

MODELLING THE US SWAP SPREAD

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ABSTRACT

The dynamics between 5-year US Treasury bonds and interest rate swaps are examined using Bivariate Threshold Autoregressive (BTAR) models to determine the drivers of spread changes and the nature of the lead-lag relation between the two instruments. This model identifies the economic –or threshold - value that market participants consider significant before realigning their portfolios. Three different regimes are identified: when the swap spread in the previous week is either high, or low, then the Treasury bond market leads the swap market. However when the swap spread is low, then none of the markets lead each other.

Key words: Swap spread, BTAR Models, regime switching

INTRODUCTION

The objective of this paper is to determine the exact nature of the relation between swaps and risk-free bonds through the application of nonlinear threshold models, which previously have been widely used for investigating the dynamics within currency and stock markets (e.g. [3], [12]). These techniques are specifically applied to an investigation of the lead-lag dynamics between the US Treasury bond and US\$ denominated swap markets where the change in the swap spread is the dependent variable. US Treasury bonds comprise the largest government bond market in the world, while US denominated interest rate swaps comprise daily turnover in excess of US\$81.3 trillion. We build upon earlier investigations in interest rate and swap markets [4,5,6,7,9] by utilising a new class of bivariate threshold autoregressive (BTAR) models [2] to capture the regime-switching, lead-lag dynamics that exist between the two US bond and swap markets.

The BTAR model is chosen for a number of reasons. First, this model provides an exact measure of the economic incentive for a portfolio investor to shift funds, in this case between two financial instruments- the swap and a fixed rate bond of equivalent maturity. This measure, termed a “threshold” or “critical” value in the BTAR model, may also be interpreted as the hidden cost necessary for financial market participants to shift between asset classes. Second, if indeed these thresholds values can be identified, then they can be used to anticipate the change in the yield curve dynamics. This will allow traders to be more cautious in managing risk and help policymakers and central banks fine tune monetary policies. Third, the threshold value can be

expressed in terms of interest rate percentages or “basis points”; a number that can be easily understood and interpreted by financial markets. This is quite different from the information provided by other models, such as Markov Switching Models [8, 11].

DATA

The weekly closing rates of US Treasury bond yields and US\$ interest rate swap rates from January 1995 to December 2004 are used in this study. In line with the market practice for end of week portfolio realignment, we use weekly data. Doing so, also overcomes stickiness that is otherwise evident in daily data. Thus, significant changes in the swap spread is clearer in weekly data, whereas monthly observations lose information, and the number of observations is fewer. The data were downloaded from the Bloomberg Fixed Income Database, on which the Treasury bond yields and swap rates are monitored closely by thousands of traders worldwide. A sample start date in the mid 1990s is more appropriate due to the tremendous growth in the interest rate derivative markets from its commencement in the early 1980s and the more recent structural change in the pricing and trading of swaps, such as the introduction of master agreements from the International Swaps and Derivatives Association, Inc. and the netting agreements for credit risk reduction that were developed in the early 1990s.

Depending on the expected direction of interest rate movement market participants will have a preference for using different instruments when they expect the spread between the two markets (the swap spread) to narrow or widen. There are basically six different scenarios. In the first four of the scenarios, the interest rates in the Treasury and swap markets are moving in the same direction, which means changes in the two markets are positively correlated. In the last two scenarios, the interest rates in the Treasury market and the swaps market are moving in different directions, which means changes in the two markets are negatively correlated.

These different scenarios are detailed below:

- Scenario I – Bond and swap rates rise (positive correlation) with a widened swap spread.
- Scenario II – Bond and swap rates decline (positive correlation) with a widened swap spread.
- Scenario III – Bond and swap rates increasing (positive correlation) with a reducing swap spread.
- Scenario IV – Bond and swap rates declining (positive correlation) with a reducing swap spread. In this scenario, market participants prefer to receive fixed in a swap than purchase government bonds, all other things being equal.
- Scenario V – Narrowing swap spread with swap and bond rates converging (negative correlation). In this scenario, market participants sell bonds and receive fixed in the swaps market simultaneously, which causes a narrowing of the swap spread.
- Scenario VI – Widening swap spread with swap and bond rates converging (negative correlation).

Note that over the sample period the average yield for the five-year Treasury bond is 5.01 percent, and the average five-year swap rate is 5.54 percent, which gives an average swap spread of 52 basis points over the period. The volatilities are similar, at 1.31 percent and 1.32 percent, respectively. Both the bond yield and the swap rate exhibit negative skewness, which means that yields tend to stay at the high end of the range. This is confirmed by the median bond yield and the median swap rate of 5.39 percent and 5.86 percent, respectively, which are higher than the

average over the sample period. Both the bond yield and the swap rate have a bimodal distribution, which means that they tend to remain at either the high end or at the low end of the range. This was in line with the monetary policy of the Federal Reserve over the period, during which the Federal Fund target rate was usually lifted or lowered in consecutive Federal Open Market Committee meetings so that interest rates would either be kept below 3.0 percent to avoid a liquidity crunch, or maintained above 5.0 percent to curtail inflationary pressures in the broader economy.

METHOD

Based on Chan's [1] study of stock indices and index futures, the lead-lag behaviour of the change (Δ) in the US Treasury bond (GOV_t) and the interest rate swap (IRS_t) at time (t) can be examined using the following regression, Equation 1, where ε is a random variable:

$$\Delta IRS_t = a + \sum_{k=-4}^4 b_k \Delta GOV_{t+k} + \varepsilon_t. \quad (1)$$

Given that the change in the Treasury bond yield and the change in the swap rate are stationary time series the Granger causality test (up to lag L) can be performed using the following sets of regressions (Equations 2):

$$\Delta IRS_t = c + \sum_{i=1}^L d_i \Delta IRS_{t-i} + \sum_{j=4}^L e_j \Delta GOV_{t-j} + \varepsilon_t, \quad (2)$$

$$\Delta GOV_t = f + \sum_{i=1}^L g_i \Delta GOV_{t-i} + \sum_{j=1}^L h_j \Delta IRS_{t-j} + \varepsilon_t$$

BTAR modelling techniques are then applied to the examination of the dynamic relationship between the change in the five-year US Treasury yield (ΔGOV_t) and the change in the five-year interest rate swap rate (ΔIRS_t), where, $\mathbf{Z}_t = (z_{1t}, z_{2t})'$ and $z_{1t} = \Delta GOV_t = GOV_t - GOV_{t-1}$, and $z_{2t} = \Delta IRS_t = IRS_t - IRS_{t-1}$. The series under study is the weekly closing prices over the period January 1995 to December 2004, which gives 522 observations. For the threshold variable, defined as $y_t = \Delta SS_t = SS_t - SS_{t-1}$, the weekly change in the swap spread (ΔSS_t) is used.

RESULTS

In the lead-lag analysis the only coefficient that is statistically significant is b_0 . Neither the lead variables (b_1 to b_4) nor the lag variable (b_{-1} to b_{-4}) are statistically significant. The results indicate that there is no lead-lag relationship between the change in the swap rate with respect to the change in the Treasury bond yield for the lead variables, or the lag variable, over the entire sample period. The next analysis involves pairwise testing for Granger Causality. For the entire sample period (January 1995 to December 2004) the null hypothesis that the change in the Treasury bond yield does not Granger-cause a change in the swap rate is rejected (F-statistic = 5.029) at least at the 95% level. The null hypothesis is also rejected for periods from one lag up to five lags (F-statistic = 3.697 to 2.677) at least at the 95% level. However, the null hypothesis that a change in the swap rate does not Granger-cause a change in the Treasury bond yield cannot be rejected, which shows that the change in the Treasury bond yield has only a unilateral causality on the change in the swap rate.

If the sample period is divided into two sub-periods, the first from January 1995 to May 2000, then the result is similar to that for the whole sample period: there is unilateral causality with the change in the Treasury bond yield Granger-causing the change in the swap rate. However, for the first sub-period, the F-statistics (3.853 to 2.352) are only significant (at least at the 95% level) from three lags to five lags. These findings are also consistent with the first sub period and the overall sample. However the F-statistics (7.031 and 3.349 respectively) are only significant (at least the 95% level) for the one lag period and two lag period only. An interesting result is that the change in the swap rate is marginally shown to Granger-cause a change in the Treasury bond yield for one lag period (at the 10% level with F-statistic = 3.855).

Using the BTAR modelling framework, three regimes can now be constructed for the dynamics of the Treasury and the interest rate swaps markets. The first regime occurs when the weekly change in the swap spread is negative and more than 3.3 basis points $\{y_{t-1} \leq r_1 = -0.033\}$. The second regime occurs when $\{r_1 = -0.033 \leq y_{t-1} \leq r_2 = 0.017\}$. The third regime exists when the weekly change in the swap spread is positive and more than 1.7 basis points $\{y_{t-1} > r_2 = 0.017\}$. The weekly lead-lag relationship between the Treasury and interest rate swaps markets in the k -th regime can be examined. If any of the upper off-diagonal elements of the estimated matrices are significant, then a change in the Treasury bond yield has a lead effect on the change in the swap rate. If any of the lower off-diagonal elements of the estimated matrices are significant, then a change in the swap rate has a lead effect on the change in the Treasury bond yield.

CONCLUSIONS

This paper examines the dynamics between US Treasury bond and swap markets using Bivariate threshold autoregressive (BTAR) models. This approach, which may be applied to other interest rate products in other markets, tests whether the lead-lag relationship between the bond market and the swap market is a nonlinear dynamic process, and second whether this relationship is governed by the change in the interest rate differential, or spread, between these two markets.

The findings from the BTAR models may be summarised in Figure 1 where three regimes are identified. In the first regime, the Treasury market leads the swaps market when the change in the swap spread is negative and more than 3.3 basis points on a weekly basis. In the second regime, there is no significant lead-lag relationship between the two markets when the change in the swap spread falls within a narrow range of negative 3.3 basis points and positive 1.7 basis points. In the third regime, the Treasury bond market leads the swaps market when the change in the swap spread is positive and more than 1.7 basis points. Simple lead-lag studies do not reveal any particular information about the dynamics between the two markets. However, Granger causality tests are useful for revealing the overall movement of the two markets, because it shows that the change in the Treasury bond yield can Granger-cause a change in the swap rate. Subjective judgment can enhance the performance of the Granger causality test.

Figure 1 Three Regimes

<p>Regime I – Change in Swap Spread (ΔSS_{t-1}) is more than – 3.3 basis point per week ΔGOV_t leads ΔIRS_t (the coefficient is positive) Number of observations = 83 (15.99% of the total sample) Only 1 lag is significant</p>	$\Delta SS_{t-1} \uparrow < -3.3 \text{ b.p.}$
<p>Regime II – Change in Swap Spread (ΔSS_{t-1}) is between – 3.3 basis point and + 1.7 basis point per week No lead-lag Number of observation = 294 (56.65% of the total sample)</p>	$-3.3 \text{ b.p.} < \Delta SS_{t-1} < 1.7 \text{ b.p.}$
<p>Regime III – Change in Swap Spread (ΔSS_{t-1}) is more than 1.7 basis point per week Mixed lead-lag relation (two conditions) Number of observations = 142 (27.36% of the total sample) First condition ΔGOV_t leads ΔIRS_t (the coefficient is positive) Longer lags (1, 2, 3) are significant Second condition ΔIRS_t lead ΔGOV_t (the coefficient is negative) Lags 2 marginally significant</p>	$\Delta SS_{t-1} \downarrow > 1.7 \text{ b.p.}$

By dividing the data into two sub-periods, we also find that for the second sub-period, the change in the swap rate can marginally Granger-cause a change in the Treasury bond yield for one lag period. However, this information cannot be revealed if a subjective decision is not made. The BTAR model, however, can reveal more information without the use of subjective decision making. The regime switch process can occur in individual observations because the switching is determined by the state of the threshold variable, namely, the magnitude and direction of the change in the swap spread. The dominance of Treasury bonds in leading the swaps market occurs when either a widening or a narrowing of the swap spread occurs. This seems to fall in line with the ‘Flight to Quality’ and ‘Flight to Liquidity’ phenomena and is probably due to the nature of Treasury securities. Usually, no credit limit is required for transactions to be carried out for financial institutions, and Treasury securities have a minimal impact on the balance sheets of various institutions.

Overall, the BTAR model provides a deeper insight than simple lead-lag studies and Granger causality tests into the dynamics between the US Treasury bonds and interest rate swaps markets. Importantly, this approach can be applied to other interest rate product in other markets. By identifying the regimes and the conditions for change in the regimes, market participants and regulators can become more informed about the probable changes that will occur in the Treasury bond and interest rate swaps markets. Similar to the findings of Chappell et al. [3], who identify the bounds within which the French Franc/Deutschmark exchange rate kept to before the launch of the Euro, the movements of the Treasury bond market and the interest rate swaps market are governed by the direction and magnitude of the change in the swap spread. The BTAR model is able to identify the threshold value of the change in the swap spread that bond and swap market

participants considered to be significant. Further research can be conducted to explain the existence of the threshold values.

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