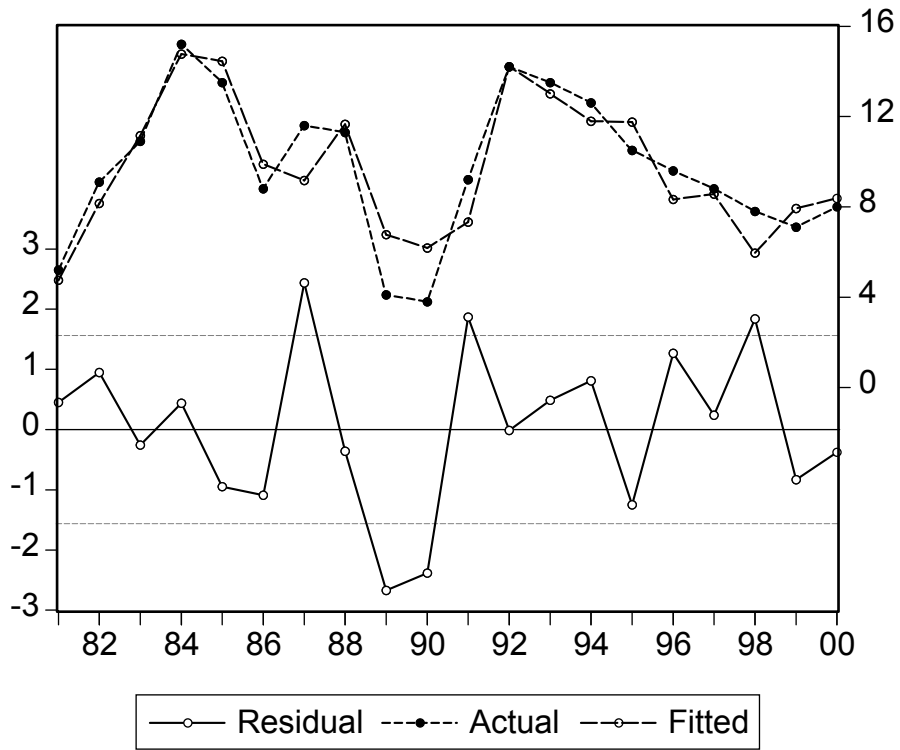


Figure 1b. One-Period Ahead Extrapolated and Actual GDP Growth Rate (right scale), and forecast errors (left scale)

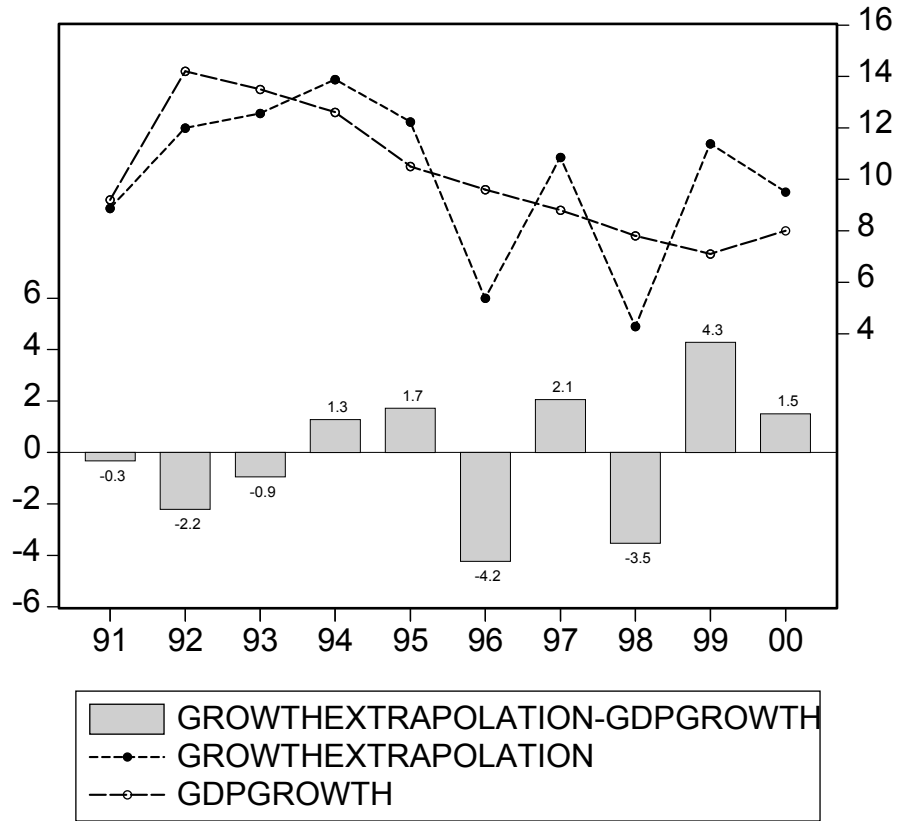


Figure 2. Actual and Fitted Monthly Growth rates in Manufacturing (right scale) and Residuals (left scale)

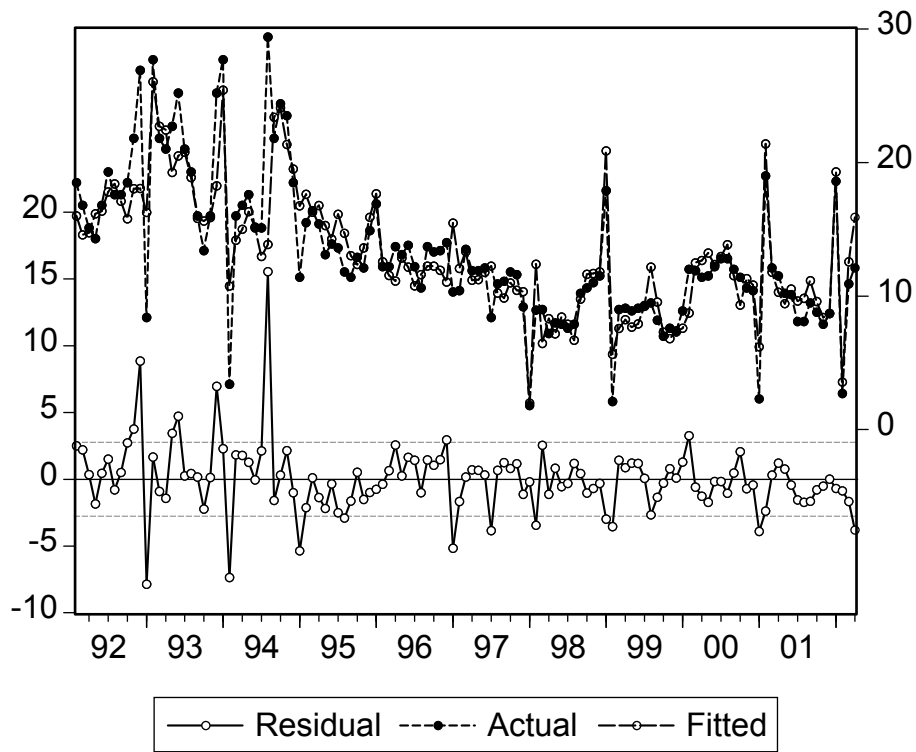


Figure 3. Actual and Fitted quarterly GDP growth rates (right scale) and Residuals (left scale)

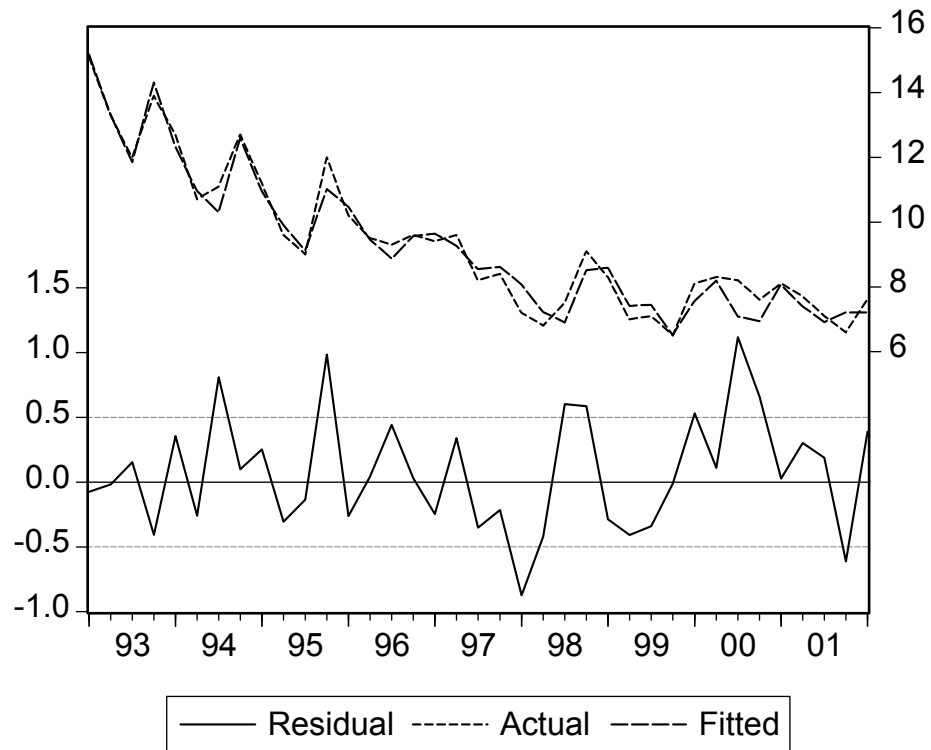


Figure 4. Actual and Fitted annual GDP growth rates (right scale) and Residuals (left scale)

