

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

Glossary	2
Cost by Manager	3
Cost by Dealer	4
Cost by Currency	5
Ten Largest Trades	6
Ten Highest Cost Trades	8
Ten Lowest Cost Trades	10

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.

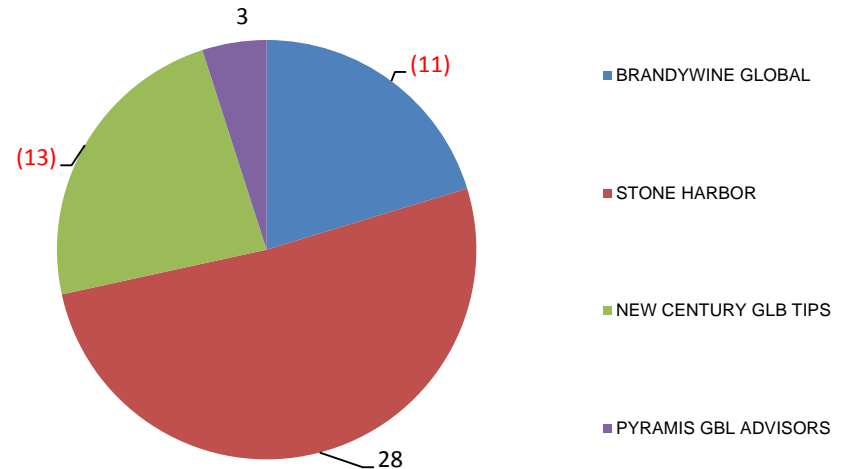
Commonwealth of PA State Empl. Ret. System - Cost By Manager (USD)

SPOT				
Manager	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
BRANDYWINE GLOBAL	94,341	47	4.96	27%
STONE HARBOR	43,562	5	1.10	29%
NEW CENTURY GLB TIPS	22,298	(12)	(5.52)	38%
PYRAMIS GBL ADVISORS	556	3	49.07	9%
TOTAL	160,757	42	2.61	29%

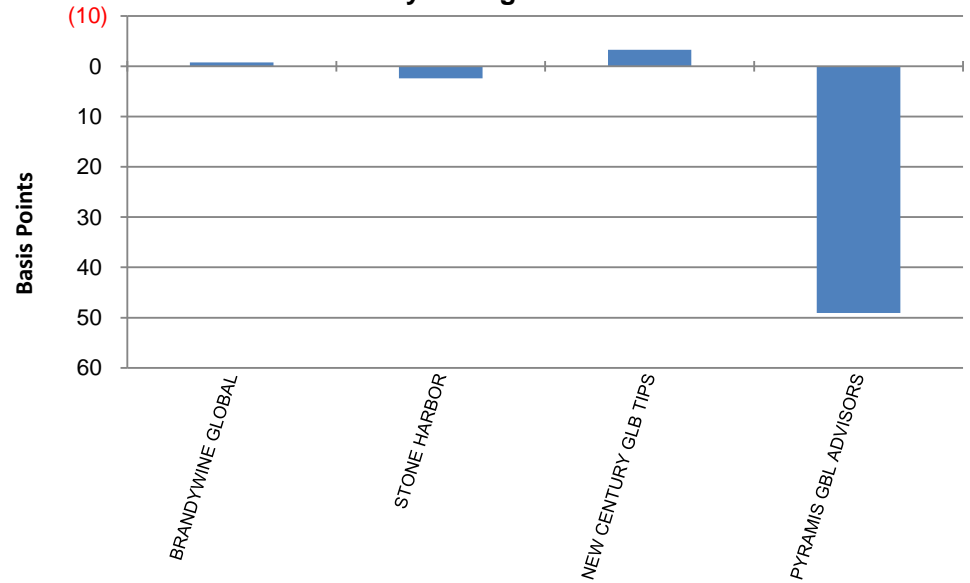
FORWARD				
Manager	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
STONE HARBOR	74,997	23	3.12	28%
BRANDYWINE GLOBAL	52,139	(58)	(11.11)	48%
NEW CENTURY GLB TIPS	16,699	(1)	(0.35)	30%
TOTAL	143,836	(35)	(2.44)	36%

TOTAL				
Manager	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
BRANDYWINE GLOBAL	146,481	(11)	(0.76)	31%
STONE HARBOR	118,559	28	2.38	28%
NEW CENTURY GLB TIPS	38,997	(13)	(3.31)	35%
PYRAMIS GBL ADVISORS	556	3	49.07	9%
GRAND TOTAL	304,593	7	0.23	30%

Total Cost by Manager in Currency (USD /K)



Total Cost by Manager in Basis Points



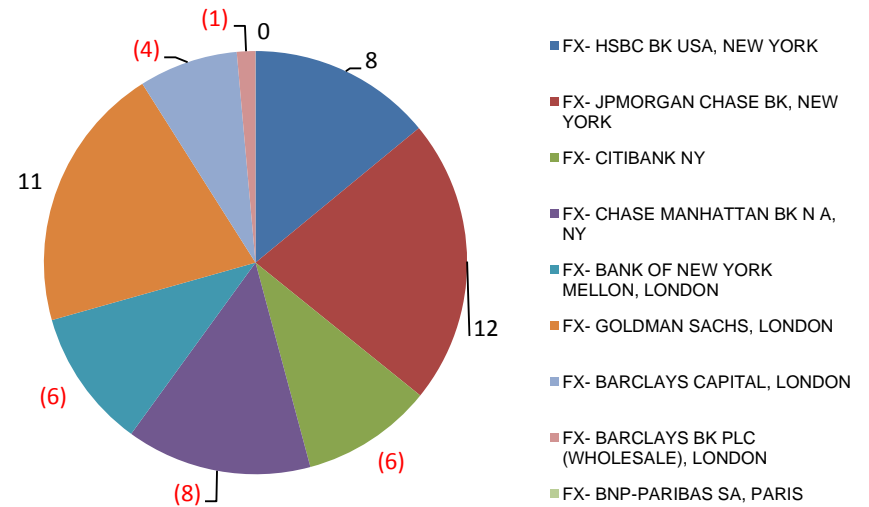
Commonwealth of PA State Empl. Ret. System - Cost By Dealer (USD)

SPOT				
Dealer	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
FX- HSBC BK USA, NEW YORK	69,766	56	7.97	25%
FX- CITIBANK NY	34,514	8	2.46	28%
FX- JPMORGAN CHASE BK, NEW YOR	23,279	(15)	(6.56)	39%
FX- CHASE MANHATTAN BK N A, NY	15,914	(7)	(4.35)	36%
FX- BANK OF NEW YORK MELLON, LC	8,819	(6)	(6.67)	40%
FX- GOLDMAN SACHS, LONDON	5,289	11	21.35	17%
FX- BARCLAYS CAPITAL, LONDON	2,608	(5)	(17.39)	57%
FX- BARCLAYS BK PLC (WHOLESALE	556	(1)	(14.05)	53%
FX- BNP-PARIBAS SA, PARIS	11	0	3.82	27%
GRAND TOTAL	160,757	42	2.61	30%

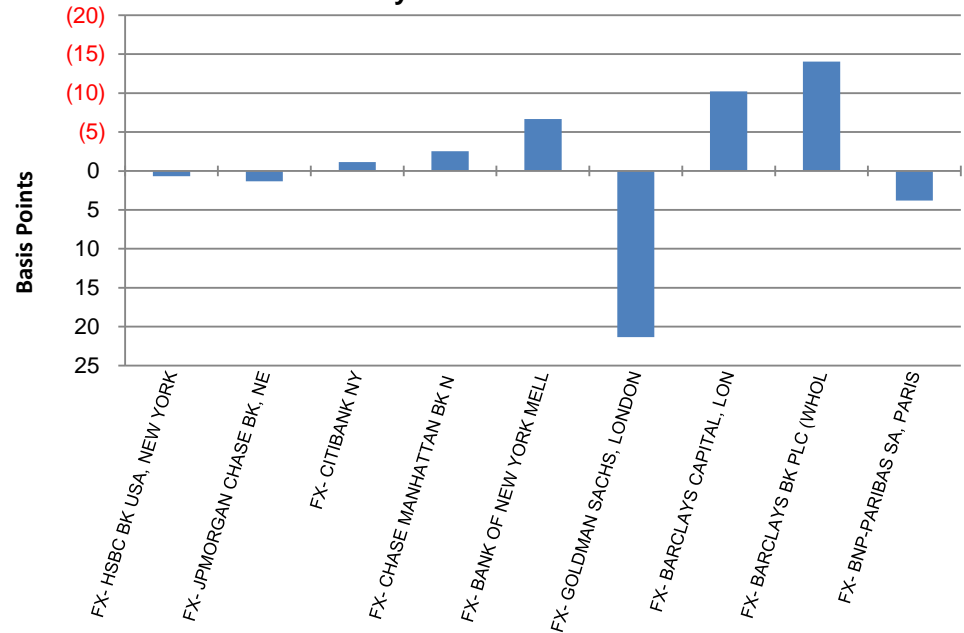
FORWARD				
Dealer	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
FX- JPMORGAN CHASE BK, NEW YOR	66,753	27	4.09	27%
FX- HSBC BK USA, NEW YORK	46,614	(48)	(10.26)	47%
FX- CHASE MANHATTAN BK N A, NY	15,216	(1)	(0.61)	31%
FX- CITIBANK NY	13,770	(14)	(10.20)	47%
FX- BARCLAYS CAPITAL, LONDON	1,483	0	2.36	28%
GRAND TOTAL	143,836	(35)	(2.44)	36%

TOTAL				
Dealer	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
FX- HSBC BK USA, NEW YORK	116,380	8	0.67	30%
FX- JPMORGAN CHASE BK, NEW YOR	90,033	12	1.34	29%
FX- CITIBANK NY	48,283	(6)	(1.15)	32%
FX- CHASE MANHATTAN BK N A, NY	31,130	(8)	(2.52)	34%
FX- BANK OF NEW YORK MELLON, LC	8,819	(6)	(6.67)	40%
FX- GOLDMAN SACHS, LONDON	5,289	11	21.35	17%
FX- BARCLAYS CAPITAL, LONDON	4,091	(4)	(10.23)	47%
FX- BARCLAYS BK PLC (WHOLESALE	556	(1)	(14.05)	53%
FX- BNP-PARIBAS SA, PARIS	11	0	3.82	27%
GRAND TOTAL	304,593	7	0.23	31%

Total Cost by Dealer in Currency (USD /K)



Total Cost by Dealer in Basis Points



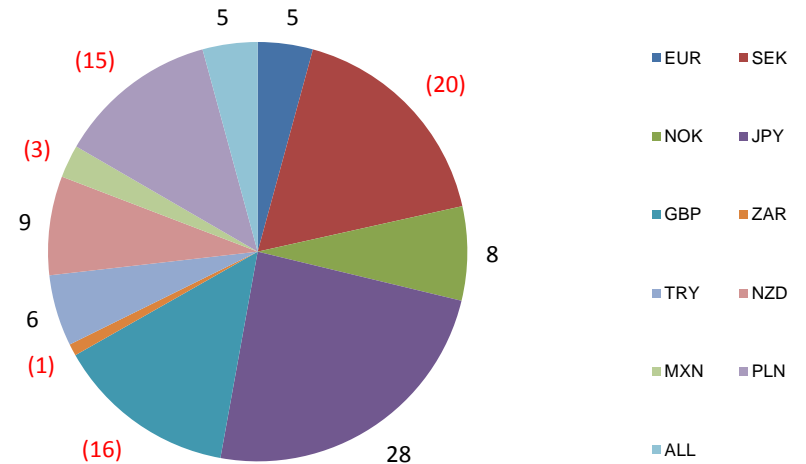
Commonwealth of PA State Empl. Ret. System - Cost by Currency

SPOT				
Currency	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
EUR - EURO (B)	41,753	(25)	(6.06)	39%
JPY - JAPANESE YEN	20,844	29	13.92	21%
NOK - NORWEGIAN KRONE	15,824	12	7.44	25%
SEK - SWEDISH KRONA	14,627	2	1.48	29%
NZD - NEW ZEALAND DOLLAR (B)	10,698	9	8.64	24%
GBP - BRITISH POUND (B)	9,664	(5)	(4.88)	37%
RUB - RUSSIAN RUBLE	8,864	8	9.24	24%
ZAR - SOUTH AFRICAN RAND	8,027	(12)	(15.25)	54%
TRY - TURKISH LIRA	7,662	26	34.44	12%
BRL - BRAZIL REAL	6,124	(0)	(0.70)	31%
ALL OTHERS	16,671	(2)	(1.28)	32%
TOTAL	160,757	42	2.61	31%

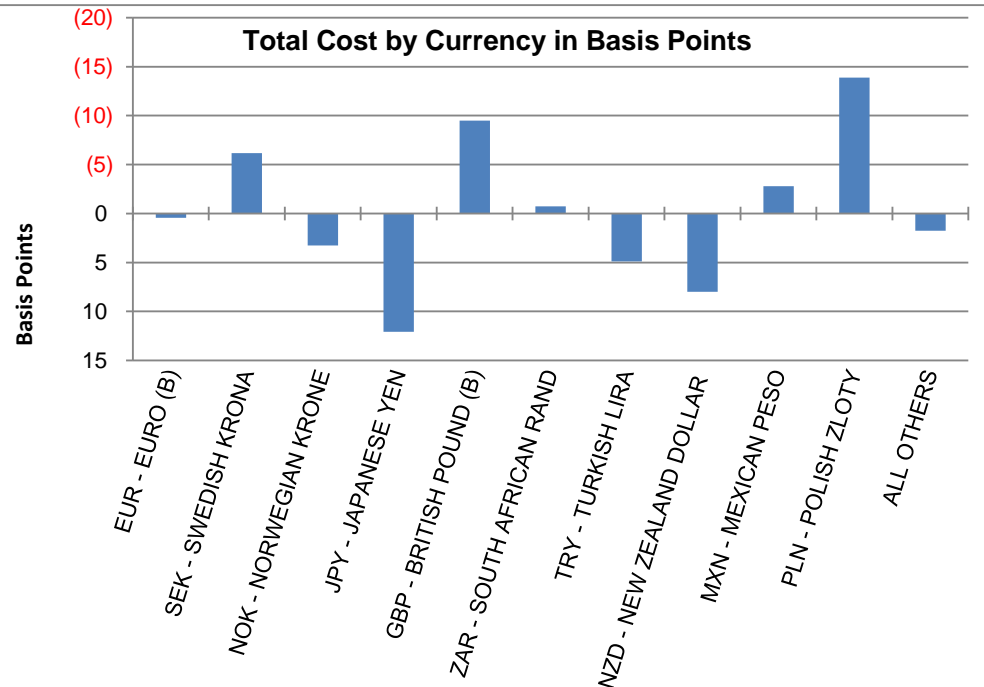
FORWARD				
Currency	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
EUR - EURO (B)	75,336	30	4.02	27%
SEK - SWEDISH KRONA	18,085	(22)	(12.37)	51%
NOK - NORWEGIAN KRONE	10,178	(3)	(3.24)	35%
MXN - MEXICAN PESO	7,508	(2)	(2.50)	34%
GBP - BRITISH POUND (B)	7,505	(12)	(15.45)	54%
PLN - POLISH ZLOTY	7,433	(13)	(16.85)	56%
ZAR - SOUTH AFRICAN RAND	6,626	11	16.85	19%
TRY - TURKISH LIRA	5,472	(20)	(36.46)	71%
JPY - JAPANESE YEN	2,505	(1)	(3.33)	35%
RUB - RUSSIAN RUBLE	1,371	(3)	(18.51)	58%
ALL OTHERS	1,815	(2)	(8.36)	43%
TOTAL	143,836	(35)	(2.44)	36%

TOTAL				
Currency	Principal (K)	ITWAP Cost (K)	ITWAP Cost (BP)	Universe Rank
EUR - EURO (B)	117,089	5	0.42	30%
SEK - SWEDISH KRONA	32,712	(20)	(6.18)	39%
NOK - NORWEGIAN KRONE	26,001	8	3.26	28%
JPY - JAPANESE YEN	23,349	28	12.07	22%
GBP - BRITISH POUND (B)	17,170	(16)	(9.50)	45%
ZAR - SOUTH AFRICAN RAND	14,653	(1)	(0.73)	31%
TRY - TURKISH LIRA	13,134	6	4.90	27%
NZD - NEW ZEALAND DOLLAR (B)	11,150	9	8.00	25%
MXN - MEXICAN PESO	10,673	(3)	(2.78)	34%
PLN - POLISH ZLOTY	10,452	(15)	(13.88)	52%
ALL OTHERS	28,210	5	1.76	29%
GRAND TOTAL	304,593	7	0.23	31%

Total Cost by Currency (USD /K)



Total Cost by Currency in Basis Points



Commonwealth of PA State Empl. Ret. System - Ten Largest 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)	Univ Rank	Interval TWAP	Entry Strike
1	1/30/2018	2/2/2018	SPOT	1W	BRANDYWINE GLOBAL	FX- HSBC BK USA, NEW Y	JPY	1,741,000,000	USD	16,044,010	0.009215	16,004,927	0.009195	34,782	21.73	17%	0.009195	0.009211
2	1/2/2018	2/9/2018	1M	2M	STONE HARBOR	FX- JPMORGAN CHASE BK,	EUR	10,643,400	USD	12,862,940	1.208537	12,834,557	1.207316	12,961	10.10	23%	1.207316	1.208212
3	1/2/2018	1/9/2018	SPOT	1W	STONE HARBOR	FX- JPMORGAN CHASE BK,	USD	12,584,590	EUR	10,431,400	0.828903	12,584,590	0.829720	(12,412)	(9.86)	46%	0.829720	0.829127
4	2/28/2018	4/9/2018	1M	2M	STONE HARBOR	FX- JPMORGAN CHASE BK,	EUR	9,964,400	USD	12,206,650	1.225026	12,150,191	1.224239	7,807	6.43	26%	1.224239	1.225529
5	2/28/2018	3/9/2018	1W	1W	STONE HARBOR	FX- JPMORGAN CHASE BK,	USD	11,998,320	EUR	9,818,636	0.818334	11,998,320	0.818907	(8,403)	(7.00)	40%	0.818907	0.818002

*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

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	1/18/2018	4/23/2018	3M	3M	BRANDYWINE GLOBAL	FX- HSBC BK USA, NEW Y	USD	10,732,580	SEK	85,500,000	7.966398	10,732,580	7.976516	(13,632)	(12.70)	51%	7.978106	53%
7	1/31/2018	2/9/2018	1W	1W	STONE HARBOR	FX- JPMORGAN CHASE BK,	USD	10,673,680	EUR	8,568,371	0.802757	10,673,680	0.803317	(7,444)	(6.97)	40%	0.801913	23%
8	1/18/2018	1/23/2018	SPOT	1W	BRANDYWINE GLOBAL	FX- HSBC BK USA, NEW Y	SEK	85,500,000	USD	10,668,160	0.124774	10,662,470	0.124699	6,388	5.99	26%	0.124599	21%
9	1/31/2018	3/9/2018	1M	2M	STONE HARBOR	FX- JPMORGAN CHASE BK,	EUR	8,507,500	USD	10,616,150	1.247858	10,560,870	1.245730	18,011	17.05	19%	1.249264	49%
10	2/9/2018	2/15/2018	SPOT	1W	BRANDYWINE GLOBAL	FX- HSBC BK USA, NEW Y	NOK	81,000,000	USD	10,152,920	0.125345	10,173,004	0.125157	15,217	14.96	20%	0.125487	49%

*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	Cost (\$)	Cost (BP)	Univ Rank	Interval TWAP	Entry Strike	
1	1/10/2018	4/13/2018	3M	4M	BRANDYWINE GLOBAL	FX- HSBC BK USA, NEW Y	USD	5,472,357	TRY	21,300,000	3.892290	5,472,357	3.906482	(19,954)	(36.46)	71%	3.902278	(14,043)	(25.66)
2	1/18/2018	4/23/2018	3M	3M	BRANDYWINE GLOBAL	FX- HSBC BK USA, NEW Y	USD	10,732,580	SEK	85,500,000	7.966398	10,732,580	7.976516	(13,632)	(12.70)	51%	7.978106	(15,775)	(14.70)
3	1/9/2018	1/11/2018	SPOT	SPOT	BRANDYWINE GLOBAL	FX- HSBC BK USA, NEW Y	USD	6,626,164	ZAR	81,800,000	12.345001	6,626,164	12.368739	(12,742)	(19.23)	59%	12.352336	(3,937)	(5.94)
4	1/2/2018	1/9/2018	SPOT	1W	STONE HARBOR	FX- JPMORGAN CHASE BK,	USD	12,584,590	EUR	10,431,400	0.828903	12,584,590	0.829720	(12,412)	(9.86)	46%	0.829127	(3,412)	(2.71)
5	2/21/2018	3/15/2018	2W	3W	BRANDYWINE GLOBAL	FX- CITIBANK NY	GBP	3,970,000	USD	5,533,505	1.393830	5,525,565	1.396381	(10,115)	(18.31)	58%	1.393424	1,608	2.91

*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

6						Interval TWAP		Entry Strike		
Trade Date	2/22/2018	Sold Currency	PLN	Reference Rate	0.295252	0.294437				
Settlement Date	4/17/2018	Sold Amount	15,000,000	Cost (\$)	(9,486)	2,753				
Contract Type 1	1M	Bought Currency	USD	Cost (BP)	(21.44)	6.22				
Contract Type 2	2M	Bought Amount	4,419,304	Univ Rank	61%	26%				
Manager	BRANDYWINE GLOBAL	Exchange Rate	0.294620							
Dealer	FX- HSBC BK USA, NEW Y	Principal Value (USD)	4,425,014							
7						Interval TWAP		Entry Strike		
Trade Date	2/22/2018	Sold Currency	SEK	Reference Rate	0.123264	0.123133				
Settlement Date	3/9/2018	Sold Amount	36,600,000	Cost (\$)	(9,422)	(4,623)				
Contract Type 1	1W	Bought Currency	USD	Cost (BP)	(20.89)	(10.25)				
Contract Type 2	2W	Bought Amount	4,502,056	Univ Rank	60%	47%				
Manager	BRANDYWINE GLOBAL	Exchange Rate	0.123007							
Dealer	FX- HSBC BK USA, NEW Y	Principal Value (USD)	4,509,605							
8						Interval TWAP		Entry Strike		
Trade Date	2/28/2018	Sold Currency	USD	Reference Rate	0.818907	0.818002				
Settlement Date	3/9/2018	Sold Amount	11,998,320	Cost (\$)	(8,403)	4,869				
Contract Type 1	1W	Bought Currency	EUR	Cost (BP)	(7.00)	4.06				
Contract Type 2	1W	Bought Amount	9,818,636	Univ Rank	40%	27%				
Manager	STONE HARBOR	Exchange Rate	0.818334							
Dealer	FX- JPMORGAN CHASE BK,	Principal Value (USD)	11,998,320							
9						Interval TWAP		Entry Strike		
Trade Date	1/31/2018	Sold Currency	USD	Reference Rate	0.803317	0.801913				
Settlement Date	2/9/2018	Sold Amount	10,673,680	Cost (\$)	(7,444)	11,220				
Contract Type 1	1W	Bought Currency	EUR	Cost (BP)	(6.97)	10.51				
Contract Type 2	1W	Bought Amount	8,568,371	Univ Rank	40%	23%				
Manager	STONE HARBOR	Exchange Rate	0.802757							
Dealer	FX- JPMORGAN CHASE BK,	Principal Value (USD)	10,673,680							
10						Interval TWAP		Entry Strike		
Trade Date	2/22/2018	Sold Currency	NOK	Reference Rate	0.127423	0.127188				
Settlement Date	4/20/2018	Sold Amount	11,600,000	Cost (\$)	(7,340)	(4,602)				
Contract Type 1	1M	Bought Currency	USD	Cost (BP)	(49.69)	(31.16)				
Contract Type 2	2M	Bought Amount	1,470,803	Univ Rank	76%	68%				
Manager	BRANDYWINE GLOBAL	Exchange Rate	0.126793							
Dealer	FX- HSBC BK USA, NEW Y	Principal Value (USD)	1,477,071							

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

Graph Legend: Trade — Interval TWAP — Market Rate —

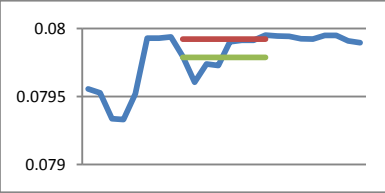
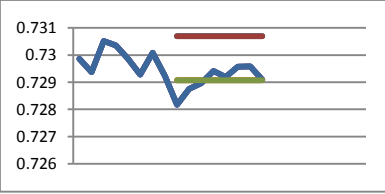
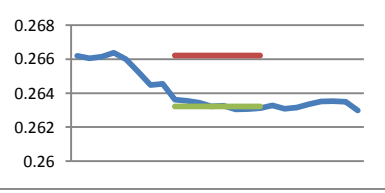
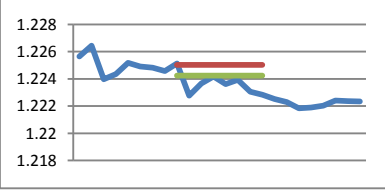
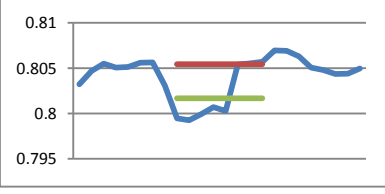
Commonwealth of PA State Empl. Ret. System - Ten Lowest Cost Trades

1					Interval TWAP	Entry Strike	
Trade Date	1/30/2018	Sold Currency	JPY	Reference Rate	0.009195	0.009211	
Settlement Date	2/2/2018	Sold Amount	1,741,000,000	Cost (\$)	34,782	8,434	
Contract Type 1	SPOT	Bought Currency	USD	Cost (BP)	21.73	5.27	
Contract Type 2	1W	Bought Amount	16,044,010	Univ Rank	17%	26%	
Manager	BRANDYWINE GLOBAL	Exchange Rate	0.009215				
Dealer	FX- HSBC BK USA, NEW Y	Principal Value (USD)	16,004,927				
Trade Date	1/10/2018	Sold Currency	TRY	Reference Rate	0.263096	0.263343	
Settlement Date	1/12/2018	Sold Amount	21,290,000	Cost (\$)	18,278	13,022	
Contract Type 1	SPOT	Bought Currency	USD	Cost (BP)	32.62	23.24	
Contract Type 2	1W	Bought Amount	5,619,638	Univ Rank	13%	17%	
Manager	BRANDYWINE GLOBAL	Exchange Rate	0.263957				
Dealer	FX- HSBC BK USA, NEW Y	Principal Value (USD)	5,602,868				
Trade Date	1/31/2018	Sold Currency	EUR	Reference Rate	1.245730	1.249264	
Settlement Date	3/9/2018	Sold Amount	8,507,500	Cost (\$)	18,011	(11,900)	
Contract Type 1	1M	Bought Currency	USD	Cost (BP)	17.05	(11.27)	
Contract Type 2	2M	Bought Amount	10,616,150	Univ Rank	19%	49%	
Manager	STONE HARBOR	Exchange Rate	1.247858				
Dealer	FX- JPMORGAN CHASE BK,	Principal Value (USD)	10,560,870				
Trade Date	2/9/2018	Sold Currency	NOK	Reference Rate	0.125157	0.125487	
Settlement Date	2/15/2018	Sold Amount	81,000,000	Cost (\$)	15,217	(11,538)	
Contract Type 1	SPOT	Bought Currency	USD	Cost (BP)	14.96	(11.34)	
Contract Type 2	1W	Bought Amount	10,152,920	Univ Rank	20%	49%	
Manager	BRANDYWINE GLOBAL	Exchange Rate	0.125345				
Dealer	FX- HSBC BK USA, NEW Y	Principal Value (USD)	10,173,004				
Trade Date	1/2/2018	Sold Currency	EUR	Reference Rate	1.207316	1.208212	
Settlement Date	2/9/2018	Sold Amount	10,643,400	Cost (\$)	12,961	3,449	
Contract Type 1	1M	Bought Currency	USD	Cost (BP)	10.10	2.69	
Contract Type 2	2M	Bought Amount	12,862,940	Univ Rank	23%	28%	
Manager	STONE HARBOR	Exchange Rate	1.208537				
Dealer	FX- JPMORGAN CHASE BK,	Principal Value (USD)	12,834,557				

*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	Graph
6	1/9/2018	4/11/2018	3M	3M	BRANDYWINE GLOBAL	FX- HSBC BK USA, NEW Y	ZAR	81,800,000	USD	6,537,620	0.079922	6,626,218	0.079787	11,163	16.85	19%	0.079887	27%	
7	2/23/2018	2/28/2018	SPOT	1W	BRANDYWINE GLOBAL	FX- CITIBANK NY	NZD	6,220,000	USD	4,544,904	0.730692	4,541,782	0.729072	10,070	22.17	17%	0.729130	17%	
8	1/15/2018	1/17/2018	SPOT	1W	STONE HARBOR	FX- GOLDMAN SACHS, LON	TRY	2,977,475	USD	792,649	0.266215	783,796	0.263216	8,829	112.65	5%	0.264196	8%	
9	2/28/2018	4/9/2018	1M	2M	STONE HARBOR	FX- JPMORGAN CHASE BK,	EUR	9,964,400	USD	12,206,650	1.225026	12,150,191	1.224239	7,807	6.43	26%	1.225529	36%	
10	1/25/2018	2/9/2018	1W	2W	STONE HARBOR	FX- JPMORGAN CHASE BK,	USD	1,454,727	EUR	1,171,685	0.805433	1,454,727	0.801669	6,798	46.73	10%	0.798872	7%	

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

Graph Legend: Trade — Interval TWAP — Market Rate —