MULTI-ASSET TRANSACTION COST ANALYTICS

FX Agency Cost Estimator

Supporting trade horizon decisions for schedule-based FX algos

OBJECTIVE

Awareness and management of optimal trading horizons and market participation is an important consideration for FX best execution and risk control. In the equity markets, a trader employing schedule-based or implementation shortfall strategies must often specify variables relating to an order's time horizon. Once done, the algo divides the trading horizon into intervals and the strategy attempts to source the liquidity targeting the market volume participation within the specified timeframe. However, because FX markets are open 24 hours, there is no standard horizon target except when a specific time to completion is guided by regulatory or workflow deadlines (for example, 16:00 GMT fix time).

The choice of horizon is an important consideration for multi-asset algo traders. Recent empirical studies show that variability of parent order execution costs can be explained by order duration almost as well as by order size or participation rate. In practice, most broker algo executions are completed within 30 minutes of release, with many taking as little as ten minutes or less.

In this paper, we review TWAP and other strategy-based analytics available via Virtu Analytics' FX Cost Curves. Using the tool, a trader only needs to provide a single parameter that quantifies the level of volatility-risk sensitivity, and an optimal trading horizon can be obtained from the cost and risk profiles contained within the new FX Agency Cost Estimator (ACE) model. We also examine how FX ACE optimal horizons vary with order size, time of the day and the currency pair in question. We provide guidance on the volatility-risk sensitivity—a key user input.

FX COST CURVES

FX ACE Cost Curves provides pre-trade cost, impact, risk and other pre-trade information associated with uniform (TWAP), volume participation (VWAP) and several other trading strategies for more than 100 currency pairs. Outputs are provided for a variety of scenarios that include a wide range of target notional values (between 5M and 1,000M), execution horizons (between five minutes and six hours) and order arrival times spanning the 24-hour FX trading cycle.

In the absence of a directional alpha signal, the customary shortfall optimization (minimizing expected implementation shortfall cost) would involve spreading out child order executions as far from each other as possible. However, since this can expose the order to significant volatility risk, the strategy is of limited interest. A better approach may be to liquidate large open currency positions algorithmically within minutes instead of hours, helping traders to strike a balance between reducing price impact and keeping the volatility risk at bay.

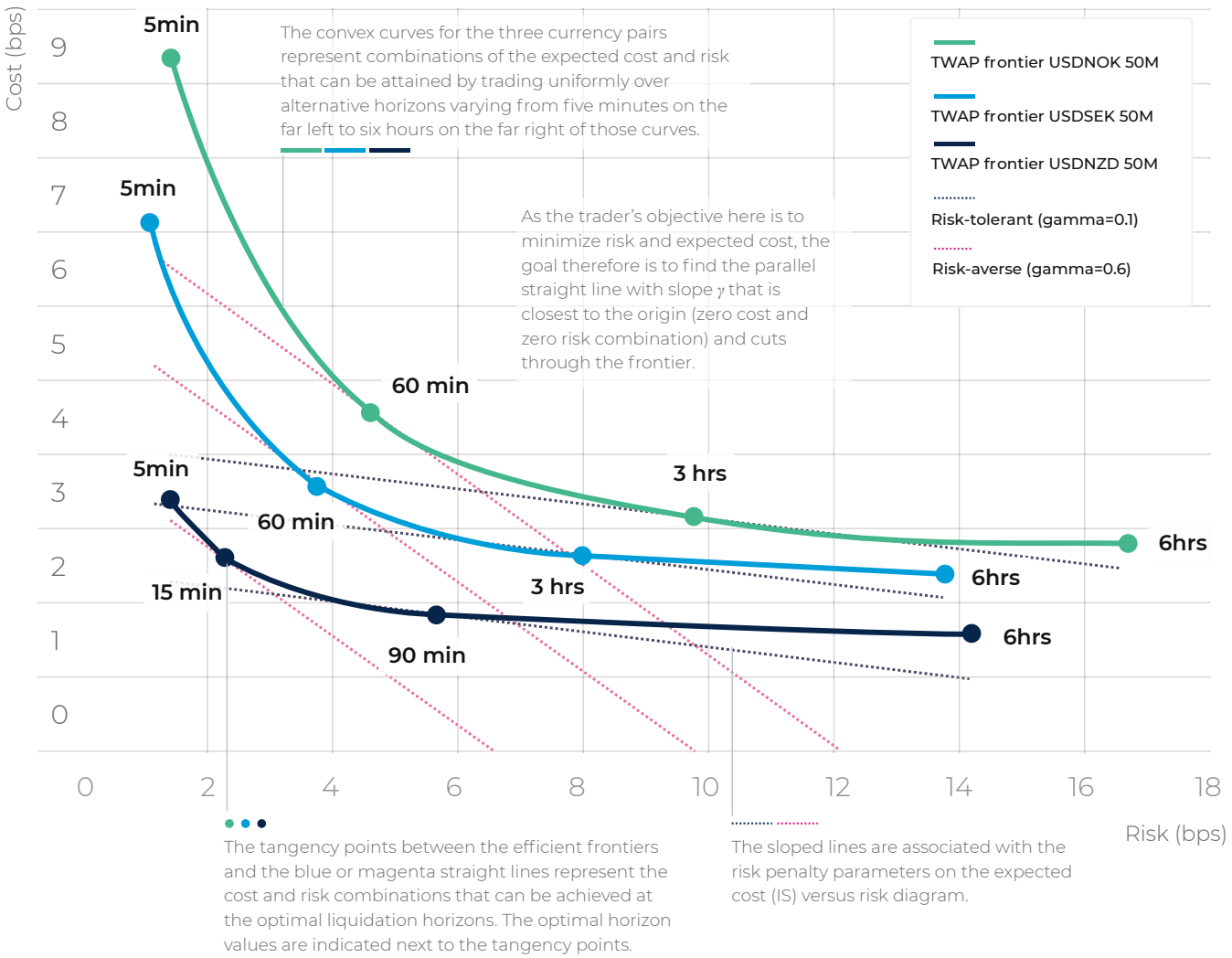
The FX trading horizon, due to the lack of a hard liquidation deadline, depends on the size of the open position relative to the market volume (liquidity), volatility and spread[1].

For simplicity, we assume that a trader utilizes TWAP (uniform) strategies over the liquidation horizon that is chosen to minimizemarket impact and spread costs and reduce exposure to market volatility. These factors are also included in the FX ACE and FX ACE Cost Curves products.

In Figure 1, TWAP's optimal time horizon to liquidate a 50M position is calculated[2] for three currency pairs: USD.NOK, USD.SEK and NZD.USD. The start time for all three pairs is 06:00 GMT—before the FX market liquidity starts picking up around 07:00 GMT. We first consider the risk penalty:

- **Risk-averse (gamma=0.6)** characterizes a trader who is willing to sacrifice the cost increase of 60 mils (1 mil = 0.01bps) in exchange for a single basis point risk reduction.
- **Risk-tolerant (gamma=0.1)** characterizes a trader who is willing to accept only a small cost increase of 10 mils for one basis point of risk reduction.

Figure 1: TWAP Optimal Horizons for 50M in USD.NOK, USD.SEK and NZD.USD with arrival time of 06:00 GMT



Source: Virtu Analytics

[1] Study methodology note: For simplicity, in this paper we assume that the trader utilizes TWAP over the entire liquidation horizon, choosing this strategy to help minimize market impact and cost spread and reduce market volatility exposure. To account for the trader's risk aversion, we factored in a volatility penalty (proportional to standard deviation of the profit/loss for the order balance) for execution in progress over the specified liquidation horizon.

[2] Optimal time horizon notation: $T^* > 0$ depends on the risk aversion parameter $\gamma > 0$. The expected cost of the TWAP strategy associated with this optimal horizon is then obtained as $Cost(S, T^*)$.

The more risk-tolerant trader whose cost-risk indifference sets represented by shallow straight lines can afford to trade the relatively risky Scandinavian currencies against Euro gradually over the three-hour horizon, while the more risk-averse trader with steeper indifference sets should trade more aggressively and finish the same order within approximately 60 minutes. For the more liquid NZD.USD, the risk-tolerant trader should execute optimally within 90 minutes whereas the risk-averse trader within 15 minutes, as waiting longer does not lead to the expected cost savings that justify the associated volatility risk increase.

Moreover, additional performance improvements may also be achieved in the optimization framework supported by FX ACE, which can help in determining optimal and risk-constrained optimized (OPT) trading schedules. The schedules are usually tilted to order arrival times, resulting in larger portions of an order being filled early in the release. The same process would apply to yield the combinations of cost and risk penalties that are located slightly below and to the left of the tangency points associated with TWAP optimal trading horizons.

PROPERTIES OF TWAP OPTIMAL HORIZONS FROM FX ACE

Table 1 shows the optimal liquidation horizons for multiple currency pairs determined by the method described earlier, using the cost versus risk diagrams for notional values of 50M (in the left half of the table) and 250M (on the right-hand side of the table) that are subject to liquidation by TWAP on behalf of the same risk-tolerant trader (characterized by γ=0.6) at different times of the day from 0:00 to 23:00 GMT.

Note: The long optimal execution horizon for the less liquid pairs, especially for large notional values, indicates the lack of sufficient liquidity in those pairs during the Asian market hours.

Table 1: FX ACE Optimal Execution Horizons by Time of Order Arrival and Currency Pair

Arr.time (50M)	EURUSD	USDJPY	GBPUSD	AUSUSD	USDMXN	EURCHF	EURNOK	USDNOK	EURDKK
0:00	5	5	10	10	45	60	120	90	360
1:00	5	5	10	5	30	60	120	60	360
2:00	5	5	10	5	45	60	120	60	360
3:00	5	5	15	10	45	90	240	90	360
4:00	10	5	15	15	90	120	240	180	360
5:00	10	5	15	15	90	90	180	120	240
6:00	5	5	10	10	60	60	90	60	120
7:00	5	5	5	5	20	20	30	15	60
8:00	5	5	5	5	10	10	10	5	30
9:00	5	5	5	5	5	5	10	5	20
10:00	5	5	5	5	10	5	10	5	20
11:00	5	5	5	5	10	10	10	10	15
12:00	5	5	5	5	10	10	10	5	15
13:00	5	5	5	5	5	10	5	5	10
14:00	5	5	5	5	5	5	5	5	10
15:00	5	5	5	5	5	5	5	5	10
16:00	5	5	5	5	5	5	5	5	5
17:00	5	5	5	5	5	10	20	10	15
18:00	5	5	5	10	5	20	45	15	20
19:00	5	5	5	10	5	30	45	20	30
20:00	5	5	5	10	5	30	45	20	30
21:00	5	5	5	15	10	30	30	20	15
22:00	10	10	10	60	10	240	240	240	360
23:00	20	15	30	30	90	120	180	180	360

Arr.time (250M)	EURUSD	USDJPY	GBPUSD	AUSUSD	USDMXN	EURCHF	EURNOK	USDNOK	EURDKK
0:00	30	10	45	20	120	180	360	240	360
1:00	20	10	45	15	120	180	360	360	360
2:00	30	15	60	20	360	360	360	360	360
3:00	30	20	60	30	360	360	360	360	360
4:00	45	20	60	30	240	240	360	240	360
5:00	45	20	90	30	180	180	240	240	360
6:00	30	20	45	30	120	120	120	120	240
7:00	15	15	20	20	60	60	60	45	120
8:00	5	10	10	15	30	20	20	15	90
9:00	5	10	10	15	30	15	20	15	45
10:00	5	15	10	20	45	15	30	20	45
11:00	10	15	10	20	45	20	30	20	45
12:00	10	15	10	20	30	20	30	20	45
13:00	5	10	10	15	10	20	15	15	30
14:00	5	5	5	10	5	15	20	10	30
15:00	5	5	5	10	5	10	15	5	20
16:00	5	5	5	10	5	10	15	10	10
17:00	10	10	10	20	10	30	45	20	30
18:00	10	15	15	30	10	60	120	45	45
19:00	15	20	20	30	15	90	120	60	90
20:00	20	20	20	30	15	90	90	45	60
21:00	20	30	30	45	20	45	45	45	30
22:00	180	120	180	120	240	360	360	360	360
23:00	90	60	120	60	180	240	360	360	360

Source: Virtu Analytics

The optimal trade horizons and FX ACE costs share some common properties:

- **Optimal trading horizon** an increasing function of notional order size or participation rate and a decreasing function of the risk penalty factor.
- **Estimated IS cost** an increasing function of the participation rate, volatility and spread.
- **Cost of the optimal horizon** the strategy grows with a slower rate of participation iin comparison to that of a TWAP strategy in a fixed trading horizon scenario.

Since the order implementation shortfall and risk penalty are both proportional to asset price volatility, the optimal horizon is largely unaffected by volatility. This observation explains why volatility prediction does not play a central role in the choice of target participation rates in applicable algorithms.

SIZE DEPENDENCE OF TWAP OPTIMAL TRADING HORIZON

Table 2 shows the optimal liquidation horizons for multiple currency pairs for the risk-averse trader (γ=0.6) at three different arrival times of the day: corresponding to the European morning (08:00 GMT), the most liquid mid-afternoon trading (14:00 GMT) and the late afternoon near-end of liquid trading in North American East Coast markets (20:00 GMT). We allow the notional value to vary between 10M and 500M and compare the optimal trade horizons for nine different currency pairs. Again, the results are largely consistent with our expectation.

Table 2: FX ACE Optimal Execution Horizons by Order Size and Currency Pair (three arrival times)

	10M, 08:00	25M, 08:00	50M, 08:00	100M, 08:00	250M, 08:00	500M, 08:00	10M, 14:00	25M, 14:00	50M, 14:00	100M, 14:00	250M, 14:00	500M, 14:00	10M, 20:00	25M, 20:00	50M, 20:00	100M, 20:00	250M, 20:00	500M, 20:00
EUR.USD	5	5	5	5	5	10	5	5	5	5	5	5	5	5	5	5	20	30
USD.JPY	5	5	5	5	10	15	5	5	5	5	5	10	5	5	5	10	20	30
GBP.USD	5	5	5	5	10	15	5	5	5	5	5	10	5	5	5	10	20	30
AUD.USD	5	5	5	10	15	20	5	5	5	5	10	15	5	5	10	20	30	45
USD.MXN	5	5	10	20	30	45	5	5	5	5	5	10	5	5	5	10	15	20
EUR.CHF	5	5	10	10	20	30	5	5	5	10	15	20	5	20	30	45	90	90
EUR.NOK	5	5	5	10	15	20	5	5	5	5	10	15	5	10	20	30	45	60
USD.NOK	5	5	10	10	20	30	5	5	5	10	20	30	10	30	45	60	90	90
EUR.DKK	10	20	30	45	90	90	5	10	10	15	30	30	10	20	30	45	60	90

Source: Virtu Analytics

Instead of solving for optimal horizon, it is often beneficial to reshape the discussion around participation rates, the notion that is more familiar to equity market participants. Specifically, we can pose the following question: **How aggressively can a market participant source the liquidity for a given currency pair to complete a large parent order without leaving an undue footprint on the market and with limited exposure to volatility risk?** Even though FX market liquidity remains dispersed across nearly a dozen electronic communication networks (ECNs) and numerous single and multi-dealer execution platforms, many FX market participants are interested in developing and rationalizing the links between the optimal trading horizons calculated using Virtu's FX ACE model and the average market volume participation rates. The average trading volume figures are released periodically by many venues and consolidated FX volume statistics are also available from market participant surveys conducted by the Bank for International Settlements, national monetary authorities and/or regulators.

Ideally, we could anticipate a robust and stable relationship between market volume participation rate and the order size. It would also be reasonable to assume more aggressive large order participation in the market, while simultaneously modulating its impact over the duration of an extended horizon. To account for this, we converted the optimal time horizon values for multiple currency pairs and order sizes (from Table 2) into participation rates relative to the daily spot market volume proxies[3]. All participation rates reported in Table 3 are expressed over the FX ACE optimal execution horizons that vary from five minutes to 90 minutes as shown in Table 2.

While the volume participation rates for small orders in major currency pairs are routinely in single digits, they can grow to 50% of market volume for orders larger than 100M, despite the longer optimal execution horizons. As the market liquidity for non-major pairs is limited (even for orders as small as 50M) the risk-cost averse trader participates at high volume participation rates—and pays a significant premium resulting in elevated price impact and execution costs.

Table 3: Optimal Participation Rates by Order Size and Currency Pair (Three arrival times)

	10M, 08:00	25M, 08:00	50M, 08:00	100M, 08:00	250M, 08:00	500M, 08:00	10M, 14:00	25M, 14:00	50M, 14:00	100M, 14:00	250M, 14:00	500M, 14:00	10M, 20:00	25M, 20:00	50M, 20:00	100M, 20:00	250M, 20:00	500M, 20:00
EURUSD	1%	3%	6%	12%	30%	29%	1%	2%	4%	8%	19%	19%	3%	6%	13%	13%	16%	22%
USDJPY	2%	5%	9%	18%	23%	30%	1%	4%	7%	15%	36%	36%	4%	9%	18%	18%	23%	31%
GBPUSD	4%	9%	19%	38%	46%	61%	2%	6%	12%	24%	59%	58%	7%	18%	36%	36%	45%	61%
AUDUSD	3%	7%	13%	13%	22%	33%	2%	6%	12%	24%	29%	38%	5%	13%	13%	13%	23%	31%
USDMXN	24%	60%	59%	58%	95%	124%	5%	12%	24%	47%	119%	117%	9%	22%	43%	44%	74%	113%
EURCHF	18%	45%	44%	88%	107%	139%	14%	34%	69%	68%	113%	168%	59%	38%	51%	70%	96%	193%
EURNOK	21%	53%	106%	104%	172%	256%	18%	44%	88%	177%	220%	293%	84%	106%	107%	144%	246%	382%
USDNOK	18%	46%	45%	91%	112%	147%	12%	30%	61%	60%	74%	96%	25%	21%	29%	46%	88%	176%
EURDKK	112%	140%	183%	244%	295%	572%	90%	112%	225%	297%	363%	725%	130%	159%	208%	270%	495%	664%

Source: Virtu Analytics

EMPIRICAL VALIDATION

Our empirical results (based on sample algo executions from Virtu's FX Peer Group clients) affirm the relationship between the order size and the trade completion horizons. For instance, the size of a parent order is positively correlated with the execution horizon across multiple currency pairs and most schedule-based type algos. The average values of realized horizons:

- **For actively trade currency pairs** vary from the median duration of two minutes for small orders to slightly more than15 minutes for large notional order sizes above 100M.
- **For less actively traded currency pairs** take in general at least five minutes to liquidate (even small orders) with median values of duration approaching more than 30 minutes for large notional order sizes above 100M.

The above values are qualitatively consistent with the optimal horizons implied by FX ACE for similar order sizes during London trading hours when most of our observed algo executions occur.

[3] Obtained from the 2019 BIS FX market participants survey.

CONCLUSION

Awareness and management of optimal trading horizons and market participation is an important consideration for FX best execution and risk control. Our study shows how FX ACE can assist in generating actionable recommendations for algos on time-to-completion that can fine-tune the risk and cost control in FX scheduled algorithms. Readers interested in more detailed calculations and information or in access to our FX Cost Curves products are encouraged to contact their Virtu representative.

ABOUT VIRTU

Virtu is a leading financial services firm that leverages cutting-edge technology to provide execution services and data, analytics and connectivity products to its clients and deliver liquidity to the global markets. Leveraging its global market making expertise and infrastructure, Virtu provides a robust product suite including offerings in execution, liquidity sourcing, analytics and broker- neutral, multi-dealer platforms in workflow technology. Virtu's product offerings allow clients to trade on hundreds of venues across 50+ countries and in multiple asset classes, including global equities, ETFs, foreign exchange, futures, fixed income and myriad other commodities. In addition, Virtu's integrated, multi-asset analytics platform provides a range of pre and post-trade services, data products and compliance tools that clients rely upon to invest, trade and manage risk across global markets.

Have questions? To learn more, contact your regional Virtu Analytics representative.
AMERICAS +1.866.265.4519 | **APAC** +852.3405.3755| **EMEA** +44.20.7670.4066 | **US** +44.20.7670.4000
analytics@virtu.com | www.virtu.com