Business cycle and inflation synchronisation in Mainland China and Hong Kong

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May 14, 2007

Abstract

This paper uses annual data spanning 1962 to 2003 to examine whether business and inflation cycles have become more similar across Chinese provinces as the economy has been liberalised and modernised. We find evidence of synchronisation, although business cycles in a group of mainly north-western provinces appear to have diverged from those in the rest of China. Both the business and inflation cycles in Hong Kong seem to have become increasingly synchronised with those in the Mainland over recent years.

Keywords: China, Hong Kong, business cycles, inflation cycles, synchronisation
JEL Classification: E32, R11

*The views in this paper are the author's and not necessarily those of the Swiss National Bank. I thank Alan Siu for suggesting this topic, the anonymous referee, Sylvie Démurger, Tom P.W. Fong, Stefan Gerlach, Wnesheng Peng, James Yetman and seminar participants at the Hong Kong Institute for Monetary Research for useful comments and Eva Chan for assistance with the data. The first draft of this paper was written while I was a visiting assistant professor at HIEBS and fully supported by a grant from the University Grants Committee of the Hong Kong Special Administrative Region, China (Project No. AoE/H-05/99). Swiss National Bank, Börsenstrasse 15, PO Box, 8022 Zürich, Switzerland, email: petra.gerlach@snb.ch.

1 Introduction

The tremendous growth of Mainland China ("China" hereafter) in recent decades has fundamentally transformed the economy as central planning has begun to give way to market forces. It is well documented that after the beginning of the economic reforms in 1978 and especially since the first half of the 1990s the coastal regions grew at a faster average pace than the rest of the country (see e.g. Démurger et al. [8], Wang [34] and Wu [35]). While there thus is ample evidence of differences in GDP growth trends, little attention has been devoted to the question whether the shocks affecting the different parts of China have become less correlated as well.

This paper studies macroeconomic cycles in China using annual real GDP and inflation data for 30 Chinese provinces and Hong Kong over the period 1962 to 2003. Our focus is on cycles in, rather than the absolute level of, economic activity and inflation. This allows us to ask whether the economic liberalisation has made business cycles at a regional level more synchronised; whether prices are affected by similar shocks in the different regions of China or whether deregulation has caused provincial inflation dynamics to diverge; and whether inflation and business cycles have become more volatile. We also study whether macroeconomic cycles in Hong Kong, which in 1997 became a Special Administrative Region of China, have become increasingly correlated with those in China.

The goal of the analysis is to provide a statistical description of the synchronisation of macroeconomic cycles in China. We thus seek to establish empirical regularities that any future work needs to be able to explain, and do not attempt to test any propositions from economic theory. The paper is structured as follows. Section 2 briefly discusses studies on regional differences in China and reviews, in particular, the literature on inflation and business cycles. Section 3 presents the data used in the analysis and discusses data problems. Section 4 studies provincial business cycles and Section 5 regional inflation cycles. To assess the degree of synchronisation, we apply principal components analysis to derive national business and inflation cycles. These are used as a benchmark with which we compare the provincial data. We find evidence of synchronisation of both business and inflation cycles. Nevertheless, it appears that business cycles in some, mainly northwestern, provinces have become less closely tied to developments in the rest of China. Section 6 examines whether macroeconomic cycles in the Hong Kong SAR have become increasingly correlated with those of China. Overall, the evidence points to some synchronisation in recent years. Section 7 concludes. The Appendix discusses as alternative approach to computing cycles the unobservable components method, which yields results similar to those presented in the main text.

2 Literature review

The literature on provincial economic activity in China typically focusses on explaining growth disparities (useful reviews are found e.g. in Wang [34] and Wu [35]). Démurger et al. [8] for instance study regional income inequality in China using data spanning 1952 to 1998. Their paper suggests that by the end of the 1990s regions with similar geographical characteristics (e.g. coastal vs landlocked provinces) and government policies had converged, while inequality between coastal and landlocked provinces persisted.[1] The authors argue that inefficient capital allocation by the banking sector and low labour mobility, caused by the government system of residence permits, are major factors preventing national convergence. They also show that the eastern provinces grew from 1992 onwards faster than the rest of China because they received most of the foreign investment that started to flow on a large scale into the country at that time.

In a closely related paper, Poncet [28] studies the synchronisation of business cycles in China over the period 1992 to 2004 by analysing the correlation of provincial data. Using quarterly employment data, she finds evidence of synchronisation, but reports that the comparatively remote provinces of Gansu, Guizhou, Ningxia, Qinghai, Shaanxi, Sichuan, Tibet and Yunnan have undergone business cycles that show low correlations with those in the rest of the country. Moreover, no synchronisation within this group is detected. To preview our results below, we also find that most of these provinces display no close

[1] Aziz and Duenwald [1] discuss this bipolarity of the income distribution in some detail. Wu [35] points out that the results on regional disparities depend strongly on whether or not data for Beijing, Shanghai and Tianjin are included in the analysis.

links with the rest of China nor with each other. Poncet also explores the causes of business cycle synchronisation in China. She finds that, among other factors, similarity in production structures and fiscal policies as well as mutual labour mobility contribute to a high correlation of economic activity of two provinces.

While Poncet only considers developments in the real economy, Tang [33] also studies inflation synchronisation in China. He estimates provincial VARs on industrial output and the retail price index over the period 1990 to 1995 and retrieves a nominal and a real shock for each province. He interprets the correlations of the real shocks as a measure of business cycle integration and the correlations of the nominal shocks as an indicator of the synchronisation of inflation rates. Tang reports that there are two groups of provinces for which business cycles are synchronised and three groups where inflation rates follow a common cycle and emphasises that geography seems to determine their composition. The first business cycle group comprises the eastern provinces of Anhui, Fujian, Hunan, Jiangxi, Liaoning and Zhejiang, while the other group consists of the western regions of Gansu, Guizhou, Qinghai, Shaanxi and Xinjiang. The urban provinces of Beijing, Guangdong, Shanghai and Tianjin; eastern Anhui, Jiangsu and Zhejiang; and southern Guangxi, Hunan and Sichuan show similar inflation developments. While we find below that inflation has become increasingly synchronised nation-wide, Tang's first group of provinces with unusual business cycles consists of much the same provinces as ours.

The question whether the national Chinese business cycle has become more similar to that of other countries is addressed by Zhang [38], who examines the origins of shocks affecting Chinese economic activity. He finds that most fluctuations in the business cycle are due to domestic shocks, which he interprets as evidence of little synchronisation of Chinese economic activity with foreign business cycles. Kim, Kim and Wang [22] follow Frankel and Rose [11], who argue that countries with close trade links experience similar business cycles, and examine whether synchronisation has increased in the Asia-Pacific region.[2] Comparing the correlations in business cycles for the samples 1980 to 1989 and

[2] Calderon, Chang and Stein [3] examine the impact of trade integration on business cycle synchronisation for a set of 147 countries over the period 1960 to 1999 and find strong evidence of positive linkages.

1990 to 2001, they find that synchronisation between China and Hong Kong (as well as Taiwan) has become stronger. Moreover, they report that business cycles in the Asia-Pacific region in general have become increasingly synchronised, which they argue is due to international capital flows.

Oppers [27] discusses aggregate macroeconomic cycles in China and reviews the link between inflation developments and business cycle swings from 1979 to 1997. We draw extensively on his study when reviewing historical inflation episodes in the Chinese provinces in Section 5. Oppers estimates a Phillips curve that decomposes the output gap into three components of aggregate demand – fixed investment, retail sales and exports – and finds that inflation is positively correlated with demand pressures. Imai [19] suggests that inflation in China is driven mainly by investment, while Ha, Fan and Shu [15] argue that inflation in the 1990s was caused by rising world prices and the devaluation of the renminbi in 1994. Gerlach and Peng [12], using a sample covering the period 1978 to 2003, also estimate the impact of economic activity on inflation in China, but find that a standard Phillips curve seems to fit the data only if it is assumed that some additional, unobserved factor impacts on price developments. They argue that this factor could represent the deregulation of prices, the liberalisation of trade and other reforms.

There have apparently been no studies comparing inflation cycles in the individual Chinese provinces and in Hong Kong. Instead, the focus has been on the convergence of price levels. Ha and Fan [14] study price differentials between Hong Kong and four Chinese cities (Beijing, Guangzhou, Shanghai and Shenzhen) over the period 1994 and 2001. They find that these differentials have declined, but that the speed of convergence with Hong Kong is much smaller than that between the cities within China. They suggest as one factor explaining this phenomenon limited factor mobility. Cheung, Chinn and Fujii [5] study the integration of prices in China, Hong Kong and Taiwan by assessing the validity of the interest rate and purchasing power parity hypotheses. They find strong signs of integration between the China and Hong Kong over the period 1996 to 2002.

The present paper adds to the existing literature in four ways. First, it uses data already from 1962 onwards. While the reliability of Chinese data is a debated issue (which we return to in the next section), the inclusion of such early data adds historical perspective and does not impact on our analysis of more recent years. Second, in contrast to a simple correlation analysis, the principal components method allows us to extract a common business (inflation) cycle from the data. In doing so, we are able to abstract from idiosyncrasies of individual provinces. Third, by analysing inflation and business cycles using the same method, we are able to compare the extent of their synchronisation. Fourth, using the same approach also for Hong Kong allows us to assess the synchronisation of its macroeconomic cycles with those of the Mainland.

3 The data

In the analysis below we consider data for the provinces of Anhui, Beijing, Chongqing, Fujian, Gansu, Guangdong, Guangxi, Guizhou, Hainan, Hebei, Heilongjiang, Henan, Hubei, Hunan, Inner Mongolia, Jiangsu, Jiangxi, Jilin, Liaoning, Ningxia, Qinghai, Shaanxi, Shandong, Shanghai, Shanxi, Sichuan, Tianjin, Xinjiang, Yunnan and Zhejiang for the years 1962 to 2003. These data are from the CEIC database [4] and the Chinese National Bureau of Statistics (NBS) [25]. We do not use data for Tibet since they start after 1962. Since the provinces of Guangdong and Hainan, and Sichuan and Chongqing, were divided during the sample period, we treat them as one province respectively. We consider thus 28 provincial time series. Since it is our aim to study the statistical properties, in particular the correlation, of economic activity and price developments in China rather than developments in individual provinces, we abstain from discussing the provincial data in detail (Sections 4 and 5 review economic events by assessing shocks and trends in the country as a whole).

Section 6, which asks whether Hong Kong's macroeconomic cycles have come to resemble those in China, uses real GDP growth and GDP deflator inflation from the website of the Hong Kong Census and Statistics Department [17].

When interpreting the results below, it is important to bear in mind that Chinese data, in particular provincial data, have been argued to be of poor quality and subject to large measurement errors.[3, 4] For instance, Holz [16] notes that the GDP data from the years of

[3]For a detailed discussion of the measurement of GDP in China, see e.g. Scheibe [30].

[4]Using unemployment data, which typically is highly correlated with the business cycle, to verify the

the Great Leap Forward are highly unreliable and asserts that during the years of central planning, there was strong pressure on provinces to meet the administratively determined growth targets, and it is likely that this impacted on the reported GDP data.[5] Holz furthermore argues that regional GDP data remained unreliable also during the reform period since provincial officials are remunerated according to the economic performance of their area of responsibility. This may have led to an incentive to exaggerate GDP numbers: strikingly, in 1998 all but one province reported GDP growth above the national average (China Economic Quarterly [6]).[6] At the end of 2004, the NBS announced that in a drive to improve quality, provincial GDP data would cease to be published by regional authorities and instead be released by Beijing (see South China Morning Post [31]). The IMF [20] reports that the NBS intends to strengthen its follow-up checks on data provided by the provinces.

Measurement errors in GDP also affect our measure of inflation, which we construct as the annual rate of change of the GDP deflator. Young [36] points out that real and nominal GDP data in China rely on reports by individual enterprises on their real and nominal output. Since evaluating the real value of their output is a time consuming task, many enterprises appear to report identical values for nominal and real output year after year, thus implying zero inflation. Young shows that GDP deflator inflation indeed tends to be lower than other measures of inflation.[7] For the period 1978 to 1998, he estimates that GDP deflator inflation understated the true rate of increase in prices by roughly two percentage points per year.

Lacking better data, we have no choice but to rely on the provincial time series. It

GDP numbers proves difficult for China because of the poor measurement of unemployment (see Giles, Park and Zhang [13]).

[5] Chow [7] points out that when the NBS published the first Statistical Yearbook in 1981, it did not conceal the economic downturn during the Great Leap Forward.

[6] Klein and Özmucur [23] use different sets of indicator variables over the period 1981 to 2000 to assess the plausibility of official GDP numbers. They conclude that the indicators and the official output data contain largely the same information. Rawski [29], by contast, is highly sceptical.

[7] Other measures have also been criticised for not capturing inflation appropriately. The Hong Kong Monetary Authority [18] for instance argues that the housing component in the CPI is too small and that as a consequence reported inflation in recent years has been too low.

should, however, be pointed out that in the statistical analysis of the business cycle below we consider output gaps, defined as output relative to potential, rather than the growth rate of GDP. To the extent that there has been a systematic bias to overstate the level of GDP, this method should reduce the importance of measurement errors.

4 Business cycle synchronisation

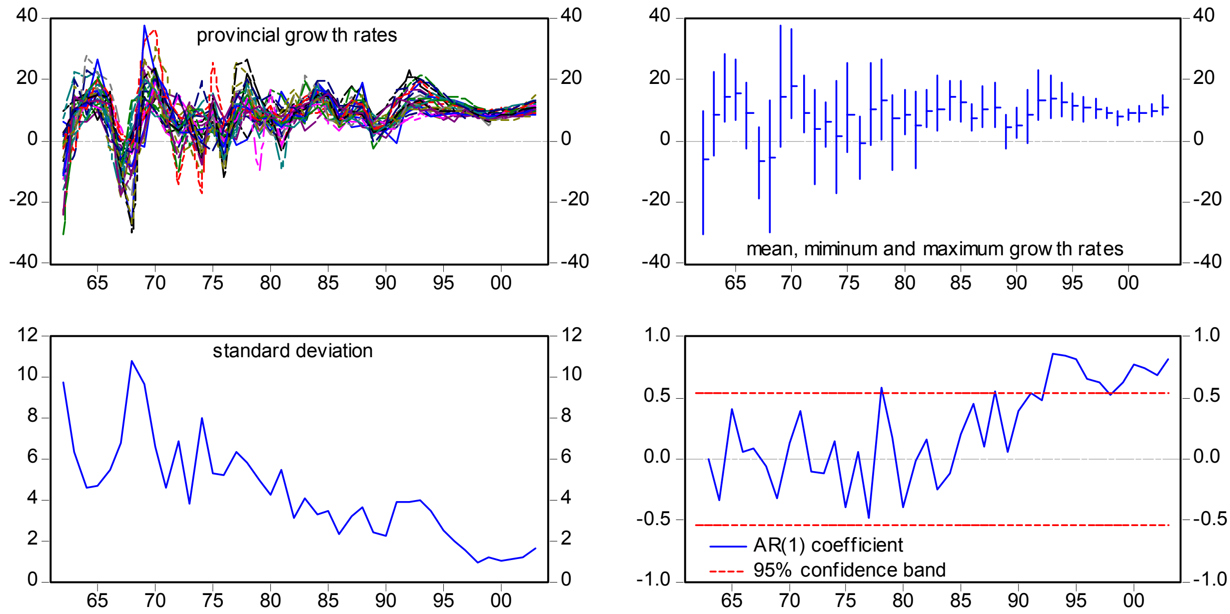
To gain a sense of the common elements of provincial business cycles in China, we present in the upper left-hand plot of Figure 1 the regional growth rates. The upper right-hand graph of Figure 1 plots the minimum, mean and maximum growth rate for each year. Most provincial GDP growth rates were negative in 1962 and then recovered quickly to an average of 15.6% in 1965. This swing reflects the economic revival after the Great Leap Forward, which had been initiated by Mao Zedong in 1958 and which had brought the collectivisation of large parts of the economy. Chinese GDP shrank again in 1967 and 1968, when the Cultural Revolution greatly hampered production. Activity recovered temporarily, but the power struggle between Zhou Enlai and the Gang of Four intensified from 1974 onwards and GDP growth dropped again to an average of -1.0% in 1976.

China began gradually to open to the world economy under the leadership of Deng Xiaoping from 1978 onwards, and the average of the regional GDP growth rates is positive for the rest of our data sample. Nevertheless, there were still swings in activity. The clearest slowdown in the second half of the sample is observed for 1989, when average growth fell to 4.1%. This coincides with tight monetary conditions at the time that were geared towards reducing inflation (see also Section 5). At the end of the sample, the mean rate of the provincial growth rates was 10.9%.

It is interesting to note that the range of growth rates declined from more than thirty percentage points at the beginning of the sample to below seven percentage points in 2003. It thus appears that regional growth rates became more similar, an impression that is confirmed by the lower left-hand plot of Figure 1, which shows the standard deviation of growth rates. Arguably, this convergence is related to the market-oriented reforms that were introduced from 1978 onwards.

Figure 1:

Summary statistics of provincial GDP growth rates



The lower right-hand plot of Figure 1 shows the first autoregressive coefficient with a 95% confidence band.[8] While at the beginning of the sample no significant autocorrelation is detected, from 1993 onwards there is evidence of a significant positive autoregressive coefficient. The dynamics of real growth in China seem hence to have become smoother over time.

Since this study concentrates on the fluctuations, rather than the growth rate, of regional economic activity, we now turn to the question how to measure business cycles. To capture provincial business cycles, we use regional output gaps. We obtain these by first calculating for each province potential GDP. Denoting the logarithm of real GDP in province j in year t by $x_{j,t}$, we apply the Hodrick-Prescott filter with a smoothing parameter of 100 to compute the logarithm of potential, $x_{j,t}^{pot}$. The output gap for province

[8]Since each period the AR coefficient is computed using 28 data points, its asymptotic standard deviation is given as $\sqrt{2/28}$ (see Fisher and Yates [10]).

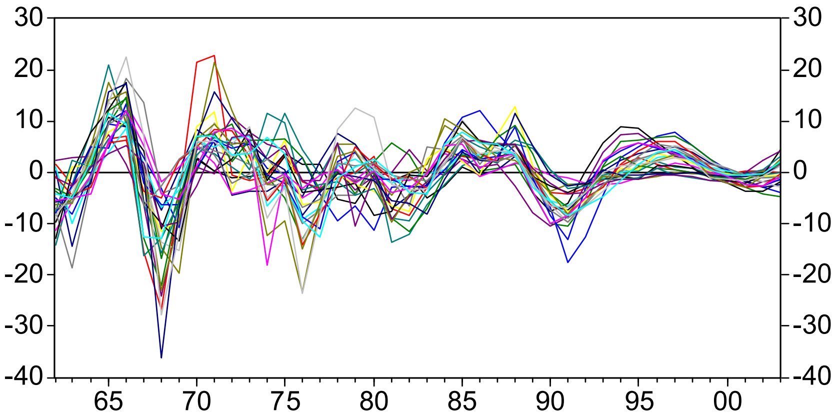
j is then given by

$$y_{j,t} \equiv 100(x_{j,t} - x_{j,t}^{pot}).$$

Figure 2 shows the regional output gaps used in the following analysis. Not surprisingly, this plot is very similar to that of the real GDP growth rates presented in Figure 1. We again find that most provinces experienced downturns during the Cultural Revolution in 1968 and 1976. We also identify economic slowdowns around 1981 and 1990, when credit conditions were tight since the authorities attempted to reduce inflation. Finally, there was a small downturn in 1998 and 1999, which might reflect the impact of the Asian financial crisis.

Figure 2:

Provincial output gaps



Given the similarity of the business cycles fluctuations in the individual provinces especially towards the end of the sample, the question arises to which extent they are driven by one common factor. Identifying such a common factor would be of interest for at least two reasons. First, if a dominant common factor is identified, this can be thought of as the Chinese business cycle. Second, it then would be possible to analyse which provinces have become increasingly synchronised with this benchmark cycle and which, if any, have diverged.

Before applying principal components analysis to do so, it should be noted that identifying the common cycle using this approach is preferable to considering an output gap constructed on aggregate nation-wide Chinese data because the latter basically is a weighted average of the regional output gaps, with the weights related to the level of provincial GDP. If one province follows a very different business cycle from the rest of the country, the principal components analysis would identify it as an outlier and attach a weight of close to zero to it.[9]

4.1 Computing the Chinese business cycle

We use the principal components procedure to decompose the 28 regional output gaps into an equal number of orthogonal factors, where we think of the first of these, denoted by y_t, as capturing the national component. The series y_t is that linear combination of the underlying regional gaps which explains the largest fraction of their total variance.[10] This fraction of variances is given by

$$\varphi_y = \frac{l_1^y}{\sum_{k=1}^{28} l_k^y},$$

where l_k^y denotes the kth largest eigenvalue of the covariance matrix of the $y_{j,t}$ series. The left panel of Table 1 shows φ_y and the factor loadings of y_t (we concentrate on the first principal component in the interest of brevity). The larger φ_y, the more dominant the common factor.

To understand the results of the principal components analysis, consider first φ_y, which indicates that the common component explains 62.7% of the total variance of the regional output gaps (implying that the other 27 principal components together reflect the remaining 37.3%). Thus, y_t captures almost two thirds of the movements in the provincial output gaps. It therefore seems appropriate to think of it as representing the economy-wide business cycle. The lower part of Table 1 reports the weights the individual provinces have in the construction of the common component. The loading factors b_j^y correspond to the elements of the first eigenvector of the covariance matrix of the $y_{j,t}$:s and have

[9] Nevertheless, we find a correlation of 0.96 between the common business cycle identified by principal components analysis and the output gap computed using aggregate Chinese data.

[10] For a discussion of principal components analysis, see e.g. Johnston [21].

been normalised such that they sum to unity. Interestingly, the weights for y_t are rather similar across provinces, ranging between 0.02 and 0.06, and they all differ significantly from zero.[11] This suggests that all regions matter for the common business cycle.

We plot y_t in Figure 3 together with an alternative measure derived in the Appendix, which is discussed briefly below.[12] The common component shows the recovery from the Great Leap Forward mentioned above and the early and late impact of the Cultural Revolution in 1968 and 1976, respectively. The common business cycle also suggests that recessions occurred during the episodes of monetary tightening around 1981 and 1989 as well as after the Asian financial crisis. Finally, it is notable that the amplitude of the swings in economic activity has shrunk over time. It thus appears that Chinese business cycles have become less volatile, which may be due to the introduction of market-oriented reforms.

Figure 3 also shows the business cycle estimate obtained in the Appendix from the unobservable components method. The business cycle from the principal components approach lies within the 95% confidence interval of this second method, which suggests that the common business cycle we identify for the Chinese provinces is robust to the choice of computation method.

4.2 Synchronisation of provincial business cycles

To gain a better sense of the synchronisation of the provincial business cycles, we plot in Figure 4 recursive estimates of φ_y. To obtain a time series of φ_y, we perform the principal components analysis repeatedly using a ten-year rolling time window. The first value of φ_y is calculated from the provincial output gap data for the period 1962 to 1971, the second value for the sample 1963 to 1972 and so on. The time axis in Figure 4 shows the end year of the moving window. The larger φ_y, the more does the common component

[11] The standard errors for the loading vector b_j^y are given by $l_j^y \sum_{i \neq j}^{28} l_i^y b_i^y b_i^{y\prime} / (l_i^y - l_j^y)^2 / T$, where T is the sample length (see Mardia et al. [24], p. 230).

[12] Since the principal components analysis provides common factors the scale of which is difficult to interpret, we normalise y_t so that its mean and standard deviation equal the weighted average mean and standard deviation of the $y_{j,t}$:s (using the loading factors b_j^y as weights).

Table 1:

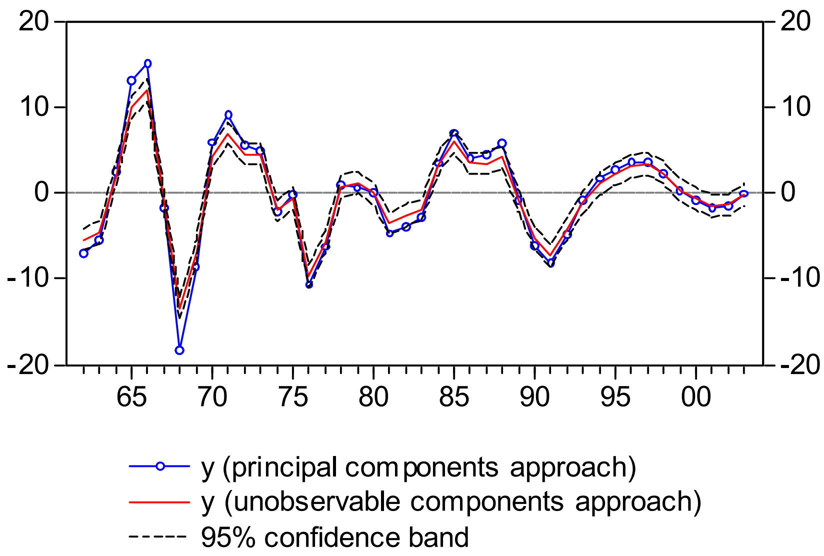
Principal components analysis

	Output gaps		Inflation
Importance of common factor		Importance of common factor	
φ_y	0.627	φ_p	0.690
Factor loadings		Factor loadings	
b^y_{Anhui}	0.034***	b^p_{Anhui}	0.035***
$b^y_{Beijing}$	0.040***	$b^p_{Beijing}$	0.030***
b^y_{Fujian}	0.040***	b^p_{Fujian}	0.042***
b^y_{Gansu}	0.023***	b^p_{Gansu}	0.021***
$b^y_{Guangdong\text{-}Hainan}$	0.032***	$b^p_{Guangdong\text{-}Hainan}$	0.034***
$b^y_{Guangxi}$	0.029***	$b^p_{Guangxi}$	0.044***
$b^y_{Guizhou}$	0.051***	$b^p_{Guizhou}$	0.036***
b^y_{Hebei}	0.027***	b^p_{Hebei}	0.036***
$b^y_{Heilongjiang}$	0.016***	$b^p_{Heilongjiang}$	0.040***
b^y_{Henan}	0.035***	b^p_{Henan}	0.037***
b^y_{Hubei}	0.045***	b^p_{Hubei}	0.036***
b^y_{Hunan}	0.027***	b^p_{Hunan}	0.041***
$b^y_{Inner\ Mongolia}$	0.035***	$b^p_{Inner\ Mongolia}$	0.035***
$b^y_{Jiangsu}$	0.034***	$b^p_{Jiangsu}$	0.032***
$b^y_{Jiangxi}$	0.028***	$b^p_{Jiangxi}$	0.030***
b^y_{Jilin}	0.040***	b^p_{Jilin}	0.031***
$b^y_{Liaoning}$	0.036***	$b^p_{Liaoning}$	0.033***
$b^y_{Ningxia}$	0.029***	$b^p_{Ningxia}$	0.045***
$b^y_{Qinghai}$	0.023***	$b^p_{Qinghai}$	0.038***
$b^y_{Shaanxi}$	0.051***	$b^p_{Shaanxi}$	0.035***
$b^y_{Shandong}$	0.053***	$b^p_{Shandong}$	0.035***
$b^y_{Shanghai}$	0.029***	$b^p_{Shanghai}$	0.034***
b^y_{Shanxi}	0.025***	b^p_{Shanxi}	0.036***
$b^y_{Sichuan-Chongqing}$	0.057***	$b^p_{Sichuan-Chongqing}$	0.037***
$b^y_{Tianjin}$	0.037***	$b^p_{Tianjin}$	0.034***
$b^y_{Xinjiang}$	0.036***	$b^p_{Xinjiang}$	0.039***
b^y_{Yunnan}	0.046***	b^p_{Yunnan}	0.037***
$b^y_{Zhejiang}$	0.040***	$b^p_{Zhejiang}$	0.037***

Note: φ denotes the fraction of the variance of the data captured by the first principal component. The factor loadings b_j are obtained from the normalised first eigenvector of the covariance matrix of the data. */**/*** denotes significance at the ten / five / one percent level.

Figure 3:

The common Chinese business cycle



dominate the movements in the regional output gaps and hence the more are the business cycles coordinated.

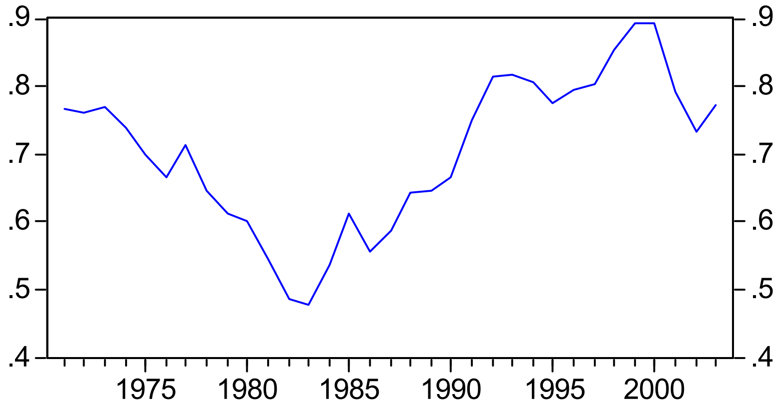
Before discussing the results of this recursive estimate of φ_y, it should be pointed out that the moving ten-year window implies that poor data quality in one decade does not affect the analysis in other decades. This feature is attractive given the changes in data quality over the sample. If the reader doubts the quality before 1987, at least those measurement errors do not contaminate the estimates of φ_y from that point in time onwards (though, as mentioned in Section 3, the data of the reform period also have been argued to be problematic).

We find that φ_y falls from over 70 percent for the sample 1962 to 1971 to below 50 percent for the sample 1974 to 1983. The importance of y_t subsequently increases, with φ_y reaching about 90 percent in the sample 1990 to 1999, and then falls again. This analysis suggests that in the 1960s, provincial business cycles were mainly driven by one common factor, which arguably was determined by political events. In the 1970s and 1980s, regional factors seem to have gained importance, which may have reflected at

Figure 4:

Importance φ_y of the common business cycle

(fraction of total variance explained by y_t)



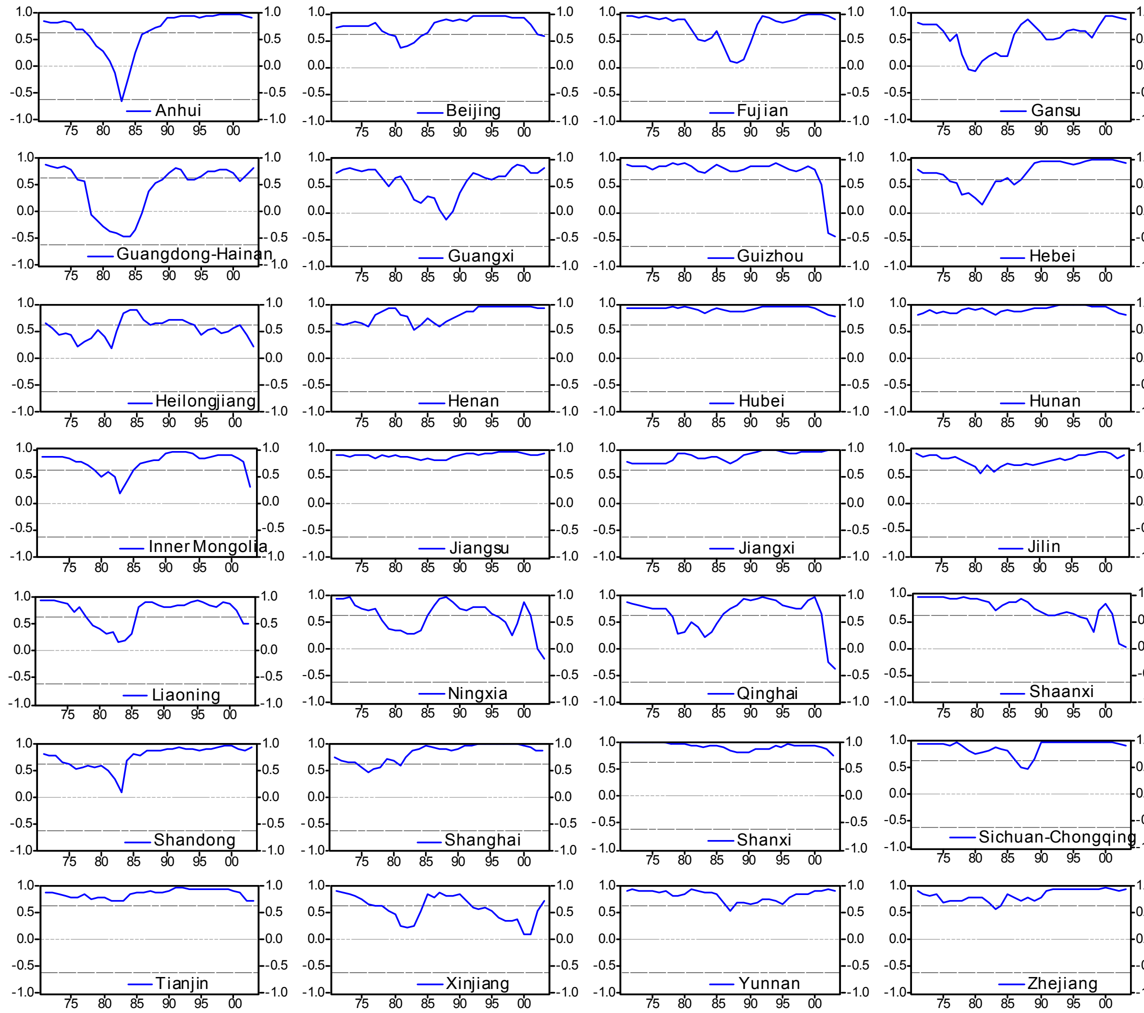
first a loss of central control due to the Cultural Revolution and, towards the end of the 1970s, the gradual abandonment of central planning. From the late 1980s onwards, when market forces gained more and more importance, the provincial output gaps appear to have evolved again in a similar fashion.

Despite this overall synchronisation, it is possible that the output gaps in some provinces have over time become less closely related to the common business cycle. Figure 5 shows the correlation between the $y_{j,t}$:s and y_t and a 95% confidence band. We again use a ten-year moving window to obtain these series. The correlations between the output gaps in the individual provinces and y_t were almost always positive. The two largest exceptions are found for Anhui and Guangdong-Hainan for the ten-year windows ending in the early 1980s. Furthermore, the correlations for Guizhou, Ningxia and Qinghai turn negative at the end of the sample.

For the majority of provinces Figure 5 shows an increase in correlation and significance over time. Thus, as suggested by the analysis of φ_y, provincial business cycles in China have become more similar. Nevertheless, we find for a number of provinces a decrease in correlation with the common component. Economic activity in Heilongjiang, Ningxia, Shaanxi and Xinjiang, all northern and northwestern provinces, has since the

Figure 5:

Correlations between provincial output gaps $y_{j,t}$ and the first principal component y_t



Note: Dashed lines show 95% confidence bands.

1970s become less synchronised with the rest of China. Two northwestern provinces, Inner Mongolia and Qinghai, the southwestern province of Guizhou and Beijing have shown a similar reduction in correlation since the end of the 1990s. These findings are compatible with those in Poncet [28] and Tang [33], who also report that many of these very provinces show no synchronisation with the common Chinese business cycle. In accordance with Poncet but in contrast to Tang, inspection of the output gaps of the eight provinces identified here does not suggest that they follow their own common business cycle.

Overall, Section 4 suggests that provincial business cycles are driven by one common component. While the general trend is for regional output gaps to become increasingly synchronised, a number of mostly northwestern provinces have in recent years experienced business cycles different from those in the rest of China. This raises the question whether price developments in these regions also have become de-coupled from those in other provinces.

5 Inflation synchronisation

We first present the provincial inflation rates in the upper left-hand plot of Figure 6. The upper right-hand graph presents the minimum, mean and maximum inflation rate for each year. While the maximum inflation rate for each year is positive, we find that in most years up until the mid-1980s some provinces experienced falling prices. After major economic policy reforms were initiated in 1978, administratively set prices were increasingly liberalised. To the extent that these prices had been set below market-clearing level, inflation was the consequence. Oppers [27] suggests that the first increase in prices in 1979 to 1981 was triggered by higher wages in the industrial sector and a jump in agricultural prices.[13] To reduce inflation, credit controls were tightened and interest rates increased, which led to a reduction of both inflation and real GDP growth.

Inflation increased again from 1982 onwards, and continued to rise in 1984, when state-owned enterprises were granted larger autonomy in setting wages. Credit controls were tightened in 1986, but financial problems in the state-owned enterprises led for the controls

[13] The following discussion is based on Oppers [27].

to be loosened, and inflation started to rise again that same year. Further liberalisation of prices caused higher inflation, but tighter credit conditions towards the end of the 1980s once more reduced inflation as well as the growth rate of GDP.

At the beginning of the 1990s, agricultural prices were adjusted upwards to market levels and price controls were reduced in the industrial and retail sectors. Inflation started to increase again in 1991. The mean of the regional inflation rates exceeded 14 percent in 1994, and credit growth was curtailed once more. Interestingly, Section 4 suggests that while the earlier episodes of monetary tightening caused recessions, there was no major downturn in economic activity in the mid-1990s. Ha, Fan and Shu [15] argue that this is due to the unification of the renminbi exchange rates, the net effect of which was a devaluation that caused higher export growth.[14] Moreover, foreign direct investment, which by the 1990s had taken on a large scale, supported growth. As the Asian financial crisis took hold, deflation began. Yu [37] argues that excess capacity and dampened demand after the crisis put downward pressure on prices. At the end of the sample, the mean rate of inflation was 2.8%.

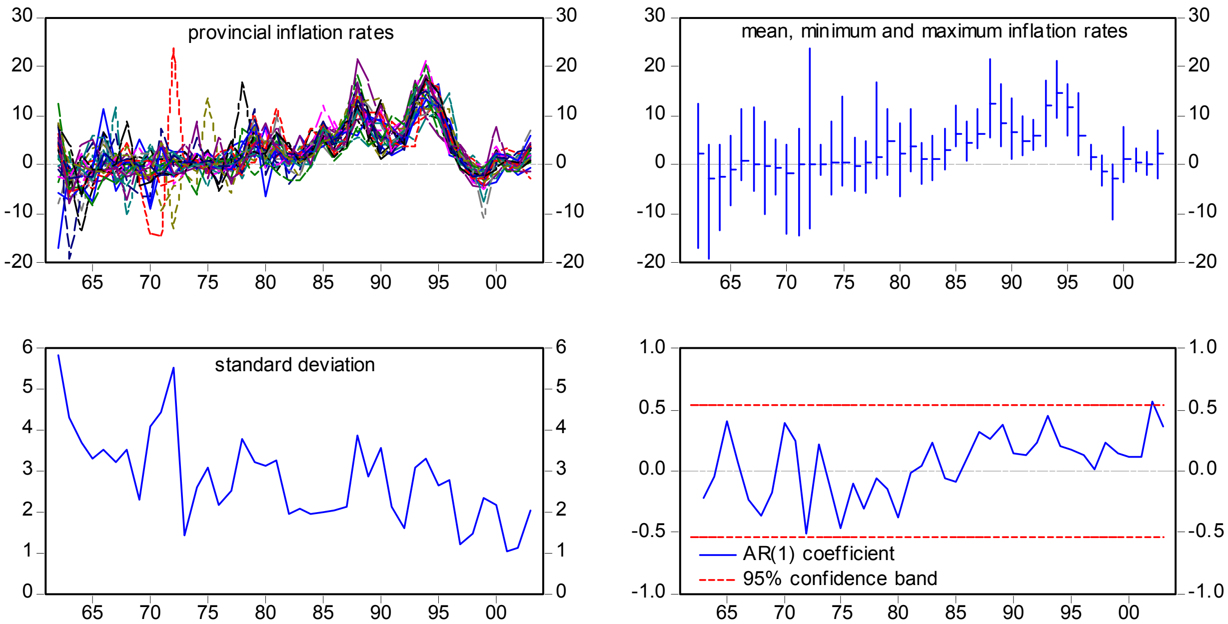
The upper right-hand plot of Figure 6 shows that the range of provincial inflation rates narrowed from 29.2 percentage points at the beginning of the sample to 9.4 percentage points at its end. Thus, inflation rates have apparently also become more similar over time. To gain a better sense of this, we show in the lower left-hand plot the standard deviation for each year and find that it declined over time. Interestingly, the dispersion of the regional inflation rates increased during the periods of increased inflation in 1988 and 1994. This constitutes a parallel to the results in the literature on inflation dispersion, where high rates of inflation are reported to coincide with a broad variation in price increases of individual goods (see e.g. Ball [2]). It is a striking finding that the standard deviation also increases for 1999, when average deflation was at its most severe since 1963.

Finally, the lower right-hand side plot shows the first autocorrelation of the regional inflation rates. While provincial inflation rates appear to have become slightly more autocorrelated over time, they show much less persistence than the output gap.

[14] On the unification of the renminbi exchange rates, see also Fernald, Edison and Loungani [9].

Figure 6:

Summary statistics for provincial inflation rates



5.1 Computing the Chinese inflation cycle

It seems plausible that the provincial inflation rates $p_{j,t}$ in China are dominated by one common factor, just as appears to be the case for the regional output gaps. To gain a better sense of this, we again perform a principal components analysis and denote the first component by p_t. The right panel of Table 1 shows its importance as captured by φ_p and reports the factor loadings. Since the results are similar to those for the output gap, in the interest of brevity the discussion here is somewhat condensed.

We find that the first principal component explains 69.0% of the variance of the regional $p_{j,t}$:s (so that the remaining 27 principal components together capture another 31.0%). All provinces significantly contribute with roughly equally large loading factors to the construction of p_t, which suggests that the first principal component reflects one dominant common factor that impacts on all regional inflation rates.[15] We plot p_t in Figure 7 and see that it clearly reflects the episodes of increased inflation discussed above.[16] In contrast to the business cycle, the amplitude of the movements in the common inflation rate has not decreased over time. One possible explanation for this is that inflation has become more volatile because the number of administratively set prices, which tend to be adjusted but rarely, has decreased. It should be noted that the large decrease in Chinese inflation in the second half of the 1990s, when the domestic economy was overheating, likely reflects the world-wide decline in inflation and is not caused by domestic factors.

Figure 7 also shows the alternative estimate of the common inflation cycle obtained using unobservable components analysis.[17] We see that the principal components approach suggests significantly higher rates of inflation during the peaks of 1988 and 1994 and more severe deflation in 1999. Thus, the common inflation cycle is not as clearly identified as that of the Chinese business cycle.

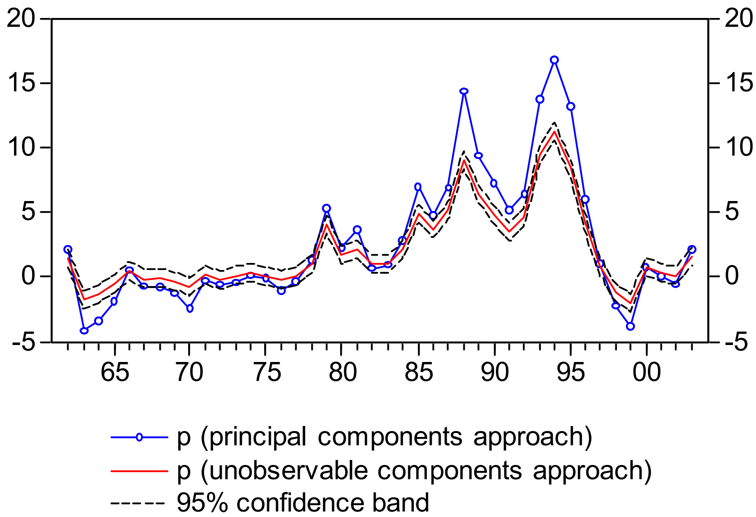
[15] The correlation between p_t and aggregate Chinese GDP deflator inflation is 0.95.

[16] We normalise the principal components measure of p_t so that its mean and standard deviation equal the weighted average mean and standard deviation of the $p_{j,t}$:s (using the loading factors b_j^p as weights).

[17] See the Appendix for details.

Figure 7:

The common Chinese inflation cycle



5.2 Synchronisation of provincial inflation cycles

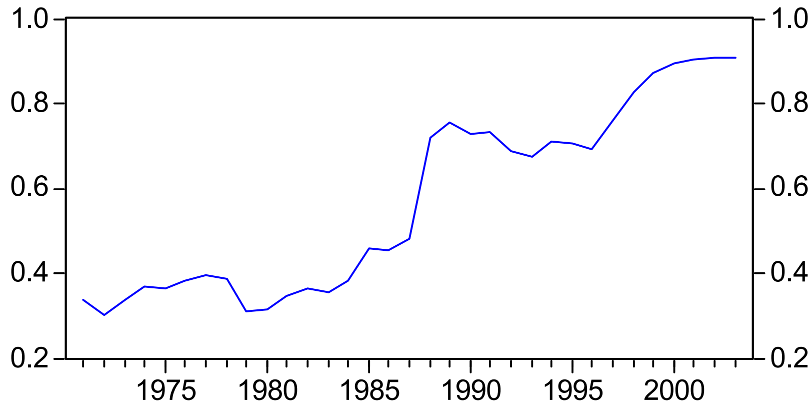
To assess whether inflation rates have become increasingly synchronised, we consider the evolution of φ_p over time. In contrast to the results reported for the output gap, Figure 8 shows a steady increase in the importance of the common component. The last data point suggests that for the period 1994 to 2003, over ninety percent of the movements in all regional inflation rates are captured by the first principal component. Thus, nation-wide developments increasingly appear to dominate the changes in the provincial price indices. It is plausible that the economic reforms led to an integration of the regional markets that is reflected in similar price movements for the same good across the country.

Finally, Figure 9 shows the correlation between the $p_{j,t}$:s and p_t. We find occasional negative correlations in the 1960s and early 1970s in most provinces, but since the 1980s, correlations have tended to be above 0.5 and increasing. By the end of the sample, all correlations are significantly larger than zero, which suggests a convergence of the shocks affecting the provincial inflation rates. It thus seems that the synchronisation of regional inflation rates has been greater than that of provincial business cycles.

Figure 8:

Importance φ_p of the common inflation cycle

(fraction of total variance explained by p_t)



6 Synchronisation between Hong Kong and China

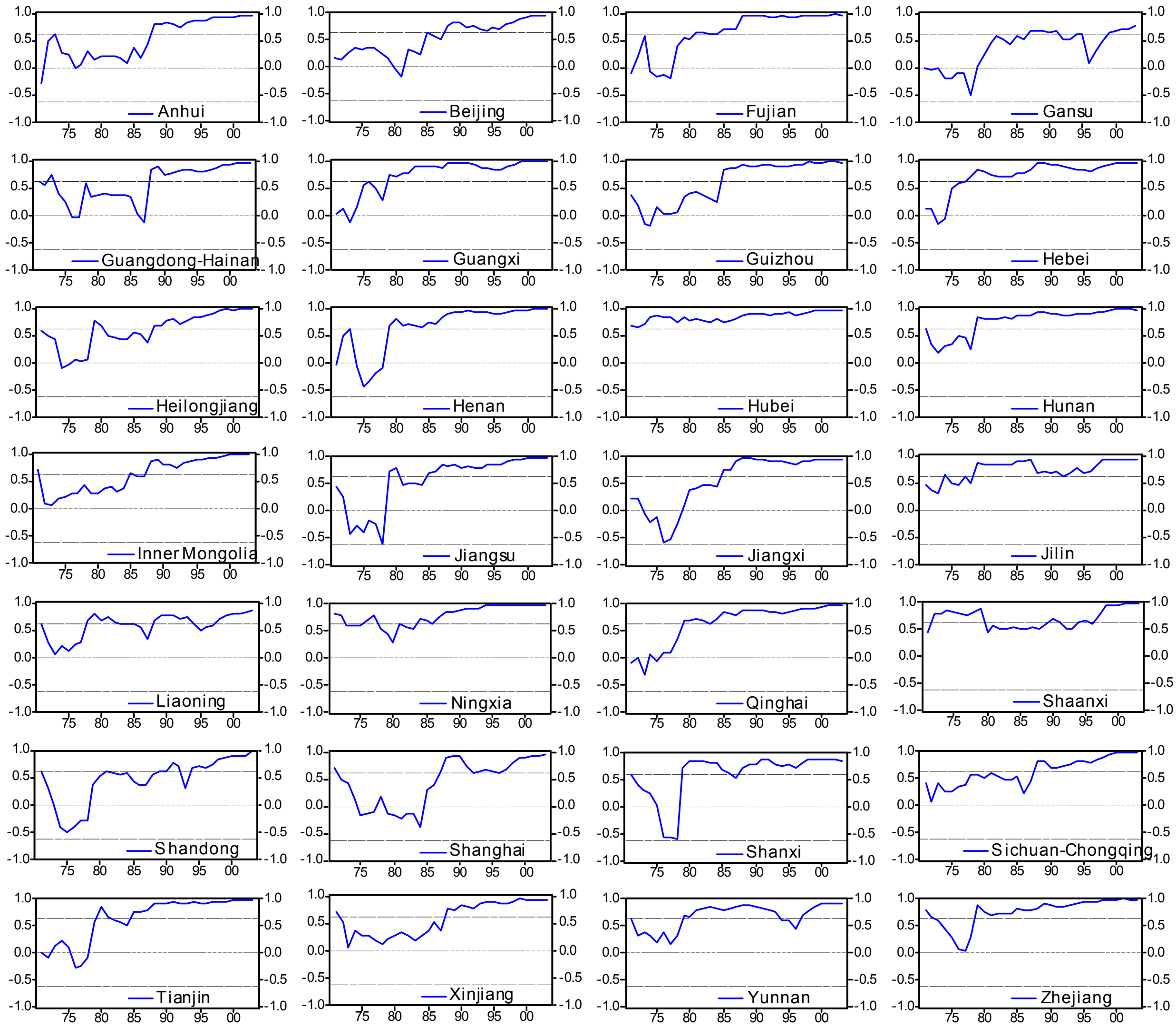
After more than 150 years as a British colony, Hong Kong became a Special Administrative Region of the People's Republic in 1997. We here provide some evidence on the timing and extent of integration between these two economies. To this end, we assess whether their business and inflation cycles have become synchronised.

Figure 10 shows Hong Kong's output gap and inflation rate together with the corresponding common component for China. Concentrating first on the business cycle, we see in the upper graph that economic activity in Hong Kong was affected by the Cultural Revolution. A second noteworthy episode is the Asian financial crisis, during which pressure for the Hong Kong dollar to be devalued was high. The consequent increase in interest rates in 1997/98 led to an economic contraction in 1998 and 1999. The Chinese business cycle does not show this pronounced downturn. It also appears that Hong Kong's recovery in 2000 was not a reflection of events in China. Nevertheless, the correlation between the business cycles seems to have risen from the 1990s onwards.

Table 2 presents the principal components analysis and shows that over the sample as a whole, the first principal component φ_y captures 81.9% of the variance of the business

Figure 9:

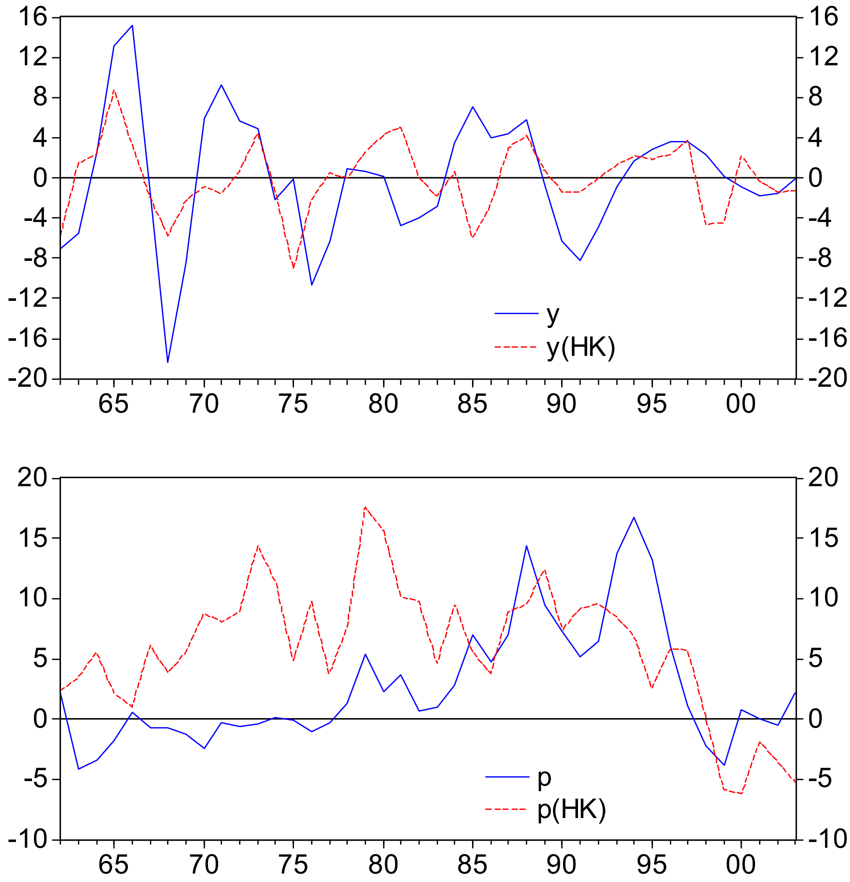
Correlations between provincial inflation rates $p_{j,t}$ and the first principal component p_t



Note: Dashed lines show 95% confidence bands.

Figure 10:

Chinese and Hong Kong macroeconomic cycles



cycles in Hong Kong and China. The weight for the common business cycle component of Chinese provinces is 76.5%, while Hong Kong's output gap accounts for 23.4% of the movements in φ_y. Figure 11 plots the path of the first principal component over time (we again use a ten-year time rolling time window). It was large at the beginning of the sample, then decreased in the 1970s and approached unity in the decade before the Asian financial crisis, when it dropped sharply. Figure 12 shows the common business cycle for China and Hong Kong, where we again also present the estimate obtained using the unobservable components approach together with a 95% confidence band.[18] The business cycle computed using the principal components approach lies most of the time within the confidence interval, especially so from the end-1980s onwards. This suggests that the common business cycle of China and Hong Kong is robust to different computation methods.

Table 2:

Principal components analysis for China and Hong Kong

	Output gaps		Inflation
Importance of common factor		Importance of common factor	
φ_y	0.819	φ_p	0.645
Factor loadings		Factor loadings	
b^y_{China}	0.765***	b^p_{China}	0.554***
$b^y_{Hong\ Kong}$	0.234***	$b^p_{Hong\ Kong}$	0.446***

Note: φ denotes the fraction of the variance of the data captured by the first principal component. The factor loadings b_j are obtained from the normalised first eigenvector of the covariance matrix of the data. */**/*** denotes significance at the ten / five / one percent level.

Next we turn to the question whether inflation cycles have begun to display increased synchronisation as well. The lower plot in Figure 10 shows that inflation in Hong Kong was higher than that in China before the introduction of Hong Kong's currency board in 1983. Thereafter, it was below Chinese inflation for some years in the 1990s and consistently after 2000.

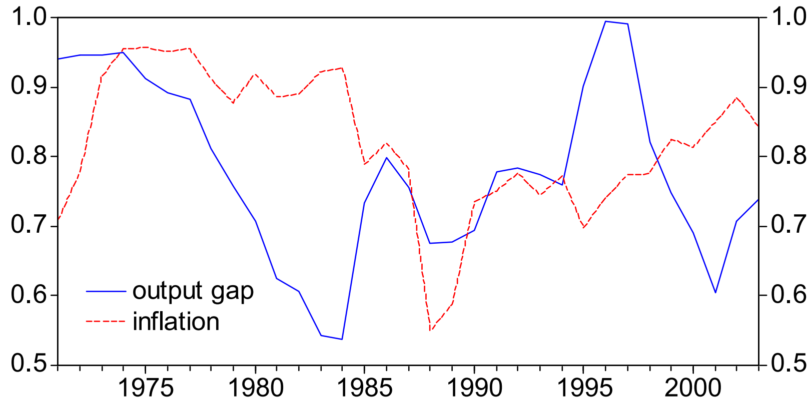
The first principal component for China's and Hong Kong's inflation rates explains

[18] We report this analysis in the Appendix.

Figure 11:

Importance φ_y (φ_p) of the common output (inflation) cycle

(fraction of total variance explained by first principal component)



64.5% of the variance in the two series. The weight on Chinese inflation is with 55.4% rather small. Figure 11 suggests that the common component was important in the 1970s and 80s, then lost in significance, only to rise again in the 1990s. Figure 12 shows that the unobservable components approach identifies a slightly different common inflation cycle for China and Hong Kong up to the mid-1980s. From then on, the common inflation obtained from the principal components approach lies within the 95% confidence band of the unobservable components analysis.

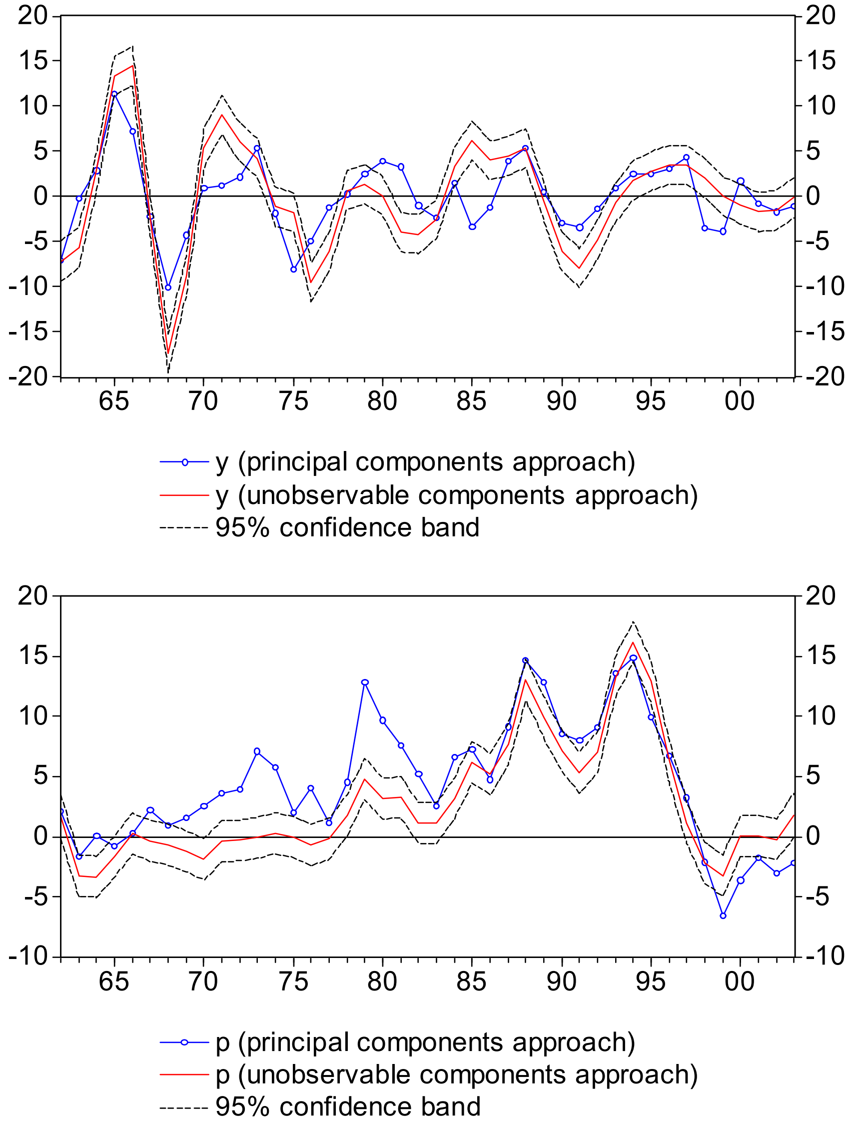
In sum, it appears that Hong Kong's macroeconomic cycles are becoming increasingly synchronised with China's. The different performance of the output gaps during the Asian financial crisis, which was mainly due to Hong Kong's exposure to international capital flows, suggests that the business cycles in Hong Kong and China will become more synchronised as the Mainland further liberalises its capital account.

7 Conclusions

The results presented in this paper indicate that there has been a synchronisation of both business and inflation cycles within China. While economic activity in the different

Figure 12:

The common business and inflation cycles for China and Hong Kong



provinces started to show a strong common component only from the mid-1980s onwards, a similar development began for inflation already in the 1960s. It is notable that, in spite of an overall convergence of the regional business cycles, economic activity in a number of provinces in the northwest displays movements that are not closely related to developments in the rest of the country. A second striking finding is that while business cycle fluctuations have become smaller, the amplitude of the inflation cycle has risen, which may be due to the decrease in the number of administratively set prices. The sharp decline in inflation at the end of the 1990s is likely to reflect a world-wide drop in inflation. As regards Hong Kong, we provide some first evidence that the business and inflation cycles are becoming increasingly synchronised with those of China.

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A Unobservable components analysis

A.1 Chinese provinces

This appendix computes the common factor of the Chinese business (inflation) cycle using the unobservable components technique proposed by Stock and Watson [32], which provides us with a measure of uncertainty. We first consider the common business cycle and assume that each regional output gap reacts to the unobserved common component y_t and an innovation, i.e.

$$y_{j,t} = \beta_j^y y_t + e_{j,t}, \tag{1}$$

where the reaction coefficient β_j^y and the variance of $e_{j,t}$ may vary between provinces.[19] Since the estimate of y_t we obtained using the principal components analysis displayed significant first autocorrelation, we assume that y_t follows an AR(1) process, i.e.

$$y_t = \alpha_y y_{t-1} + u_t. \tag{2}$$

Note that we do not include a constant since output gaps have by construction a mean of zero.

The 28 equations of the form (1) can be thought of as observation equations in a state space model, while equation (2) is the state equation. We estimate the resulting state space model using the Kalman filter and choose as normalising restriction $\beta_{Beijing}^y = 1$. The left panel in Table 3 shows the estimated reaction coefficients for the different provinces. We find that β_{Gansu}^y and $\beta_{Heilongjiang}^y$ are insignificant, but that all other coefficients are significantly larger zero. The common output gap has the smallest significant impact on Guangdong-Hainan, while Sichuan-Chongqing reacts most strongly to y_t.

Turning to the common inflation cycle, we assume that the regional inflation rates are given by

$$p_{j,t} = \beta_j^p p_t + v_{j,t}, \tag{3}$$

[19] Note that this assumption distinguishes the unobservable from the principal components analysis. In the latter, we had that $y_{j,t}$ was a linear combination of 28 principal components, rather than being given by one common component plus an error.

Table 3:

Unobservable components analysis

α_y	0.516***	α_p	0.851***
β^y_{Anhui}	0.931***	β^p_{Anhui}	1.287**
$\beta^y_{Beijing}$	**1**	$\beta^p_{Beijing}$	**1**
β^y_{Fujian}	1.087***	β^p_{Fujian}	1.559**
β^y_{Gansu}	0.784	β^p_{Gansu}	0.833*
$\beta^y_{Guangdong\text{-}Hainan}$	0.579***	$\beta^p_{Guangdong\text{-}Hainan}$	1.255**
$\beta^y_{Guangxi}$	0.758**	$\beta^p_{Guangxi}$	1.645**
$\beta^y_{Guizhou}$	1.366***	$\beta^p_{Guizhou}$	1.314**
β^y_{Hebei}	0.716***	β^p_{Hebei}	1.346**
$\beta^y_{Heilongjiang}$	0.433	$\beta^p_{Heilongjiang}$	1.501**
β^y_{Henan}	0.968***	β^p_{Henan}	1.390**
β^y_{Hubei}	1.219***	β^p_{Hubei}	1.335**
β^y_{Hunan}	0.739***	β^p_{Hunan}	1.517**
$\beta^y_{Inner\ Mongolia}$	0.955***	$\beta^p_{Inner\ Mongolia}$	1.313**
$\beta^y_{Jiangsu}$	0.927***	$\beta^p_{Jiangsu}$	1.230**
$\beta^y_{Jiangxi}$	0.783***	$\beta^p_{Jiangxi}$	1.135**
β^y_{Jilin}	0.909***	β^p_{Jilin}	1.180**
$\beta^y_{Liaoning}$	0.998**	$\beta^p_{Liaoning}$	1.202**
$\beta^y_{Ningxia}$	0.733**	$\beta^p_{Ningxia}$	1.548**
$\beta^y_{Qinghai}$	0.582***	$\beta^p_{Qinghai}$	1.423**
$\beta^y_{Shaanxi}$	1.361***	$\beta^p_{Shaanxi}$	1.254**
$\beta^y_{Shandong}$	0.798***	$\beta^p_{Shandong}$	1.298**
$\beta^y_{Shanghai}$	0.681**	$\beta^p_{Shanghai}$	1.167**
β^y_{Shanxi}	1.361***	β^p_{Shanxi}	1.329**
$\beta^y_{Sichuan\text{-}Chongqing}$	1.533***	$\beta^p_{Sichuan\text{-}Chongqing}$	1.381**
$\beta^y_{Tianjin}$	0.999***	$\beta^p_{Tianjin}$	1.290**
$\beta^y_{Xinjiang}$	0.939***	$\beta^p_{Xinjiang}$	1.451**
β^y_{Yunnan}	1.216***	β^p_{Yunnan}	1.398**
$\beta^y_{Zhejiang}$	1.086***	$\beta^p_{Zhejiang}$	1.374**

Note: Estimates of state space models given by equations (1) and (2), and (3) and (4), respectively. Normalising assumption is $\beta_{Beijing} = 1$. Equation (4) includes an unreported insignificant constant. */**/*** denotes significance at the ten / five / one percent level.

where again the variability of the shocks and the reaction to p_t may differ between provinces. Since the common component obtained using the principal components analysis follows an AR(1) process, we assume that

$$p_t = \alpha_0 + \alpha_p p_{t-1} + w_t. \tag{4}$$

The right panel in Table 3 shows the estimation output. We find significant reactions to p_t for all provinces. The weakest response is estimated for Gansu, while prices in Fujian seem to react most strongly to a change in the common inflation rate.

A.2 China and Hong Kong

Since the common business and inflation cycles for the Chinese provinces display second order autocorrelation, we adjust equations (2) and (4) to

$$y_t = \alpha_{y1} y_{t-1} + \alpha_{y2} y_{t-2} + u_t \tag{5}$$

and

$$p_t = \alpha_0 + \alpha_{p1} p_{t-1} + \alpha_{p2} p_{t-2} + w_t. \tag{6}$$

to estimate the common component for China and Hong Kong. Table 4 shows the estimation output. We find significant first and, for the buiness cycle, second order correlation of the unobserved component and a significant impact of Hong Kong's variables on the common component.

Table 4:

Analysis for China and Hong Kong

α_{y1}	0.911***	α_{p1}	1.147**
α_{y2}	-0.719***	α_{p2}	-0.394
β^y_{China}	**1**	β^p_{China}	**1**
$\beta^y_{Hong\ Kong}$	0.253**	$\beta^p_{Hong\ Kong}$	0.768***

Note: Estimates of state space models given by equations (1) and (5), and (3) and (6), respectively. Normalising assumption is $\beta_{China} = 1$. Equation (6) includes an unreported insignificant constant. */**/*** denotes significance at the ten / five / one percent level.