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Measuring Chinese business cycles with dynamic factor models☆

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ABSTRACT

The Stock–Watson method and the dynamic Markov switching factor (DMSF) model are employed to construct macroeconomic composite coincident indexes for the Chinese economy, January 1990–March 2008. Four coincident indicators, namely, industrial production, investment in fixed assets, sales revenues, and the money supply, M_1, are selected to compute the coincident index. Strong asymmetries are found with recent business cycles in China characterized by expansions of longer duration and smaller amplitude relative to the contraction stage. The two models produce similar composite index series, but the DMSF model shows frequent transitions that are difficult to interpret. A comparison of the composite coincident index and other measures of macroeconomic activity provides economic interpretations of the patterns in the index. There are notable differences between the index and GDP growth rates over this period, reflecting its more comprehensive measurement of economic activity. This more comprehensive view of macroeconomic activity increases understanding of changes in China's policies and economic fluctuations that are not shown by GDP growth rates alone.

1. Introduction

Burns and Mitchell (1946) developed methods for measuring business cycles and, based on them, the leading, coincident and lagging composite indexes were developed by the National Bureau of Economic Research (NBER) to depict macroeconomic activity and to anticipate future developments. Burns and Mitchell believed that business cycles are the results of the transmission and diffusion through the economy of a series of economic activities, and it is the general up and down movement of all parts of the economy that defines the business cycle. Although composite indexes are widely used by many governments, the classical methods used to compute indexes are sometimes criticized for lack of statistical foundation. Therefore, alternative mathematical models have been adopted to construct macroeconomic climate indexes. Among them the dynamic factor model adopted by Stock and Watson (1989, 1991, 2003) is an influential method for constructing macroeconomic climate indexes. They regard macroeconomic fluctuations as an unobserved common component of a set of macroeconomic variables, and this common component depicts the comovement of the major macroeconomic variables and embodies the essential features of macroeconomic activity. They put the dynamic factor model into state space representation and use the Kalman filter technique to estimate the unobserved component, which

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is regarded as the new coincident composite index. In this study the dynamic factor model of Stock and Watson is applied to Chinese data, in order to characterize the essential features of economic fluctuations in China's economy since 1990.

Keynes (1936) argued that expansions and contractions were different from each other, with the former being long-lived while the latter were more violent. There is a growing interest in studying the nonlinear and asymmetric features of the business cycle in modern business cycle research and empirical analysis. Neftci (1984) and Sichel (1989) provided direct evidence on business cycle asymmetry, Quandt (1972), Goldfeld and Quandt (1973), and Ploberger, Kramer, and Kontrus (1989) considered models that allow structural change. Hamilton's (1989) seminal paper proposed the use of a Markov switching (MS) process to model expansions and recessions in U.S. GNP. Hamilton succeeded in reproducing the business cycle turning points established by the NBER. From then on, the Markov switching model has been widely used in the study of asymmetric features in business cycles and finance. This model is appropriate for the computation of a composite index to monitor business cycle activity. Diebold and Rudebusch (1996), by introducing the Markov switching mechanism to the dynamic factor model, proposed a multivariate dynamic factor model with regime switching that encompasses the comovement of key variables together with asymmetric features of the business cycles. The dynamic factor model with Markov switching expresses the idea that all observed coincident economic indicators depend on an autoregressive (AR) unobserved common factor known as the composite index of coincident indicators, plus a set of AR processes of idiosyncratic shocks to each indicator. The specific AR process governing the composite index depends on whether the economic condition is in recession or expansion states. Based on this model, Chauvet (1998) studied the characterization of business cycle dynamics in the U.S.; Kim and Nelson (1998) studied the business cycle turning points and tests of duration dependence; Kaufmann (2000) measured European countries' business cycles.

This study augments the dynamic factor model of Stock and Watson to capture possible asymmetries in Chinese business cycles through the inclusion of Markov switching. This application of the dynamic factor model and its extension to incorporate Markov switching are driven by several objectives. First, this use of the dynamic factor Markov switching model is distinguished from others in its application to a rapidly growing economy that has not experienced negative growth during the period of this study. Therefore, the methodology is tested for its ability to distinguish between strong expansions and growth recessions, i.e., periods of slower but positive growth. Second, this application tests for and measures the asymmetric feature of the business cycles in China, providing information on the average amplitude and duration of the two phases of the business cycle. Third, movements in the constructed composite index are compared with other macroeconomic events to more fully understand the relation between the index and macroeconomic activity. Finally, the comprehensive nature of the composite index is compared with fluctuations in GDP growth rates to reveal important differences in these two alternative measures of economic activity.

The organization of the paper is as follows. Section 2 presents the dynamic factor model and the model with Markov switching. In Section 3, we select four coincident indicators in China and construct a new coincident composite index to analyze the features of the business cycle history in China from January 1990 until March 2008. Section 4 concludes the paper.

2. The dynamic Markov switching factor model

2.1. Dynamic factor model

Stock and Watson (1989, 1991, 2003) developed a linear econometric model of coincident indicators to represent US business cycles. All the coincident indicators are linear functions of the current and lagged values of the unobserved common factor, which is interpreted as the composite index, plus individual error terms. These indicators are assumed to be generated by an AR process. The dynamic factor model is written as:

$$\Delta y_{it} = \gamma_i(L)\Delta c_t + u_{it}, \quad i = 1, 2, \cdots, n \tag{1}$$

$$\phi(L)\Delta c_t = \varepsilon_t, \varepsilon_t \sim \text{i.i.d.} N(0, \sigma_\varepsilon^2) \tag{2}$$

$$\psi_i(L)u_{it} = \upsilon_{it}, \upsilon_{it} \sim \text{i.i.d.} N(0, \sigma_i^2), \quad i = 1, 2, \cdots, n \tag{3}$$

where Δy_{it} is the demeaned first difference of the ith coincident indicator which is decomposed into the AR process of Δc_t, the first difference of the common factor c_t, and the indicator specific component u_{it}. Both the first difference of the common factor and the individual errors are AR processes. The variance of the innovation for Δc_t, σ_ε^2, is set to 1 in order to normalize the common component; $\gamma_i(L)$, $\phi(L)$ and $\psi_i(L)$ are lag operator polynomials ordered p_i, q, r_i, respectively, with roots outside the unit circle; all the shocks are assumed to be independent.

In order to estimate a model with unobserved components, the state space model is applied. Once the dynamic factor model above is written in state space form, the Kalman filter technique allows maximum likelihood estimation as well as inference on the unobserved component Δc_t.