An adaptive approach to forecasting three key macroeconomic variables for transitional China

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\section*{ABSTRACT}

The macroeconomic forecasts for emerging economies often suffer from the constraints of instability and limited data. In light of these constraints, we propose the use of a local autoregressive (LAR) model with a data-driven estimation window, i.e., a local homogenous interval, that is adaptively identified to strike a balance between information efficiency and stability. When applied to three key macroeconomic variables of China, the LAR model substantially outperforms the alternative models for various forecast horizons of 3 to 12 months, with forecast error reductions of between 4% and 64% for the IP growth, and between 1% and 68% for the inflation rate. The one-quarter ahead performance of the LAR model matches that of a well-known survey forecast. The patterns of the identified local intervals also coincide with the characteristic evolution of the gradual reforms and monetary policy shifts in China. In short, the LAR model is suitable for not only forecasting, but also the real-time monitoring of the effects of regime and policy changes in emerging economies.

\section{1. Introduction}

Compared with the forecasts for developed economies, the macroeconomic forecasts for emerging markets and transition economies face greater challenges in two key areas: first, the structural changes due to policy and regime shifts occur more frequently (Balcllal et al., 2013); and second, the available data tend to be far more limited (Jusczak et al., 1993; Liu et al., 2012). In this paper, we examine these features by using a local autoregressive (LAR) model to estimate and forecast three key macroeconomic variables of China. We find that the LAR model is able to deliver robust predictive performance under the constraints of instability and limited data.

The accurate prediction of macroeconomic variables is a crucial factor in policy decisions. However, economists and policymakers face difficulties in predicting these variables, even for developed economies, which suffer less from the aforementioned problems (De Gooijer and Hyndman, 2006; Clements and Hendry, 2008; Manganelli, 2009). In general, the problem of instability increases the parameter uncertainty in parameterised models (Stock and Watson, 1999, 2007; Hendry and Clements, 2003; D’Agostino et al., 2013; Cross and Poon, 2016). This problem is more severe in emerging markets (Jusczak et al., 1993). Thus, given the increasing importance of emerging markets in the world economy, there is an urgent need to develop accurate economic forecasts for developing countries. Kaya (2013) examines the yield curve forecasting performance in Turkey. Gupta and Steinbach (2013) forecast key macroeconomic variables for South Africa using a DSGE-VAR model. Pourazarm and Cooray (2013) examine and forecast the electricity demand in Iran. Liu et al. (2012) evaluate the GDP nowcasts for Latin American economies. In a study on the Chinese economy, Maier (2011) compares the out-of-sample performance of three mixed-frequency forecasting models, and finds that the factor model fares best. Mikosch and Zhang (2014) use a mixed sampling model to forecast Chinese GDP growth, and extensively evaluate the predictive power of various indicators. However, the research on systematic forecasting in the context of transition economies has largely overlooked the transition effects. Although some studies recognise the data limitation and instability problems (Jusczak et al., 1993; Liu et al., 2012; Balcllal et al., 2015), the tools for conducting accurate forecasting are still lacking.

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There are numerous fruitful studies on forecasting macroeconomic variables in the literature, including time series models, macro-theoretical based models such as the Philips curve model, structural VAR models and factor-augmented VAR models (Forni et al., 2000, 2003; Stock and Watson, 2002a, 2002b; Bai and Ng, 2002, 2008; Moser et al., 2007). To address the issue of parameter instability, many models include features such as a long memory and structural breaks (Banerjee et al., 2008; Stock and Watson, 2009; Clark and McCracken, 2010; Geweke and Jiang, 2011; Bekiros, 2014). However, complex econometric models often fail to outperform simple time series models or ad-hoc forecasts based on surveys (Angetal, 2007; Stock and Watson, 2008; Belmonte and Koop, 2014), especially for emerging markets with limited data (Liu et al., 2012). The factor-augmented VAR model, for example, hinges on the effective selection of factors and tends to perform poorly in out-of-sample forecasting due to the potential structural changes in the factors. Predicting local shifts in the factors can also present computationally non-trivial challenges (Castle et al., 2013).

In terms of the modeling and forecasting for emerging economies, a desirable model is required to appropriately strike a balance between efficiency and parameter stability under the constraint of limited information. We consider the recently developed LAR model to be a particularly suitable candidate. The model is based on the local parametric approach (LPA) proposed by Spokoiny (1998, 2009), which is predicated on the idea that a parametric framework can be used to locally approximate sophisticated stochastic processes within data-driven intervals of homogeneity at each time point. Chen et al. (2010) propose an LAR model to forecast the realized volatilities with long-memory patterns prevalent in financial time series. The empirical out-of-sample forecast of the LAR model outperforms the popular alternative models. Chen and Niu (2014) further apply the local adaptive approach to forecast the US yield curve. Their method substantially outperforms the alternative term-structure models at 3- to 12-month forecast horizons. The approach is shown to capture structural changes in the time series quite well, and the detected interval endpoints are in line with major policy changes and economic recessions. Recent successful applications of the adaptive approach include Härdle et al. (2014, 2015), Xu et al. (2015), Chen and Li (2016) in forecasting the order flows, trading volumes, tail events and energy prices in financial markets.

To verify the effectiveness of the LAR model in the context of emerging markets and economics in transition, we take China as a representative context for our empirical study. China has undergone notable reforms since 1978, gradually changing from a planned economy to its current socialist market model, and has actively adopted modern technologies and management practices (Naughton, 2007; Lin, 2013; Chow, 2015). The transition has been accompanied by several decades of rapid economic growth and remarkable economic achievements. China's GDP growth averaged 9.8% per year from 1978 to 2013, and in 2009, China surpassed Japan as the world's second largest economy. Given this structural instability and the data limitations, we use the LAR model to forecast three key macroeconomic variables of China: the growth rate of industrial production (IP growth) as a proxy for real output growth, the CPI inflation rate as representative of the nominal variables, and the seven-day China Interbank Offered Rate (Shibor), which was only available from the Shanghai Interbank Offered Rate (Shibor), which was officially launched in January 2007, much later than the Chibor. These two rates follow each other very closely in the common sample period and jointly play crucial roles as the basic interest rates in China.

We consider three macroeconomic variables from the China Economic and Industry Database (CEIC) and use their longest available samples: the CPI inflation rate (1992:1–2015:12) and the year-on-year growth rate of industrial production (IP growth) (1995:1–2015:12), which are sampled monthly; and the weighted average of the seven-day Shibor, which is taken from the closing rate of the weekly final trading day from January 2001 to December 2015, a total of 773 data points (Fig. 1).

Table 1 presents the descriptive statistics for the three time series. The graphs of the autocorrelation functions in Fig. 2 show that all three series exhibit high persistence, with the autocorrelations slowly decaying up to lag 30. This feature indicates either a long memory or structural changes. The interest rate series presents a clustering feature of volatility, and jumps that imply changing volatility in innovations. This evidence provides the justification for applying an adaptive approach that features a globally changing, yet locally stationary data-generating process.

3. LAR-based adaptive modeling and forecasting

In this section, we introduce the model set-up and estimation procedure of the LAR model. Each of the macroeconomic time series is modelled as an LAR(1) process, which is also elaborated in detail in Chen et al. (2010).

3.1. The LAR model

3.1.1. The LAR model and estimator

Each macroeconomic variable is modelled using a simple LAR(1) model that defines the data-generating process as an autoregressive process with one lag. Unlike the traditional AR(1) model, the parameter set is allowed to be time varying and thus is indexed to the local time t when the model is estimated with data up to t. Denoting the parameter set as \( \theta_t = (\theta_0, \theta_1, \sigma_t^2) \), the model is,

\[
\chi_t = \theta_0 + \theta_1 \chi_{t-1} + \mu_t, \quad \mu_t \sim N(0, \sigma_t^2).
\]  

The time-varying parameter set indicates that the model recognises possible parameter changes in the data-generating process. In addition, it is worth mentioning that there are other interest rate candidates, such as the Shanghai Interbank Offered Rate (Shibor), which was officially launched in January 2007, much later than the Chibor. These two rates follow each other very closely in the common sample period and jointly play crucial roles as the basic interest rates in China.
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