THE VALUE OF MILLISECOND EXPIRY OPTIONS IN SPOT FOREIGN EXCHANGE MARKETS

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Abstract

The spot foreign exchange marketplaces are split into two types by their respective trading rules: markets with conventional resting orders versus markets with resting that orders that include optionality. This optionality is owned by the counterparty who placed the resting order and provides the option to refuse the aggressive order matched against the resting order. This paper describes and contrasts these two types of markets. A valuation method for these very short expiry options on the later marketplace is proposed. Appropriate historical volatility metrics are defined and applied for these uniquely short expiry timescales. These historical volatility and valuation methods are used to describe some historical intraday periods, and are applied to various trading scenarios. Unique behaviors driven by the value of these options are highlighted. The benefits and risks of trading on these markets are described in light of this valuation approach. The effects of various addition constraints on the liquidity providers for these optionality matching marketplaces are introduced. Through judicious timing of order placement and appropriate constraints on the behaviors of the liquidity providers on these markets, the result is shown to be tighter spreads, greater breath and depth of liquidity, and the high fill ratios than the more conventional non-optionality matching markets.

Keywords: Forex, Foreign Exchange, Latency Arbitrage, High-Frequency Trading, Regulation, Low Latency Traders, Market Making

1. INTRODUCTION

In the global electronic foreign exchange markets there are two types of markets which are distinguished by the different types of orders that are placed and executed. In the more conventional matching markets, resting bids and offers are placed (by the "maker") and aggressive buys and sells (placed by the "taker") are matched against these resting orders. Though the bid or offer can be withdrawn under most circumstances, once the resting order has been matched with an "aggressive" buy or sell, the order will be executed pending any credit issues. This market will be referred to as an "Orders Crossing Orders" (OXO) market.

Uniquely for foreign exchange, there is a second type of market where bids and offers are continuously provided ("streamed") to specific pools of counterparties by the maker. When one of these counterparties (the taker) attempts to deal on one of these resting orders, this aggressive order attempt (referred to as a "request") is relayed to the maker of the passive order and the maker then decides whether to fill, partially fill, or reject this request to trade (from the taker) on the maker's posted, resting order. This process will be referred to as "last look (LL)" market making, that is, the maker of the resting order is given an option on whether to honor the taker's request to trade on the maker's resting order. This unusual market practice arose to protect the maker from latency arbitrage (Norges Bank, 2015) by the takers at the dawn of making of electronic FX markets by banks for their clients. This second market type, LL, (perhaps due to its uniqueness and optionality) is subject to increasing scrutiny by various international regulators (Bank of England, 2015).

In order to provide a quantitative framework for these discussions, this paper will develop an approach to value these individual last look options, their value as a stream, and the appropriate historical volatilities to support these valuations. The differences between an OXO market and a LL market are then discussed, and the various unique requirements placed on LL markets are discussed in light of this valuation approach. With quantitative valuation available, the benefits and risks of participating in the LL markets as both takers and makers are explored.

There is little academic literature concerning last look market making, perhaps due to its exclusivity to FX spot markets and the proprietary knowledge the models would represent. A theoretical modeling of the effects of the last look optionality on the performance of the last look market and the impact on other markets both last look and OXO (Cartea, 2015) predicts some of the benefits reported in this paper. An option based approach, conversely for the OXO markets, modeled the firm bids and offers as written puts and calls owned by the takers as a method to predict the bid offer spreads (Copeland, 1983). Recent literature has also been generated by various regulatory agencies (Norges Bank, 2015; Bank of England, 2015) expressing concerns about the last look marketplaces without providing any models or data for analysis.

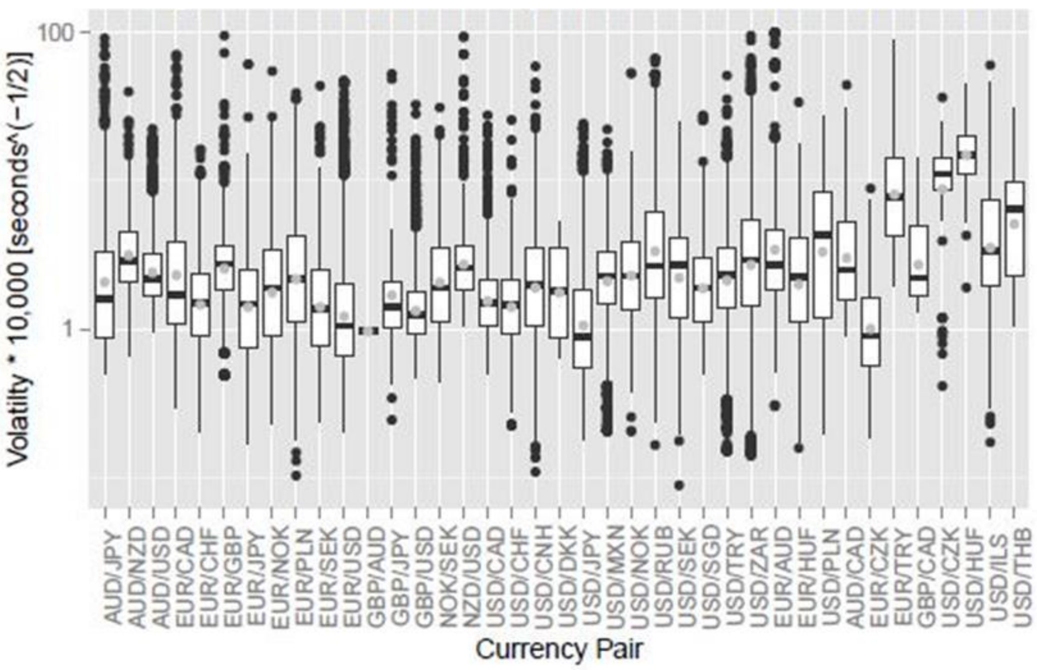
2. VALUATION

This last look decision typically can take from 50 to 500 or more milliseconds and represents an option sold by the "taker" by the request to buy or sell at the posted price (posted by the "maker). It is proposed that these exceptionally short expiry options can be appropriately valued within the Black Scholes (Black, 1973) framework with an appropriately calculated volatility. In fact, this work will show that the valuation is primarily driven by the assumptions made for the volatility used in valuing these unusual options.

3.1 Historical Intraday Volatility

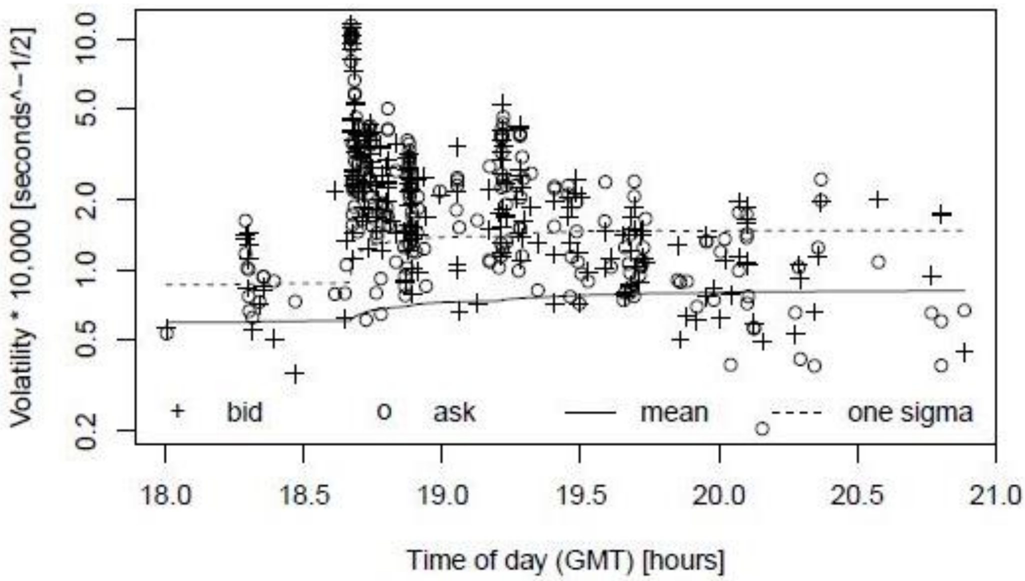
A number of assumptions must be made to compute an appropriate intraday volatility to be used in valuing options of expries under one second. Since the maker and taker both participate on either the bid or the offer side of the market, the volatility for both bid and offer are calculated independently. This approach both avoids the fluctuations due to trades at either price (Roll, 1984) and represents a more accurate valuation of the option since bid and offer volatilities can differ significantly over these time scales. The time series of bids and offers to be used for these volatility estimates will be taken from the primary OXO market (either EBS or Reuters). Both these markets have a fixed pricing update frequency though a price may not be updated at every opportunity. The updates are between 100 and 250 milliseconds, on the same order of magnitude as the expiries. Newer OXO markets provide continuous updating, which provides additional complexity and noise without compensatory improvements in estimation of volatility. In order to capture the intraday variations in price volatility, the intraday volatility is calculated with a moving window of either 20 significant updates or one minute, whichever is shorter. A significant update is one with either a price or size change in the resting bid or offer. Volatilities are calculated separately for bids and offers. Another complication is the occasional absence of any bid or offer, often during times of great volatility or in uncommon, illiquid pairs. These rare occurrences are ignored for lack of a better approach, and are rare enough to appear to not significantly impact the estimates. Another concern is the appearance of a significant update after a long (order of seconds) quiescence period. Since the update frequency is fixed on whichever OXO market is used for the specific pair, it is assumed that the maximum time period for this update is the update frequency. This approach provides a realistic upper bound of the latency of the change. It should be noted that shorter update frequencies can occur through a variety of processes: the book is updated upon fills or misses, and there are multiple feeds for each OXO market due to credit screening and redundancy. A minimum update frequency, therefore, is also defined to provide a reasonable minimum bound representative of the market providing the data. Finally, when older resting orders are uncovered due to a removal or exhaustion of the top of book quote, the uncovered rate is considered new for the purposes of volatility estimation. Given this computation process, the distribution of intraday combined bid and offer volatility for a number of currency pairs for the month of December, 2015 is given in the Figure 1 below

Figure 1. Historical Volatility on Order of Seconds Horizon



As can been seen in Figure 1, the intraday volatilities have significant variance for each pair and across pairs. Of particular interest for the valuation of the optionality of last look quotes is the behavior of the windowed intraday volatility (and the variance of this volatility) during periods of high activity during the day. Figure 2 shows the windowed volatility, the day's mean windowed volatility, and the day's variance of the windowed volatility.

Figure 2. EUR/USD Intraday Volatility on 12/16/2015

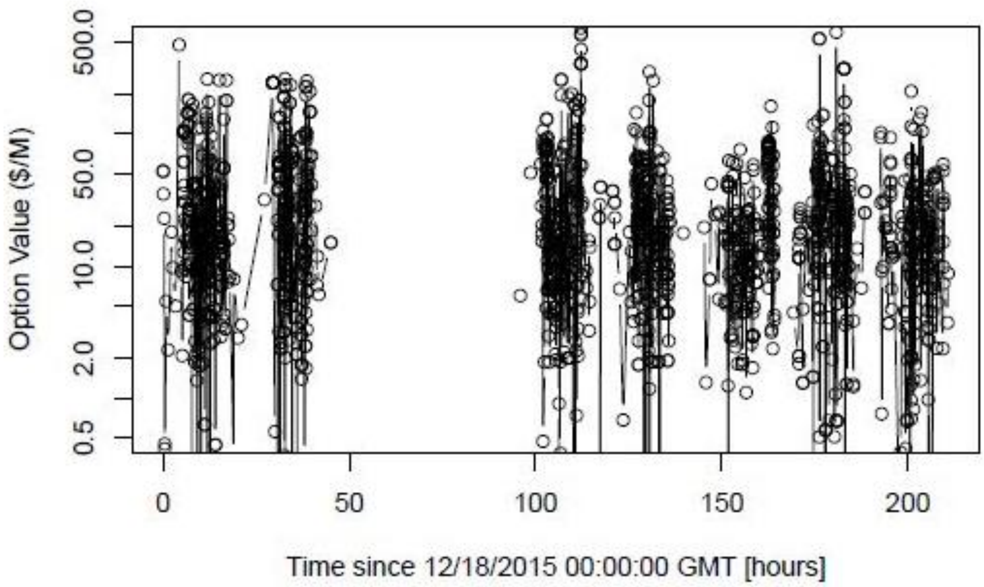


As Figure 2 demonstrates, the windowed volatility can vary greatly during the day, with periods of volatility an order of magnitude greater than the day's mean. It is contended that these excursions in windowed intraday volatility drive the valuations of Last Look market making overall.

3.2 Use of Windowed Intraday Volatility for Option Valuation

With these windowed volatilities, at the money put and call option valuations can be calculated with the standard Black Scholes model (Black and Scholes, 1983). The value of the stream, however, is also dependent on the takers' requests. Without the request there is no option to value. Rather than attempt a simulation of order arrivals, Figure 3 uses a historical stream of requests from takers and the resultant option values.

Figure 3. At-The-Money option values over multiple trading days



These valuations appear reasonable compared to the actual value of these trades over this historical period. They may be a bit overvalued since volatilities are calculated on the previous quote movements (which may have triggered the order request) and the actual value of the option will depend on the future quote movements. Of equal if not greater importance are the sensitivities to the various parameters these valuations provide. These sensitivities are crucial for both trading and regulating LL marketplaces.

Using the mean volatility (104% annualized), expiry (200 milliseconds), and strike (at the money) used for the historical period of Figure 3, the table below shows the actual sensitivities of the option value (per $M notional) to these parameters:

sensitivity	$/M	units
expiry	$106	$/M-notional-sec
strike	$500k	$/M-notional
volatility	$175k	$M-notional

3. Last Look Market Maker Requirements

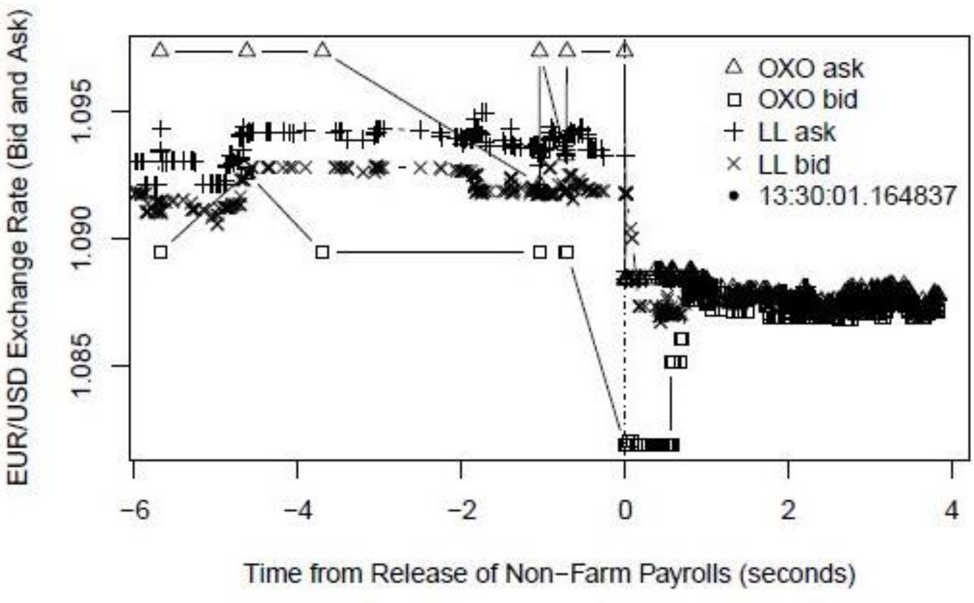
The market makers on Last Look marketplaces are receiving millisecond expiry options. The counterparties ("takers") on these markets are selling these options. As in any competitive marketplace, competition between makers reduces some of the value from these options through three major requirements on the market makers:

1. Spreads: Spreads are expected to be tighter than the OXO markets.
2. Fill rates: Both trade count-based and volume-based fill ratios are points of competition between the makers. Typically, the takers require 60 to 85% fill ratios. These fill rates are much higher than the fill rates found on OXO marketplaces and require the LL makers to accept some uneconomical requests.
3. Response times: Perhaps even more important to informed makers are the response times, i.e. how long the maker can hold the request which is, in fact, the expiry. Generally hold times greater than 350 milliseconds are unacceptable and hold times no longer than 150 milliseconds or less are now starting to be required. Algorithm trading requires shorter response times than manual traders. OXO markets vary widely on response times with EBS taking as long as over 400 milliseconds on occasion. Reuters will typically respond on the order of 10 milliseconds with longer responses (as much as double) during times of very high volumes.
4. Maximum quote update frequency: This requirement appears to be more for the benefit of the owner of the infrastructure (less required bandwidth) than for the takers, though the net effect is to increase the spread and thereby reduce the value to the takers. There is also a psychological detriment for manual traders when the prices change faster than they can click (or even perceive).

4. Last Look Market Behaviors

When an important measurement of the economy is about to be released, the spreads on OXO markets widen, reflecting the informational uncertainty immediately before an important release. Conversely, spreads on Last Look markets will tighten immediately before a release, in hope of capturing the optionality of the requests when the information is released. Figure 4 demonstrates this behavior for the Non-Farm payrolls release in December, 2015.

Figure 4. Non-Farm Payrolls OXO versus LL December, 2015



5. Conclusion

The benefits of participating as a taker in last look markets are tighter spreads, greater apparent liquidity, and better fill rates. The benefits for the makers are ownership of these extremely short expiry options, (which in principle will prevent latency arbitrage), and increased volumes and resultant market visibility.

The risks of participating in LL markets for the taker are selling an option to the maker of possible indeterminate expiry. As the Figure 4 shows, the value (as taken to the be the large difference in spread between the OXO markets and the LL markets) of these options increases dramatically at the scheduled times of uncertainty (i.e. economic releases).

To counter these disadvantages to the taker, the marketplace on which the LL markets participate enforce a number of additional requirements on the makers. One requirement that is easily valued with the methodology described in this paper is a hard limit on the length of the expiry period. This requirement is quite helpful in preventing some of the more egregious behaviors of some makers. Another common requirement on the maker is a volume fill ratio, typically as high as 80% or more of the volume of requests made. This particular requirement is beneficial to the takers in ensure fill ratios significantly better than the equivalent OXO markets. Additional requirements sometimes seen include requirements on the frequency of updating bids and offers, and on the symmetry of cancellations.

By judicial use and timing by the taker, and by appropriate constraints on the maker by the marketplace, the LL markets provide tighter spreads, greater breadth and depth of liquidity, and better fill ratios than the equivalent OXO markets.

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