Economics Letters 120 (2013) 27–31

Contents lists available at SciVerse ScienceDirect

Economics Letters

journal homepage: www.elsevier.com/locate/ecolet

Euler equations and money market interest rates: The role of monetary policy and risk premium shocks

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HIGHLIGHTS

- In theory, Euler equation and money market interest rates are equal.
- VAR evidence suggests that they are negatively correlated.
- Stochastic risk premium disturbances can account for this observation.
- Implementing collateral constraints tied to housing might be promising.

ARTICLE INFO

Article history:
Received 5 November 2012
Received in revised form
9 March 2013
Accepted 17 March 2013
Available online 28 March 2013

JEL classification:
E10
E43
E44
E52

Keywords:
Euler interest rate
Monetary policy
Risk premium shocks

ABSTRACT

We challenge the view that the negative correlation between the Federal Funds and the Euler equation interest rate is linked to monetary policy. Using Monte Carlo experiments, we show that the negative correlation can be explained by risk premium disturbances.

1. Introduction

The limited performance of consumption Euler equations is well known. Recently, Canzoneri et al. (2007) present another failure of consumption Euler equations. Using a novel approach, they challenge the view that the money market interest rate targeted by the central bank is equal to the rate implied by a Euler equation, as is commonly assumed in standard New Keynesian (NK) models. Canzoneri et al. (2007) use US data and derive conditional moments of consumption and inflation from an estimated vector autoregression (VAR). These moments and actual observations are then used to compute interest rates implied by consumption Euler equations obtained from alternative specifications of preferences. By comparing implied with actual interest rates, two results stand out. First, the behavior of implied rates differs significantly from the Federal Funds rate. In particular, real interest rates implied by Euler equations are strongly negatively correlated with the observed money market rate. Second, using standard regression analysis and impulse response functions, Canzoneri et al. (2007) report that the Federal Funds rate and the Euler equation rate move in opposite directions following a monetary policy tightening.

The purpose of this paper is to explore the link between the correlation between implied and actual interest rates and the stance of monetary policy. As explained by Canzoneri et al. (2007), the fact that the two rates do not coincide is intuitive if the representative household has standard, additively separable CRRA preferences. Empirical studies show that consumption responds in a hump-shaped fashion to a monetary contraction (see Christiano et al., 2005). That is, in the quarters following a monetary contraction, interest rates and consumption growth are negatively correlated. Standard preferences, however, imply that consumption growth and interest rates are positively correlated. Consequently, using a standard Euler equation to compute implied interest rates

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http://dx.doi.org/10.1016/j.econlet.2013.03.025

results in a negative correlation between actual and implied interest rates. With this intuition in mind, adding habit persistence to household preferences seems to be a promising candidate to reconcile the dynamics of money market interest rates and rates implied by Euler equations.[1] Most prominently, Fuhrer (2000), Christiano et al. (2005), and Smets and Wouters (2007) rely on habit persistence to explain the observed dynamics of output and consumption in response to a monetary policy shock. From this perspective, the finding in Canzoneri et al. (2007) that the implied Euler equation rate and the Federal Funds rate do not coincide across a large number of preference specifications that explicitly allow for habit formation is quite surprising.[2]

To investigate the sources of the negative correlation between implied and actual interest rates, we make use of a Monte Carlo experiment. We assume that the model economy is defined by a full-fledged NK dynamic stochastic general equilibrium (DSGE) model. We use this model as a data-generating process and compute replications of simulated data. We then use the simulated data to construct implied Euler equation rates following the methodology set forth by Canzoneri et al. (2007). Based on this setup, counterfactual simulations allow us to explore the sources of the spread between implied and actual interest rates in a direct way. We choose to use the estimated model in Smets and Wouters (2007) (henceforth, SW) as our data-generating process. We do so because of several reasons. First, the SW model features complex dynamics with a rich set of structural shocks that aims to describe a fairly complete quantitative description of the US economy. Second, the consumption Euler equation in the SW model deviates from a standard Euler equation along two dimensions. On one hand, it features habit formation. On the other hand, it allows for nonseparability between consumption and labor effort. This is relevant because Collard and Dellas (2012) find that this feature limits the failure of consumption Euler equations identified by Canzoneri et al. (2007). Third, we choose to use the SW model for our Monte Carlo experiment, because the model features a wedge between the money market interest rate and the interest rate implied by the consumption Euler equation. A shock to this wedge (risk premium shock) distorts the equality between the two rates and causes a change in the consumption pattern of households. Hence, given that in the data-generating process implied by the SW model the spread between Euler equation and actual interest rates is simply a statistical noise, we are able to disentangle the impact of monetary policy on the correlation between the two rates from the effect that arises from the assumption of risk premium disturbances.

In the next section, we use US data to compute interest rates implied by consumption Euler equations for two sets of preferences and compare these rates to the Federal Funds rate. In Section 3, we use a Monte Carlo experiment to explore the relationship between implied and actual interest rates. Section 4 concludes the paper.

2. Comparing Euler equation and money market interest rates

Here, we follow the approach in Canzoneri et al. (2007) and compute nominal and real interest rates implied by consumption Euler equations. We compute implied interest rates for the specification of preferences as in Smets and Wouters (2007) and for standard, additively separable CRRA preferences.[3] As in Smets and Wouters (2007), the consumer's objective function is assumed to be

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{1}{1-\sigma_c} \left(C_t - H_t\right)^{1-\sigma_c} \right) \exp\left(\frac{\sigma_c - 1}{1+\sigma_l} L_t^{1+\sigma_l} \right), \tag{1}$$

where E_0 denotes the expectation operator at period $t = 0$, C_t denotes consumption relative to a habit stock, H_t, and L_t is hours worked. The parameter σ_c is the coefficient of relative risk aversion, and σ_l is the inverse elasticity of labor supply. The habit stock is external and is defined by $H_t = \lambda C_{t-1}$, where λ governs the degree of habit formation. Smets and Wouters' specification of consumer preferences nests the standard CRRA utility function with separability between consumption and hours worked and no habit formation. If σ_c approaches 1 and $h = 0$, the period utility function implied by (1) approaches to a standard log utility function, so that lifetime utility reads

$$E_0 \sum_{t=0}^{\infty} \beta^t \log(C_t). \tag{2}$$

The corresponding Euler equations to conditions (1) and (2) are

$$\frac{\exp\left(\frac{\sigma_c-1}{1+\sigma_l} L_t^{1+\sigma_l}\right)}{(C_t - \lambda C_{t-1})^{\sigma_c}} = \beta E_t \left(\frac{\exp\left(\frac{\sigma_c-1}{1+\sigma_l} L_{t+1}^{1+\sigma_l}\right)}{(C_{t+1} - \lambda C_t)^{\sigma_c}} \frac{R_t \epsilon_t^b}{\Pi_{t+1}} \right) \tag{3}$$

$$\text{and} \quad \frac{1}{C_t} = \beta E_t \left(\frac{1}{C_{t+1}} \frac{R_t \epsilon_t^b}{\Pi_{t+1}} \right), \tag{4}$$

where R_t is the gross nominal interest rate controlled by the central bank, Π_t is the gross inflation rate, and ϵ_t^b is a risk premium shock that represents a wedge between R_t and the return on bonds held by households. The shock is assumed to follow an AR(1) process in logs. Following the analysis in Canzoneri et al. (2007), we abstract from the shock term when we compute implied Euler equation interest rates.

Log-linearizing (3) around the steady state balanced growth path of the model yields the following dynamics of nominal, respectively, real interest rates[4]

$$\begin{aligned} r_t = {} & (1/c_3)(c_1 c_{t-1} - c_t + (1-c_1) E_t c_{t+1} \\ & + c_2 (l_t - E_t l_{t+1})) + E_t \pi_{t+1} \end{aligned} \tag{5}$$

and

$$rr_t = (1/c_3)(c_1 c_{t-1} - c_t + (1-c_1) E_t c_{t+1} + c_2 (l_t - E_t l_{t+1})), \tag{6}$$

where $c_1 = \frac{\lambda/\gamma}{1+\lambda/\gamma}$, $c_2 = \frac{(\sigma_c - 1)(W_*^h L_*/C_*)}{\sigma_c(1+\lambda/\gamma)}$, $c_3 = \frac{1-\lambda/\gamma}{\sigma_c(1+\lambda/\gamma)}$, and γ is the steady state growth rate. The log-linear dynamics of nominal and real interest rates implied by (4) are given by

$$r_t = E_t c_{t+1} - c_t + E_t \pi_{t+1} \tag{7}$$

$$\text{and} \quad rr_t = E_t c_{t+1} - c_t. \tag{8}$$

To compute implied interest rates from Eqs. (5)–(8), we use the posterior mean estimates for the model parameters as reported in Smets and Wouters (2007) and for the conditional forecasts we follow Canzoneri et al. (2007) and assume that the dynamics of consumption, employment, and inflation can be captured in a VAR defined as

$$Z_t = A_0 + A_1 Z_{t-1} + \cdots + A_p Z_{t-p} + u_t, \tag{9}$$

1 See Schmitt-Grohé and Uribe (2008) and Dennis (2009) for a review on the concept of habit formation in macroeconomic models.

2 See Canzoneri et al. (2007) for a further discussion.

3 In each model it is assumed that the representative household is infinitely lived and chooses consumption, labor effort, and one-period nominal bonds to maximize lifetime utility subject to a budget constraint.

4 A lower case letter denotes the log-linear deviation of the corresponding upper case letter from the balanced growth path, and starred variables refer to steady state values (see Smets and Wouters, 2007). Note that Canzoneri et al. (2007) compute implied interest rates under the assumption of conditional lognormality. As they have already pointed out, the assumption of lognormality results in Euler equations that differ from those derived by log-linearization only by a constant.