The Spanish Review of Financial Economics 10 (2012) 18–29

The Spanish Review of Financial Economics

www.elsevier.es/srfe

Article

A market based approach to inflation expectations, risk premia and real interest rates☆

Ricardo Gimeno, José Manuel Marqués

Banco de España, Spain

ARTICLE INFO

Article history:
Received 21 November 2011
Accepted 22 December 2011
Available online 3 March 2012

JEL classification:
G12
E43
E44
C53

Keywords:
Real interest rates
Risk premium
Inflation expectations
Affine model

ABSTRACT

In this paper we approach the inflation expectations and the real interest rate by using the information contained in the yield curve. We decompose nominal interest rates into real risk-free rates, inflation expectations and risk premia using an affine model that takes as factors the observed inflation rate and the parameters generated in the zero yield curve estimation. Under this approach we could obtain a measure of inflation expectations free of any risk premia. Moreover in our estimation we avoid imposing arbitrary restrictions as is mandatory under other methodologies based on unobserved components.

The empirical exercise has been applied to an economy – like the Spanish one during the 90s – with an important convergence process and a change in the monetary policy regime. The results suggest that the evolution of inflation expectations has been smoother than was expected.

1. Introduction

Inflation expectations and real risk-free rate are two variables that are not observable although their evolution affects the nominal interest rates. In fact, nominal interest rates can be decomposed, from a theoretical perspective, into three components: real risk-free rates, inflation expectations and risk premia. Disentangling which component is the main driver of some of the changes seen in nominal interest rates is often crucial in several different realms such as bond pricing, the analysis of investment or other expenditure decisions made by firms or households or in the process of monetary policy decision-making. Unfortunately, however, the above-mentioned components are not directly observable and the literature only proposes partial solutions to obtain this decomposition.

The most common approach consists in taking inflation expectation as the inflation finally observed and subtracting this ex-post inflation rate from nominal interest rates to obtain an estimate of real risk-free rates. This implies assuming that there is no risk premium and also that agents are able to perfectly foresee the inflation rate. These assumptions are most likely to be only slightly restrictive in reasonably stable economies where the variability of prices is small. However, in other cases the risk premia or the inflation expectations errors could be significant. Moreover, if the economy exhibits some convergence process or if the central bank modifies its monetary policy strategy it seems natural to expect significant variations in risk premia and/or (rational) important mistakes when forecasting inflation. This is for instance the case of Spain and several other European countries involved in EMU creation where uncertainty over convergence finally achieved and the introduction of an inflation targeting for the Banco de España could have originated fluctuations on these variables. Another well known example of sharp modifications in the monetary policy stance was the beginning of the Volcker period as governor of the Board of the Federal Reserve. In those environments, ex-post real interest rates could provide a misleading approach to the actual behavior of real risk-free rates and inflation expectations could not be properly approximated by its ex-post values.

An alternative to ex-post real rates consists in using the return on inflation-indexed bonds to approach real rates, whereas inflation expectations are estimated as the difference with respect to their nominal reference. However, these bonds are not traded in many countries or have been introduced only recently. In addition, although this alternative provides an intuitive estimation of real rates, it does not consider the risk premia and thus provides a

☆ We thank J. Ayuso, R. Blanco, Albert Lee Chun, Fernando Restoy, Itzhak Venezia the participants at the seminars at the Banco de España, the Business School of the Hebrew University and the HEC of Montreal for their useful comments. We are also thankful to the Sanger Chair of Banking and Risk Management of the HUJ for its financial support, and the project grant ECO2009-13616/ECON of Ministerio de Ciencia y Teconología.

E-mail addresses: rgimeno@bde.es (R. Gimeno), manuel-m@bde.es (J.M. Marqués).

2173-1268/$ – see front matter © 2011 Asociación Española de Finanzas. Published by Elsevier España, S.L. All rights reserved.
doi:10.1016/j.srfe.2011.12.002

biased estimation of both real risk-free rates and inflation expectations (see Evans, 1998), a bias that in some circumstances – let us think of the Great Moderation process (see Summers, 2005), can hardly be negligible.

Against this background, this paper proposes a methodology to decompose nominal interest rates into its three components from an affine model of the nominal term structure. This methodology is related to the macro-finance literature in which authors such as Diebold et al. (2006), Diebold et al. (2005), Carriero et al. (2006), and Ang et al. (2008) (ABW) incorporate macro-determinants into a multi-factor yield curve model with non-arbitrage opportunities. Our decomposition departs from previous approaches by extracting the risk premia from the difference between the nominal term structure and a notional term structure where the price of risk is set equal to zero.

We also propose a new affine model where interest rates are affine relative to a vector of factors that includes inflation rates and exogenously determined factors based on the Nelson–Siegel exponential components of the yield curve (Nelson and Siegel, 1987) in a similar vein to Carriero et al. (2006) and Diebold and Li (2006). Moreover, in our case we include the condition of non-arbitrage opportunities along the yield curve as well as taking into account the risk-aversion. Taking these two conditions together allows us to decompose nominal interest rates as the sum of real risk-free interest rates, expected inflation and the risk premium. We therefore depart from Dai and Singleton (2000), Laubach and Williams (2003), and ABW (2008), who consider latent components, which they endogenously estimate. The latent component methodology depends heavily on the initial conditions and the arbitrary selection of some maturities that have to be observed without error as well as some *ad-hoc* restrictions on the parameters (Kim and Orphanides, 2005). Our proposal supposes a less restrictive approach and the results seem to be more robust.

This model and decomposition methodology are applied to the Spanish nominal interest rates during the nominal convergence period that led the Spanish economy to be one of the eleven first members of the Economic and Monetary Union. The decomposition exercise shows a decline in Spanish real risk-free interest rates during the nineties of an order close to 3 pp, a figure significantly lower than the estimations with other methodologies. In fact, Blanco and Restoy (2011) highlights that traditional approaches that produce much higher declines in real risk-free rate, are not compatible with the observed evolution of Spanish macroeconomic figures (such as GDP growth rate or employment rate) and the increase experienced by some asset prices, such as the case of stock or house prices. Moreover, the results show that, during some episodes, long-run expected inflation rates were systematically higher than ex-post actual inflation rates. This finding could very likely be reflecting the uncertainties surrounding the Spanish success in fulfilling the Maastrich criteria on time. In fact, risk premia upturns coincide with the shifts in inflation expectations. Thus changes in inflation expectations and inflation risk premia account for a substantial part of the decrease in nominal interest rates during the convergence process.

The rest of the paper is structured into three further sections. In Section 2, we derive the decomposition of nominal interest rates and in Section 3 we describe the main results for the Spanish economy. Finally, Section 4 concludes.

2. Modeling interest rates

2.1. The affine model

As stated by Piazzesi (2009), affine term structure models allow the risk premium to be separated from expectations about future interest rates. These models have been widely used in the financial literature to price fixed-income assets since the seminal works of Vasicek (1977) and Cox et al. (1985). Including inflation in the specification of the model, as in ABW (2008) and in Carriero et al. (2006), will also make it possible to jointly estimate inflation expectations and real interest rates.

An affine model assumes that interest rates can be explained as a linear function of certain factors,

$$y_{t,t+k} = \frac{-1}{k}(A_k + B'_k X_t) + u_{t,t+k} \qquad u_t \sim N(0, \sigma^2 I) \tag{1}$$

where $y_{t,t+k}$ is the nominal interest rate in period t with term k, X_t is a vector of factors, A_k and B'_k are coefficients and $u_{t,t+k}$ represents the measurement error. Changes in interest rates across time will be the outcome of changes in the factors, whereas differences in the term structure will be driven by the coefficients A_k and B'_k applied.

There is extensive evidence on the predictability of interest rates (see Diebold and Li, 2006), and this feature is usually included in the affine model by assuming that X_t factors follow a VAR structure (in the same vein as Diebold et al., 2006),

$$X_t = \mu + \Phi X_{t-1} + \Sigma \varepsilon_t \qquad \varepsilon_t \sim N(0, I) \tag{2}$$

where μ is a vector of the constant drifts in the affine variables X_t, Σ is the variance–covariance matrix of the noise term and Φ is a matrix of the autoregressive coefficients. The VAR model accounts for the observed predictability in the interest rates but allows, at the same time, some degree of uncertainty in the future values of interest rates, represented by the noise vector ε_t that follows a standard i.i.d. Gaussian normal distribution. In order to avoid identification problems we will impose matrix Σ to be diagonal in Eq. (2), so relationships between factors X_t will be reflected by coefficients of matrix Φ rather than shocks.[1]

In order to avoid arbitrage opportunities, the values of parameters A_k and B'_k of Eq. (1) should be restricted according to Eq. (3),

$$e^{A_{k+1}+B'_{k+1}X_t} = E_t[e^{A_1+B'_1X_t} e^{A_k+B'_kX_{t+1}}] \tag{3}$$

The left hand-side of Eq. (3) represents the valuation of a zero-coupon bond with maturity in $k+1$ that under the non-arbitrage condition should be equivalent to the expected value one period ahead of the same bond with maturity k discounted with the short-term interest rate. As can be seen in Annex 1, solving forward Eq. (3) implies a recursive form for the A_k and B'_k coefficients.

The consideration of risk-aversion in this framework implies some compensation for the uncertainty about longer maturities,[2] in which the random shocks ε_t accumulate. In this respect, it is clear that the higher the variance of random shocks on VAR Eq. (2) (identified by matrix Σ), the greater the uncertainty about future values of interest rates. So, in order to compensate investors for lending money at longer terms, some risk premium related to Σ should be embedded in the nominal interest rates (see Annex 1). Coefficients that translate matrix Σ into the risk premium are called prices of risk (λ_t) and, following the literature, these coefficients are affine to the same factors X_t,

$$\lambda_t = \lambda_0 + \lambda_1 X_t \tag{4}$$

where λ_0 is a vector and λ_1 a matrix of coefficients. If λ_1 is set to be equal to zero, then the risk premium will be constant, while if we leave it unrestricted, we will obtain a time-varying risk premium.

[1] A more general specification of $\sum$ will imply a VARMA approach that would only affect the short-term forecasts but would create identification problems. Given that our focus is on the long-run forecast of the variables, we rely rather on VAR modelling.

[2] Bekaert and Hodrick (2001) reviewed the evidence which suggests that expected returns on long bonds are, on average, higher than on short bonds, reflecting the existence of a risk premium and that this premium is time-varying.