

# Time Series and Cyclical Analysis on Chinese GDP Growth in 2003-2022

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**Abstract:** This paper analyzes the trend of China's GDP from 2003 to 2022 using time series analysis, detrending and business cycle method. It highlights the importance of government investment in infrastructure and human capital to enhance efficiency in the Chinese economy. The paper finds that consumption, investment, and government consumption are highly positively correlated with GDP, suggesting that the government can stimulate the economy by increasing mass consumption, business investment, and government purchases. However, the value of net exports, which depends on the simultaneous changes of export value and import value, has great uncertainty and makes it difficult for the government to stimulate the economy through changes in net exports. Furthermore, the paper suggests that the priority in stimulating the economy should be given to increasing government consumption, followed by consumption and investment. The paper proposes several stimulus measures, including increasing infrastructure construction, issuing consumer vouchers, and reducing interest rates for business loans. These measures aim to boost government consumption, stimulate consumption, and encourage business investment, ultimately contributing to economic growth and development.

**Keywords:** Chinese GDP Growth; Time Series Analysis; Detrending; Business Cycle.

## 1. Introduction

GDP (Gross Domestic Product) is the final result of all permanent units in a country (or region) in a certain period of time. Under the expenditure approach, GDP is calculated as the total value of purchases made by all final user [1]. The components of GDP are personal consumption, private investment, government consumption and net exports of goods and services [2]. With the pandemic over, innovation and digitization reignited China's economic growth. The economy grew 18.3% year-on-year in the first quarter of 2021. It's the most significant GDP increase since China began tracking quarterly GDP in 1992[3]. Chinese consumption has been steadily increasing for many years; however, it did not keep pace with other components of GDP. This was the result of an extraordinarily high Chinese saving rate, one of the highest in the world. At the same time the trade balance has been gradually becoming less important for the Chinese economy. China should focus more on its domestic economy, and this is something it has been doing in the last few years. Additionally, government investment in infrastructure and human capital should continue, in order to enhance efficiency in the Chinese economy [4]. The components of GDP are time series data because they are variables that takes different values at different times. This paper uses the time series analysis, detrending and business cycle method to analyze the trend of China's GDP from 2003 to 2022, so as to provide a numerical reference for economic policy decision-making.

## 2. The Model

### 2.1. Trend, Detrend and Cyclical Components:

Trend component is a general pattern detected in the time series data over a long period of time. Cyclical component is fluctuations detected in the time series data around the trend. This paper detrended the data by calculating each cyclical component to remove time factor. Cyclical component

formula: Cyclical component = (real-trend)/trend \*100%.

**The variables** are the value of GDP, GDP trend, difference between real GDP and GDP trend ,GDP cyclical; consumption, consumption trend, difference between real consumption and consumption trend, consumption cyclical; investment, investment trend, difference between real investment and investment trend, investment cyclical; government consumption, government consumption trend, difference between real government consumption and government consumption trend, government consumption cyclical; net export, net export trend, difference between real net export and net export trend, and net export cyclical.

### 2.2. Standard Deviation and Correlation

Standard deviation is a statistic that measures the dispersion of a dataset relative to its means. Correlation is a statistics that measures the degree to which two datasets move in coordination with one another, the value always lies in the range of (-1,1).

## 3. The Data

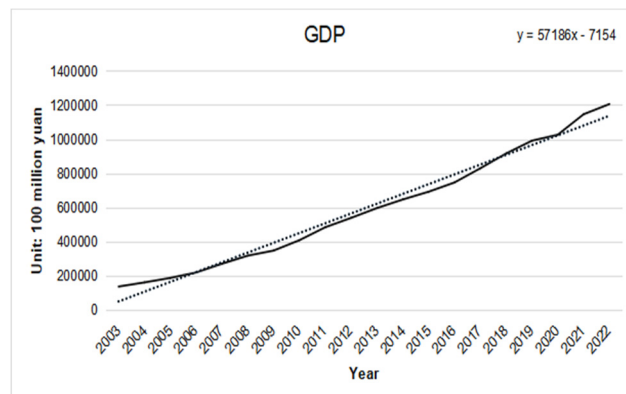
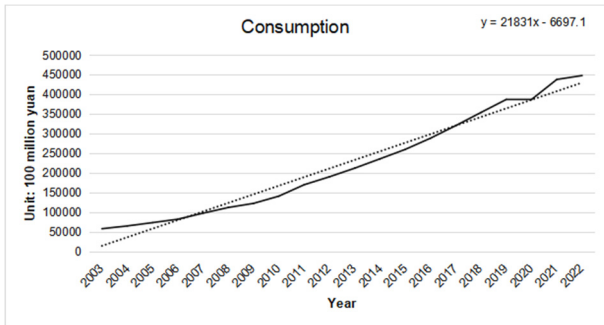


Figure 1. Chinese GDP Trend graph 2003-2022.

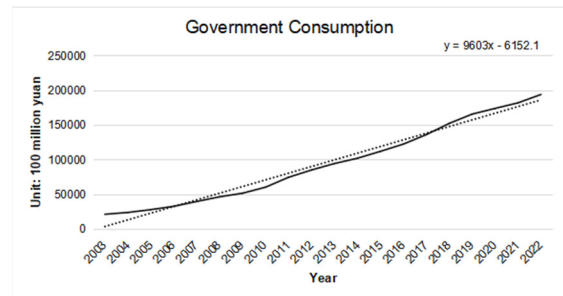
**Table 1. Chinese GDP data 2003-2022**

Year	GDP	Consumption	Investment	Government Consumption	Net Export
2003	137146.7	58689.9	54446.8	21045.1	2964.9
2004	161355.6	65724.8	67725.6	23669.7	4235.6
2005	187657.5	74153.7	75576	27718.8	10209.1
2006	219597.5	82842.4	87578.6	32521.9	16654.6
2007	270499.4	98231.3	109339.3	39505.8	23423.1
2008	318067.6	112654.7	134941.6	46244.5	24226.8
2009	347650.3	123121.9	158074.5	51416.7	15037.1
2010	408505.4	141465.5	191866.9	60115.9	15057.1
2011	484109.3	170390.8	227673.5	74356.5	11688.5
2012	539039.9	190584.8	248960	84859.1	14636
2013	596344.5	212477.3	275128.7	94186.4	14552.1
2014	646548	236238.5	294906.1	101792.7	13610.8
2015	692093.7	260202.4	297826.5	111718.2	22346.5
2016	745980.5	288668.2	318198.5	122138.3	16975.6
2017	828982.8	320689.5	357886.1	135828.7	14578.4
2018	915774.3	354124.4	402585.2	152010.6	7054.2
2019	990708.4	387188.1	426678.7	165443.6	11397.9
2020	1025628.4	387185.8	439550.3	173625.4	25266.9
2021	1145282.9	438015.2	495784.3	181673	29810.5
2022	1205017	447910.2	523890.4	193722.8	39493.7

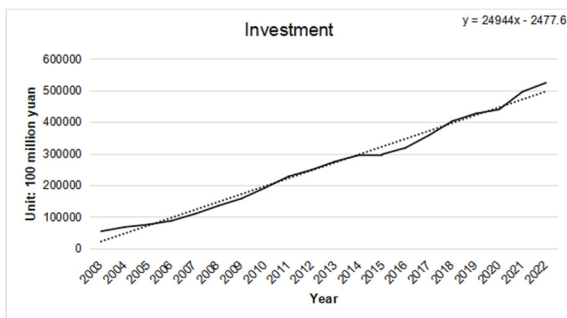
Note: Source: NBS Unit: 100 million yuan



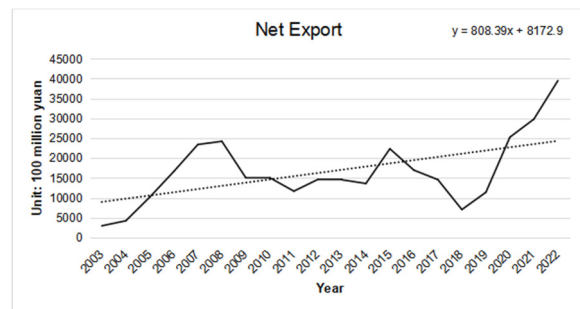
**Figure 2. Chinese Consumption Trend Graph 2003-2022.**



**Figure 4. Chinese Government Consumption Trend Graph 2003-2022.**



**Figure 3. Chinese Investment Trend Graph 2003-2022.**



**Figure 5. Chinese Net Export Trend Graph 2003-2022.**

The standard deviation values for GDP cyclical components is 40.86%, this implies the degree of discrete of this set of data GDP cyclical and its mean value is 40.86%. The standard deviation values for consumption cyclical components is 67.05%, this implies the degree of discrete of this set of data consumption cyclical and its mean value is 67.05%. The standard deviation values for investment cyclical component is 33.73%, this implies the degree of discrete of this set of data investment cyclical and its mean value is 33.73%. The standard deviation values for Government Consumption cyclical component is 115.35%, this implies the degree of discrete of this set of data Government Consumption cyclical and its mean value is 115.35%. The standard deviation values for Net Export

cyclical component is 45.89%, this implies the degree of discrete of this set of data Net Export cyclical and its mean value is 45.89%.

The ratio of consumption cyclical standard deviation and GDP cyclical standard deviation is 1.64, this implies the fluctuation degree of consumption cyclical standard deviation is 1.64 times of the fluctuation degree of GDP cyclical standard deviation. The ratio of investment cyclical standard deviation and GDP cyclical standard deviation is 0.83, this implies the fluctuation degree of investment cyclical standard deviation is 0.83 times of the fluctuation degree of GDP cyclical standard deviation.

**Table 2.** Cyclical graph 2003-2022.

Year	GDP cyclical	Consumption cyclical	Investment cyclical	Government Consumption cyclical	Net Export cyclical
2003	174.12%	287.80%	142.35%	509.84%	-66.99%
2004	50.49%	77.80%	42.85%	81.32%	-56.73%
2005	14.14%	26.12%	4.45%	22.34%	-3.67%
2006	-0.90%	2.75%	-9.99%	0.81%	46.01%
2007	-2.97%	-4.13%	-10.56%	-5.63%	91.76%
2008	-5.33%	-9.36%	-8.32%	-10.15%	86.03%
2009	-11.57%	-15.74%	-8.17%	-15.81%	8.72%
2010	-9.29%	-15.77%	-2.64%	-14.94%	2.85%
2011	-4.61%	-10.22%	2.55%	-7.37%	-24.34%
2012	-4.55%	-9.94%	0.81%	-5.58%	-9.97%
2013	-4.11%	-8.98%	1.19%	-5.32%	-14.73%
2014	-4.79%	-7.46%	-0.65%	-6.68%	-23.85%
2015	-6.00%	-6.10%	-7.45%	-5.87%	19.62%
2016	-5.98%	-3.44%	-8.23%	-4.80%	-12.90%
2017	-2.55%	-0.02%	-3.71%	-1.50%	-28.18%
2018	0.88%	3.36%	1.50%	3.06%	-66.58%
2019	2.66%	6.24%	1.21%	5.31%	-47.99%
2020	0.34%	0.24%	-1.56%	4.15%	11.19%
2021	6.11%	7.33%	5.16%	3.04%	26.68%
2022	6.02%	4.18%	5.54%	4.20%	62.25%

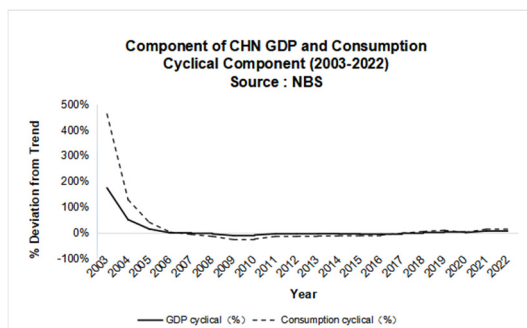
**Table 3.** Standard deviation value

GDP Cyclical Component SD	40.86%
Consumption Cyclical Component SD	67.05%
Investment Cyclical Component SD	33.73%
Government Consumption Cyclical Component SD	115.35%
Net Export Cyclical Component SD	45.89%

**Table 4.** Standard deviation ratio

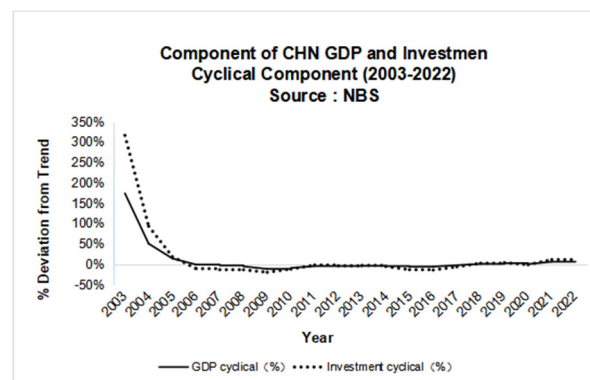
Consumption SD / GDP SD	1.64
Investment SD / GDP SD	0.83
Government Consumption SD / GDP SD	2.82
Net Export SD / GDP SD	1.12

The ratio of Government consumption cyclical standard deviation and GDP cyclical standard deviation is 2.82, this implies the fluctuation degree of Government Consumption cyclical standard deviation is 2.82 times of the fluctuation degree of GDP cyclical standard deviation. The ratio of net export cyclical standard deviation and GDP cyclical standard deviation is 1.12, this implies the fluctuation degree of net export cyclical standard deviation is 1.12 times of the fluctuation degree of GDP cyclical standard deviation.



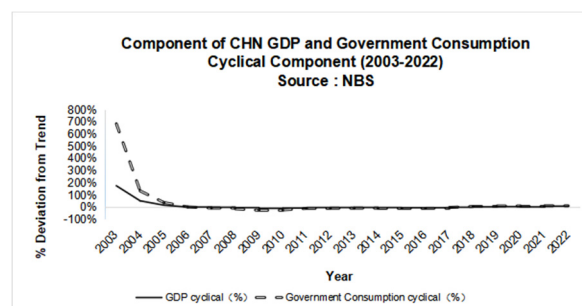
**Figure 6.** Component of CHN GDP and Consumption Cyclical Component (2003-2022).

The co-movement Figure 6 indicates that the cyclical fluctuations of consumption are 1.64 times that of GDP cyclical fluctuations.



**Figure 7.** Component of CHN GDP and Investment Cyclical Component (2003-2022).

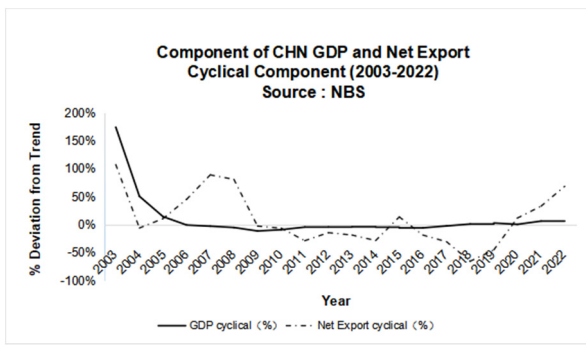
The co-movement Figure 7 indicates that the cyclical fluctuations of investment are 0.83 times that of GDP cyclical fluctuations.



**Figure 8.** Component of CHN GDP and Government Consumption Cyclical Component (2003-2022).

The co-movement Figure 8 indicates that the cyclical fluctuations of government consumption are 2.82 times that of GDP cyclical fluctuations.

The co-movement Figure 9 indicates that the cyclical fluctuations of consumption are 1.12 times that of GDP cyclical fluctuations.



**Figure 9.** Component of CHN GDP and Net Export Cyclical Component (2003-2022).

**Table 5.** Correlation value.

GDP & Consumption Cyclical Component Correlation	0.999
GDP & Investment Cyclical Component Correlation	0.992
GDP & Government Consumption Cyclical Component Correlation	0.989
GDP & Net Export Cyclical Component Correlation	-0.414

Correlation between the cyclical components of China GDP and of consumption is 0.999, this implies cyclical components of China GDP and of consumption have the same ascending and fall, they are highly correlated. Correlation between the cyclical components of China GDP and of investment is 0.992, this implies cyclical components of China GDP and of investment have the same ascending and fall, they are highly correlated. Correlation between the cyclical components of China GDP and of government consumption is 0.989, this implies cyclical components of China GDP and of government consumption have the same ascending and fall, they are highly correlated. Correlation between the cyclical components of China GDP and of net export is -0.414, this implies cyclical components of China GDP and of net export have the opposite ascending and fall, they are weakly correlated.

## 4. Results

Consumption is highly positively correlated with GDP, investment is highly positively correlated with GDP, government consumption is highly positively correlated with GDP and net exports are negatively correlated with GDP. Government consumption standard deviation / GDP standard deviation is bigger than consumption standard deviation / GDP standard deviation, consumption standard deviation / GDP standard deviation is bigger than investment standard deviation / GDP standard deviation.

## 5. Conclusion

As consumption, investment and government consumption are highly positively correlated with GDP, the government can stimulate the economy by increasing mass consumption business investment and government purchases. The value of net exports is equal to the value of exports minus the value of

imports. Therefore, the change of the net export value depends on the simultaneous changes of the two variables of export value and import value. Since the import value and the export value do not necessarily rise and fall at the same time, the change of the net export value has great uncertainty. Therefore, it is difficult for the government to stimulate the economy by changing the amount of net exports. The larger the value of -standard deviation ratio, the more this item is easier to recover the economy in the short term. As Government consumption standard deviation / GDP standard deviation is bigger than consumption standard deviation / GDP standard deviation, consumption standard deviation / GDP standard deviation is bigger than investment standard deviation / GDP standard deviation. The priority in which the government stimulates the economy can be: first increase government consumption, second increase consumption, and finally increase investment. Stimulus Economic measures are as follows: Measures to increase government consumption: continue to increase infrastructure construction, especially new infrastructure, continue to innovate, shift from traditional infrastructure to new infrastructure, such as digital infrastructure, government online administrative platforms which could improve the government efficiency. Measures to increase consumption: In the short term, the government can issue consumer vouchers to send money directly to the people to stimulate consumption. Consumption levels are easy to rise but hard to fall. From a long-term perspective, in the future, the income level of residents should be continuously increased, the distribution structure of residents' income should be improved, and the proportion of residents' consumption in GDP should be continuously increased, so as to ensure a smoother economic internal cycle and more sustainable economic development [5]. Measures to increase business investment: reduce interest rates in the short term, reduce business loan interest rates so that companies can borrow money from banks for investment.

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