

Commonwealth of PA State Empl. Ret. System

FX Manager, Dealer and Currency Report vs Interval TWAP with Detail of Largest and Highest Cost Trades

01/01/2018 to 03/31/2018

Report Currency: USD

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We make no warranties as to completeness or correctness of this report. We strive for accuracy over completeness in the trades we measure. We rely on sources that we believe can provide reliable price information for our measurement. We may exclude trades that we suspect contain erroneous information, that are priced outside the published hi-lo range for the day, or that display commission rates far in excess of typical institutional commission rates (as reflected in our database). This report does not represent a comprehensive audit of our client's trading. Each presentation of this report's results should include this disclaimer.

Glossary of Metrics

Manager, Dealer and Currency Pages

Principal Principal is the notional value of trading represented in the report.

Cost /K This measure compares the foreign exchange rate of the actual executed trade with the Interval Tick-Weighted Average Price (ITWAP) of the currency from trade Entry datetime to Execution datetime. Results are shown in thousands of USD. Note: Interdealer volumes are not presently available in the FX market. This report uses a tick-weighted approach where every inter-dealer trade counts the same, so time periods with more trading are more heavily weighted.

Cost /BP This measure compares the foreign exchange rate of the actual executed trade with the Interval Tick-Weighted Average Price (ITWAP) of the currency from trade Entry datetime to Execution datetime. Results are shown in basis points.

Percentile Rank This measure compares cost results to specialized benchmarks created using results from similar trades executed by other Abel Noser Solutions clients. A rank of 50% equates to the median. A low rank represents a favorable result while a high rank represents an unfavorable result.

Largest and Highest Cost Trade Detail Pages

Trades Each entry on these pages corresponding to a single, discrete trade. The indicative data (trade date, settlement side, sold amount, bought amount, costs) pertains to this one trade. The trades on the Largest Trades tab are ranked by principal value in USD of the sold amount. Trades on the Highest Cost tab are ranked by Interval TWAP Cost in USD.

Contract Types Each trade is linked to two contract types. When the contract type are the same, the trade met the settlement criteria exactly for that particular contract type. When two different contract types are present, then the system used the two standard types shown to interpolate a reference rate for corresponding to the exact settlement data of the trade.

Graph The graph next to each trade shows the trade (in red), Interval TWAP (in green), and the market exchange rate (in blue). The rates are all expressed as the bought currency divided by the sold currency. When the trade (in red) is higher compared to the market data, this indicates a favorable result; a trade that appears lower generally indicates a high-cost exchange. Each graph covers a 24-hour period that extends from 8 hours before the entry date/time to 16 hours afterward.

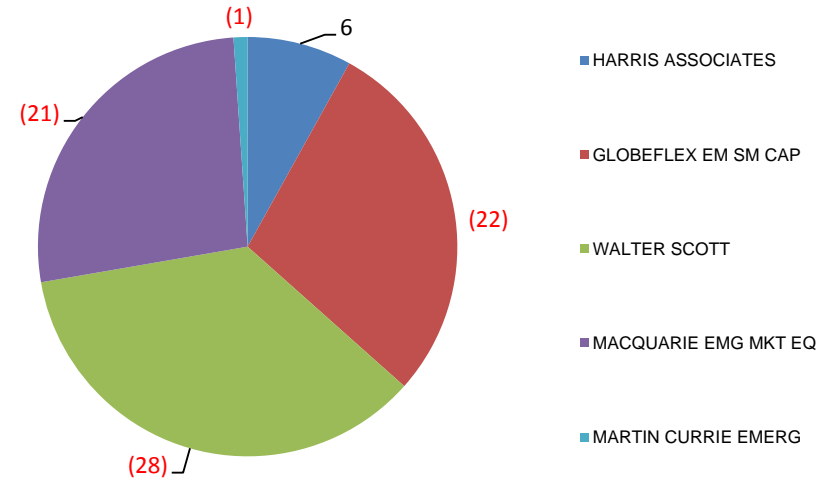
Commonwealth of PA State Empl. Ret. System - Cost By Manager (USD)

SPOT				
Manager	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
HARRIS ASSOCIATES	122,319	7	0.61	30%
GLOBEFLEX EM SM CAP	35,005	(22)	(6.35)	39%
WALTER SCOTT	21,200	(28)	(13.13)	51%
MACQUARIE EMG MKT EQ	14,220	(21)	(14.61)	53%
MARTIN CURRIE EMERG	2,633	(1)	(3.20)	35%
TOTAL	195,377	(64)	(3.29)	35%

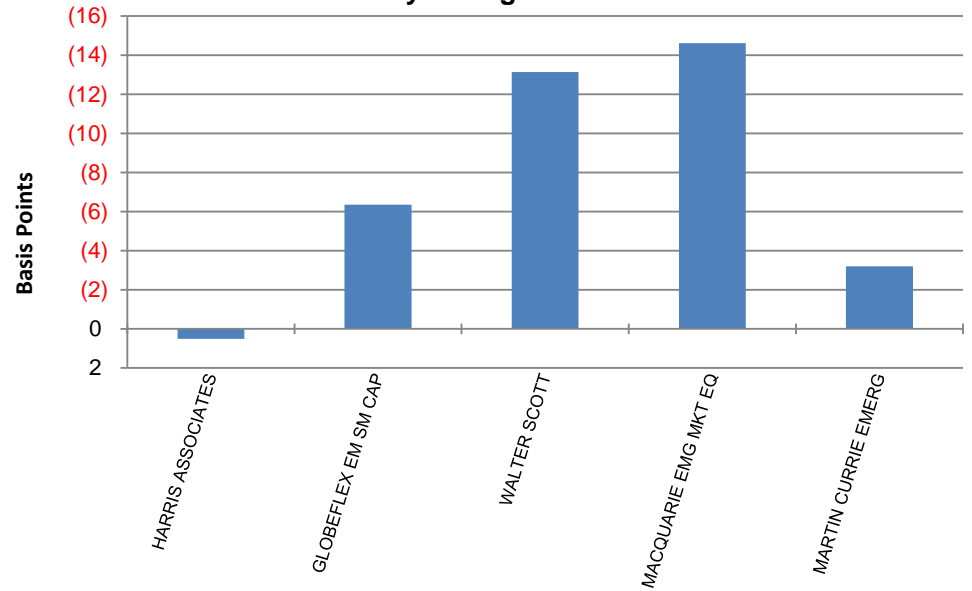
FORWARD				
Manager	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
HARRIS ASSOCIATES	2,044	(1)	(5.87)	38%
TOTAL	2,044	(1)	(5.87)	38%

TOTAL				
Manager	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
HARRIS ASSOCIATES	124,363	6	0.51	30%
GLOBEFLEX EM SM CAP	35,005	(22)	(6.35)	39%
WALTER SCOTT	21,200	(28)	(13.13)	51%
MACQUARIE EMG MKT EQ	14,220	(21)	(14.61)	53%
MARTIN CURRIE EMERG	2,633	(1)	(3.20)	35%
GRAND TOTAL	197,421	(65)	(3.31)	35%

Total Cost by Manager in Currency (USD /K)



Total Cost by Manager in Basis Points

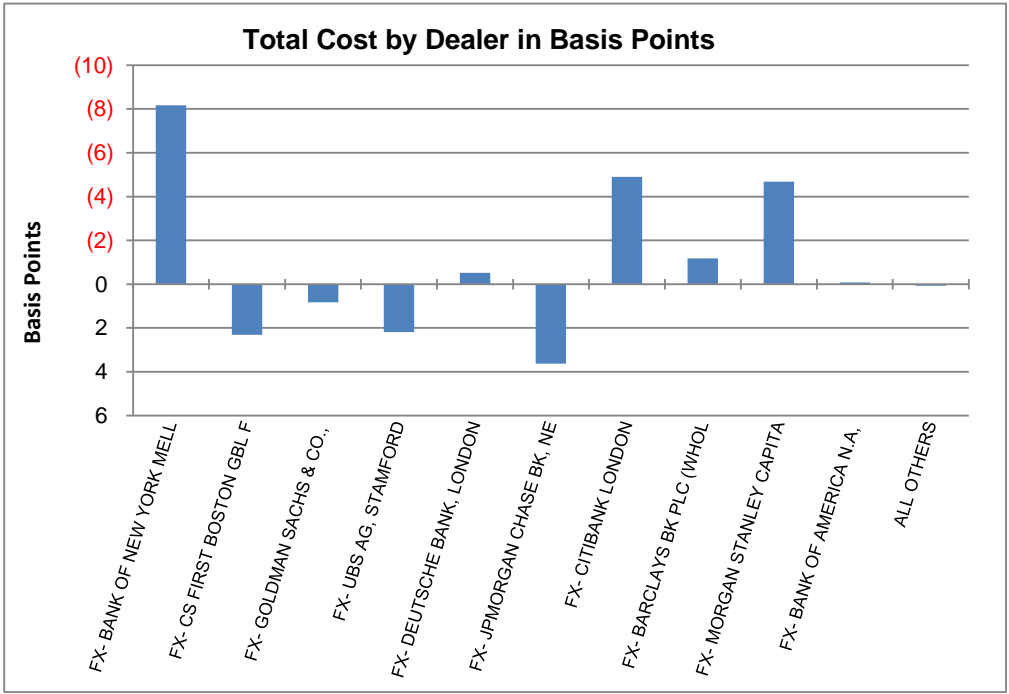
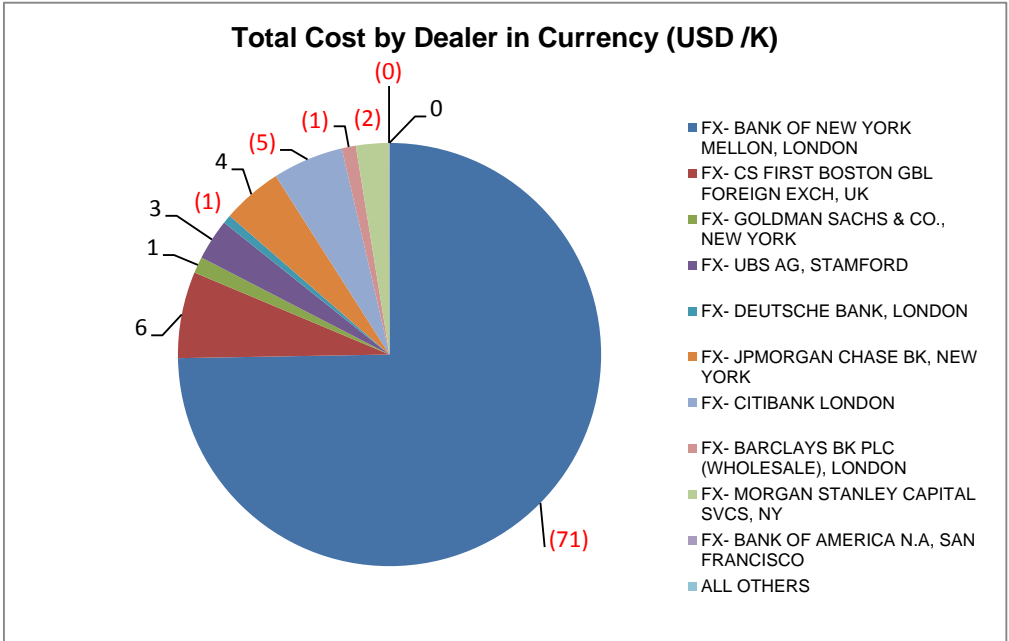


Commonwealth of PA State Empl. Ret. System - Cost By Dealer (USD)

SPOT				
Dealer	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
FX- BANK OF NEW YORK MELLON, LC	84,900	(70)	(8.23)	43%
FX- CS FIRST BOSTON GBL FOREIGN	27,221	6	2.31	28%
FX- GOLDMAN SACHS & CO., NEW YC	14,424	1	0.82	29%
FX- UBS AG, STAMFORD	13,611	3	2.19	29%
FX- DEUTSCHE BANK, LONDON	12,116	(1)	(0.52)	31%
FX- JPMORGAN CHASE BK, NEW YOR	12,030	4	3.63	28%
FX- CITIBANK LONDON	10,479	(5)	(4.90)	37%
FX- BARCLAYS BK PLC (WHOLESALE	8,614	(1)	(1.19)	32%
FX- MORGAN STANLEY CAPITAL SVC	5,065	(2)	(4.69)	37%
FX- BANK OF AMERICA N.A, SAN FRA	4,945	(0)	(0.08)	30%
ALL OTHERS	1,971	0	0.07	30%
GRAND TOTAL	195,377	(64)	(3.29)	36%

FORWARD				
Dealer	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
FX- BANK OF NEW YORK MELLON, LC	2,044	(1)	(5.87)	38%
GRAND TOTAL	2,044	(1)	(5.87)	38%

TOTAL				
Dealer	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
FX- BANK OF NEW YORK MELLON, LC	86,944	(71)	(8.17)	42%
FX- CS FIRST BOSTON GBL FOREIGN	27,221	6	2.31	28%
FX- GOLDMAN SACHS & CO., NEW YC	14,424	1	0.82	29%
FX- UBS AG, STAMFORD	13,611	3	2.19	29%
FX- DEUTSCHE BANK, LONDON	12,116	(1)	(0.52)	31%
FX- JPMORGAN CHASE BK, NEW YOR	12,030	4	3.63	28%
FX- CITIBANK LONDON	10,479	(5)	(4.90)	37%
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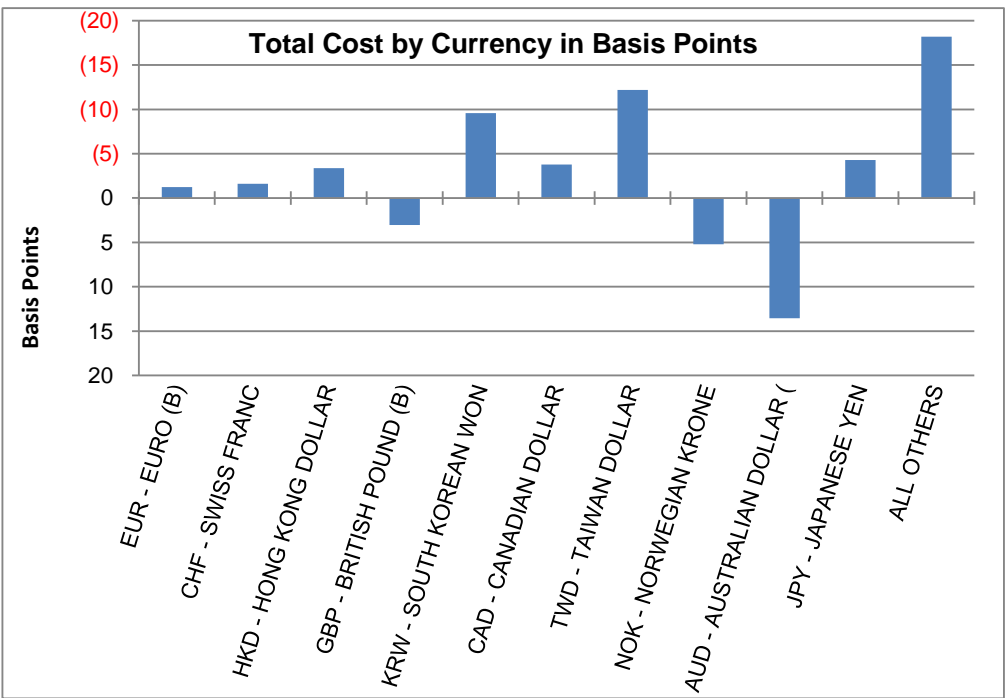
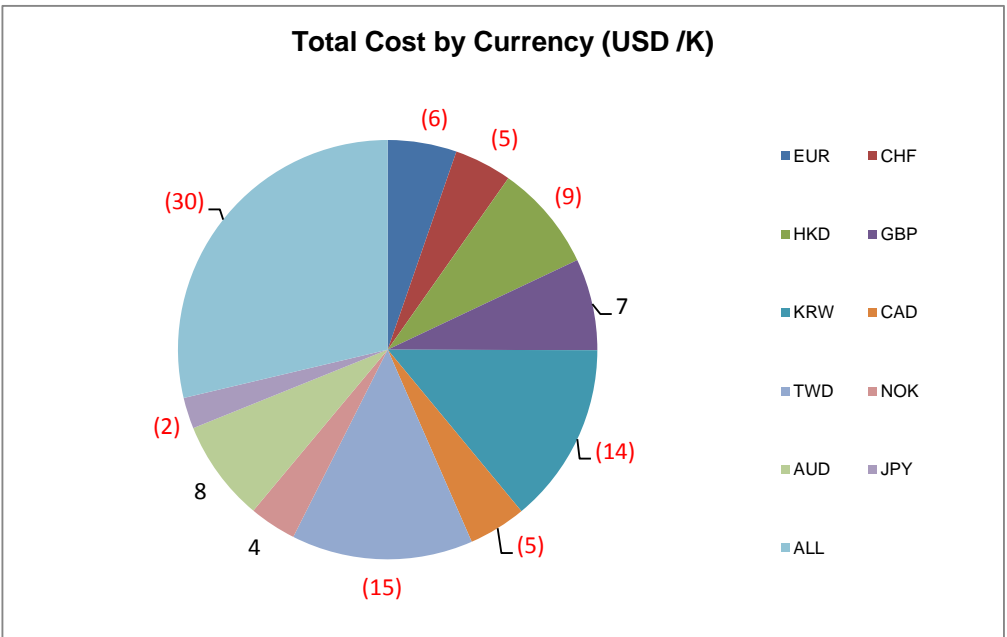


Commonwealth of PA State Empl. Ret. System - Cost by Currency

SPOT				
Currency	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
EUR - EURO (B)	44,996	(6)	(1.23)	32%
CHF - SWISS FRANC	26,428	(3)	(1.29)	32%
HKD - HONG KONG DOLLAR	25,224	(9)	(3.38)	35%
GBP - BRITISH POUND (B)	24,054	7	3.05	28%
KRW - SOUTH KOREAN WON	15,115	(14)	(9.59)	45%
CAD - CANADIAN DOLLAR	12,185	(5)	(3.79)	35%
TWD - TAIWAN DOLLAR	11,934	(15)	(12.19)	50%
NOK - NORWEGIAN KRONE	7,244	4	5.22	27%
AUD - AUSTRALIAN DOLLAR (B)	6,006	8	13.54	21%
JPY - JAPANESE YEN	5,800	(2)	(4.30)	36%
ALL OTHERS	16,392	(30)	(18.20)	58%
TOTAL	195,377	(64)	(3.29)	36%

FORWARD				
Currency	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
CHF - SWISS FRANC	2,044	(1)	(5.87)	38%
TOTAL	2,044	(1)	(5.87)	38%

TOTAL				
Currency	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
EUR - EURO (B)	44,996	(6)	(1.23)	32%
CHF - SWISS FRANC	28,472	(5)	(1.62)	32%
HKD - HONG KONG DOLLAR	25,224	(9)	(3.38)	35%
GBP - BRITISH POUND (B)	24,054	7	3.05	28%
KRW - SOUTH KOREAN WON	15,115	(14)	(9.59)	45%
CAD - CANADIAN DOLLAR	12,185	(5)	(3.79)	35%
TWD - TAIWAN DOLLAR	11,934	(15)	(12.19)	50%
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JPY - JAPANESE YEN	5,800	(2)	(4.30)	36%
ALL OTHERS	16,392	(30)	(18.20)	58%
GRAND TOTAL	197,421	(65)	(3.31)	36%



Commonwealth of PA State Empl. Ret. System - Ten Largest Trades

Trade Rank	Trade Date	Settlement Date	Contract Type 1	Contract Type 2	Manager	Dealer	Sold Currency	Sold Amount	Bought Currency	Bought Amount	Exchange Rate	Principal Value (USD)	Reference Rate	Interval TWAP	Entry Strike	Cost (\$)	Cost (BP)	Univ Rank		
1	3/16/2018	3/21/2018	SPOT	1W	HARRIS ASSOCIATES	FX- BANK OF NEW YORK M	USD	6,729,684	CHF	6,421,000	0.954131	6,729,684	0.952648	0.950736	10,459	23,949	15.54	35.59	20%	12%
2	3/21/2018	3/22/2018	TOM	TOM	WALTER SCOTT	FX- BANK OF NEW YORK M	USD	3,757,423	CHF	3,581,816	0.953264	3,757,423	0.952578	0.952724	2,706	2,129	7.20	5.67	25%	26%
3	3/16/2018	3/21/2018	SPOT	1W	HARRIS ASSOCIATES	FX- BANK OF NEW YORK M	USD	2,693,595	NOK	20,814,000	7.727220	2,693,595	7.720459	7.716722	2,357	3,659	8.75	13.58	24%	21%
4	3/15/2018	3/16/2018	TOM	TOM	WALTER SCOTT	FX- BANK OF NEW YORK M	USD	2,586,448	CHF	2,447,298	0.946200	2,586,448	0.950116	0.947256	(10,704)	(2,885)	(41.39)	(11.15)	73%	48%
5	1/17/2018	1/19/2018	SPOT	SPOT	HARRIS ASSOCIATES	FX- UBS AG, STAMFORD	USD	2,169,881	EUR	1,767,623	0.814617	2,169,881	0.817264	0.818425	(7,048)	(10,142)	(32.48)	(46.74)	69%	75%

*Graph covers a 24 hour period starting eight hours before entry time

Graph Legend: Trade — Interval TWAP — Market Rate —

Commonwealth of PA State Empl. Ret. System - Ten Largest Trades

6											
Trade Date	2/9/2018	Sold Currency	USD	Interval TWAP	0.936512	Entry Strike	0.935044				
Settlement Date	3/21/2018	Sold Amount	2,043,886	Reference Rate	0.936512	Cost (\$)	(1,200)				
Contract Type 1	1M	Bought Currency	CHF	Cost (\$)	(1,200)	Entry Strike	2,005				
Contract Type 2	2M	Bought Amount	1,913,000	Cost (BP)	(5.87)	Entry Strike	9.81				
Manager	HARRIS ASSOCIATES	Exchange Rate	0.935962	Univ Rank	38%	Entry Strike	23%				
Dealer	FX- BANK OF NEW YORK M	Principal Value (USD)	2,043,886								
7											
Trade Date	3/8/2018	Sold Currency	HKD	Interval TWAP	0.127525	Entry Strike	0.127567				
Settlement Date	3/12/2018	Sold Amount	15,953,850	Reference Rate	0.127525	Cost (\$)	(2,140)				
Contract Type 1	SPOT	Bought Currency	USD	Cost (\$)	(2,140)	Entry Strike	(2,815)				
Contract Type 2	SPOT	Bought Amount	2,032,378	Cost (BP)	(10.52)	Entry Strike	(13.83)				
Manager	GLOBEFLEX EM SM CAP	Exchange Rate	0.127391	Univ Rank	47%	Entry Strike	52%				
Dealer	FX- BANK OF NEW YORK M	Principal Value (USD)	2,034,740								
8											
Trade Date	1/25/2018	Sold Currency	USD	Interval TWAP	0.802727	Entry Strike	0.799398				
Settlement Date	1/29/2018	Sold Amount	2,011,461	Reference Rate	0.802727	Cost (\$)	2,380				
Contract Type 1	SPOT	Bought Currency	EUR	Cost (\$)	2,380	Entry Strike	10,710				
Contract Type 2	SPOT	Bought Amount	1,616,566	Cost (BP)	11.83	Entry Strike	53.25				
Manager	HARRIS ASSOCIATES	Exchange Rate	0.803678	Univ Rank	22%	Entry Strike	9%				
Dealer	FX- CS FIRST BOSTON GB	Principal Value (USD)	2,011,461								
9											
Trade Date	3/12/2018	Sold Currency	USD	Interval TWAP	7.840196	Entry Strike	7.840043				
Settlement Date	3/14/2018	Sold Amount	2,003,871	Reference Rate	7.840196	Cost (\$)	(2,133)				
Contract Type 1	SPOT	Bought Currency	HKD	Cost (\$)	(2,133)	Entry Strike	(2,093)				
Contract Type 2	SPOT	Bought Amount	15,694,040	Cost (BP)	(10.64)	Entry Strike	(10.45)				
Manager	MACQUARIE EMG MKT EQ	Exchange Rate	7.831861	Univ Rank	47%	Entry Strike	47%				
Dealer	FX- BANK OF NEW YORK M	Principal Value (USD)	2,003,871								
10											
Trade Date	1/3/2018	Sold Currency	HKD	Interval TWAP	0.127930	Entry Strike	0.127931				
Settlement Date	1/5/2018	Sold Amount	15,408,460	Reference Rate	0.127930	Cost (\$)	15				
Contract Type 1	SPOT	Bought Currency	USD	Cost (\$)	15	Entry Strike	(1)				
Contract Type 2	SPOT	Bought Amount	1,971,222	Cost (BP)	0.07	Entry Strike	(0.01)				
Manager	MARTIN CURRIE EMERG	Exchange Rate	0.127931	Univ Rank	30%	Entry Strike	30%				
Dealer	FX- CANADIAN IMPERIAL	Principal Value (USD)	1,971,236								

*Graph covers a 24 hour period starting eight hours before entry time

Graph Legend: Trade — Interval TWAP — Market Rate —

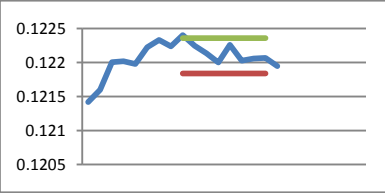
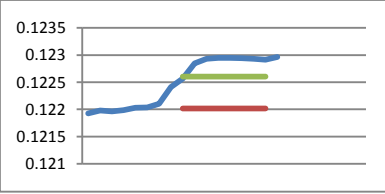
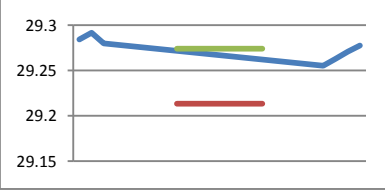
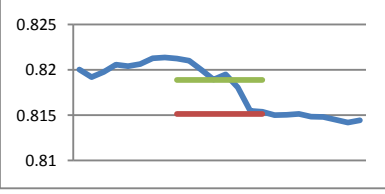
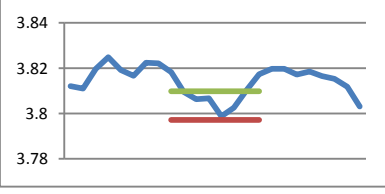
Commonwealth of PA State Empl. Ret. System - Ten Highest Cost Trades

Trade Rank	Trade Date	Settlement Date	Contract Type 1	Contract Type 2	Manager	Dealer	Sold Currency	Sold Amount	Bought Currency	Bought Amount	Exchange Rate	Principal Value (USD)	Reference Rate	Interval TWAP	Entry Strike	Cost (\$)	Cost (BP)	Univ Rank
1	3/15/2018	3/16/2018	TOM	TOM	WALTER SCOTT	FX- BANK OF NEW YORK M	USD	2,586,448	CHF	2,447,298	0.946200	2,586,448	0.950116	0.947256	(10,704)	(41.39)	73%	
2	1/17/2018	1/19/2018	SPOT	SPOT	HARRIS ASSOCIATES	FX- UBS AG, STAMFORD	USD	2,169,881	EUR	1,767,623	0.814617	2,169,881	0.817264	0.818425	(7,048)	(32.48)	69%	
3	3/20/2018	3/21/2018	SPOT	SPOT	MACQUARIE EMG MKT EQ	FX- BANK OF NEW YORK M	KRW	1,597,978,000	USD	1,487,392	0.000931	1,495,324	0.000934	0.000936	(4,848)	(32.42)	69%	
4	1/25/2018	1/26/2018	TOM	TOM	WALTER SCOTT	FX- BANK OF NEW YORK M	SEK	5,027,331	USD	635,218	0.126353	634,576	0.127234	0.127345	(4,427)	(69.76)	83%	
5	1/19/2018	1/22/2018	TOM	TOM	WALTER SCOTT	FX- BANK OF NEW YORK M	USD	1,546,603	EUR	1,260,239	0.814843	1,546,603	0.817076	0.816868	(4,238)	(27.40)	65%	

*Graph covers a 24 hour period starting eight hours before entry time

Graph Legend: Trade — Interval TWAP — Market Rate —

Commonwealth of PA State Empl. Ret. System - Ten Highest Cost Trades

Trade ID	Trade Date	Settlement Date	Contract Type 1	Contract Type 2	Manager	Dealer	Sold Currency	Sold Amount	Bought Currency	Bought Amount	Exchange Rate	Principal Value (USD)	Reference Rate	Interval TWAP	Entry Strike	Cost (\$)	Cost (BP)	Univ Rank	Graph
6	1/10/2018	1/11/2018	TOM	TOM	WALTER SCOTT	FX- BANK OF NEW YORK M	SEK	6,886,268	USD	839,012	0.121838	839,701	0.122359	0.122359	0.122287	(3,585)	(42.69)	73%	
7	1/11/2018	1/12/2018	TOM	TOM	WALTER SCOTT	FX- BANK OF NEW YORK M	SEK	5,762,739	USD	703,153	0.122017	708,650	0.122604	0.122604	0.122542	(3,406)	(48.06)	76%	
8	3/12/2018	3/12/2018	SPOT	SPOT	MACQUARIE EMG MKT EQ	FX- BANK OF NEW YORK M	USD	1,150,160	TWD	33,600,000	29.213327	1,150,160	29.274015	29.274015	29.272434	(2,389)	(20.77)	60%	
9	3/1/2018	3/5/2018	SPOT	SPOT	HARRIS ASSOCIATES	FX- BARCLAYS BK PLC (W)	USD	485,922	EUR	396,089	0.815129	485,922	0.818879	0.818879	0.820471	(2,235)	(46.00)	75%	
10	1/17/2018	1/19/2018	SPOT	1W	HARRIS ASSOCIATES	FX- BANK OF NEW YORK M	USD	664,123	TRY	2,521,762	3.797133	664,123	3.809778	3.809778	3.827737	(2,212)	(33.30)	69%	

*Graph covers a 24 hour period starting eight hours before entry time

Graph Legend: Trade — Interval TWAP — Market Rate —

Commonwealth of PA State Empl. Ret. System - Ten Lowest Cost Trades

1									
Trade Date	3/16/2018	Sold Currency	USD	Interval TWAP	Entry Strike				
Settlement Date	3/21/2018	Sold Amount	6,729,684	Reference Rate	0.950736				
Contract Type 1	SPOT	Bought Currency	CHF	Cost (\$)	10,459				
Contract Type 2	1W	Bought Amount	6,421,000	Cost (BP)	15.54				
Manager	HARRIS ASSOCIATES	Exchange Rate	0.954131	Univ Rank	20%				
Dealer	FX- BANK OF NEW YORK M	Principal Value (USD)	6,729,684						
2									
Trade Date	1/17/2018	Sold Currency	USD	Interval TWAP	Entry Strike				
Settlement Date	1/19/2018	Sold Amount	982,194	Reference Rate	1.254446				
Contract Type 1	SPOT	Bought Currency	AUD	Cost (\$)	4,965				
Contract Type 2	SPOT	Bought Amount	1,235,464	Cost (BP)	50.55				
Manager	HARRIS ASSOCIATES	Exchange Rate	1.257862	Univ Rank	9%				
Dealer	FX- CS FIRST BOSTON GB	Principal Value (USD)	982,194						
3									
Trade Date	1/17/2018	Sold Currency	GBP	Interval TWAP	Entry Strike				
Settlement Date	1/19/2018	Sold Amount	714,794	Reference Rate	1.379308				
Contract Type 1	SPOT	Bought Currency	USD	Cost (\$)	4,403				
Contract Type 2	SPOT	Bought Amount	994,350	Cost (BP)	44.53				
Manager	HARRIS ASSOCIATES	Exchange Rate	1.391100	Univ Rank	10%				
Dealer	FX- UBS AG, STAMFORD	Principal Value (USD)	988,603						
4									
Trade Date	2/1/2018	Sold Currency	USD	Interval TWAP	Entry Strike				
Settlement Date	2/2/2018	Sold Amount	855,302	Reference Rate	0.803415				
Contract Type 1	TOM	Bought Currency	EUR	Cost (\$)	3,573				
Contract Type 2	TOM	Bought Amount	688,233	Cost (BP)	41.78				
Manager	WALTER SCOTT	Exchange Rate	0.804667	Univ Rank	10%				
Dealer	FX- BANK OF NEW YORK M	Principal Value (USD)	855,302						
5									
Trade Date	2/16/2018	Sold Currency	AUD	Interval TWAP	Entry Strike				
Settlement Date	2/20/2018	Sold Amount	598,689	Reference Rate	0.792149				
Contract Type 1	SPOT	Bought Currency	USD	Cost (\$)	3,116				
Contract Type 2	SPOT	Bought Amount	477,036	Cost (BP)	65.83				
Manager	HARRIS ASSOCIATES	Exchange Rate	0.796800	Univ Rank	8%				
Dealer	FX- CS FIRST BOSTON GB	Principal Value (USD)	473,252						

*Graph covers a 24 hour period starting eight hours before entry time

Graph Legend: Trade — Interval TWAP — Market Rate —

Commonwealth of PA State Empl. Ret. System - Ten Lowest Cost Trades

Trade ID	Trade Date	Settlement Date	Contract Type 1	Contract Type 2	Manager	Dealer	Sold Currency	Sold Amount	Bought Currency	Bought Amount	Exchange Rate	Principal Value (USD)	Reference Rate	Cost (\$)	Cost (BP)	Interval TWAP	Entry Strike	Univ Rank	
6	3/21/2018	3/22/2018	TOM	TOM	WALTER SCOTT	FX- BANK OF NEW YORK M	USD	3,757,423	CHF	3,581,816	0.953264	3,757,423	0.952578	2,706	7.20	25%	0.952724	2,129	26%
7	2/2/2018	2/6/2018	SPOT	SPOT	HARRIS ASSOCIATES	FX- UBS AG, STAMFORD	EUR	834,386	USD	1,041,564	1.248300	1,039,878	1.245341	2,465	23.71	17%	1.244173	3,438	13%
8	1/25/2018	1/29/2018	SPOT	SPOT	HARRIS ASSOCIATES	FX- CS FIRST BOSTON GB	USD	2,011,461	EUR	1,616,566	0.803678	2,011,461	0.802727	2,380	11.83	22%	0.799398	10,710	9%
9	3/16/2018	3/21/2018	SPOT	1W	HARRIS ASSOCIATES	FX- BANK OF NEW YORK M	USD	2,693,595	NOK	20,814,000	7.727220	2,693,595	7.720459	2,357	8.75	24%	7.716722	3,659	21%
10	1/24/2018	1/29/2018	SPOT	1W	HARRIS ASSOCIATES	FX- JPMORGAN CHASE BK,	USD	294,249	JPY	32,348,660	109.936496	294,249	109.152542	2,098	71.31	8%	109.489410	1,197	10%

*Graph covers a 24 hour period starting eight hours before entry time

Graph Legend: Trade — Interval TWAP — Market Rate —