Journal of Banking & Finance 39 (2014) 68–86

Contents lists available at ScienceDirect

Journal of Banking & Finance

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

Applying a macro-finance yield curve to UK quantitative Easing

Jagjit S. Chadha [a,b], Alex Waters [a,c,*]

[a] School of Economics, University of Kent, Canterbury, United Kingdom
[b] Centre for International Macroeconomics and Finance, University of Cambridge, United Kingdom
[c] The Commonwealth Secretariat, London, United Kingdom

ARTICLE INFO

Article history:
Received 23 August 2012
Accepted 4 November 2013
Available online 18 November 2013

JEL classifications:
E43
E44
E47
E58
E65

Keywords:
Term structure of interest rates
Monetary policy
Quantitative Easing

ABSTRACT

We estimate a macro-finance yield curve model for both the nominal and real forward curve for the UK from 1993 to 2008. Our model is able to accommodate a number of key macroeconomic variables and allows us to estimate the instantaneous response of the yield curve and so gauge the impact of Quantitative Easing on forward rates. We find that 10 year nominal interest rates on average are lower by 46 basis points which can largely be explained by three main channels: portfolio balance; liquidity premium and signalling but there is no sizeable impact on real interest rates.

1. Introduction

Over the past couple of decades, researchers have taken a particular interest in trying to determine the macroeconomic factors driving the dynamics of the term structure of interest rates (see, for example, Knez et al., 1994). The workhorse model has been the affine term structure model that relies on a no-arbitrage condition and allows all bond maturities to be priced. The literature here includes Ang and Piazzesi (2003), Rudebusch and Wu (2008), Dewachter and Lyrio (2006), Hördahl et al. (2006) and Ang et al. (2011) as examples. Another direction in which the macro-finance literature moved was to use the parsimonious Nelson and Siegel (1987) set-up in which dynamic yield curve factors are estimated.[1] The flexible Nelson-Siegel curve can approximate the cross-sectional shape of the yield curve and imposing further no-arbitrage assumptions may depress the model's ability to forecast the yield curve and condition on many macroeconomic variables (Diebold and Li, 2006 and Diebold et al., 2006). The literature often focuses on the three macroeconomic variables that are associated with monetary policy: inflation, real output and the policy interest rate. In recent years research has started to extend beyond these variables, such as Afonso and Martins (2012) who study the effects of fiscal variables on the term structure or Dewachter and Iania (2011) on the effects of financial variables. Whilst the number of macroeconomic variables used to explain yield curve dynamics in affine models remain quite limited. This is because affine models have to be solved under both historical and risk neutral measures, for which parameter estimation is computationally burdensome (Borgy et al., 2011).

In this paper we extend a new methodology that allows us to explore the macroeconomic underpinnings of the UK's nominal and real term structure of interest rates that can accommodate a much larger number of macroeconomic variables.[2] In total we examine 31 different macroeconomic variables over five key groups of data: inflation, real activity, monetary and fiscal policy, financial prices and international factors. The estimation is performed in two stages; firstly adopting the state space methodology similar to that of Diebold et al. (2006) and Afonso and Martins (2012). We

* Corresponding author. Address: Debt Management Section, Special Advisory Services Division, Commonwealth Secretariat, London SW1Y 5HY, United Kingdom. Tel.: +44 (0) 20 7747 6300.

E-mail addresses: jsc@kent.ac.uk (J.S. Chadha), a.waters@commonwealth.int (A. Waters).

[1] Some have argued that it is not completely clear whether the no-arbitrage condition is a necessary assumption in a joint macro-finance experiment because bond markets are so actively traded, at least in developed countries, that any arbitrage opportunities would be traded away instantly (Diebold et al., 2005).

[2] See Breedon et al. (2012) for a version of this method applied to the nominal term structure.

0378-4266/$ - see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.jbankfin.2013.11.008

estimate a variant of Nelson-Siegel, which is Svensson's four factor model (1994, henceforth referred to as Svensson), for the forward curve for both the UK nominal and real term structures using a Kalman filter and maximum likelihood estimation. This methodology does not impose no-arbitrage, which reduces the number of parameters that need to be estimated but allows for more flexible forecasting of the macroeconomic variables. Then, by using seemingly unrelated regression (henceforth, SUR) we test down from the 31 different macroeconomic and financial variables to determine which macroeconomic factors can explain the nominal and real forward curve. We do not allow for bidirectional interaction between the macroeconomy and the term structure. We limit our study to the effects that the macroeconomic and financial variables have on the term structure because in the majority of cases there will be lags from the changes in the yield curve and their impact on macroeconomic variables and, in the case, of overseas factors, the impact of the UK yield curve on overseas may be rather limited.

In this paper we make two main contributions. The first is a detailed analysis of the macroeconomic and financial factors that affect either or both of the nominal and the real term structure of interest rates. This literature has previously focused on the nominal term structure but we have also isolated macroeconomic and financial variables that impact on the real term structure. From the 31 macroeconomic and financial variables we identify 10 different variables that have an effect on the nominal term structure in the UK. Amongst these are the variables that concern monetary policy makers, debt-to-GDP and international variables such as the effective exchange rate, measures of German real activity and the Federal Funds Rate. For the real dynamic factors the macroeconomic variables do less well and there are four variables that drive the real curve: debt-to-GDP, inflation expectations, the Libor spread and notes and coins. We identify a net supply effect on government bonds across our included maturities, inflation expectations are more important than actual inflation, and that the exchange rate and international macroeconomic announcements from Germany and the US have an effect on the nominal curve.

This paper builds on the approach of Breedon et al. (2012), who analyse the effects that the first round of QE had on the nominal UK term structure. We develop a more detailed methodology and extend our analysis to include the real term structure of interest rates, as well as offering a decomposition of the impact of QE on the term structure based on the portfolio balance, liquidity and signalling effects. Our model allows for a more detailed and richer conditioning of movements in the term structure than can be undertaken by an events study. Our work is in a similar vein to Bernanke et al. (2004), who use their model to assess the impact of Japanese Quantitative Easing. Also Christensen et al. (2009), who analyse the effectiveness of the central bank liquidity facility that was provided to financial institutions to improve and ease liquidity constraints in the interbank lending market. To analyse the impact of such policy they use a multi-factor affine term structure model of the US government yields and bank credit risk. Both sets of authors perform counterfactual analysis to determine if the path of interest rates had changed drastically in light of the policy action.

Given that central banks typically use the short-term interest rate as their main policy tool, the term structure of interest rates forms a key element of the transmission mechanism of monetary policy. And so the second contribution that our paper makes to the existing literature is a methodology that is well suited for analysing specific monetary policy episodes. We develop this particular contribution further by analysing the impact that Quantitative Easing (QE) in the UK had on the term structure of interest rates. In the UK, the Bank of England's first episode of QE operated from March 2009 to January 2010. We define QE as large scale purchases of government bonds funded by borrowed Central Bank reserves that are implemented when the policy rate is at its effective zero lower bound.[3] To examine the impact of QE we conduct an out-of-sample forecast of the term structure for both the nominal and the real term structure of interest rates across the QE period. The forecasts in each period are conditioned on the estimated coefficients of the statistically significant macroeconomic and financial variables over our estimation sample from March 1993 to December 2008. We assume that the forecasted path is the counterfactual path of interest rates that would have occurred if QE had not been employed by the Bank of England.[4]

Our out-of-sample forecast are similar in size to other recent literature on the first round of QE in the UK such as Caglar et al. (2012) and Meaning and Zhu (2011) with the five year forward and the 10 year forward on average overestimating the actual curve by 60–70 and 40–50 basis points respectively. We find the overestimate of nominal forward rates is plausible both in terms of timing and maturities targeted: the overestimate occurs from March 2009 and maturities greater than 24 months show an over-prediction relative to the actual curve.

Furthermore, we analyse the forecast error by decomposing it into the three channels: portfolio balance, liquidity premium and signalling. The portfolio balance channel represents the supply effect within the bond market in which imperfect substitutability of different assets means that the relative supply of bonds can determine their price. The liquidity premium can be alleviated when a Central Bank intervenes and becomes a large scale purchaser of bonds and improve the functioning of the bond market. Both of these channels should exert downward pressure on longer-term yields and foster an easing in financial conditions and stimulate growth. The signalling channel refers to the market's expectations of the future path of interest rates based on the signals the market receives from both the monetary authorities and the wider macroeconomy leaving the impact on the yield curve ambiguous. One way to uncover the signalling effect is with the use of risk-adjusted market interest rates used to gauge the expected path of interest rates.

Overall we find that all three channels exerted downward pressure on the term structure and we show that it is the signalling channel that plays the most prominent role when QE was first implemented but this effect dissipates as QE purchases were extended. The portfolio balance channel had the largest effect at the end of the sample as the amount of purchases increased. This channel alone is found to reduce yields by as much as 136 basis points at 10 years. The liquidity premium channel does play a small role in reducing yields for the 5 year forward but not for the 10 year forward. On average, the forecast error at 5 and 10 years is 67 and 46 basis points respectively and the average estimated impact that the three channels have on the term structure are 88 and 86 basis points respectively.[5]

The forecast of the real curve does not demonstrate any persistent deviation from the realised path of interest rates. This is an appealing result as the Bank of England did not undertake any

[3] At the time of writing the Bank of England was still using QE as the tool for conducting monetary policy and we focus our analysis solely on what was called the first round of QE which occurred from the March of 2009 to January 2010.

[4] QE intended to stimulate nominal spending and so it could be surmised that the conditioning macroeconomic variables may include the positive impact of QE directly on macroeconomic variables. Implying the impact on the term structure within our forecasts was not independent from QE. But given the policy lag between the implementation of QE and any impact on the macroeconomy we assume that this impact is at most minimal. Also, with regards to the efficacy of QE, we only concern ourselves with the first part of the monetary transmission mechanism, which is the immediate impact on asset prices, in this particular case, bonds. We leave the greater impact of QE on the macroeconomy to others and for future research.

[5] The impact of the three channels sum to more than the forecast error which suggests a further factor such as credit risk may exist. Such a channel may have exerted some upward pressure on the term structure over this time period. We provide some anecdotal evidence in Section 5 for such a factor.