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The yield curve and the macro-economy across time and frequencies ☆

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ABSTRACT

We assess the relation between the yield curve and the macroeconomy in the U.S. between 1961 and 2011. We add to the standard parametric macro-finance models, as we uncover evidence simultaneously on the time and frequency domains. We model the shape of the yield curve by latent factors corresponding to its level, slope and curvature. The macroeconomic variables measure real activity, inflation and monetary policy. The tools of wavelet analysis, the set of variables and the length of the sample allow for a thorough appraisal of the time-variation in the direction, intensity, synchronization and periodicity of the yield curve–macroeconomy relation.

1. Introduction

The last 25 years have witnessed the development of a prolific literature on the relation between the shape of the sovereign debt yield curve and the main macroeconomic variables. Such relation – possibly bidirectional – is relevant for policymakers in a twofold sense: first, the information content of the yield curve may be valuable for the prediction of business cycles, inflation and monetary policy; second, the response of the yield curve may be informative about the transmission of monetary policy and, overall, the dynamic impact of shocks on the macroeconomy.

Early analyses have focused mainly on the slope of the yield curve shape to forecast output or inflation. Typically the authors set *a priori* a number of possible lead horizons for the dynamic relation between the yield curve and the macrovariables, and only infrequently allowed for bidirectional relations (e.g. Harvey, 1988; Stock and Watson, 1989;

☆ The data and the MatLab and GAUSS scripts necessary to replicate all our results are available for download at http://sites.google.com/site/aguiarconraria/joanasoares-wavelets. In the same website, the reader can find and freely download a wavelet MatLab toolbox that we wrote.

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Estrella and Hardouvelis, 1991; Mishkin, 1990a,b,c). Many papers, including recent ones such as Chauvet and Potter (2005), Benati and Goodhart (2008), and Rudebusch and Williams (2009), have used empirical proxies for the slope – in some others, also for the level and curvature – that roughly account for the shape of the yield curve. In such literature, the identification of changes in the relation between the yield curve and the macroeconomy was based on structural break tests (as in, e.g., Estrella et al., 2003; Giacomini and Rossi, 2006).

An alternative literature, following Ang et al. (2006) – with an arbitrage-free model – and Diebold et al. (2006) – with the Nelson and Siegel (1987) decomposition of the yield curve – has specified macro-finance models in which the shape of the yield curve is modelled with a set of latent factors that try to distill the whole information of the curve, at each period of time, into three factors corresponding to the level, slope and curvature. Such macro-finance vector autoregressive (VAR) models allowed for progress in the study of the relation between the yield curve and the main macroeconomic variables along two paths: first, the assessment of bidirectional feedbacks with some flexibility; second, the assessment of time variation, in the continuous framework of time-varying VARs (see e.g. Ang et al., 2011; Mumtaz and Surico, 2009; Bianchi et al., 2009a,b).

The literature so far has been conducted strictly in the time-domain, thus being essentially uninformative about the frequencies at which the relation between the yield curve components and the macroeconomic variables occur. Yet, the co-movement between the yield curve shape and the main macroeconomic variables surely has been subject to time-variation and structural changes not only as regards its intensity, direction and synchronicity (the lead-lag horizons), but also as regards to its frequency. Hence the contribution of this paper: we adopt a time–frequency framework, which is a natural econometric approach to progress in the study of the relation between the yield curve and the macroeconomy; in particular, we employ wavelet tools to study the relation between the level, slope and curvature of the yield curve and macroeconomic activity, inflation and the policy interest rate, in the U.S., across time and frequencies, using the wavelet power spectrum, coherency and phase difference.

To measure the shape of the yield curve, we adopt the decomposition of the curve into three latent factors – level, slope and curvature – of Nelson and Siegel (1987), which has a long tradition in the finance literature, is model-based, accounts for the whole shape of the curve and is implemented by means of formal econometric techniques. Studying the yield curve–macro relation in the time–frequency domain with such a latent factors approach to the yield curve, rather than using empirical proxies, is a further contribution of the paper.

We reach several conclusions. First, the yield curve level has been determined by the fed funds rate (FFR) at low frequencies, especially after the outset of Alan Greenspan's mandate in 1987 at which point the high coherency between these variables moved progressively to cycles of longer period (larger than 12 years). Inflation has led the yield curve level at business cycle frequencies (oscillations of period between 4 and 12 years), but only until 1993, when inflation volatility went down markedly. As expected, the yield curve level has not related closely with real economic activity, unless this is measured by the unemployment rate – less volatile, more persistent, and lagging monthly output growth – which has co-moved with the level with some lag at business cycle frequencies until 2005.

Second, consistent with the monetary policy explanation for the predictive power of the yield curve slope, the FFR and the slope have significantly co-moved in the same direction at all cyclical frequencies across most of the sample period, with the slope either leading or moving contemporaneously. At business cycle frequencies, increases in the slope led increases in inflation and anticipated recessions with a larger lag – consistent with monetary policy reacting to expectations of inflation but impacting only with a lag, first on output and then on inflation. The predictive power of the slope vanished after 1985, when the Great Moderation began, to reappear in 1990 regarding real activity and in 1993 regarding inflation (but here only at cycles of 4–8 years and with a considerably smaller lag, which is compatible with more effective inflation targeting). Since the early 2000s, at the business cycle frequencies, flatter yield curves became associated with expansions, rather than recessions, which led to the well-known yield curve *conundrum* of 2006.

We have not found evidence of a significant role for the curvature either as a leading or as a coincident indicator of economic activity, nor did we find a clear-cut relation between the curvature and inflation. However, during the *conundrum*, the curvature and the slope were good predictors of the FFR, which indicates that the yield curve may have failed to forecast economic activity but not monetary policy.

The remaining of the paper is organized in five sections. In the second section we describe the related literature, showing how its evolution motivates the use of time–frequency methods. In the third section we present the wavelet analysis tools that are used in the paper. In the fourth section we present the data, with a special focus on the modeling and estimation of the yield curve latent factors. In the fifth section we present and discuss our empirical results. Section six concludes.

2. Literature overview

In this section we review the literature on the relation between the yield curve and the macroeconomy. We first describe its evolution regarding the set of yield curve components as well as of macroeconomic variables. We then highlight how time-variation or structural breaks in the yield curve–macro relation became dominant in the literature and how it has remained silent about the frequency-domain aspects of the relation, thus establishing the motivations for our paper. We finally refer to the literature that is closer to our paper, clarifying our contributions.