The Persistence Characteristics of Output Growth in China:

How Important is the Business Cycle?

James S Laurenceson[†*]

The University of Queensland

Australia

Abstract

Output growth volatility at the macroeconomic level reflects the impact of demand and supply-side shocks. These shocks differ in terms of the persistence of their impact on output growth with the former typically being responsible for cyclical fluctuations of the business cycle variety. This paper uses Spectral Density Analysis to decompose the persistence characteristics of output growth in China since 1953, including in its provinces and regions. An important finding is that the persistence characteristics of output growth changed dramatically in most provinces during the reform period to the extent that only a minority of output growth variance can be attributed to business cycle fluctuations. This finding points to a number of challenges for policy-makers, including questions over the expected effectiveness of using macroeconomic policies that are intended to smooth business cycle fluctuations when the nature of output growth volatility is considerably more complex.

JEL codes – E32, O11, O30

Key words – China, business cycles, persistence

[†] School of Economics, The University of Queensland, St Lucia, Brisbane, Queensland, Australia, 4070; Ph – (617) 3365 6085; Email – j.laurenceson@uq.edu.au

[*] The author would like to acknowledge input provided by David Hyslop and research assistance provided by Daniel Quiggin.

1. Introduction

Output growth volatility at the macroeconomic level reflects the impact of different types of shocks. Traditionally, macroeconomic theory has classified shocks as emanating from either the demand or supply side of the economy. At least since Blanchard and Quah (1989), it has become popular to identify demand and supply-side shocks by virtue of the different persistence characteristics they cause in output growth. Specifically, demand-side shocks have an impact that is more “transitory” or “temporary” in nature, while supply-side shocks have an impact that is more “permanent”. Demand-side shocks are those that typically cause cyclical fluctuations of the business cycle variety. While there are no hard and fast rules, it is generally accepted that a business cycle is a fluctuation in output growth, and other associated variables such as unemployment, that lasts for between 3-8 years (e.g., Prescott, 1986). Even the most serious demand-side shocks, such as the recent Global Financial Crisis, are not expected to exert an impact on output growth beyond 8 years. On the other hand, supply-side shocks, such as the introduction and diffusion of new technologies, can continue to have an impact on output growth well beyond this time horizon (e.g., Perez, 2002). Understanding the persistence characteristics of output growth can therefore shed light on the nature of shocks that have been impacting upon an economy.

Understanding the persistence characteristics of output growth can also have important policy implications. Countries employ monetary and fiscal policies in an attempt to smooth business cycle fluctuations. Given price stickiness, the demand-side shocks that typically give rise to business cycles cause real GDP to temporarily depart from potential GDP. However, supply side shocks cause potential GDP itself to change. Therefore, if supply side shocks are the most prominent cause of real GDP volatility, it is not clear how macroeconomic policy might enhance welfare. Indeed, if policymakers have imperfect information regarding the new level of potential GDP, activist macroeconomic policy could even lead to greater instability.

Levy and Dezhbakhsh (2003) used Spectral Density Analysis (SDA), an analytical technique that will be discussed in the following section, to decompose the persistence characteristics of output growth series from 58 countries. They showed that there was considerable heterogeneity across countries. For example, in the case of the US, the majority of output growth volatility was found to consist of cyclical fluctuations (called “frequencies”) consistent with the business cycle, i.e., of duration between 3-8 years. In the case of Japan however, the majority of output growth volatility was found to consist of frequencies lower than the business cycle, i.e., of duration longer than 8 years. In commenting on this finding, the authors noted that heterogeneity is in some sense unsurprising given, “that the distribution of shocks that an economy experiences is conditional on its technology, institutions and policy, all of which are likely to change over time” (p.1500).

The transformation of the People’s Republic of China from an extremely low income country at its formation in 1949 to what is now the world’s second largest economy has been remarkable. The average annual growth rate of real GDP over the period 1953-2008 was 8.4 percent. However, as can be seen in Figure 1, this high average rate of output growth conceals the fact that China’s economic emergence has been far from smooth. To the best of our knowledge, Laurenceson and Rodgers (2010) were the first to examine the persistence characteristics of output growth in the case of China. Considering quarterly real GDP growth data over the period 1979Q1-2009Q3, they found that output growth volatility could in large part be attributed to fluctuations occurring at lower than business cycle frequencies. This finding pointed to the prominence of supply-side shocks during this period.

Insert Figure 1 here

This paper seeks to extend upon the analysis undertaken by Laurenceson and Rodgers (2010) in three ways. Firstly, the period of analysis is extended back to also include the pre-reform period. Given large differences in economic institutions and policies in China before and after economic reforms began in the late 1970s, it is interesting to compare the persistence characteristics of output growth between the two periods. For example, numerous researchers have documented technological stagnation in the pre-reform period (e.g., Chow, 1993; Lin, et al. 2001). To the extent that output growth volatility occurring at lower than business cycle frequencies reflects the introduction and diffusion of new technologies, one might expect to find a smaller proportion of volatility occurring over these frequencies in the pre-reform period. Secondly, in addition to studying the persistence characteristics of national output growth, provincial and regional output growth are also considered. Specifically, it is interesting to see whether there is any evidence of heterogeneity in the persistence characteristics of output growth across provinces in a given time period. At first glance, many of the possibilities raised by Levy and Dezhbakhsh (2003) that might explain heterogeneity across countries, such as differences in technology, institutions and policy, may seem unlikely to apply within a given country. However, in a country as geographically vast, economically decentralized and culturally diverse as China, homogeneity cannot be taken for granted. Thirdly, to the extent that heterogeneity across provinces is apparent, an initial attempt is made to explain these differences.

Section 2 outlines the salient features of SDA, the analytical technique that is used to decompose output growth data by frequency. Section 3 discusses data sources. Section 4 presents the SDA results concerning the persistence characteristics of provincial, regional and national output growth over the full period and in two sub-periods, pre- and post-reform. To pre-empt one of the findings, considerable heterogeneity in the persistence characteristics of output growth across provinces is revealed. Section 5 then presents the results of a very simple econometric exercise that attempts to begin to explain this heterogeneity. Section 6 summarizes the findings and highlights the associated implications.

2. Methodology

Studying the characteristics of economic data in the frequency domain has long played second fiddle to the time domain. Nonetheless, the relevant literature stretches back at least to the pioneering works of Granger and Hatanaka (1964) and Granger (1966). In this section, an overview is provided of what SDA accomplishes in conceptual terms, along with a discussion of how the output produced by SDA can be interpreted. Those readers seeking a more purely technical treatment may like to consult Hamilton (1994).

In simplest conceptual terms, SDA decomposes a data series

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:

$$\mathrm{var}(x_t) = \sigma^2 = 2\int_0^{\pi} s(w)d\omega \qquad (4)$$

where $s(w)$ is the spectral density, or power spectrum, at frequency ω. Spectral density is defined as the Fourier transform of the autocovariance function of x_t. Thus, the spectral density at a particular frequency shows the relative contribution of that frequency to the variance (volatility) in x_t. Spectral density values can be plotted against frequency to form a spectral density function. In turn this implies that taking the integral of the spectral density function over a given frequency range and dividing it by the integral of the entire function can show the relative contribution of that frequency range to the variance in x_t.

A worked example is useful. In what follows SDA is applied to an update of the dataset used by Laurenceson and Rodger (2010). This sample consists of *N*=128 quarterly observations of real GDP growth for China over the period 1979Q1-2010Q4. By (1) and (2), the lowest frequency that SDA will be able to detect in this sample is

Recall from (1) that SDA divides a given sample size *N* into a number of discrete frequencies, estimate of the relative contribution of business cycle frequencies to total variance. This contribution is found to be 36 percent, while that of lower than business cycle frequencies is 48 percent. The remainder, 16 percent, is accounted for by higher than business cycle frequencies. This acts as further confirmation that during the period being considered supply side shocks were a prominent source of output growth volatility.

Insert Figure 2 here

3. Data

In the following section, SDA is applied to provincial real GDP growth data. The full period of analysis covers 1953-2009, a total of 57 annual observations. The full period is also broken into two sub-periods of equal length, 1953-1980 and 1981-2008. These sub-periods correspond *roughly* to the pre-reform and reform periods, respectively. Annual data are used as quarterly data are not available at the provincial level.[1] The starting date is dictated by data availability. The PRC was only founded in 1949 and for most provinces the first available GDP figure is in 1952. Thus, the first available GDP growth rate is for 1953. Annual real GDP growth data over this time period are available for all of China's 31 provinces from provincial statistical yearbooks, with the exceptions of Sichuan and Hainan. Data for Sichuan and Hainan are only available in the second sub-period. On the few occasions when data are not available from provincial statistical yearbooks, such as for Hainan in the early 1980s, then NBS (1999) is relied upon.[2] Data appearing in provincial statistical yearbooks were cross-checked against the national yearbook in a bid to ensure consistency.

[1] Even at the national level, official quarterly real GDP growth data are only available since the mid-1990s. Laurenceson and Rodgers (2010) rely on estimated data for much of their sample.

[2] Note that Hainan and Chongqing only received official provincial status in 1988 and 1997, respectively. Prior to then they were sub-provincial entities associated with Guangdong and Sichuan, respectively.

Provincial real GDP data are also aggregated to form regional and national-level data. The regions considered are those into which China is typically disaggregated – Coastal versus Inland, and Coastal versus Central and Western. The Coastal region includes Beijing, Tianjin, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan. The Central region includes Hebei, Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan and Guangxi. The Western region includes Chongqing, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang. The Inland region comprises the Central and Western regions. Sichuan and Hainan are not included in regional and national calculations due to incomplete data series.

4. SDA Results

4.1 Full period, 1953-2009

This section considers the persistence characteristics of real GDP growth across provinces and regions over the full period, 1953-2009. Thus, SDA is being performed on a sample consisting of N=57 annual observations. By (1) and (2), the lowest frequency that SDA will be able to detect in this sample is

The spectral density functions of the various provinces and regions are presented in Figure 3. These functions are divided into the three frequency ranges of interest – lower than business cycle frequency cycles (LFC), business cycle frequency cycles (BCFC) and higher than business cycle frequency cycles (HFC). Table 1 presents the proportion of variance found in each of the frequency ranges.

Heterogeneity in spectral density functions across provinces is clearly evident in Figure 3. This heterogeneity takes several forms. Firstly, it can be seen that spectral density values are much higher in some provinces than others. This reflects the fact that some provinces have a larger variance with respect to real GDP growth than others. The province recording the highest spectral density values is Beijing. An examination of Beijing's real GDP growth data reveals why: the series contains instances such as in 1953 when real GDP growth was 137.3% while in 1961 it was (-) 40.6%. Secondly, some provinces exhibit clear peaks in their Spectral Density Functions while others do not. Shanxi, Hubei and Guangdong are examples of the former, while Jilin, Heilongjiang and Shandong are examples of the latter. Recall that clear peaks are noteworthy because they signal strong periodicity being present in the data. Thirdly, the location of the highest spectral density value varies across provinces. For the majority of provinces (22 out of 29), the highest spectral density values occurs in the business cycle frequency range. Nonetheless, this still leaves a significant minority of one quarter of all provinces where the highest value occurs in the lower than business cycle frequency range. Another observation evident from Figure 2 is that despite differences in spectral density functions at the provincial level, there is remarkable uniformity at the regional level.

Insert Figure 3 here

The results presented in Table 1 serve to elaborate on the heterogeneity evident in Figure 3. Large differences between provinces are apparent with respect to the proportion of real GDP growth variance that occurs in the different frequency ranges. The share of lower than business cycle frequencies ranges from 14.99% in Ningxia to 46.06% in Guangdong, while the share of business cycle frequencies ranges from 28.43% in Anhui to 70.54% in Shanghai. The share of higher than business cycle frequencies ranges from 6.81% in Zhejiang to 35.79% in Anhui. Again, when viewed at a regional level, this provincial heterogeneity is largely masked.

Insert Table 1 here

It is worthwhile noting that the above results, which suggest that for the majority of provinces real GDP growth volatility predominantly occurs over business cycle frequencies, do not necessarily conflict with the results of the illustrative exercise reported in Section 3. Most obviously, the analyses cover different time periods. Also, annual data are used here whereas quarterly data were used in the Section 3. Quarterly data inevitably allows the detection of higher frequency cycles (i.e., cycles of two quarters versus cycles of two years), which may then have the effect of diluting the relative share of lower frequency cycles. Finally, the "national" result reported here is based on an aggregation of real GDP data reported at the provincial level. While technically this aggregation should result in a figure equal to the official national real GDP figure, statistical discrepancies mean that this is not always the case.

4.2. Sub-periods, 1953-1980 and 1981-2008

In this section results derived from two sub-periods are presented. The purpose here is to try to shed light on whether there have been any changes in the persistence characteristics of provincial and regional output growth over time. Each sub-period consists of N=28 annual observations. This means that the lowest frequency that SDA will be able to detect in each sub-period is frequency range is taken to be 0 ≤ ω ≤ 0.898, which corresponds to cycles of duration greater than 7 years. The business cycle frequency range is taken to be 0.898 ≤ ω ≤ 2.020, which corresponds to cycles of duration 3.111 - and 7 years. The higher than business cycle frequency range is taken to be 2.020 ≤ ω ≤ π, which corresponds to cycles of duration less than 3.11 years.

Two points are worth noting before presenting and discussing the results. Firstly, note that the smaller sample size being considered in each sub-period reduces the maximum cycle duration that can be detected compared with the full period. Secondly, note that the precise definition of the frequency ranges differ in this section compared with the previous section. For example, in Section 4.1 the lower than business cycle frequency range was taken to correspond to cycles of duration 8.143 years or greater, whereas here it is taken to correspond to cycles of duration 7 years or greater. The reason for this difference relates to the smaller sample size, which amplifies the problems associated with the fact that SDA produces output at discrete frequencies. With a sample size of N=28, the next available frequency lower than ω = 0.898 is ω = 0.673, which corresponds to cycles of duration 9.333 years. These factors mean that while the results from the two sub-periods can be compared with each other, they should not be directly compared with the results from the previous section.

Figure 4 presents the spectral density functions for China's provinces in the two sub-periods. Firstly, note that the scaling between the two sub-periods differs quite dramatically.[3] This reflects the fact that the variance associated with real GDP growth in the second sub-period is much lower than in the first sub-period. Secondly, note that in the first sub-period, the highest spectral density value for all provinces occurred in the business cycle frequency range, albeit sometimes at the extreme lower

[3] In particular, note that the scale used in the first sub-period for Beijing is unique. This reflects the exceptionally high variance associated with Beijing's real GDP growth during this sub-period.

bound. This contrasts markedly with the results from the second sub-period where 27 of 31 provinces recorded their highest spectral density value in the lower than business cycle frequency range.

Insert Figure 4 here

The rising prominence of lower than business cycle frequencies is further elaborated upon in Table 2. To take one example: in the case of Inner Mongolia the proportion of lower than business cycle frequencies in total variance increased from 27.71 percent in the first sub-period to 77.60 percent in the second sub-period. Meanwhile, the proportion of business cycle frequencies fell from 41.84 percent to 5.43 percent. In the second sub-period, the proportion of variance accounted for by the lower than business cycle frequency range was greater than that of the business cycle frequency range in 22 of 31 provinces. This compares with just 4 of 29 in the first sub-period. To be sure, there were some exceptions: in the cases of Henan and Gansu, the share of lower than business cycle frequencies actually fell. In other provinces, such as Tibet, the share of lower than business cycle frequencies increased, but business cycle frequencies remained the dominant frequency range. For all regions business cycle frequencies were the dominant frequency range in the first sub-period. In the second sub-period however, lower than business cycle frequencies had become the dominant frequency range in all regions with the exception of the Western region. The Western region is notable for the relatively small increase in the proportion of lower than business cycle frequencies, from 27.96 percent in the first sub-period to 37.37 percent in the second sub-period. At the national level, the results in Table 2 show that in the second sub-period, only 33.87 percent of output growth variance can be attributed to business cycle frequencies. This compares with 57.74 percent for lower than business cycle frequencies.

Insert Table 2 here

A more formal way to observe the rising prominence of lower than business cycle frequencies is to regress the proportion of variance occurring in the lower than business cycle frequency range (*LBC*), i.e., columns 2 and 3 of Table 2, on a constant and a dummy variable (*DUMMY*) that takes the value of 0 in the first sub-period and 1 in the second sub-period. The resultant equation (5) is presented below. Standard errors are in parentheses above the equation while probability values associated with the calculated *T* statistics are in parentheses below the equation. It can be seen that the coefficient to the dummy variable is positive and statistically significant at the 1 percent level.

$$\underset{(0.0001)}{\overset{(2.133)}{LBC = 28.97}} \ \underset{(0.0001)}{\overset{(3.016)}{+20.78\,Dummy}} \qquad (5)$$

The general tendency for lower than business cycle frequencies to increase as a proportion of output growth variance in the second sub-period is in a sense unsurprising. As noted in Section 1, the pre-reform period was distinguished by a distinct lack of technological progress. However, the onset of economic reforms at the end of 1978 unleashed numerous supply-side shocks on the Chinese economy. For example, Lin (1992) elaborated upon the nature of output growth volatility associated with the introduction of the Household Responsibility System (HRS). This supply-side shock, which featured vastly improved incentives for farmers, generated a cycle in output growth that lasted beyond a decade. In the 7 year period from 1978-1984, agricultural output surged by an enormous 42%. Lin's (1992) analysis suggested that nearly half of this increase could specifically be attributed to the HRS. However, the HRS reform was a one-off event that was essentially completed by 1984. As a result, the output growth slowdown that occurred in the mid to late 1980s (i.e., the second half of the cycle) was largely unavoidable and, "…even without any other cause, the rate of output growth would have fallen to about half of the previous level" (Lin, 1992, p.47). Other notable supply side shocks included the opening of the economy to international trade and investment, and the emergence of a domestic non-state sector.

5. Explaining Heterogeneity Across Provinces

While the onset of economic reforms in the late 1970s might explain the general tendency for lower than business cycle frequencies to increase in prominence over time, it remains the case that the relative importance of lower than business cycle frequencies varies considerably across provinces, even in a given sub-period. For example, according to Table 2, in the second sub-period the proportion of lower than business cycle frequencies ranged from 23.09 percent in Tibet to 77.60 percent in Inner Mongolia. This section begins to try to explain such heterogeneity.

Providing an explanation is far from straightforward, not least of all because macroeconomic theory is in a poor state with respect to accounting for observed phenomena in the frequency domain. The so-called "neoclassical synthesis", which dominates macroeconomics textbooks, paints a dichotomy with respect to output growth. On the one hand, there is the trend rate of output growth, which is determined on the supply side of the economy by the (usually) relatively smooth growth of factor inputs, such as capital and labor, and total factor productivity. On the other hand, there are cyclical fluctuations around the trend – business cycles – that reflect temporary disequilibrium typically as a result of demand-side shocks in an environment of price stickiness. However, as the leading macroeconomist Robert E. Hall (2005, p.133) notes,

> "The traditional notion no longer holds that the economy moves along a smooth growth trend with temporary cyclical departures. This notion is badly incomplete as a description of the data. Key variables – real GDP, unemployment, and real returns – display important movements at frequencies below the business cycle but above long-term trend".

The results of Levy and Dezhbakhsh (2003) discussed earlier allude to these important movements, particularly in certain countries such as Japan. The results presented in the previous section also suggest that lower than business cycle frequencies are important in the case of China, at least during the reform period.

One possible explanation for heterogeneity in the case of China relates to the fact that economic reform has contained a distinct geographical element. While the country's transition to a market economy is typically traced back to the Third Plenum of the Eleventh National Party Congress Central Committee in December 1978, the reality is that some provinces have marketized at a much more rapid rate than others. Partly this reflects the impact of central government policy. For example, it is well-known that certain coastal provinces, such as Guangdong, were given central government permission to open up to flows of international trade and investment long before others were (Kueh, 1992). Such provinces, being located on the coast, also have a natural locational advantage for engaging in international trade and investment. The pace of marketization that has been achieved also reflects the reform savvy of provincial governments. In many cases, the provinces that first opened to flows of international trade and investments were also at the forefront of domestic liberalization, such as encouraging the emergence of a domestic non-state sector. What all this means is that certain provinces would have experienced a variety of supply-side shocks more starkly and before others did. The fact that inter-provincial barriers to trade and investment have remained stubbornly high during the reform period (Young, 2000) could also have contributed to the impact of a given supply-side shock having a more provincial rather than regional or national-level impact.

To consider whether differences in marketization across provinces can help to explain heterogeneity in the persistence characteristics of provincial output growth, use is made of a "marketization index" constructed by Wang, et al. (2007). These authors constructed this index for all of China's provinces using data that draws on 23 categories relating to marketization. For example, the index considers the non-state share in industrial output, the prominence of foreign investment and the extent to which market pricing applies to consumer goods, capital goods and farm products. Although the index is available over the period 1997-2005, the methodology changed in 2001 and so to determine the extent of marketization achieved by each of China's provinces an average value of the index (*Market*) over the period 2001-2005 is taken. Along with a constant, this value is then regressed on the proportion of output growth variance occurring in the lower than business cycle frequency range (*LBC*) in the second sub-period, i.e., column 3 of Table 2. Using a single index as an explanatory variable is useful because many of the individual components of the index are highly positively correlated and hence entering them separately into the equation would result in multicollinearity problems. If the above hypothesis is correct, then the coefficient to the marketization index should be positive and significant. The estimated equation (6) is presented below. It can be seen that the coefficient is indeed positive and statistically significant at the 5 percent level. However, it should be noted that the adjusted R^2 for the estimated equation is modest at 0.15. Thus, while differences in the extent of marketization achieved by China's provinces might be one factor that contributes to heterogeneity in the persistence characteristics of provincial output growth, it is unlikely to be the only one.

$$\underset{(0.000)}{\overset{(7.217)}{}}\quad LBC = \underset{(0.000)}{\overset{(7.217)}{32.810}} + \underset{(0.019)}{\overset{(1.233)}{3.060}}MARKET \tag{6}$$

6. Conclusion

This paper investigated the persistence characteristics of output growth in the case of China since 1953, including in its provinces and regions. Such an exercise is useful because it helps to identify the nature of shocks impacting upon an economy. It also has policy implications in that if shocks are predominantly supply-side in origin, then it is not clear how macroeconomic policy might be used to effectively smooth their effects.

The key findings are as follows. Firstly, the persistence characteristics of output growth changed dramatically in most provinces during the reform period to the extent that only a minority of output growth variance can be attributed to business cycle fluctuations. Secondly, in a given time period, regional and national-level data act to conceal considerable heterogeneity in the persistence characteristics of output growth at the provincial level. Thirdly, during the reform period some of this heterogeneity appears to reflect differences in the extent of marketization that has been achieved by China's 31 provinces.

One of the implications of the above results is that policy-makers need to exercise caution when interpreting fluctuations in China's output growth. Specifically, it should not be assumed that fluctuations in output growth reflect volatility of the business cycle variety. Indeed, the results suggest that during the reform period, fluctuations at business cycle frequencies can only account for a minority of the observed variance in output growth. This in turn raises questions over the expected effectiveness of using macroeconomic policies that are intended to smooth business cycle fluctuations when the nature of output growth volatility is considerably more complex. Given the apparent prominence of supply-side shocks, it is possible that the activist use of monetary and fiscal policies could have the effect of worsening instability. Another challenge associated with using macroeconomic policy to smooth output growth volatility is that the nature of volatility, namely its persistence characteristics, varies so dramatically across provinces. This implies that macroeconomic policy could have different effects in different provinces.

References

Blanchard, O., Quah, D. 1989. The dynamic effects of aggregate demand and supply disturbances. *American Economic Review*, 79(4), 655-673.

Chow, G. 1993. Capital formation and economic growth in China*. Quarterly Journal of Economics*, 108(3), 809-842.

Granger, C. 1966. The typical shape of an economic variable. *Econometrica*, 34(1), 150-161.

Granger, C. and Hatanaka, M.,1964. *Spectral analysis of economic time series*. Princeton University Press, Princeton.

Hall, R. 2005. Separating the business cycle from other economic fluctuations. National Bureau of Economic Research, NBER Working paper No. 11651. Available at - http://www.nber.org/papers/w11651

Hamilton, J. 1994. *Time series analysis*. Princeton University Press, Princeton.

King, R., Watson, M. 1996. Money, prices, interest rates and the business cycle. *The Review of Economics and Statistics*, 78(1), 35-53.

Kueh, Y.Y. 1992. Foreign investment and economic change in China, *The China Quarterly*, 131, 637-690.

Laurenceson, J. and Rodgers, D. 2010. China's macroeconomic volatility – how important is the business cycle? *China Economic Review*, 22(1), 324-333.

Lin, J. 1992. Rural reforms and agricultural growth in China, *American Economic Review*, 82(1), 34-51.

Lin, J., Cai, F. and Li, Z. 1996. Pre-reform economic development in China. In Y.Lin, F. Cai and Z. Hong (Eds.), *The China Miracle: development strategy and economic reform*. Chinese University Press, Hong Kong, 59-90.

Levy, D., Dezhbakhsh, H. 2003. International evidence on output fluctuation and shock persistence. *Journal of Monetary Economics*, 50(7), 1499-1530.

National Bureau of Statistics. 1999. *Comprehensive statistical data and materials on 50 years of New China*, China Statistics Press, Beijing.

National Bureau of Statistics. 2009. *China Statistical Yearbook 2009*. China Statistics Press, Beijing.

Perez, C. 2002. *Technological revolutions and financial capital: the dynamics of bubbles and golden ages*, Edward Elgar, Cheltenham.

Prescott, E. 1986. Theory ahead of business cycle measurement. Quarterly Review of the Federal Reserve of Minneapolis, 9-22. Available at - http://minneapolisfed.org/research/sr/sr102.pdf

Wang, X., Fan, G. and Zhu, H. 2007. Marketization in China: progress and contribution to growth. In R. Garnaut and L. Song (Eds). *China: linking markets for growth*. ANU EPress, Canberra, 30-44.

Young, A. 2000. The razor's edge: distortions and incremental reform in the People's Republic of China, *Quarterly Journal of Economics*, 115(4), 1091-1135.

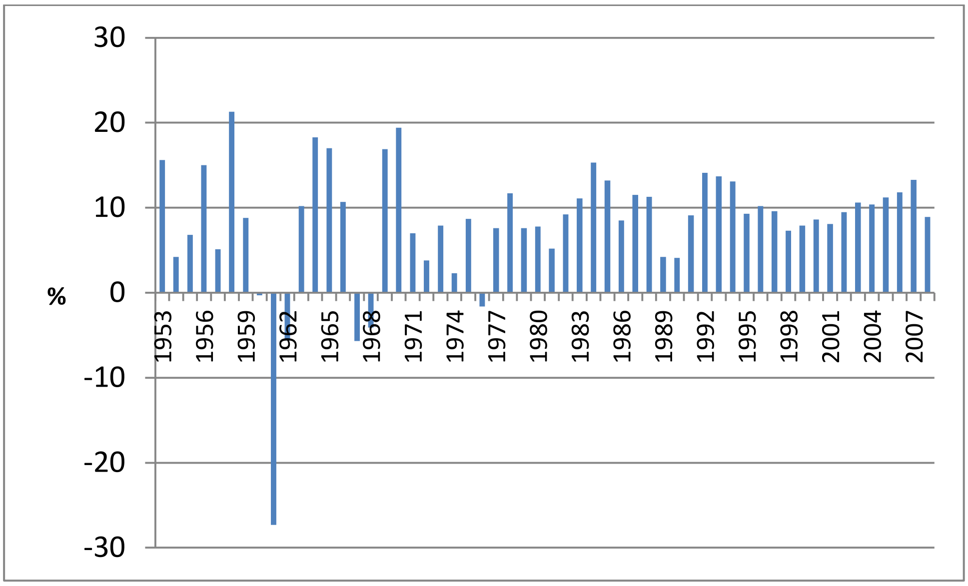
Table 1. – Persistence characteristics of provincial real GDP growth, 1953-2009

Province / Region	Proportion of variance in lower than business cycle frequency range (%)	Proportion of variance in business cycle frequency range (%)	Proportion of variance in higher than business cycle frequency range (%)
Beijing	21.38	58.46	20.16
Tianjin	22.89	69.28	7.83
Hebei	31.33	61.05	7.62
Shanxi	19.41	65.51	15.08
Inner Mongolia	28.47	48.76	22.77
Liaoning	21.56	64.88	13.56
Jilin	15.62	65.00	19.37
Heilongjiang	22.05	63.19	14.75
Shanghai	17.10	70.54	12.36
Jiangsu	42.92	42.69	14.39
Zhejiang	38.27	54.92	6.81
Anhui	35.77	28.43	35.79
Fujian	31.94	57.67	10.39
Jiangxi	37.97	42.07	19.96
Shandong	33.72	45.17	21.11
Henan	38.28	42.07	19.64
Hubei	21.21	51.12	27.67
Hunan	27.04	47.48	25.48
Guangdong	46.06	42.14	11.81
Guangxi	39.01	43.90	17.08
Hainan	n/a	n/a	n/a
Chongqing	19.31	56.94	23.75
Sichuan	n/a	n/a	n/a
Guizhou	21.63	64.22	14.15
Yunnan	19.87	57.87	22.26
Tibet	17.11	55.15	27.74
Shaanxi	16.30	60.41	23.28
Gansu	26.19	64.89	8.92
Qinghai	27.10	56.96	15.94
Ningxia	14.99	62.04	22.96
Xinjiang	19.44	57.82	22.74
Coastal	23.96	67.44	8.60
Inland	27.92	62.35	9.73
Central	30.99	57.76	11.25
Western	20.22	66.42	13.36
National	26.67	64.82	8.52

Table 2. – Persistence characteristics of provincial real GDP growth, 1953-1980 and 1981-2008

Province / Region	Proportion of variance in lower than business cycle range (%)		Proportion of variance in business cycle frequency range (%)		Proportion of variance in higher than business cycle frequency range (%)	
	1953-1980	1981-2008	1953-1980	1981-2008	1953-1980	1981-2008
Beijing	22.17	32.37	52.67	61.81	25.16	5.82
Tianjin	28.72	64.11	57.33	29.89	13.94	5.99
Hebei	36.62	46.21	54.88	36.93	8.50	16.86
Shanxi	28.95	47.44	54.10	33.28	16.95	19.28
Inner Mongolia	27.71	77.60	41.84	5.43	30.46	16.97
Liaoning	27.02	42.98	54.77	50.76	18.21	6.26
Jilin	14.90	30.13	61.71	57.86	23.39	12.01
Heilongjiang	22.98	53.46	58.41	39.21	18.60	7.33
Shanghai	23.27	64.36	61.15	26.48	15.58	9.17
Jiangsu	36.25	40.79	38.89	45.06	24.86	14.14
Zhejiang	41.96	64.08	45.84	26.62	12.20	9.30
Anhui	28.52	65.51	25.87	25.15	45.61	9.34
Fujian	31.17	54.89	50.57	35.10	18.26	10.00
Jiangxi	35.65	61.27	35.82	26.00	28.53	12.72
Shandong	31.79	53.48	40.25	38.70	27.96	7.83
Henan	45.67	37.21	33.15	32.84	21.18	29.95
Hubei	32.57	52.49	34.69	26.35	32.74	21.17
Hunan	35.92	52.81	33.13	35.88	30.95	11.31
Guangdong	26.43	64.55	54.67	23.73	18.90	11.72
Guangxi	40.36	70.34	37.20	17.50	22.44	12.15
Hainan	n/a	45.72	n/a	33.74	n/a	20.54
Chongqing	23.64	57.55	47.82	31.07	28.54	11.38
Sichuan	n/a	56.48	n/a	23.92	n/a	19.52
Guizhou	35.78	46.57	48.80	31.64	15.41	21.79
Yunnan	25.35	25.81	48.13	29.89	26.51	44.30
Tibet	11.83	23.09	42.91	57.88	45.27	19.03
Shaanxi	21.07	36.40	52.45	36.78	26.47	26.82
Gansu	35.60	30.68	53.96	46.29	10.44	23.03
Qinghai	29.00	53.50	53.92	22.19	17.08	24.31
Ningxia	17.26	37.12	58.17	39.52	24.57	23.36
Xinjiang	21.97	55.01	52.23	27.65	25.80	17.34
Coastal	26.68	57.61	60.26	36.69	13.06	5.71
Inland	33.65	59.38	53.83	29.66	12.52	10.95
Central	35.36	66.66	50.16	24.71	14.48	8.62
Western	27.96	37.37	56.60	40.39	15.45	22.24
National	30.36	58.56	57.54	33.87	12.09	7.57

Figure 1. Real GDP Growth for China, 1953-2008



Source – NBS (2009)

Figure 2. Spectral Density Function, National Real GDP Growth 1979Q1-2010Q4

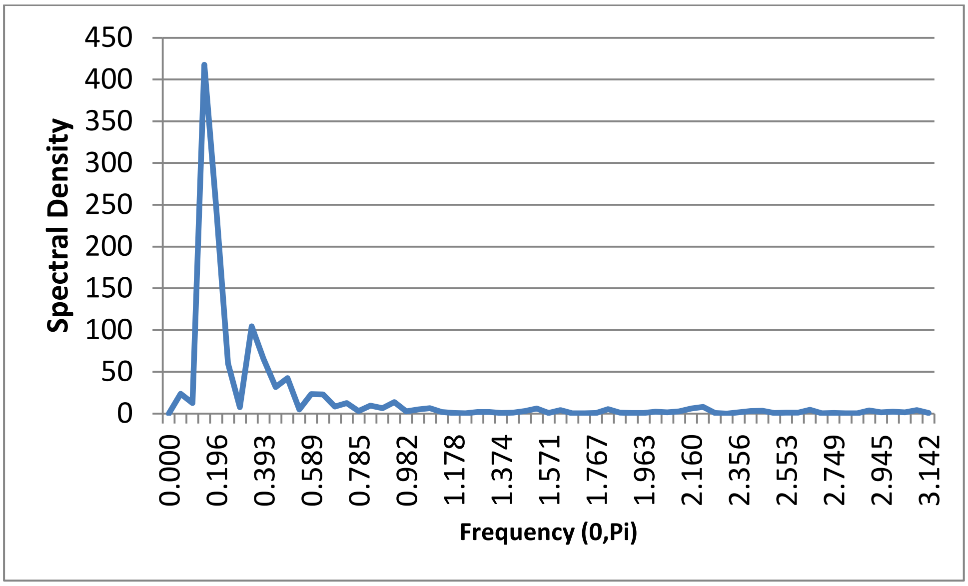
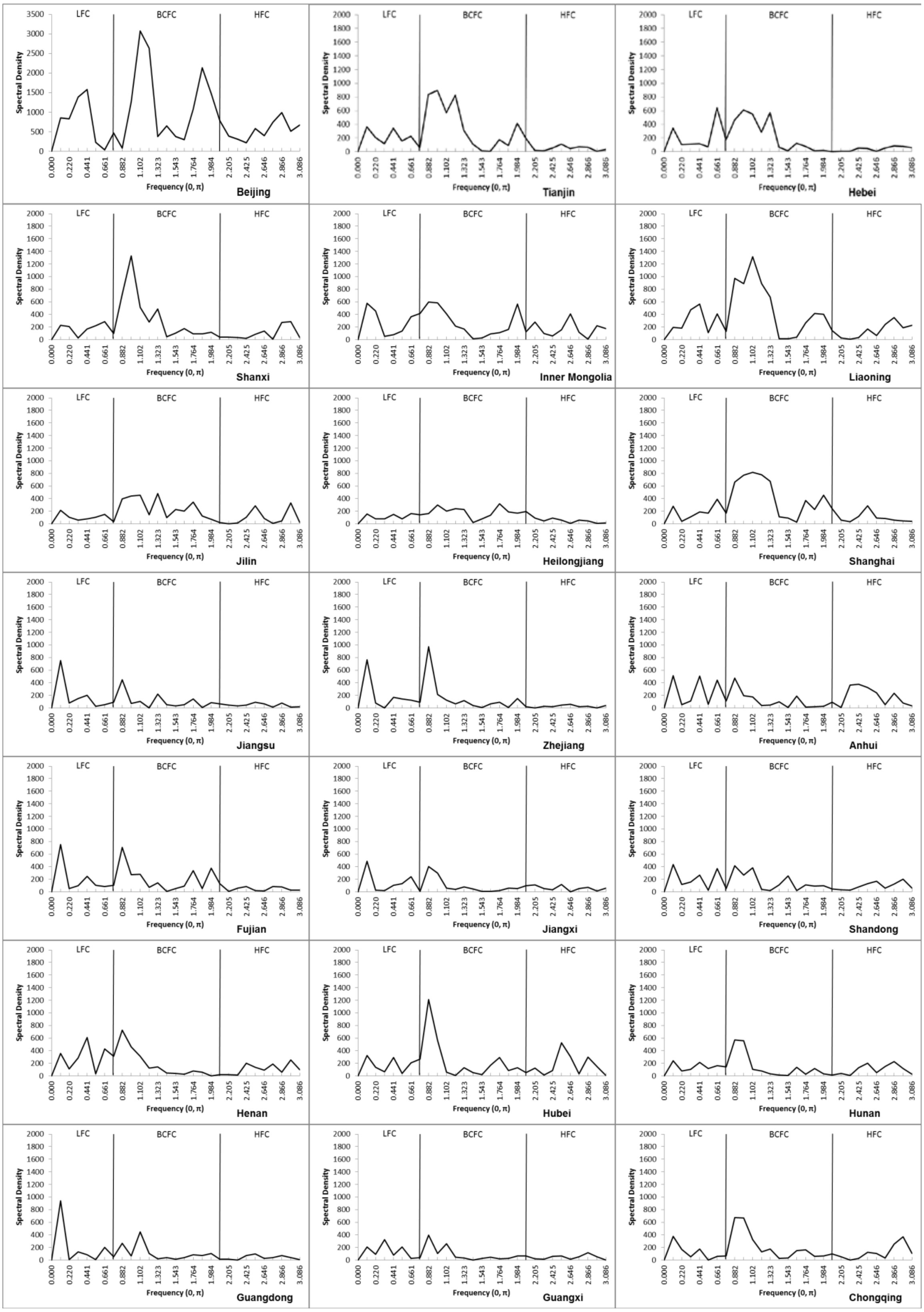


Figure 3. Spectral Density Functions for China's Provinces and Regions, 1953-2009



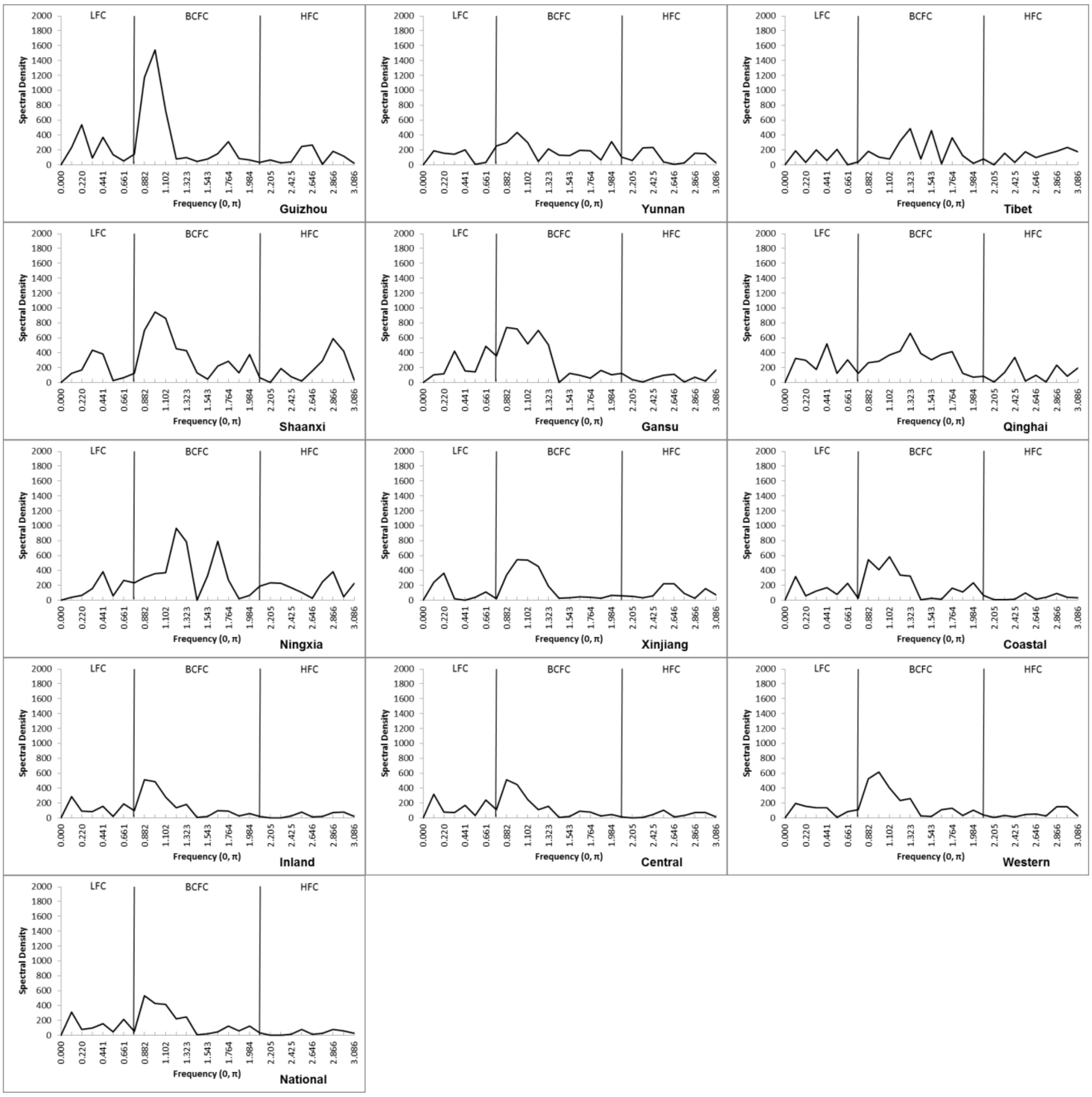
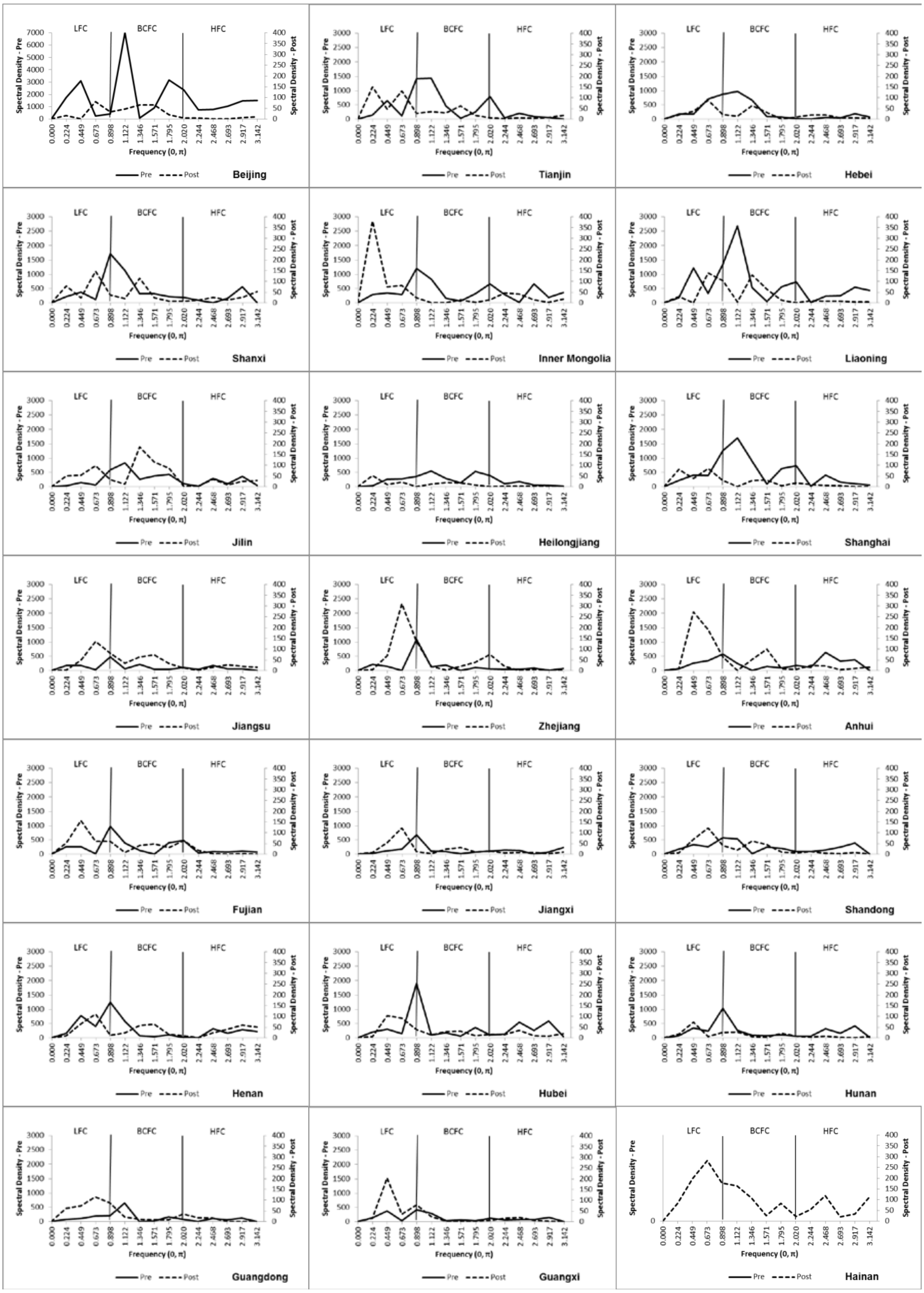
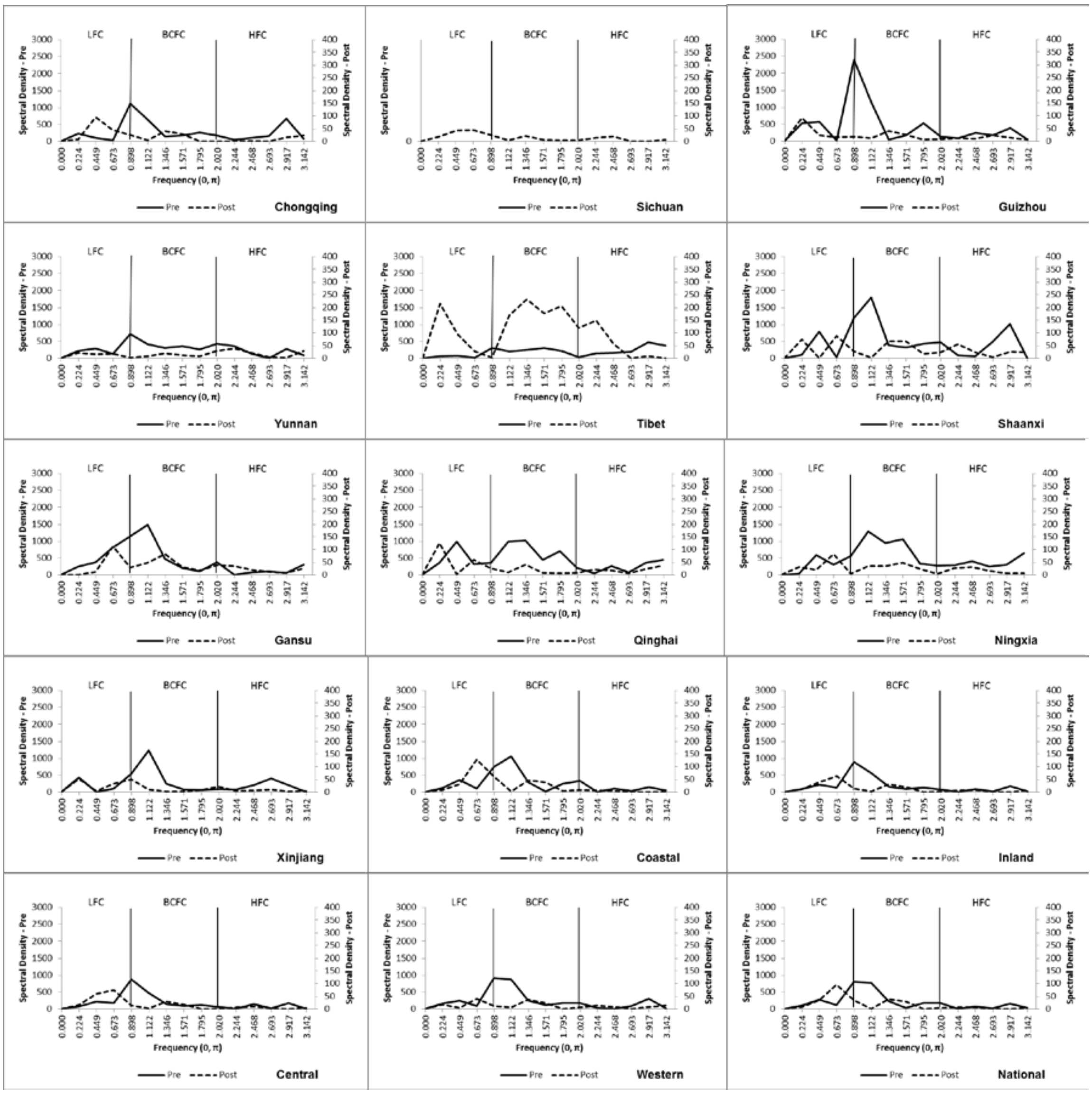

LFC
BCFC
HFC
Spectral Density
Frequency (0, π)
0.000
0.220
0.441
0.661
0.882
1.102
1.323
1.543
1.764
1.984
2.205
2.425
2.646
2.866
3.086
Guizhou
Yunnan
Tibet
Shaanxi
Gansu
Qinghai
Ningxia
Xinjiang
Coastal
Inland
Central
Western
National

Figure 4. Spectral Density Functions for China's Provinces and Regions, 1953-1980 (Pre) and 1981-2008 (Post)




LFC
BCFC
HFC
Spectral Density - Pre
Spectral Density - Post
Frequency (0, π)
Pre
Post
Chongqing
Sichuan
Guizhou
Yunnan
Tibet
Shaanxi
Gansu
Qinghai
Ningxia
Xinjiang
Coastal
Inland
Central
Western
National