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Eeva Kerola

In search of fluctuations: Another look at China's incredibly stable GDP growth

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Abstract

China's official real GDP growth has held surprisingly stable in recent years. As national GDP figures influence both policy analysis and political decisions, the GDP growth rate of the massive Chinese economy has also great international implications. Taking the nominal GDP growth and price index data as given and experimenting with alternative deflators, this paper attempts to track missing fluctuations in real GDP growth in recent years. Based on the constructed growth series, real GDP growth decreased during 2015–2016 and picked up in 2017. Growth has been again decelerating this year. Furthermore, the constructed growth rate seems to be well below the recent official figures.

Keywords: China, GDP, deflators, principal component
JEL classification: C38, E01, E3, P2

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1 Introduction

Economic statistics influence policy analysis and political decisions. In the case of China, the world's second largest economy by nominal GDP and largest in terms of purchasing power parity, gross domestic product figures matter for the entire world. China accounts for nearly a fifth of global aggregate GDP and a third of global GDP growth.

Against this backdrop is the long-standing debate over the reliability of China's GDP figures. An appendix in Jia (2011) offers an extensive literature review on the studies of China's macro data quality. For example, Rawski (2001) argues that the Chinese economy may have grown by a couple of percentage points less than the official 1997–2001 figures (about 7 % p.a.). Others (e.g. Maddison and Wu, 2007; Maddison, 2006; Young, 2003) make similar findings after comparing official GDP figures against various supply side indicators. Other studies contradict these findings. For example, Holz (2006a, 2006b and 2014), Clark et al. (2017a and 2017b), and Perkins and Rawski (2008) assert that the official data to be roughly correct and may even understate true economic growth.

To resolve this issue, several alternative GDP measures have emerged. The Conference Board's *Total Economy Database* provides an alternative estimate for Chinese GDP data based on the working paper of Wu (2014). The Conference Board assessment presumes biases in the data relate to misreporting at the local level or methodological opacity, especially with regard to price deflators. The Conference Board's alternative series is constructed from the bottom up on a sector-by-sector basis, relying on both official and constructed series. This alternative GDP series indicates much larger volatility in the year-on-year estimates, sometimes showing higher growth rates than the official numbers (de Vries and Erumban, 2017).

A second widely cited alternative is the *Li Keqiang index*, named after the current premier. A US State Department memo released by Wikileaks reveals that Li, while serving as a party committee secretary in Liaoning, confided to the US ambassador in 2007 the China's official GDP figures were so unreliable that he personally used three alternative indicators to determine what was actually happening in the economy: electricity volume, bank loans, and railway cargo volume. The Li Keqiang index reveals a much more volatile economy in recent years than the official figures suggest.

Fernald et al. (2015) proxy China's economic activity with *trade partner export data*. Because imports move very closely with GDP in economies with good statistical systems, they utilize export data to China or Hong Kong as reported by the United States, the euro area, and Japan. For

a dataset ending in 2014, they find a significant improvement in the reliability of reported Chinese GDP figures since 2008 in capturing fluctuations in economic activity.

Chinese GDP growth has also been estimated from outer space. Growth in *nighttime light intensity* has proven a good proxy for economic growth that is immune to falsification and misreporting (Henderson et al., 2012). Satellites measure the brightness of nighttime lights across Chinese provinces over time. The estimated GDP in Henderson et al. (2012) for 1992–2006 indicates a sizable gap to the officially reported GDP figures. Clark et al. (2017a and 2017b) further utilize this nighttime light data to estimate an alternative weighted average of the three indicators in the Li Keqiang index. Since 2012, their estimate of Chinese GDP was never lower than the official statistics and shows an acceleration in 2016, even as the official growth rate remained virtually unchanged.

Other alternative indices include *Barclays' index*, which uses purchasing manager indices (PMIs), as well as the *Bloomberg and Capital Economic (CE) indices*, which use linear combinations of variables such as value added of industrial production, freight, passenger traffic, electricity production, floor space completed, and retail sales. The *Lombard Street Index* (by TS Lombard) takes the official nominal GDP and a range of price indices covering all expenditure components of GDP to compute an alternative deflator, from which is calculated the alternative real GDP growth rate.

Based on the broad range of alternative estimates, the current "true value" of Chinese GDP growth could be anywhere between 3 % and just over 10 %. Data discrepancies are always problematic and can distort assessments of the economic situation leading to inappropriate economic policies and bad business decisions. Equally problematic is the remarkable stability of the real GDP growth figures reported in recent years masking all changes in economic activity. This paper seeks to track the missing fluctuations of the real GDP growth rate by experimenting with alternative deflators.

The paper is organized as follows. A brief overview of the national gross domestic product and deflators is given in the next section. Alternative deflators and the respective real GDP growth rates are calculated and presented in section 3. Section 4 discusses the findings and concludes.

2 Chinese gross domestic product and deflators

2.1 Nominal and real GDP growth

Before 1985, China's national accounts were compiled according to the Material Production System developed in the Soviet Union and used by countries with centrally planned economies. The country then gradually transitioned to the United Nations' System of National Accounts (SNA). In 1992, a more conventional value-added approach was introduced. China's GDP was initially estimated only from the production side, but China's National Bureau of Statistics (NBS) formally adopted an expenditure approach in 1993.

Since 1992, the NBS has published annual and quarterly GDP estimates. Quarterly GDP is currently estimated separately for: agriculture, forestry, animal husbandry and fishing; mining and quarrying; manufacturing; electricity, gas and water; construction; transport, post and telecommunications; wholesale, retail trade and catering; banking and insurance; real estate; information transmission, software and information technology service, leasing and commercial service and others. China currently compiles its national accounts according to the SNA 2008. Holz (2014) provides a thorough and comprehensive account of Chinese GDP statistics and the compilation methods. Extensive coverage in Xu (2002, 2003, 2008, and 2009) offers suggestions on dealing with several problems in data collection and computation.[1]

The NBS is a government department operating directly under the auspices of the Party and State Council, who appoint NBS key personnel and provide funding. The NBS has little authority over provincial statistics bureaus or over the statistics divisions of other central government departments. Its direct control is limited to its own survey teams (Holz, 2014). Most data compilation to date has occurred outside NBS control.

It is well known that aggregate provincial GDP growth figures typically indicate substantially higher growth than the national figure. Revelations in recent years of extensive data falsification at the provincial level has caused the NBS to rely more on economic censuses, annual data from directly reporting units, and sample surveys to improve the accuracy of national figures. To address this issue, the NBS will end the current arrangement and take over data collection at the regional level from 2019 onwards.

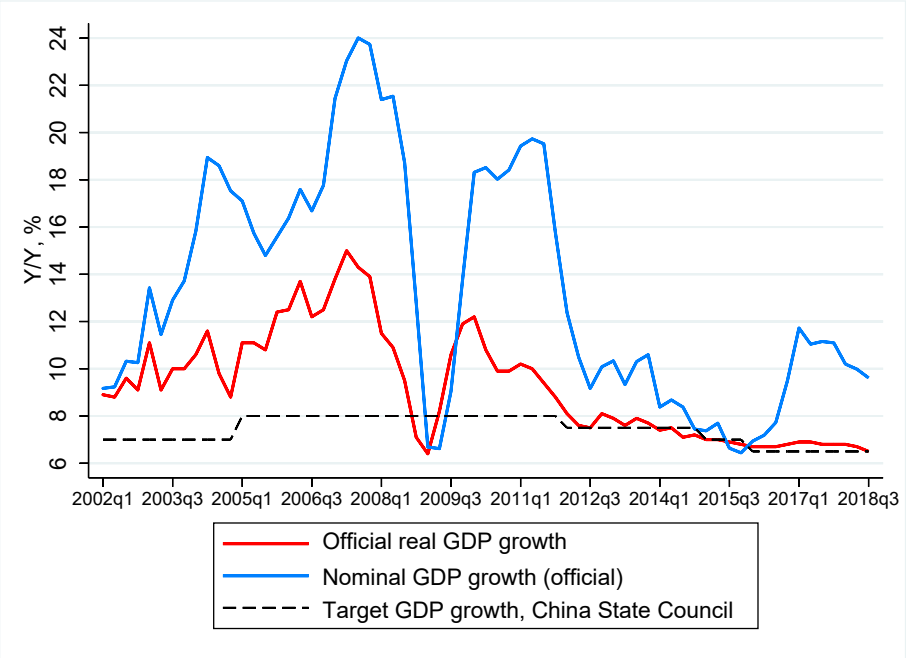
In discussing the institutional scope of data falsification in China, Holz (2014) concludes that the final official GDP values may be rather haphazard values with large technical limitations to data quality. He states that it is likely that choices leading to the final official GDP values are known

[1] Xu Xianchun is a former NBS deputy director.

only to very limited circle within the NBS and quite possibly the decisions are made by only a handful of people in an environment of implicit (or even explicit) expectations raised by top leaders.

The lack of fluctuation in the real GDP growth rate in recent years is hard to ignore. In Figure 1, we see fluctuations in the nominal GDP series after 2014, but virtually no movement in the real GDP growth series.

Figure 1 Nominal and real GDP growth rates, 2002Q1–2018Q3



The statistical reporting problems may partly relate to China's ambitious official target of doubling China's real 2010 GDP by 2020. This explicit growth target, which was announced by the Party in 2012, seems to have forced officials to pursue numbers to meet their mandated targets at many levels of the economy. Contrary to what some observers anticipated, the official real GDP growth target was again announced for the present year to be around 6.5 %. It remains probable that the official figures will remain locked into the GDP doubling target through 2020.

Broadly speaking, it seems more doubt has been cast on China's real GDP figures than on nominal GDP numbers. Clark et al. (2017b) note that there is much less discrepancy on average with *nominal* growth rates than between official central government and provincial *real* GDP growth assessments. They infer that the NBS computes the national real GDP rate by taking the nominal growth rates reported by the provincial authorities and deflating them using a common deflator. China's nominal annual GDP series have also been subject to revisions several times in recent years. Given that real growth rates in recent years have been largely unchanged, it should mean that the implicit deflator has been revised accordingly. This is not plausible, however, as price

indices are final in the year they are published and neither the annual nor the monthly price indices have ever been revised (Holz, 2014).

2.2 Deflators

Chinese official economic data does not include deflators, but the implicit deflators can be obtained by dividing the official growth rate of the nominal values by the official real growth rate. While the statistics agencies of most countries estimate real GDP by deflating nominal GDP with a separate independently constructed price index, this is not the case in China. Appendix A in Holz (2014) discusses how the NBS obtains its sectoral and expenditure deflators. Prior to 2004, the NBS was heavily dependent on enterprise-provided, output-based implicit deflators to deflate nominal value added (Young, 2003). Since 2004, NBS has adopted predominantly relevant price indices to deflate its nominal value added series. One complication for observers is that the NBS changes its deflator calculation methods over time without specifying precisely which period is covered by which method (Holz, 2014).

The deflators the NBS says it uses are described in the IMF Dissemination Standards Bulletin Board (DSBB). These deflators are summarized in Table 1 in the Appendix. Nominal value added figures for agriculture, animal husbandry, forestry and fisheries are deflated with the agricultural product price index. For industrial activities (mining, manufacturing, production and supply of electricity, gas and water), the producer price index is used. For construction, value added is deflated with the fixed-asset investment price index. Retail price indices are used for wholesale and retail trade. For transport, storage and posts, as well as for hotels and catering services, the relevant price indices in the consumer price index (CPI) are used as deflators. Value added of financial intermediation is deflated with the CPI and investment price index. Other services are deflated with the average wage index and service sub-indices of the CPI. To deflate the value added of real estate sector, a series of price indices are used (real estate sales price index, land exchanging price index, real estate and leasing price index, and CPI).

Views differ on deflator quality. Klein and Özmucur (2002–2003) argue that the deflator is overestimated due to unobserved or disregarded quality changes, and thus real GDP growth may be severely underestimated. In contrast, Movshuk (2002) argues that official implicit deflators underestimate true price development, while Young (2003) finds that real GDP growth is lowered by nearly two percentage points if implicit deflators are replaced with proxies for sectoral price indices. Holz (2014) derives alternative real GDP growth rates using combinations of price indices to deflate

the nominal GDP data. He finds that the derived real GDP growth rates come close to official figures, deviating no more than one percentage point in either direction. His data end in 2012, however, precisely when fluctuations vanish from the real GDP growth series.

3 Computing alternative deflators

To come up with alternative deflators, I proceed along two paths. I assume for both that the nominal GDP series and the published price indices are accurate, taking them as given. Data are quarterly observations dating from 2002Q1 to 2018Q3.

In section 3.1., published price indices are used to deflate the nominal value added (VA) data separately for each sector, aggregate the obtained real VA series, and compute the growth rate. I also regress the official implicit GDP deflator by sectoral price indices, using the estimated deflator to construct an alternative real GDP growth rate.

In section 3.2., an alternative deflator is constructed using principal component analysis. I combine information from a relatively large set of price indices into a smaller number of components. The components are then used as explanatory variables in estimating the implicit GDP deflator. The estimated deflator, in turn, is used to deflate the nominal GDP series and get another set of constructed real GDP growth rates.

3.1 Deflating the production-side nominal value added series

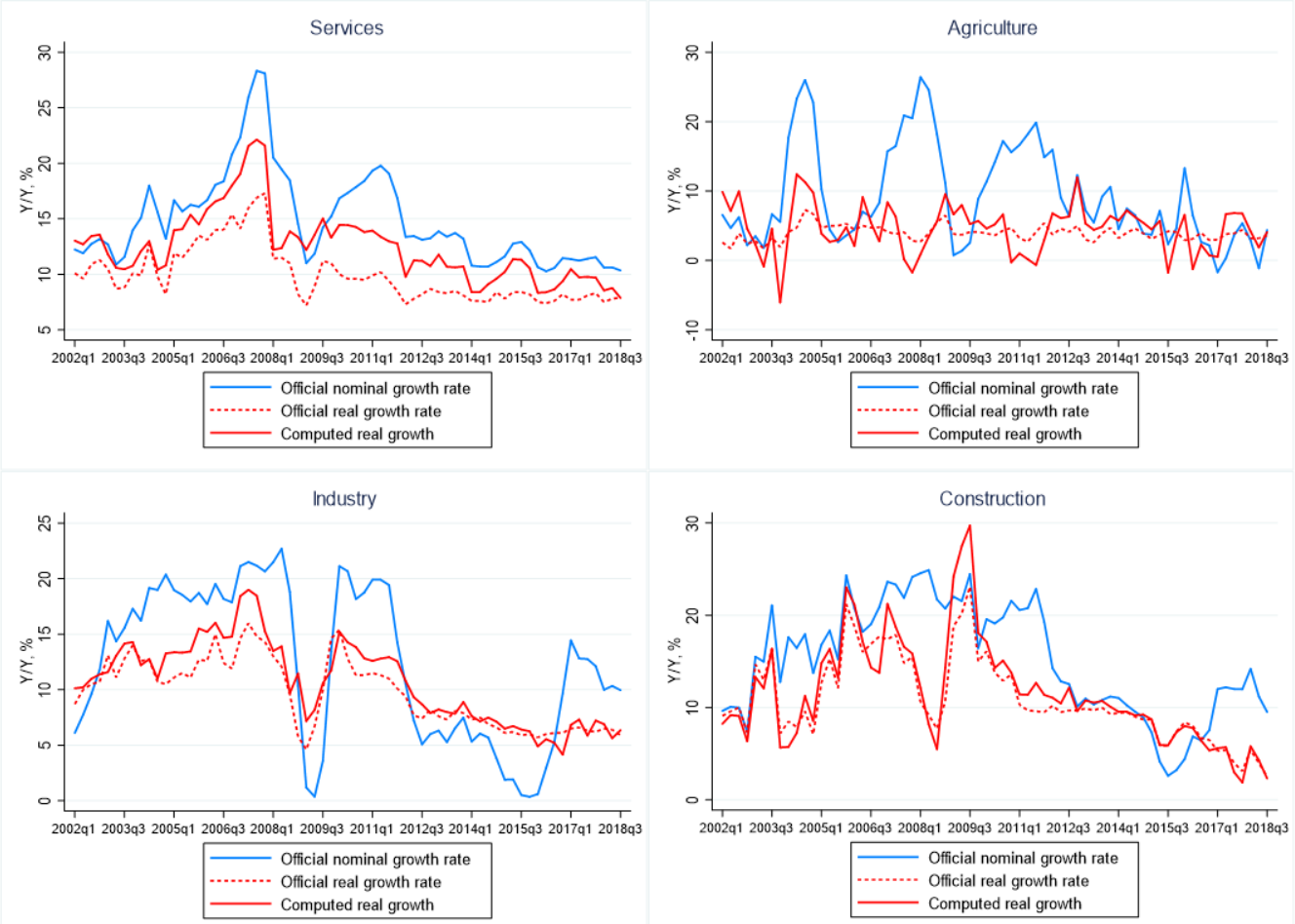
The focus here is on the production side of GDP, where data availability is less of an issue. As noted by Holz (2014), much of the data that the NBS uses in compilation of its real GDP figure is not publicly available, so the task of the researcher is to find publicly available data that best match the price data the NBS claims to be using. The growth rate of the nominal GDP can be reconstructed to a large degree by aggregating the nominal value added series of four core sectors: industry, services, construction, and agriculture.

Using the officially announced deflators (price indices) presented in Table 1, I deflate the nominal sectoral VA series to construct another real GDP growth series. Following the idea in Holz (2014), but to simplify the task at hand I use more aggregated VA and price index series. The price indices used are producer price index for the industrial sector VA, the consumer price index for the service sector VA, the structures (construction and installation) sub-index of investment in fixed-asset price index for the construction sector VA, and the agricultural product price index for agri-

cultural sector VA. Deflating the nominal growth series with these price indices gives the alternative, computed real growth series. Figure 2 presents the nominal value added growth (blue line), the official real growth (red dashed line), and the computed real growth deflated by the price index (red solid line) for each sector.

For services, the official real growth is below the computed growth and shows less variation. The largest differences between the official and computed real growth rates are in agriculture, where the official nominal value added growth varies between 25 % and -2 %, while official real growth fluctuates around 1 % and 7 %. The computed real growth is much more volatile. For industry, the computed real growth rate comes quite close to the official series, but with more fluctuations at the end of the time span. For construction, the computed real growth rate follows the official rate rather closely.

Figure 2 Official real and nominal growth rates of sectoral value added series and the computed real growth



After deflating the nominal sectoral VA series with the respective price indices, I take an aggregate and the annual growth rate. This gives the first alternative real GDP growth rate (dashed black line

in Figure 3 below). This alternative real GDP growth rate is higher than the official real GDP growth rate for almost the entire time span. However, its shape is more or less uniform until early 2014.

Taking a slightly different approach, my starting point here is the implicit GDP deflator. I then try to find the best match with a combination of available price indices. The official implicit deflator is regressed by constructed weighted price indices for each of the four sectors using OLS estimation. I use the sectoral shares of total value added in each quarter as weights to account for structural changes in the economy. Dependent variables are obtained by multiplying the sectoral share of the total VA by the respective aggregate price index (as described above).

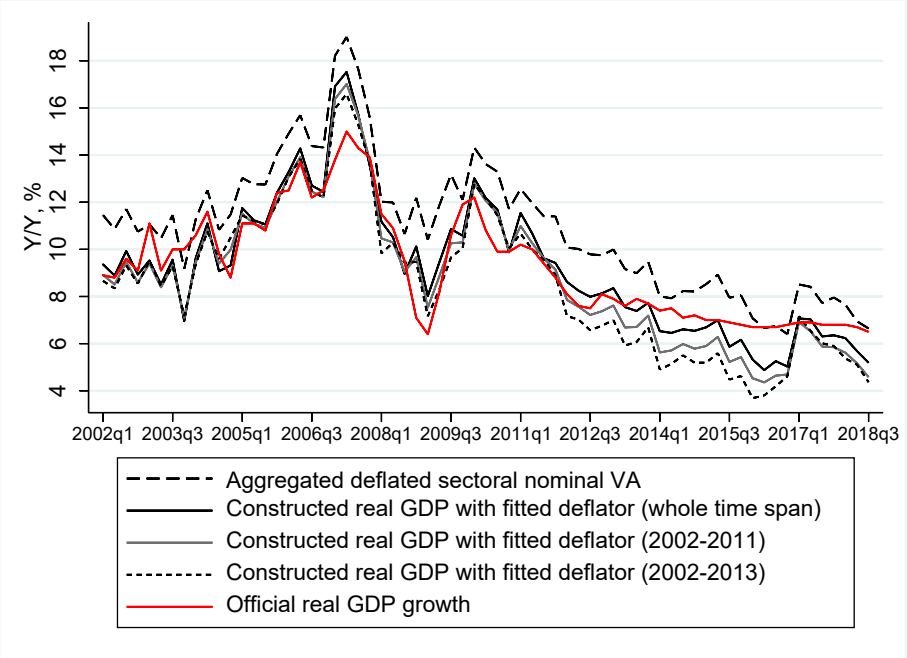
It could be the China's incredibly stable real GDP growth in recent years has affected the series of the implicit deflator that is used as the independent variable in the estimation. One might get different results using only observations from a time span when fluctuations also appear in the real GDP growth rate. A Wald test for a structural break performed after the estimation indicates that I can reject the null hypothesis of no structural break at the 1 % level and the estimated break date is the third quarter of 2012.[2] The Wald test statistic points towards a spike in the value of the test statistic at the estimated quarter, but the value of the test statistic increases already quite quickly after 2011. As was already evident in Figure 1, we see a decrease in fluctuation of the real GDP growth in 2012 that becomes almost identical with the official target rate by early 2014.

To overcome this, I use two additional time spans in my estimations: one breaking at 2014 (2002Q1–2013Q4) and another breaking at 2012 (2002Q1–2011Q4). The OLS regression results are presented in Table 2 in the Appendix with the respective estimated deflators. The estimated deflators are highly correlated as can be seen in Tables 6–8 in the Appendix (deflators I to III). The correlation between the estimated deflators and the official, implicit deflator is about 0.95 before 2012, but decreases to 0.89 for 2012–2018.

I then use these estimated GDP deflators to deflate the nominal GDP. This set of alternative real GDP growth rates is presented in Figure 3 below (black line for the whole time span, dotted line for the shorter time span ending at 2014, and gray line for the shortest time span ending at 2012). The official real GDP growth rate is denoted in red.

[2] Supremum Wald test for a structural break at an unknown break date.

Figure 3 Real GDP growth rate and constructed series



The set of three alternative real GDP growth rates constructed with the estimated GDP deflators track the trend of the official real GDP growth rate rather well up to early 2014. During 2002–2013, the aggregate deflated sectoral nominal VA deviates on average by some two percentage points from the official real GDP growth rate. After 2014, the deviation halves. For the three other alternative growth rates, the average deviation is close to zero until 2013 and thereafter rises to just over one percentage point (below zero). Figure 8 in the Appendix presents the deviations.

Based on all of these constructed real growth series, economic growth decreases in 2015–2016, picks up in 2017, and begins to decelerate again during the first three quarters of 2018 well below what the official growth rate suggests.

3.2 Using principal component analysis to derive an alternative GDP deflator

My next approach combines a much larger amount of price index data to fit the official, implicit GDP deflator using principal component analysis, a technique that transforms a number of possibly correlated variables into a smaller number of uncorrelated variables, i.e. principal components (Jolliffe, 2002). The first principal component accounts for as much of the variability in the data as possible, while each succeeding component accounts for as much of the remaining variance. After the principal components are determined, a standard regression model is conducted to regress the implicit deflator on the estimated principal components.

As price indices, I use a total of 70 different sub-indices from the consumer price index, the investment price index, the producer price index, the purchasing price index, and the retail price index series, separating for urban and rural populations in addition to the national aggregate. I also include wage growth in urban non-private sectors. With low productivity in non-private sector, the wage growth could be an important component of the service sector deflator. In addition, I add industrial, energy, and agriculture raw material indices, as well as the total raw material index excluding energy. The full series is presented in Table 3 of the Appendix.[3]

For the whole time span, the first estimated principal component explains 41 % of the total sample variance, while 15 % is explained by the second component. The first ten components have an eigenvalue greater than one and are able to explain cumulatively 93 % of the total sample variance, as shown in Table 4 in Appendix. As time span shortens (although the factor loadings of the principal components are not entirely identical), the first principal component explains an ever higher share of total sample variance. Figure 7 in the Appendix shows how the first principal component drives the implicit deflator.

I start by regressing the official implicit deflator on the first ten principal components and a constant term using OLS estimation. I then sequentially eliminate regressors with the lowest t-values until all coefficients satisfy the 5 % significance threshold. In the resulting model for the whole time span, I end up with principal components 1 and 2. The first principal component has high factor loadings on consumer goods' and food producer price indices, retail price indices and aggregate consumer price indices for both urban and rural areas. The second principal component has highest factor loadings on clothing and household facilities' consumer price index, on durable consumer goods' producer price index and consumer prices of health care and transport.

I redo the principal component analysis and the regressions for the shorter time spans. For the time span ending in 2013, the principal components left in the regression are 1, 2, and 9. The first principal component is rather similar to the whole time span case; it has high factor loadings on consumer goods and food producer price indices, both urban and rural retail price indices, and aggregate consumer price indices. The second principal component has high factor loadings on metallurgical and producer goods producer price indices, on industrial and energy raw material indices, and on purchasing price indices. The ninth principal component has high factor loadings on food and recreation consumer price indices, producer price index for textile and investment price index for equipment and instruments.

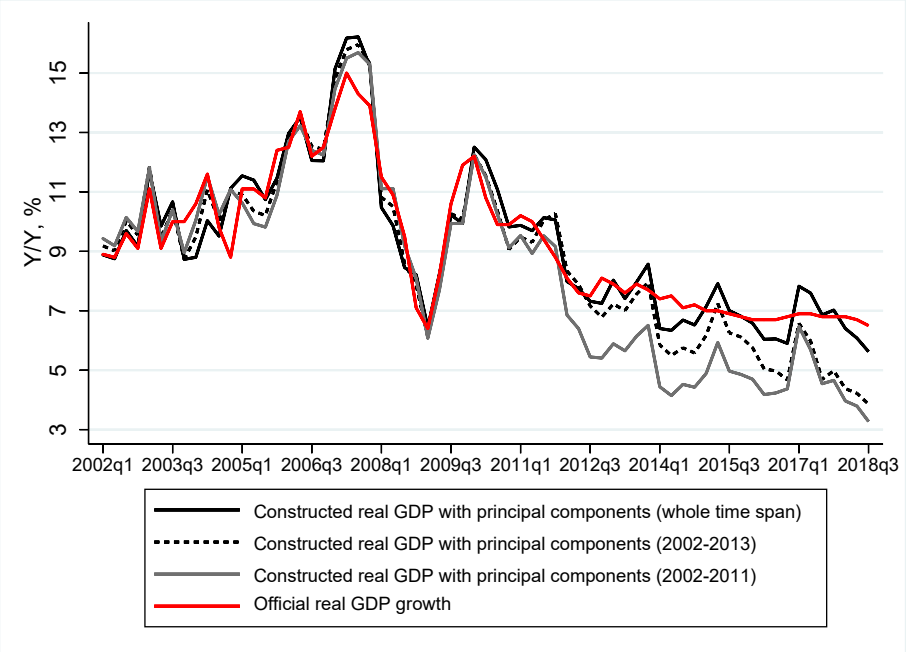
[3] As stationary data are necessary in principal components analysis, the price index data for 1998Q1–2018Q3 are tested by the DF-GLS test by Elliott, Rotherberg and Stock (*Econometrica*, 1996) and by the Phillips-Perron test. Both tests confirm the price index series can be considered stationary.

For the shortest time span, which ends in 2011, the principal components left in the regression are 1, 2, 8 and 9. The first principal component is nearly identical with the other two time spans above in terms of their factor loadings. The second principal component has high factor loadings on national recreational consumer price index, and on the producer price indices for producer goods and metallurgical industry. The eighth principal component has highest factor loadings on consumer price indices for food and recreation. The ninth principal component has high factor loadings on health care, personal articles and food consumer price indices in all areas, and on textile producer price index.

The result is three estimated deflators, one for each time span. OLS regression results and the respective estimated deflators are depicted in Table 5 in the Appendix. For the two shorter time spans I form an out-of-sample prediction with the estimated principal components and their regression coefficients. Again, the correlation matrices between these estimated deflators and the implicit deflator is shown in Tables 6-8 in the Appendix (deflators IV to VI). For this second set of estimated deflators, the correlation with the implicit deflator is smaller for the more recent time span. However, the two sets of estimated deflators (deflators I–III and deflators IV–VI) are highly correlated with each other, and the correlation remains broadly unchanged regardless of the time span considered.

After deflating the official nominal GDP growth rate with these estimated deflators, I get another set of alternative real GDP growth rates (Figure 4 below). The official real GDP growth rate is again denoted in red.

Figure 4 Real GDP growth rate and deflated series with constructed deflators

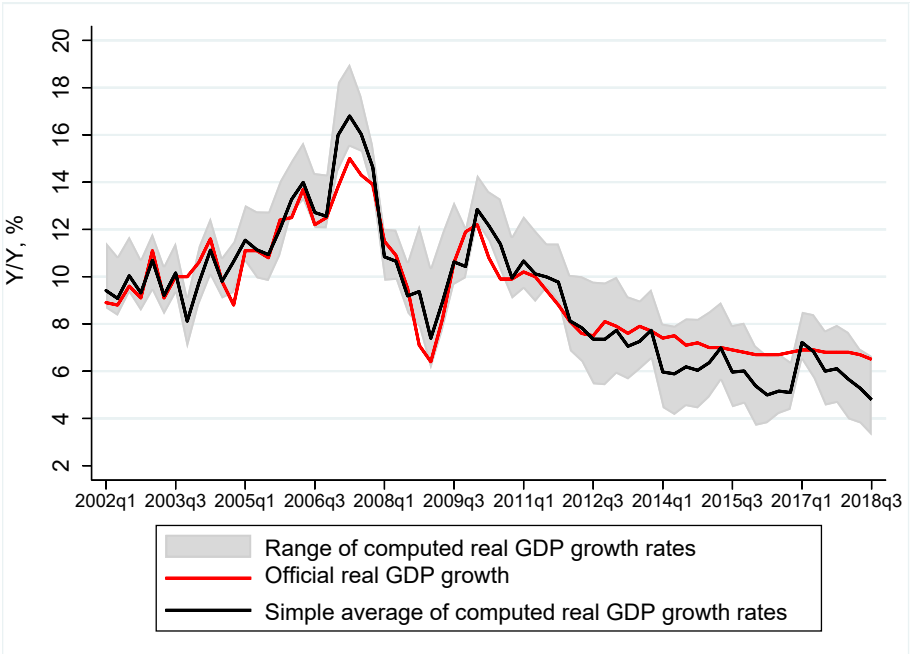


Although estimated differently, these constructed real GDP series behave similarly to those estimated in section 3.1. They quite closely track official real GDP growth until around 2014. Compared to Figure 3, the difference in levels after 2014 is now distinctly larger between the alternative real GDP growth rates for the various time spans. If the deflator is constructed based on estimated coefficients for the shortest time span (ending in 2011), the out-of-sample prediction of the real GDP growth rate deviates from the other series as early as the start of 2012 by about two percentage points. Despite the larger errors with respect to the official real GDP growth rate (Figure 9 in the Appendix), however, the direction of the fluctuations after 2014 is similar across estimations.

4 Discussion of findings and conclusions

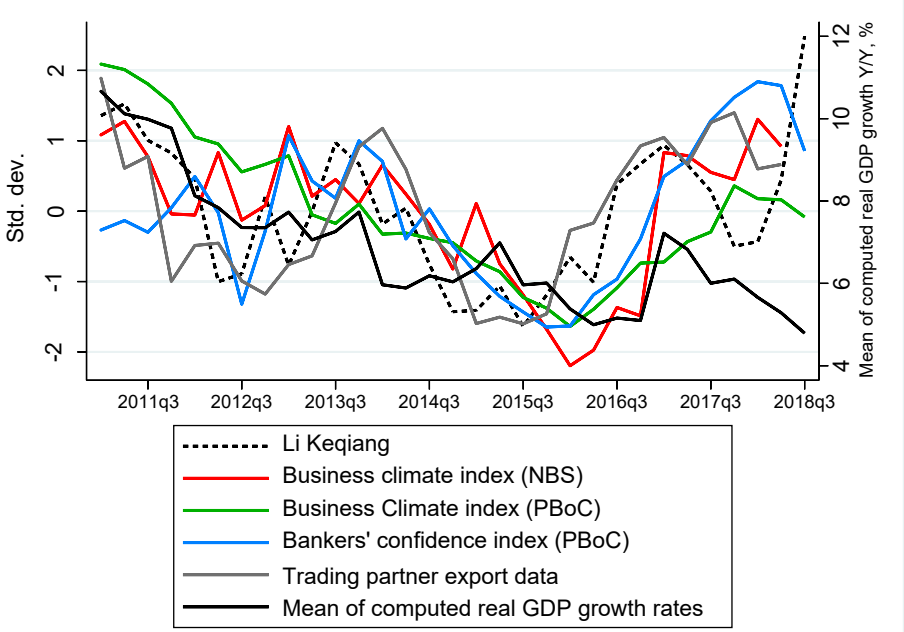
Figure 5 shows the range and simple average of all alternative real GDP growth rates constructed in this paper. The constructed series match the official growth rate rather closely until sometime around 2012. In recent years, the official rate has been at the upper end of the range of estimates. The constructed series indicate a slowing of GDP growth in 2015–2016, an abrupt acceleration in 2017, and a loss of steam in 2018. Furthermore, the computed alternative deflators reveal a real GDP growth rate on average lower than what the official numbers would suggest. Estimated range for the 2018 third quarter growth is between 3.3 % and 6.6 % (simple mean 4.8 %), while the official growth rate stands at 6.5 %.

Figure 5 Range and simple average of all computed real GDP growth rates



How credible are these revealed fluctuations? Some evidence from the changes in Chinese economic activity can be obtained from publicly available survey based indicators. Figure 6 below depicts some of the publicly available Chinese indicators during 2011–2018. There are two business climate indices and a separate confidence index that relates to the banking sector. The Business Climate Index published by the NBS (red line) focuses on the industrial sector. The Business Climate Index published by the People's Bank of China (green line) is based on a survey covering around 5,800 enterprises and constructed similar to the widely used purchasing manager indices (an index value over 50 means a positive trend and under 50 means a worsening business climate or recession). The PBoC also conducts its own Bankers' Confidence Index (blue line). These indicators (normalized in Figure 6 with zero mean and unit standard deviation) seem consistent with the alternative real GDP growth rates constructed in this paper in that they show decreases in 2015–2016, increases in 2017, and slight drops in 2018.

Figure 6 Normalized indicators of economic activity in China 2011–2018



Following Fernald et al. (2015), I also include the real growth rate of China's imports from US, euro area, and Japan (gray solid line). A similar pattern emerges. Real export growth obtained from trading partner data decreases in 2015, increases during 2016–2017, and decelerates again in 2018. Lastly, I include the Li Keqiang index (black dashed line). The Li Keqiang index trend is somewhat different. It falls both in 2015 and 2017, but shows a sharp increase in 2018.

Further evidence can be drawn from assessments and analysis regarding the Chinese economy during these years. For example BOFIT Forecasts for China from 2015–2018[4] seem to reinforce the findings of this paper and depict more or less the same picture of China's business cycles behind the smooth GDP growth figures (extractions from the published forecasts are presented in Annex, Table 9).

This paper identifies fluctuations from 2014 onwards that do not appear in the official figures for GDP growth. Based on the constructed growth series, the rate of real GDP growth declined in 2015–2016, then picked up in 2017, only to decelerate again in 2018. Furthermore, the constructed growth rates seem to be below the recent official figures, with simple mean of estimates decreasing to 4.8 % for the third quarter of 2018. These findings are consistent with some of the available alternative GDP measures, as well as with observed changes in China's economic activity and policy stance.

[4] The BOFIT Forecast for China is prepared twice a year and is part of the Bank of Finland's international economic analysis effort. The forecast is available online at https://www.bofit.fi/en/monitoring/forecasts-for-Russia-and-China/forecast-for-china/

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Appendix

Table 1 Official deflators, production and expenditure side of GDP

GDP by kind of economic activity	
Nominal series	**Official deflator**
Agriculture, animal husbandry, forestry and fishery	Agriculture product price index
Industry (mining, manufacturing, production and supply of electricity, gas and water)	PPI
Construction	Fixed-asset investment price index
Wholesale and retail trade	Retail price indices
Transport, storage and posts	Related price index in CPI
Hotels and catering services	Related price index in CPI
Real estate	Real estate sale's price index, land exchanging price index, real estate and leasing price index and CPI
Financial intermediation	CPI and IPI, etc.
Other services	Average wage index and the service sub-indices of the CPI
Final expenditure on the GDP	
Nominal series	**Official deflator**
Household consumption expenditure	Sub-indices of the CPI
Government consumption expenditure	
–Expenditure on goods and services	Relevant sub-indices of the urban CPI
–Government employee wages and salaries	Government employee average wage growth rate
–Consumption of fixed capital	Fixed-asset investment price index
Gross fixed capital formation	Sub-indices of the fixed investment price index
Changes in inventories	PPI for farm products, PPI for industrial products, purchasing price indices for industrial producers and the Commodity retail price index
Net export of goods	Price indices of exports and imports goods (compiled by Customs Authorities)
Net export of services	Chinese CPI for exports, CPI of main developed foreign countries for imports

Source: IMF DSBB

Table 2 (with chart). OLS regression results and estimated deflators

	Whole time span	2002Q1–2013Q4	2002Q1–2011Q4
Service PI	0.660*	1.054***	1.443***
	(0.26)	(0.28)	(0.35)
Industry PI	0.869***	0.727***	0.545**
	(0.13)	(0.15)	(0.18)
Construction PI	1.501	1.589	1.318
	(0.77)	(0.97)	(1.03)
Agriculture PI	1.368***	0.947**	0.786*
	(0.27)	(0.33)	(0.38)
Constant	1.750***	2.001***	2.087***
	(0.24)	(0.25)	(0.26)
Adj.R-square	0.885	0.898	0.897
dfres	62	43	35

Dependent variable: official implicit GDP deflator. Independent variables are price indices weighted by the sectoral share of total value added.

Standard errors in parenthesis.

* p<0.05, ** p<0.01, *** p<0.001

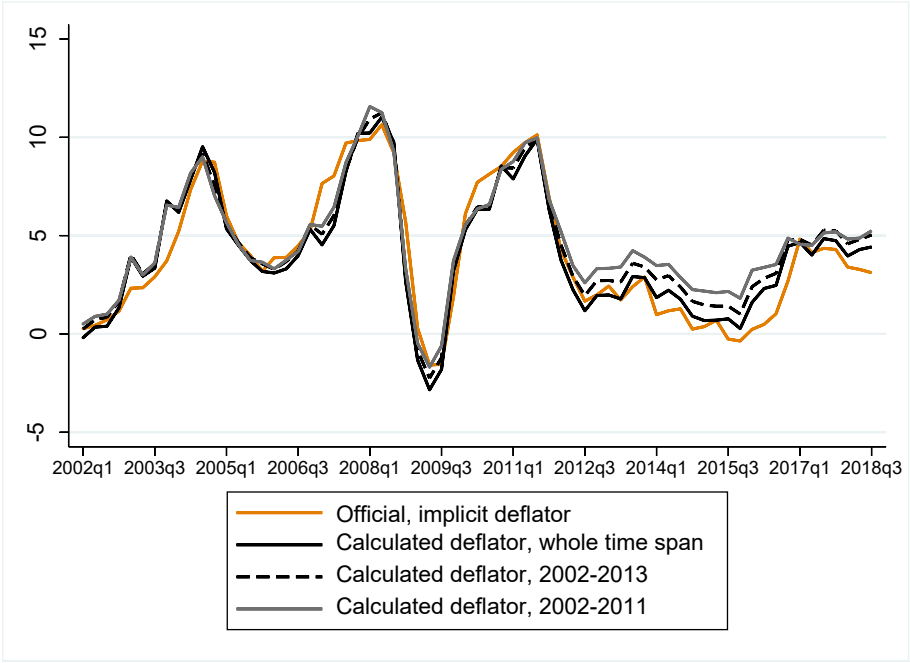

Table 3 Variables used in principal component analysis for the implicit deflator

1	Consumer Price Index, National, All Areas, Total
2	Consumer Price Index, National, All Areas, Clothing, Total
3	Consumer Price Index, National, All Areas, Food, Grain
4	Consumer Price Index, National, All Areas, Transport & Communications, Total
5	Consumer Price Index, National, All Areas, Food, Aquatic Products
6	Consumer Price Index, National, All Areas, Food, Eggs
7	Consumer Price Index, National, All Areas, Recreation, Education & Culture Articles, Total
8	Consumer Price Index, National, All Areas, Food, Total
9	Consumer Price Index, National, All Areas, Household Facilities, Articles & Services, Total
10	Consumer Price Index, National, All Areas, Health Care & Personal Articles, Total
11	Consumer Price Index, National, All Areas, Residence, Total
12	Consumer Price Index, National, All Areas, Food, Vegetables, Fresh Vegetables
13	Consumer Price Index, National, All Areas, Total
14	Consumer Price Index, National, Urban, Total
15	Consumer Price Index, National, Urban, Residence, Total
16	Consumer Price Index, National, Urban, Food, Eggs
17	Consumer Price Index, National, Urban, Food, Aquatic Products
18	Consumer Price Index, National, Urban, Food, Grain
19	Consumer Price Index, National, Urban, Food, Fresh Vegetables
20	Consumer Price Index, National, Urban, Transport & Communications, Total
21	Consumer Price Index, National, Urban, Clothing, Total
22	Consumer Price Index, National, Urban, Household Facilities, Articles & Services, Total
23	Consumer Price Index, National, Urban, Recreation, Education & Culture Articles, Total
24	Consumer Price Index, National, Urban, Health Care & Personal Articles, Total
25	Consumer Price Index, National, Rural, Total
26	Consumer Price Index, National, Rural, Food, Eggs
27	Consumer Price Index, National, Rural, Food, Aquatic Products
28	Consumer Price Index, National, Rural, Residence, Total
29	Consumer Price Index, National, Rural, Food, Grain
30	Consumer Price Index, National, Rural, Food, Fresh Vegetables
31	Consumer Price Index, National, Rural, Household Facilities, Articles & Services, Total
32	Consumer Price Index, National, Rural, Recreation, Education & Culture Articles, Total
33	Consumer Price Index, National, Rural, Food, Fresh Vegetables
34	Consumer Price Index, National, Rural, Household Facilities, Articles & Services, Total
35	Consumer Price Index, National, Rural, Recreation, Education & Culture Articles, Total
36	Consumer Price Index, National, Rural, Health Care & Personal Articles, Total
37	Consumer Price Index, National, Rural, Transport & Communications, Total
38	Consumer Price Index, National, Rural, Clothing, Total
39	Investment Price Index, National, Fixed Assets, FAI, Construction & Installation
40	Investment Price Index, National, Fixed Assets, Purchase, Equipment & Instruments
41	Investment Price Index, National, Fixed Assets, FAI, General
42	Investment Price Index, National, Fixed Assets, Producer, Other Charges
43	Investment Price Index, National, Fixed Assets, structures (construction and installation)
44	Producer Price Index, National, By Branch of Industry, Core, Core Branch, Petroleum
45	Producer Price Index, National, By Branch of Industry, Core, Core Branch, Paper
46	Producer Price Index, National, By Branch of Industry, Core, Core Branch, Metallurgical
47	Producer Price Index, National, By Branch of Industry, Core, Core Branch, Food
48	Producer Price Index, National, By Branch of Industry, Core, Core Branch, Textile
49	Producer Price Index, National, By Branch of Industry, Core, Core Branch, Building Materials
50	Producer Price Index, National, By Branch of Industry, Core, Core Branch, Coal & Coking
51	Producer Price Index, National, By Branch of Industry, Core, Core Branch, Others
52	Producer Price Index, National, By Branch of Industry, Core, Core Branch, Machine Manufacturing
53	Producer Price Index, National, By Branch of Industry, Core, Core Branch, Timber
54	Producer Price Index, National, By Branch of Industry, Core, Core Branch, Power
55	Producer Price Index, National, By Branch of Industry, Core, Core Branch, Leather
56	Producer Price Index, National, By Branch of Industry, Core, Core Branch, Tailoring
57	Producer Price Index, National, By Branch of Industry, Core, Core Branch, Cultural, Educational & Handicrafts Article
58	Producer Price Index, National, By Branch of Industry, Others, Coal Mining, Washing & Dressing
59	Producer Price Index, National, By Branch of Industry, Others, Food Manufacturing
60	Producer Price Index, National, By Commodity, Consumer Goods, Clothing
61	Producer Price Index, National, By Commodity, Consumer Goods, Durable Consumer Goods
62	Producer Price Index, National, By Commodity, Consumer Goods, Food
63	Producer Price Index, National, By Commodity, Consumer Goods, Total
64	Producer Price Index, National, By Commodity, Consumer Goods, Article for Daily Use
65	Producer Price Index, National, By Commodity, Producer Goods, Total
66	Agricultural Product Price Index, Total
67	Purchasing Price Index, Purchasing Price, Total
68	Purchasing Price Index, Total
69	Retail Price Index, National, Rural, Total
70	Retail Price Index, National, Urban, Total
71	Industrial Raw Materials Index, HWWI
72	Agricultural Raw Materials Index, HWWI
73	Energy Raw Materials Index, HWWI
74	Total Raw Material Index excluding energy, HWWI
75	Average Wage: Urban Non-private
76	Average Wage: Urban Non-private: State Owned Unit
77	Average Wage: Urban Non-private: Urban Collective Owned Unit
78	Average Wage: Urban Non-private: Other

Table 4 Proportion of variance explained by 10 first principal components (three time spans)

	whole time span		2002Q1–2013Q4		2002Q1–2011Q4	
	Proportion, %	Cumulative, %	Proportion, %	Cumulative, %	Proportion, %	Cumulative, %
Comp1	0.4147	0.4147	0.4588	0.4588	0.4921	0.4921
Comp2	0.1537	0.5684	0.1539	0.6127	0.1288	0.6209
Comp3	0.1127	0.6811	0.0817	0.6944	0.0811	0.702
Comp4	0.061	0.7421	0.0645	0.7589	0.0677	0.7697
Comp5	0.048	0.7901	0.0573	0.8162	0.0555	0.8252
Comp6	0.0404	0.8305	0.0436	0.8598	0.048	0.8732
Comp7	0.0354	0.8659	0.0326	0.8924	0.0258	0.899
Comp8	0.0289	0.8948	0.0242	0.9166	0.0251	0.9241
Comp9	0.021	0.9158	0.0163	0.9329	0.0161	0.9402
Comp10	0.0129	0.9287	0.012	0.9449	0.0125	0.9527

Principal components analysis

Figure 7 First principal component and the official implicit deflator

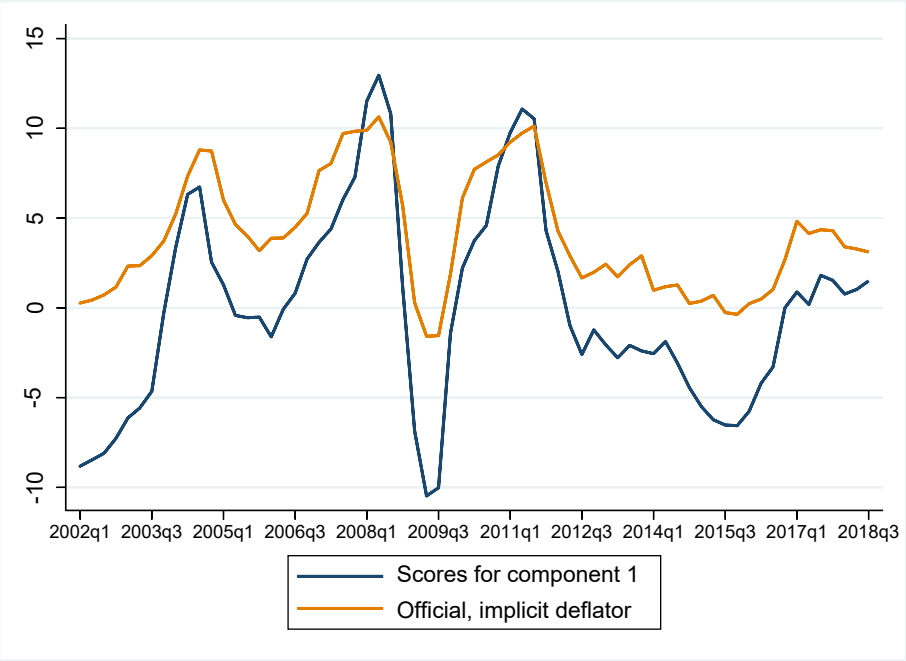

Table 5 (with chart). OLS regression results and estimated deflators

	whole time span	2002Q1–2013Q4	2002Q1–2011Q4
Comp1	0.566***	0.554***	0.561***
	(0.02)	(0.02)	(0.02)
Comp2	-0.202***	0.195***	0.124*
	(0.03)	(0.04)	(0.05)
Comp9		0.312**	0.321**
		(0.11)	(0.10)
Comp8			0.218*
			(0.10)
Constant	4.057***	4.914***	5.390***
	(0.11)	(0.12)	(0.12)
Adj.R-square	0.932	0.938	0.938
dfres	64	44	35

Dependent variable: official implicit GDP deflator.
Standard errors in parenthesis.

* p<0.05, ** p<0.01, *** p<0.001

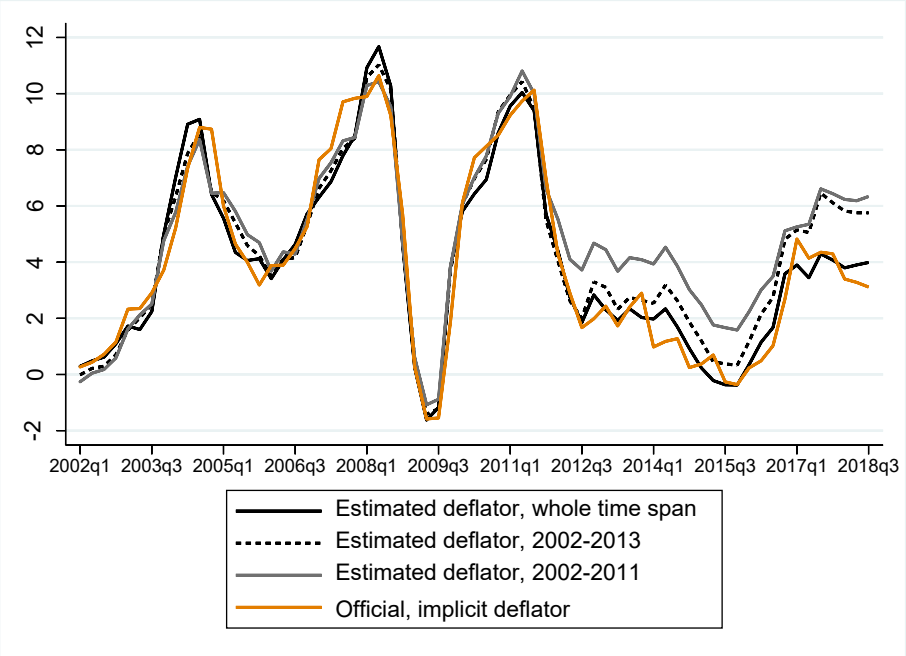

Figure 8 Residuals from first set of estimations

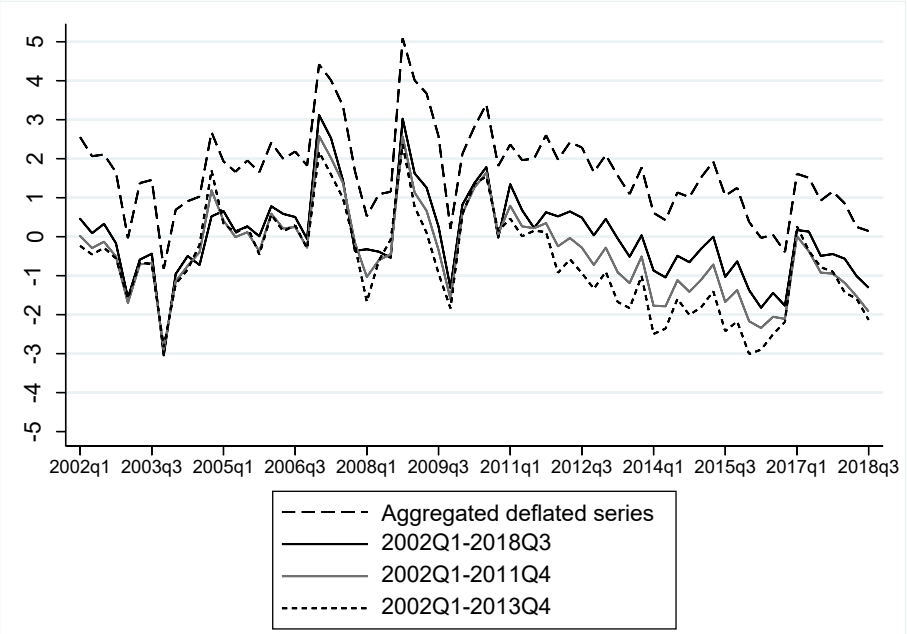

Figure 9 Residuals from principal component regressions

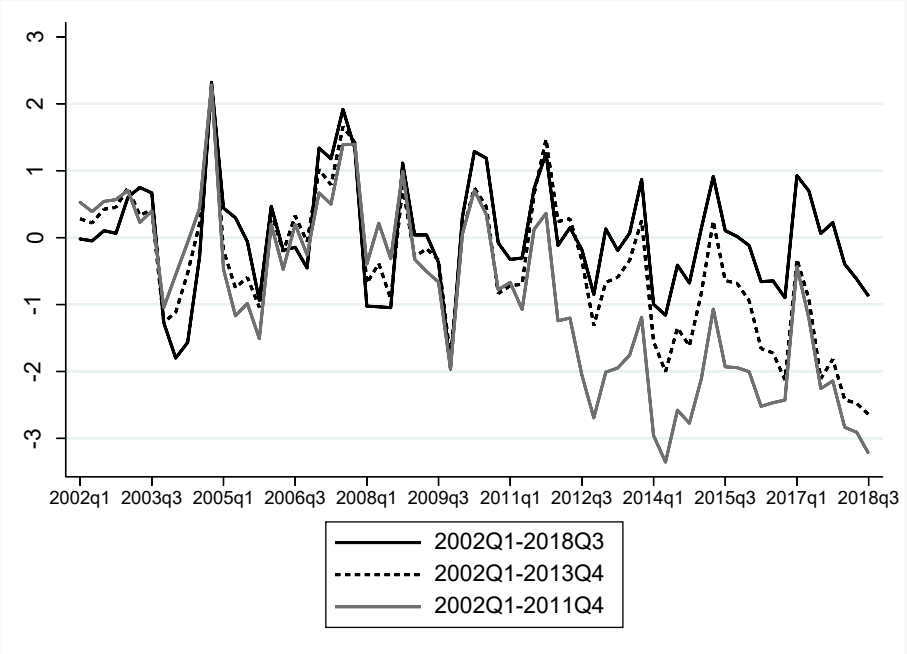

Table 6 Correlation between the official implicit deflator and constructed alternative deflators (whole time span)

	Implicit	DeflI	DeflII	DeflIII	DeflIV	DeflV	DeflVI
Implicit	1.0000						
DeflI	0.9446	1.0000					
DeflII	0.9415	0.9967	1.0000				
DeflIII	0.9304	0.9850	0.9949	1.0000			
DeflIV	0.9663	0.9597	0.9634	0.9565	1.0000		
DeflV	0.9495	0.9522	0.9606	0.9535	0.9768	1.0000	
DeflVI	0.9207	0.9250	0.9428	0.9487	0.9447	0.9815	1.0000

Table 7 Correlation between the official implicit deflator and constructed alternative deflators, 1998–2011

	Implicit	DeflI	DeflII	DeflIII	DeflIV	DeflV	DeflVI
Implicit	1.0000						
DeflI	0.9448	1.0000					
DeflII	0.9506	0.9977	1.0000				
DeflIII	0.9529	0.9916	0.9976	1.0000			
DeflIV	0.9607	0.9593	0.9705	0.9743	1.0000		
DeflV	0.9702	0.9504	0.9611	0.9646	0.9920	1.0000	
DeflVI	0.9717	0.9413	0.9526	0.9575	0.9815	0.9953	1.0000

Table 8 Correlation between the official implicit deflator and constructed alternative deflators, 2012–2018

	Implicit	DeflI	DeflII	DeflIII	DeflIV	DeflV	DeflVI
Implicit	1.0000						
DeflI	0.8922	1.0000					
DeflII	0.8947	0.9961	1.0000				
DeflIII	0.8727	0.9718	0.9867	1.0000			
DeflIV	0.9256	0.9181	0.9342	0.9312	1.0000		
DeflV	0.8754	0.9501	0.9559	0.9218	0.9467	1.0000	
DeflVI	0.8896	0.9106	0.9288	0.9175	0.9765	0.9769	1.0000

Table 9 Extractions from BOFIT China Forecasts, 2015–2018

2015 The stock market rally early in the year ended with a crash in the summer. Thereafter, capital outflows from China increased substantially, putting depreciation pressure on the yuan. Inconsistent and confused policy by authorities in the summer of 2015 with regard to stock and forex markets implied significant costs for the government and added to market uncertainty. Structural change in the economy was further driven by weakness in export demand and slowing construction and fixed investment growth. Demand for the products of heavy industry fell and a number of industries suffered from severe overcapacity problems.
2016 Growth in China's economic output was boosted as a result of the government's stimulus policy. Capital outflows and expectations of yuan depreciation reflected mounting uncertainty in financial markets. Confidence surveys conducted by the NBS, the PBoC and several private institutions pointed to exceptionally weak economic performance especially in late 2015 and early 2016, as well as substantial rebound in growth thereafter. After a couple of lackluster years, China's foreign trade experienced rapid growth since late 2016.
2017 It appeared that economic conditions were improved compared to 2015–2016 on the recovery of the external demand and steady growth in domestic consumption. China used economic stimulus and pursued expansionary policies to keep the country on track to meeting its official 2020 growth target and maintain favorable economic conditions ahead of the convening of the 19th National Congress of the Communist Party of China in October. The accommodative monetary stance fueled indebtedness, which continued to rise rapidly.
2018 Uncertainty is again reflected in plunging prices on stock exchanges and yuan depreciation. Indeed, many indicators suggest an economic slowdown is underway, with particular interest focusing on weak growth in fixed investment, a key driver of demand. In the first half of this year, there were still news about the central government's efforts to curb indebtedness by freezing local government infrastructure projects already in progress. By summer, however, local governments were being encouraged to hurry up and issue their own bonds in order to raise funds to complete their construction projects to support growth and provide jobs. China's medium-term outlook is somewhat darker.

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