Potential Stimulation of Economy in China After COVID-19 Crisis——Analysis Through Past Data of Chinese GDP

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Abstract —The economy of China could be in need for stimulation after the crisis of COVID-19, and in which area should it be stimulated is the question that should be discussed. This paper analyzed potential feasible stimulation for this short-term shock using historical GDP data of China from 1980 to 2021 and the method of HP-filter. The result of this paper indicated that: 1) a high synchronization and positive correlation can be discovered in the cyclical component of consumption and investment with GDP in China; 2) similar dispersion of data with cyclical GDP could be found in the cyclical part of consumption and government spending, while the distribution of cyclical net export and investment were relatively unstable; 3) stimulation through investment could be a potential direction for the recovery of Chinese economy after COVID-19.

Keywords: GDP, Cyclical Analysis, Co-movement

1. Introduction

The recovery of economy could be important for a country after the shock of certain crisis. Ever since 2020, when the outbreak of COVID-19 took place in Wuhan, Hubei Province, China had suffered from serious economic loss and stimulation of economic growth could be in urgent need for the recovery and further development of Chinese economy. To find potential solution for mitigating the negative impact of this COVID-19 pandemic, either analysis upon past data or estimation of future performance could be feasible. This paper would use the former approach to find possible solution through data of Chinese GDP from 1980 to 2021 using final demand approach of GDP calculation, which divides GDP into four components of consumption, investment, government expenditure and net export to locate possible direction of economic stimulation for solving this crisis. Due to the characteristic of short-term effect of COVID-19, analysis upon the cyclical variation of each component would be conducted using the detrending process through HP-filter. After obtaining empirical result of calculation, this paper has provided possible policy suggestion of stimulating economy during this period through investment and drawn three conclusions: 1) consumption and investment are the two components whose cyclical variation were highly synchronized and positively correlated with the one of overall GDP in China; 2) Investment and net export in China were relatively cyclically volatile while consumption and government spending had similar cyclical data dispersion with GDP; 3) stimulation through investment could be potential solution in mitigating short-run economic shock such as COVID-19 in China.

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2. Literature review

Ever since the beginning of 2020, the time point when the outbreak of COVID-19 took place in Wuhan, Hubei Province in China, Chinese economy has encountered serious downturn, which can be confirmed through relative researched in the past two years. The estimates of Zhang et al. indicated that within the first quarter, the GDP in China has decreased by approximately 6.7% and decrease of 9.4% and 5.3% can be discovered in the production of the second and third industry together with a decrease in the value added by agricultural industry 3.2% for the same time period [1]. For provinces such as Hubei and Sichuan where serious pandemic has taken place or strict lockdown policies has been enforced, the negative impact of COVID-19 could be even worse. According to the research conducted by Ke and Hsiao, during the first quarter of 2020, a decrease of approximately 37% and 46% in the total GDP and secondary value added of Hubei Province respectively due to the lock down policy [2]. The situation in Sichuan can be confirmed through a survey claimed that small and medium enterprises in Sichuan, who contribute the majority of economic growth, has suffered from great crisis of survival and resulted in an obvious recession of local economy [3]. With the crucial impact of COVID-19 on Chinese economy, to assist the stabilization of domestic economy, specific method could be applied by the government to stimulate the recovery of economy, but to which direction should the stimulation be promoted is the question that worth discussing.

To analyze the feasible stimulation for economy short-term downturn as COVID-19, the historical cyclical variation of GDP and its component can be applied. GDP refers to gross domestic product, and it is the core idea that used to measure the economic status and development level of specific region. Through the estimation of GDP within a given time period, the developing trend and volatility of regional economy can be revealed. As stated by Landefeld et al., GDP of countries can be measured by three approaches: value-added approach, income by type approach and final demand approach [4]. Within the method of final demand approach, GDP can be divided into four components of consumption, investment, government spending and net export, thus it is possible to analyze how GDP would interact with the variation of each of the four components to give a potential direction of economic stimulation. There have been certain researches illustrating the stimulation effect of each of these components. For instance, Connoly and Li argued that government consumption spending has no significant effect on the growth of GDP while Liao, Wang and Huang highlighted in their article that growth in real GDP can be promoted by consumption for some degree with certain negative effect [5,6]. Although these statements are well supported by sufficient evidence, they might not be suitable for explaining the situation in China, which makes the analysis upon the interaction between GDP and its four components relatively important before giving reliable policy suggestions. Furthermore, through the research of de Groot and Franses that multiple cycles could exist for a stable economic variable, which could be of great assistance for economies in maintaining the balance from exogenous shock [7]. In considering this, due to the characteristic of short-term shock of COVID-19, it could be feasible to analyze possible solution through the interaction of the cyclical data of GDP and its four components.

With the review stated above, this article would apply the cyclical researching method used by Yan and Shi that in analyzing the interaction between clean energy consumption and GDP to evaluate how the variation in each GDP component would stimulate the change in overall GDP [8]. The detrending process of data would be conducted using the HP-filter developed and

applied by Hodrick and Prescott [9]. This method would be used together with the time series data of Chinese GDP and its component from 1980 to 2021 to examine whether each component could be feasible in the short-term stimulation of economy during COVID-19 pandemic.

3. Data and Methodology

3.1 Data

To estimate the cyclical volatility of GDP components, cyclical correlation between each of them and GDP in China, data about Chinese GDP, consumption, investment, government expenditure and net export within the time period from 1980 to 2021 has been obtained from National Bureau of Statistic. However, due to the lack of relevant price index of each component and inflation rate covering the period, the data used was the nominal GDP and its component within China.

3.2 Methodology

GDP can be defined as a time series data as it is possessed through the observation upon the same targeted substance within a given time period that can reflect the variation of GDP according to time, thus GDP and its component should satisfy the following equation:

$$Time\ series = Trend + Cyclical\ Difference \ldots (1)$$

Trend is the overall direction that specific time series data is developing towards, whilst cyclical component refers to the difference between the real result of time series data and the trend of it, which is caused by the volatility of the data. Cyclical component could be an important element for estimating the volatility of the five data set and how each component interact with GDP as it does not include trend that would disturb the overall observation. In this case, in order to demonstrate the variation of each component and the correlation between them and GDP, detrending process is needed to extract cyclical percentage from the time series data of GDP, and the method of HP-filter is used in the article for estimating the trend of each data set.

HP-filter refers to the model developed by Hodrick and Prescott which is used to estimate the trend of specific time series data set [6]. Its main purpose is to make trend value estimation be in line with two demands, and the first one can be expressed as:

$$min\left(\sum_{t=1}^{T}(y_t - \tau_t)^2\right) \ldots (2)$$

Within this function, T refers to the time stamp of the final observation upon the data set, t is the time stamp of each individual observation, y_t is the real result of the observation upon the time series data at time t, τ_t means the trend value of the time series data at time t. The former part of the function demonstrates the sum of the difference between the real observation and the trend value estimated at specific time point, each result within the sum is squared to prevent reciprocal results from cancelling each other. To achieve the objective of having a trend value evaluation that can perfectly fit the observation result, this should be minimized so that the estimated trend would be perfectly significant in presenting the development of the time series data observed.

The second requirement for trend evaluation is:

$$min\left(\sum_{t=2}^{T-1}[(\tau_{t+1}-\tau_t)-(\tau_t-\tau_{t-1})]^2\right)\ldots(3)$$

This function is the sum of difference between two margins among three trend value estimated, and they have all been squared before summing up for the same purpose mentioned above. As trend line is expected to be a smooth curve, the margins between each two points should be as close to each other as possible, which would make the latter part of HP-filter function close to zero.

However, to make the trend line as smooth as possible, its fluctuation would also be minimized and makes it almost impossible to satisfy the demand of perfectly fitting the real results from observation, which would make the two requirements conflict with each other. In considering this, Hodrick and Prescott promote this function to combine the two requirements:

$$min\left(\sum_{t=1}^{T}(y_t-\tau_t)^2+\sum_{t=2}^{T-1}[(\tau_{t+1}-\tau_t)-(\tau_t-\tau_{t-1})]^2\right)\ldots(4)$$

This equation illustrates that idea that the best trend estimation should be as close to real result as possible and has a curve as smooth as possible. By minimizing the combination of the two effects, the theoretical significant trend evaluation can be formed. With the trend value being obtained through HP-filter, the cyclical component of GDP, consumption, investment, government expenditure and net export can be calculated as:

$$cyclical\ component = (observation - trend\ value) \div trend\ value \ldots(5)$$

With this cyclical component computed, it would now be possible to estimate the variance, volatility, and correlation of GDP and each of its components.

4. Empirical Result

4.1 HP-filter trend estimation

It is an important step to test whether the trend value estimated through HP-filter can explain real trend of GDP development well. Due to the requirement for data detrending, an appropriate and accurate trend estimation of GDP and each of its components should be ensured. Real Data and Trend Estimation of Chinese GDP, Consumption, Investment, Government Expenditure and Net Export as shown in Figure1-5.

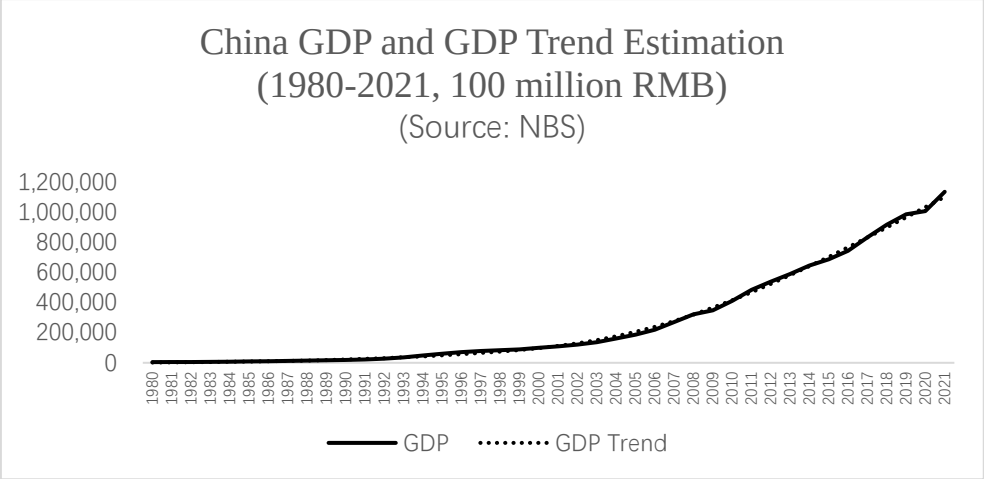

Figure 1. China GDP and GDP Trend Estimation (1980-2021, 100 million RMB)

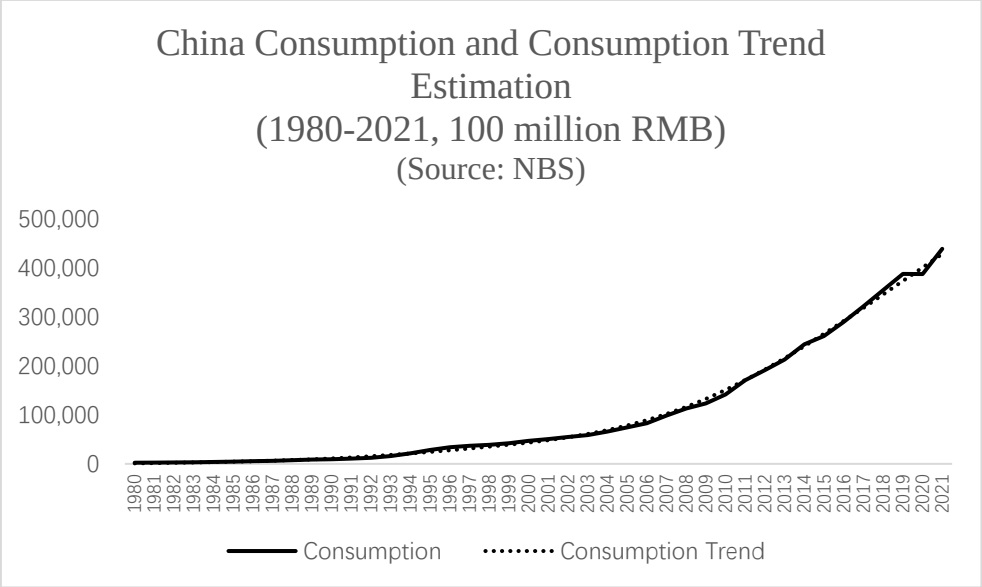

Figure 2. China Consumption and Consumption Trend Estimation (1980-2021, 100 million RMB)

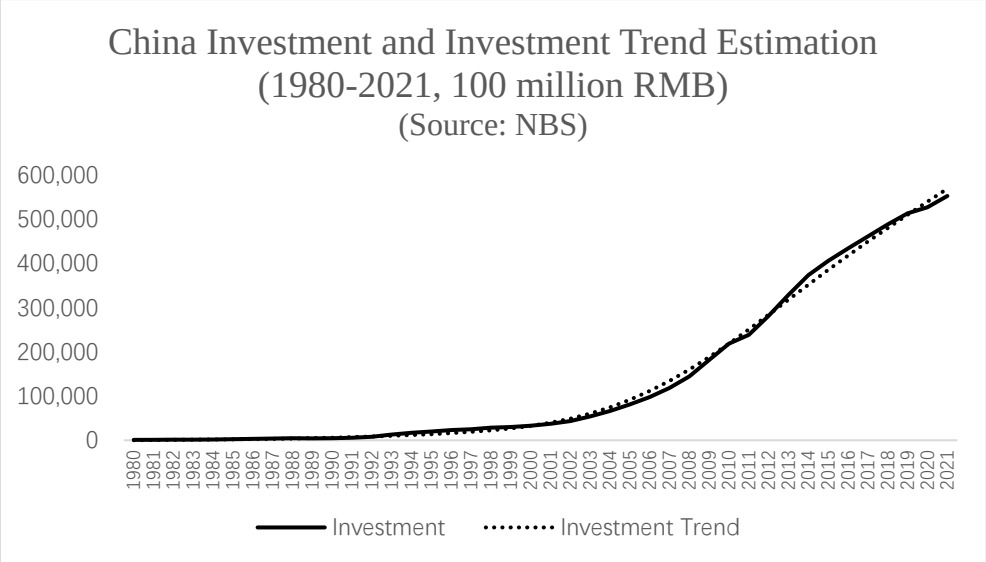

Figure 3. China Investment and Investment Trend Estimation (1980-2021, 100 million RMB)

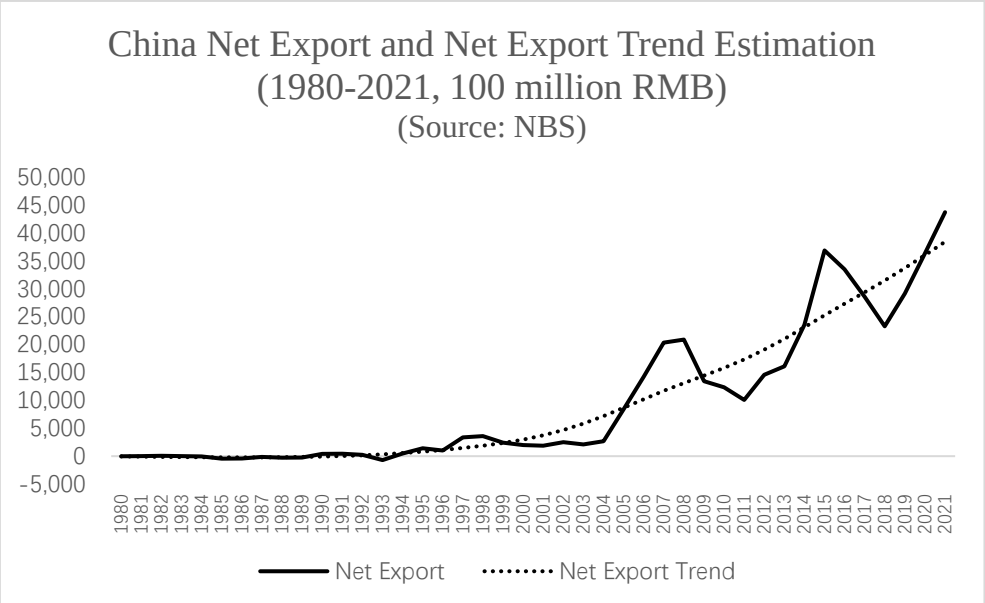

Figure 4. China Net Export and Net Export Trend Estimation (1980-2021, 100 million RMB)

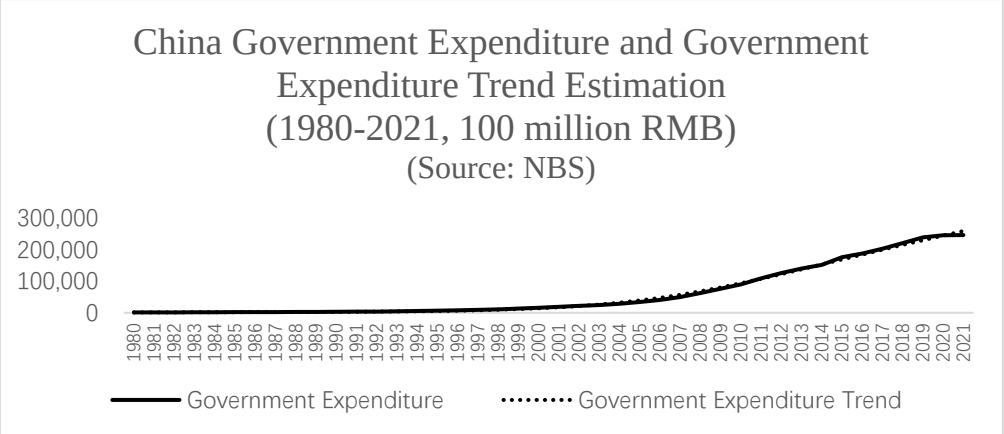

Figure 5. China Government Expenditure and Government Expenditure Trend Estimation (1980-2021, 100 million RMB)

Figure 1 is the line graph composed of the real data the trend estimation of Chinese GDP from 1980 to 2021. It can be observed from Figure 1 that, the trend estimation of GDP through HP-filter was highly synchronized with movement of the real result from observation, thus it is feasible to use data estimated to conduct detrending process on GDP. At the same time, Figure 2, the line graph that demonstrated consumption's trend value and real data within the period of 42 years, has shown a moderate variation in the trend estimated that make it feasible in explaining the developing trend of Chinese GDP. What is more, the trend result of Chinese investment from HP-filter estimation was in line with the observation (see Figure 3). However, as shown in Figure 4, although the curve of trend estimation of net export remained at the center of the real data curve, it was not significant in estimating the development of net export in China. This could be the result of high volatility of net export. Lastly, the graph in Figure 5 could produce the similar result with Figure 1-3, that government expenditure in China would be able to possess trend that highly synchronized with real records.

4.2 Co-movement and correlation analysis

With the trend value obtained, the cyclical component of GDP and each of its components can be expressed through the equation:

$$Cyclical = \frac{Real\ Data - Trend}{Trend} \dots (6)$$

After conducting the process of obtaining cyclical component, the co-movement between each component and GDP itself can be illustrated with their movement graph as shown Figure 6-9 below.

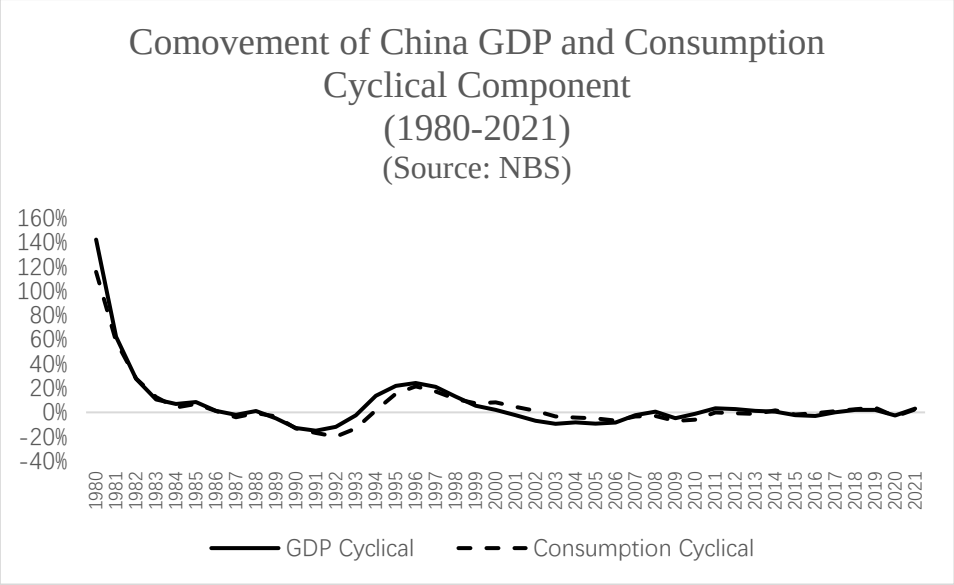

Figure 6. Comovement of China GDP and Consumption Cyclical Component (1980-2021)

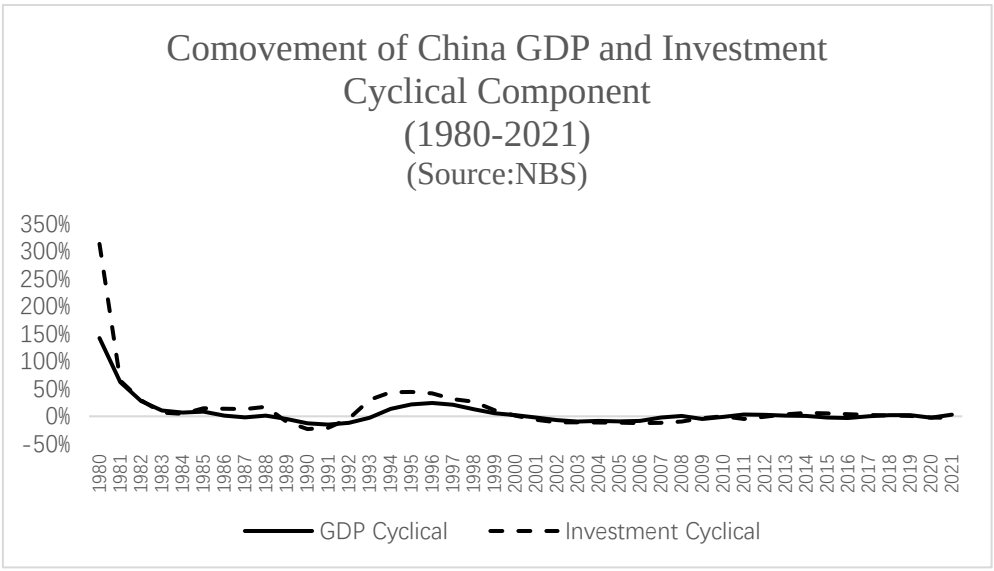

Figure 7. Comovement of China GDP and Investment Cyclical Component (1980-2021)

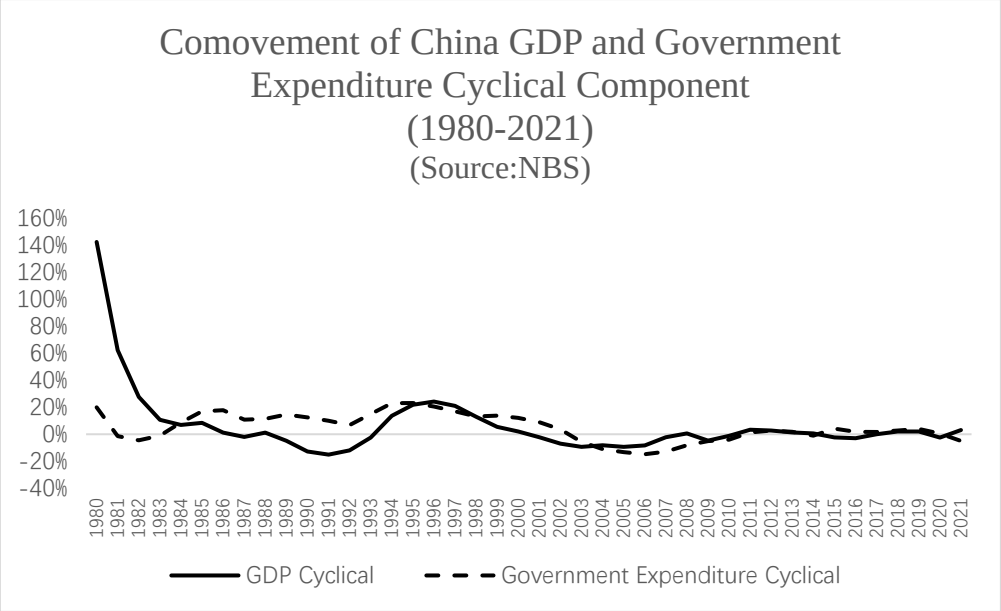

Figure 8. Comovement of China GDP and Government Expenditure Cyclical Component (1980-2021)

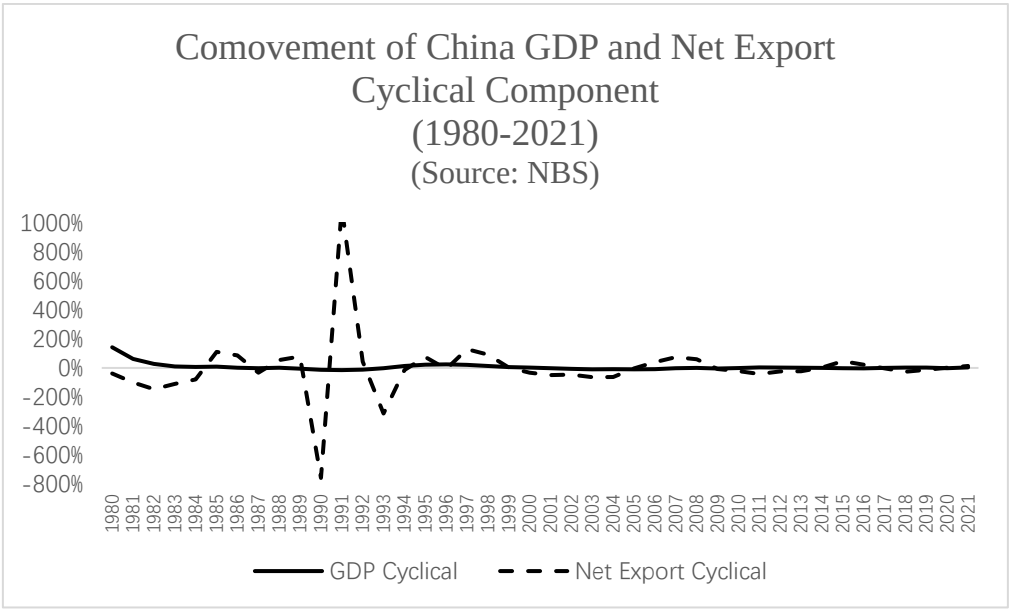

Figure 9. Comovement of China GDP and Net Export Cyclical Component (1980-2021)

As can be observed through Figure 6-9, almost all of GDP and its components has experienced a significant high cyclical variation at the beginning of the time period from 1980 to 2021. Potential reason behind this could be the reform and open policy that had been launched since 1978

in China, which had led to a tremendous increase in the growth of Chinese economy. As demonstrated in Figure 6 and Figure 7, the variance of cyclical component of both consumption and investment was highly synchronized with the circumstance of GDP cyclical component throughout the time period observed, whilst a relatively higher volatility can be discovered in the one of investment. Meanwhile, it can also be discovered through Figure 8 that even with a similar variation with GDP cyclical, the cyclical component of government expenditure was not proven to have a strong co-movement with GDP. What is more, as shown in Figure 9, the variation of cyclical net export was extremely volatile in comparison with other factors and its co-movement with cyclical GDP could not be directly observed from the graph. The statement above indicates that consumption and investment are the two components that have similar cyclical variation with GDP in China in comparison with government expenditure and net export, which could be a support for stimulating economy through these two aspects.

In addition to co-movement analysis, the relationship among GDP and its components can also be illustrated through their correlation. After conducting a correlation calculation, this paper has generated Table 1 below to present the correlation of GDP and its four components.

Table 1. Correlation of Cyclical GDP and Its Components

GDP & Consumption Correlation	0.982
GDP & Investment Correlation	0.957
GDP & Government Expenditure Correlation	0.312
GDP & Net Export Correlation	-0.076

The result of correlation calculation in Table 1 clarified a high and positive correlation of consumption and investment with GDP greater than 0.5, which revealed the possibility of promoting an obvious increase in GDP through the increase in consumption and investment. However, it can also be observed from Table 1 that, due to the insignificant correlation that government and net export had upon cyclical GDP, especially with a negative correlation that net export possessed, these two parts might not be feasible in ensuring the growth of GDP.

4.3 Volatility analysis

To further confirm the volatility of each cyclical components and the co-movement among them, the standard deviation of each cyclical data set and the standard deviation ratio between components have been applied. The estimated result has been presented in Table 2 and Table 3 respectively.

Table 2. Standard Deviation of GDP and Each of Its Components

GDP Cyclical SD	0.253
Consumption Cyclical SD	0.217
Investment Cyclical SD	0.511
Government Expenditure Cyclical SD	0.102

Net Export Cyclical SD	2.231

Note: The standard deviation ratio between components was calculated using the standard deviation of each cyclical component divided by cyclical GDP.

Table 3. Cyclical Standard Deviation Ratio between each component and GDP

Consumption and GDP Cyclical SD Ratio	0.857
Investment and GDP Cyclical SD Ratio	2.016
Government Expenditure and GDP Cyclical SD Ratio	0.403
Net Export and GDP Cyclical SD Ratio	8.801

According to Table 2 above, investment and net export are the two data sets that had a relatively larger value for standard deviation, which indicated a large dispersion of distribution of these two components, while the standard deviation of the other three data set tended to have a stable distribution of data. Furthermore, Table 3 implied that consumption and government expenditure fluctuate in the similar range with cyclical GDP, while the cyclical variation of investment and net export are much larger than the one of GDP. The result above can be interpreted as that cyclical variation of consumption and government spending would be relatively stable and difficult to vary largely in the short term. What is more, the other two fragments would have a large range of cyclical component and would be altered with less difficulty.

5. Conclusion

Using HP-filter approach for detrending and the time series data of Chinese GDP, consumption, investment, government expenditure and net export from 1980 to 2021, this article could draw the three conclusions stated below.

First, for the situation in China, consumption and investment are the two components which possess cyclical variation highly synchronized and positively correlated with GDP. However, the correlation that government expenditure and net export have was not proven to be significant. According to this, it can be suggested that when in need of stimulating local economy, the stimulation through domestic consumption and investment could be relatively more feasible than through government expenditure and net export, because the change in the former two components would possibly result in the variation of the same direction due to the positive and strong correlation they have.

What is more, the empirical result also illustrated that in China, investment and net export are relatively more volatile in the distribution of cyclical variation among the five data sets, whilst consumption and government expenditure obtain dispersions similar with cyclical GDP, which could be supportive for the idea that consumption and government expenditure are feasible for ensuring long-term growth of economy with short-term booming can be catalyzed using investment and export. This is because the data variation of consumption and government expenditure expressed a smooth and stable dispersion, which is also highly synchronized with the

distribution of GDP. This characteristic could be a disadvantage in the short-term as they could be too stable to stimulate, but the stability of trend development is important for a healthy economy in the long run, thus makes the two components capable of promoting continuous growth of Chinese economy. The same idea can be applied upon investment and net export in explaining their feasibility of short-term stimulation.

The third conclusion was drawn through the combination of the first two conclusions, which is that stimulation through investment could be a potential solution for the short-run shock in China as the consequence of COVID-19 pandemic. This is because investment is the GDP component that owns both volatility and correlation that needed for this task. On the one hand, the relatively high standard deviation and SD ratio of investment implies that it can be easily stimulated without being constrained by the overall GDP within short term. On the other hand, the positive correlation with cyclical GDP it has could be interpreted as that partial increase in GDP in the short run can be achieved with the short-term growth of investment. Based on these conclusions, this paper would suggest that Chinese government might be able to mitigate the negative impact of COVID-19 for some extend through the stimulation of personal investment in the short run, while consumption should be stabilized for the long-term growth after the shock.

Although this paper provided some conclusions and suggestion based on the data and analysis, there are still some limitations that would constrain the feasibility of this paper. First, due to the lack of sufficient data of Chinese price index of all GDP components from 1980 to 2021, this paper has applied the data of nominal GDP and its component for analysis, which could result in the possibility that the estimation would be affected by inflation. Secondly, the conclusion was drawn using the historical data of economy, which means it might not be feasible if the economic environment in China varies greatly in the future. Hence, the feasibility of past economic law concluded through historical data in future could be a probable direction of future researches to verify the idea of this paper. Last but not least, this article only concluded with the idea of stimulating short-term economy during COVID-19 through investment, but the question of investing in which specific area or industry was still not answered. Investment in certain areas within different time period could result in tremendous difference in effect, and this can be supported by the claim of Baker, Khater and Haddad, which pointed out that private infrastructure investments could have marginal effect on GDP when political environment is relatively stable [10]. Therefore, it could be a direction for future researches to analyze which exact area of investment could be the most efficient one in mitigating the economic crisis of COVID-19 pandemic in China.

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