Melanie Cristi
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US Treasury Futures Roll Microstructure Basics

1 Introduction

The Treasury futures roll occurs quarterly with the March, June, September, and December delivery cycle of Treasury futures contracts. Investors with positions in Treasury futures typically roll their positions when the beginning of the contract expiration month approaches. The deferred month, or the next quarterly contract, will become the new front month contract following expiration. Holders of long positions in the front month contract, who typically do not want to take delivery, sell to buy the deferred month contract, while holders of short positions in the front month will buy the front month contract and sell the deferred. This shift in open interest from the expiring front month contract to the deferred contract takes place before the delivery period begins.

For reference, the delivery period can be outlined as follows:

- *First Intention Day* occurs two business days prior to the first day of the expiration month and is the first date that longs may be selected to take delivery. Therefore, long position holders would aim to complete their rolls by this date, or more specifically, by 18:00 Chicago time on this date. By this time, the large majority of the quarterly Treasury roll would have taken place.
- *First Notice Day* is the day after First Intention Day, or the last business day of the month prior to the expiration month. Longs that were matched with shorts on First Intention Day are given instructions on how to take delivery, and the short's clearing firm will invoice the long's clearing firm by 14:00 Chicago time.
- *Delivery Day* is the third final day of the delivery process, and occurs the day after the First Notice Day. This is the day that shorts must have the Treasuries for delivery in their accounts, to be delivered to the longs.

The delivery period ends on the Last Delivery Day. For the 2-year, 3-year, and 5-year Treasury note futures, this occurs on the third business day of the month following the delivery month (April, July, October, January). For the 10-year Treasury note, 30-year Treasury bond, and Ultra T-bond futures, this occurs on the last business day of the delivery month.

This report outlines key research components that must be analyzed when constructing an algorithm for trading the Treasury roll. Before delving into the research, we highlight two important factors of the US Treasury futures market microstructure:

- The timing of the US Treasury Futures Roll, and
- The matching engine for US Treasury Futures Spreads (CME).

1.1 Timing the Treasury Futures Roll

The Treasury futures roll period generally occurs during the 2–4 days before the First Intention Day. This is the optimal time to roll a futures position because of the opportunity to take advantage of peak liquidity.

Figure 1 shows the average posted size for each calendar spread contract compared to its outright counterpart, averaged across six roll events from March 2010 through June 2011. First Intention Day is marked by 0 on the x-axis, illustrating that the bulk of roll activity, in terms of posted liquidity, occurs within the four days preceding it.

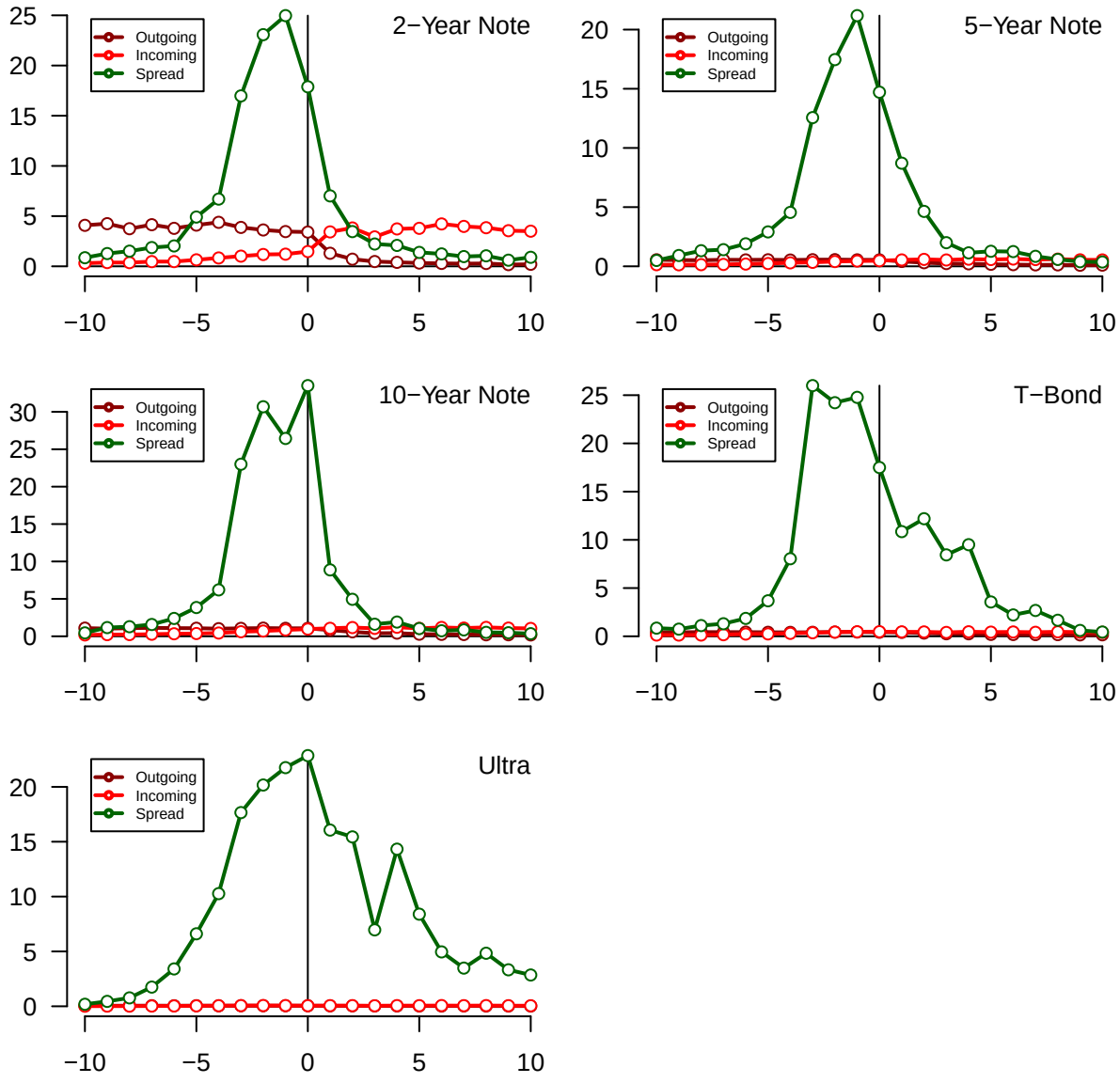

Figure 1: Posted size for spreads and outright contracts for the 5-year note. For all graphs, the horizontal axis is business days relative to First Intention Day, and the vertical axis is posted size (bid plus ask) in thousands of lots. During the roll period a few days before intention day, liquidity in the calendar spread is vastly greater than liquidity in the legs.

1.2 The Roll Matching Engine

Traders of the Treasury futures roll often assume that passive fills do not exist or are otherwise unattainable. Our research reveals the contrary. An often-overlooked aspect of trading the Treasury futures roll is the matching engine used by the exchange (CME Group) to assign fills. The matching algorithm used for all Treasury spread contracts is "Split FIFO/Pro-Rata." Fills are allocated so that a percentage of every order is filled either FIFO or pro-rata. Pro-rata allocation for US Treasury futures spreads equals 100%. The fill allocation sequence is as follows:

1. TOP order = 100% allocation, then
2. Pro-rata allocation, 2 lot minimum (100%), then
3. Pro-rata leveling of 1 lot, based on original order size, and finally
4. FIFO on any residual lots.

Knowledge of the exchange's matching engine algorithm can be taken advantage of by using optimal order placement strategies to capture passive fills. Additionally, it is important to note that Treasury future spread contracts are Reduced Tick (RT) spreads, a feature unique to CME Group US Treasury futures. While the standard calendar spreads trade in published tick size of 1/32 or 1/2 of 1/32, the RT spreads trade in a reduced tick size of 1/4 of 1/32.

Currently, CME group provides detailed quote data only for the 2-year and 5-year note Treasury futures. Our analysis of quote data of these two spread contracts from an average of the previous four roll cycles reveals that 85–90% of market orders are pro-rata fills, while 10–15% of market orders are allocated fills under time priority. This matching algorithm characteristic should become much more apparent to discern beginning on September 18, 2011, when CME Group will begin publishing individual match events for all Treasury spread contracts. In addition to the 2-year and 5-year Treasury futures spreads, the reporting will also include 3-year note, 10-year note, 30-year Treasury bond and Ultra T-bond futures spreads (as well as 2-year note futures outrights and Eurodollar futures).

2 Research Components

2.1 Volume Curves of US Treasury Spread Futures

Economic events and data releases undoubtedly drive activity in interest rate markets, and this is no exception during the roll period. Events that occur during the roll cycle could impact the timing of when market participants precisely decide to roll their positions. We analyze liquidity patterns during significant macroeconomic events that occur during the roll period in order to anticipate shifts in volume and/or volatility. We track over 100 economic events/data releases and their impact on market volume and volatility. The events include FOMC meetings and rate decisions, Treasury and European debt auctions, and data releases, such as non-farm payrolls.

To analyze the impact of these events during the roll cycle, we first create a base profile using the exponentially weighted rolling average of the spread volume during the past ten rolls, starting from March 2009. Subsequently, we calculate the impact of each significant event that is scheduled to occur during the roll period and layer this profile on top of the base profile. An event is considered statistically significant if it has occurred on at least three occasions within the ten previous roll cycles.

Significant events that are scheduled during the upcoming roll period include, but are not limited to, the following:

- GDP,
- New Home Sales,
- Durable Goods Orders,
- Pending Home Sales,
- Minutes of FOMC Meeting,
- US Treasury Auction: 2-year note, and
- US Treasury Auction: 5-year note.

The volume curve forecast is published for each spread contract daily from five business days before and after first intention day. The forecasted curves are used by our execution algorithms to generate a volume-based trade schedule for every incoming VWAP order.

2.2 Volatility Curves of US Treasury Spread Futures

Economic events that cause large spikes in volume naturally also cause swings in volatility. Market reactions to the information are varied in terms of speed, timing, and position-taking, and thus execution algorithms must also be prepared for market volatility. As with the volume curves, our volatility curve forecasts track the impact of significant market events using the exponentially-weighted historical volatility using data from the past five rolls, starting in June 2010. However, in addition to the historical data, we us a real-time intraday volatility calculation.

This intraday/historical volatility model is also used by our algorithms, upon receipt of an incoming order, to generate the order's trade schedule bands. This means that during periods of higher volatility, the schedule bands will tighten towards TWAP in order to mitigate exposure to volatility. Each individual spread contract has its own volatility scaling factor, that is, if an event impacts short-term interest rates more than long-term interest rates, the scale will be higher (and the bands tighter) for the short-term contracts.

Figure 2 illustrates the volume and volatility forecasts that we have statistically generated for the 10-year note contract, for Monday, August 29, 2011 of the upcoming roll period, the business day prior to First Intention Day. The blue lines represent the projected percentage of total daily volume in 15 minute intervals. The red lines represent the projected volatility in ticks per 15 minute intervals. The economic data events scheduled for this day are PCE Core (MoM, YoY), Personal Income, and Personal Spending.

Our research has found that across all spread contracts, liquidity dissipates approximately 15 minutes prior to the scheduled event. This probably occurs because the outcome of the event is unknown, so most market participants withdraw from the market. Once the data is released publicly, liquidity is replenished gradually in relation to the market reaction to the event. The staggered response causes volatility in the markets that must also be analyzed by the algorithm.

2.3 Large Trades

Traders of the Treasury futures roll often look to large prints in the market as indicators for when the larger players in the market are adjusting their risk into the deferred month. A common assumption is that the bulk of the large trades occur all at once, causing a significant shift in open interest. However, we have observed that large trades actually

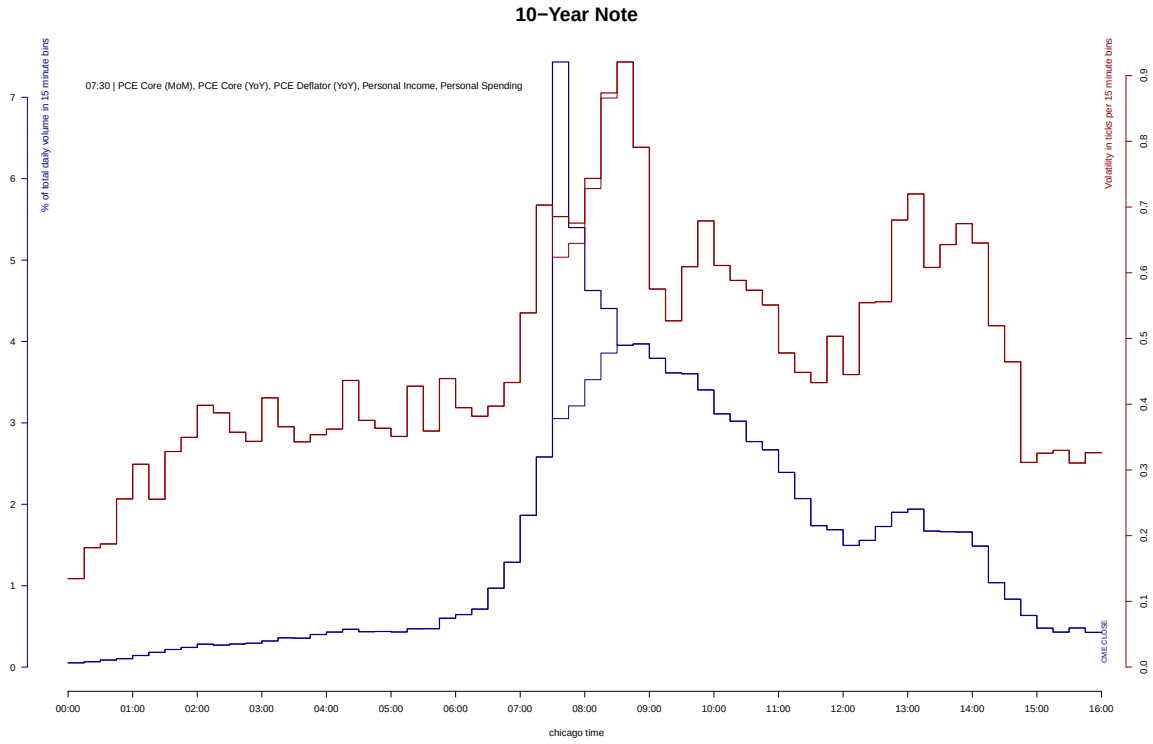

Figure 2: Volume/volatility curve forecast for August 29, 2011, for the 10-year note.

occur as early as one week before intention day, and that they are spread out across each day prior to intention day.

Table 1 shows the table of large trade prints that occurred during the June 2011 roll cycle. The maximum trade size for all Treasury futures spread contracts is 30,000. We calculate the five largest trades that printed for each spread contract. Notable observations:

- Most large trades occurred in the morning (Eastern Time).
- The largest trades occur in the 10-year note futures spread.

3 Summary

Algorithmic execution of Treasury spread futures requires thoughtful consideration to the market microstructure of the US Treasury futures roll. Many of the aforementioned concepts are often overlooked, yet can contribute to an advantageous reduction in transaction costs when utilized using a systematic approach.

For more information, contact `sales@quantitativebrokers.com` or `646.293.1800`.

Contract	Date	Time (EST)	Side	Price	Traded Size	Intended Size	Residual Size
ZFM1-ZFU1	23-May-11	9:34:23 AM	S	1.1328	13452	13452	0
ZFM1-ZFU1	24-May-11	7:47:51 AM	S	1.1641	12080	14000	1920
ZFM1-ZFU1	24-May-11	9:49:33 AM	S	1.1641	10806	10806	0
ZFM1-ZFU1	25-May-11	8:21:42 AM	S	1.1563	20000	20000	0
ZFM1-ZFU1	26-May-11	7:35:30 AM	S	1.1641	10000	10000	0
ZNM1-ZNU1	24-May-11	10:55:46 AM	B	1.3750	12642	12642	0
ZNM1-ZNU1	25-May-11	8:54:12 AM	B	1.3750	12642	12642	0
ZNM1-ZNU1	26-May-11	7:43:49 AM	S	1.3672	19999	19999	0
ZNM1-ZNU1	26-May-11	11:30:36 AM	S	1.3594	15572	15572	0
ZNM1-ZNU1	31-May-11	7:54:28 AM	B	1.4063	15000	15000	0
ZTM1-ZTU1	24-May-11	10:40:51 AM	B	0.3906	20881	25000	4119
ZTM1-ZTU1	25-May-11	8:20:34 AM	S	0.3828	25000	25000	0
ZTM1-ZTU1	25-May-11	8:23:31 AM	B	0.3828	25000	25000	0
ZTM1-ZTU1	25-May-11	10:16:10 AM	B	0.3828	16898	16898	0
ZTM1-ZTU1	26-May-11	6:36:57 AM	S	0.3906	21425	23107	1682
ZBM1-ZBU1	24-May-11	9:18:33 AM	B	1.3047	14698	16000	1302
ZBM1-ZBU1	25-May-11	11:00:41 AM	S	1.2969	11920	11920	0
ZBM1-ZBU1	25-May-11	8:42:16 AM	B	1.2969	10255	10255	0
ZBM1-ZBU1	25-May-11	3:21:28 PM	B	1.3047	7996	10869	2873
ZBM1-ZBU1	26-May-11	8:33:49 AM	S	1.3125	10794	10794	0
UBM1-UBU1	23-May-11	10:30:57 AM	S	1.4922	20000	20000	0
UBM1-UBU1	23-May-11	12:52:17 PM	S	1.4922	9934	9934	0
UBM1-UBU1	24-May-11	8:00:14 AM	B	1.5000	9999	9999	0
UBM1-UBU1	24-May-11	8:00:24 AM	B	1.5000	9999	9999	0
UBM1-UBU1	26-May-11	7:36:18 AM	S	1.5000	11463	11463	0

Table 1: Five Largest Trades for Treasury futures spreads during the June 2011 roll.

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