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Ataman Ozyildirim
The Conference Board, New York
&
Harry X. Wu
Institute of Economic Research, Hitotsubashi University, Tokyo
& The Conference Board China Center, Beijing

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Economics Program
845 Third Avenue
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Ataman Ozyildirim
The Conference Board, New York
Ataman.Ozyildirim@conference-board.org

&

Harry X. Wu
Institute of Economic Research, Hitotsubashi University, Tokyo
& The Conference Board China Center, Beijing
Harry.Wu@ier.hit-u.ac.jp

ABSTRACT

This study appraises The Conference Board (TCB) coincident and leading economic indices (CEI and LEI) for China with a focus on China CEI. The evaluation is mainly based on a critical discussion of the major data problems in the Chinese official statistics and their implications in modeling China's macroeconomic dynamics, and a development of a set of new commodity indicators as alternatives to some of the components in the existing TCB China CEI and LEI. It also examines the trends, cyclical movements and turning points in the Chinese economy as identified by the TCB China indices. Our empirical findings through regressions show that despite the data problems the existing TCB China CEI is robust in predicting the cyclic movements of GDP. However, commodity-based indicators which tend to pronounce the variations of industrial output indeed better model the dynamics of GDP.

JEL classification: C53; E32; P24

Key Words: Coincident and leading economic indicators; GDP; trends, cycles and turning points; Chinese macroeconomic statistics

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1. BACKGROUND AND MOTIVATION

It is difficult to exaggerate the importance of China's macroeconomic performance to the world economy and the danger of misreading China. In China also there is increasingly need for proper and reliable macroeconomic performance data to be used in macroeconomic policy making as well as in business planning. All these undoubtedly require not only accurately measuring China's relative size, economic structure and long-run growth using annual time series data, but also accurately modeling and predicting its cyclical movements and turning points using high-frequency (monthly or at least quarterly) data.

However, the precise measurement and analysis of high-frequency and short-term cyclical movements in the Chinese economy have received less attention compared to the measurement and analysis of its relative size, structural changes and long-run growth. This is largely because compared with high-frequency data there are many more and longer time series of annual data available in the official statistics. Moreover, measurement problems—related to the size and growth of the economy—due to institutional and methodological deficiencies have caused a long debate about the real performance of the Chinese economy in the long run (for a review see Wu, 2002 and Maddison and Wu, 2008).

Work in China for monitoring China's macroeconomic performance using high-frequency data began in 1987, marked by the set up of the State Information Center (SIC) under the National Development and Reform Commission (NDRC). The actual research on developing and using leading economic indicators was implemented by a key research project under China's Eighth Five Year Plan (1991-95). Since the early 1990s, along with the official adoption of "socialist market economy", several state agencies have initiated their own independent monitoring system including the National Bureau of Statistics (NBS), People's Bank of China (PBOC), Development Research Center (DRC) of the State Council, Chinese Academy of Sciences (CAS) and Chinese Academy of Social Sciences (CASS). Since the early 2000s, several leading and coincident indicators have been publicly released on a regular basis including those constructed by SIC, the China Economic Monitoring and Analysis

Center (CEMAC) of NBS,[1] the Center of Scientific Forecasting (CESF) of CAS, and most recently, the China Center for International Economic Exchanges (CCIEE).

Outside China, this type of research has been carried out since the mid 2000s by a few non-profit organizations including The Conference Board (TCB) and Organization for Economic Co-operation and Development (OECD) as well as their researchers such as Guo, Ozyildirim and Zarnowitz (2009) and Nilsson and Brunet (2006), by some commercial agencies such as Goldman Sachs (Asia) and by academics (e.g. Curran and Funke, 2006). OECD's China composite leading indicator (CLI) exactly follows its CLI approach for member countries and selected non-member countries (OECD, 2008) and is now regularly available (e.g. OECD, February 2010). In May 2010, The Conference Board publicly released its China leading economic index (LEI) and coincident economic index (CEI) after over four years of internal research and experimental exercises following the NBER approach to constructing the same indices for the United States and several other economies around the world (TCB, May 17, 2010).

Now, with more coincident and leading indicators available for the Chinese economy, what the potential users or researchers on China at large really want to know is not what are the component indicators in the constructed index and how sophisticated the methodology used in the construction of the index, but rather, given all well-know problems in the Chinese official statistics, how reliable an available indicator is in modeling China's economic activities and in predicting its likely moments. If potential data problems are inevitably causing biases, how to evaluate the problems and find alternative ways to minimize the biases.

Unquestionably, the reliability of a leading economic index depends not only on the selection of its components, but more importantly, on the reliability of its reference, coincident economic indicator, that the leading index refers to. In the case of China, given the data problems and in the absence of a dating committee, it is first and crucial to investigate and understand the nature of the data problems that may be inherent in the coincident indicator or its components and then look for a proper way to handle the problems in a transparent manner. Once the potential problems of the reference index are minimized if not eliminated, the selection of the indicators for a

[1] In 2004, CEMAC formed a joint venture with Goldman Sachs (Asia) which brought in the latter's two years of experience in constructing leading indicator for China.

composite leading index should be undertaken supported strongly by the application of economic concepts, the understanding of the behavior of economic agents in the Chinese economy and sound empirical tests.

Most of the research on China's high-frequency data to date has focused on the construction of leading indicators without an in depth consideration given to what those leading indicators may lead. An exception to this is Guo *et al*. (2009). Moreover, the 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. 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.

We argue that for the purpose of identifying and dating business cycles and growth cycles in China, it is not possible to rely on GDP as the discussion 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 a business cycle chronology that is based on high frequency data and a multivariate approach and one that is separate from national income account measures such as GDP or its component part such as industrial gross value added. A recent example of research taking this approach is Guo *et al.* (2009).

The rest of this paper is structured into six main sections. Section 2 introduces the basic TCB approach to the construction of composite indexes (CEI and LEI). Section 3 reviews major data problems in the macroeconomic indicators of the official statistics and discusses their implications for modeling and predicting China's macroeconomic dynamics. Section 4 compares the TCB China CEI and LEI with those indices developed by other agencies for similar purposes. Section 5 examines the trends, cyclical movements and turning points in the Chinese economy as identified by the TCB China CEI. Further considering the potential data problems, Section 6 develops a set of commodity-based new indicators and proposes alternative TCB CEIs and LEIs and appraises them with regressions that models China's GDP growth. Section 7 concludes the paper.

2. THE TCB COMPOSITE INDEX APPROACH

In market economies, economic activity goes through sequences of expansions and contractions. The seminal work of Burns and Mitchell (1946), based on the business cycle research done at the National Bureau of Economic Research (NBER) and others, has laid the foundations of the indicator approach to business cycle measurement and analysis. The sequences of economic activity that characterize business cycles occur with regularity even though they are not periodic. Moreover, the sequences observed in employment, production, sales and income coincide with and help define the economic cycle while others tend to lead and help predict the cyclical turning points. The cyclical movements in all of these processes occur over the course of several months. The Conference Board follows the indicator approach and has applied it internationally to advanced and emerging economies after taking over the responsibility for publishing the LEI for the United States in 1996. Composite indexes of business cycle indicators (leading and coincident) have been used for many countries to monitor these cyclical movements. For the case of China, Guo *et al*. (2009) also show that an adequate contemporary index of Chinese coincident indicators (CEI) can be developed to help track cyclical movements in China.

The Conference Board's indicator approach focuses on classical business cycles which occur in levels of economic activity. The approach relies on a business cycle chronology based on coincident indicators and indexes to evaluate the cyclical characteristics (such as conformity to cycle, consistency of lead times, smoothness, etc.) of leading indicators. When business cycle contractions and revivals (or turning points) are scarce as a result of high growth trends, the usual approach has been modified to look at growth cycles which are defined as cycles in deviations from a long term trend for evidence. This modified approach was first applied by Mintz (1969) and later by Klein and Moore (1985). The modified approach looks at growth cycles (or cycles in deviations from trend) in the post-World War II European economies which also exhibited strong growth trends and few business cycle recessions.[2] In their development of the LEI for China Adams *et al*. (2010) also

[2] Klein and Moore (1985) showed that the typical classification of measures of different types of economic activity into leading, coincident, and lagging with respect to business cycles also applied to growth cycles.

consider evidence based on growth cycles. Growth cycle analysis requires the estimation of long term trends accurately.

Variables which have movements that tend to precede the CEI and related coincident indicators are called leading indicators. For example, average hours of work in manufacturing lead employment: firms tend to lengthen (shorten) hours of work before they hire new (fire old) workers, which is often more difficult and costly for various reasons. Claims for unemployment benefits lead total (rate of) unemployment. New orders received by manufacturers and permits construction companies lead output and shipments and construction, respectively. Rises or declines in stock prices, sensitive commodity prices, real money and credit supplies, and related interest rates also often give early positive or negative business activity signals.[3] The best leading indicators based on their cyclical characteristics (i.e. conformity and consistency relative to the cycle, timeliness, economic and statistical importance etc.), can be combined to form a composite index. For the case of China, it turns out, informational problems and measurement issues affecting leading series are especially challenging. But, given the caveats about data quality summarized and discussed in the next section, these challenges should not be overwhelming.

In the composite index construction, a symmetric percent change formula is used to calculate the monthly changes in the components of a composite index. Before combining the monthly changes of the components into an equally weighted average, they are first adjusted or standardized by multiplying them with their standardization factor. In the TCB methodology, this step is called a volatility adjustment. Standardization factors equate the volatility of different components so that each component has a similar opportunity to contribute to 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

[3] See, among others, Zarnowitz (1992), esp. part III, and references therein.

index is rebased to equal 100 in the base year (i.e. currently 2004=100 for all countries covered by TCB).

The procedure for constructing the TCB composite indexes is as follows (see Business Cycle Indicators Handbook (2001) and The Conference Board web site for further details and discussion):

1) Calculate month to month changes, $r_{i,t} = 200 \cdot \left(\frac{X_{i,t} - X_{i,t-1}}{X_{i,t} + X_{i,t-1}} \right)$ for each component, $X_{i,t}$, where i = 1,…, n, and n is the total number of index components.
2) Adjust the month to month changes calculated in (1) by multiplying eachby the component's standardization factor w_i . The results of this step are the monthly contributions of each component: $c_{i,t} = w_i \cdot r_{i,t}$. The standardization factor, w_i , is based on the inverse standard deviation of the month to month changes calculated in (1). w_i are normalized to sum to 1.
3) Add the volatility adjusted month to month changes calculated in (2) across the components for each month to obtain the growth rate of the composite index. This step results in the sum of the volatility adjusted contributions, $s_t = \sum_{i=1}^{n} c_{i,t}$. For the coincident index, the next step in the calculation (4) below is performed. For the leading index there is an additional trend adjustment before moving to (4). The sum of the volatility adjusted contributions for the leading index is then trend adjusted so that the long term trend of the leading index equals to that of the coincident index. The trend adjustment factor is added to $s_t' = \sum_{i=1}^{n} c_{i,t} + t$ where t is the difference between the mean of s_t for the unadjusted LEI growth rates and the mean of s_t for the CEI.
4) Compute preliminary levels of the index using the reverse of 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 1986 in the case of China). The first month's value is $I_1 = 100$. The second month's value $I_2 = I_1 \cdot \left(\frac{200 + S_2}{200 - S_2} \right) = 100 \cdot \left(\frac{200 + S_2}{200 - S_2} \right)$ and this formula is used recursively to compute the index levels for each month that data are available.

The index is rebased to average 100 in 2004. That is, the history of the index is multiplied by 100 and divided by the average for the twelve months of 2004.

3. MAJOR PROBLEMS IN THE CHINESE OFFICIAL STATISTICS

In this section we review studies on the major problems in Chinese official statistics that may affect the data commonly used in constructing leading and coincident indicators. Our discussion will concentrate on the problems of the macroeconomic indicators especially those in the national accounts, i.e. output, expenditure and income indicators, as well as labor market indicators. The discussion also supports the TCB multivariate approach as a more appropriate approach to modeling current economic activities in the case of China rather than relying on a single measure of output or income. Note that most of the data problems observed and studied in the literature refer to Chinese annual data, but they are valid for Chinese high-frequency data.

Gross output, value added and prices

Industrial value added indicator has been used almost by all organizations in constructing coincident economic indicators for China (Table 1). However, output data (value added, gross output, sales etc.) are considered most problematic in the Chinese official statistics. The problem is to a large extent a heritage of the Soviet-style material product system (MPS) adopted and practiced in the central planning period as well as methodological deficiencies in the transition of both the economic and statistical systems and institutional flaws caused by the prevailing political system (Wu, 2000 and 2002; and Maddison and Wu, 2008). In 1992, most of the Soviet-style MPS measures were dropped in favor of the United Nations System of National

Accounts (SNA) principles in the construction of the production, expenditure and income accounts.[4]

Historical accounts have since been reconstructed by NBS and there have also been continuous adjustments to the GDP estimates especially following industrial and service censuses (Xu, 2009). However, the methods used in the reconstruction and adjustments have not been made fully transparent. The most recent two adjustments were made by incorporating results from the First and Second Economic Censuses for 2004 and 2008, respectively. Some post-census adjustments have been found problematic and unjustifiable by normal procedures and conventional wisdom.[5] Careful researchers can also find that most of the adjustments have not been adopted in the construction of the high frequency data.

A series of scholarly work have suggested that the official estimates tend to underestimate China's GDP level while overestimating its GDP growth. As various studies have shown, the underestimation of the level of GDP was caused by an undercoverage effect due to the nature of MPS and a price distortion effect attributed to government industrial policy that subsidized heavy industries while taxing agriculture and services under central planning. The overestimation of the GDP growth was due to methodological problems that underestimate price changes (Wu, 2011a) and institutional flaws in the wake of the market-oriented reform that have provided strong incentives to local officials to exaggerate output growth (Keidel, 1992; Rawski, 1993; World Bank, 1994; Woo, 1996; Maddison, 1998; Maddison and Wu, 2008; Wu, 2002 and 2011a).

These problems could partially be examined in Figure 1 by the differences in the GDP growth between the estimates by NBS using more macro indicators and justified aggregation approaches and the weighted regional estimates reported by regional

[4] The official GDP estimates for 1978 onwards are made from both the production and expenditure sides, but there have been serious inconsistencies between the two measures and NBS considered the former as more reliable (Xu and Ye, 2000, p.12). However, Keidel (2001) has provided his alternative estimate of the expenditure-side GDP that shows a rather different pattern of annual growth compared with the production-side GDP.

[5] Wu (2007) has found that the post-census adjustment was made directly to the real output, which implicitly adjusted prices groundlessly (census by nature is unable to observe price changes). After replicating the adjustment procedures using the standard interpolation approach, he shows that the reported NBS estimates are arbitrarily modified and especially deliberately left 1998 unadjusted—the year for which researchers argued that China was heavily hit by the Asian financial crisis whereas the official GDP estimates suggested that China basically remained intact.

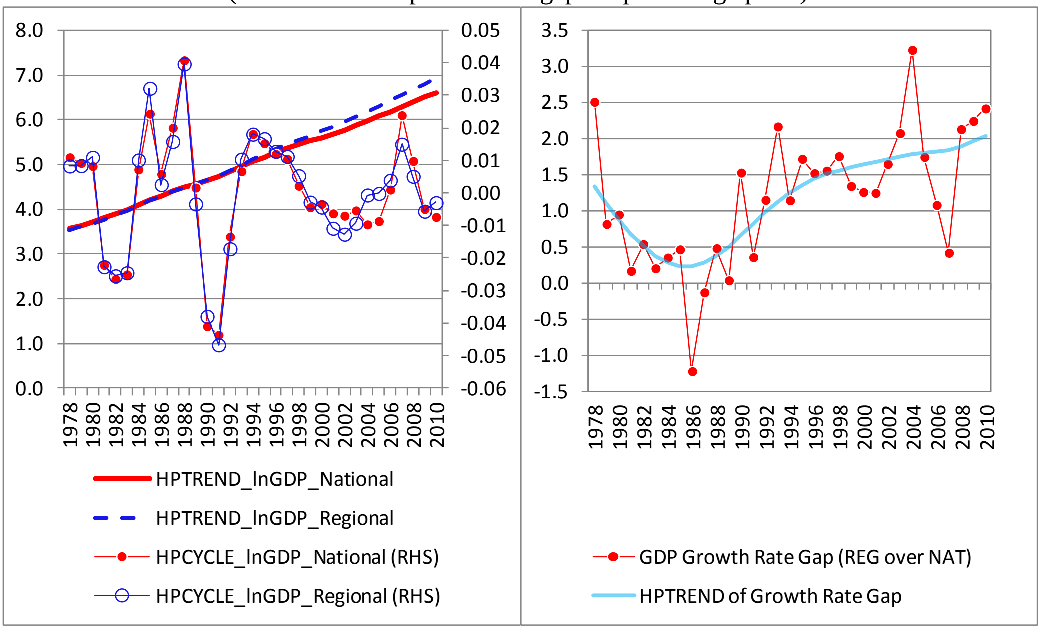
statistical offices that are heavily influenced by local governments. The GDP trends and cycles in the left-hand panel are estimated by the Hodrick-Prescott filter. They show that not only the degree and pattern of GDP volatility differ between the national and regional estimates, but also their growth trends deviated since the early 1990s. The absolute gap in the annual growth rate between regional and national estimates as shown in the right-hand panel (measured as national rate subtracted by regional rate) are huge and have remained increasingly positive (i.e. regional estimates are greater than national estimates) since the early 1990s.

This however by no means suggests that the national GDP estimates have no problem. Rather, it shows that regional political incentives have complicated the problems and blurred the business or growth cycles due to the "political cycles" caused by office terms and five-year plans that induce local governments to show their "good performance" and to compete for resources.

FIGURE 1

TRENDS AND CYCLICAL MOVEMENTS OF NATIONAL GDP ESTIMATES AND WEIGHTED REGIONAL GDP ESTIMATES, AND THEIR GAPS IN GROWTH RATE, 1978-2010

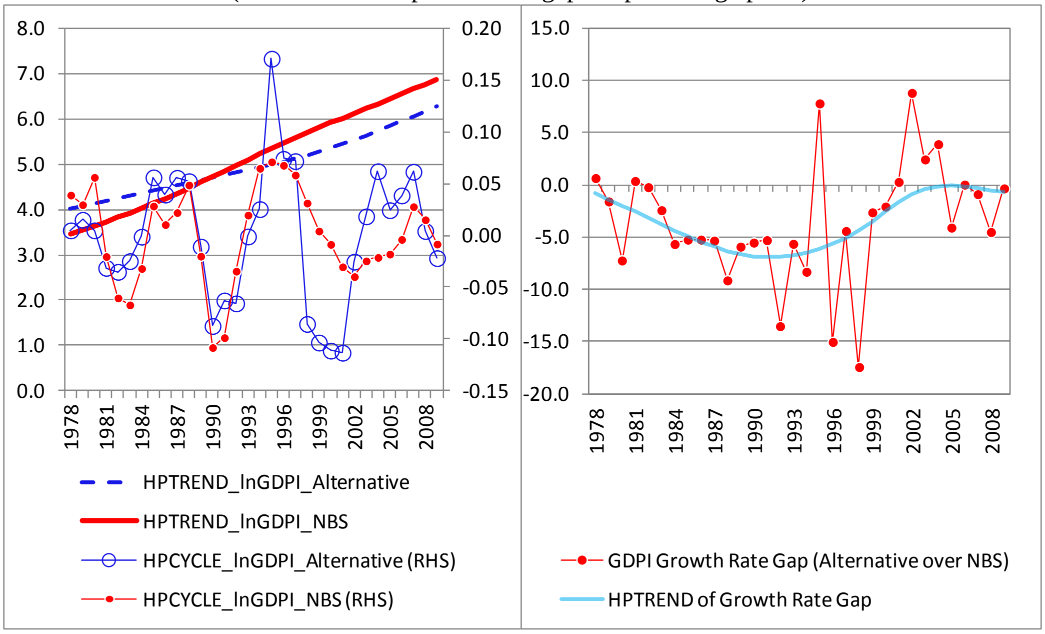
(Growth rates in percent and gaps in percentage point)



Source: Authors' estimates based on data from *China Statistical Yearbook 2011* (NBS, 2011, Tables 2-1, 2-4 and 2-14, with historical data on earlier volumes).

Measuring price levels accurately has remained as one of the major problems in real GRDP estimates. It is because of not only price distortions under central planning but also problems in current price surveys and deflation procedures in official estimates. Studies using alternative price indices have indeed shown different growth estimates from those of NBS (Jefferson et al., 1996; Ren, 1997; Woo, 1998; Wu, 2002). Because of this problem using volume movements to gauge real growth has been well justified. This approach can bypass the problematic price measures and to some extent reduce the upward biases due to institutional problems. There have been a number of important studies attempting to make alternative estimates using different volume indicators, such as physical output (commodity) index (Wu, 2002 and 2011a) and energy consumption approximation (Adams and Chen, 1996; Rawski, 2001). Despite different results in these studies, all appear to support the upward bias hypothesis about the Chinese official data in growth estimates.

FIGURE 2
OFFICIAL AND COMMODITY-BASED ALTERNATIVE INDUSTRIAL VALUE-ADDED ESTIMATES FOR CHINESE INDUSTRY, 1978-2009
(Growth rates in percent and gaps in percentage point)



Source: Based on Wu (2002 and 2011a). See Maddison and Wu (2008) and Wu (2011a) for methodological discussion and sources of data.

Figure 2 presents Wu's recently revised and updated commodity-based estimates for China's industrial value added (2011a). Compared with the NBS estimates, Wu's alternative estimates (in the left-hand panel) clearly suggest a slower trend of growth but a greater degree of volatility (note that the HP-filtered cycles of the official and alternative estimates cannot be directly compared because of different trends). In particular, as measured by the absolute gaps in the annual growth rates between Wu and official estimates (the right-hand panel), the commodity-based estimates suggest a much stronger impact of a crisis (negative gap) than the official estimates, especially, the economic downturns following the Asian financial crisis in 1997-98 and the global economic crisis in 2008.

Since annual data are more important in terms of demonstrating economic and political achievements and justifying budget proposals for local and national plans, they are more likely to be fabricated than high-frequency data that are often taken as temporal and partial. However, as the raw and basic data for the annual estimates, the high-frequency data cannot be problem free. One may argue that the differences between the two types of data could be useful in gauging the biases in the official statistics.

Employment

Employment data are conceptually indispensable in modeling macroeconomic performance. Persons employed can be used as a key indicator in constructing a coincident index (Table 1), whereas average hours worked per worker can be used as a key indicator in constructing a leading index. The available official employment statistics are far from sufficient to satisfy the basic requirement for constructing coincident and leading indices. In a nutshell, annual employment data suffer from serious structural breaks and inconsistencies. High-frequency employment data are narrow in coverage, short history of data series, and biased to the state sectors and government-monitored activities. It is well known that China's overlong socialist ideology hurdle has made official statistical authorities shy away from accurately accounting for unemployment and private activities. This means that official employment indicator cannot timely and sufficiently capture more market-sensitive employment changes of the non-state sectors, especially private activities.

As discussed in Wu (2001) and in Wu and Yue (2010), official data on annual employment statistics contain serious conceptual problems at the sector level such as including auxiliary service personnel in manufacturing employment, maintaining the unemployed on payrolls in state owned enterprises (until 1998), and excluding the employment in small enterprises and self-employment. Official annual employment data also suffer from significant structural breaks. Especially, available sector level employment statistics do not add up to the national total that is based on population censuses (Yue, 2005; Maddison and Wu, 2008). More specifically, following the 1990 population census, the official estimates show an astonishing 17% or 94.2

million jump in the number of total employment in 1990 albeit in the middle of a significant growth slowdown began in the second half of 1989. This created a huge gap between the census and regular population survey-based employment estimates and annual employment statistics reported by the labor authorities. This gap has from then onwards remained more or less the same in official statistics.

These annual employment data problems reflect deficiencies in high frequency employment statistics. Firstly, there are no data on hours worked in Chinese official statistics. Available data on persons employed on a monthly basis are industrial employment of enterprises at a designated size and above.[6] Conceptually, this employment indicator comes close to fulfilling, for the most part, our selection criteria: it makes economic sense as a coincident indicator, is produced monthly by a reliable (official) source, is relatively smooth, and presents no visible seasonal adjustment or other measurement problems. However, it is important to bear in mind some major deficiencies in the indicator.

As noted in Guo, et al. (2009), this measure is narrower than employment series used in the coincident indexes for other countries and it does not cover services or agricultural employment at all. Neither does it 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 rapidly 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, since this employment indicator refers to the most stable part of the industrial employment that includes all state enterprises and non-state firms at or above the designated size (a measure for large enterprises in the formal sector), it may not be able to sufficiently capture the most sensitive part of the labor market changes because state enterprises are most labor-market inflexible and therefore their employment are resilient to slowdowns and recessions.[7] Public employment can also on some occasions serve counter-cyclical

[6] See Guo et al. (2009) in detail.

[7] For example, a careful reading of the available industrial employment data and crosschecked them with another employment indicator for urban employment and employment data from the 2004 economic census, suggests this employment indicator may be overstating the trend growth of manufacturing employment from 2004 to 2007 (Guo, *et al*., 2009).

economic policies and this motive could potentially obscure cyclical events in indicators that are skewed towards the public sector.

Investment

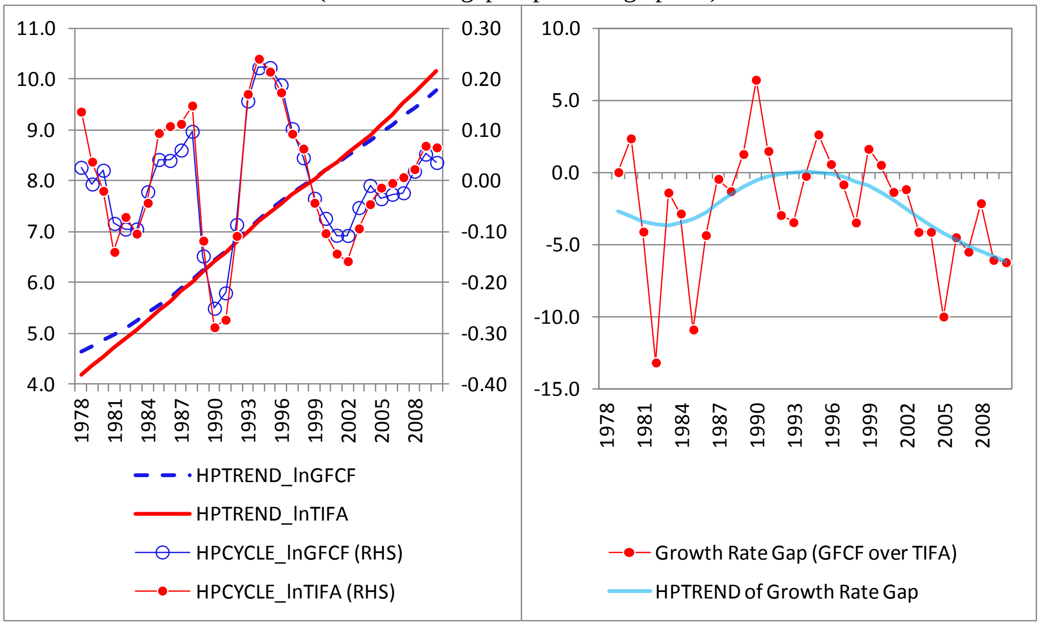
The Chinese official investment statistics are constructed using data collected through authorities that plan and monitor fixed capital investment. The primary indicator is *total investment in fixed assets* (TIFA),[8] available in both monthly and annual data. It is the basis for, but not equal to, the *gross fixed capital formation* (GFCF) in the Chinese national accounts.

Both TIFA and GFCF have suffered from the same conceptual problem that miscount inventory as investment though the degree of the miscounting may have been declining along with the market-oriented reform (Wu, 2011b). By the official definition, both indicators refer to the *workload* of investment activity in money terms including construction and purchase of fixed assets regardless if investment projects are completed and actually transferred to investors or users (NBS, 2001, p.220). As commented by Xu (1999, pp. 62-63), this is different from the GFCF concept in the SNA that capital formation only takes place when a contract-based ownership transaction of capital goods from a producer or constructor to a user (investor) is completed (CEC et al., 1993[9]). In other words, the Chinese GFCF does not exactly follow the SNA ownership criterion of fixed capital formation. Therefore, it tends to exaggerate investment while underestimating inventory. Since GFCF and inventory are likely to have very different cyclical movements, this problem has significant implications in dating the current economic situation and in predicting future turning points.

[8] This term has also been cited as FAI (fixed asset investment).

[9] The general SNA principles governing the time of recording and valuation of gross fixed capital formation is "when the ownership of the fixed assets is transferred to the institutional unit that intends to use them in production" (CEC, 1993, p.223).

FIGURE 3
TRENDS AND CYCLICAL MOVEMENTS OF TIFA AND GFCF AND GAPS IN THEIR ANNUAL GROWTH RATES
(Growth rate gap in percentage point)



Source: Authors' estimates based on data from *China Statistical Yearbook 2011* (NBS, 2010, Tables 2-18 and 5-2, with historical data on earlier volumes).

There are, however, two key differences between TIFA and GFCF. First, TIFA includes land transaction costs[10] but GFCF does not. Second, TIFA does not include intangible assets but GFCF does. In China, land belongs to the state or semi-state organizations in the case of farm land. The central government and local governments control the primary release of "land use rights". There have been criticisms on the increasingly reliance of local governments on land-revenue generated by selling "land use rights" and the so-called "government-state banks-developers conspiracy" that deliberately drove up the prices of "land use rights", hence creating property bubbles in the past decade. The inclusion of land transaction costs in TIFA not only creates double counting but also introduces non-market factors and hence affecting accurate dating of true business or growth cycles.[11]

[10] In the Chinese official statistics the term "land transaction costs" refers to the price paid for the "land use right" not the costs of services (e.g. legal and accountancy) involved in land transaction. In essence, it should be considered the price of land in the absence of a land market based on private ownership in majority.

[11] The measurement problems become worse when land transaction costs of an investment project are reported based on "market prices" or "market evaluation at the time of expected completion" rather than (low) preferential or administrative "prices" at the time of the government authority's primary release (Wu, 2011b).

Figure 3 shows different trends and deviations from trend of GFCF and TIFA in the left-hand panel and their gaps in annual growth rate in the right-hand panel. Clearly, TIFA has grown at an increasingly faster rate than GFCF since the late 1990s (shown in increasingly negative value). The problem is that the estimation of GFCF is based on TIFA with adjustments that are not transparent in details, and the same adjustments have not been applied to TIFA.

Income and Consumption

Official statistics on household income and consumption are also biased. The main problem is that the traditional diary-keeping approach in household income and consumption surveys is difficult to be continuously practiced in a rapidly marketizing economy with institutional deficiencies that provide leeway for growing grey income. On the one hand, local statistical authorities' limited resources for the surveys cannot provide enough incentives for selected households to regularly and accurately maintain their dairies for daily expenses. On the other hand, high income households, households that have "gray income", and households with members as government officials tend to decline the assignment. To get enough samples, local statistical offices have to include more households with regular wage earning or retirement pension. Consequently, the selected samples are increasingly biased towards low income households (Wu, 2007a).

The above review of the problems of selected indicators suggests that for the purpose of identifying and dating business and growth cycles in China, it is not possible to solely or mainly rely on official GDP estimates and their components. This well justifies the need of a measure of business or growth cycle chronology that is multivariate and determined to a large extent separately from national income account measures.

4. The TCB Selection of Indicators and Compared with Other Studies

This section begins with the basic CEI and LEI approach as adopted by TCB and its application for China. It then compares the components of coincident and leading indicators in existing studies with those of TCB taking into account the main data problems reviewed, and discusses the implications for the indicators constructed by individual agencies.

Given the context characterizing the data problems and measurement biases and errors discussed in the previous section, here we review the existing composite indexes that measure and track the chronology and dynamics of the cycles in the China's economy. This section begins with the CEI and LEI as adopted by TCB created using the methodology presented in section 2 above. It then compares the components of coincident and leading indicators in existing studies with those of TCB taking into account the main data problems reviewed, and discusses the implications for the indicators constructed by individual agencies.

Following the TCB approach to the selection of economic indicators for the construction of a coincident economic index five indicators were selected for China as discussed in Adams et. al. (2010): 1) industrial value added, 2) manufacturing employment, 3) electricity production, 4) passenger traffic, and 5) retail sales (see Guo et. al., 2009 and Adams et. al. 2010). They argue that these are adequate indicators of current economic and business cycle conditions and thus they coincide with the business cycle turning points that are determined by combining the individual coincident indicators into an index. In what follows, we ask whether TCB's selection of the components of the TCB China CEI are justified by examining their roles and by comparing them with the indicators used in the CEIs constructed by other agencies as summarized in Table 1.

Conceptually, as already discussed, an output measure such as GDP should not be ignored but due to the problems in the Chinese statistics it is inappropriate to solely rely on GDP or its components directly from the national accounts. The quarterly frequency of GDP statistics also makes this important economic variable less suitable for cyclical analysis. As TCB, all the agencies have selected industrial value added (or industrial GDP) as one of their coincident indicators except OECD which used industrial value added as its only reference or coincident indicator. The differences in the measured trends, cycles and turning points between these studies depend on how the industrial value added indicator or the combination of the industrial value added indicator with other coincident indicators capture the underlying real economic movements. This will inevitably cause controversies in the absence of a widely accepted dating committee.

The next most commonly used coincident indicators are electricity production, fixed assets investment and retail sales of consumer goods, all have been used in three studies. TCB has selected electricity production and retail sales for its coincident index. In section 3, we have already discussed the reasons for not using the fixed assets investment as a business cycle indicator. Besides, FAI is difficult to deflate. Electricity production is a more appropriate variable to be included in CEI because electricity cannot be stored and moves with production, consumption and investment. It is also a less biased variable and sensitive to market changes. The indicator of retail sales also captures activities of consumption demand and hence serves as an additional indicator of economic activity.

We feel it is justified to include industrial employment in a coincident index for China despite its problems. Among other agencies, CEMAC is the only agency that also uses this indicator. Although focusing on state and larger sized enterprises located in cities has made the indicator less sensitive to changes in the labor market, we are convinced that it is still better than nothing at all from the labor market.[12] There is simply no proper substitute for it. However, the indicator of passenger traffic may have to some extent compensated for the missing information of the labor market indicator because it captures the movements of migrant workers in China. None of other agencies has used this indicator, which means that the coincident indices constructed by CAS, SIC and OECD are not able to capture any labor market information.

In order to apply its composite index calculation methodology, The Conference Board has found it necessary to transform the indicators published by official agencies in several ways. Business cycles are short term phenomena that occur over months so their measurement and analysis requires tracking of month to month movements using monthly data. The officially published year-over-year growth rates or year-over-year growth rates of year-to-date cumulative values have to be disaggregated and transformed to monthly growth rates otherwise the cyclical movements they present would be too smooth to be of use in business cycle analysis. Moreover, the year over year transformation of the data can lead to phase shifts in the cycle that could distort the accurate location of turning points. The transformation required is complicated by the difficulty of linking last year's December values with the next year's January values (often January and February values are published as a sum).

[12] The size criterion (5 million yuan annual sales) has a potential to create coverage inconsistency in a rapid growth and inflationary economy, which is a problem that deserves a further investigation.

The study of business cycles also requires data that are adjusted to remove seasonal and price (inflation) movements. In the case of China, the irregular calendar effects created by Chinese New Year holidays require special attention in the seasonal adjustment process. The lack of proper price indexes also poses a challenge. After obtaining seasonally adjusted deflated monthly growth figures for the indicators from published data, The Conference Board calculates cumulated levels data with a fixed base year for each indicator to make them comparable to each other and to the business cycle chronology. The growth cycle chronology further requires the estimation of a trend and the calculation of deviations from this trend (which wouldn't be possible without the fixed level index for the indicators).

TABLE 1
COMPONENTS OF COMPOSITE COINCIDENT ECONOMIC INDICATORS FOR CHINA: TCB IN COMPARISON WITH OTHER STUDIES

	TCB	OECD	CEMAC	CAS	SIC
Electricity production	√			√	√
Government revenue			√		√
Household disposable income			√		
Industrial employment	√		√		
Industrial value added	√	√	√	√	√
Investment in fixed assets			√	√	√
Money supply (M1)				√	
Passenger traffic	√				
Profits of industrial enterprises			√		
Retail sales of consumer goods	√		√		√
Sales of industrial enterprises				√	
Total trade (exports and imports)			√		

Sources: See background discussion in Section 1 on these agencies and their indices. Indicators selected by TCB are in bold.

CEMAC and CAS have used enterprise report-based indicators, sales and profits, respectively. They are not appropriate because the actual payment for a sale may be lagged or in advance subject to the changes of market situation including market expectations and the reported profits may be manipulated for various reasons. CAS has also used M1 (cash in circulation) that is influenced not only by market situation but also by government policy responding to economic developments and the development of new credit instruments which should not be considered as changes in macroeconomic performance.

Furthermore, both SIC and CEMAC have included government revenue and CEMAC has included household income in their coincident indicators. Both of these measures are inappropriate because of serious measurement problems. Because of institutional deficiencies and different incentives between the central and local governments, government revenues and expenditures have never been properly measured in the official statistics. In addition to the land-revenue as mentioned which to some extent functions as a land use tax, there are hidden local revenues and expenditures that are not captured by the statistics, which should be considered as fiscal resource leakage. The fiscal decentralization initiated at the beginning of the economic reform provided local governments with strong incentives to minimize the revenues that are supposed to be surrendered to or shared with the central government. Extra-budgetary arrangements that were designed to motivate local governments by allowing them to keep extra income and have control over the usage of their revenues provided strong incentives for local authorities to shift more resources away from the formal budgetary arrangements. The fiscal re-centralization attempt by the central government in 1994 did not stop this trend; rather it led to a further leakage of fiscal resources to "outside-budget coffers" that are completely out of the central government's monitoring and control. Some studies show that there has been a rapid growth of locally controlled extra-budgetary and outside-budgetary funds, estimated almost equivalent to about half of the available fiscal resources (Jia and Bai, 1998; Ma and Ho, 2004). This inevitably results in an incorrect measure of the government behavior.

Finally, Total Trade (trade transactions used by CEMAC) are closely related to manufacturing and export activity and they can reflect the changes of market expectations and economic conditions in trading partners that may signal future changes rather than closely record the current movements of the market.

Now we turn to indicators that help anticipate business cycle movements. Adams et. al. (2010) has identified 21 potential leading indicators that could serve as LEI components. They compare and assess these indicators against the business and growth cycle chronologies they derive from the coincident index described above and select 6 indicators to construct the LEI for China including: 1) total loans, 2) exports (before 2005) and manufacturing PMI exports orders (after 2005), 3) manufacturing PMI supplier deliveries sub-index, 4) PBoC 5,000 raw materials supply sub-index, 5) NBS consumer expectations index, and 6) total floor space started. Given China's long term growth trajectory throughout the 1990s and 2000s and the scarcity of business cycle turning points, they complement their analysis of leading indicators with growth cycle analysis. Growth cycle analysis can help in particular to evaluate indicators that don't have reliable long histories that cover business cycle turning points.

While there are some similarities in the compositions of various leading composite indexes developed by various agencies, there are also major differences. The selections of Adams et. al. (2010) concentrate more on market and economic sentiment of agents (household and businesses) via surveys by NBS and the central bank. In contrast, both OECD and CAS focus more on quantitative data on commodities, such as steel, oil, fertilizers, cement and motor vehicles. While OECD and the Chinese agencies have selected monetary aggregates such as M1, M2 and deposits, TCB has selected total loans which could provide a more direct link to credit expansion and contraction in the economy.

TABLE 2
COMPONENTS OF COMPOSITE LEADING ECONOMIC INDICATORS FOR CHINA: TCB IN COMPARISON WITH OTHER STUDIES

	TCB	OECD	CEMAC	CAS	SIC
Money supply (M1)		√			√
Money supply (M2)			√		
Ratio of monetary fund occupation					√
Enterprise deposits		√			
Short and long term treasury bill interest spread			√		
Total loans	√				
Foreign direct investment (realized)				√	
Newly started investment projects			√		
Total floor space started	√		√		√
Area of land developed for real estate			√		
Ratio of sales to gross output			√		
Inventory (finished products)				√	
Steel production				√	√
Cement production		√			
Crude oil production				√	
Chemical fertilizer production		√		√	
Motor vehicle production		√			
PMI export orders	√				
Freight traffic			√		
Freight handled by coastal ports			√	√	√
Hang Seng Index (H shares)			√		
PMI supplier deliveries sub-index	√				
PBoC 5000 raw materials supply sub-index	√				
NBS consumer expectations index	√		√		

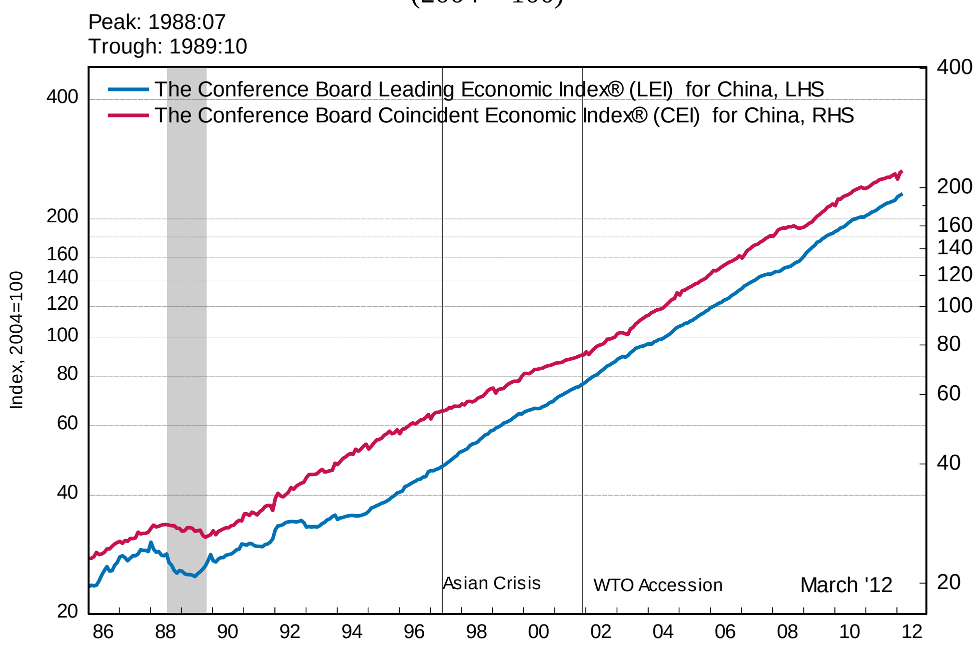
Source and Note: Indicators selected by TCB are in bold. See Section 1 for the sources of information of other agencies.

5 ASSESSING TCB CEI-IDENTIFIED TRENDS, CYCLES AND TURNING POINTS FOR THE CHINESE ECONOMY

Trends, cycles and turning points

A study of business cycles does not require trend estimation and elimination, but a study of growth cycles does (Zarnowitz and Ozyildirim, 2006). Major cyclical slowdowns and speedups deserve to be analyzed, but the needed time series decomposition presents difficult problems, mainly because trends and cycles influence each other. Chart 1 shows the composite indexes CEI and LEI. The shaded area represents the recession identified using the CEI and the Bry-Boschan procedure to detect turning points.

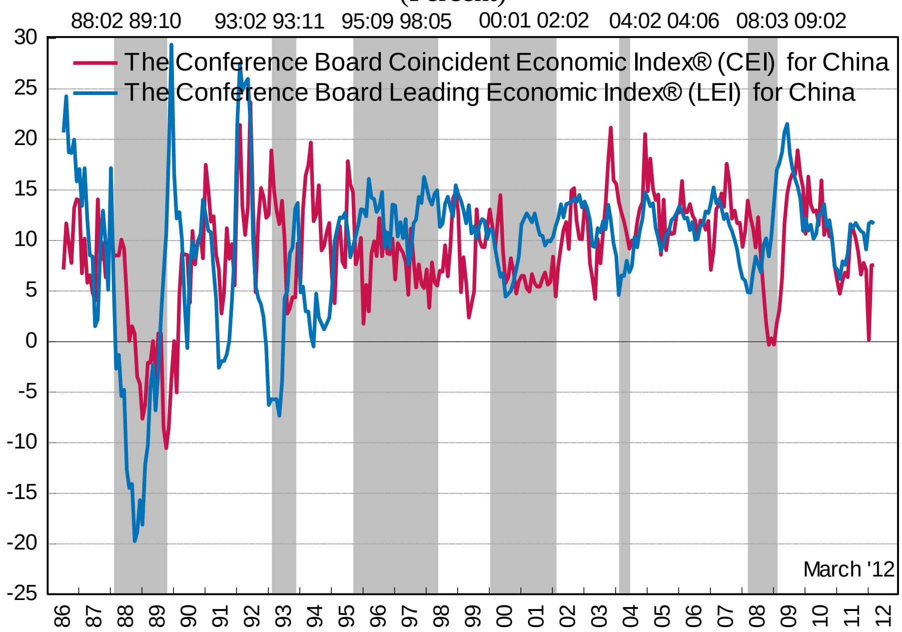
FIGURE 4
THE CONFERENCE BOARD CHINA CEI AND LEI: 1986 – 2012
(2004 = 100)



Source: The Conference Board (web address…)

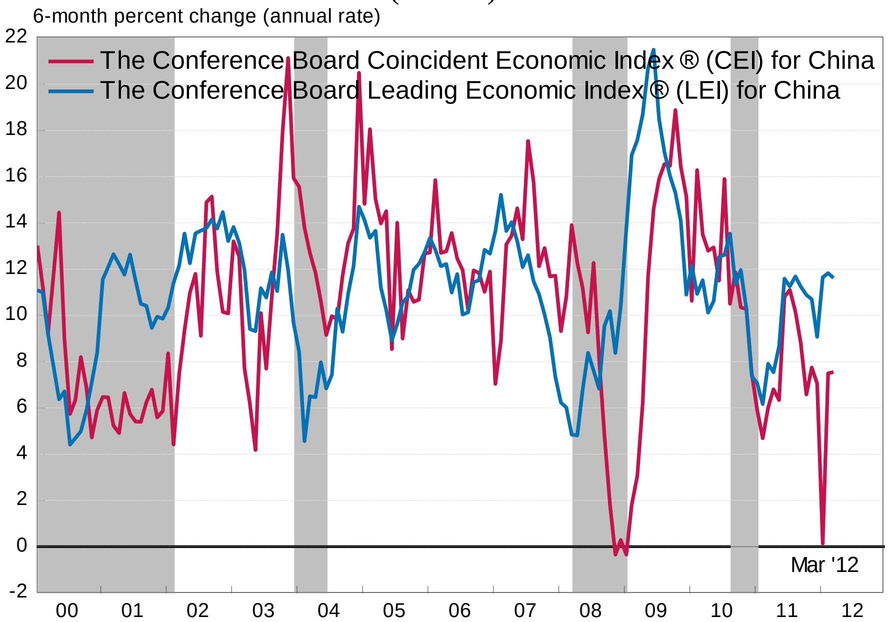
Both indexes show small irregular movements but they are dominated by long term growth trends. Nevertheless, the growth trend also shows periods of speeding and slowing down. The backdrop lines marks the Asian Financial Crisis and WTO Accession events which appear to have influenced the indexes' trends and cyclical movements. In Figures 5 and 6 we show the six month growth rates in percentages of the two indexes with the former chart showing the entire period covered by the TCB China indices and the latter zooming in the recent years from M01/2000. The shaded areas in both charts represent the growth cycle slowdowns determined using the CEI (deviations from trend) and the Bry-Boschan algorithm. It is noticeable that while the growth rates are fairly volatile, they generally appear to get lower during these slowdown periods.

FIGURE 5
SIX-MONTH GROWTH RATES OF THE CEI AND LEI: 1986 – 2012
(Percent)



Source: The Conference Board.

FIGURE 6
SIX-MONTH GROWTH RATES OF THE CEI AND LEI: 2000– 2012
(Percent)



Source: The Conference Board.

In Table 3 based on the TCB China CEI we summarize the turning point dates of the business and growth cycle chronologies for China since 1986. It shows that the only business cycle recession identified by The Conference Board for the Chinese economy since 1986, according to this chronology based on the turning points of the CEI, started in July 1988 and ended in October 1989. Economic activity in China, as measured by the CEI, has been on a long, and relatively stable, growth trend since that business cycle trough. However, as Table 3 also shows economic activity has also exhibited 7 growth cycles, that is economic activity has regularly fluctuated above and below it long term trend.

TABLE 3
CHRONOLOGY OF BUSINESS AND GROWTH CYCLES FOR CHINA, 1986-2011

Growth cycles Peaks (P) and Troughs (T)			*Duration in months of growth cycles and phases*			*Business cycles Peaks (P) and Troughs (T)*			*Duration in months of business cycles and phases*		
P	*T*	*P*	*P* to *T*	*T* to *P*	*P* to *P*	*P*	*T*	*P*	*P* to *T*	*T* to *P*	*P* to *P*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Feb-88	Oct-89	Feb-93	20	40	60	Jul-88	Oct-89		15		
Feb-93	Nov-93	Sep-95	9	22	31						
Sep-95	May-98	Jan-00	32	20	52						
Jan-00	Feb-02	Dec-03	25	22	47						
Dec-03	Jun-04	Mar-08	6	45	51						
Mar-08	Jan-09	Aug-10	10	19	29						
Aug-10	Feb-11		6								
Mean			15.4	28.0	45.0				15.0		
Median			10.0	22.0	49.0				15.0		
s.d.			10.3	11.4	12.4						

Source: The Conference Board.

According to Table 3, the first growth cycle downturn identified in the sample began in February 1988, preceding the July 1988 peak of the business cycle expansion or the beginning of the recession. Growth cycle downturns generally begin earlier than business cycle recessions as the economy gradually begins to slow. Sometimes these slowdowns develop into recessions, but many other times, as in China's case, the economy does not contract although it slows down and moves below trend. The growth cycle down turn ended in October 1989 same month as the business cycle trough and the economy began to expand rapidly again until February 1993 when another growth cycle slowdown began although this time it didn't turn into a recession. This type of asymmetry in the relationship between business and growth cycle timing of peaks and troughs is also observed in other countries' business and growth cycle chronologies although there is no consensus on the explanations.

The next growth cycle slow down in Table 3 begins in Sep-95 and ends in May-98, corresponding somewhat with the Asian financial crisis. These dates and the behavior of the CEI around its trend are also consistent with findings of other studies. Similarly the dates of the remaining growth cycle slowdowns and recoveries seems to be consistent with the general conditions for the US and global economy since 2000 which is not too surprising as the Chinese economy, and especially, its industrial sector became much more integrated into the global economy, and at the same time susceptible to global fluctuations.

6. A Further Appraisal by Alternative CEIs and LEIs

Inspired by Wu's (2002) earlier work that uses commodity data to gauge and assess annual industrial output (the alternative industrial value added estimates in Figure 2), and with recently available relatively rich high-frequency commodity data that could just match the period covered by the TCB China CEI and LEI, in this study we develop a new set of commodity-based alternative indicators that we argue can help test the robustness of the current TCB China composite indices and may even improve them.

In what follows, we first describe the nature of the available commodity data and explain how they are processed for our purposes and the procedures for constructing new commodity-based indicators. We then report regression results for testing the sensitivity of the current TCB China composite indices in predicting quarterly GDP and the usefulness of the commodity-based alternative indicators.

Construction of commodity-based indicators

The Chinese statistical authority has made high-frequency commodity data publically available through CEIC China Premium Database.[13] Since the first release a few years ago, the number of commodities reported in the database has been increased and the time series of the commodities has also been prolonged. The number of commodities

[13] http://www.ceicdata.com/

is now over 500 compared with less 40 several years ago. Unfortunately, despite the substantial increase in the number of commodities those that are sufficiently matching the time series of the current TCB China composite indices, starting in 1986, are still rather limited. After a first round of carefully sorting the available commodity data in terms of definition, coverage and consistency, we got 87 commodities. However, data for 17 of these commodities were discontinued during this study. Considering the continuity in this exercise in future, we then decided to work on the rest of 70 commodities. In the second stage of the data work that engages pricing, weighting and aggregating the 70 commodities, the number was further reduced to 56.

Almost all of the commodity data began their series in M01/1986 or within 1986 except for a very few commodities such like "garments" beginning in M01/1989 and "washed coal" beginning in M04/1993. We decide to keep them because their importance in the economy. The gaps in these commodities are filled with changes in relevant commodities before the pricing and weighting. For example, the gaps in "garments" are filled by changes in "fabrics" and the gaps in "washed coal" are filled by changes in "coke".[14]

There are no publically available prices at commodity level. The commodity prices used in this study are based on the commodity prices used in Wu (2002) which were available in a joint research project between NBS and Institute of Economic Research at Hitotsubashi University. The most recent price data in Wu's data set are for 1997 and there is impossible to update them to the fixed base year of 2004 at the same level of details. In this exercise, we update the 1997 commodity prices to 2005 by the official industry-specific producer price indices (PPIs) that are published annually. It is impossible to adjust the prices to the 2004 benchmark because 2005 is the first year that NBS began to publish PPIs for 39 two-digit level industries instead of the traditional 14 industry groups. Since the base year for the composite indexes is essentially a scaling factor to make time series comparisons easier near the end of the

[14] There are 13 commodities that do not have values for M01-03/86. They are filled by the same value as M04/86, assuming no growth in the first 3 months of those series. There are also missing values for some commodities in later periods. Specifically, missing values in "iron ore" for M01/97-M12/98 are filled by "iron"; missing values in "dyestuffs" in M01-11/2011 are filled by "fabrics"; missing values in "artificial fibres" in M01-10/2011 are filled by "yarns"; missing values in "silk" in M01-10/2011 are filled by "garments"; missing values in "canned food" in M01/1986-M12/2003 are filled by "dairy products".

sample (otherwise, the index would be 100 in January 1986 and grow significantly), this should not introduce a significant bias.

Using prices as weights, we take a several stages of grouping to construct the 56 qualified commodities as useful indicators that serve our purpose. The first level of our grouping categorizes the commodities into "consumer goods" and "producer goods". Then, the "producer goods" group is further divided into two sub-groups, that is, "primary (or input) materials" and "manufactured goods". Lastly, the "primary materials" is further divided into "energy-based primary materials" and "non-energy-based primary materials".

Construction of alternative CEIs and LEIs

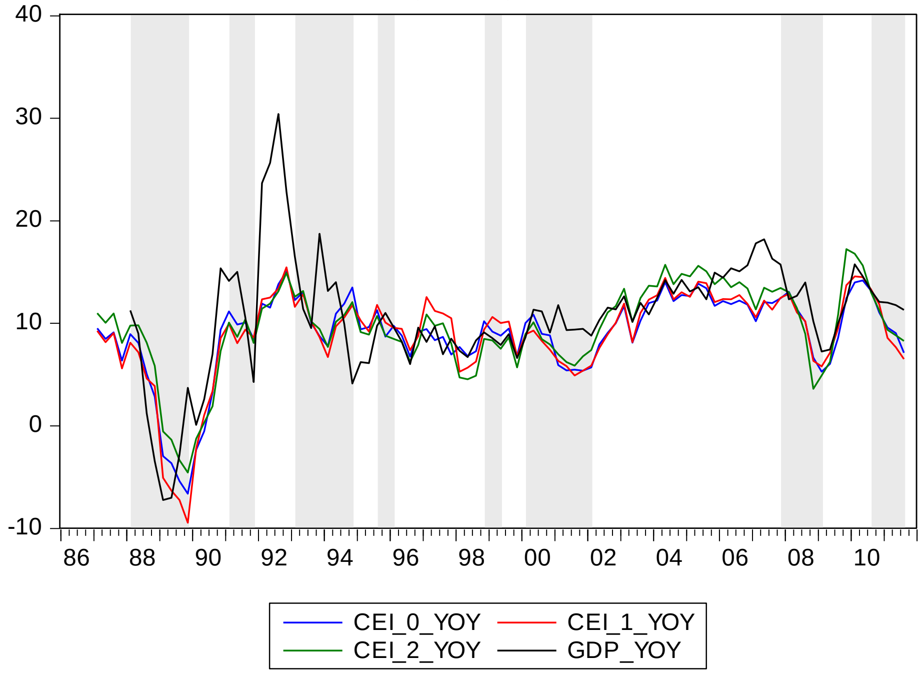
Based on these commodity-based new indicators, we have constructed two alternative CEIs and two alternative LEIs to the existing TCB China CEI and LEI using the same index calculation methodology, but with additional components. Let us refer the existing indices as CEI_0 and LEI_0. The alternative CEI_1 substitutes "energy-based primary materials" for the "electricity production" indicator[15] in CEI_0 and CEI_2 substitutes "all commodities" for "industrial value added" in CEI_0. On the other hand, the alternative LEI_1 replaces "raw materials" in LEI_0 by commodity-based "producer goods" and LEI_2 replaces "consumer expectation index" in LEI_0 by commodity-based "consumer goods".

Before using these alternative indices in regression exercises to test for the robustness of the existing indices and the usefulness of the commodity-based indicators, we examine the annual growth rate of all alternative CEIs with that of the official GDP in Figure 7. In order to compare the official quarterly GDP index in year-over-year (yoy) growth rate, we first convert all the monthly CEIs to quarterly CEIs, and then derive their yoy growth rates from the index value of the same quarter between two adjacent years. These indices are presented against the background of China's business and growth cycles (shaded in grey) as identified by the existing TCB CEI_0.

[15] The "energy-based materials" indicator replaces "electricity production" not because it's a direct substitute, but we also don't want to over represent one type of indicator. It would be like double counting and putting too much emphasis on industrial and energy production.

Firstly, the yoy quarterly growth rate in the official GDP is greater than that of all CEIs. Over the period from Q1/1987 to Q3/2011, GDP grew by 2.57 per quarter, equivalent to 10.41 per annum. In the case of CEI_1, it is 2.19 percent per quarter, equivalent to 8.82 percent per annum, which is very close to that of CEI_0, i.e. 2.18 percent or 8.86 percent per annum. The yoy quarterly growth rate for CEI_2 is higher than all other CEIs, 2.29 percent or 9.27 percent per annum.

FIGURE 7
ANNUAL GROWTH RATE OF THE TCB ALTERNATIVE CEIS AND THE CHINESE GDP
(Percent)



Source: Authors' estimates.

Secondly, CEIs suggest a slower growth when GDP appeared to have reached the peak of a growth cycle and a greater decline or slowdown when there was a shock, which is in line with what we discussed earlier. All CEIs show a similar pattern of quarterly changes, but the alternative CEIs, especially CEI_2, show greater volatilities than that of CEI_0 because of the incorporation of commodity indicators. The alternative CEIs suggest that there were much greater shocks to the economy brought by the Tiananmen crackdown in Q2/1989, by the harsh austerity program in Q3/1993, and by the collapse of Lehman brothers in Q3/2008. They also suggest that the negative impact of the Asian financial crisis is much more severe than what appeared to be by the official GDP and the existing CEI_0. On the other hand, the effect of

Deng's southern China trip in Q1/1992 to promote reform appears to be greatly exaggerated.

Regressions

In the regression exercises we take the officially published real GDP figures as given and ask whether composite indexes of coincident and leading indicators help explain the variation in real GDP growth. These exercises don't directly address whether or not the target variable has measurement problems or not. The measurement problems of GDP complicate the appraisal of the indicators used as independent variables. However, in the preceding sections we argued that the CEI and LEI provide a high quality and reliable measures of macroeconomic fluctuations in the Chinese economy, despite the many caveats about measurement issues and biases. We argue that as long as the dependent variable is the same in different models, the comparison of the models should yield insights about which alternative variables are useful or not.

With the commodity indicators and alternative CEIs and LEIs based on these indicators, we propose the following regression models for the purpose of an empirical assessment of these indices.

First, we would like to conduct an OLS in-sample autoregressive model of the existing CEI and its alternatives using quarterly data. This aims to compare the in-sample autoregressive results for CEI_0 with its alternatives, CEI_1 and CEI_2, which use commodity data. This exercise also helps us assess the subsequent model discussed later in this section.

(1) $$\ln CEI_t = \sum_{i=6}^{j} \varphi_{1,i} \ln CEI_{t-i} + \varepsilon_{1,t}$$

where CEI in logarithm refers to the current and alternative CEIs and the maximum number of lags is 6 to account for the autoregressive dynamics of the CEI. The results for the current and alternative CEIs are reported in Table 4.

The results show the CEI_0 regression has a good fit for the data with an adjusted R^2 of 0.79 but only the first lag at t-1 has a significant coefficient. The models with the same specification, but using CEI_1 and CEI_2 alternatively, also show a similar fit but their adjusted R^2 are slightly lower and the coefficients on the first lag show a similar pattern of magnitude and significance. Information criteria, AIC and SIC, are also the lowest for the first model. This suggests the alternative CEI are all similar in explaining their own autoregressive dynamics.

TABLE 4
IN SAMPLE FITTING OF THE TCB CEI AND ITS ALTERNATIVES CEIS
(Equation 1 estimated by OLS regression)

	Model 1 (ln*CEI*_0)	Model 2 (ln*CEI*_1)	Model 3 (ln*CEI*_2)
ln*CEI*_0 (-1)	0.7546***		
	(6.9592)		
ln*CEI*_0 (-2)	0.0470		
	(0.3467)		
ln*CEI*_0 (-3)	-0.0012		
	(-0.0096)		
ln*CEI*_0 (-4)	0.1793		
	(1.3972)		
ln*CEI*_0 (-5)	-0.0028		
	(-0.0212)		
ln*CEI*_0 (-6)	-0.1201		
	(-1.1766)		
ln*CEI*_1 (-1)		0.6880***	
		(6.3485)	
ln*CEI*_1 (-2)		0.1063	
		(0.8045)	
ln*CEI*_1 (-3)		0.0046	
		(0.0353)	
ln*CEI*_1 (-4)		0.1142	
		(0.8739)	
ln*CEI*_1 (-5)		0.0181	
		(0.1383)	
ln*CEI*_1 (-6)		-0.0778	
		(-0.7373)	
ln*CEI*_2 (-1)			0.8110***
			(7.4878)
ln*CEI*_2 (-2)			0.0556
			(0.3916)
ln*CEI*_2 (-3)			-0.0932
			(-0.6773)
ln*CEI*_2 (-4)			0.1582
			(1.1734)
ln*CEI*_2 (-5)			0.0176
			(0.1304)
ln*CEI*_2 (-6)			-0.0799
			(-0.7454)
$\bar{R}^2$	0.79	0.77	0.76
AIC (Akaike info criterion)	-5.99	-5.74	-5.86
SC (Schwarz criterion)	-5.67	-5.42	-5.54
Durbin-Watson Stat	1.94	1.96	1.96
Log Likelihood	302.47	290.24	296.34

Sources: Authors' estimation. See text for the construction of the alternative CEIs and The Conference Board CEI. Observations: 1987:Q2 – 2011:Q3.
Note: All variables are first constructed in the form of indices (2004=100), and then measured as a deviation from a trend derived by the Hodrick-Prescott filter with λ=1600.

Next, we run a GDP projection model that aims to predict quarterly GDP using the existing and alternative quarterly CEIs and the existing LEI. We will leave a more extensive study of the alternative LEIs using commodities data to subsequent research.

(2) $$\ln GDP_t = \alpha_0 + \beta_1 \ln GDP_{t-1} + \sum_{i=4}^{j} \varphi_{1,i} \ln CEI_{t-i} + \gamma_1 \ln LEI_t + \varepsilon_{1,t}$$

where, quarterly GDP is predicted by itself with one period lag, quarterly CEI with 4 lags, plus the current quarter LEI, all in logarithms. In this exercise, CEI_0, CEI_1 and CEI_2 are alternatively used to examine the robustness of the existing CEI and the effect of alternative CEIs that incorporate commodity indicators. As in Equation 1, we deliberately have LEI for the current period only though it may also have some lagging effect.

TABLE 5
CHINA'S QUARTERLY GDP PREDICTED BY TCB CEI AND LEI AND THEIR ALTERNATIVES
(Equation 2 estimated by OLS regression)

	Model 1A	Model 1B	Model 1C
Constant	-0.0001	-0.0001	-0.0001
	(-0.0544)	(-0.0271)	(-0.0430)
ln*GDP* (-1)	0.5605***	0.5863***	0.6456***
	(6.0437)	(6.5618)	(7.6148)
ln*CEI*	0.6844***		
	(3.9603)		
ln*CEI* (-1)	-0.1342		
	(-0.5831)		
ln*CEI* (-2)	0.1477		
	(0.6563)		
ln*CEI* (-3)	-0.5507**		
	(-2.4341)		
ln*CEI* (-4)	0.2236		
	(1.3538)		
ln*CEI*_1		0.5963***	
		(3.8115)	
ln*CEI*_1 (-1)		-0.0879	
		(-0.4308)	
ln*CEI*_1 (-2)		0.0796	
		(0.3990)	
ln*CEI*_1 (-3)		-0.4780**	
		(-2.3699)	
ln*CEI*_1 (-4)		0.2313	
		(1.5231)	
ln*CEI*_2			0.6892***
			(4.1172)
ln*CEI*_2 (-1)			-0.2942
			(-1.3128)
ln*CEI*_2 (-2)			0.1668
			(0.7694)
ln*CEI*_2 (-3)			-0.6041***
			(-2.7464)
ln*CEI*_2 (-4)			0.2858
			(1.7576)
$\bar{R}^2$	0.67	0.67	0.68
AIC (Akaike info criterion)	-4.87	-4.86	-4.88
SC (Schwarz criterion)	-4.69	-4.67	-4.70
Durbin-Watson Stat	1.95	1.90	1.89
F-statistic	34.27	33.52	34.83

The results of Equation 2 are reported in Table 5. Models 1A, 1B, and 1C use the alternative CEIs to predict GDP and show that the model fit is very similar in the alternative models. In these models the CEI enters the model with significant coefficients on lags *t*-1 and *t*-3, in addition to the *t*-1 lag of GDP. Moreover, the magnitudes of the coefficients are roughly similar. However, among the Model 1 alternatives, 1C appears to be the best based on especially Schwarz Criterion, which suggests that the alternative CEI_2 better predicts the variation of quarterly GDP, *ceteris paribus*, and more importantly, since CEI_2 substitutes an "all commodity"-based industrial production indicator for the NBS "industrial value added" indicator in CEI_0, the results may at least suggest that a well-constructed commodity indicator can be a good candidate for a value indicator when the latter is missing or distrusted.

TABLE 5: CONTINUED

	Model 2A	Model 2B	Model 2C	Model 3A	Model 3B	Model 3C
Constant	-0.0006	-0.0004	-0.0004	-0.0005	-0.0004	-0.0003
	(-0.3092)	(-0.2237)	(-0.2151)	(-0.2603)	(-0.1822)	(-0.1669)
ln*GDP* (-1)	0.4769***	0.5259***	0.5095***	0.5259***	0.5734***	0.5553***
	(5.3819)	(5.9993)	(5.6491)	(6.1465)	(6.7216)	(6.3909)
ln*CEI*	0.4651***	0.4126**	0.4877***			
	(2.7410)	(2.3054)	(2.7542)			
ln*CEI* (-1)	-0.0299	-0.0630	-0.0643			
	(-0.1390)	(-0.2901)	(-0.2908)			
ln*CEI* (-2)	0.2384	0.2407	0.2114			
	(1.1353)	(1.1302)	(0.9781)			
ln*CEI* (-3)	-0.4741**	-0.5182**	-0.5030**			
	(-2.2483)	(-2.4354)	(-2.3194)			
ln*CEI* (-4)	0.3907**	0.3841**	0.3936**			
	(2.4576)	(2.3795)	(2.3534)			
ln*CEI*_1				0.4044***	0.3268*	0.4316***
				(2.5883)	(1.9024)	(2.6634)
ln*CEI*_1 (-1)				-0.0304	-0.0287	-0.0516
				(-0.1584)	(-0.1467)	(-0.2616)
ln*CEI*_1 (-2)				0.1459	0.1462	0.1109
				(0.7750)	(0.7638)	(0.5753)
ln*CEI*_1 (-3)				-0.3959**	-0.4373**	-0.4236**
				(-2.0748)	(-2.2686)	(-2.1667)
ln*CEI*_1 (-4)				0.3660**	0.3552**	0.3659**
				(2.4827)	(2.3677)	(2.3725)
ln*LEI*	0.3102***			0.2836***		
	(3.9597)			(3.6236)		
ln*LEI*_1		0.3518***			0.3251***	
		(3.6146)			(3.1689)	
ln*LEI*_2			0.2590***			0.2307***
			(3.0884)			(2.7921)
$\bar{R}^2$	0.72	0.71	0.70	0.71	0.70	0.69
AIC (Akaike info criterion)	-5.01	-4.99	-4.95	-4.97	-4.94	-4.92
SC (Schwarz criterion)	-4.80	-4.78	-4.74	-4.76	-4.73	-4.71
Durbin-Watson Stat	1.94	1.89	1.95	1.91	1.88	1.92
F-statistic	36.36	35.14	33.50	34.43	33.02	31.99

Each of the next three sets of models (2A, 2B, 2C; 3A, 3B, 3C; 4A, 4B, 4C) adds LEI, LEI_1, and LEI_2 at time *t*, in addition to one lag of GDP and lags of the alternative CEIs. The motivation for this is that since LEI data is available before GDP data is published even its current values should help predict current GDP in addition to the CEI data. Thus, the coefficient on the current quarter LEI should be positive and significant, as shown in the table for all the cases. Model 4A further confirms the finding in Model 1C that CEI_2 performs better than other CEIs. As for

LEIs, all indices appear to be equally significant but among which and judged by the magnitude of the coefficient, LEI_1 appears to be better than others. This suggests that the commodity-based "producer goods" indicator indeed performs better than the "raw materials" indicator used in LEI_0.

TABLE 5: CONTINUED

	Model 4A	Model 4B	Model 4C
Constant	-0.0007	-0.0004	-0.0004
	(-0.3499)	(-0.1885)	(-0.2268)
ln*GDP* (-1)	0.5378***	0.6327***	0.5816***
	(6.5671)	(7.8486)	(6.9861)
ln*CEI*_2	0.4942***	0.4005**	0.4964***
	(3.0803)	(2.2062)	(2.9100)
ln*CEI*_2 (-1)	-0.1430	-0.2146	-0.1800
	(-0.6846)	(-1.0019)	(-0.8313)
ln*CEI*_2 (-2)	0.2465	0.2465	0.2265
	(1.2326)	(1.1887)	(1.0919)
ln*CEI*_2 (-3)	-0.5028**	-0.5727***	-0.5453***
	(-2.4725)	(-2.7383)	(-2.5914)
ln*CEI*_2 (-4)	0.4471***	0.4446***	0.4460***
	(2.9018)	(2.7481)	(2.7381)
ln*LEI*	0.3337***		
	(4.2366)		
ln*LEI*_1		0.3340***	
		(3.2973)	
ln*LEI*_2			0.2686***
			(3.1937)
$\bar{R}^2$	0.73	0.71	0.71
AIC (Akaike info criterion)	-5.04	-4.98	-4.97
SC (Schwarz criterion)	-4.83	-4.77	-4.76
Durbin-Watson Stat	1.89	1.88	1.89
F-statistic	37.98	34.65	34.33

Sources and Notes: See Table 4.

Our last regression exercise is essentially the same as Equation 2, but it is designed to examine the effect of commodity indicators independently. It begins with a GDP prediction model using the existing CEI_0 (Equation 3a). We then replace the CEI_0 by all the commodity indicators (Equation 3b) with which we would like to see if these commodity indicators are sufficient to capture the variations as in CEI_0.

(3a) $$\ln GDP_t = \alpha_0 + \beta_1 \ln GDP_{t-1} + \sum_{i=4}^{j} \varphi_{1,i} \ln CEI_{t-i} + \varepsilon_{1,t}$$

(3b) $$\ln GDP_t = \alpha_0 + \beta_1 \ln GDP_{t-1} + \sum_{i=4}^{k} \eta_{1,i} \ln X_{t-i}^{m} + \varepsilon_{1,t}$$

where X stands for commodity indicator and superscript m stands for each commodity indicator (m = 1,…,4), namely, "consumer goods" and "manufactured goods", "energy-based primary materials" and "non-energy-based primary materials" within the "producer goods" category.

This baseline model is revised further into three equations (4a, 4b and 4c) to add commodity indicators to a model with CEI_0, a model with LEI_0 and a model with both CEI_0 and LEI_0. Note that the commodity indicators are changed according to the presence of CEI_0 or LEI_0 or both, to avoid "double counting" in the equation.

(4a) $$\ln GDP_t = \alpha_0 + \beta_1 \ln GDP_{t-1} + \sum_{i=4}^{j} \varphi_{1,i} \ln CEI_{t-i} + \sum_{i=4}^{k} \eta_{1,i} \ln X^{m}_{t-i} + \varepsilon_{1,t}$$

(4b) $$\ln GDP_t = \alpha_0 + \beta_1 \ln GDP_{t-1} + \gamma_1 \ln LEI_t + \sum_{i=4}^{j} \eta_{1,i} \ln X^{m}_{t-i} + \varepsilon_{1,t}$$

(4c) $$\ln GDP_t = \alpha_0 + \beta_1 \ln GDP_{t-1} + \sum_{i=4}^{j} \varphi_{1,i} \ln CEI_{t-i} + \gamma_1 \ln LEI_t + \sum_{i=4}^{k} \eta_{1,i} \ln X^{m}_{t-i} + \varepsilon_{1,t}$$

TABLE 6
CHINA'S QUARTERLY GDP PREDICTED BY TCB COMMODITY INDICATORS AND CEI AND LEI
(Estimated by OLS Regression)

	Model 1A (Equation 3a)	Model 1B (Equation 3b)	Model 2A (Equation 4a)	Model 2B (Equation 4b)	Model 2C (Equation 4c)
Constant	-0.0001	-0.0003	0.0000	-0.0005	-0.0006
	(-0.0544)	(-0.1559)	(0.0123)	(-0.2307)	(-0.3283)
ln*GDP*(-1)	0.5605***	0.7158***	0.6364***	0.6829***	0.4819***
	(6.0437)	(8.4063)	(6.4868)	(11.1982)	(5.1160)
ln*ALL*			0.1647		0.3849
			(0.9779)		(1.1642)
ln*ALL* (-1)			-0.3176*		-0.2900*
			(-1.5085)		(-1.4913)
ln*ALL* (-2)			0.2246		0.2016
			(1.0714)		(1.0654)
ln*ALL* (-3)			-0.5368***		-0.4362**
			(-2.5840)		(-2.3217)
ln*ALL* (-4)			0.3960**		0.4474***
			(2.1298)		(2.6704)
ln"*Consumer*"		-0.0145		-0.0153	-0.1445*
		(-0.2490)		(-0.3470)	(-1.8598)
ln"*Consumer*" (-1)		-0.0706			
		(-1.0815)			
ln"*Consumer*" (-2)		-0.0144			
		(-0.2207)			
ln"*Consumer*" (-3)		-0.0432			
		(-0.6780)			
ln"*Consumer*" (-4)		0.0096			
		(0.1684)			
ln"*Producer*"_Manufacturing		0.0763**			
		(2.0137)			
ln"*Producer*" _Manufacturing (-1)		-0.0319			
		(-0.7680)			
ln"*Producer*" _Manufacturing (-2)		0.0716*			
		(1.8946)			
ln"*Producer*" _Manufacturing (-3)		-0.1104***			
		(-2.7612)			
ln"*Producer*" _Manufacturing (-4)		0.0297			
		(0.8167)			
ln"Producer"_Primary_Total				0.2379***	0.1998
				(2.6429)	(0.6141)
ln"Producer"_Primary_Energy		0.0281	0.0365		-0.2136
		(0.2076)	(0.2217)		(-1.1605)
ln"*Producer*"_*Primary_Energy* (-1)		0.1875	0.1619		0.1151
		(1.3286)	(0.8655)		(0.6764)

ln"*Producer*"_*Primary*_*Energy* (-2)		0.0317	-0.0781		-0.0544
		(0.2217)	(-0.4200)		(-0.3234)
ln"*Producer*"_*Primary*_*Energy* (-3)		0.1051	0.3215*		0.2495
		(0.7736)	(1.7632)		(1.5146)
ln"*Producer*"_*Primary*_*Energy* (-4)		-0.0942	-0.2666		-0.2793*
		(-0.7221)	(-1.5594)		(-1.8088)
ln"*Producer*"_*Primary*_*Non-energy*		0.2596**			
		(2.1817)			
ln"*Producer*"_*Primary*_*Non-energy* (-1)		-0.1380			
		(-0.9744)			
ln"*Producer*"_*Primary*_*Non-energy* (-2)		-0.0113			
		(-0.0804)			
ln"*Producer*"_*Primary*_*Non-energy* (-3)		-0.1295			
		(-0.9035)			
ln"*Producer*"_*Primary*_*Non-energy* (-4)		0.2297*			
		(1.8296)			
ln*CEI*	0.6844***		0.4484**		0.2587
	(3.9603)		(2.2263)		(1.3693)
ln*CEI* (-1)	-0.1342		0.1179		0.2682
	(-0.5831)		(0.4629)		(1.1554)
ln*CEI* (-2)	0.1477		-0.0862		0.0243
	(0.6563)		(-0.3402)		(0.1065)
ln*CEI* (-3)	-0.5507**		-0.2706		-0.1773
	(-2.4341)		(-1.0722)		(-0.7764)
ln*CEI* (-4)	0.2236		0.0610		0.1128
	(1.3538)		(0.3222)		(0.6314)
ln*LEI*				0.2708***	0.2887***
				(4.4841)	(3.6272)
$\bar{R}^2$	0.67	0.67	0.68	0.68	0.74
AIC (Akaike info criterion)	-4.87	-4.74	-4.80	-4.91	-4.99
SC (Schwarz criterion)	-4.69	-4.16	-4.35	-4.78	-4.46
Durbin-Watson Stat	1.95	1.67	1.83	2.18	1.84
F-statistic	34.27	10.46	13.70	52.42	15.51

Sources: Authors' estimation. See the text for the construction of the commodity indicators. Observation: 1987:Q2 – 2011:Q3, 98 after adjustment.

Note: All variables are first constructed in the form of indices (2004=100), and then measured as a deviation from a trend derived by the Hodrick-Prescott filter with λ=1600.

The regression results of Equation 3a and 3b, and 4a, 4b and 4c are reported in Table 6. As the results show, both the cyclical movements of quarterly "producer goods" and "primary materials" indicators appear to be good explanatory variables in predicting quarterly GDP cyclical movements. Of the "primary materials" the "non-energy-based producer goods" indicator plays a more important role. However, the performance of "consumer goods" appears to be rather weak (which may to some extent suggest that investment rather than consumption is the main driver of the Chinese economy, though this discussion if beyond the scope of the present study).

7. Concluding Remarks

In this study we have appraised The Conference Board China CEI and LEI with a focus on the CEI. Our evaluation begins with a critical discussion of the major data problems in the Chinese official statistics and their implications in modeling China's macroeconomic dynamics. We then compare the TCB indices with those constructed by other organizations for the same purposes and examine the trends, cyclical movements and turning points in the Chinese economy as identified by the TCB China indices. A major contribution of this study is the development of a set of new commodity indicators as alternatives to some of the components in the existing TCB China CEI and LEI, and the construction of alternative CEIs and LEIs for testing the robustness of the existing indices and the usefulness of the commodity indicators.

We have conducted the tests in some regression exercises. Our empirical findings show that despite the data problems the existing TCB China CEI is robust and gives a good description and measure of the macroeconomic cycles in China. However, commodity-based indicators which tend to pronounce the variations of industrial output indeed better model the dynamics of GDP. They confirm that the TCB China CEI is sound and well built index in dating and predicting the dynamism of the Chinese economy. On the other hand, our exercises with the commodity indicators also suggest that the alternative CEIs can indeed help to better address the biases in the official estimates of GDP and hence improve the current CEI.

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