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Forecasting multiple-term structures from interbank rates☆

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ABSTRACT

The classic relationship between deposit rates and interest rate derivatives has been fractured since August 2007. Uncertainty in the interbank money market has increased the risk premia differentials on unsecured deposit rates of different tenors, such as Euribor, leading to a new pricing framework of interest rate derivatives based on multiple discount curves. This article analyzes the economic determinants of this new multi-curve framework. We employ basis swap (BS) spreads – floating-to-floating interest rate swaps – as instruments for extracting the interest rate curve differentials. Our results show that the multi-curve framework mirrors the standard single-curve setting in terms of level, slope and curvature factors. The level factor captures 90% of the total variation in the curves, and this factor significantly covariates with the spread between financial and risk-free bond yields, a proxy of systemic risk. This variable anticipates future movements of the curve level for all tenors. Moreover, unidirectional causality running from market-wide liquidity to curve residuals is also detected. Finally, we show how the information content in liquidity and systemic risk could improve the forecastability of interest rate curves under financial distress.

1. Introduction

The risk of losses resulting from lending in the interbank money market, or interbank risk, is a recent phenomenon in financial markets (Filipovic & Trolle, 2013). The financial distress that began in August 2007 resulted in a preference for cash flows receiving payments with shorter maturities, increasing the spreads on unsecured deposits, such as Libor or Euribor rates, of different tenors. This uncertainty in unsecured deposit rates has been transmitted to derivative markets because many interest rate-linked instruments, such as forward rate agreements (FRAs) and interest rate swaps (IRSs), reference those interbank rates. This new scenario is characterized by the rupture of classic relationships between deposit rates and interest rate derivatives. For example, deposit rates and overnight interest swap (OIS) rates of the same maturities, which historically evolved with negligible spreads, started to diverge. Similarly, the spreads between the forward rates implied by consecutive deposits and those implied by market FRAs have been significantly different from zero since August 2007. Furthermore, basis swap (BS) spreads and floating-to-floating IRS instruments, traditionally close to zero, have increased to unprecedented levels. These non-negligible discrepancies between the implicit rates of deposit and market instruments have led to a novel multi-curve framework, where the assumption of a unique zero-coupon curve as benchmark for pricing derivative instruments suddenly does not hold. Investors and practitioners now select appropriate term structures according to the tenor of the interbank reference.

This paper analyzes the dynamics of the multi-curve framework, searching for economic drivers that could illuminate this new scenario. We exploit the informational content of BS spreads, a type of IRS in which the parties exchange two floating rate interests. BSs are used to swap interest rate payments linked to short-term reference rates of different tenor for the maturity of the contract. These BS quotes reflect the premium that exists for term lending compared to rolling funding at shorter intervals in the interbank money markets. Our sample focuses on the BS spreads written on Euribor against OISs linked to Eonia, which is commonly accepted as the risk-free reference rate in the interbank market. In this context, the BS spread can be considered a direct measure of the credit and liquidity premia embedded in the multiple

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curves, as it accounts for the difference between lending at longer (risky) Euribor rates against shorter (risk-free) tenors.

This article adopts an orthodox procedure to analyze the multi-curve setting by following the approach in Diebold and Li (2006) for the standard single-curve framework. This methodology extracts the curves at different tenors using the spline fitting of Nelson and Siegel (1987). When applied to BS data, we are able to identify the multiple-curve (main) factors, which eases the process of comparing sets of curve dynamics while taking advantage of the goodness of fit properties of this model. Then, the methodology of Diebold and Li (2006) is used to characterize the information contained in each curve into three parameters that evolve dynamically. These parameters are interpreted as the level, slope and curvature factors of the term structure (Nelson & Siegel, 1987), providing an extensive analysis of the determinants of these curve factors and their relationships to various macroeconomic and financial variables. Additionally, our approach considers the information content of the model residuals, similarly to Hu, Pan, and Wang (2013) or Berenguer, Gimeno, and Nave (2013). The dataset employed here is composed of weekly BS spreads from the Euro interbank market, and it corresponds to different maturities and tenors underlying the Euribor rates. The BS spread market data period ranges from June 2008 to August 2013, including the recent European sovereign debt crisis.

The main contributions of this article to the financial literature are threefold. First, this paper shows that the multi-curve framework mirrors the single-curve framework. We find that information in the multi-curve setting can be divided into three factors explaining the level, slope and curvature, and this information accounts for approximately 97% of the total variation in the spreads. Furthermore, we explore the different sources of commonality among these curves, studying each factor's behavior.

Second, a projection of the time series coefficients onto a set of economic variables shows the role of credit and liquidity risk as determinants of the multi-curve framework. The time series of the factor levels covaries significantly with a proxy for systemic risk, the spread between a bond index of AAA European Financial firms and the German sovereign yields. Analogously, illiquidity in the market, proxied by the ECB liquidity indicator, is statistically significant in explaining the model residuals.

Interested on the role of global credit and marketwide liquidity conditions in explaining the dynamics of the multiple-curves, we finally develop a vector autoregression (VAR) analysis. The results show that our systemic risk proxy anticipates future movements of BS levels for all tenors. In this way, a shock in this financial-sovereign spread leads to a statistically significant response in the BS level factors, suggesting that systemic risk could be the main economic driver of interest rate factors for levels. Moreover, unidirectional causality running from liquidity to curve residuals is detected. In a complementary analysis also based on the VAR methodology, we show how the information content in liquidity and systemic risk could improve the predictability of interest rate curves under financial distress.

The interest rate derivatives market is one of the largest markets worldwide – in terms of notional outstanding, the market accounts for more than 80% of the total amount outstanding of over-the-counter (OTC) derivatives.[1] However, the academic literature on the multi-curve framework is still sparse; see, for example, recent papers by Mercurio (2009), Henrard (2014) and Filipovic and Trolle (2013). This paper belongs to the growing literature on interbank risk. Our work is most closely related to Filipovic and Trolle (2013), who employ a similar dataset but consider a different methodological approach. Additionally, Filipovic and Trolle (2013) focus on understanding the roles of credit and liquidity in explaining interbank spreads in risk premiums, while we seek to characterize the dynamic properties of the multi-curve setting. This strategy permits us to draw important conclusions about the commonalities in the behavior of interest rates in the multi-curve framework beyond examining their sources. A recent series of papers has also analyzed Libor-OIS spreads as measures of interbank risk, emphasizing their credit and liquidity risk components; see, for instance, Michaud and Upper (2008), Schwartz (2010), Eisenschmidt and Tapking (2009) or McAndrews, Sarkar, and Wang (2008). Our research also employs interbank spreads but extends its analysis to the entire term structure of these spreads captured by BS quotes. This strategy allows us to explore a more complete set of information regarding interbank risk because BSs contain information concerning market expectations of future Libor-OIS spreads. In addition, we consider several term structures of BS spreads associated with interbank rates of different tenors. To the best of our knowledge, this paper represents the first attempt to model the multiple curves using the methodology in Diebold and Li (2006).

Thus, this article seeks to characterize the economic determinants of the multi-curve framework using the informational content of BS spreads. The structure of the paper is as follows. Section 2 presents the multi-curve framework and its connection to BSs. Section 3 introduces the structure of the market and the dataset. Section 4 shows the estimation of the multiple-term structures, and Section 5 explores their economic determinants. Lastly, Section 6 conducts an out-of-sample exercise of forecasting, and some conclusions are provided in Section 7.

2. One curve, multiple curves and basis swap spreads

Next, we review the classic link between forward and implicit rates and its connection to the existence of a unique curve for valuation. As is conventional in the interest rate derivative market, we consider simple compounded interest rates.

2.1. The replicating portfolio

The departures of interest rate derivatives market quotes from the classic single-curve framework can be illustrated using the replicating strategy of an FRA, an interest rate derivative contract that guarantees the interest rate on an obligation that will be lent or borrowed in the future. This agreement starts at future date T_i, finalizing at maturity date T_j, where $\tau(T_i,T_j)$ is the time elapsed. Within an FRA, one party decides to exchange a variable or reference interest rate $L(t,T_x)$ with tenor T_x, usually an interbank market reference such as Euribor. Accordingly, her counterparty interchanges a fixed interest rate $F(t,T_i,T_j)$ that is determined at the beginning of the contract. Because FRAs are liquidated at time T_i, the cash flow of an FRA at maturity is the spread among variable and fixed interest rates. The rate $F(t,T_i,T_j)$ is fixed to equalize the present value of EUR 1 at time T_i and the present value of a deposit of EUR 1 from time T_i until T_j,

$$P(t,\ T_i) - (1 + F(t,\ T_i,\ T_j)\tau(T_i,\ T_j))\,P(t,\ T_j) = 0, \quad \text{with } i < j \tag{1}$$

considering as discount factors the prices at time t of zero-coupon bonds with maturity T_x, i.e., $P(t,T_x) = 1/(1 + L(t,T_x)\tau(t,T_x))$.

The cash flows of an FRA can be replicated by combining a long position in a bond with maturity T_i and face value EUR 1 and a short position in a bond with maturity T_j and face value $(1 + F(t,T_i,T_j)\tau(T_i,T_j))$. Therefore, there exists an equivalence between i) entering into an FRA and ii) obtaining funding at different periods. This previous expression may be restated to represent the well-known non-arbitrage relationship between forward and FRA rates. In other words, ignoring that credit and liquidity issues may affect the funding that can be obtained at different periods, the implicit forward rate from deposits and the FRA rate should be equal. This replicating portfolio argument holds regardless of the tenor of the FRA, implying that there should be consistency between the value of a particular tenor FRA rate and the capitalization of shorter tenor forward rates. In this way, the forward

[1] For instance, the notional outstanding of IRS (FRA) contracts was USD 461.3 (82.3) trillion in December 2013, according to the September 2014 BIS Quarterly Review.