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A panel analysis of the fisher effect with an unobserved $I(1)$ world real interest rate☆

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ABSTRACT

The Fisher effect states that inflation expectations should be reflected in nominal interest rates in a one-for-one manner to compensate for changes in the purchasing power of money. Despite its wide acceptance in theory, much of the empirical work fails to find favorable evidence. This paper examines the Fisher effect in a panel of 21 OECD countries over the period 1983–2010. Using the Panel Analysis of Non-stationarity in Idiosyncratic and Common Components (PANIC), a non-stationary common factor is detected in the real interest rate. This may reflect permanent common shifts in e.g. time preferences, risk aversion and the steady-state growth rate of technological change. We therefore control for an unobserved non-stationary common factor in estimating the Fisher equation using both the Common Correlated Effects Pooled (CCEP) and the Continuously Updated (Cup) estimation approach. The impact of inflation on the nominal interest rate is found to be insignificantly different from 1, providing support of the Fisher effect.

1. Introduction

The Fisher effect states that inflation expectations should be reflected in nominal interest rates in a one-for-one manner to compensate for changes in the purchasing power of money (Fisher, 1930). This implies that the ex ante real interest rate, defined as the difference between the nominal interest rate and expected inflation, is not affected by changes in inflation expectations. While probably not being valid in the short run, the Fisher effect is expected to hold as a long-run equilibrium concept. Insofar as permanent changes in expected inflation originate from permanent shocks in the rate of money growth, this is in accordance with the so-called long-run superneutrality of money. Despite its wide acceptance in theory, most of the empirical work fails to find convincing evidence in favor of the Fisher effect. As nominal interest rates and inflation are typically found to be non-stationary, the long-run Fisher effect implies that these two variables should cointegrate with a unit slope coefficient such that the real interest rate is stationary and therefore not affected by permanent shocks to inflation. A survey of this literature shows that unit root tests find real interest rates to be non-stationary (see e.g. Lai, 2008; Rapach and Weber, 2004; Rose, 1988) while cointegration analysis either finds no cointegration between nominal interest rates and inflation (see e.g. Koustas and Serletis, 1999; MacDonald and Murphy, 1989) or when cointegration is found the estimated slope is significantly less (see e.g. Evans and Lewis, 1995) or significantly greater (see e.g. Crowder and Hoffman, 1996) than one.

A number of theoretical explanations for the empirical failure of the Fisher effect have been put forward. First, inflation expectations are not observed and are therefore replaced by ex post observed inflation to calculate ex post real interest rates. Evans and Lewis (1995) argue that the alleged permanent component in these ex post real interest rates may be due to people incorporating anticipated shifts in the inflation process into their expectations implying a persistent deviation of observed inflation from expected inflation over the period these shifts do not materialize. Second, Darby (1975) argues that the presence of taxes on interest income implies that nominal interest rates have to rise by more than one-for-one in response to a change in inflation expectations in order to keep the after-tax real interest rate constant. These tax effects may thus explain why nominal interest rates and inflation cointegrate with a slope coefficient greater than one. Third, in the seminal papers of Mundell (1963) and Tobin (1965) higher inflation causes a substitution out of money balances into bonds and real assets, putting downward pressure on real interest rates. This may explain why nominal interest rates and inflation cointegrate with a slope coefficient less than one.

A plausible econometric explanation is that the existing empirical evidence on the Fisher effect is flawed as it is based on a country-by-country analysis often using at most 50 annual observations. Using such relatively small data span results in low power of conventional unit root and cointegration tests, especially when there is high persistence under the alternative hypothesis of stationarity. Westerlund

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(2008) therefore suggests to test the Fisher effect in a panel of quarterly data covering 20 OECD countries between 1980 and 2004. Taking into account error cross-sectional dependence when testing for cointegration, he shows that the null hypothesis of no panel cointegration between interest rates and inflation can be rejected while the hypothesis of a unit slope coefficient on inflation cannot be rejected.

An alternative, but yet unexplored, explanation is that the real factors behind the real interest rate are not stable over time. Standard neoclassical growth models with household intertemporal utility maximization imply that the real interest rate is a function of time preference, risk aversion and the steady-state growth rate of technological change. While time preference and risk aversion are generally believed to be fairly stable, or at least changing only slowly over extended periods of time, shifts in steady-state growth, such as the 'productivity slowdown' of the early 1970s and the 'New Economy' resurgence of growth in the late 1990s, have been widely documented in the literature (see e.g. Oliner and Sichel, 2000; Roberts, 2001). Additional determinants of real interest rates suggested in the literature are demographic changes, changes in the stance of fiscal policy and the evolution of public debt, changes in the taxation of profits, (de)regulation of financial markets, … (see e.g. Ardagna, 2009; Blanchard and Summers, 1984; Chadha and Dimsdale, 1999). Permanent shifts in any of these factors induce a unit root in the real interest rate and by extension in the residuals of a regression of the nominal interest rate on inflation. However, this does not automatically invalidate the Fisher hypothesis of a one-for-one relation between nominal interest rates and inflation. Basically, the sources of the non-stationary behavior of real interest rates are omitted non-stationary variables that should be added to a regression of nominal interest rates on inflation for this to be a cointegrating relation. Note that this argument not only explains the failure to find cointegration but also the large variety of estimated slope coefficients over empirical studies that do find cointegration as Everaert (2011) shows that omitting relevant non-stationary variables yields spurious estimation results with standard cointegration tests indicating these results to be a cointegration regression in far too many cases.

Ideally, the non-stationary determinants of real interest rates should be included in a regression of nominal interest rates on inflation. However, there is a large variety of possible determinants which are, moreover, not directly observable or at least hard to measure. A promising way out of this problem is to identify these determinants by exploiting the strong cross-section correlation between interest rates observed over countries. Increasing economic integration leads to a substantial degree of linkage between real interest rates of different countries and has led a number of authors to construct and analyze a world real interest rate (Barro and Sala-i Martin, 1990; Koedijk et al., 1994; Lee, 2002) or to relate national real interest rates to international rather than to domestic events (Blanchard and Summers, 1984).

This paper uses recent advances in panel data econometrics to identify and account for unobserved common factors in a panel of quarterly data for nominal interest rates and inflation covering 21 OECD countries between 1983 and 2010. The analysis consists of two steps. In the first step, we investigate the integration properties of the data using the Panel Analysis of Non-stationarity in Idiosyncratic and Common Components (PANIC) of Bai and Ng (2004). The most important conclusion from this analysis is that real interest rates and the error terms of a fixed effects (FE) regression of nominal interest rates on inflation can both be decomposed in a single non-stationary common factor and a stationary idiosyncratic component. The latter finding is consistent with Westerlund (2008) who also shows that real interest rates and Fisher equation regression errors are stationary after filtering out common factors. This leads him to conclude that nominal interest rates and inflation cointegrate. However, Westerlund does not analyze the integration properties of the common factors but simply assumes these to be stationary. Our finding of a non-stationary common factor invalidates his conclusion and implies that regression results ignoring this common factor are spurious (see Urbain and Westerlund, 2011). In the second step we therefore estimate the relation between nominal interest rates and inflation taking into account a common non-stationary component in real interest rates. In particular, we use the common correlated effects pooled (CCEP) estimation approach proposed by Pesaran (2006) and Kapetanios et al. (2011) and the continuously-updated (Cup) estimation approach proposed by Bai et al. (2009). The advantage of both approaches is that they can consistently estimate the relationship between nominal interest rates and inflation under very general integration properties of the data without the need to identify and measure the determinants of real interest rates as long as these determinants are common to all countries. Thus, rather than treating the cross-section correlation as a nuisance, which requires adjustment of standard unit root and cointegration tests, we exploit the comovement of interest rates to identify unobserved common determinants of real interest rates. This allows us to test the Fisher effect in the presence of a non-stationary world real interest rate. Endogeneity of observed inflation induced by a rational expectations forecasting error is taken into account using CupBC, a bias-corrected version of the Cup estimator, and CCEP_GMM, a GMM version of the CCEP estimator. We also propose how to test for cointegration from the error terms of the CCEP and CUP estimators. A small-scaled Monte Carlo simulation shows that the CupBC and CCEP_GMM estimators and cointegration tests perform reasonably well for the modest sample size $T = 112$, $N = 21$ that is available for our empirical analysis. From the estimation results, the hypothesis of a one-for-one relation between the nominal interest rate and inflation cannot be rejected using either the CupBC or the CCEP_GMM estimator.

The paper is organized as follows. Section 2 outlines the standard Fisher equation. Section 3 analyses the time series properties of the data. Section 4 augments the standard Fisher equation with a non-stationary factor and discusses how this factor-augmented equation can be estimated. Section 5 presents the estimation results and analyses the small sample properties of the proposed estimators using a Monte Carlo simulation. Section 6 concludes.

2. The standard Fisher equation

Fisher (1930) hypothesized that inflation expectations should be reflected in the nominal interest rate in a one-for-one manner to compensate for changes in the purchasing power of money. This implies that the real interest rate should be invariant to changes in expected inflation. Formally, the Fisher hypothesis can be stated as $\beta = 1$ in

$$i_{it} = r^e_{it} + \beta\pi^e_{it}, \qquad i = (1, \ldots, N), \quad t = (1, \ldots, T), \tag{1}$$

where i_{it} is the nominal interest rate observed in country i at time t, r^e_{it} is the ex ante real interest rate and π^e_{it} the expected rate of inflation.

The validity of the Fisher effect cannot be directly analyzed using Eq. (1) as r^e_{it} and π^e_{it} are unobserved ex ante variables. The Fisher equation can be written in terms of ex post observed variables after making two assumptions. First, the ex ante real interest rate is driven by real factors which are typically assumed to be more or less stable over time such that r^e_{it} can be written as

$$r^e_{it} = \alpha_i + \nu_{it}, \tag{2}$$

where α_i is a country-specific constant and ν_{it} is a stationary error term which captures temporary fluctuations in r^e_{it}. Second, assuming rational expectations

$$\pi_{it} = \pi^e_{it} + \zeta_{it}, \tag{3}$$

where ζ_{it} is a mean zero stationary forecast error orthogonal to any information known at time t. Inserting Eqs. (2) and (3) in Eq. (1) yields

$$i_{it} = \alpha_i + \beta\pi_{it} + \epsilon_{it}, \tag{4}$$