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Abstract

This paper reviews some of China's high frequency economic indicators and our principal findings on their selection and use. Our aim is to develop a composite index of coincident indicators (CEI) which can be used to obtain timely information on the present state of the China's economy and provide an appropriate measure to analyze China's short-term macroeconomic dynamics. Notably, combining industrial production, retail sales, manufacturing employment, income of financial institutions, and passenger traffic volume works well as the method for dating business cycles for China. It shows that, over the past two decades, there was one marked recession which occurred in 1988:8 to 1989:12. In addition to this business cycle chronology we also develop a growth cycle chronology based on the deviations from trend of the CE which shows that there were four cyclical slowdowns since 1986. Whereas GDP growth lacks cyclical movements and appears to be dominated by trend and irregular movements, in contrast to GDP, CEI works well as a measure of cyclical dynamics and can contribute to the analysis of short term fluctuations of Chinese economic activity relative to its long term growth.

1. Introduction

China's fast growth and integration into the global economy have caused, and are still causing, a great increase in China's economic influence worldwide. This has been among the most dramatic economic developments in recent decades. China's rapid economic growth arose from several recent trends: (a) globalization, i.e. integration of capital, labor and trade markets across the world; (b) steady productivity growth through technological progress and continuous restructuring of state-owned enterprises and (c) enormous inflows of foreign capital and advanced technologies through foreign direct investment. Given the size and complexity of the Chinese economy, which now ranks as the second largest in the world in terms of purchasing power parity (PPP), monitoring and understanding economic cycles in China is crucial for understanding the broad economic movements associated with the rapid transformation and growth of the Chinese economy. The new estimates of PPP by the International Comparison of Prices at the World Bank[1] do not change these conclusions even though they suggest that China's GDP is now 9.7 percent of world GDP in 2005, instead of the previous estimate of 14.2 percent. These new estimates contribute to the debate on the precise size of the Chinese economy even though they don't alter the ranking of China's economy relative to other countries. The precise measurement and analysis of high frequency and short term cyclical movements in China have received less attention compared to the measurement and analysis of its relative size, economic structure, and growth trends. This paper tries to fill this gap by developing and analyzing a composite index of coincident economic indicators (i.e. an index of current economic activity, CEI).

Market economies are generally characterized by sequences of expansions and contractions in economic activity that occur across the various sectors of the economy and broadly affect the economy as a whole. A nation's general economic activity has several measurable aspects: employment, production, real income or output, real sales or

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[1] See www.worldbank.org/data/icp Previous PPP estimates for China relied on a bilateral comparison of prices in the US and China using 1986 data.

demand. To identify and date fluctuations in the level and growth of current activity, comprehensive measures of high-frequency (preferably monthly or at least quarterly) changes in these variables are required. These indicators are called "coincident" because their cyclical movements have a rough but significant tendency to display a similar timing of rises and declines: their cyclical peaks and troughs cluster around and help define the peaks and troughs of aggregate economic activity, respectively. Indicators generally gain in reliability when properly selected and combined into composite indexes, based on good records of past performance (see Zarnowitz, 1992).

Business cycles are commonly characterized by the co-movement of many economic variables: processes that represent different aspects of aggregate economic activity. Allowing for mostly moderate leads and lags, comprehensive production and employment, real sales and real income series tend to trend and fluctuate in rough synchronicity and form clusters of peaks and troughs around the recessions and revivals, respectively, of the market economy in question. It is this set of basic observations about business cycles that calls for the use of multivariate measurement at this juncture.

In the indicator approach to analyzing business cycles, first developed at the NBER, current economic activity is measured by an index of coincident economic indicators (CEI) which then serves as the target of the index of leading economic indicators (LEI). The Conference Board (TCB) uses coincident indexes to develop chronologies of business cycles and to explore historical features of the cyclical movements (McGuckin, Ozyildirim and Zarnowitz, 2007). This applies to all countries covered by TCB global indicators program.

Most of the research on China's high frequency data has focused on the construction of leading indicators without much consideration given to what those leading indicators lead. Moreover, this research on developing and using leading indicators has been hindered because of the exceptional difficulty of finding suitable components (see Nilsson and Brunet, 2006). Nevertheless, OECD has developed a composite leading index that tracks and predicts turning points in the deviations from

trend in industrial output.[2] Curran and Funke (2006) develop a China composite leading indicator consisting of exports, real estate climate index and Shanghai Stock Exchange Index. However, to evaluate the forecasting performance of the leading indicator they take real GDP as the reference series without constructing a coincident index.

In this paper we argue that a composite index of coincident indicators is the crucial first step toward obtaining timely information on the present state of the China's economy and providing an appropriate measure to analyze China's short-term and intermediate-term macroeconomic dynamics. We review some of China's high frequency economic indicators and our principal findings on their selection and use. We argue that the CEI we develop is an appropriate variable of aggregate economic activity and should help to further the research on leading indicators. Moreover, the CEI could further provide some guidance in developing and improving other aggregate economic measures based on the national income accounts.

General business cycle analysis in the U.S. is facilitated by the determination of a business cycle chronology. The NBER research program performed this function in the early years and currently the NBER dating committee has the responsibility to determine the business cycle chronology for the U.S. Since no such committee exists elsewhere, TCB takes an approach which approximates the decisions of the NBER committee using a composite index of the components of CEI and the monthly interpolated real GDP to determine the business cycle chronology in the various countries it publishes LEI's for. However, for the purpose of identifying and dating business cycles in China, it is not possible to follow this as the discussion of GDP below shows. Because of the special nature of China's economic structure, institutional framework, and high growth economy, what is needed is a measure of economic activity and business cycle chronology that is multivariate and separate from national income account measures such as GDP.

The rest of the paper is organized as follows. The next section discusses GDP vis-à-vis its appropriateness as a coincident indicator in the case of China, and then develops

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[2] According to Nilsson and Brunet (2006), the industrial output measure is based on gross industrial out put for 1978-1994 and industrial value added for 1995-2004. The value of the linked industrial output series is expressed in constant prices of 1995.

a business cycle chronology. In section 3, we evaluate the strengths and weaknesses of selected coincident indicators. Section 4 develops a chronology of China's growth cycles since the late 1980s and the last section concludes.

2. Developing China's Coincident Index

The objective of a coincident index - to provide an optimal composite instrument for measuring and dating fluctuations in aggregate economic activity - is the same for each country's economy, but the actual results vary depending on the availability and quality of the data. In China, there are challenges to finding suitable series, despite the fact that the statistical improvements (such as stratified sampling) introduced in the late-80s create much-improved opportunities for measurement. However, the resulting time series are still quite short and sometimes inconsistent. In addition, measuring short-run fluctuations in China is still complicated by the more-or-less centralized control of data releases as well as difficulties related to local government incentives which could lead to measurement errors.[3]

The major constraint is data availability in China. According to the World Bank Quarterly Update (February 2008), it is still common in China to make comparisons of nominal and real (current price and constant price) growth rates, and the source agencies are not always clear in their communications. The distinction between nominal and real figures is crucial for performing meaningful economic analysis and drawing reliable conclusions. The indicator system is widely used to monitor cyclical fluctuations in real economic activity and to do this it is essential to adjust nominal values for inflation. Some price indexes, such as CPI and retail price index (RPI), need to be converted from "previous year = 100" year over year percent change figures to create indexes with fixed base periods.[4] Fixed-base CPI, PPI and RPI going back to the 1980s need to be developed to provide deflators for the corresponding series based on current (nominal) valuations. In

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[3] For example, Cai (2000) reports on data falsification in the countryside.
[4] China's National Bureau of Statistics (NBS) has published fixed-base CPI since 2000 in *China Monthly Economic Indicators*, but unexpectedly ceased in 2006.

this paper, we have paid special attention to appropriate deflation of nominal values, to the extent possible given the available data.

It is also important to distinguish cyclical fluctuations from seasonal movements. In order to do this, we seasonally adjust all the candidate coincident indicators discussed below, with special attention to the difficult problem of important moving holidays such as the Chinese (lunar) New Year.

We consider whether the candidate components adhere to our set of selection criteria for coincident indicators, namely: conformity — the series must conform well to the business cycle; consistent timing — the series must exhibit a consistent timing pattern as a coincident indicator; economic significance — cyclical timing must be economically logical; statistical adequacy — data must be collected and processed in a statistically reliable way; smoothness — month-to-month movements must not be too erratic; and currency or timeliness — the series must be published on a reasonably prompt schedule, preferably within a month (see TCB, 2001). For China, the search for the most comprehensive and representative time series with the best historical timing record in the CEI category yielded five choices: gross value of industrial output, retail sales of consumer goods, employment in manufacturing, cash income of financial institutions and volume of passenger traffic. All five series start in 1986 except manufacturing employment which is only available from 2000. As indicated in Table 1, we have also evaluated several other series, such as government revenue, total energy production, total earnings in urban units, real imports, disposable income per capita of urban household and electricity output, but these series turn out to be less satisfying as discussed in section 3. Table 1 also lists the components in NBS's CEI for comparison.[5]

Industrial production measures the production and supply of goods by manufacturing, mining and utility businesses. Retail sales measures the demand for goods and services mainly for personal and household use in the economy. Employment measures labor input used in the manufacturing sector to produce these goods. Note that

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[5] In addition to the five selected components we investigate in Appendix B three alternative versions of CEI. However, all four CEI produce the same dates of a single recession in China over this period.

manufacturing employment receives special attention in the data available for China, even though, as a result of reforms and structural changes as well as the development process itself, manufacturing employment has undergone significant changes. Cash income in financial sector is included as a measurement of an important and growing class of services. However, this series as well as that on the volume of passenger traffic are not as generally accepted as measures of aggregate economic activity as the other three indicators chosen. Unfortunately, we have not identified an appropriate coincident monthly series of personal income, although the disposable income per capita of urban household may serve as the closest available substitute.

There are several advantages to relying on the CEI, rather than using only GDP in measuring economic fluctuations in China and elsewhere. First, GDP is at best available quarterly, with some reporting lags; by contrast, CEI is constructed with more frequently available and timely data series, which move contemporaneously with the business cycle. Hence, CEI can be used to draw an early and more reliable picture of the evolution of the current economic activity.

The second advantage of CEI is that as a multivariate index. Real GDP is the most comprehensive measure of economic output or outlays, but CEI includes elements of input as well as output (employment and industrial production), real income as well as real demand or sales (revenue of financial institutions, retail sales of consumer goods). The consensus of cyclical movements of these major coincident indicators inspires more confidence than the movement of any univariate measure, even as comprehensive as GDP. This is particularly true when the accuracy and reliability of official China's GDP statistics has come under criticism in recent years (for example, Keidel, 2001, Rawski, 2001 and Wu, 2007).

The third and final advantage of CEI is a byproduct of its broad coverage. GDP as a complex accounting measure is often subject to long strings of sometimes large revisions.[6] CEI revisions are less prone to such unexpected changes because their

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[6] According to China's National Bureau of Statistics (NBS), there are three steps of accounting procedure in releasing official figures of GDP, namely, preliminary accounting, preliminary verification and final

revisions are potentially smaller and more likely to offset each other between the index components.

GDP estimates for China exist on an annual basis for the period from 1950s to present, but quarterly statistics of GDP are only available after 1987, which is a relatively short period for cyclical turning point analysis.[7] Moreover, NBS released the official revision of China's annual GDP data for the period 1993-2004 following China's first national economic census in 2004, but the corresponding quarterly data have not been revised and released yet.[8] Furthermore, since China does not officially publish quarterly GDP price deflators or the level of GDP data in real terms, appropriate deflators must be applied to get real GDP levels. To obtain quarterly GDP values the sum of the value added of various industry sectors, namely primary, secondary, and tertiary industries is calculated. *Primary industry* refers to the production of primary products, i.e. agriculture (including crops and animal husbandry), forestry and fishing. *Secondary industry* typically involves the processing of primary products and covers mining, manufacturing,

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verification. The results are released 20 days after accounting quarter, 45 days after accounting quarter and the end of December next year when the annual final data are confirmed, respectively, for each revision step.

[7] There are three main data sources used in China's GDP estimation. First, National Bureau of Statistics (NBS) collects the data on agriculture, forestry, husbandry and fishing; mining and quarrying, manufacturing, electricity, gas and water; construction; wholesale, retail trade, and catering, fixed-asset investment; labor; wages; price; household income and expenditure. Second, other government agencies under State Council collect the data on transport, customs, balance of payments, etc. Third, the rest of data come from final financial accounts by institutions such as banks, the Ministry of Railway, the National Bureau of Post and Telecommunications, etc. The NBS data account for the highest proportion of all data. For the state-owned enterprises and the non-state-owned enterprises with 5 million yuan of annual sales or more, the report forms on production, sales and financial status formulated by the NBS are filled in by these enterprises and submitted directly to NBS over the internet. On the other hand, for non-state-owned enterprises with annual sales of less than 5 million yuan and individual business, the data are calculated by a sample survey conducted by the Enterprise Investigation Organization of the NBS.

[8] China State Council's Leading Group of First National Economic Census and the National Bureau of Statistics (NBS) jointly published the results of its first national economic census that provides basic information about the country's secondary and tertiary industries in December, 2005. As a result, the aggregated size of GDP and its share across industries was verified. Preliminary estimation using results from the economic census indicates that China's GDP for the year 2004 was 15,987.8 billion yuan at current prices, representing an increase of 2,300 billion yuan or 16.8 percent over the preliminary estimated figure using regular annual statistical data. Of the total increase of 2,300 billion in GDP, the increase of the value-added for the tertiary industry accounted for 2,130 billion or 93 percent. This revision did not cover the pre-1993 period because of a previous output revision for the period 1978-92 after China's first tertiary census for 1992 (see Wu, 2007). Therefore, we apply the proportional procedure for temporal disaggregation of the recently revised annual GDP data and the main analysis will be carried out over the period after 1987, using quarterly adjusted GDP statistics from the industry output side.

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electric power, gas and water production and supply and construction. *Tertiary industry* produces services of various kinds for production and consumption. It consists of all activities that are not classified as primary or secondary industries. However, the separate estimations on each industry are only available since 1992. The investment related parts of GDP should preferably be deflated with a capital-goods price index, and the foreign trade parts, with export and import price indexes, etc. CPI should be used as a deflator for only the consumption-related part of GDP, not the whole GDP. However, only CPI data are available for adjusting *quarterly* GDP over the entire period of 1987-2007.

More importantly, there is a large body of literature and ongoing debate suggesting that official China GDP growth estimates contain serious upward biases (Maddison, 1998, Keidel, 2001, Rawski, 2001 and Wu, 2007). Two factors may explain the bias. First, as argued in Keidel (2001) and Wu (2007), China had a long tradition of reporting economic output by using the Soviet's Material Product System (MPS) measurement system prior to 1993, which tends to inadequately calculate the nominal output value. Despite the fact that China has switched to the system of National Accounts (SNA) in 1993, China's GDP statistics are still far from perfect, and tertiary sector statistics may be particularly problematic (Xu, 2004). Second, the existing data reporting system, established in the central planning period, tends to produce statistics skewed towards the government's economic targets. For example, Rawski (2001) argues that the official data showing 7-8% real GDP growth during 1998-2001 reflected official objectives rather than economic outcomes. Undoubtedly, if the official GDP statistics lack reliability, they will significantly affect the accuracy of assessment of business cycle chronology. Thus, we turn to the coincident indicators independent of GDP to date business cycles in China.

Taken together, these caveats warn against using real GDP as a central measure of China's economic activity, but they do not mean that it should be ignored. Figure 1 shows GDP deflated by CPI and converted from quarterly to monthly observations by linear interpolation between mid-months of consecutive quarters in Figure 1. There is one

short and small recession suggested in 4/1988-3/1989.[9] We can see that there was little recovery in 1989, with a setback at the end of the year; much stronger recovery in 1990, with a similar setback. The Figure also suggests a stronger recovery in 1991-92, with a third setback late in 1992. The expansion moderates and stabilizes thereafter through the rest of the decade, accelerates and stabilizes further in the new millennium.

Dating Business Cycles in China with Coincident Indicators

We combine five individual indicators — which cover industrial production, retail sales, manufacturing employment, income of financial institutions, and volume of passenger traffic into a composite index to determine the chronology of China's Business Cycle (see the Appendix for details on the index methodology). The monthly change in the index is an equally weighted average of the monthly changes of its components.[10]

The dating of China's business cycle based on this composite index of five coincident indicators shows that China enjoyed impressively strong economic growth with only one recession in 8/1988-12/1989 (see Figure 2). Visual inspection indicates that the recession, while relatively long, was mild (40.2 at peak to 34.7 at trough) and the immediate recovery was quick (back to 40 by the end of 1990). This stays roughly in line with the finding based on the expenditure accounts approach in Keidel (2001), which

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[9] The turning points in each indicator, as well as those in the composite index of these indicators, have been selected visually by the authors or by applying the Bry-Boschan algorithm that has been used to approximate the turning point selection procedures applied by NBER researchers. Most of the time by far, but not always, the two methods give the same results; in a few cases, a mechanical application of the dating rules followed by the computer, which is described in Bry and Boschan (1971) yields flawed results than can be improved by informed judgment.

[10] The monthly change is calculated using a symmetric percent change formula. However, using percent changes or log differences makes little difference to the resulting index. Before aggregation, the monthly changes of the components are first adjusted by multiplying them with their standardization factor. This step is called a volatility adjustment. Standardization factors determine how monthly changes in each component contribute to the monthly change in the associated index. These factors are designed to give each component a similar opportunity to contribute to the change in the index in any given month. This adjustment equalizes the volatility of the contributions from each component in an index. The standardization factors are based on the inverse of the standard deviation of the monthly changes in the series and these component standardization factors are made to sum to one. This summing to one of the standardization factors is done to assure that the cyclical part of the composite index is limited to a magnitude similar to the average deviation from the mean growth rate of the components of the index. This sum of the contributions is then cumulated and the resulting coincident index is rebased to equal 100 in 2000 (i.e. 2000=100).

states that the negative growth in 1989 was due to a severe slump in rural household consumption, with the recovery in 1990 due to a strong urban and government consumption. That is, the recession, particularly in 1989, was much more serious than officially reported. The index reveals that China's economic growth was very fast in 1990-92, a little slower but very persistent in 1993-98, and particularly strong after accession of WTO at the end of 2001. There are no further recessions in this period. Significant slowdown in economic activity is not seen either, except perhaps briefly in 2000-01 (see Figure 2).[11]

Figure 3, which compares the evolution of real GDP and the coincident index since 1987, demonstrates that the two aggregates show similar growth trends and patterns. GDP had a relatively mild and somewhat shorter contraction. Moreover, let us not forget that GDP is quarterly, and using this series alone is problematic because of uncertain effects of deflation, revisions and monthly interpolations. Both series show little visible effects of the Asian financial crisis in 1997 and its aftermath: GDP virtually none, CEI some relatively short and small fluctuations in 1998 and 2000. We find that correlation between real GDP and China's CEI is around 0.99 in levels (see Table A1). The correlation between 12-month growth rates of CEI and real GDP is 0.694 while the correlation between 6-month growth rates of real GDP and CEI is 0.518. By contrast, the correlation between 6-month growth rates of real GDP and CEI in U.S. is much higher: 0.86 (see Lee, 2005).

3. Strengths and Weakness of Selected Component Indicators

In what follows we discuss each potential coincident indicator and reasons why it was included in the CEI or not.

3.1. Gross Industrial Production (GIP)

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[11] We experimented with several other combinations of coincident indicators listed in Table 1 Panel A. Some of these are shown in Appendix B. The dates of the recession in all cases remained the same.

The first series we examine is the Gross Industrial Production starting in the 1980s. It is calculated following the principle of factory approach in China, i.e., industrial enterprise is used as the basic accounting unit in calculating the gross industrial output value. The GIP is a monthly measure of the total volume of final industrial products produced and industrial services provided during a given period in China.[12]

We employ the Producer Price Index (PPI) to deflate the nominal Gross Industrial Production to obtain the real GIP series. As shown in Figure 4a, this component indicator has a relatively long and consistent history, having grown about fivefold from 1986 to 2007 and has one specific cycle contraction in 2/1988-2/1990. Table 2 indicates that the real industrial output had a lead of around 6 months at the peak and a lag of 2 months at the trough of China's business cycle.

3.2. Real Retail Sales (RRS)

The next series we investigate is real retail sales. This monthly series also starts in 1986. It refers to the sum of retail sales of consumer goods sold by all sectors of China's economy to urban and rural residents and social groups. Data on retail sales of consumer goods cover all enterprises, government units and farmers engaged in retail selling.

Figure 4b plots the component indicator, which is deflated by Retail Price Index (RPI)[13]. This series has one specific cycle contractions in 8/1988-12/1989, which is exactly coincident at both peak and trough (Table 2). It also shows a sharp but short up and down movement in the opening months of 1991 and 1992 and the closing months of 1993. Growth in RRS is substantial in 1990-95. It should be noted that the definitions of RRS used during pre- 1992 period is somewhat different from that used in the post 1992 period. This is unfortunately neglected, but Figure 5b does not suggest any discontinuity.[14]

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[12] One alternative component is value added of industry, which refers to gross industrial output minus intermediate input plus value-added tax. However, this series starts from 1994.

[13] In order to deflate the level of retail sales, we convert the Retail Price Index which is originally published as "previous year = 100" to fixed-base (2000=100).

[14] Pre-1992 includes sales of agricultural raw materials.

3.3. Manufacturing Employment (ME)

This monthly [15] series refers to persons employed by all state-owned manufacturing enterprises as well as by non-state-owned enterprises *with an annual sales income of over 5 million Yuan.* Employees include management staff, manual workers, re-employed retirees, foreigners and Chinese compatriots from Hong Kong, Macao and Taiwan. Clerical, administrative, and sales staff as well as scientific and technical workers are also included as manufacturing employees. Those who have temporarily left their working place are also considered as employed. Manufacturing employment fulfills, for the most part, our selection criteria: it makes economic sense as a coincident indicator, is produced monthly by a reliable source, is relatively smooth, and presents no visible seasonal adjustment or other measurement problems. However, the series does not start until 2000, so there is a limited history for the series to prove its worth as a coincident indicator.

We find that there is one specific cycle contraction, dated in 4/2000-1/2002 as shown in Figure 4c. According to McGuckin and Spiegelman (2004), 26 of the 38 major Chinese industries had negative job growth between 1995 and 2002, and the pace of downsizing has been particularly fast at state-owned enterprises. The manufacturing employment series shown in Figure 4c is roughly in line with these findings. The job losses before 2002 can be traced to restructuring and rapidly advancing domestic productivity, the driving factors behind China's growing international competitiveness. Manufacturing employment has resumed its upward trend since 2002-2003.

Comparing monthly manufacturing employment in 2004 to the corresponding annual data reported in the 2004 Economic Census shows that the monthly series was much lower in 2004. This series shows an average of about 50 million manufacturing

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[15]The manufacturing employment series, which covers 31 manufacturing sectors, has been changed from monthly to quarterly since 2007. It has been converted to monthly series by linear interpolation between center months of each quarter.

employees for all enterprises designated size and above in 2004, whereas the 2004 Economic Census reports an average of 56.7 million employees for the same period (Banister, 2007). For 2007, ME shows about 62 million people employed in manufacturing enterprises of designated size and above (with annual sales income over 5 million Yuan) and this number is widely accepted as an accurate reflection of current manufacturing employment in China following subsequent improvements in the collection of employment data by NBS. Another NBS series Total Urban Employment, discussed below, shows about the same level of employment in 2007 as ME. While the coverage of the two series is not identical (making direct comparison impossible), combined with the data from the 2004 Economic Census, a careful reading of the available employment data suggests ME, may be overstating the trend growth of manufacturing employment from 2004 to 2007.

As noted, this measure, ME in units of designated size and above, is narrower than employment series used in the coincident indexes for other countries[16] and it does not cover services or agricultural employment. Neither does ME include smaller establishments and households, self-employed, and other less formal manufacturing organizations. Agriculture is still a large sector of the Chinese economy and services represent a growing sector. Since agricultural and services employment are not subject to the same cyclical forces as manufacturing and/or industrial employment, this omission may not be too detrimental for the CEI. However, both sectors in China constitute important parts of the economy that should be monitored closely. Unfortunately, high-frequency data o agriculture in China seem to be in very short supply.[17]

3.4. Cash Income of Financial Institutions (CIF)

This monthly series refers to the total cash income of major financial institutions, including People's Bank of China, policy banks, state-owned commercial banks, other commercial banks, urban cooperative banks, urban credit cooperatives and rural credit

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[16] For example, the U.S. coincident index uses employees on nonagricultural payrolls as a component.
[17] Quarterly value of total output in agriculture starts in 2001.

cooperatives. It excludes foreign financial institutions in China. It starts in 1986 and covers incomes' from Commodity Sales, Service Trade, Taxes, Urban and Rural Individual Business, Savings Deposits, Repayment of Loans by Residents Exchange of Foreign Currencies and others. Figure 4d plots the component series, which is deflated by Consumer Price Index (CPI). The series peaks in 9/1988 and has a trough in 12/1989, which is roughly coincident at the peak and the trough of the business cycle. It also shows a sharp jump at the end of 1998, probably caused by an undocumented modification of the data definition.

Unfortunately, we have not identified an appropriate coincident monthly series of personal income. It is not common practice to use income in the financial sector as a coincident indicator and as a component of a coincident index. However, the role of financial services in China's economy is growing rapidly as a result of financial liberalization. Although it is less than satisfactory as a monthly coincident indicator, CIF is nonetheless included for lack of a more adequate income series.

3.5. Total Volume of Passenger Traffic (VPT)

This monthly series refers to the volume of transported passengers multiplied by the transport distance, using passenger-kilometers in millions as units for measurement. We chose to look at this series because the economic importance of service sectors relative to goods sectors has steadily increased in China, yet the above mentioned components provide no specific attention to service sectors except CIF. Conceptually, the passenger transportation activities should be closely and positively related to overall economic activity and income levels, and they are affected when the state of the overall economy has changed in recession, whether due to unanticipated shocks, or for some

endogenous reason.[18] Hence transportation plays a critical role in facilitating economic activity between sectors and across regions (see Lahiri, *et al.*, 2003).

Figure 4e suggests that there is one specific cycle contraction in VPT, during 11/1988-5/1990. Table 2 shows that VPT lagged by around 5 months at the peak and the trough. Declines in 1993 and in 1995 were not picked by the Bry-Boschan program, presumably because they are not long enough. VPT shows a sudden and short down-and-up movement due to the SARS outbreak between November 2002 and July 2003, and we treat this as an outlier when indexing.

Moreover, seasonal adjustment of this series is complicated and may not be adequate as passenger transportation is probably sensitive to holidays (the seasonal adjustment is further complicated by the use of lunar calendar for these holidays and the external shocks, e.g. SARS in 2003).

3.6. Total Earnings in Urban Units (EUU)

This series covers employed persons by types of ownership of employer in China's urban areas (see Figure 4f). Total earnings refer to the total remuneration paid during the reference period, including wages and salaries and other payments (in cash and kind). The firms covered are state-owned units, urban collective units and others. EUU is available quarterly since Q1 1992, which provides a longer history than ME (beginning in 2000), but it is still shorter than the other components of China's CEI which start in 1986. It grew from about 200 billion Yuan in 1994 to 500 in 2005, which is much less percentage-wise than real IP (400 to almost 2,000) or real retail sales (180 to 500). Because EUU is a quarterly series, it has to be converted to monthly series by linear interpolation between center months of each quarter, which gives it an artificial smoothing advantage. We notice that there is no contraction picked up by the Bry-

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[18] The Freight Traffic, on the other hand, is more likely to be a leading indicator. Almost all intermediate goods are moved through the transportation system to build business inventories; therefore the transport of freight is closely connected with movement in inventories and thus possesses a predictive quality.

Boschan algorithm; however, a growth-cycle slowdown is noticeable in the neighborhood of 1996-98.

3.7. Real Imports (RI)

The monthly total real imports are calculated at cif in billions of US dollars. To get a measure in real terms of RI we deflated imports with CPI. RI comprises the value of all merchandise imported into China's Customs territory, including goods from abroad entering customs warehouses, bonded areas or special economic zones.

Real imports grew little from about $10 to $12 billion, in the 12 years from 1986 through 1998. During that period, it experienced four specific-cycle contractions (see Figure 4g). Some of these movements may be at least partially due to the Chinese government's trade policy actions. After that period, imports grew sharply (five-fold or more) during the eight years 1999-2006, from 12 to 60 billion US dollars. This can be partly attributed to WTO accession as China agreed to lower trade barriers for imports in certain areas, such as automobiles. Although the Bry-Boschan program identified no cyclical contractions in RI for that period, we see one clear slowdown in 2001. Because of the lags at the business cycle contraction turning points and the extra turning points, this series is not selected for inclusion in the CEI.

3.8. Total Energy Production (EP)

Starting in 1986, this monthly series covers the total output of primary energy by all energy producing enterprises in China. It is a comprehensive measure showing the capacity, scale, composition and development of energy production of the country. The production of primary energy includes that of coal, crude oil, natural gas, hydro-power and electricity generated by nuclear energy and other means such as wind power and geothermal power. However, it excludes the production of fuels of low calorific value, bio-energy, solar energy and secondary energy converted from primary energy. It is well known that there is a close relationship between energy supply, energy consumption, and GDP. Given that energy is treated as an intermediate product of labor and capital as well

as given a positive relationship between GDP, energy supply and consumption, the production of primary energy serves as a good indicator of economic development.

Figure 4h shows that energy production in China has two specific cycle contractions in 2/90-9/90 and 1/97-2/00. The former does not correspond to the cyclical contraction in the other coincident indicators and the latter represents an extra cycle. Therefore, this series is not included in the CEI.

3.9. Government Revenue (GR)

The series (Figure 4i) is monthly and starts in 1986. It covers the budgetary units of the central and local governments. In general, the financial resource available to the government includes:

a) Various tax revenues, i.e., value added tax, business tax, consumption tax, land value added tax, tax on city maintenance and construction, resources tax, tax on use of urban land, stamp tax, personal income tax, enterprise income tax, tariff, tax on agriculture and animal husbandry and tax on occupancy of cultivated land, etc.

b) Special revenues, i.e., revenue collected from imposing fee on sewage treatment, revenue collected from imposing fee on urban water resources, and extra-charges for education, etc.

c) Other revenues, such as revenue from the repayment of capital construction loan, revenue from capital construction projects, and donations and grants.

We note that this series has large short-term volatility throughout the entire sample period, missed the business cycle peak and it has one specific contraction in 12/92-1/95, which lasts more than two years. It does not qualify for inclusion in the CEI.

3.10. Disposable Income Per Capita of Urban Household

This series measures the disposable personal income of urban households divided by the corresponding population. It represents the amount of personal income available to people for consumption spending and saving. The monthly series does not start until 1992 and has only been available quarterly since Q1 2007, so there is a too short history and

limited information for it to qualify as a satisfactory coincident indicator. We notice that there is no contraction picked up by the Bry-Boschan algorithm. However, a sudden jump in the beginning of sample period can be visually picked (see Figure 4j). While this may be a satisfactory substitute for a personal income series, we decided not to include it in the CEI.

3.11. Electricity Output

The monthly series covers all electricity produced in China, including thermal power, hydro-electric power and others. Notably, electricity is the most important component of primary energy. However, after the adoption of the open door policy in 1978, China's power sector has not expanded as fast as the whole economy (see Shiu and Lam, 2004). Growth of capital investment in the power industry has lagged behind the general economic growth, while the demand for electricity in China has increased tremendously as the economy has developed and living standards have improved significantly. The Bry-Boschan program identified no cyclical contraction since its starting date in 1986. Because of its low cyclical sensitivity, this series is not included in the CEI.[19]

3.12 Searching for a Better Representation of Employment in the Coincident Index

We selected manufacturing employment, ME, as the employment measure for the CEI, despite being only available from 2000, because it is a broad measure of urban and rural employment in manufacturing establishments across all ownership types (state-owned, town and village, joint-ventures, and private). However, compared to another quarterly employment series published by NBS, namely, total urban employment, it is a narrow measure because ME doesn't include agricultural or service sector employment. The lack of employment data in the CEI before 2000 is problematic as it creates a

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[19] However, the State Information Center uses this series in their coincident index. Also, note than a coincident index published by the NBS uses the total energy production series discussion in section 3.8.

discontinuity in the index and the total urban employment series can avoid this discontinuity, but it has other problems.

The quarterly series of total urban employment published by National Bureau of Statistics (NBS) is shown in Figure 5. This series starts in 1986, but covers only employed persons in establishments that are state-owned, urban collective and others; it excludes those in private sector establishments. The effect of this narrower coverage is easily seen in the decline in the series from 1996 to 2003. In this period of privatization and restructuring, state-owned enterprises employment share in total employment declined, while the share of employment in other types of firm ownership rose dramatically. Annual data on the composition of total employment, graphed in Figure 6a starting from 1978, shows this change in the composition of total employment which accelerated in the 1990s, and picked up even further after 1997. The share of state-owned enterprise (SOE) workers in total employment has dropped from about seventy percent in the early 1990s to about twenty five percent in 2004. At the same time, the share of workers in other types of establishments increased from less than ten percent to just over seventy percent over the same time period (Figure 6a).[20]

Because of these important changes in the distribution of employment across different ownership types, the quarterly total urban employment series starting in 1986 does not accurately reflect overall economic activity, and should be supplemented by a corresponding measure of private employment before it can be used in the coincident index. In fact, including it in the CEI (instead of the manufacturing employment series) results in an additional recession in 8/98-1/99 which was relatively sharp but short. In

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[20] Other types of ownership include: cooperative units, joint ownership units, limited liability corporations, share holding corporations limited private enterprises, units with funds from Hong Kong, Macau, and Taiwan, foreign funded units, self-employed individuals. Shares of employment by ownership type plotted in Figure 6a are based on total urban employment where employment is measured by the number of people aged 16 and above who are working and are compensated by payment or receive business income. Shares of staff and workers by ownership types show a similar change in composition; however, the share of staff and workers in state owned enterprises remains stable at almost 75 percent through 1998, and declines to about 60 percent in 2004 while the share in other types of ownership rises from essentially zero to about 30 percent. Staff and workers refer to people working in and receive payment from establishments, but it does not include employment in township enterprises, private enterprise employment, urban self-employment, retires, re-employed retirees, teachers in locally operated schools, foreigners and persons from Hong Kong, Macao, and Taiwan who work in urban units and others excluded by regulation.

addition, this series does not conform well to the other four indicators identified as having coincident cyclical timing.

As discussed above, the use of ME as a coincident index component could lead to a potential upward bias in the trend of the resulting CEI from 2004 to 2007. However, the lack of a measure that includes the rapidly growing services employment in the CEI could result in biasing its trend downward. Another bias, but in the opposite direction, could be due to the lack of agricultural employment whose share in total employment was stable in the second half of the 1990s but appears to have started to decline somewhat since 2004. (Although ME covers rural manufacturing employment and the share of rural nonagricultural employment has risen and the share of agricultural employment has fallen since the late 1990s in rural areas, Figure 6b).

One advantage of the composite index approach is that employment is one component out of many and measurement problems may be offset or averaged out to some extent. However, the potential sources of bias in the CEI due to employment statistics and their net effects on the CEI deserve further research. Employment constitutes a very important part of the economy that should not be omitted from a coincident index. Unfortunately, most of the available data on employment are annual data. Our search for a satisfactory monthly employment series is continuing.

4. Chronology of China's Growth Cycles

Since 1986, (over slightly more than two decades) China has achieved impressive economic growth with but a single major interruption. This is shown by both the real GDP presented in Figure 1 and the composite index of coincident indicators presented in Figure 2. GDP has a single cyclical decline in this period, lasting about a year from April 1988 to March 1989. CEI also had only one slightly longer and later decline in August 1988-December 1989 (the Figures highlight these episodes with shaded areas between the above dates of peaks and troughs).

The approximate concurrence of cyclical declines in these two comprehensive time series provides substantial support for the notion that a business cycle recession did

occur near the end of the 1980s. CEI, being a multivariate measure combining several aspects of general economic activity, supplies us with the preferred dates for the recession. Importantly, CEI has larger and better articulated cyclical movements than GDP, which has had more irregular movements in the recovery during the early 1990s and steadier upward trend subsequently (see Figure 3).

Growth cycle analysis can provide useful insights into the significant slowdowns and growth accelerations that occurred during China's unusually extensive and intensive economic expansion. Fluctuations in deviations from trend (growth cycles) complement fluctuations in levels (business cycles). In times of high growth trends, the former often replace the latter, which may be particularly important for developing economies.

Classical research on growth cycles uses carefully calculated trends of the variables under investigation in recognition of the fact that trends and cycles interact and influence each other. A method that was found to work well here produces "phase-average trend" (PAT), which allows for this relationship.[21] As indicated by Ozyildirim and Zarnowitz (2006), the PAT method lacks the mathematical elegance or apparent simplicity of other approaches that can be summarized by formulae. The multi-step, successive approximations approach is dictated by the objective of deriving estimates that reflect in a reasonable way the interplay of longer (trend) and shorter (cyclical) movements. PAT passes smoothly through the principal segments of higher and lower average growth in the data, which makes it nonlinear and flexible.

Figure 1 and 2 contain the PAT trends for GDP and CEI, respectively. Their close inspection indicates that GDP clings to its trend much more closely than does CEI to its

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[21] Boschan and Ebanks (1978) describe a 10-step procedure to calculate the phase average trend (PAT). First, a 75-month moving average of the data is computed to approximate a secular trend. The deviations from this preliminary trend are calculated in order to determine cyclical turning points. These turning points determine the phases of fluctuations (periods of high growth and low growth). Then, mean values of the original data for each successive phase are computed and placed in the midpoint of each phase. From these phase averages a three phase moving average (triplets) is calculated and also placed in the midpoint of the period spanned by three phases. Then, the triplets are connected by monthly interpolation. The level of the trend in each segment is adjusted by making sure the sum of the trend values equal the sum of the actual data in each segment. The transitions from segment to segment are smoothed by using a 12-month moving average which gives the final PAT. The use of centered 75-month moving averages makes it necessary to extrapolate backward (forward) over the first (last) 37 months of the series covered. This is the main source of problems and errors here: note that the slope of the trend at the end of the period must be estimated while the relevant cyclical developments are still unknown.

trend. This is, indeed, confirmed and amplified by full analysis of the resulting estimates of growth cycles.

Figure 7 presents the deviations of China's real GDP growth from its phase average trend. The data are based on monthly interpolation, seasonally adjusted values. The shaded areas represent cyclical declines in this series determined according to the Bry-Boschan algorithm as running from each peak (P) to the following trough (T). The dates of these specific cycle turning points are listed above the chart. We find that the series of deviations from the trend declined strongly during 1988-90, 1991, but mildly and shortly in 1993-94, 1995-96, 1998-99, 2004-05. The cyclical slowdown in 2000-03 was relatively persistent but mild. So here we have one possible approach to how a growth cycle chronology for China may be estimated, in this case using only one variable namely real GDP.

Figure 8 shows the results of using the same approach for CEI, the composite index of selected coincident indicators. We find a total of four such cyclical slowdowns during 1986-2007. These periods are 8/88-12/89, 2/93-10/93, 4/97-1/98 and 1/00-1/02.[22] It is evident that the growth cycles are more frequent and more symmetrical than business cycles, which is because long business cycle expansions are usually interrupted by significant slowdowns. In a growing economy, business cycle expansions exceed contractions on average in both duration and amplitude. Compared with this asymmetry, growth cycles, being measured from upward trends, have much more symmetrical phases of similar length and size. However, in China growth cycles show longer upward than downward movements. Figure 8 suggests that the series of deviations from the trend of CEI declined strongly coincident with China's business cycle recession of 1988-89. This means that the growth slowdown in China deteriorated into an absolute decline in aggregate economic activity or classical recession during 8/88-12/89. The slowdowns were much milder and shorter on the following occasions. The latest recorded growth

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[22] According to Nilsson and Brunet (2006), the OECD has also developed a chronology of growth cycles based on deviations from trend in the value of industrial output. They find five growth cycles in the 1986-2004 period: 9/88-8/90, 1/91-12/91, 10/94-1/95,5/97-2/99, and 7/00-2/02. The first and last sets of turning points agree with our determination based on the deviations from CEI.

cycle trough occurred in January 2002, after two years of cyclical slowdown. The Chinese economy has continued to maintain its growth momentum since then.

Given the heavier dependence of the Chinese economy on external trade in recent years, it is evident that the cyclical fluctuations in the Chinese economy are more closely correlated to the external economic shocks. The third growth cycle roughly coincided with the Asian economic crisis in 1997-98 and the global economic downturn in 2001 may also have impacted on the latest economic slowdown.

Perhaps somewhat surprisingly, given the broad similarity over time of the levels of CEI and GDP (Figure 4), the two variables yield quite different growth cycle chronologies. The deviations from PAT of real GDP for China yield seven growth-cycle recessions over the period 1988-2005, while the deviations from PAT of CEI yield four cycle recessions over the period 1988-2002. The GDP deviations are dominated by the irregular component, almost completely so after 1994. Their short-term volatility is so high that dating their specific cycle turning points is an extremely difficult exercise with uncertain results. In comparison, the CEI deviations have much larger and clearer cyclical and smaller irregular movements.

Taken together, there is little doubt that much better results for growth cycle analysis are obtained by using CEI than GDP. The former produces four slowdowns that are well articulated, while the latter has seven cyclical slowdowns that are poorly articulated.

5. Concluding Remarks

This paper presents our findings in constructing a coincident economic index for China using publicly available economic data. The goal is developing chronologies of business cycles and growth cycles, which itself provide important information. We further expect that a multivariate measure such as CEI will help provide some guidance to improving China's GDP statistics.

As the proposed method of identifying and dating business cycles in China we combine five coincident indicators. There are at least the following four arguments in

favor of using these coincident indicators to determine business cycle turning points rather than only relying on real GDP in China (cf. Zarnowitz, 2001). (1) General economic activity has different aspects that need to be taken into account in deciding when expansions and contractions have occurred. (2) Co-movement of economic variables is an essential characteristic of the business cycle. (3) Economic statistics generally are subject to unknown data errors, so that the evidence from a number if independently compiled indicators tends to be more reliable than the evidence from any individual series. (4) Revisions affect the dating results obtained from a set of indicators less than they do the results obtained from a single series. This is particularly true when the accuracy and reliability of official China's GDP statistics has come under criticism in recent years.

The combination of five coincident indicators for China shows there was a marked recession which occurred in 1988:8 to 1989:12 over the past two decades. The Chinese economy reaccelerated strongly in 1992, stabilized in 1993-98, and rose up again thereafter after the access to WTO.

In order to make a well-informed recommendation about whether the CEI is an essential tool to measure and monitor China's current aggregate economic activity, we analyzed deviations from trend in the CEI and proposed a growth cycle chronology. The growth cycle concept is viewed as particularly relevant for fast-growing developing economies with sustained periods of economic expansions. The results point out that there were four cyclical declines since 1986, as determined from the PAT deviations from the CEI. It declined in 8/88-12/89, 2/93-10/93, 4/97-1/98 and 1/00-1/02. This finding is consistent with the observation in Ozyildirim and Zarnowitz (2006) that all recessions involve slowdowns, but not all slowdowns involve recessions; hence, growth cycles are more numerous than business cycles. A comparison of growth cycles based on the CEI with those based on GDP show that GDP is dominated by a smooth trend and short-term volatility whereas CEI exhibits well articulated cyclical movements.

Our findings suggest that with its increased dependence on external trade the cyclical fluctuations of the Chinese economy may be more closely correlated with

external shocks in recent years. However, heavier dependence of China's growth on domestic demand and particularly investment might suggest cyclical events may develop domestically rather than arise as a result of external shocks. In either case, an appropriate measure of economic activity like the CEI developed in this paper can help to monitor and analyze the causes and consequences of these cyclical dynamics.

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Table 1. List of Indicators

Indicator	Start date	Frequency	Unit
Panel A (CEI components)			
1. Gross Value of Industrial Output	1986.1	M	Yuan bn
2. Retail Sales of Consumer Goods	1986.1	M	Yuan bn
3. Manufacturing Employment	2000.1	Q[1]	Person mn
4. Cash Income of Financial Institutions	1986.1	M	Yuan bn
5. Volume of Passenger Traffic	1986.6	M	Person mn-kilo
Panel B (Excluded components)			
1. Electricity Production	1986.1	M	KWH bn
2. Total Earning of Employee in Urban	1992. 1	Q	Yuan bn
3. Total Energy Production	1986.1	M	SCE Ton mn
4. Government Revenue	1986.1	M	Yuan bn
5. Disposable Income/capita of Urban Household	1992.1	Q[1]	Yuan
6. Real Imports	1986.1	M	USD bn
Panel C (NBS CEI components)			
1. Value-added Industrial Production	1994.1	M	Yuan bn
2. Retail Sales of Consumer Goods	1986.1	M	Yuan bn
3. Industrial Employment	1999.1	Q[1]	Person mn
4. Fixed Assets Investment	1986.1	M	Yuan bn
5. Total Trade	1986.1	M	USD bn
6. Government Revenue	1986.1	M	Yuan bn
7. Disposal Income/capita of Urban Household	1992.1	Q[1]	Yuan
8. Industrial Profits	1991.1	Q[1]	Yuan bn

Note: Monthly data till the end of 2006.

Table 2. Timing of CEI Components at Business Cycle Peaks and Troughs

	GIP	RRS	ME	CIF	VPT	GDP
Starting Date	1986M1	1986M1	2000M1	1986M1	1986M1	1987Q1
Business Cycle Peak	Lead (-) and lag(+)					
Aug-88	-6	0	N/A	+1	+5	-4
Extra Turns	0	0	+1(4/00)	0	0	0
Missed Turns	0	0	0	0	0	0
Mean	-3.00	0.00	0.00	0.50	2.50	-2.00
Median	---	0.00	---	---	5.00	-4.00
St. Deviation	---	---	---	---	---	
Business Cycle Trough	Lead (-) and lag(+)					
Dec-89	+2	0	N/A	0	+5	-9
Extra Turns	0	0	1(1/02)	0	0	0
Missed Turns	0	0	0	0	0	0
Mean	1.00	0.00	0.00	0.00	2.50	-4.50
Median	2.00	0.00	---	---	5.00	-9.00
St. Deviation	---	---	---	---	---	
Combined Statistics						
Mean	0.50	0.00	0.00	0.17	1.67	-2.17
Median	2.00	0.00	---	---	5.00	-6.50
St. Deviation	1.41	0.00	0.00	0.71	0.00	3.54

Notes:
1. China's business cycle peak and trough are determined using an index that combines five coincident indicators.
2. Turning points of CEI candidates are selected by the Bry-Boschan algorithm.
3. N/A denotes the series shows no specific-cycle in Aug88 to Dec89, for which the data are not available.

Figure 1. China GDP and Phase Average Trend
Note: GDP is deflated by CPI and converted from quarterly to monthly by linear interpolation between mid-months of consecutive quarters. Shaded areas represent business cycle contraction based on the GDP.
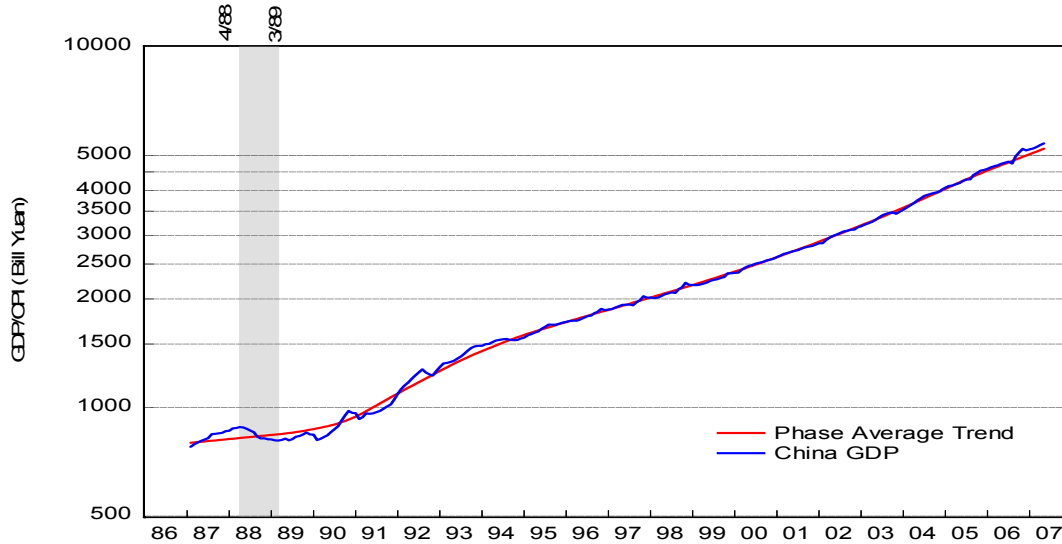
Figure 2. China Coincident Index and Phase Average Trend
Note: We combine five individual indicators — which cover industrial production, retail sales, manufacture employment, income in financial institutions, and passenger traffic into a composite index to determine the chronology of China's Business Cycle. Shaded areas represent business cycle recession based on the China Coincident Index.
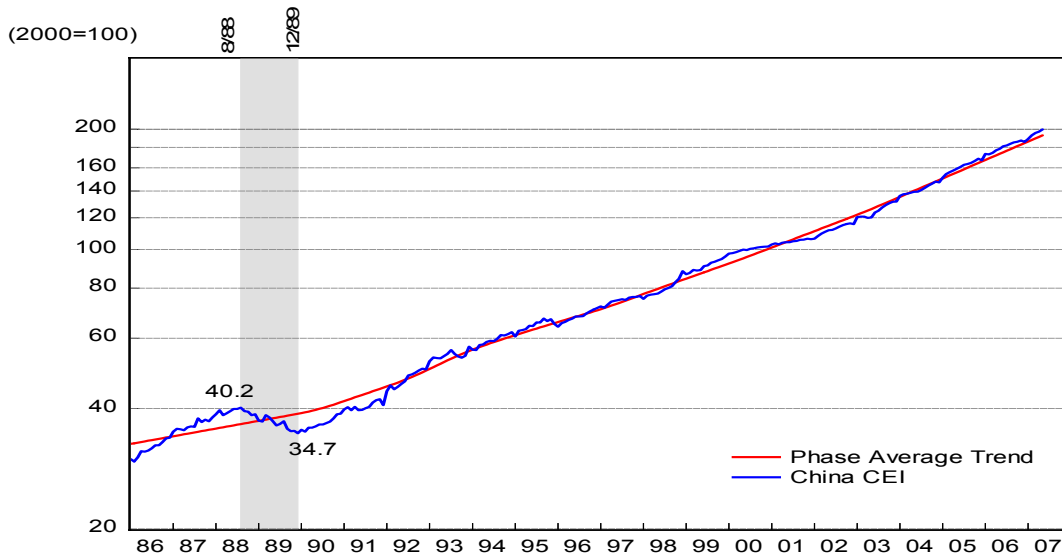
Figure 3. Coincident Index and GDP
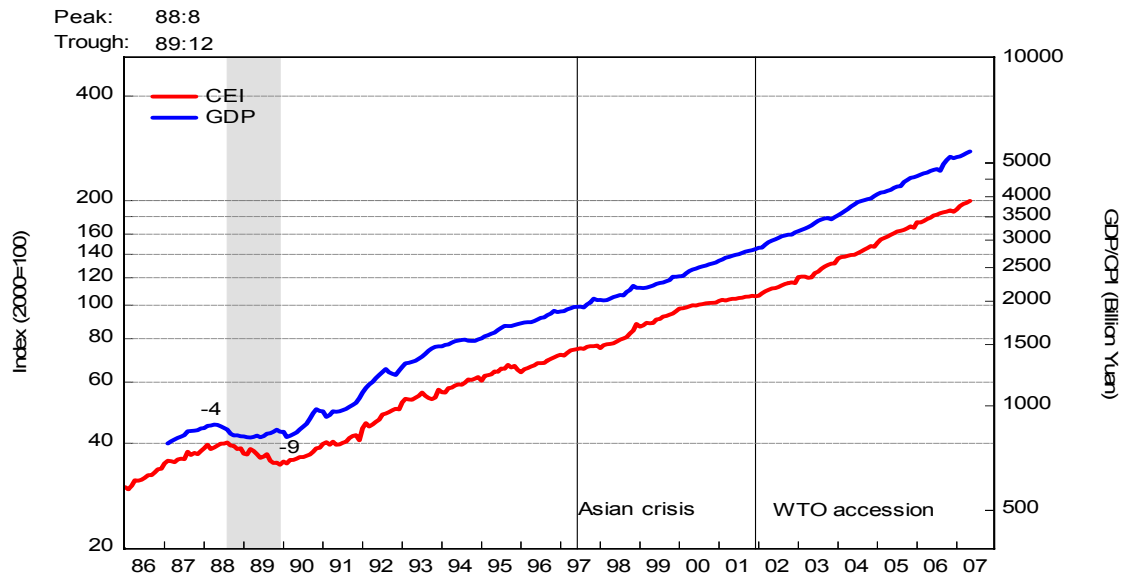
Figure 4. Selected Coincident Economic Indicators

Notes: The turning points of each indicator in Figure (a) to (k) have been selected visually by the authors or by applying the Bry-Boschan algorithm- which is a computer program that has been used to approximate the turning point selection procedures applied by NBER researchers. The shaded areas represent these contractions. We seasonally adjust all the component series, with special attention to the difficult problem of important moving holidays such as the Chinese (lunar) New Year. – and + denote lead and lag in months, respectively. Data are from CEIC and The Conference Board.

(a) Gross Industrial Production
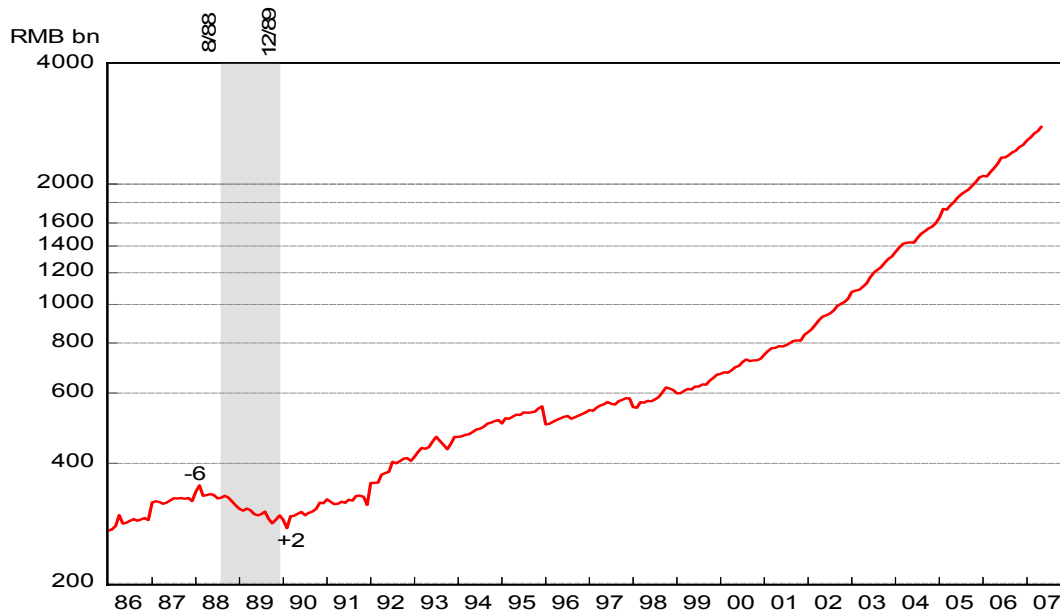
(b) Real Retail Sales of Consumer Goods

RMB bn
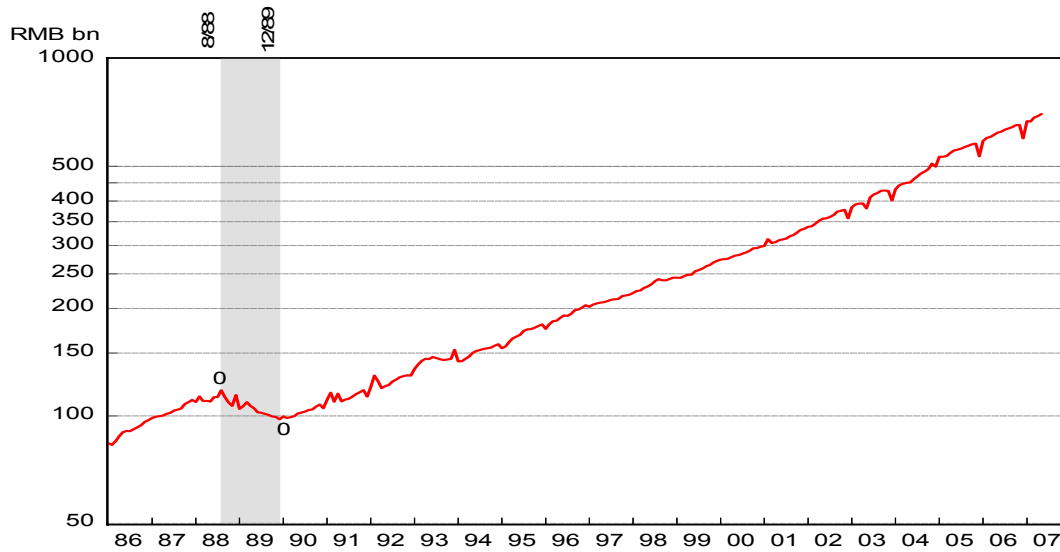
(c) Manufacturing Employment

Person mn
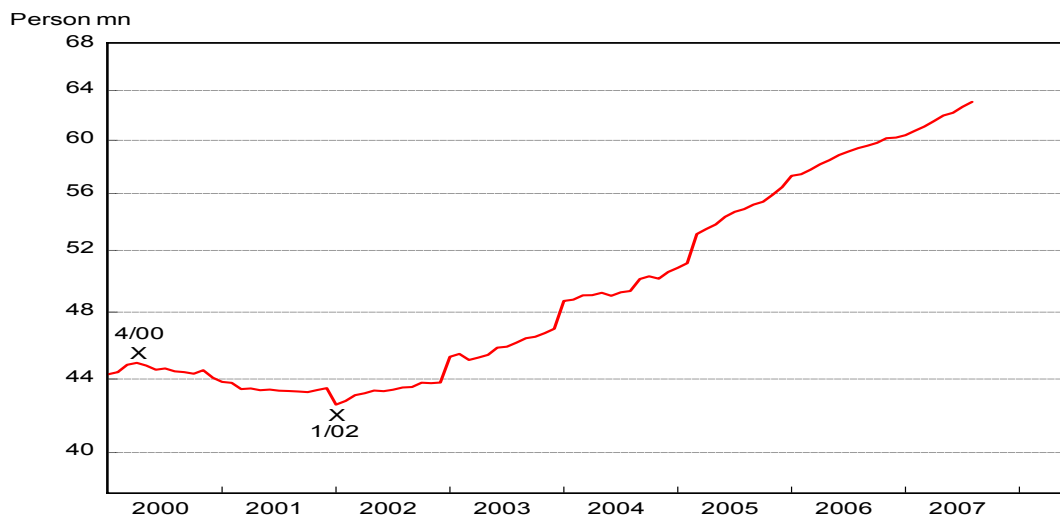
(d) Real Cash Income of Financial Institutions
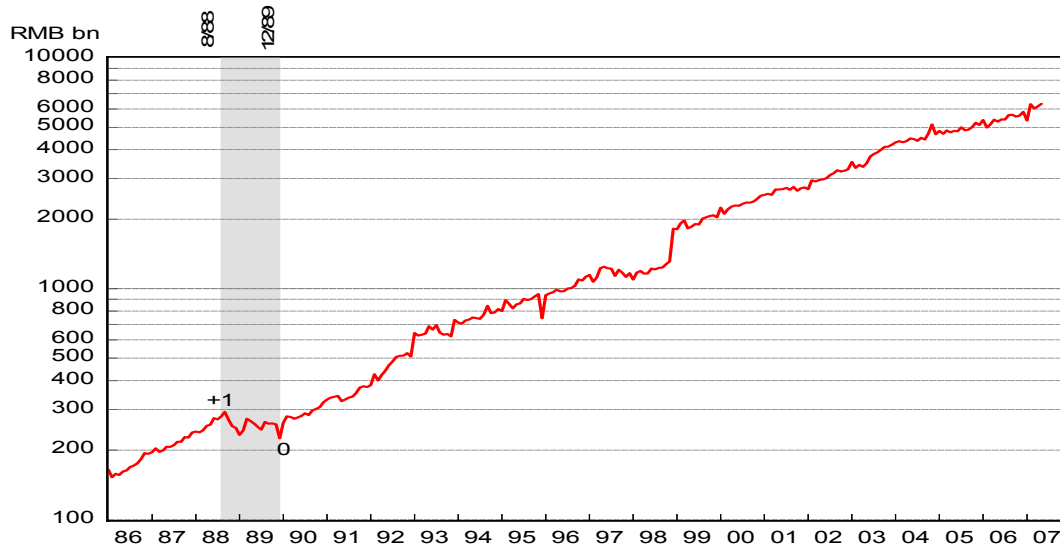
(e)Total Volume of Passenger Traffic

(f) Total Earnings in Urban Units

RMB bn

1000
900
800
700
600
500
400
300

200

92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07

(g) Real Imports

US$ bill

100

50
40
35
30
25
20

15

+4

10

+6

5

87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07
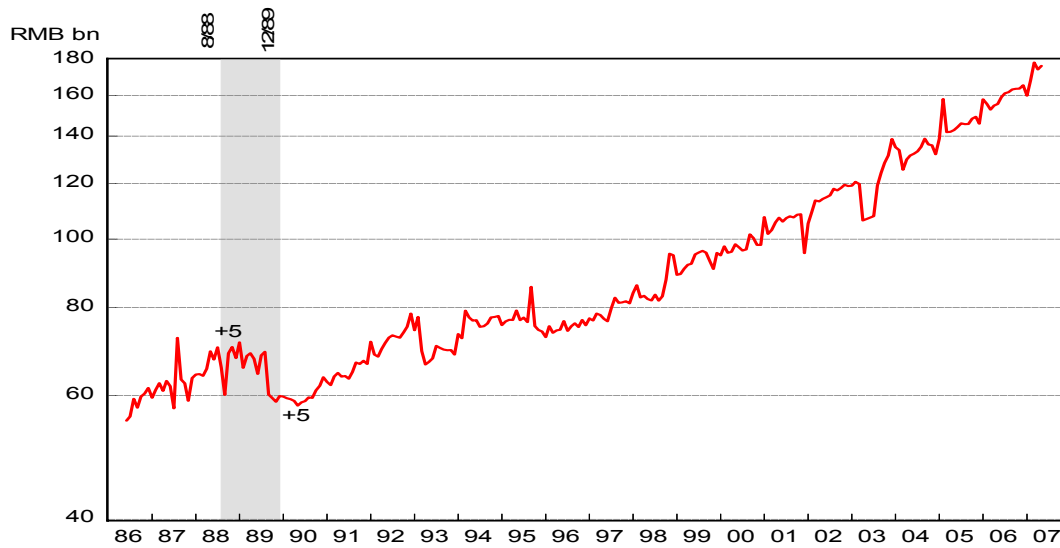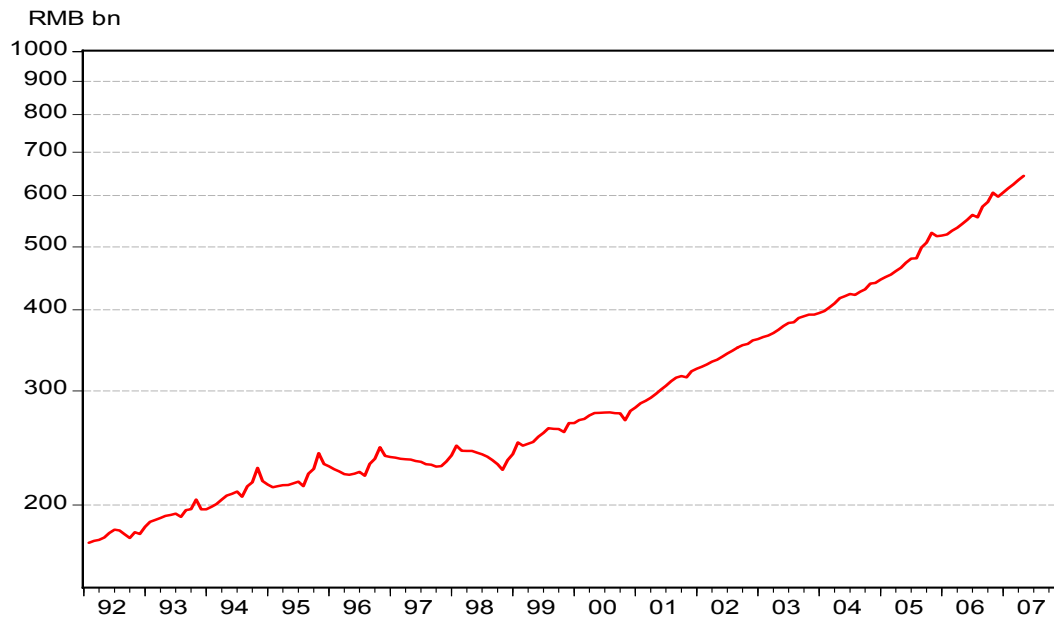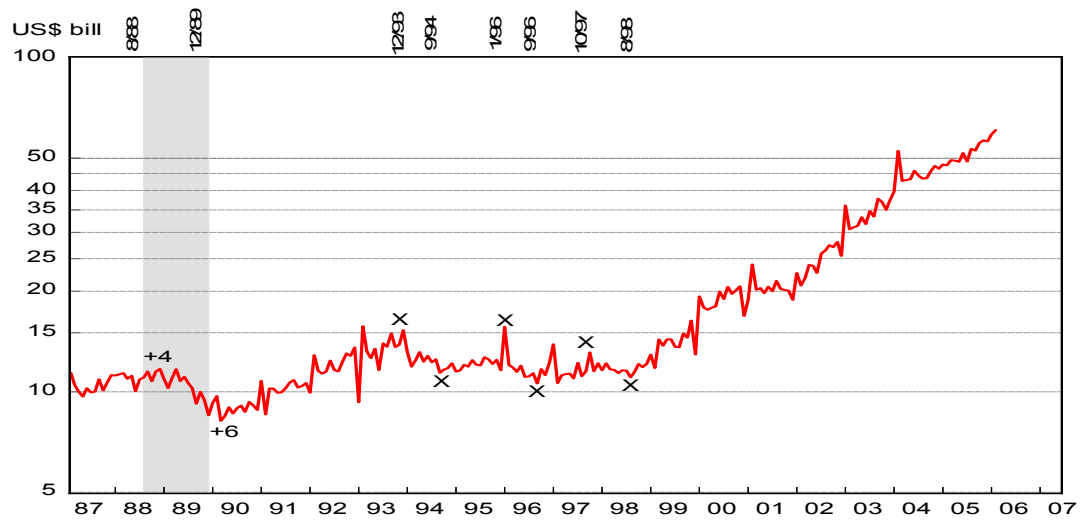
(h) Total Energy Production
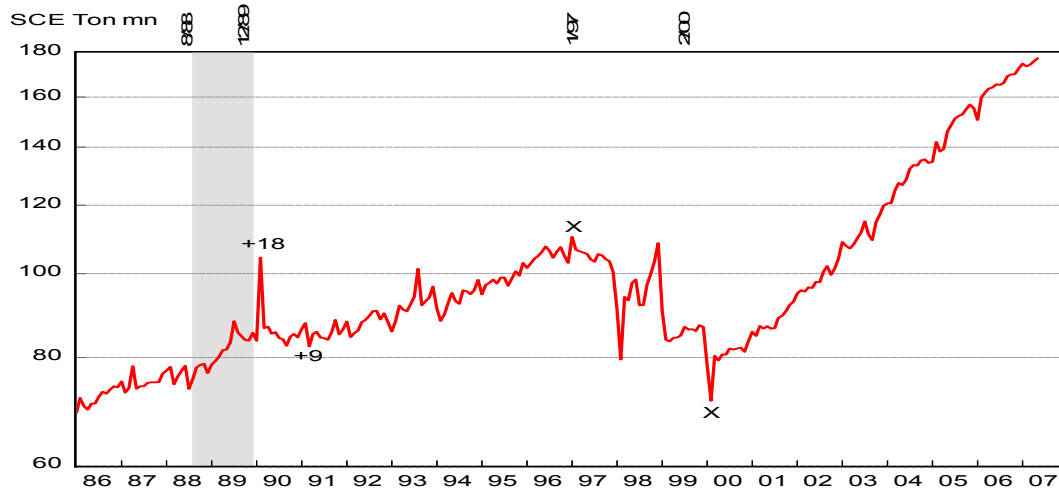
(i) Government Revenue
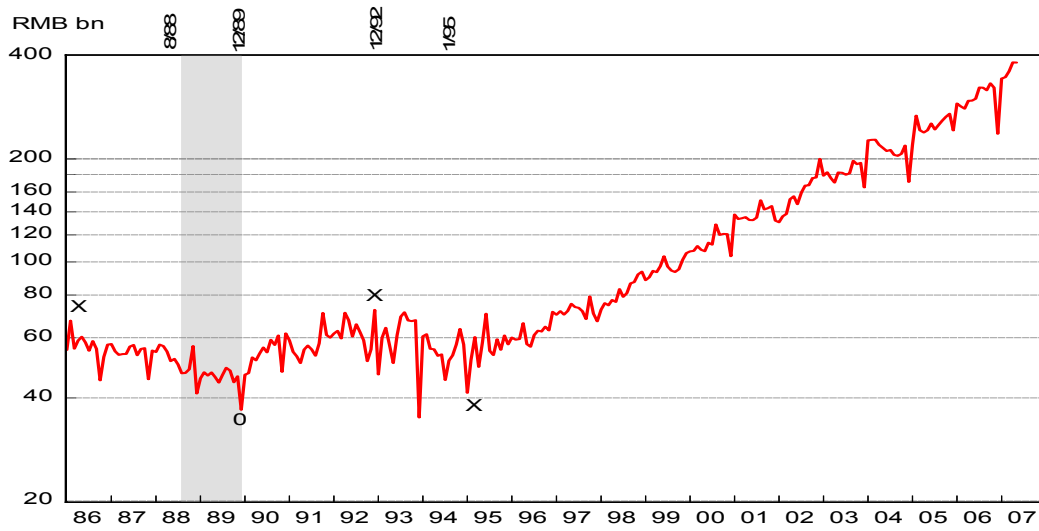
(j) Disposable Income per Capita of Urban Household
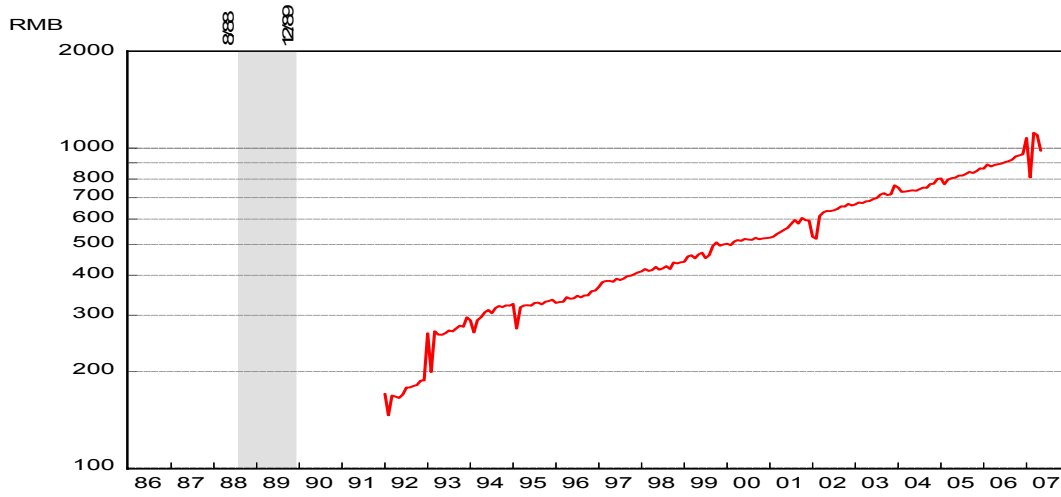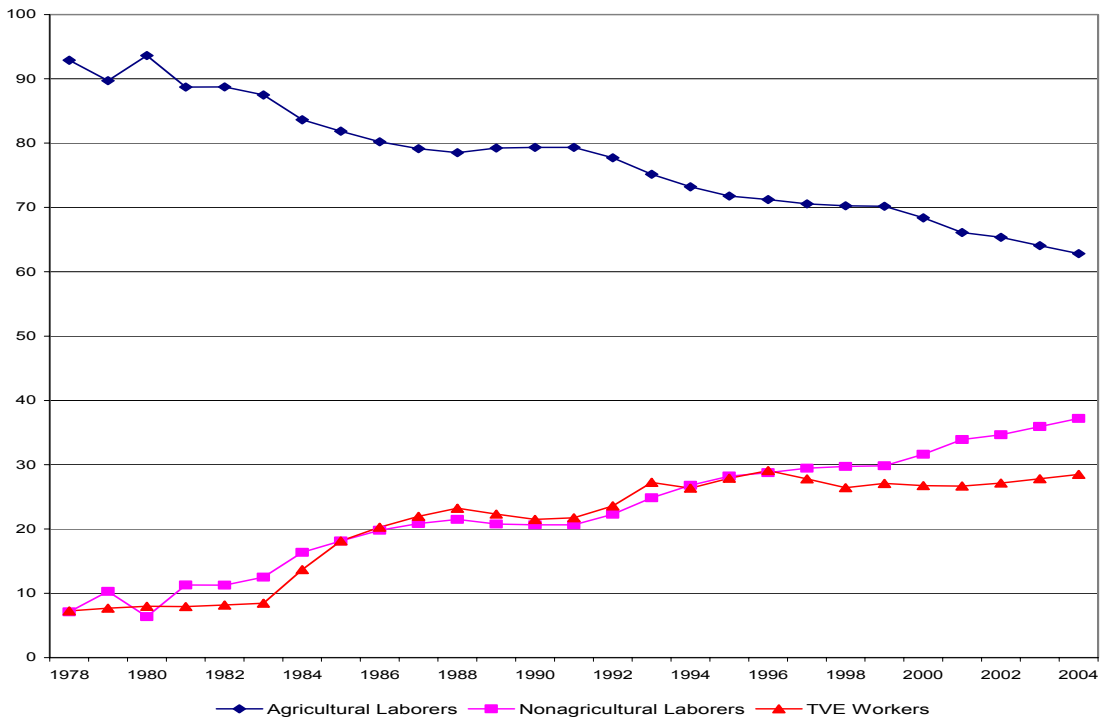

(k) Electricity Output
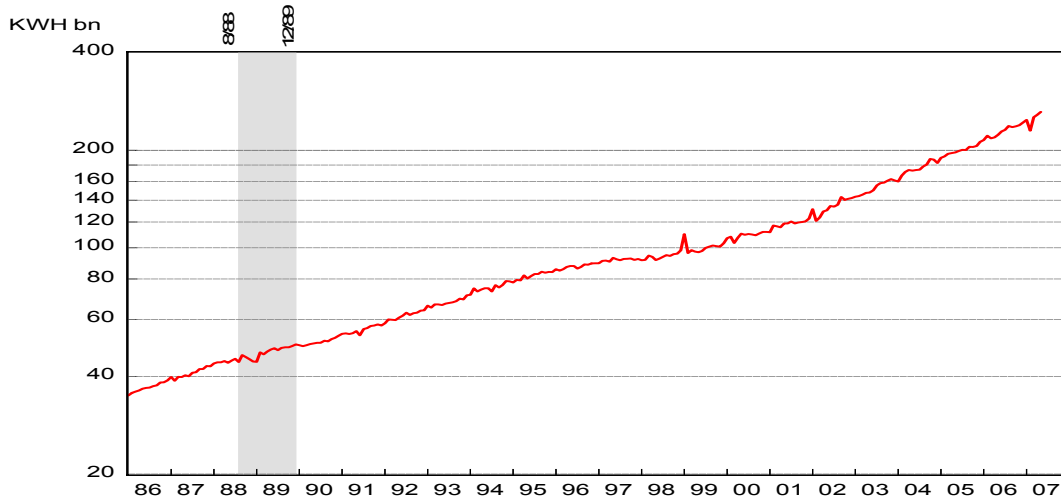
Figure 5: Total employment in Urban Establishments (state-owned, urban collective, other, excluding private) Source: NBS
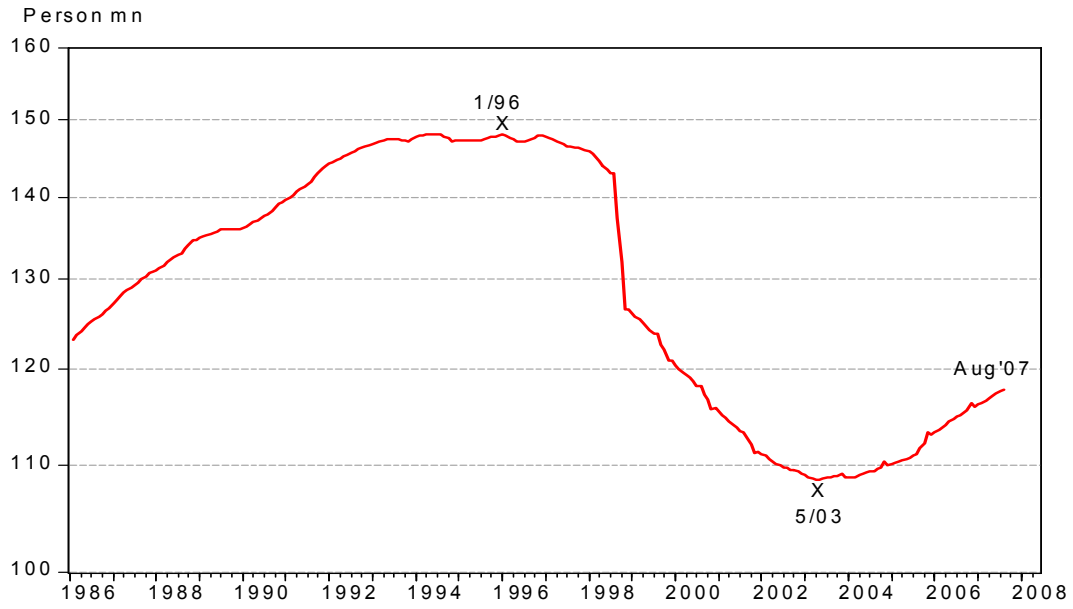
Figure 6a: Distribution of Urban Labor Force by Types of Ownership, Annual, 1978-2004 (Percentage) Source: NBS
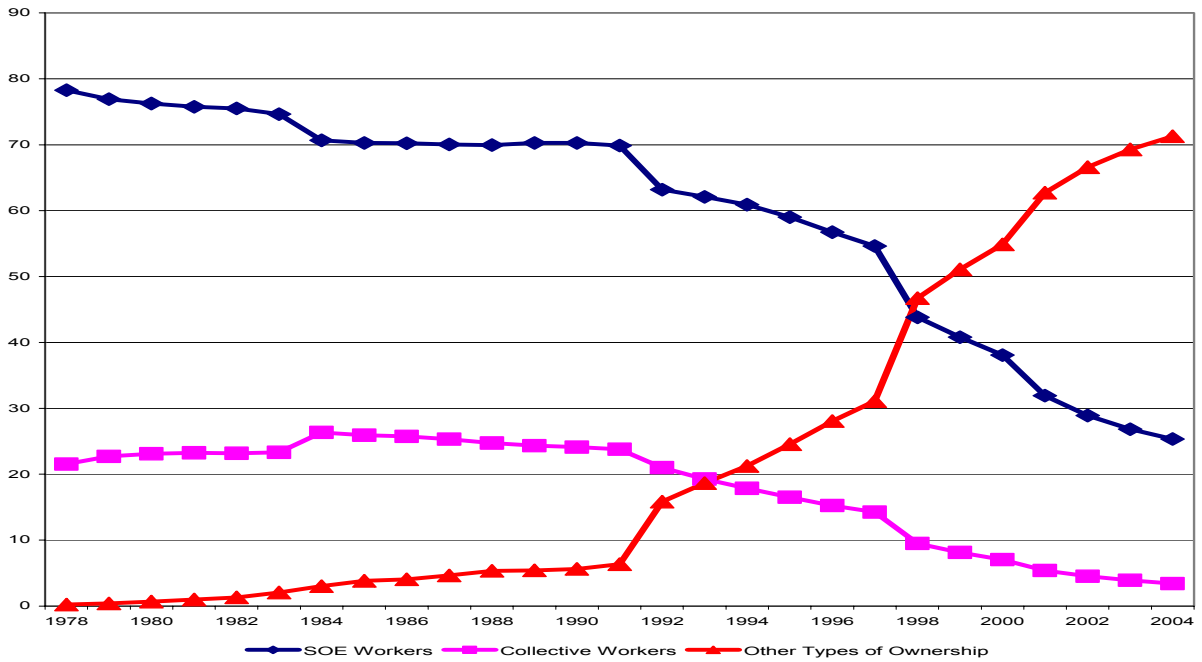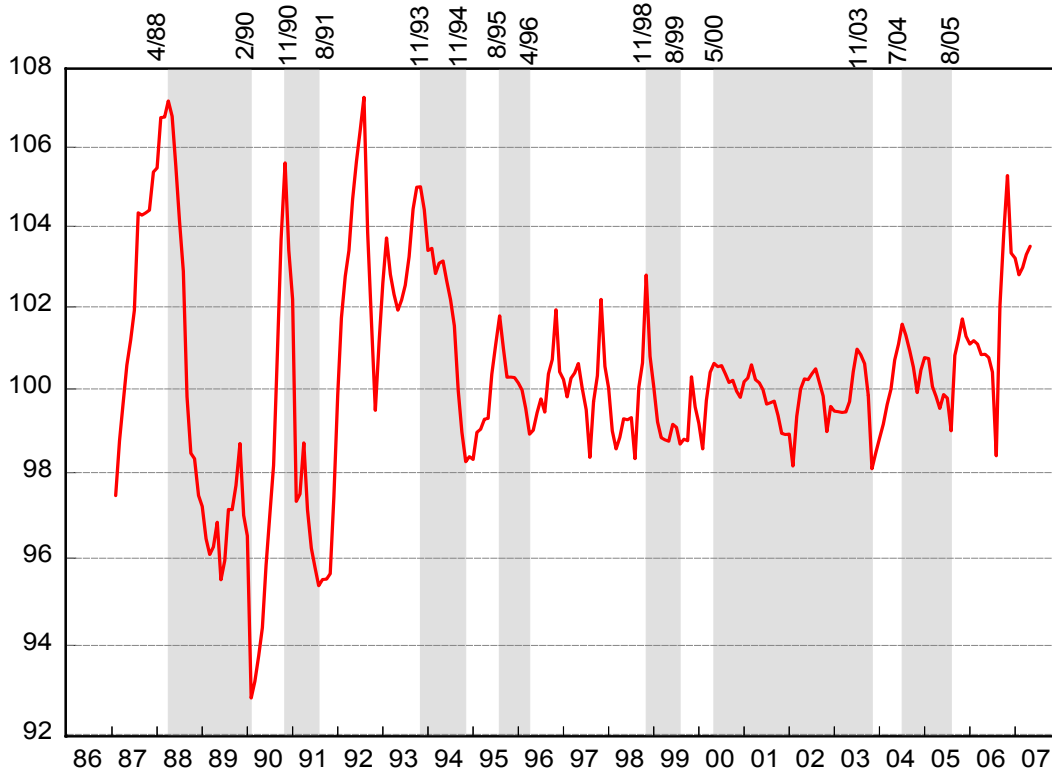

Figure 6b: Distribution of Rural Labor Force among Economic Activities, 1978-2004 (percentage) Source: NBS
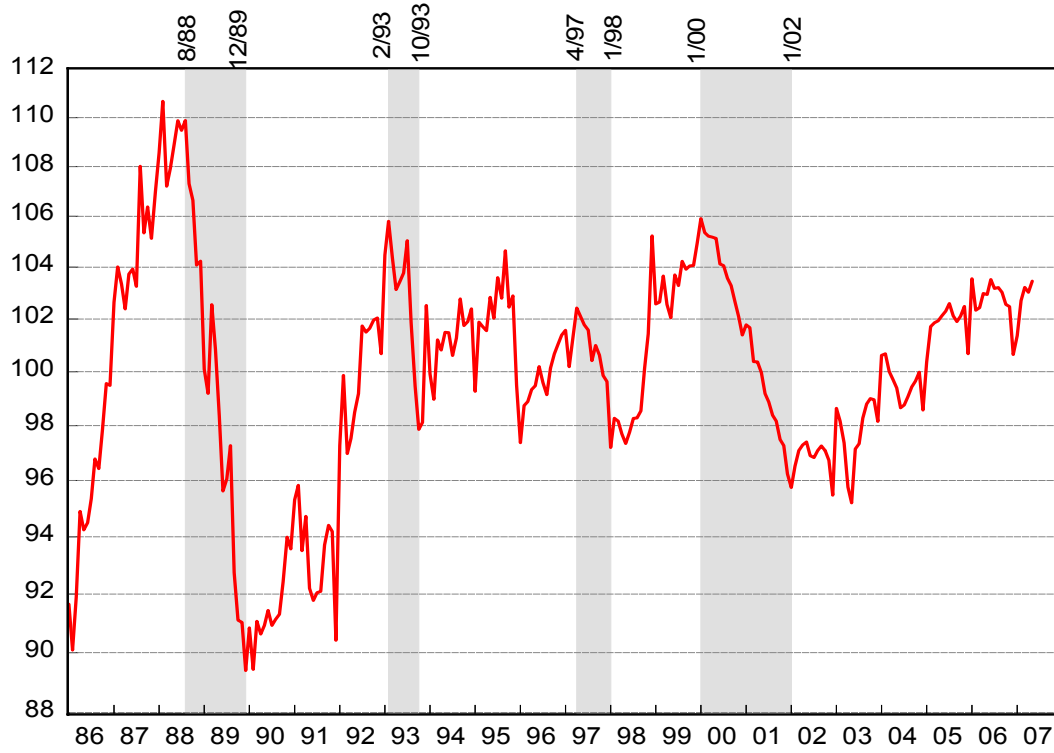

Note: TVE denotes Town and Village Enterprises.

Figure 7. China Real GDP Deviations from Phase Average Trend
Note: Shaded areas represent growth cycle contractions based on the China GDP

Figure 8. China Coincident Index Deviations from Phase Average Trend
Note: Shaded areas represent growth cycle recessions based on the China Coincident Index

Appendix A

The procedure for Constructing China's Coincident Composite Indexes is as follows:

(1) Calculate month to month changes, $r_{i,t} = 200 * \dfrac{X_{i,t} - X_{i,t-1}}{X_{i,t} + X_{i,t-1}}$ for each component, $X_{i,t}$,

where $i = 1,\ldots,n$.

(2) Adjust the month to month changes by multiplying then by the component's standardization factor, w_i. The results of this step are the monthly contributions of each component $c_{i,t} = w_i * r_{i,t}$.

(3) Add the adjusted month to month changes across the components for each month to obtain the growth rate. This step results in the sum of the adjusted contributions,

$$s_t = \sum_{i=1}^{n} c_{i,t} \, .$$

(4) Compute preliminary levels of the index using the symmetric percent change formula listed at (1). The index is calculated recursively starting from an initial value of 100 for the first month of the sample period (i.e. January 1987). The first month's value is I_1=100. The second month's value $I_2 = I_1 * \dfrac{200 + S_2}{200 - S_2} = 100 * \dfrac{200 + S_2}{200 - S_2}$ and this formula is used recursively to compute the index levels for each month that data are available.

(5) The index is rebased to average 100 in 2000. The history of the index is multiplied by 100 and divided by the average for the twelve months of 2000.

Appendix B

In order to make a well-informed recommendation about whether the CEI is an essential tool to measure and monitor China's current and future aggregate economic activity, we did further analysis by combining different components to create various version of CEI and using cointegration test and out-of-sample forecast.

B.1. Alternative Versions of CEI

1. CEI including Gross Earnings and Real Imports (CEI6)

The composite index combining six components, which include industrial production, retail sales, manufacturing employment, gross earnings, real imports and passenger traffic, shows the business cycle peak and trough dates for CEI6 (2/88 and 2/90) in Figure A1. The visual inspection indicates that the contraction, while relatively long, was mild and the immediate recovery was quick. The CEI6 slowed in 1991, reaccelerating strongly in 1992, stabilizing in 1993-98, and speeding up again thereafter (access to WTO was a likely factor). There are no further recessions in this period. Significant slowdown in economic activity is not seen either, except perhaps briefly in 2000-01.

2. CEI Excluding Passenger Traffic (CEI5)

The volume of passenger traffic plotted in Figure 5e suffers from high volatility: short and sharp declines in the year of 1992, 1995, and 2003, and generally large, irregular fluctuations. This series also exhibits a 5-month lag at the peak and 5-month lag

at the trough of the recession of 1988-89. Taken together, it makes sense to ask how an omission of VPT would affect the composite coincident index for China.[23]

Comparing CEI5 in Figure A2 with CEI6 in Figure A1 helps to answer this question. In fact, their behaviors are very similar: the dates of the recession (2/88-2/90) are unchanged for these two series. Neither the growth trends nor the volatility of the indexes are substantially affected. As usual, excluding a single one of six components of an index makes quite a limited difference.

3. CEI Excluding Passenger Traffic and Earnings (CEI4)

Total Earnings in the Urban Units (EUU, see Figure 5f) is the least cyclical of the proposed components of China's Coincident Index. This series is not satisfactory since it is interpolated from quarterly to monthly, implying heavy linear smoothing. As a result, EUU, which starts only in 1992, shows no specific cycle declines that are picked up by the Bry-Boschan program. The total earning in urban units declined within each of the following consecutive years -- 1996, 1997, and 1998 -- but none of these declines was long and large enough to qualify. Figure A3 shows CEI for China based on four variables only, excluding both VPT and EUU.

This index, too, retains the dates of the cyclical decline in 2/1988-2/1990. However, a small extra recession in 2/1993-1/1994 is picked up by the Bry-Boschan turning point program. Otherwise, the exclusion of EUU demonstrates the almost

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[23] Some of our sources in China, too, are uncertain about the choice of this series as a component of the TCB coincident index for this country.

negligible difference, as evidenced by a detailed comparison of Figure A3 with Figure A2.

Table A1. Correlations between Real GDP and CEI

|	Real GDP		
	Level	6-month growth	12-month growth
CEI	0.998	0.518	0.694
CEI6	0.993	0.545	0.710
CEI5	0.972	0.427	0.556
CEI4	0.975	0.450	0.578

Figure A1. Coincident Index with Six Components (CEI6)

Note: We take an approach which approximates the decisions of the NBER committee using a combination of the components of CEI — which include industrial production, retail sales, manufacture employment, personal income, real imports and passenger traffic — with real GDP as a method for dating business cycles in China. The shaded area represents the recession.
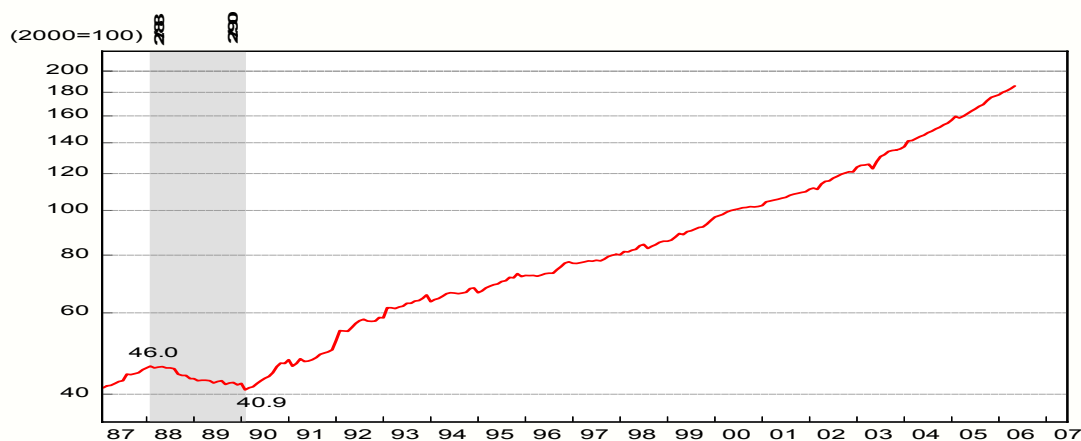
Figure A2. Coincident Index with Five Components (CEI5)

Note: The components of CEI5 include industrial production, retail sales, manufacture employment, personal income and real imports. Shaded area represents China's recession.
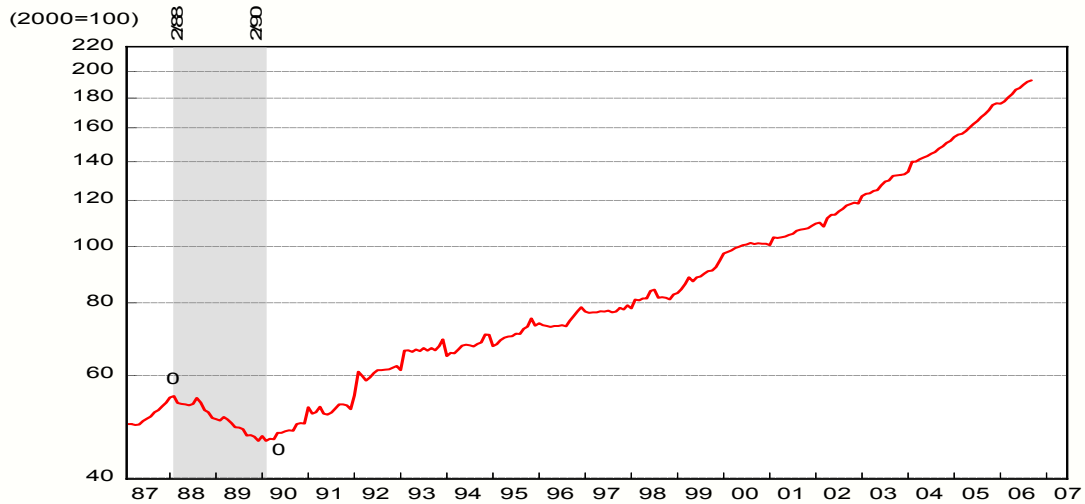
Figure A3. Coincident Index with Four Components (CEI4)

Note: The components of CEI4 include industrial production, retail sales, manufacture employment and real imports. Shaded area represents China's recession. X denotes extra cycle.