Journal of Banking & Finance 59 (2015) 57–75

Contents lists available at ScienceDirect

Journal of Banking & Finance

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

Riding the swaption curve

Johan Duyvesteyn [a,b,*], Gerben de Zwart [c,1]

[a] Robeco, Department of Investment Research, P.O. Box 973, NL-3000 AZ Rotterdam, The Netherlands
[b] Erasmus University Rotterdam, Erasmus School of Economics, Burgemeester Oudlaan 50, NL-3062 PA Rotterdam, The Netherlands
[c] APG Asset Management, Department of Quantitative Equity Strategies, P.O. Box 75283, NL-1070 AG Amsterdam, The Netherlands

ARTICLE INFO

Article history:
Received 4 April 2013
Accepted 6 May 2015
Available online 18 June 2015

JEL classification:
G120
G130
G140

Keywords:
Volatility risk premium
Term structure
Swaptions
Straddles
Bonds
Interest rate derivatives

ABSTRACT

We conduct an empirical analysis of the term structure in the volatility risk premium in the fixed income market by constructing long-short combinations of two at-the-money straddles for the four major swaption markets (USD, JPY, EUR and GBP). Our findings are consistent with a concave, upward-sloping maturity structure for all markets, with the largest negative premium for the shortest term maturity. The fact that both delta–vega and delta–gamma neutral straddle combinations earn positive returns that seem uncorrelated suggests that the term structure is affected by both jump risk and volatility risk. The results seem robust for macroeconomic announcements and the specific model choice to estimate the risk exposures for hedging.

1. Introduction

Previous research in equity and fixed income strongly supports the market price of volatility risk to be negative for both markets. In contrast, investors trade volatility very differently in these markets. The commonly used trading instrument in the equity market is the variance swap (Carr and Wu, 2009), which pays the difference between realized variance and a benchmark variance rate that is set at the start of the contract.[2] On the other hand, institutional investors in the fixed income market hardly use variance swap contracts, but are very comfortable trading over-the-counter (OTC) swaptions to get volatility exposure. An important reason behind this might be a lack of clear benchmark points for volatility trading in the fixed income market. This is illustrated by a gap of 20 years between the introduction of the VIX in 1993 (Whaley, 1993) as a benchmark in the equity markets and the recent introduction of the SRVX index as the first interest rate-based volatility index (Mele and Obayashi, 2012). Only recently, equity variance swaps have been generalized to the fixed income market by Trolle (2009), Mele and Obayashi (2013), Mueller et al. (2013), Li and Song (2013) and Trolle and Schwartz (2014). This is most likely because of the 'non-trivial design issues' (Li and Song, 2013) and a lack of public data due to the OTC market structure. This might explain why, apart from Mueller et al. (2013), these studies focus on studying and replicating variance swap contracts at a single maturity and pay little attention to the term structure of the volatility risk premium. However, swaptions naturally give rise to a maturity term structure.[3]

* Corresponding author at: Robeco, Department of Investment Research, P.O. Box 973, NL-3000 AZ Rotterdam, The Netherlands. Tel.: +31 10 2243405.

E-mail addresses: j.duyvesteyn@robeco.nl (J. Duyvesteyn), gerben.de.zwart@apg-am.nl (G. de Zwart).

[1] Tel.: +31 20 6048182.

[2] See Carr and Wu (2009) for a detailed discussion on variance swaps in equity markets.

[3] A seemingly related, but nonetheless unrelated, line of previous work studies riding strategies on the yield curve instead of the swaption volatility curve. Yield curve-riding strategies are popular investment approaches for fixed income managers to achieve additional returns and have been widely documented; see for example the study of Dyl and Joehnk (1981). Basically 'yield curve-riding' or 'rolling down' strategies buy longer-dated bonds and sell before maturity. When these bonds approach maturity and the yield curve is upward-sloping, they will be valued at a lower yield. A profit will be realized when the bond is sold at the higher price. In contrast to these yield curve-riding strategies, this study is the first empirical research on the significance of long-short straddle combinations that 'ride' the swaption curve. Riding the swaption curve and riding the yield curve thus have in common that their respective forward curves are not realized over time.

http://dx.doi.org/10.1016/j.jbankfin.2015.05.012

This paper complements the literature by a comprehensive empirical analysis of the term structure in the volatility risk premium for the four major swaption markets (USD, JPY, EUR and GBP).[4] We build on Low and Zhang (2005) who relate the volatility risk premium to straddle returns by proving that the average return of a delta-neutral straddle must not be zero if volatility risk is priced. We argue that conclusions can be inferred on the term structure of the volatility risk premium by studying the average return of a long-short combination of two delta-neutral straddles with different maturities. In particular, we study long-short straddle combinations which are either delta–gamma or delta–vega neutral. We are the first to apply these two strategies in the fixed income market. Hence, we provide results showing it is plausible that the delta–gamma and delta–vega neutral strategies can be linked to volatility risk and jump risk respectively, corroborating the equity market findings of Cremers et al. (2015). Since sellers of volatility risk might also desire a jump risk premium to compensate for sudden and extreme losses caused by the unexpected nature of jumps, we use this link to better understand our empirical results. The presence of a jump risk premium is not unlikely because there is evidence for the presence of jumps in interest rates. Johannes (2004) reports a significant impact of jumps on the pricing of fixed income derivatives on Treasury bills. Dungey et al. (2009) relate jumps in the fixed income market to the release of macroeconomic data and show that about 2/3 of jumps can be explained by these releases. Using variance swaps, Li and Song (2013) show in a recent paper, that jump tail risk is time varying in the swaption market.

Our research provides a number of new results. We use a large data set of at-the-money implied volatility quotes on the 10-year swap rate and 1 to 12-month swaption maturities between April 1996 and December 2011 to calculate the returns of the long-short straddle strategies. Our main finding is that we find statistically significant returns for all markets and for both delta–gamma and delta–vega neutral strategies. This finding is consistent with an upward-sloping term structure in the volatility risk premium implying a less negative premium for longer-term swaption maturities. The strategy returns consistently decrease across maturities, which suggests that the risk premium curve flattens for longer maturities. The low, although increasing, correlations between the delta–gamma and delta–vega neutral strategies, that is −23% for the 3 vs 6-month maturity strategy, −4% for 6 vs 9-month and 38% for the 9 vs 12-month, indicate that the two strategies are uncorrelated and probably capture different effects. This suggests that the term structure of the volatility risk premium is affected by both jump risk and volatility risk, especially at short-term maturities. In general, all these empirical findings are consistent across the four individual markets.

Second, it is important to recognize that our strategy is based on the Black (1976) model to estimate the risk exposures for hedging and to calculate the returns. To assuage this concern, we re-run our strategies on the Vasicek (1977) model for all markets and on the stochastic volatility model proposed by (Hagan et al., 2002) for the vega neutral strategy in the USD market.[5] The Hagan et al. (2002) model is also known as the Stochastic Alpha Beta Rho (SABR) model. In the Vasicek (1977) framework we find comparable summary statistics to our main findings for all markets. The vega neutral returns under the SABR model seem, in general, comparable to the returns under the Black model. For example the 3 vs 6-month strategy has a return (Sharpe ratio) of 0.89% (0.60) under the SABR model and 0.85% (0.54) under the Black model. Additionally, we do robustness checks of our findings on the 2-year swap rate and the USD swaption smile, we analyze the impact of macroeconomic announcements, and we empirically check the exposure of the strategy returns to the underlying swap rate.

Third, we study the economic importance of our results. For example, the average return across the four markets for the 3 vs 12-month delta–gamma neutral strategy is 1.89% (t-stat = 4.33) and an annualized Sharpe ratio of 1.35. The delta–vega neutral strategy reports a return of 1.14% (t-stat = 3.69) and an annualized Sharpe ratio of 0.95. However, after calculating break-even costs and comparing these with expected trading costs, we conclude that the returns of the strategies are not realizable by investors and therefore are not economically significant. This corroborates the findings for equity option strategies obtained by Santa-Clara and Saretto (2009).

Our paper relates to several strands of literature. Most importantly our study is directly related to the literature on the volatility risk premium in fixed income. Earlier studies, such as Goodman and Ho (1997) and Duarte et al. (2007), examine the presence and sign of the volatility risk premium in the fixed income market by analyzing the returns of a delta-hedged investment strategy. Since then, Almeida and Vicente (2009) have studied the volatility risk premium of fixed income Asian options, and Fornari (2010) has studied the volatility risk premium by calculating the difference between the implied volatility and forecast of realized volatility using a GARCH model. Recently, a growing body of literature which explores variance swap contracts in fixed income markets is emerging. Variance swap contracts provide model-free estimates of the variance risk premium because no assumptions are made about the price process of the underlying swap rate. Trolle (2009) studies the variance risk premium in the US Treasury market by estimating variance swaps under simplifying assumptions and concludes that the variance risk premium is negative. Merener (2012) studies a variance strategy on forward swap rates. Mueller et al. (2013) and Mele and Obayashi (2013) both analyze variance contracts on Treasury futures. Mele and Obayashi (2013) mainly focus on the theoretical derivation of the contract. Mueller et al. (2013) introduce a variance contract that is robust to jumps and can be replicated in the market at daily frequency. This approach helps them to empirically analyze the variance premium across the maturity and tenor spectrum, and leads them to conclude that the variance risk premium is negative, but less negative for longer maturities (increasing in maturity), and more negative for longer-term swap rates (decreasing in tenor). We see our work complementing theirs, because our data is on swaptions which is a different market, we focus on a straddles trading strategy and we make a distinction between volatility and jump risk. Trolle and Schwartz (2014) and Li and Song (2013) both study variance swaps in the swaption market and both have large and proprietary 'swaption cube' data sets from different providers that include data along three dimensions: swap tenors, swaption maturities and strike rates. Li and Song (2013) focus on jump risk and conclude that jump risk is time varying, while Trolle and Schwartz (2014) study variance and skewness risk premiums which are reported to be time varying and negative.

Our paper is also related to the strand of literature on test design for the existence of volatility risk premia. An important contribution in this field includes Branger and Schlag (2008) who provide a detailed discussion on the limitations of hedging-based strategies. In particular, discrete trading and model misspecification may cause tests to yield unreliable results. Doran (2007) demonstrates that delta–gamma hedged option portfolios are less

[4] Straddles are typically used to speculate on future changes of volatility. A straddle has zero delta exposure at inception. Straddles comprise a combination of a call option (receiver swaption) and a put option (payer swaption) on a swap with the same maturity and the same underlying strike rate. A receiver swaption is a call option on a receive fixed swap where the swaption holder has the right to receive a fixed rate on a swap in the future. A payer swaption is a call option on a pay fixed swap (or a put option on a receive fixed swaption) where the holder has the right to pay a fixed rate on a swap in the future.

[5] The additional data which is required to estimate the SABR model is not available for other markets.