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THE ROLE OF LAST LOOK IN FOREIGN EXCHANGE MARKETS

ASSET MANAGER PERSPECTIVE

Last Look is a unique feature of foreign exchange (FX) markets that gives liquidity providers the option to reject orders received from liquidity takers in response to the provider's quote. This feature is effective in reducing the risk of latency arbitrage in a fragmented, high-speed market place with no centralised price discovery.

Last Look introduces execution uncertainty for investors. We evaluate Last Look in terms of the impact on investors and from the viewpoint of 'well-functioning markets'. We first characterise Last Look as an option contract. Using our own execution data across global FX pairs, we also study the impact on the liquidity taker over time, particularly if one of the options was 'exercised' in Last Look and the order rejected.

Last Look serves a legitimate need of liquidity providers, and can help improve available liquidity to investors. However, there are intrinsic conflicts related to the asymmetry in optionality it introduces, as well as the potential for misuse of private information. We advocate greater transparency in the application of Last Look. We also believe that monitoring of liquidity providers' behaviour will continue to be a crucial element in maintaining fair implementations of Last Look.

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Introduction

The foreign exchange market has a number of unique features. Transactions take place bilaterally over-the-counter (OTC), or they are handled via one of multiple electronic communication networks (ECNs). This fragmented market operates without a consolidated tape recording quotes and trades, leading to opacity about historical or current price levels. This introduces the risk of latency arbitrage. Foreign exchange liquidity providers (LPs) have developed 'Last Look' in response – a unique market structure feature that gives the LP the option to reject orders received from liquidity takers in response to the provider's quote. This option is in effect for a certain amount of time, typically measured in milliseconds, which we call the evaluation period. In other words, the LP's quotes are non-firm, and the LP gets one 'Last Look' or chance to decide whether to take the other side of the order. Last Look is prevalent in FX markets – both in bilateral OTC trading with a customer (typically in larger trade sizes) and on ECNs. However, the implementation of Last Look by LPs is neither standardized nor, in many cases, transparent.

The issues that Last Look are meant to address are not unique to FX markets. Other markets – equities in particular – have come up with alternative solutions for these issues. This means we can compare Last Look to these other solutions in terms of the impact on investors such as ourselves, as well as on the well-functioning of markets overall.

Last Look and the solutions in other markets are an attempt to address several issues facing LPs. First, LPs might receive orders from market participants with better information about future prices – a fundamental information asymmetry[1]. Second, a fragmented, high-speed market place can give rise to 'relativistic prices', where prices at any point in time are not known with certainty. In this case, information asymmetries might be the result not of better fundamental information, but of better technology. The LP provides a quote to other market participants – either bilaterally in an OTC market structure or through a multilateral ECN or exchange. This quote encapsulates the LP's best estimate of current prevailing market prices, an assessment of potential information asymmetries, combined with the LP's risk tolerances and existing inventory positions.

LPs will update their quotes as any of those factors change. However, given the fragment market place, they may not receive new information about some of these factors as fast as other market participants, which can give rise to latency arbitrage – a fast-moving market participant may exploit a LP's stale quotes that do not reflect changing market prices, for example. If the stale quote is far enough away from the now-current prices (more than the bid/offer spread), there is the potential for risk-free arbitrage. A fragmented and high-speed marketplace exacerbates this problem. In the limit (arguably reached in both FX and equities markets), prices become *relativistic*

1 This has long been recognised in the academic literature, where markets are modelled as consisting of informed traders, 'noise' traders, and a liquidity provider that cannot distinguish between the two, at least ex ante. See seminal work by Glosten, Lawrence and Paul Milgrom, "Bid, Ask and Transaction Prices in a Specialist Market with Heterogeneously Informed Traders," Journal of Financial Economics, *14, 1985, and Kyle, Albert, "Continuous auctions and insider trading",* Econometrics *53, 1985.*

and depend on the observer's location. In this case, protection from latency arbitrage becomes crucial for LPs.

In equity markets, this has led to a technological arms race amongst both LPs and liquidity takers, building optimised private networks that collate price information from exchanges and other trading venues. This arms race introduces a dead-weight cost of trading, which ultimately has to be borne by investors. It has also introduced more uncertainty about prices and instantaneously available liquidity. Posted limit orders are typically much smaller now than they were before Reg NMS was introduced in the US equity market. The average life span of orders is much shorter, with cancel-to-trade ratios for all US stocks hovering around 20 – in other words, 20 out of 21 limit orders get cancelled before they get executed[2]. From an investor perspective, equity markets are thus characterised by lower instantaneous, displayed liquidity and greater price uncertainty.

FX LPs have similarly invested heavily in technology in response to this potential latency arbitrage. In addition, Last Look has categorically made time more granular and reduced latency arbitrage opportunities. Compared to equity markets, this has reduced the LP's incentives to reduce quote size for a given bid/ask spread, leading to greater instantaneously available liquidity. However, from an investor's perspective, Last Look introduces execution uncertainty (compared to the price uncertainty in equity markets).

The service of LPs is clearly valuable to the market as a whole, and should be adequately rewarded. Both equity markets and FX markets have developed solutions to the issue of latency arbitrage, which have enabled LPs to limit the potential of persistent negative profits from latency arbitrage. However, the question is what the impact of these innovations is on long-term investors. In the next section, we describe Last Look as an option overlay, and show the impact that it has on the expected payoff profile of a liquidity taker. We consider how this impact differs from that in equity markets, where shallower instantaneous liquidity and greater price uncertainty introduce a different set of issues. We then discuss other potential issues that arise from a market with a Last Look feature, and describe how we monitor and control for these issues.

Last Look as an Option Contract

LPs provide quotes to other market participants, either through a limit order book (such as in equity markets) or following a request for quote (RFQ). The quotes provide optionality to the other market participants – they can either respond to the quote with an order, or they can ignore the quote. If they respond with an order, the LP has to contend with the possibility that the order placer is better informed about prices, and hence is taking advantage of the LP. Better information, in this context, could refer either to better fundamental information, or to faster price feeds (stale quote, or latency, arbitrage).

2 Source: U.S. Securities and Exchange Commission SEC MIDAS (http://www.sec.gov/marketstructure/midas.html).

Last Look is a mechanism to control this informational asymmetry. As of today, there is very little academic literature on this topic. This may reflect a scarcity of data available to researchers, or a limited focus on this unique market structure. In one recent academic working paper, Cartea and Jaimugal (2015)[3] examine the motivation for risk-neutral LPs to implement Last Look functionality in the context of informational asymmetries and latency arbitrage. They show that in a market with both better informed Latency Arbitrageurs and slower real-money Fair Traders, Last Look will reduce the quoted spread on a single trading venue. The amount of the reduction is a function of the proportion of Latency Arbitrageurs in the market. However, if there is competition in trading venues, venues with the Last Look feature may quote larger spreads due to signalling effects.

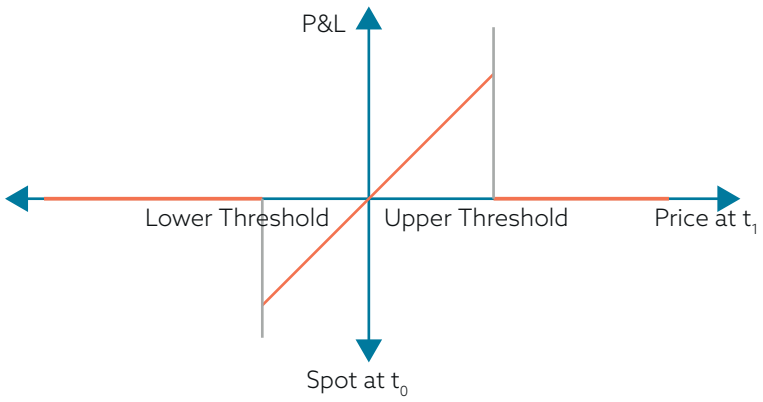
Cartea and Jaimugal (2015) model the LP as risk-neutral, and show how Last Look impacts the quoted spread, for varying rejection thresholds. Conceptually, this is equivalent to modelling Last Look as an option contract, where the liquidity taker sells an at-the-money option to the LP that knocks in if prices are outside the 'upper' threshold at expiry of the option. For the purchase of a currency, for example, this involves the simultaneous selling of a call option.

The thresholds can be either asymmetric or symmetric. In the asymmetric case, the LP rejects orders if prices have moved against the LP, but accepts them if they have moved against the liquidity taker. In the symmetric case, the LP rejects in both cases. This means that in addition to selling an at-the money option to the LP, the liquidity taker simultaneously purchases an at-the-money option from the LP that knocks in if the price has moved against the liquidity taker by more than the 'lower' threshold at expiry. Using the example of the purchase of a currency again, this involves the purchase of a put option on the currency, with a 'lower' threshold knock-in once prices have moved against the liquidity taker. Note that in the case of both symmetric and asymmetric thresholds, the LP learns about the intended trade direction once the liquidity taker responds to the quote with an order.

At expiry (that is, at the end of the evaluation period), the payoff profile to the liquidity taker of a purchase with symmetric rejection is depicted in Figure 1. In the case of asymmetric rejection, losses would be unlimited (i.e. there would be no lower threshold). This discontinuous payoff function only captures the position of the liquidity taker at the time of a particular transaction. In the case of the order being rejected, the liquidity taker may have to re-submit an order at a later time.

3 Cartea, Álvaro and Jaimungal, Sebastian, "Foreign Exchange Markets with Last Look", SSRN Working Paper, http://ssrn.com/abstract=2630662, July 2015.

Figure 1: Payoff Profile of Last Look for Liquidity Taker at End of Last Look Period



The discontinuity in the payoff introduces complexity in evaluating the impact of Last Look on investors as liquidity takers. In the case of asymmetric Last Look, the liquidity taker should receive a premium for the option written to the LP. This premium takes two forms – tighter bid/ask spreads, and greater quote depth[4]. In the case of symmetric Last Look, the net impact on the liquidity taker is more ambiguous since it involves both the purchase and the sale of an option.

Modelling Last Look as an option contract helps to characterise the interaction between liquidity taker and LP each time an order is placed. However, we also need to look at the impact on the liquidity taker over time, particularly if one of the options was exercised in Last Look and the order rejected. In this case the LP has private information about the trading intentions of the liquidity taker. This private information is potentially valuable, particularly if the liquidity taker has exogenous reasons for trading the FX pair (such as the need to fund the purchase of another asset), rather than an expected return forecast (or 'alpha view') on a currency.

The Impact of Last Look on Investors

Last Look is one approach to handling the potential of aggressive latency arbitrage in a fragmented market. It preserves quote depth at tight spreads, but introduces execution uncertainty, in contrast to the equity market approach which preserves execution certainty but reduces quote depth.

While Last Look is serving its purpose of controlling the impact of latency arbitrage *at a particular point in time*, the execution uncertainty potentially impacts the trading performance of a long term investor over time. This intertemporal impact is related to the release of private information about

4 Cartea and Jaimungal (2015) show that different threshold levels lead to different equilibrium spreads, but also different rejection rates. In particular, rejection rates under very tight thresholds may be so high that the effective cost to the liquidity taker increases when accounting for the cost of rejected trades. Cartea and Jaimungal also show that in the case of multiple trading venues, equilibrium dynamics may mean that venues with Last Look do not display tighter spreads than those without Last Look.

trading intention. In the case of an order rejection, this release of information is not compensated for by an executed trade.

In a market with Last Look, the dissemination of information about trading intention occurs in stages. First, in an RFQ environment, information about interest in a given currency and a given size is revealed, though not the side. In a competitive RFQ process, this is exposed to multiple counterparties. In the second stage, sending an order to the counterparty with the best quote reveals the side of the trade intention (buying or selling of a currency).

The winning LP now has complete private information about the trading intentions of the liquidity taker. This information can be used in several ways. First, there is the potential of 'pre-hedging' during the evaluation time. If this is successful at a favourable price, the liquidity taker's order is accepted; otherwise, the order could be rejected at the end of the hold time. If the LP rejected every order where pre-hedging was not successful, this would represent a riskless profit to the LP.

Second, the LP can retain the information about trading intentions even after the order was rejected at the end of the Last Look hold time. In the limit, this information can be collected cost-free by rejecting all orders while retaining the information. This is unlikely in practice, but we would expect rational LPs to make use of the private information gathered, regardless of whether they accepted the order.

In the case of trading via ECNs, the information dissemination process is simpler and more limited. LPs typically provide a continuous quote stream to the ECNs, so will not receive any information about interest in a currency until an order is placed by the liquidity takers. At this point, the LP has information about the size and direction of the trade intention. Importantly, the identity of the liquidity taker is not revealed, since ECNs typically maintain anonymity through prime brokerage arrangements that remove the need for credit checks. This means that the LP's private information is limited to the size and direction of the trade intention. While this can be valuable in the expectation formation about future prices, it is more limited than in the case of the OTC RFQ process.

In many cases, large investors have to trade FX orders (for example, to fund the purchase of an asset in a foreign currency), and may have limited flexibility in the timing of these orders. In such cases, the private information gathered about trading intentions can then be used at a future time when the large investor initiates another RFQ process to trade the same order that had been rejected earlier. We would expect to see less competitive quotes at that point, to the detriment of the investor.

Managing Potential Conflicts of Interest

Last Look serves a legitimate need of LPs, and can help to improve available liquidity to clients. However, there are significant intrinsic conflicts embedded in Last Look, primarily related to the asymmetry in optionality that is introduced, as well as the potential for misuse of private information.

The absence of a consolidated tape of quotes and trades in FX markets, particularly for OTC transactions, makes benchmarking LP behaviour more complex than in equity markets. Ensuring that potential conflicts of interest are mitigated involves monitoring and benchmarking the pool of counterparties that serve as potential LPs using metrics that can be established without reference to a consolidated tape.

We believe that platform providers, who establish connectivity between liquidity takers and LPs for OTC transactions, as well as ECNs have a role in the policing of LPs. They have a more centralised and complete view of LP behavior than the liquidity takers. Unfortunately, interests are not always aligned between platform providers and liquidity takers. As a result, we have developed our own set of metrics, necessarily more restricted than those that could be employed by platform providers, to monitor LPs' behaviour.

Some of the metrics we monitor are static – such as the rejection thresholds, the maximum evaluation periods permitted, and the symmetry of the thresholds. These metrics may be subject to negotiation, or may reflect the technology setup of the counterparties and the RFQ process used.

A second set of metrics we monitor concern the quoting and rejection behaviour of counterparties. This includes the percentage of time counterparties provide the best quotes, and the rejection rate stemming from Last Look. We condition these metrics on currency pairs, trade size, and on prevailing volatility regime, amongst other factors.

The third set of metrics involves the price action in a currency pair following the rejection of an order through Last Look, and the quoting behaviour of the counterparty that had rejected the order. Based on a prevailing volatility regime, we analyse how likely subsequent quote prices are under the assumption of no exploitation of the private information about our order.

Our counterparties differ substantially across all of these metrics. For example, several of our counterparties have to date not been able or willing to implement symmetric thresholds in their Last Look process. Rejection rates differed substantially across counterparties but did not, in general, appear to be a function of trade size or price volatility. This suggests that risk management considerations did not play a significant role in the decision to reject an order. We do observe some evidence of adverse skewness in the distribution of price moves following a rejected trade, though this may be a function of the time period and currency pairs we looked at.

The evidence we have gathered suggests that Last Look's potential benefits, such as tighter spreads and deeper liquidity, accrue to liquidity takers without disproportionate costs from rejected trades on average. This likely reflects the highly competitive market for LPs, limiting their ability to extract gain from the private information about trade intentions.

Nevertheless, we believe that continuous monitoring is essential to managing the conflicts of interest inherent in Last Look. This monitoring influences our RFQ process, in particular, where we have introduced dynamic selection of counterparties on a per-order basis.

The Role of Last Look

Financial markets have come up with a number of different solutions to the problem of potential latency arbitrage in fragmented, high speed market places. Last Look, the solution developed in FX markets, is effective in dealing with this problem, and has the potential to deliver tighter spreads while maintaining relatively greater quote depths. However, it introduces uncertainty in execution, since an order can be unilaterally rejected by the LP. This solution is in contrast to those of other markets. In equity markets, for example, quotes are generally firm and hence execution is certain. The cost in equity markets is a much reduced quote depth.

While Last Look is effective in dealing with latency arbitrage, it, together with the OTC nature of FX markets, introduces a number of potential conflicts of interest that require careful monitoring by liquidity takers. We have developed a number of metrics to assist us in that process; we believe that other large investors need to spend time developing similar metrics that are appropriate for their investment process.

In addition, we believe that platform providers and ECNs should also take greater responsibility for monitoring and policing the behaviour of participants, particularly LPs. The current revenue model for platform providers, in particular, may make this difficult since aggressive monitoring would lead to conflicts of interest. We are in favour of developing revenue models that align the interests of platform providers more closely with those of investors as liquidity takers, if that results in the platform providers taking greater responsibility for monitoring.

There are three areas, in particular, where we believe that greater transparency, in conjunction with better monitoring by platform providers, would be beneficial for the well-functioning of FX markets. First, the evaluation period should be limited to price comparisons only, which is sufficient to prevent latency arbitrage. We believe that more prescriptive codes of conduct for LPs are needed in this regard. In addition, the protocols between LPs and platform providers need to provide for auditable timestamps and effective ex-post monitoring.

Second, OTC dealers as LPs need to be more transparent about their implementation of Last Look thresholds. The expected payoff profiles of LPs with asymmetric thresholds will be different from those with symmetric thresholds, giving an advantage to the first group in a competitive RFQ process. To level the playing field, we need transparency about the implementation of these thresholds. Some LPs provide symmetric thresholds only on their proprietary platforms, for example. Others offer some form of price improvement if prices move in the liquidity taker's favour. From an asset manager's perspective, we would like to see this on third party platforms as well, with the liquidity taker given the choice of being rejected or receiving price improvement should markets move in the liquidity taker's favour.

Third, the reasons for order rejection need to be made more transparent. Rejections that serve the purpose of limiting the potential for latency arbitrage are an acceptable feature of current FX markets, in our view. Other reasons for rejection may not be. We believe that transparency around rejection reasons, together with auditable timestamps, will serve to improve market quality.

We recognise that the bilateral, OTC nature of FX markets makes a regulatory approach to transparency best practices problematic, but note that several studies such as the recent Final Report of the Fair and Effective Markets Review[5] in the UK have raised the issue of greater transparency in FX trading, including Last Look practices. There have been a number of efforts in establishing acceptable codes of conduct, such as the ACI Model Code[6], which prescribe both transparency around the implementation of Last Look and acceptable uses of the private information gathered by LPs. The Bank of International Settlements has also established a Foreign Exchange Working Group which is tasked with facilitating the establishment of a single global code of conduct standard, which is intended to be principles-based.

We welcome these efforts, and believe they can help in establishing acceptable conduct in FX markets. However, monitoring of LP behaviour by investors will continue to be a crucial element in maintaining fair implementations of Last Look and managing the potential conflicts of interest.

5 HM Treasury, Bank of England and Financial Conduct Authority, "Final Report of the Fair and Effective Markets Review", http://www.bankofengland.co.uk/markets/Documents/femrjun15.pdf, June 2015.

6 ACI The Financial Markets Association, "The Model Code", https://acifma.com/model-code, February 2015.