Approximating the DGP of China's Quarterly GDP

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Abstract

We demonstrate that the data generating process (DGP) of China's cumulated quarterly Gross Domestic Product (GDP, current prices), as it is reported by the National Bureau of Statistics of China, can be (very closely) approximated by a simple rule. This rule is that annual growth in any quarter is equal to annual growth in its previous quarter plus an error term that is only nonzero in the first quarter of each year and with small variance. We show that this rule fits the data for 1992Q1 to 2005Q4 well, for total GDP as well for its three sector-specific components. It also gives accurate forecasts for 2006Q1 to 2009Q4. We also study the time series properties of GDP growth in constant prices, and show that these series behave as random walks, with much larger error variance.

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1. Introduction

Since 1992 China presents its quarterly GDP figures in a format that is accessible to the general public. In 2007 the National Bureau of Statistics of China (NBSC) published the China Quarterly GDP Time Series for 1992Q1-2005Q4. Since 2006 this information also appears on the NBSC website (www.stats.gov.cn).

In this paper we analyze the time series properties of the GDP series as they are given as aggregates in current prices (100 million Yuan). We will analyze the total GDP series as well as the three sector-specific GDP series, concerning the Primary, Secondary and Tertiary Sectors. We construct time series models for the data covering 1992Q1-2005Q4, and we use these models to forecast the data for 2006Q1 to 2009Q4. The data are presented in Appendix A and B. We also analyze the GDP growth rates at constant prices, and these data appear in Appendix C and D.

The Chinese GDP series in current prices are reported in a format that contrasts with the usual practice in western countries. First, the data are given in cumulated format, that is, Quarter 1 first, and then in Quarter 2 the NBSC presents the sum of Quarters 1 and 2, and so on. Second, when cumulating the data, NBSC also includes revised figures of earlier quarters. Third, after one year, it is only the cumulated value in Quarter 4 (which is of course equal to the sum for that particular year) that is revised.[1][2] To write it in a more formal way, denote actual, that is, de-cumulated GDP in a single year as $Y_{Q,T}$, where Q is either Quarter 1, 2, 3 or 4, and T is year. Next, denote $Y_{Q,T}^{r}$ as the first revised value of the quarter, $Y_{Q,T}^{rr}$ as the second revised value, and so on. The data that the NBSC subsequently reports in the Quarters 1 to 4 are thus equal to

[1] The practice of presenting cumulated data is a heritage of the planned economy, where macroeconomic data are expected to meet certain targets. By using cumulated data, one can see at a glance to what extent the targets have been met.

[2] Since 2003 the NBSC is reporting de-cumulated growth figures in its press releases, but not in the time series on the NSBC website.

$$
\begin{aligned}
X_{1,T} &= Y_{1,T} \\
X_{2,T} &= Y^{r}_{1,rT} + Y_{2,T} \\
X_{3,T} &= Y^{rr}_{1,T} + Y^{r}_{2,T} + Y_{3,T} \\
X_{4,T} &= Y^{rrr}_{1,T} + Y^{rr}_{2,T} + Y^{r}_{3,T} + Y_{4,T}
\end{aligned}
\tag{1}
$$

And, with (approximately) a one year lag, NBSC presents $X^{r}_{4,T}$, the revised year-total. A consequence of this way of reporting is that the data have graphical patterns like those reported in Figures 1 and 2. Another consequence is for de-cumulated GDP for China, which would amount to data like $X_{2,T} - X_{1,T}$, and so on, and that is that these data are difficult to interpret and to analyze as they amount to a mixture of actual figures and revisions. In fact, the actual and revised figures can simply not be identified. A graph of the de-cumulated data which we will not analyze in this paper appears in the Appendix. A third consequence is that a random error term in Quarter 1 will have largest variance, as the forecast errors for subsequent quarters must get smaller due to the accumulation as in (1).

In this paper we focus on the actual data as presented by the NBSC, that is, those as constructed in (1), the cumulated GDP data at current prices. Additionally, we analyze the time series properties of real growth rates (concerning cumulated GDP at constant prices).

Our rather basic analysis shows that the GDP data (cumulated levels at current prices) can be fitted and predicted with (relatively) great precision. The rule that seems to govern the data is that growth in a quarter, relative to the same quarter in the previous year, is a random walk. Second, as expected, this random walk experiences shocks only in the first quarter, and in the other three quarters, the error term has variance (approximately) equal to zero. In words this means that once the observation in Quarter 1 is known, the data for the rest of the year can be predicted quite accurately. We show that the median percentage error of one-step-ahead forecasts for the actual nominal GDP (in 100 million Yuan) for these quarters has a mean often lower than 1.0%. In terms of de-cumulated series, such a forecast precision is associated with a de-cumulated series with a very regular seasonal pattern, with a steep trend, and with no important downturns.

GDP growth in constant prices can also be described as a random walk, albeit that the error term variance is much larger. As a result, real GDP growth, as opposed to nominal GDP growth, cannot accurately be predicted through extrapolation.

2. An analysis of cumulative GDP in current prices

We start with an analysis of cumulative total GDP, as it is given in Figure 1, for the sample 1992Q1 to 2005Q4. The data seem to have a trend (upwards) and strong and increasing seasonality, which is of course largely due to the accumulation process. It is common in such instances to take logarithms of the data and to use so-called differencing filters to remove non-stationary components, see Franses (1998), among others. Denoting the quarterly series as composed like (1) as x_t, where t runs from 1992Q1 to 2005Q4, then we shall analyze the properties of

(2) $$(1-L)(1-L^4)\log x_t$$

The L denotes the familiar lag operator and "log" denotes the natural logarithm. In words, the variable in (2) is the change (1-L) in the annual growth rate $(1-L^4)\log x_t$, observed per quarter. A graph of the series in (2) is given in Figure 3.

2.1 Approximating the DGP

The time series properties of this variable turn out to have interesting properties, and certainly when compared with GDP data for other countries. The first property is that the mean of the variable in Figure 3 is equal to zero. A regression of $(1-L)(1-L^4)\log x_t$ on a constant gives a t-ratio of -0.990. The residuals of this regression do not appear to be auto-correlated. The LM test for first to fourth auto-correlation has a p-value of 0.164. This is quite interesting as many quarterly and trending economic time series can be

described by the so-called airline model [3], which implies auto-correlations for $(1-L)(1-L^4)\log x_t$ at lags 1, 3, 4 and 5.

The series $(1-L)(1-L^4)\log x_t$ has a second interesting property and that is that in the regression of the squares of $(1-L)(1-L^4)\log x_t$ on four seasonal dummies only the parameter for the first seasonal dummy obtains a significant parameter (t-statistic is 6.977). Basically this means that total GDP in current prices can be described by

$$(3) \qquad (1-L)(1-L^4)\log x_t \sim (0, D_{1,t}\sigma^2)$$

where $D_{1,t}$ is a one-zero seasonal dummy for the first quarter and σ^2 is the variance of the error term. The variance is estimated as 0.001098 with standard error 0.000151. The finding that only the variance in the first quarter matters is largely due to the accumulation process. On the other hand, that the variance is very small implies that the associated de-cumulated series would show a very regular and repetitive seasonal pattern, a steep and straight trend, and an absence of important downturns.

2.2 Forecasts

The expression in (3) says that in all quarters but the first one, the data on GDP in current prices obey the rule: growth in this quarter is equal to growth in the previous quarter. And in the first quarter, the rule is this quarter's growth is growth in the previous quarter plus a non-zero error term. In other words, the actual data $(1-L)(1-L^4)\log x_t$ are all approximately zero except in Quarter 1, which is visualized in Figure 4.

With the model in (3), we can easily create forecasts for GDP, using the following extrapolation scheme:

[3] The airline model is given by $(1-L)(1-L^4)\log x_t = (1+\theta_1 L)(1+\theta_4 L^4)\varepsilon_t$, see Franses (1998, Chapter 5), where ε_t is an error term with zero auto-correlation. This model is also at the heart of various seasonal adjustment programs.

$$(4) \qquad GDP_{t+h} = \exp\left[\log(GDP_{t+h-1}) + \log(GDP_{t+h-4}) - \log(GDP_{t+h-5}) + \tfrac{1}{2} D_{1,t+h}\sigma^2\right]$$

where GDP_{t+h} denotes the h-step-ahead forecast. In case of recurrent one-step-ahead (static) forecasts, the forecast origin each time moves with one quarter. In case of multiple-step-ahead (dynamic) forecasts, the forecast origin is the same (2005Q4), and in (4) earlier forecasts then replace the future observations.

In Figure 5 we give the multiple-step-ahead forecasts generated from 2005Q4 as the forecast horizon, and the realizations as they are displayed in Appendix B. It is clear from this graph that these multiple-step-ahead forecasts seem to give an adequate impression of the upward trend in China's GDP. The actual forecasts are presented in Table 1. This table also gives the percentage forecast error. Even though the forecasts are created for years ahead, still the percentage forecast error remains below around 10%.

In Figure 6 we give the one-step-ahead forecasts, where the first forecast origin is 2005Q4, then in becomes 2006Q1 and so on, until 2009Q3. Table 2 presents these forecasts and the percentage forecast errors. As could be expected given (3), the forecast errors in the first quarters are largest, with the exceptionally large value in 2009Q1. So, indeed, it is not easy to forecast first-quarter GDP in current prices in China. In contrast, the forecast errors for the other three quarters are small, as one can safely state that percentage forecast errors below 1% are quite small (for levels of GDP type data). The median error is 0.436 and the median absolute error is 0.599.

The model in (3) suggests that once the first-quarter observation is known, it shall not be too difficult to forecast Quarters 2, 3 and 4. If we thus generate three-step-ahead forecasts for the final quarter (= year) GDP data, we get forecasts of 210236.0 for 2006Q4, 253135.1 for 2007Q4, 307823.5 for 2008Q4 and 311422.6 for 2009Q4. These forecasts have percentage errors equal to 0.802, 1.648, 2.021 and 7.684, respectively, which is rather small (as compared forecasts for the levels of GDP for other countries).

3. The three components of cumulated GDP in current prices

Given that total cumulated GDP can be approximated by a simple model as given in (3), it is now of interest whether this also holds for its three components. Following the same approach as in the previous section, it so turns out the nominal GDP for the Primary Sector, for the Secondary Sector and for the Tertiary Sector each can be described by a model like (3), where the σ^2 is estimated (with standard errors in parentheses) as 0.004161 (0.000989), 0.001470 (0.000255) and 0.001341 (0.000333), respectively. Clearly, the error term has largest variance for the Primary Sector. Graphs similar to that in Figure 4 are given in Figures 7, 8 and 9. One can see a very close fit between the data and the model. Hence, the data generating process (DGP) of Chinese GDP in current prices can be approximated rather well.

In Tables 3 to 8 we present the multiple-step-ahead forecasts and one-step-ahead forecasts for the three sectors, and we contrast these with the realizations displayed in Appendix B. One can see that these forecasts are again quite accurate, although forecasts for the Secondary Sector seem to be best, except for 2009Q4.

4. An analysis of growth rates at constant prices

The second important variable that is reported by the National Bureau of Statistics of China is the Growth Rate of Gross Domestic Product at Constant Prices. Dong (2006) discusses the creation of these inflation-corrected growth rates. In contrast to what is common practice in western countries, NBSC does not report a single GDP deflator. In fact, each component of the national accounts has its own deflator. We might therefore expect that modeling and forecasting of this variable would be less easy than in the earlier case of cumulated GDP at current prices.

The relevant growth rates for total GDP appear in Figure 10 and for the three sectors in Figure 11. In Figure 12 we contrast the growth rates with those of the USA, where one should bear in mind that the Chinese data refer to real growth rates of cumulated data within each calendar year. Until 2007Q4, the USA growth figures show

stability with an average of 3.2%. The Chinese data show much more fluctuations. The data as used in this paper are displayed in Appendix C and D. Again, we analyze the data for 1992Q1 to 2005Q4 and we create forecasts for 2006Q1 to 2009Q4.

Given the fact that constant prices GDP cannot be derived as a function of current prices GDP and a GDP deflator, we shall not expect that (3) has predictive value for the models for constant prices GDP. The autocorrelations of the growth rates (total and for the three sectors) show a pattern that is typical for a unit root process (relevant more formal tests confirm this), so we will analyze the growth rates after first differencing, that is, this quarter's growth minus growth in the previous quarter.

For constant prices growth in total GDP we obtain

$$(5) \qquad Growth_t - Growth_{t-1} = 0.254 D_{1,t} - 0.371 D_{2,t} + \varepsilon_t$$

where $D_{1,t}$ and $D_{2,t}$ are the one-zero dummies for Quarters 1 and 2. If we regress the squares of the estimated residuals on the four seasonal dummies, one can learn that the variance in Quarter 1 is about 0.97 and significant, while the variances in the other three quarters are estimated as being insignificantly different from zero. Note that this variance is substantially larger than that for nominal GDP. Anyway, similar to GDP at current prices, it shall thus be most difficult to forecast data in Quarter 1. This is reflected by the one-step-ahead forecasts in Table 9, where indeed the forecast errors are largest in the first quarter, and notably in 2008Q1 and 2009Q1.

A similar model as in (5) is obtained for the growth rates at constant prices for GDP in the Primary Sector. The estimation results are

$$(6) \qquad Growth1_t - Growth1_{t-1} = 0.669 D_{1,t} - 1.021 D_{2,t} + \varepsilon_t$$

And also here we obtain that error variance in Quarter 1 is the only significant variance, with value 0.867.

For the Secondary Sector GDP growth rates we get

(7) $$Growth2_t - Growth2_{t-1} = -0.869 D_{1,t} + \varepsilon_t$$

Here the error variance in Quarter 1 is 3.339, so one may expect large forecast errors in Quarter 1.

Finally, for the Tertiary Sector we obtain that the growth simply is a zero-mean random walk. The variance of this variable is 1.852 in Quarter 1 and 0.824 in Quarter 4, and otherwise this variance is zero.

In contrast with the GDP data at current prices, the GDP data at constant prices will be much less easy to forecast. This is also reflected by the forecast errors in Tables 10, 11 and 12. In particular, the forecast for 2009Q4 for the Secondary sector is quite off track.

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5. Discussion and conclusion

In this paper we have demonstrated that quarterly Chinese GDP time series data, at current prices, can be predicted quite well using very simple extrapolation schemes. The relevance of this extrapolation scheme is in part due to the accumulation process. This forecast accuracy does not only hold for one-step-ahead forecasts, where percentage errors of less than 1% are often found, but also for multiple-step-ahead forecasts where percentage errors are much larger, but still much smaller than what is typically found for other country-specific GDP data. When econometric models are to be developed to predict GDP for China, they should have the challenge of improving this reported forecast accuracy.

In contrast to what is common practice, China does not use a single GDP deflator, but uses various different prices data to correct the current prices GDP to constant prices GDP. This should make the growth rates in constant prices GDP much less easy to model and forecast, which we verified in the second part of the paper. Basically, these growth rates are random walks, with some mild seasonality and with large variance.

Current prices GDP in China is reported in cumulated form. This makes the Quarter 4 observation automatically equal to the year total. The cumulated data contain actual quarterly data and the revisions to earlier quarters. This makes the de-cumulated

GDP data less useful as it cannot be identified which part of the de-cumulated observation can be associated with genuine new information and with revisions. This should reduce the usefulness of de-cumulated GDP in econometric models for other macro-economic variables. At the same time, as there is almost no variation in the cumulated GDP data, at least not in Quarters 2, 3 and 4, this particular series is also less useful for subsequent econometric modeling. The only variable that could be considered for modeling and forecasting is the growth rate of GDP at constant prices.

When it comes to forecasting GDP at current prices, the only observation that seems of interest to forecast is the first-quarter observation. Given knowledge of that quarter, the next three quarters within the same year can be predicted with great accuracy.

Finally, GDP growth in constant prices can also be described as a random walk, albeit that the error term variance is much larger. Therefore real GDP growth cannot accurately be predicted through extrapolation.

Appendix A: The data for 1992Q1-2005Q4

Aggregates in current prices, in 100 million Yuan

Quarter	GDP	Primary Industry	Secondary Industry	Tertiary Industry
1992Q1	4974.300	589.9000	2365.200	2019.200
1992Q2	11332.10	1690.900	5350.300	4290.900
1992Q3	18451.50	3670.800	8319.500	6461.200
1992Q4	26923.50	5866.600	11699.50	9357.400
1993Q1	6500.500	673.1000	3363.800	2463.600
1993Q2	14543.50	1897.400	7532.200	5113.900
1993Q3	23591.50	4020.500	11574.60	7996.400
1993Q4	35333.90	6963.800	16454.40	11915.70
1994Q1	9064.700	922.7000	4710.100	3431.900
1994Q2	20149.70	2539.500	10546.10	7064.100
1994Q3	32596.60	5380.300	16248.60	10967.70
1994Q4	48197.90	9572.700	22445.40	16179.80
1995Q1	11858.50	1232.600	6227.100	4398.800
1995Q2	25967.60	3420.800	13693.40	8853.400
1995Q3	41502.60	7139.200	20775.60	13587.80
1995Q4	60793.70	12135.80	28679.50	19978.40
1996Q1	14261.20	1487.200	7576.500	5197.500
1996Q2	30861.80	4251.900	16197.90	10412.00
1996Q3	48533.10	8194.100	24413.80	15925.20
1996Q4	71176.60	14015.40	33835.00	23326.20
1997Q1	16256.70	1675.500	8433.500	6147.700
1997Q2	34954.30	4730.500	18109.30	12114.50
1997Q3	54102.40	8547.500	27084.20	18470.70
1997Q4	78973.00	14441.90	37543.00	26988.10
1998Q1	17501.30	1775.200	8757.100	6969.000
1998Q2	37222.70	4860.400	18693.10	13669.20
1998Q3	57595.20	8740.200	28013.00	20842.00
1998Q4	84402.30	14817.60	39004.20	30580.50
1999Q1	18789.70	1878.600	9204.800	7706.300
1999Q2	39554.90	5039.900	19479.00	15036.00
1999Q3	61414.20	9048.700	29436.90	22928.60
1999Q4	89677.10	14770.00	41033.60	33873.50
2000Q1	20647.00	1924.900	9981.400	8740.700
2000Q2	43748.20	5094.500	21429.90	17223.80
2000Q3	68087.50	9169.300	32629.50	26288.70
2000Q4	99214.60	14944.70	45555.90	38714.00
2001Q1	23299.50	2035.200	11127.40	10136.90
2001Q2	48950.90	5297.100	23813.30	19840.50
2001Q3	75818.20	9715.200	35856.10	30246.90
2001Q4	109655.2	15781.30	49512.30	44361.60

2002Q1	25375.70	2181.300	11811.30	11383.10
2002Q2	53341.00	5635.200	25562.60	22143.20
2002Q3	83056.70	10325.60	38807.30	33923.80
2002Q4	120332.7	16537.00	53896.80	49898.90
2003Q1	28861.80	2258.100	13776.40	12827.30
2003Q2	59868.90	5779.400	29478.00	24611.50
2003Q3	93329.30	10866.40	44853.10	37609.80
2003Q4	135822.8	17381.70	62436.30	56004.80
2004Q1	33420.60	2663.500	16077.30	14679.80
2004Q2	70405.90	7027.500	34674.50	28703.90
2004Q3	109967.6	13385.00	52869.60	43713.00
2004Q4	159878.3	21412.70	73904.30	64561.30
2005Q1	38848.60	3013.600	18968.40	16866.60
2005Q2	81422.50	7652.000	40902.60	32867.90
2005Q3	125984.9	14451.20	61542.40	49991.30
2005Q4	183867.9	23070.40	87364.60	73432.90

Source: National Bureau of Statistics of China (2007), *China Quarterly GDP Time Series*, 1992-2005, Department of National Accounts, China Statistics Press, ISBN 978-7-5037-5356-5.

Appendix B: The data for 2006Q1-2009Q4

Quarter	GDP	Primary Industry	Secondary Industry	Tertiary Industry
2006Q1	44419.80	3093.000	22076.10	19250.70
2006Q2	93611.60	7973.600	47909.40	37728.60
2006Q3	144569.6	15058.20	72008.20	57503.20
2006Q4	211923.0	24040.00	103162.0	84721.00
2007Q1	53058.00	3654.000	26465.00	22939.00
2007Q2	112458.0	9283.000	57614.00	45561.00
2007Q3	174428.0	17937.00	86405.00	70086.00
2007Q4	257306.0	28627.00	124799.0	103880.0
2008Q1	63475.00	4720.000	31658.00	27097.00
2008Q2	134726.0	11800.00	69330.00	53596.00
2008Q3	208025.0	22062.00	103974.0	81989.00
2008Q4	314045.0	33702.00	149003.0	131340.0
2009Q1	65745.00	4700.000	31968.00	29077.00
2009Q2	139862.0	12025.00	70070.00	57767.00
2009Q3	217817.0	22500.00	106477.0	88840.00
2009Q4	335353.0	35477.00	156958.0	142918.0

Source: http://www.stats.gov.cn/english (Consulted: January 22 2010)

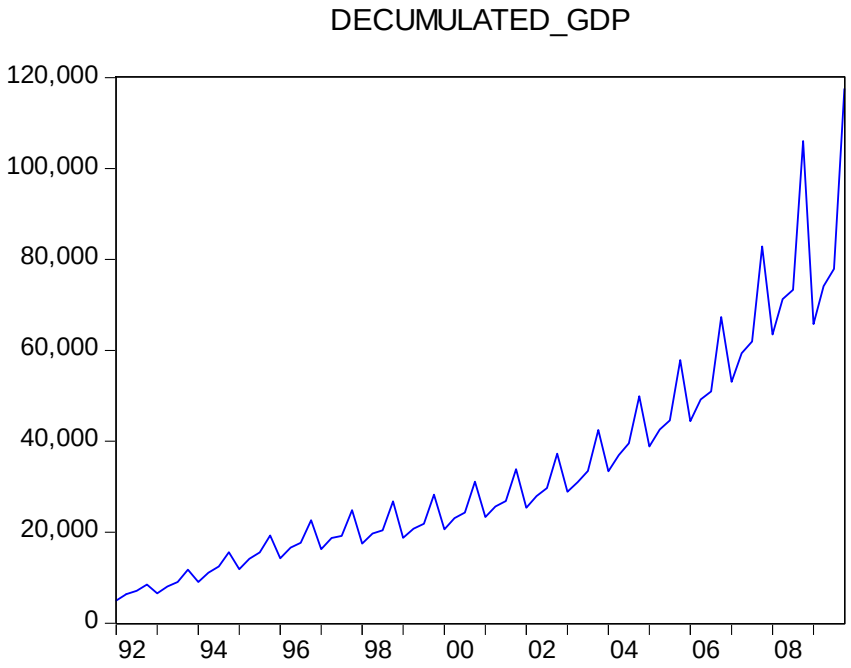

Figure A1: Quarterly GDP (de-cumulated) as the aggregate in current prices, 1992Q1-2009Q4

Appendix C: The data for 1992Q1-2005Q4

The data in this table are calculated at constant prices, and are relative to the same period of the preceding year = 100

Quarter	GROWTH	GROWTH1	GROWTH2	GROWTH3
1992Q1	13.6	10.0	17.4	9.80
1992Q2	13.3	7.70	18.0	9.50
1992Q3	13.3	5.50	18.8	10.8
1992Q4	14.2	4.70	21.2	12.4
1993Q1	15.1	6.10	19.4	12.2
1993Q2	14.8	4.20	19.7	13.1
1993Q3	14.3	4.20	19.4	13.0
1993Q4	14.0	4.70	19.9	12.2
1994Q1	12.9	6.00	16.5	9.80
1994Q2	12.4	4.50	16.6	9.60
1994Q3	12.4	4.50	16.9	9.90
1994Q4	13.1	4.00	18.4	11.1
1995Q1	12.0	6.00	14.7	9.70
1995Q2	11.0	6.20	13.6	8.80
1995Q3	10.6	5.50	13.1	9.20
1995Q4	10.9	5.00	13.9	9.80
1996Q1	10.9	5.50	12.3	10.2
1996Q2	10.3	5.00	12.0	9.60
1996Q3	10.0	4.80	11.9	9.60
1996Q4	10.0	5.10	12.1	9.40
1997Q1	10.4	5.00	10.3	12.2
1997Q2	10.2	5.00	10.7	11.6
1997Q3	9.60	3.90	10.3	11.5
1997Q4	9.30	3.50	10.5	10.7
1998Q1	7.60	4.00	7.60	8.60
1998Q2	7.20	2.20	7.70	8.50
1998Q3	7.50	2.50	8.10	9.00
1998Q4	7.80	3.50	8.90	8.40
1999Q1	9.10	4.00	9.60	9.50
1999Q2	8.30	3.00	9.00	9.20
1999Q3	8.10	3.30	8.70	9.30
1999Q4	7.60	2.80	8.10	9.30
2000Q1	9.00	3.00	9.10	10.4
2000Q2	8.90	1.50	9.50	10.7
2000Q3	8.90	2.20	9.60	10.7
2000Q4	8.40	2.40	9.40	9.70
2001Q1	8.50	3.10	9.20	8.80
2001Q2	8.10	1.80	9.50	8.40
2001Q3	8.00	2.90	9.10	8.40
2001Q4	8.30	2.80	8.40	10.3
2002Q1	8.90	3.40	9.10	9.90
2002Q2	8.90	2.00	9.50	10.1

2002Q3	9.20	3.40	9.80	10.2
2002Q4	9.10	2.90	9.80	10.4
2003Q1	10.8	3.60	12.5	10.3
2003Q2	9.70	2.10	11.8	9.10
2003Q3	10.1	3.10	12.5	9.30
2003Q4	10.0	2.50	12.7	9.50
2004Q1	10.4	4.60	11.6	10.0
2004Q2	10.9	4.40	11.5	11.6
2004Q3	10.5	6.00	11.1	10.9
2004Q4	10.1	6.30	11.1	10.1
2005Q1	10.5	4.60	11.2	10.6
2005Q2	10.5	5.00	11.3	10.8
2005Q3	10.4	5.00	11.2	10.9
2005Q4	10.4	5.20	11.7	10.5

Appendix D: The data for 2006Q1-2009Q4

The data in this table are calculated at constant prices, and are relative to the same period of the preceding year = 100

Quarter	GROWTH	GROWTH1	GROWTH2	GROWTH3
2006Q1	11.4	4.50	12.6	11.3
2006Q2	12.0	5.10	13.6	11.7
2006Q3	11.8	4.90	13.3	11.8
2006Q4	11.6	5.00	13.0	12.1
2007Q1	13.0	4.40	14.6	12.7
2007Q2	13.4	4.00	15.0	13.5
2007Q3	13.4	4.30	14.8	14.0
2007Q4	13.0	3.70	14.7	13.8
2008Q1	10.6	2.80	11.5	10.9
2008Q2	10.4	3.50	11.3	10.7
2008Q3	9.90	4.50	10.6	10.5
2008Q4	9.00	5.50	9.30	9.50
2009Q1	6.10	3.50	5.30	7.40
2009Q2	7.10	3.80	6.60	8.30
2009Q3	7.70	4.00	7.50	8.80
2009Q4	8.70	4.20	9.50	8.90

Source: http://www.stats.gov.cn/english (Consulted: January 22 2010)

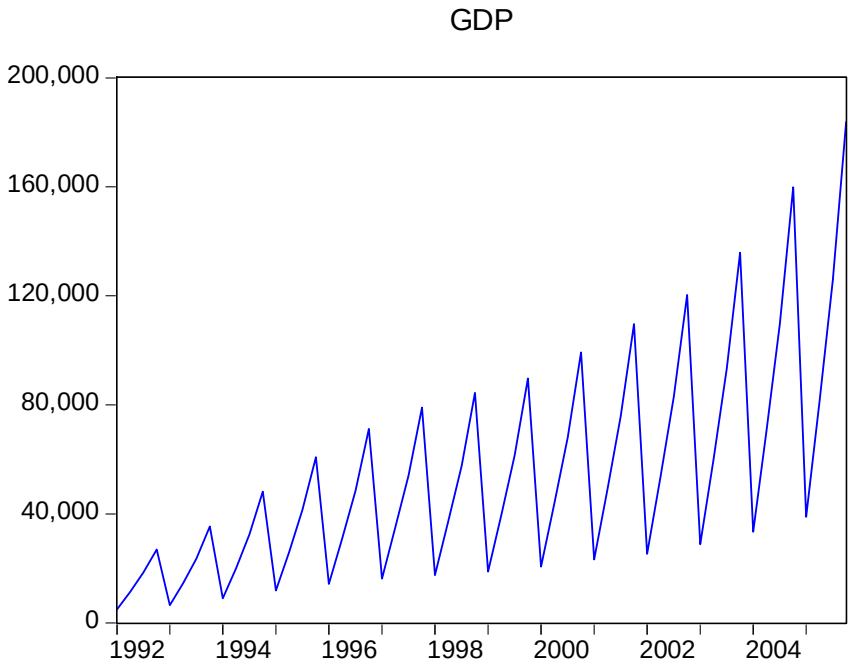

Figure 1: Quarterly GDP (cumulated) as the aggregate in current prices, 1992Q1-2005Q4 (the data are given in Appendix A)

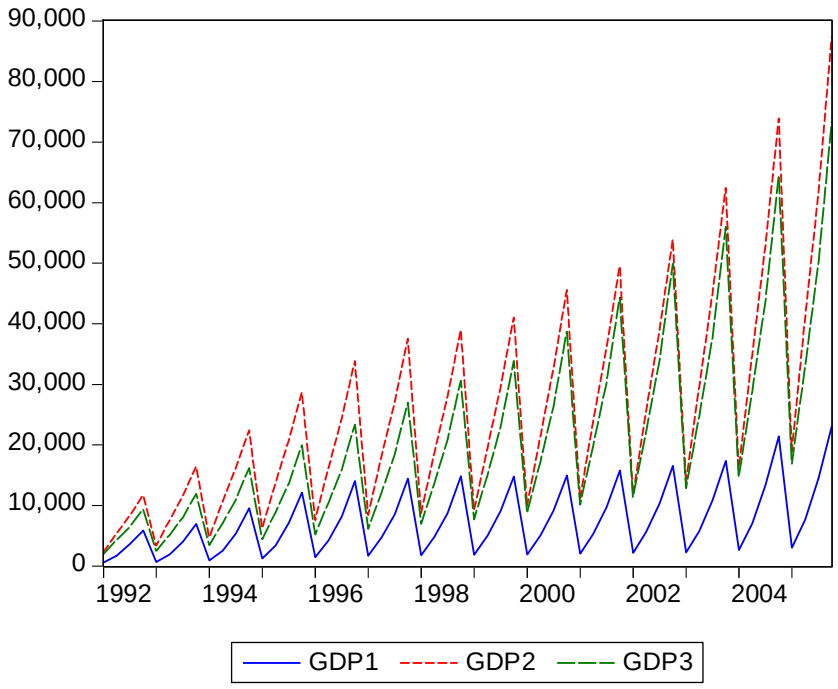

Figure 2: Quarterly GDP (cumulated) as the aggregate in current prices, 1992Q1-2005Q4, per industry (primary, secondary and tertiary) (the data are given in Appendix A)

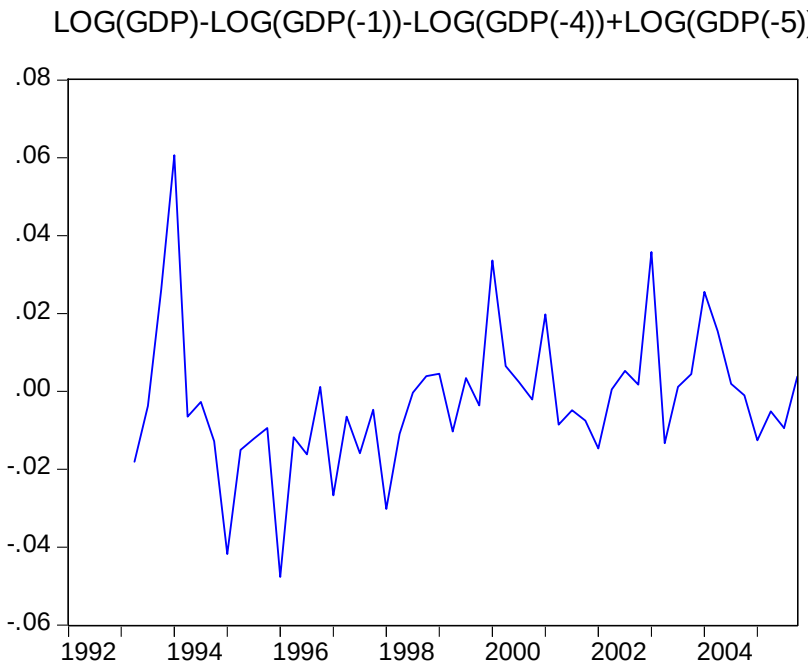

Figure 3: Quarterly change in the annual growth rate of GDP (cumulated) as the aggregate in current prices, 1992Q1-2005Q4

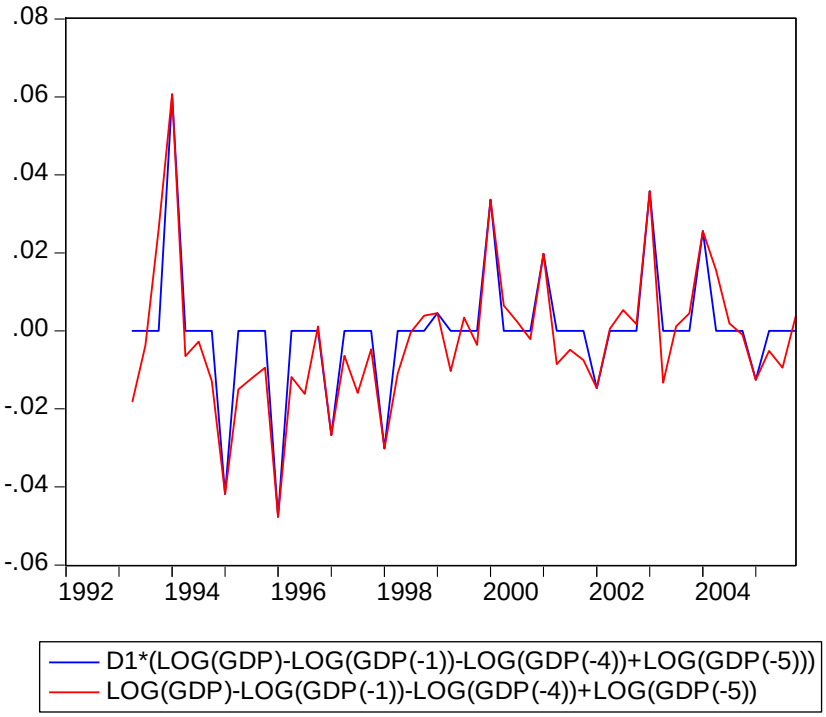

Figure 4: Quarterly change in the annual growth rate of GDP (cumulated) as the aggregate in current prices, 1992Q1-2005Q4 versus the same variable when assumed to be non-zero only in Quarter 1

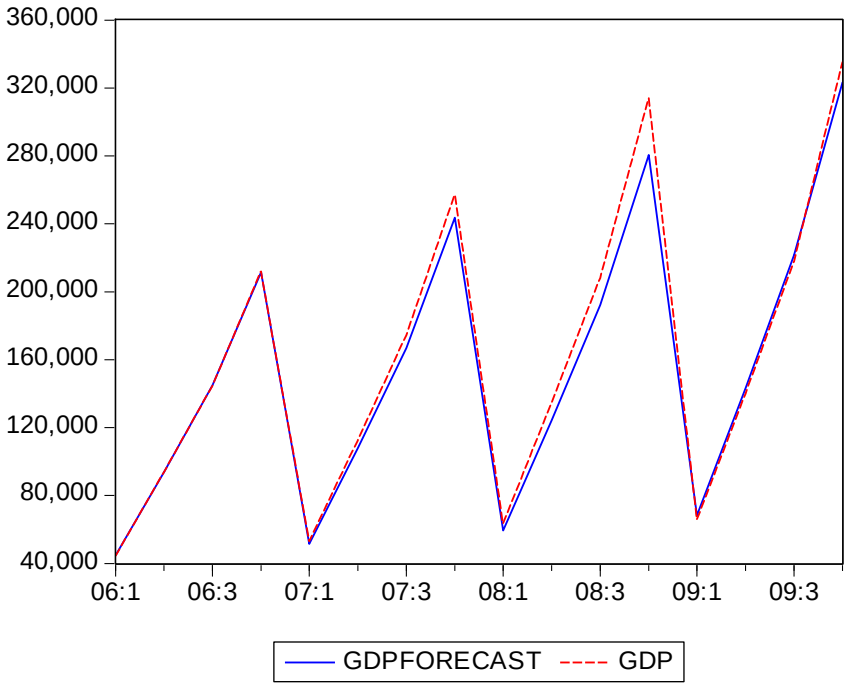

Figure 5: Multi-step-ahead forecasts (Dynamic Forecasts) for 2006Q1 to 2009Q4 from forecast origin 2005Q4 generated using (4).

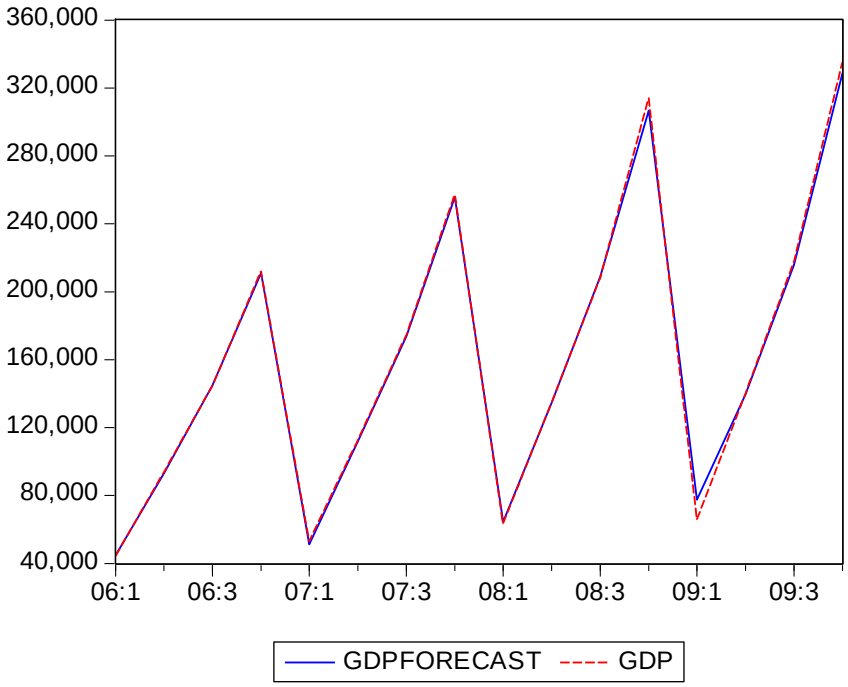

Figure 6: One-step-ahead forecasts (Static Forecasts) for 2006Q1 to 2009Q4 from forecast origin 2005Q4, 2006Q1, and so on, generated using (4).

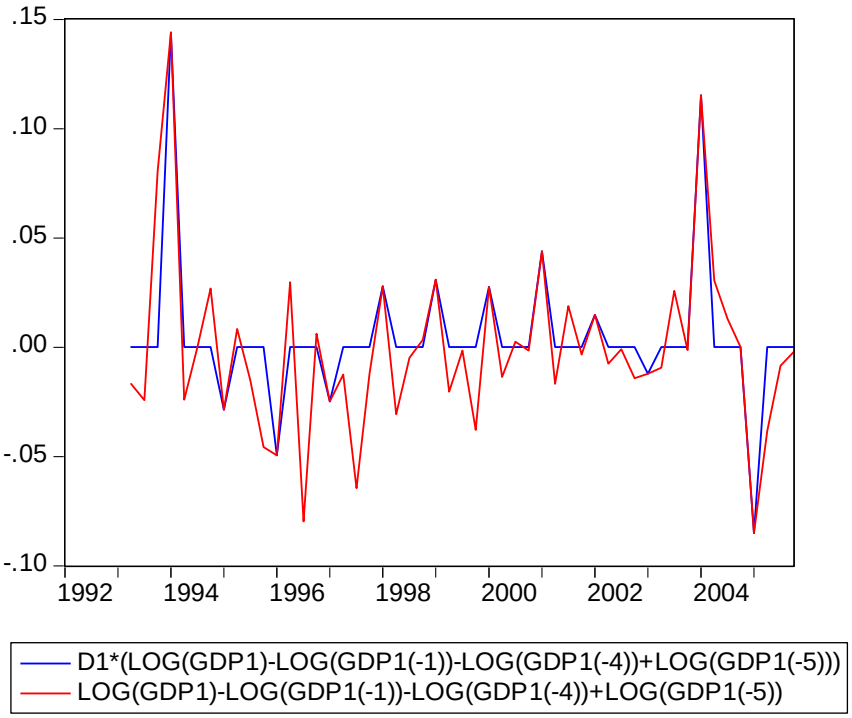

Figure 7: Quarterly change in the annual growth rate of GDP ***Primary Sector*** (cumulated) as the aggregate in current prices, 1992.1-2005.4 versus the same variable when assumed to be non-zero only in Quarter 1

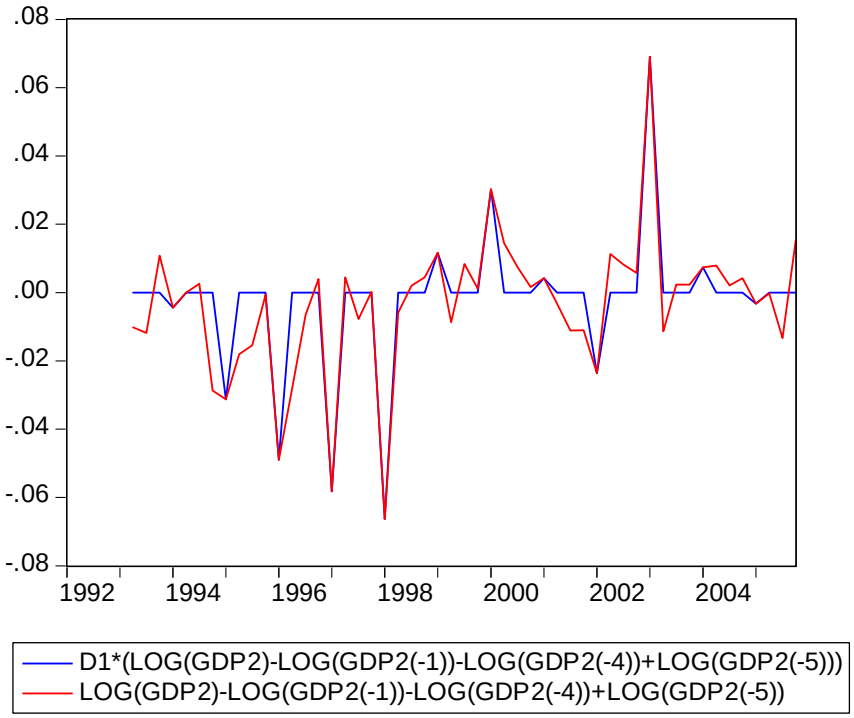

Figure 8: Quarterly change in the annual growth rate of GDP ***Secondary Sector*** (cumulated) as the aggregate in current prices, 1992.1-2005.4 versus the same variable when assumed to be non-zero only in Quarter 1

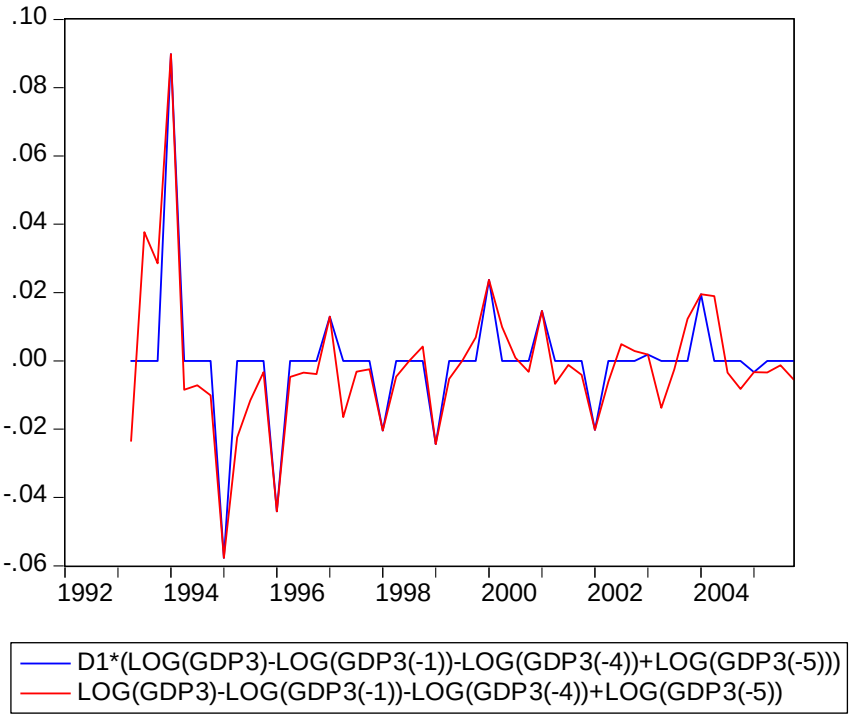

Figure 9: Quarterly change in the annual growth rate of GDP ***Tertiary Sector*** (cumulated) as the aggregate in current prices, 1992.1-2005.4 versus the same variable when assumed to be non-zero only in Quarter 1

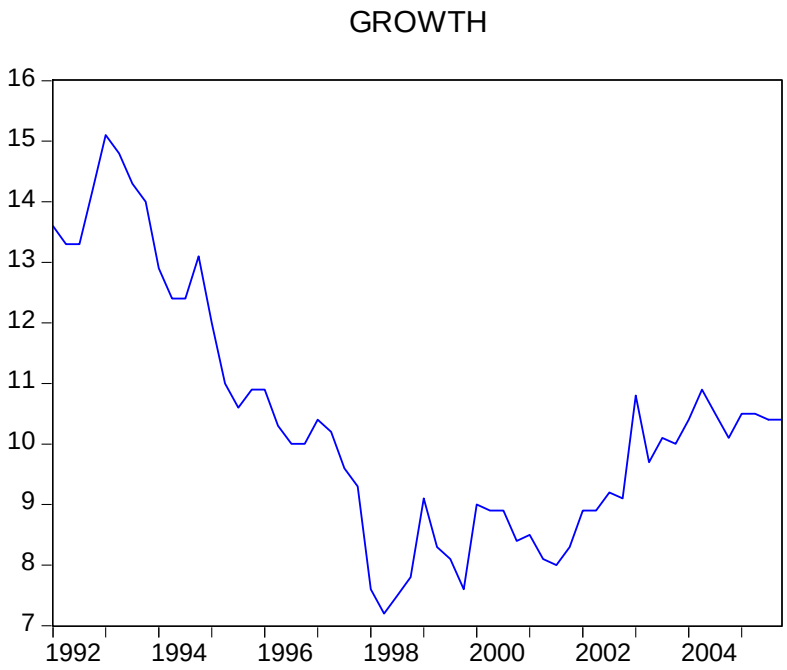

Figure 10: Growth Rate of total GDP, at constant prices, 1992Q1-2005Q4.

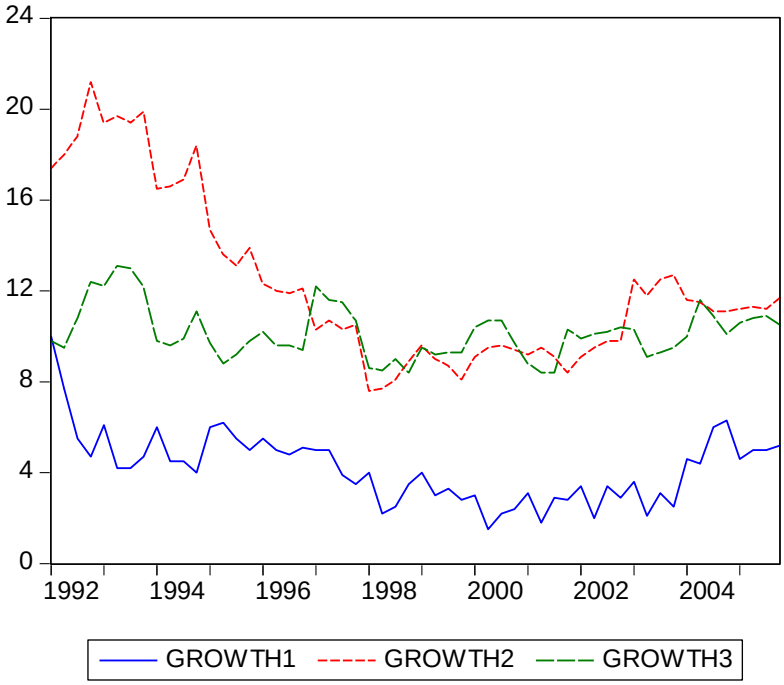

Figure 11: Growth Rate of GDP in the three sectors, at constant prices, 1992Q1-2005Q4.

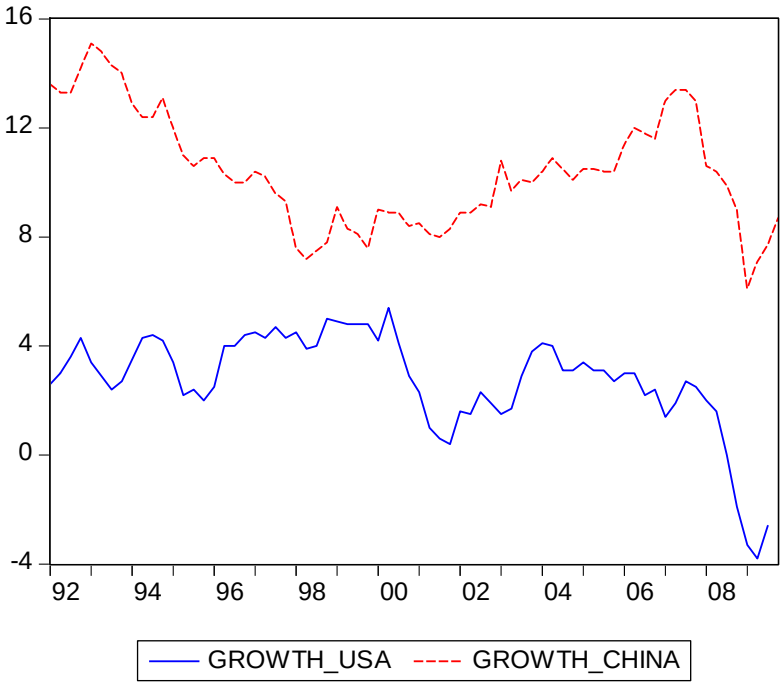

Figure 12: Real growth rates, USA and China, 1992Q1-2009Q4.

Table 1: Multiple-step-ahead forecasts and realizations of the levels of current prices GDP, 2006Q1-2009Q4, percentage forecast error computed as $100 * \frac{GDP - Forecast}{GDP}$

Quarter	Forecast	GDP	Percentage Forecast Error
2006Q1	44702.33	44419.80	-0.636
2006Q2	93691.30	93611.60	-0.085
2006Q3	144968.4	144569.6	-0.276
2006Q4	211573.2	211923.0	0.165
2007Q1	51466.36	53058.00	3.000
2007Q2	107868.0	112458.0	4.082
2007Q3	166903.9	174428.0	4.314
2007Q4	243586.9	257306.0	5.332
2008Q1	59286.41	63475.00	6.599
2008Q2	124257.9	134726.0	7.770
2008Q3	192264.1	208025.0	7.576
2008Q4	280598.7	314045.0	10.650
2009Q1	68332.17	65745.00	-3.935
2009Q2	143216.9	139862.0	-2.399
2009Q3	221599.3	217817.0	-1.736
2009Q4	323411.7	335353.0	3.962

Table 2: One-step-ahead forecasts and realizations of the levels of current prices GDP, 2006Q1-2009Q4, percentage forecast error computed as $100 * \frac{GDP - Forecast}{GDP}$

Quarter	Forecast	GDP	Percentage Forecast Error
2006Q1	44702.33	44419.80	-0.636
2006Q2	93099.14	93611.60	0.547
2006Q3	144845.1	144569.6	-0.191
2006Q4	210991.2	211923.0	0.440
2007Q1	51225.62	53058.00	3.454
2007Q2	111816.0	112458.0	0.571
2007Q3	173675.1	174428.0	0.432
2007Q4	255692.1	257306.0	0.627
2008Q1	64455.67	63475.00	-1.545
2008Q2	134537.1	134726.0	0.140
2008Q3	208966.8	208025.0	-0.453
2008Q4	306866.3	314045.0	2.286
2009Q1	77514.53	65745.00	-17.902
2009Q2	139544.1	139862.0	0.227
2009Q3	215955.3	217817.0	0.855
2009Q4	328827.5	335353.0	1.984
Median error			0.436
Median absolute error			0.599

Table 3: Multiple-step-ahead forecasts and realizations of the levels of current prices GDP, ***Primary Sector***, 2006Q1-2009Q4, percentage forecast error computed as $100 * \frac{GDP - Forecast}{GDP}$

Quarter	Forecast	GDP1	Percentage Forecast Error
2006:1	3253.665	3093.000	-5.195
2006:2	8261.563	7973.600	-3.612
2006:3	15602.39	15058.20	-3.614
2006:4	24908.20	24040.00	-3.612
2007:1	3520.170	3654.000	3.663
2007:2	8938.260	9283.000	3.714
2007:3	16880.37	17937.00	5.891
2007:4	26948.41	28627.00	5.864
2008:1	3816.436	4720.000	19.143
2008:2	9690.526	11800.00	17.877
2008:3	18301.06	22062.00	17.047
2008:4	29216.45	33702.00	13.309
2009:1	4146.254	4700.000	11.782
2009:2	10527.98	12025.00	12.449
2009:3	19882.65	22500.00	11.633
2009:4	31741.35	35477.00	11.769

Table 4: One-step-ahead forecasts and realizations of the levels of current prices GDP, ***Primary Sector***, 2006Q1-2009Q4, percentage forecast error computed as

$$100 * \frac{GDP - Forecast}{GDP}$$

obs	Forecast	GDP1	Percentage Forecast Error
2006Q1	3253.665	3093.000	-5.194
2006Q2	7853.609	7973.600	1.505
2006Q3	15058.56	15058.20	-0.002
2006Q4	24039.44	24040.00	0.002
2007Q1	3229.705	3654.000	11.612
2007Q2	9419.830	9283.000	-1.474
2007Q3	17531.01	17937.00	2.263
2007Q4	28635.92	28627.00	-0.032
2008Q1	4360.271	4720.000	7.621
2008Q2	11991.18	11800.00	-1.620
2008Q3	22800.45	22062.00	-3.347
2008Q4	35210.40	33702.00	-4.476
2009Q1	5568.335	4700.000	-18.475
2009Q2	11750.00	12025.00	2.287
2009Q3	22482.67	22500.00	0.077
2009Q4	34371.09	35477.00	3.218
Median error			0.000
Median absolute error			2.275

Table 5: Multiple-step-ahead forecasts and realizations of the levels of current prices GDP, ***Secondary Sector***, 2006Q1-2009Q4, percentage forecast error computed as $100 * \frac{GDP - Forecast}{GDP}$

Quarter	Forecast	GDP2	Percentage Forecast Error
2006Q1	22439.63	22076.10	-1.647
2006Q2	48387.80	47909.40	-0.999
2006Q3	72804.70	72008.20	-1.106
2006Q4	103352.4	103162.0	-0.185
2007Q1	26565.62	26465.00	-0.380
2007Q2	57284.89	57614.00	0.571
2007Q3	86191.34	86405.00	0.247
2007Q4	122355.8	124799.0	1.958
2008Q1	31473.37	31658.00	0.583
2008Q2	67867.76	69330.00	2.109
2008Q3	102114.4	103974.0	1.789
2008Q4	144960.0	149003.0	2.713
2009Q1	37315.21	31968.00	-16.727
2009Q2	80464.83	70070.00	-14.835
2009Q3	121068.1	106477.0	-13.704
2009Q4	171866.3	156958.0	-8.674

Table 6: One-step-ahead forecasts and realizations of the levels of current prices GDP, ***Secondary Sector***, 2006Q1-2009Q4, percentage forecast error computed as $100 * \frac{GDP - Forecast}{GDP}$

Quarter	Forecast	GDP2	Percentage Forecast Error
2006Q1	22439.63	22076.10	-1.647
2006Q2	47603.90	47909.40	0.638
2006Q3	72084.89	72008.20	-0.107
2006Q4	102221.7	103162.0	0.911
2007Q1	26087.10	26465.00	1.428
2007Q2	57434.16	57614.00	0.312
2007Q3	86594.29	86405.00	-0.219
2007Q4	123787.5	124799.0	0.811
2008Q1	32039.26	31658.00	-1.204
2008Q2	68919.10	69330.00	0.593
2008Q3	103975.7	103974.0	-0.002
2008Q4	150174.8	149003.0	-0.786
2009Q1	37825.67	31968.00	-18.324
2009Q2	70008.89	70070.00	0.087
2009Q3	105083.8	106477.0	1.308
2009Q4	152590.0	156958.0	2.863
Median error			0.200
Median absolute error			0.799

Table 7: Multiple-step-ahead forecasts and realizations of the levels of current prices GDP, ***Tertiary Sector***, 2006Q1-2009Q4, percentage forecast error computed as $100 * \frac{GDP - Forecast}{GDP}$

Quarter	Forecast	GDP3	Percentage Forecast Error
2006Q1	19197.17	19250.70	0.278
2006Q2	37409.47	37728.60	0.846
2006Q3	56898.92	57503.20	1.051
2006Q4	83579.60	84721.00	1.347
2007Q1	21864.42	22939.00	4.685
2007Q2	42607.14	45561.00	6.483
2007Q3	64804.45	70086.00	7.536
2007Q4	95192.14	103880.0	8.364
2008Q1	24918.96	27097.00	8.038
2008Q2	48559.52	53596.00	9.397
2008Q3	73857.88	81989.00	9.917
2008Q4	108490.8	131340.0	17.397
2009Q1	28419.28	29077.00	2.262
2009Q2	55380.59	57767.00	4.131
2009Q3	84232.57	88840.00	5.186
2009Q4	123730.4	142918.0	15.508

Table 8: One-step-ahead forecasts and realizations of the levels of current prices GDP, ***Tertiary Sector***, 2006Q1-2009Q4, percentage forecast error computed as $100 * \frac{GDP - Forecast}{GDP}$

Quarter	Forecast	GDP3	Percentage Forecast Error
2006Q1	19197.17	19250.70	0.278
2006Q2	37513.79	37728.60	0.569
2006Q3	57384.31	57503.20	0.207
2006Q4	84467.23	84721.00	0.300
2007Q1	22224.81	22939.00	3.113
2007Q2	44957.14	45561.00	1.325
2007Q3	69440.78	70086.00	0.921
2007Q4	103259.6	103880.0	0.597
2008Q1	28145.34	27097.00	-3.869
2008Q2	53819.54	53596.00	-0.417
2008Q3	82446.15	81989.00	-0.558
2008Q4	121522.4	131340.0	7.475
2009Q1	34282.89	29077.00	-17.904
2009Q2	57512.30	57767.00	0.441
2009Q3	88369.63	88840.00	0.529
2009Q4	142314.8	142918.0	0.424
Median error			0.433
Median absolute error			0.564

Table 9: One-step-ahead forecast for constant prices growth in GDP (total, based on cumulated data), realizations and differences calculated as Realization-Forecast

Quarter	Forecast	GROWTH	Growth-Forecast
2006Q1	10.7	11.4	0.7
2006Q2	11.0	12.0	1.0
2006Q3	12.0	11.8	-0.2
2006Q4	11.8	11.6	-0.2
2007Q1	11.9	13.0	1.1
2007Q2	12.6	13.4	0.8
2007Q3	13.4	13.4	0.0
2007Q4	13.4	13.0	-0.4
2008Q1	13.3	10.6	-2.7
2008Q2	10.2	10.4	0.2
2008Q3	10.4	9.90	-0.5
2008Q4	9.90	9.00	-0.9
2009Q1	9.30	6.10	-3.2
2009Q2	5.73	7.10	1.4
2009Q3	7.10	7.70	0.6
2009Q4	7.70	8.70	1.0
Median error			0.10
Median absolute error			0.75

Table 10: One-step-ahead forecast for constant prices growth in GDP (***Primary Sector***, based on cumulated data), realizations and differences calculated as Realization-Forecast

Quarter	Forecast	GROWTH1	Growth1-Forecast-
2006Q1	5.9	4.5	-1.4
2006Q2	3.5	5.1	1.6
2006Q3	5.1	4.9	-0.2
2006Q4	4.9	5.0	0.1
2007Q1	5.7	4.4	-1.3
2007Q2	3.4	4.0	0.6
2007Q3	4.0	4.3	0.3
2007Q4	4.3	3.7	-0.6
2008Q1	4.4	2.8	-1.6
2008Q2	1.8	3.5	1.7
2008Q3	3.5	4.5	1.0
2008Q4	4.5	5.5	1.0
2009Q1	6.2	3.5	-2.7
2009Q2	2.5	3.8	1.3
2009Q3	3.8	4.0	0.2
2009Q4	4.0	4.2	0.2
Median error			0.20
Median absolute error			1.00

Table 11: One-step-ahead forecast for constant prices growth in GDP (***Secondary Sector,*** based on cumulated data), realizations and differences calculated as Realization-Forecast

Quarter	Forecast	GROWTH2	Growth2-Forecast-
2006Q1	10.8	12.6	1.8
2006Q2	12.6	13.6	1.0
2006Q3	13.6	13.3	-0.3
2006Q4	13.3	13.0	-0.3
2007Q1	12.1	14.6	2.5
2007Q2	14.6	15.0	0.4
2007Q3	15.0	14.8	-0.2
2007Q4	14.8	14.7	-0.1
2008Q1	13.8	11.5	-2.3
2008Q2	11.5	11.3	-0.2
2008Q3	11.3	10.6	-0.7
2008Q4	10.6	9.3	-1.3
2009Q1	8.4	5.3	-3.1
2009Q2	5.3	6.6	1.3
2009Q3	6.6	7.5	0.9
2009Q4	7.5	9.5	2.0
Median error			-0.15
Median absolute error			0.95

Table 12: One-step-ahead forecast for constant prices growth in GDP (***Tertiary Sector,*** based on cumulated data), realizations and differences calculated as Realization-Forecast

Quarter	Forecast	GROWTH3	Growth3-Forecast-
2006Q1	10.5	11.3	0.8
2006Q2	11.3	11.7	0.4
2006Q3	11.7	11.8	0.1
2006Q4	11.8	12.1	0.3
2007Q1	12.1	12.7	0.6
2007Q2	12.7	13.5	0.8
2007Q3	13.5	14.0	0.5
2007Q4	14.0	13.8	-0.2
2008Q1	13.8	10.9	-2.9
2008Q2	10.9	10.7	-0.2
2008Q3	10.7	10.5	-0.2
2008Q4	10.5	9.50	-1.0
2009Q1	9.50	7.40	-2.1
2009Q2	7.40	8.30	0.9
2009Q3	8.30	8.80	0.5
2009Q4	8.80	8.90	0.1
Median error			0.20
Median absolute error			0.50

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