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Improving inflation prediction with the quantity theory

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HIGHLIGHTS

- We consider the role of the quantity theory in improving inflation forecasts.
- We find that the cointegration-based quantity theory does not hold for the period after 1995 for the US data.
- That period is well explained by an adaptive quantity theory based on a functional-coefficient cointegration that adapts to the unemployment rate.
- The forecasting exercises show that the adaptive quantity theory has superior pre-dictive power for targeting future inflation.

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ABSTRACT

This paper focuses on the role of the quantity theory in improving inflation forecasts. We find that the cointegration-based quantity theory does not hold for the period after 1995 for the U.S. data. However, that period is well explained by an adaptive quantity theory based on a functional-coefficient cointegration that adapts to the unemployment rate. The forecasting exercises show that the adaptive quantity theory has superior predictive power for targeting future inflation.

1. Introduction

Inflation forecasting has played an important role in US monetary policy, which leads to continuous effort to search for good indicators of future inflation. This paper focuses on the role of the quantity theory in targeting inflation. Inspired by Chow (1987, 2007), Chow and Wang (2010) and Bachmeier and Swanson (2005), we consider the cointegrating relationship between price and excess money supply suggested by the quantity theory.

Motivated from parameter instability in empirical applications (De Grauwe and Grimaldi, 2001; Moroney, 2002), we study a functional-coefficient cointegration (Xiao, 2009; Cai et al., 2009) between price and excess money supply, with the cointegrating vector adapting to the unemployment rate. Such a choice of the state variable provides close linkage to the Phillips Curve, which emphasizes the relationship between the unemployment rate and the inflation level. We further compare the forecasting performance of various cointegration models, built upon the adaptive quantity theory, in predicting the US inflation. We find that the quantity theory, particularly the functional-coefficient cointegration, is effective in predicting future inflation. Due to space limitation, details not reported in this paper can be found in an earlier working paper, Wang et al. (2015).

The rest of the paper is organized as follows. Section 2 introduces the quantity theory and provides cointegration analysis between price and excess money supply. Section 3 reports the inflation forecasting results and Section 4 concludes.

2. The quantity theory

2.1. Preliminaries

We begin with the Fisher Identity,

$$M_tV_t = P_tY_t, \quad (1)$$

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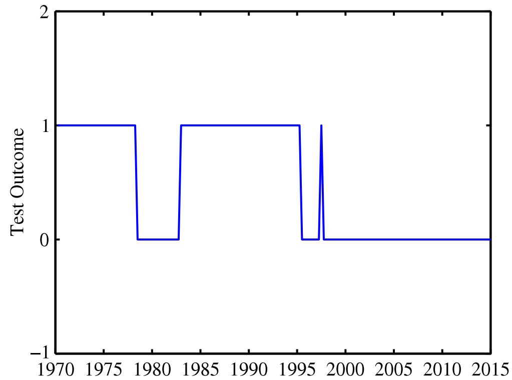

Fig. 1. Testing outcomes for cointegration between p and m. Here "1" stands for the existence of one cointegration and "0" for none.

where M stands for the money stock, V for velocity of the circulation, P for the price level and Y for the real output. In our analysis, we use the Consumer Price Index for P, the Gross Domestic Product in chained 2009 dollars as a measure of Y, and M2 for measure of M. All data are seasonally adjusted quarterly US figures ranging from 1959:1 to 2015:1.

Taking the logarithm on (1) and rearranging yield

$$v_t = p_t - m_t, \tag{2}$$

where $p_t \equiv \log P_t$, and $m_t \equiv \log(M_t/Y_t)$ is referred to as excess money supply. The velocity $v_t \equiv \log(V_t)$ has been often argued to be stationary (Feldstein and Stock, 1994; Estrella and Mishkin, 1997), while the Augmented Dickey–Fuller (Dickey and Fuller, 1981) test suggests that both p and m are unit root processes. As a result, Eq. (2) suggests that p_t and m_t are cointegrated with cointegrating vector $(1, -1)$, using the terminology of Engle and Granger (1987). This observation leads to studies (Chow, 1987, 2007; Chow and Wang, 2010) that investigate whether the quantity theory of money is congruent with the real world economy.

We consider a general cointegration model as in Bachmeier and Swanson (2005),

$$p_t = \beta m_t + v'_t, \tag{3}$$

where β may be different from 1 and v'_t is the regression residual. Using Johansen's maximum eigenvalue test (Johansen, 1995), we check on the cointegration relationship between p_t and m_t. The results based on an expanding window basis (with the samples starting from 1959:1, and 1970:1 being the first testing point) are displayed in Fig. 1. It is observed that p_t and m_t were not cointegrated anymore after 1995, consistent with the findings of Bachmeier and Swanson (2005), who attributed the lack of cointegration since mid-1990s to a structural break.

2.2. The adaptive quantity theory

To incorporate possible structural breaks and parameter instability, we consider a functional-coefficient cointegration model (Xiao, 2009; Cai et al., 2009),

$$p_t = \beta(z_t)m_t + v''_t \tag{4}$$

where the cointegration between p_t and m_t is adapting to an economic variable, z_t, for which we shall use the unemployment rate in the subsequent analysis, and v''_t is the regression residual. The above model is referred to as the "Adaptive Quantity Theory of Money". See Wang et al. (2015).

Two questions of central importance here are: (i) whether the functional cointegration is supported by the US data; and (ii) whether it is necessary to use functional cointegration instead of conventional cointegration that has constant (stable) cointegrating parameters. Xiao (2009) laid down the theoretical underpinnings to address both questions with his functional cointegration test and stability test.

We implement both tests of Xiao (2009) to the data sample recursively on an expanding window basis with 1995:1 as the first test point, and the smoothing bandwidth is set as $h = c \cdot \hat{\sigma}_z \cdot n^{-9/20}$ for $c = 0.8,\ 1,\ 1.2$, with $\hat{\sigma}_z$ denoting the sample standard deviation of z_t, and n the sample size. The test results are reported in Fig. 2. It is observed that p_t and m_t are functionally cointegrated for almost all of the subsamples after 1998:2 under different choices of bandwidths. Furthermore, the constancy of the functional cointegrating vector is rejected most of the time under various choices of bandwidths. These results strongly suggest the existence of functional cointegration and are consistent with those from the Johansen test that p_t and m_t are not cointegrated in the conventional way after 1995.

3. Empirical results

In this section, we provide empirical evidence to show that the adaptive quantity theory of money is useful in improving inflation prediction accuracy. We first present the forecasting models and then provide the empirical forecasting performance of these models.

3.1. Forecasting models

We consider the error-correction models (ECMs) derived from cointegrations between p and m to form the forecasting models. Also included for comparison is a frequently used model based on the Phillips Curve (Stock and Watson, 1999). The benchmark model is chosen to be the Autoregression of order ℓ (AR(ℓ)). For forecasting horizon $s = 1, 2, \ldots, 20$, models under consideration are listed below.

- AR(ℓ)

$$\Delta p_{t+s} = \xi_0 + \sum_{i=0}^{\ell-1} \xi_i \Delta p_{t-i} + \epsilon_{t+s}.$$

- AR with excess money supply (AR-m)

$$\Delta p_{t+s} = \xi_0 + \sum_{i=0}^{\ell_1-1} \xi_i \Delta p_{t-i} + \sum_{i=0}^{\ell_2-1} \zeta_i \Delta m_{t-i} + \epsilon_{t+s}.$$

- ECM with error correction from QTM (QTM-ECM)

$$\Delta p_{t+s} = \xi_0 + \sum_{i=0}^{\ell_1-1} \xi_i \Delta p_{t-i} + \sum_{i=0}^{\ell_2-1} \zeta_i \Delta m_{t-i} + \delta \cdot ecm_t + \epsilon_{t+s},$$

with $ecm_t = p_t - m_t$.

- ECM with error correction from Constant-coefficient Cointegration (C-CI-ECM)

$$\Delta p_{t+s} = \xi_0 + \sum_{i=0}^{\ell_1-1} \xi_i \Delta p_{t-i} + \sum_{i=0}^{\ell_2-1} \zeta_i \Delta m_{t-i} + \delta \cdot \widetilde{ecm}_t + \epsilon_{t+s},$$

with $\widetilde{ecm}_t = p_t - \tilde{\beta} m_t$, and $\tilde{\beta}$ denotes the least square estimate of β in (3).

- ECM with error correction from Functional-coefficient Cointegration (F-CI-ECM)

$$\Delta p_{t+s} = \xi_0 + \sum_{i=0}^{\ell_1-1} \xi_i \Delta p_{t-i} + \sum_{i=0}^{\ell_2-1} \zeta_i \Delta m_{t-i} + \delta(z_t) \cdot \widehat{ecm}_t + \epsilon_{t+s},$$

with $\widehat{ecm}_t = p_t - \hat{\beta}(z_t) m_t$, where $\hat{\beta}(z_t)$ is obtained by the kernel estimator of Xiao (2009).