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Linking the interest rate swap markets to the macroeconomic risk: The UK and us evidence

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ABSTRACT

In this paper we aim to link the volatility of interest rate swap (hereafter, IRS) markets to the macroeconomic risk/uncertainty of the UK and the US. In doing so, we obtain the low-frequency volatility of IRS using a recently developed Asymmetric Spline GARCH (ASP-GARCH) model of Rangel and Engle (2012). Our findings suggest a strong relationship between uncertainties of macroeconomic fundamentals and the fluctuation in swap market volatility. The association between the two is robust with respect to the choice of different alternative measures of volatility that are used in the literature on GARCH modelling. From the perspectives of practical implications, the findings suggest that policy makers should use low-frequency volatility in order to examine market responses to key macroeconomic policies, and that market participants may rely on low-frequency volatility to extract trading signals. Using such signals, hedgers could make forecast of whether they need to increase (decrease) IRS usage to hedge risk originating from macroeconomic uncertainty.

1. Introduction

Financial economists have keen interests in guaging the macroeconomic driving forces of the risk and returns on assets, and seek to identify the causal relationship between the financial market and macroeconomic risk or uncertainty (Chen, Roll and Ross (1986), among others).[2] Prior research shows that macroeconomic risk plays an important role for hedging or speculation purposes with the use of derivatives. Beber and Brandt (2009), for example, conjecture that market participants use derivatives to hedge or speculate on macroeconomic risk. Cowen (2009) argues that underestimation of macroeconomic risk is one of the major sources of global financial crises. Among derivative market instruments, interest rate swaps (IRS) has a forward looking feature and has received extensive attention (see, for instance, Beber and Brandt (2009) and Azad, Fang and Wickramanayake (2011)).

The recent BIS (2011) survey indicates that the outstanding 'notional principal' in swaps trading has grown from virtually nothing in the early 1990s to more than US $450 trillion in 2011, which has also surpassed that of the US Treasury debt. The phenomenal growth is also reflected in the Derivatives Usage Survey 2009 of ISDA, in which it shows that ranging from 70 to 94 percent of the world's largest corporations use swaps and other derivative products to manage their business and macroeconomic risks. This paper tests the hypothesis that there is a high (less) incentive for the hedgers to use swaps when macroeconomic risk or uncertainty is high (low). We decompose volatility into two components: (1) high-frequency or short-term volatility and (2) low-frequency or long-term volatility. One important advantage of this volatility decomposition is that, in contrast to the high-frequency component, low-frequency volatility generates a parsimonious volatility term structure that can be modelled as a function of macroeconomic risk to discover the macroeconomic sources of variation in volatility term structure. In addition to examining the responses of low-frequency IRS volatility to changes in macroeconomic risks, this paper contributes to the literature by examining the lead-lag relationship between IRS and macroeconomic risk.

In regards to the benefits of using low-frequency volatility, Engle and Lee (1999), Adrian and Rosenberg (2008), Engle and Rangel (2008) and Azad et al. (2011) show that the low-frequency component represents the slow moving trend that varies systematically with fundamental economic variables. They find that the use of the low-frequency component indicates a stronger relationship between macroeconomic risk and the volatility of the financial market. To our best knowledge, our paper is

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[2] Influential prior research includes: Officer (1973), Schwert (1989), Hamilton and Lin (1996), Diebold and Yilmaz (2008), Lettau, Ludvigson and Wachter (2008), Genberg and Sulstarova (2008), Engle and Rangel (2008), Beber and Brandt (2009) and Azad et al. (2011). Beber and Brandt (2009) define macroeconomic risk as the market participants being unsure about the current state of the economy. We use the terms macroeconomic risk, macroeconomic uncertainty, macro-risk and macroeconomic volatility interchangeably in this paper.

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the first that uses Asymmetric Spline GARCH (hereafter ASP-GARCH) model of Rangel and Engle (2012) to estimate and decompose the aggregate volatility shocks in IRS markets into high and low-frequency components.

Our approach is also in line with that of Azad et al. (2011). Azad et al. (2011) point out that the economically and statistically insignificant (albiet positive) relationship between macroeconomic risk and volatility in stocks, bonds and derivatives markets reported in the extant research is largely due to misspecification of volatility. For example, many studies use aggregate volatility shocks as a proxy for financial market volatility (see, e.g., Schwert (1989), Hamilton and Lin (1996), Diebold and Yilmaz (2008)).

Our sample covers the major international swap markets in the UK and the US for different maturities. The two markets together represent around 40% of the total swap market during the period from June 1998 to June 2010. Data for the empirical analysis span from October 1989 to April 2010 meaning that almost the entire history of swap is incorporated into the empirical analysis.

Importantly, we find a positive and statistically significant relationship between interest rate swaps and most of the macroeconomic variables. We also find that some macroeconomic variables (CPI volatility and money supply in the UK; interest rate volatility and industrial production volatility in the US) are negatively correlated with the US swap market. The explanations of the mixed findings are provided in the result section. In terms of the explanatory power, the results for the UK show the best fit. There is also a bi-directional causality between macroeconomic risk variables and low-frequency IRS volatility for both markets. Interestingly, our findings suggest that swap market volatility leads macroeconomic risk variables, which implies that swap market volatility contains a fair amount of information in predicting macroeconomic risk/uncertainty. Schwert (1989), Engle, Ghysels and Sohn (2008) and Azad et al. (2011) also report similar findings in different financial markets.

We conduct robustness tests including the use of alternative measures of volatility: the benchmark long-term volatility obtained from C-GARCH model of Engle and Lee (1999) and the model-free realised volatility. These alternative volatility measures are then regressed on the macroeconomic risk proxies. The evidence suggests that, compared with these two alternative measures, the low-frequency volatility obtained from using Rangel and Engle's (2012) approach gives a strong link between the swap market and the macroeconomy. Moreover, the use of low-frequency volatility results in higher adjusted R-squared statistics compared to the alternative measures.

The rest of this paper is organised as follows. Section 2 describes the data, variables and a summary of directional hypotheses of macroeconomic risk. We give the methodology in Section 3, and critically analyse the empirical findings in Section 4. Section 5 shows robustness checks and Section 6 concludes.

2. Data and variable description

2.1. Data

We use the swap rates and macroeconomic variables in the UK and the US. We estimate low-frequency volatilities of IRS from daily closing mid-rates on swap maturities of 5 and 10 year. These maturities represent shorter to longer maturities, respectively, and are relatively more liquid than other maturities. Swaps data are collected from DataStream. Since our macroeconomic variables are in monthly observations, while the swap rates are in daily observations, we need to obtain a measure of monthly low-frequency IRs volatilities. The procedure is explained in the methodology section. Data for macroeconomic variables are collected from different sources, which are discussed in Table 1. Empirical analysis covers the period from October 1989 to April 2010. As noted, this sample represents almost the entire history of swap.

2.2. Variable description

The dependent variables are the low-frequency swaps volatilities, while the explanatory variables are the proxies for macroeconomic risk and variables related to economic policies as in Azad et al. (2011). Azad et al. (2011) explain the reasons why those macroeconomic variables are chosen, particularly in swap markets. Taking the same variables also helps us making a cross-country comparison of empirical findings. Since volatilities are not directly observable in each country and for each swap maturity, we estimate the daily low-frequency volatility by using the Asymmetric Spline-GARCH of Rangel and Engle (2012) which is an improvement over that of Engle and Rangel (2008). We then take the average of the daily low-frequency volatilities for the respective month considering 21 trading days in a month. For robustness checks, we also consider two alternative measures of low-frequency volatilities: the benchmark long-term volatility from Engle and Lee's (1999) additive volatility decomposition, and the model-free realised volatility. We obtain these three measures of volatilities for each swaps maturity.

Further, since the theory does not indicate an entirely one-way relationship between financial markets and macroeconomy, we expect a lead-lag/feedback relationship between the two, following Chen et al. (1986), Schwert (1989) and Azad et al. (2011). Studying this relationship has several benefits. First, one can investigate whether policy makers implicate the market reactions (feedback effects) into the

Table 1
Macroeconomic Variables, Proxies and Predicted Signs.

This table summarises the macroeconomic risk variables, relevant proxies and their predicted signs, and the source of data. We take the conditional volatility from GARCH (1,1) to proxy for the volatility of innovations on macroeconomic fundamentals, similar to Bansal and Yaron (2004) and Wachter (2006).

Macroeconomic Variables	Proxies/transformations	Pred. Sign on Low-frequency IRS Volatility	Source
Volatility of industrial production	Conditional volatility from a GARCH (1,1) model obtained from industrial production index	+/−	DataStream
Volatility of CPI	Conditional volatility from a GARCH (1,1) model obtained from seasonally adjusted consumer price index	+	DataStream
Volatility of interest rate	Conditional volatility from a GARCH (1,1) model obtained from short-term bond index yield (3-month)	+	DataStream
Foreign exchange volatility	Option implied volatility, obtained from the real effective exchange rate	+	DataStream
Slope of the yield curve	Difference between long-term and short-term Treasury Bond (TB) yield	+/−	DataStream
Unemployment rate	Changes in seasonally adjusted unemployment rate	+/−	DataStream
Money supply (M2)	(Volume or percentage) changes from the previous month in average amounts outstanding/money stock	+	Central banks, DataStream