China’s Output Growth Volatility - How Important is the Business Cycle?

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Abstract

The existing literature that discusses the volatility or non-trend aspects of China’s output growth during the reform period does so with overwhelming reference to the business cycle. However, the business cycle is only a sub-set of volatility that occurs within a particular frequency band. In this paper we decompose China’s output growth volatility by frequency and find that considerable volatility occurs at lower than business cycle frequencies. This suggests that in order to understand the nature of China’s output growth volatility and its causes it is necessary to move beyond the construct of the business cycle and shocks to aggregate demand.

JEL codes – E32, O40

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1. Introduction

China’s trend output growth during the reform period has been nothing short of spectacular. In the three decades since 1979, real GDP has grown at an average annual rate of nearly 10 per cent. Much research attention has been devoted to better understanding this outcome. Growth accounting studies, such as Kuijs and Wang (2006), have sought to explain the extent to which the trend rate of real GDP growth can be accounted for by growth in factor inputs on the one hand and total factor productivity on the other. Others, such as Tseng and Zebregs (2002), have sought to highlight the causes of trend growth, such as openness to international trade and investment.

However, the path to emerging as the world’s second largest economy has not been a smooth one. Figure 1 shows the growth rate in real GDP (in year-on-year format) at a quarterly frequency over the period 1979Q1–2009Q1. While the mean of this series is 9.65 per cent, real GDP growth ranges from a minimum of 0.2 per cent in 1989Q4 to a maximum of 17.3 per cent in 1992Q4.

Figure 1 here

There are a number of studies that discuss the volatility or non-trend aspects of China’s output growth during the reform period (e.g., Khor, 1991; Yusuf, 1994; Imai, 1996; Oppers, 1997; Yu, 1997; Brandt and Zhu, 2000; Zhang and Wan, 2005; Gong and Lin, 2008; He, et al. 2009). However, a feature of this literature is that it discusses output growth volatility with overwhelming reference to the business cycle. This is understandable given that traditionally macroeconomic theory has painted the growth path of output as a dichotomy. On the one hand, there is the trend rate of growth, which is determined by the relatively smooth evolution of factors such as factor inputs and total factor productivity. On the other hand, there are cyclical fluctuations around the trend - business cycles – that are typically the result of shocks to aggregate demand.1

1 This characterization of the business cycle might be referred to as the “modern definition”. Harding and Pagan (2002) refer to a “classical definition”, which divides the business cycle into periods of positive and negative output growth. In contrast, the modern definition divides the business cycle into periods of above and below trend growth. Given that China has never experienced a classical business cycle because output growth has never turned negative, the existing literature implicitly uses the modern definition.
However, a problem arises because in the more recent empirical macroeconomic literature, it has been recognised that business cycles are in fact only a subset of output growth volatility. Specifically, business cycles refer to volatility that occurs within a particular frequency band. By the most generous definition, business cycles are cycles that are of between 6 and 32 quarters in length (Baxter and King, 1999). Others prominent macroeconomists, such as Sargent (1979), confine them to a much narrower band. Yet even if the most generous definition is used, significant volatility might still occur at higher or lower frequencies, or both. For example, Hall (2005) observes that in the case of the US, key macroeconomic variables, such as real GDP and unemployment, appear to display important movements at lower than business cycle frequencies.

Separating out business cycles from output growth volatility more generally is important not only for better understanding the nature of output growth volatility. It is also important for the discussion of causes. The existing literature provides valuable insights into the causes of China’s business cycles. For example, using a Structural VAR model, Zhang and Wan (2005) found that China’s business cycles could mostly be attributed to shocks to aggregate demand. However, what remains to be seen is whether business cycles can account for the majority of output growth volatility. If they cannot, then it becomes necessary to look beyond the construct of the business cycle in order to understand the nature of output growth volatility, and beyond shocks to aggregate demand in the discussion of causes.

This paper is structured as follows. In keeping with the existing literature, Section 2 begins by identifying the business cycles that China has experienced during the reform period using an updated data set. Section 3 then decomposes China’s output growth volatility by frequency. Section 4 concludes.

2. Business Cycle Identification
Earlier studies tended to identify business cycles based on an ocular examination of macroeconomic series such as real GDP growth or inflation. More recent studies have adopted more sophisticated techniques, such as performing a trend / cycle decomposition using a data filter. In this section we perform a trend / cycle
decomposition using two data filters – the Hodrick-Prescott (H-P) filter (Hodrick and Prescott, 1997) and the Baxter-King (B-K) band-pass filter (Baxter and King, 1999). The later is a frequency filter, which we set to extract cycles of between 6 quarters and 32 quarters in length, i.e., business cycles. Although the H-P filter is extremely popular, it is not without its critics (see Cogley and Nason, 1995), and accordingly the B-K filter serves as a useful robustness check. The results are presented in Figure 2 in the form of output gaps, i.e., the percentage deviation in real GDP from trend GDP. By construction the B-K filter truncates both ends of the sample and is therefore only available over the period 1981Q1-2006Q1.

Figure 2 here

The business cycles identified using the two filters are extremely consistent in terms of their degree of co-movement: the correlation coefficient between them is 0.97. There are, however, some differences with respect to the magnitude of estimated output gaps. For example, according to the H-P filtered series, China experienced a business cycle peak equal to 5.6 per cent of GDP in 1988Q3. The B-P filtered series concurs that a peak occurred in this period but puts the size of the output gap at 3.8 per cent of GDP.

The business cycle turning points identified by both filters correspond to well known macroeconomic events in China. For example, in September 1988, the central government initiated an austerity program in response to sharply rising inflation and 1988Q3 is identified as a business cycle peak. This austerity program, combined with the loss of confidence in China’s economic reform program as a result of the Tiananmen Square incident in June that year, led to the large positive output gap rapidly giving way to a negative output gap by 1989Q3. Similarly, Deng Xiaoping’s “Southern Tour” in early 1991 is widely credited with restoring confidence in China’s economic reform program. In Figure 2 a business cycle trough is observed in 1991Q2 after which the large negative output gap shrinks rapidly. The effects of the recent global financial crisis are also evident in the H-P filtered series at the very end of the sample period.
Another fascinating feature of Figure 2, which is largely beyond the scope of this paper but deserving of more research attention nonetheless, is that China’s business cycles appear to have become more benign in the second half of the reform period. According to the H-P filtered series, prior to the early 1990s output gaps fluctuated in a band equal to around 5 per cent of GDP. Since then, they have fluctuated in a band equal to 2 per cent of GDP.

The existing literature provides valuable insights into the causes of China’s business cycles. In particular, there are several hypotheses of the causes of business cycles in the first half of the reform period and these can also be used to shed light on why business cycles might have moderated in the second half of the reform period.

Chai (1997) summarises one of the most common hypotheses of business cycles in the first half of the reform period. In the early stages of reform, there was a decentralization of decision-making authority from the central government to provincial and county-level government authorities. In keeping with the transition to a market economy, controls over prices were also relaxed but this was not done so uniformly across sectors of the economy. While prices in some sectors, such as light manufacturing, were liberalized almost immediately, those in more basic industries, such as raw materials, energy and transportation, continued to be set at below market levels. This restricted the profitability of these sectors. Accordingly, the emerging non-state-owned sector had little incentive to invest in these sectors, and nor did local governments since they offered limited scope for earning taxation revenue. Decentralization also meant that the former credit plan had become largely indicative and local government officials acquired considerable influence over the lending decisions of local branches of state banks. These changes predictably saw funds being channelled away from funding investment in basic industries and these became bottlenecks to output growth. As a result, the central government was forced to invest in these sectors directly. However, as funds had been diverted to projects favoured by local government officials, the central government had to rely on money creation to finance these investments. This situation was made worse by the fact that central government tax revenue as a percentage of GDP had deteriorated markedly as the traditional tax base – the retained profits of state-owned enterprises – was whittled away by partial price liberalization and the emerging non-state sector. The
combination of fixed asset investment in both price-liberalized and non-liberalized sectors, and the money creation that made this possible, resulted in spikes in both output growth and inflation. On those occasions when inflation started to get out of hand, such as in 1988, the central government was forced to reinstate a rigid version of the centralised credit plan. This led to credit to firms outside the credit plan drying up, i.e., those in the non-state sector, and resulted in sharp falls in output growth.

The above explanation points to the necessity of more extensive price liberalization and fiscal reforms in order to moderate the business cycle. Considerable progress was made in these areas in the second half of the reform period (e.g., Chai, 1997; Zhang, 1999).

Brandt and Zhu (2000) offer a related, but distinct hypothesis for the cause of China’s business cycles during the first half of the reform period. They argue that the fundamental cause was not so much the de-centralization of decision-making authority but rather the central government’s commitment to maintaining employment in the state sector. Because the state sector was less efficient than the emerging non-state sector, maintaining employment in the former required resource transfers in the form of cheap credits from state banks and money creation. When the credit plan became indicative, banks began diverting more funds to the more efficient non-state sector. While this increased output growth, it also forced the government to rely more heavily on money creation to finance transfers to the state sector, thus fueling inflation. The solution the central government embarked upon was to temporarily mandate a return to a rigid credit plan.

This explanation points to the importance of the central government scaling back its support for state sector employment in order to moderate the business cycle. Such a program began in earnest in the mid-1990s in the form of the “grasping the large, letting go of the small” policy, which resulted in millions of state sector workers being made redundant.

One of the few studies to use formal econometric methods to analyze the causes of China’s business cycles is Zhang and Wan (2005). As their focus is macroeconomic rather than institutional in nature, they discuss causes in terms of aggregate demand
versus aggregate supply shocks. Using a Structural VAR model, they find that aggregate demand shocks were the dominant source of business cycle fluctuations over the period 1985-2000, although supply shocks did seem to have gained in importance over time. Examples of shocks to aggregate demand were several, including Deng Xiaoping’s “Southern Tour” in 1991 and the Asian Financial Crisis in 1997.

While the existing literature is relatively effective in identifying China’s business cycles and in discussing causes, we are not aware of any study that analyses the extent of output growth volatility occurring outside of business cycle frequencies. The above institutional factors and aggregate demand shocks may well have driven China’s business cycles, but it remains to be seen whether business cycles fluctuations can account for the majority of output growth volatility.

3. How Important are Business Cycles?
This section aims to shed light on the relative importance of output growth volatility occurring at business cycle frequencies. Existing empirical studies, to our knowledge none of which include China, suggest that the relative importance of volatility at business cycle frequencies can vary from country to country. For example, King and Watson (1996) and Ahmed, et al. (2004) found that in the case of the US, volatility occurring at business cycle frequencies could account for the majority of variance in the real GDP growth series. However, using an international data set, Levy and Dezhbakhsh (2003) reported far greater heterogeneity: in some countries, such as Japan, volatility at business cycle frequencies could only account for a relatively small fraction of total variance.

An analytical technique that can decompose the variance in output growth by frequency is Spectral Analysis. Here we simply provide an overview of what Spectral Analysis accomplishes in conceptual terms. Those readers seeking more technical detail might like to consult Granger (1966), which is the classic paper that applies Spectral Analysis to economic time series.
As outlined in King and Watson (1996), a covariance stationary variable, \( x_t \), such as real GDP growth, can be decomposed into an integral of various frequency components:

\[
x_t = \int_0^\pi x_t(\omega)d\omega = \int_0^\pi [a(\omega)\cos(\omega t) + b(\omega)\sin(\omega t)](d\omega)
\]

where \( a(\omega) \) and \( b(\omega) \) are uncorrelated random variables with zero mean and common variance \( 2s(\omega) \).

The variance of \( x_t \) can then be decomposed as:

\[
\text{var}(x_t) = \sigma^2 = 2 \int_0^\pi s(\omega)d\omega
\]

where \( s(\omega) \) is the spectral density, or power spectrum, at frequency, \( \omega \). Spectral density is defined as the Fourier transform of the autocovariance function of \( x_t \). Therefore, the value of spectral density at a particular frequency, \( \omega \), shows the contribution of that frequency to variance in \( x_t \), \( \sigma^2 \).

Figure 3 shows the estimated spectral density function of China’s output growth, as proxied by real GDP growth, over the period 1979Q1-2009Q1, a total of 121 quarterly observations. The data were first seasonally adjusted using the US Census Bureau’s X-12 procedure. Figure 3 presents the results in terms of frequencies but these can also be interpreted in terms of cycles of different length (i.e., quarters), \( p \), through the relation –

\[
\omega = \frac{2\pi}{p}
\]

The entire frequency range, \( 0 \leq \omega \leq \pi \), can be divided into three bands of interest. Lower than business cycle frequencies, i.e., cycles greater than 32 quarters,
correspond to the frequency band, $0 \leq \omega \leq 0.190$. Business cycle frequencies, i.e., cycles between 6 and 32 quarters, correspond to the frequency band, $0.196 \leq \omega \leq 1.047$. Higher than business cycle frequencies, i.e., cycles of less than 6 quarters, correspond to the frequency band, $1.256 \leq \omega \leq \pi$.

**Figure 3 here**

Volatility occurring at higher than business cycle frequencies is found to contribute little to the variance in the series. A clear peak in the spectrum occurs at $\omega = 0.156$, which corresponds to cycles of around 40 quarters in length. As Levy and Dezhbakhsh (2003) note, such peaks are significant because they imply strong periodicity in the data. The second and third highest spectral density values occur at $\omega = 0.208$ and $\omega = 0.104$, respectively, which correspond to cycles of around 30 and 60 quarters, respectively. Thus, considerable spectral mass is found at the extreme lower end of the business cycle frequency band, and at lower than business cycle frequencies.

Before discussing the above results, they are first subjected to some sensitivity testing. First it is considered whether the results are sensitive to the presence of outliers. To test this, the observations with the highest and lowest values were replaced with the sample average and the spectral density function was re-estimated (Figure 4, Sensitivity Test 1). This exercise was then repeated by replacing the observations with the two highest and two lowest values with the sample average (Figure 4, Sensitivity Test 2), and again by replacing the three highest and lowest values (Figure 4, Sensitivity Test 3), and finally, by replacing the four highest and lowest values (Figure 4, Sensitivity Test 4). As can be seen in Figure 4, the shape of the spectral density function proves robust. In all cases, a spectral peak is recorded at $\omega = 0.156$, and the second and third highest spectral density values occur at the extreme lower end of the business cycle frequency band and lower than business cycle frequencies.

**Figure 4 here**
Next, it is considered whether the spectral density function proves sensitive to the measure of output growth used. To test this, the spectral density function is re-estimated using China’s industrial output growth series. This series consists of 220 monthly observations over the period 1991M2-2009M5. The source is *China’s Monthly Statistics*. The results are presented in Figure 5. Given the use of monthly observations, here lower than business cycle frequencies correspond to the frequency band, \( 0 \leq \omega \leq 0.065 \). Business cycle frequencies correspond to the frequency band, \( 0.065 \leq \omega \leq 0.349 \). Higher than business cycle frequencies correspond to the frequency band, \( 0.370 \leq \omega \leq \pi \). The results in Figure 5 serve to reinforce those found in Figure 3. As with the spectrum of China’s real GDP growth, the spectrum of China’s industrial output growth also exhibits a clear peak. This occurs at \( \omega = 0.057 \), which corresponds to cycles of 110 months in length (\( \approx 9 \) years). Again, the second and third highest spectral density values occur at the extreme lower end of the business cycle frequency band and at lower than business cycle frequencies.

**Figure 5 here**

The above results have important implications. In particular, they suggest that the construct of the business cycle is inadequate for understanding the nature of China’s growth volatility during the reform period. Also, while studies such as Zhang and Wan (2005) have drawn attention to the role played by aggregate demand shocks in causing China’s business cycles, the above results suggest that such shocks only offer a partial explanation at best of China’s output growth volatility more generally. Specifically, what the results point to is the prominent role played by events that have highly persistent, albeit ultimately temporary, effects. The high degree of persistence found in the cyclical component of China’s output growth is more in keeping with shocks emanating from the supply side of the economy than from the demand side (see Blanchard and Quah, 1989).

A number of momentous supply-side events occurred during the reform period that might serve as useful candidates. At the very beginning of the reform period, an
enormous wave of productivity was unleashed as a result of the nation-wide spread of the household responsibility system and the advent of rural markets. It is important to note that typical of policy-making in China during the reform period, these developments were not the result of a central government policy edict that was adopted on a national scale at a single point in time. Rather, they grew out of local experimentation and, more often than not, policy-makers at the central level found themselves responding in a reactive fashion (Ash, 1988). The process of diffusion meant that these developments did not simply constitute a one-off shock to productivity growth but rather the effects were felt over a sustained period of time. Nonetheless, as Perkins (1994) observed, the impact ultimately proved temporary and by the mid-1980s productivity growth had begun to return to its long run trend rate. Productivity gains in agriculture also freed up rural labour and helped to facilitate the sectoral reallocation of labour from low productivity agriculture to higher productivity manufacturing. The Open Door Policy also played an important role in facilitating this shift. Yet, as Sachs and Woo (1997) pointed out more than a decade ago, even with China’s large rural population, the boost to productivity growth that comes from the sectoral reallocation of labour also ultimately comes with a use-by date attached. In more recent times, one might also consider the productivity impact wrought by the diffusion of information and communication technologies.

All of the above is not to say that business cycles and demand side shocks are unimportant. As can be seen in Figure 3 and Figure 5, while a spectral peak occurs at lower than business cycle frequencies, there remains significant spectral mass in the business cycle frequency band. Moreover, the business cycle remains as important as ever from a policy perspective as macroeconomic policies, such as monetary policy, are intended to exert an impact over business cycle frequencies. Nonetheless, the results do serve to put the volatility that has resulted from demand-side events such as the global financial crisis in perspective.

4. Conclusion
This paper began with the observation that the existing literature that discusses the volatility or non-trend aspects of China’s output growth does so with overwhelming reference to the business cycle. However, the business cycle is only a subset of output growth volatility that occurs within a particular frequency range. As a result, the
nature and causes of China’s output growth volatility have been inadequately explored.

To shed light on the relative importance of business cycles, a Spectral Analysis was performed on China’s real GDP growth series over the period 1979Q1-2009Q1. This was then supplemented with a Spectral Analysis performed on China’s industrial output growth series over the period 1991M2-2009M5. The results were consistent and showed a clear spectral peak occurring at lower than business cycle frequencies. Also, the second and third highest spectral density values occurred at the extreme lower end of the business cycle frequency band and at lower than business cycle frequencies.

The implications of these results are two-fold. Firstly, they show that the construct of the business cycle is inadequate for understanding the nature of China’s output growth volatility during the reform period. Secondly, they suggest that while shocks to aggregate demand might well been the leading cause of business cycles, they offer limited explanatory power for China’s output growth volatility more generally. What appear to have been more important are supply side events, such as the boost to productivity that occurred as a result of the diffusion of the household responsibility system and rural markets at the beginning of the reform period.
References


Figure 1. China’s Real GDP Growth (% Y-O-Y), 1979Q1-2009Q1

Source – Data from 1979Q1-1999Q4 are from Abeysinghe and Rajaguru (2004). Data from 2000Q1 to 2009Q1 are from China’s National Bureau of Statistics.
Notes – 1. In the absence of official data prior to 1995, these are estimated by Abeysinghe and Rajaguru (2004) using a modified version of the Chow-Lin procedure. The interested reader should refer to this source for details. 2. Growth rates are seasonally unadjusted.
Figure 2. China Business Cycles, 1978Q1-2009Q1

Source – see Figure 1.
Note – GDP growth data are first seasonally adjusted using the US Census Bureau’s X12 technique.
Figure 3. China’s Real GDP Growth Spectrum (1979Q1-2009Q1)
Figure 4. China’s Real GDP Growth Spectrum (1979Q1-2009Q1) – Sensitivity Testing
Figure 5. China’s Industrial Output Growth Spectrum (1991M2-2009M5)