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"FX Optimal Pairs Examined"

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6:20pm – 7:00 pm

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Background Info

- Forex is the largest and most liquid global market, with average daily turnover estimated at $4 trillion, in April 2010, according to the Bank for International Settlements http://www.bis.org/publ/rpfx10.htm

- "Pairs-Trading" is a well-known traditionally equity-based technique. This technique has not been widely analyzed in fx when we compared it to the volume of academic works in "fx-carry," UIP, or "forward rate bias" (see Fama (1984), Hansen and Hodrick (1980), and Jurek (2009))

➢ We begin this research line, with a simple examination of employing the "AL-technique" to 14 FX rates all data expressed in USD/FC

Investment Thesis

Optimal FX Pairs strategy attempts to capture the dynamic opportunities of spread convergence for a given set of two pairs within the liquid currency markets.

General Procedure:

- First, we compute the exhaustive set of pairs, on 14 of the most liquid currencies
- Second, the top pairs are identified by sorting each pairs by a given criteria (rolling 1-year Sharpe Ratio) and these pairs enter the Optimal-Pairs portfolio. The constituents of the Optimal-Pairs portfolio may change over time as new pairs enter and exit accordingly each day

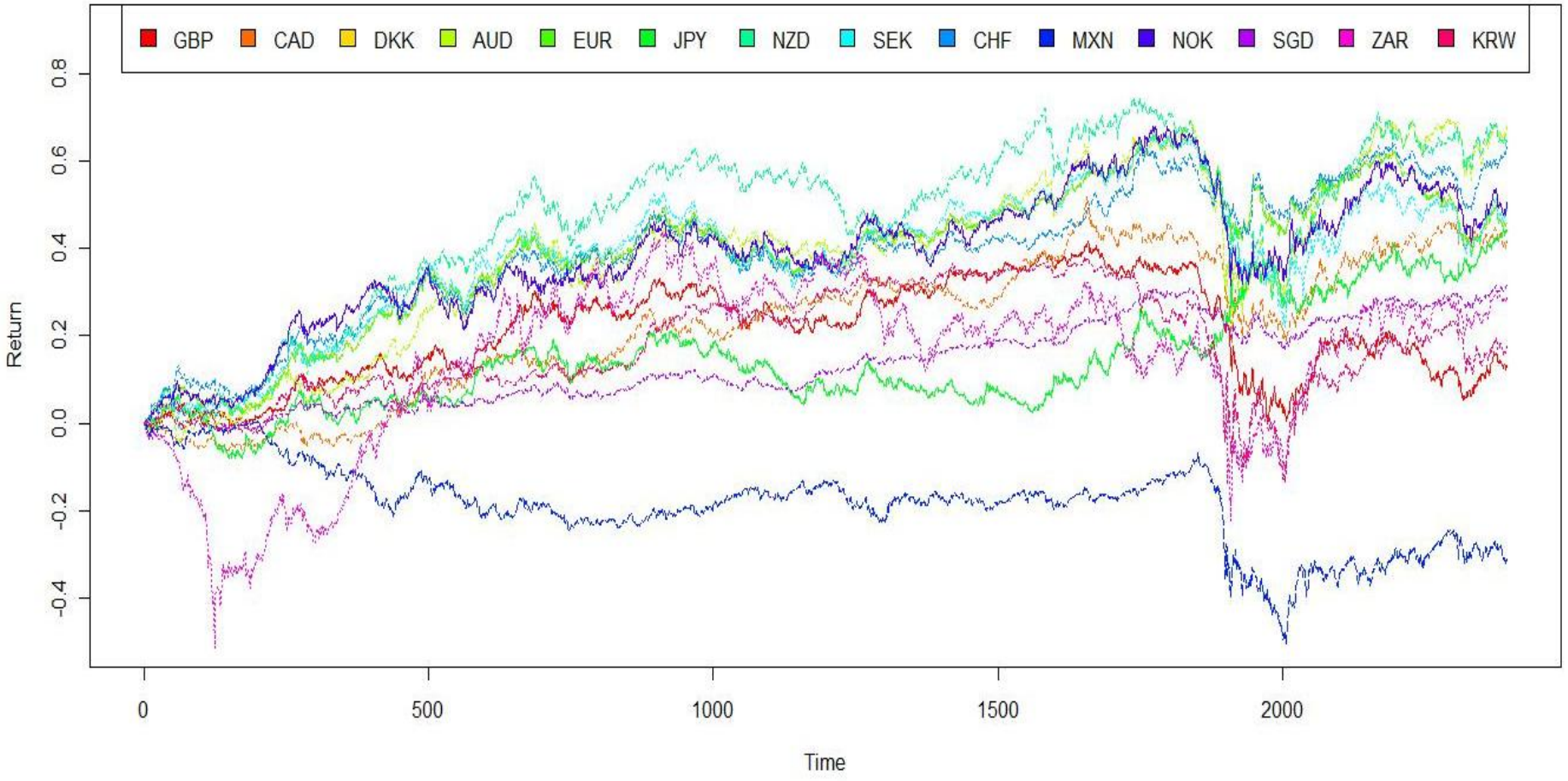
Currency Data Employed

- The following currencies rates are included in the investment space:

1. GPBUSD (British Pound)	8. SEKUSD (Swedish Krona)
2. CADUSD (Canadian Dollar)	9. CHFUSD (Swiss Franc)
3. DKKUSD (Danish Krone)	10. MXNUSD (Mexican Peso)
4. AUDUSD (Australian Dollar)	11. NOKUSD (Norwegian Krone)
5. EURUSD (Euro)	12. SGDUSD (Singapore Dollar)
6. JPYUSD (Japanese Yen)	13. ZARUSD (South Africa Rand)
7. NZDUSD (New Zealand Kiwi)	14. KRWUSD (South Korean Won)

- Start Date: 7/1/2001, End Date: 9/2/2010 (daily data)

Historical Daily Performance of Currencies



Investment Opportunity Set

- Pairs of currencies are assembled to perform mean-reversion process in the spirit of AL(2010)
- Because of asymmetry, we have a total of 182 pairs of currencies ($14^2 - 14$)
- The following table shows all the pairs in our investment space and their associated pairID

	GBP	CAD	DKK	AUD	EUR	JPY	NZD	SEK	CHF	MXN	NOK	SGD	ZAR	KRW
GPB	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CAD	15	16	17	18	19	20	21	22	23	24	25	26	27	28
DKK	29	30	31	32	33	34	35	36	37	38	39	40	41	42
AUD	43	44	45	46	47	48	49	50	51	52	53	54	55	56
EUR	57	58	59	60	61	62	63	64	65	66	67	68	69	70
JPY	71	72	73	74	75	76	77	78	79	80	81	82	83	84
NZD	85	86	87	88	89	90	91	92	93	94	95	96	97	98
SEK	99	100	101	102	103	104	105	106	107	108	109	110	111	112
CHF	113	114	115	116	117	118	119	120	121	122	123	124	125	126
MXN	127	128	129	130	131	132	133	134	135	136	137	138	139	140
NOK	141	142	143	144	145	146	147	148	149	150	151	152	153	154
SGD	155	156	157	158	159	160	161	162	163	164	165	166	167	168
ZAR	169	170	171	172	173	174	175	176	177	178	179	180	181	182
KRW	183	184	185	186	187	188	189	190	191	192	193	194	195	196

*Blue cells contain pairs that are ignored.

Pair Trading Procedure

Pair Trading Procedure

We present a walkthrough of the “AL-technique” for signal generation for the pair GBP and CAD.

Let

- n = 60, the rolling window length in days
- R^{GBP} be a vector of daily returns for the British Pound of length n
- R^{CAD} be a vector of daily returns for the Canadian Dollar of length n

Pair Trading Procedure (cont'd)

Step 1: Perform a linear regression between 2 return vectors

$$R^{GBP} = \alpha + \beta R^{CAD} + \varepsilon$$

Step 2: Estimate the parameters of the process $X = \sum \varepsilon$

(Ornstein-Uhlenbeck process)

$$dX = \kappa(\mu - X)dt + \sigma dW$$

Step 3: Perform a linear regression between X_{k+1} and X_k (AR(1))

$$X_{k+1} = a + bX_k + \xi$$

Step 4: The parameters are recovered by the following formulas

$$\kappa = -252 \times \log(b) \qquad \mu = \frac{a}{1-b}$$

$$\sigma = \sqrt{\frac{2\kappa \times \mathrm{Var}(\xi)}{1-b^2}}$$

Pair Trading Procedure (cont'd)

where

- κ is the mean-reversion rate
- μ long-term mean
- σ is the volatility

The long-term standard deviation σ_{eq} is given by the following formula

$$\sigma_{eq} = \sqrt{\frac{\mathrm{Var}(\xi)}{1-b^2}} = \frac{\sigma}{\sqrt{2\kappa}}$$

Pair Trading Procedure (cont'd)

The s-score is a dimensionless variable defined as follows

$$s = \frac{X_k - \mu}{\sigma_{eq}}$$

The s-score measures the distance to long-term mean in units long-term standard deviation, i.e. how far away GBP is from the theoretical equilibrium with CAD.

If the s-score is too high, we believe that GPBUSD is over-priced and/or CADUSD is under-priced, and vice versa, If the s-score is too low, then GPBUSD is under-priced and/or CADUSD is over-priced.

Pair Trading Procedure (cont'd)

- Thresholds for s-score are taken from AL framework:

Buy to open: -1.25	**Sell to open: 1.25**
Sell to close: -0.50	**Buy to close: 0.75**

- We then trade accordingly:
  - If $s < -1.25$, we enter a trade by buying 1 unit of GPB and short-selling β units of CAD (where β is from Step 1). When $s > -0.5$, we close the position by selling GPB and buying CAD.
  - If $s > 1.25$, we short-sell 1 unit of GBP and buy β units of CAD. When $s < 0.75$, we close the position by buying GBP and selling CAD.

Pair Trading Procedure (cont'd)

Dynamic Pairs Portfolio Construction

Dynamic Pairs Portfolios

- After the warm-up period of 252 trading days, portfolios of optimal pairs are constructed
  - "Optimal" is defined in term of the rolling 252-day Sharpe ratio (assuming risk-free is 0)
  - Sort all possible pairs based on their historical Sharpe ratios,
  - Add the top 20 performers to portfolios

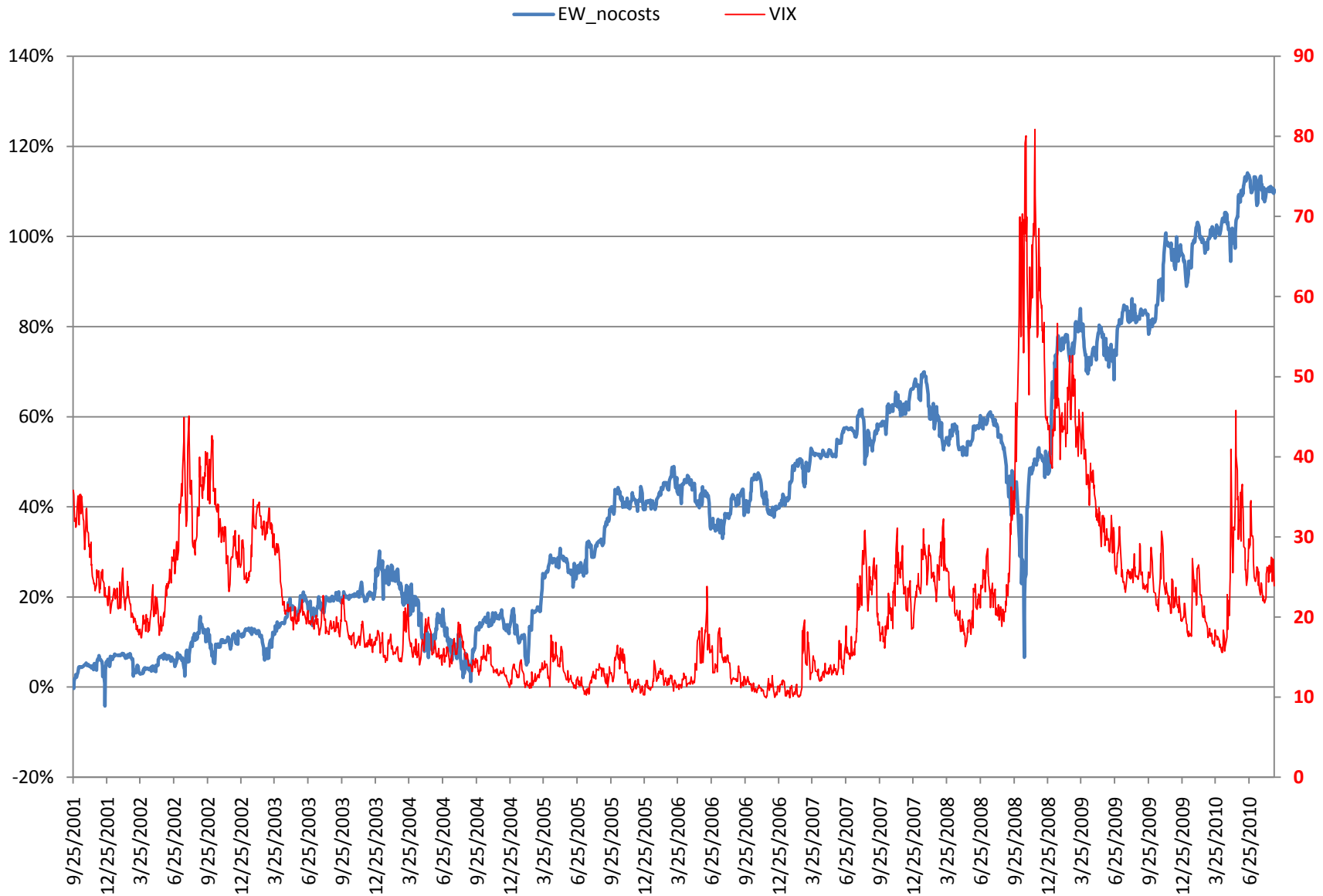
Portfolio constituent pairs may change over time, but they must satisfy these two conditions:

– If a pair is currently trading, no new pair can replace this pair, prematurely. (NO PREMATURE REPLACEMENT)

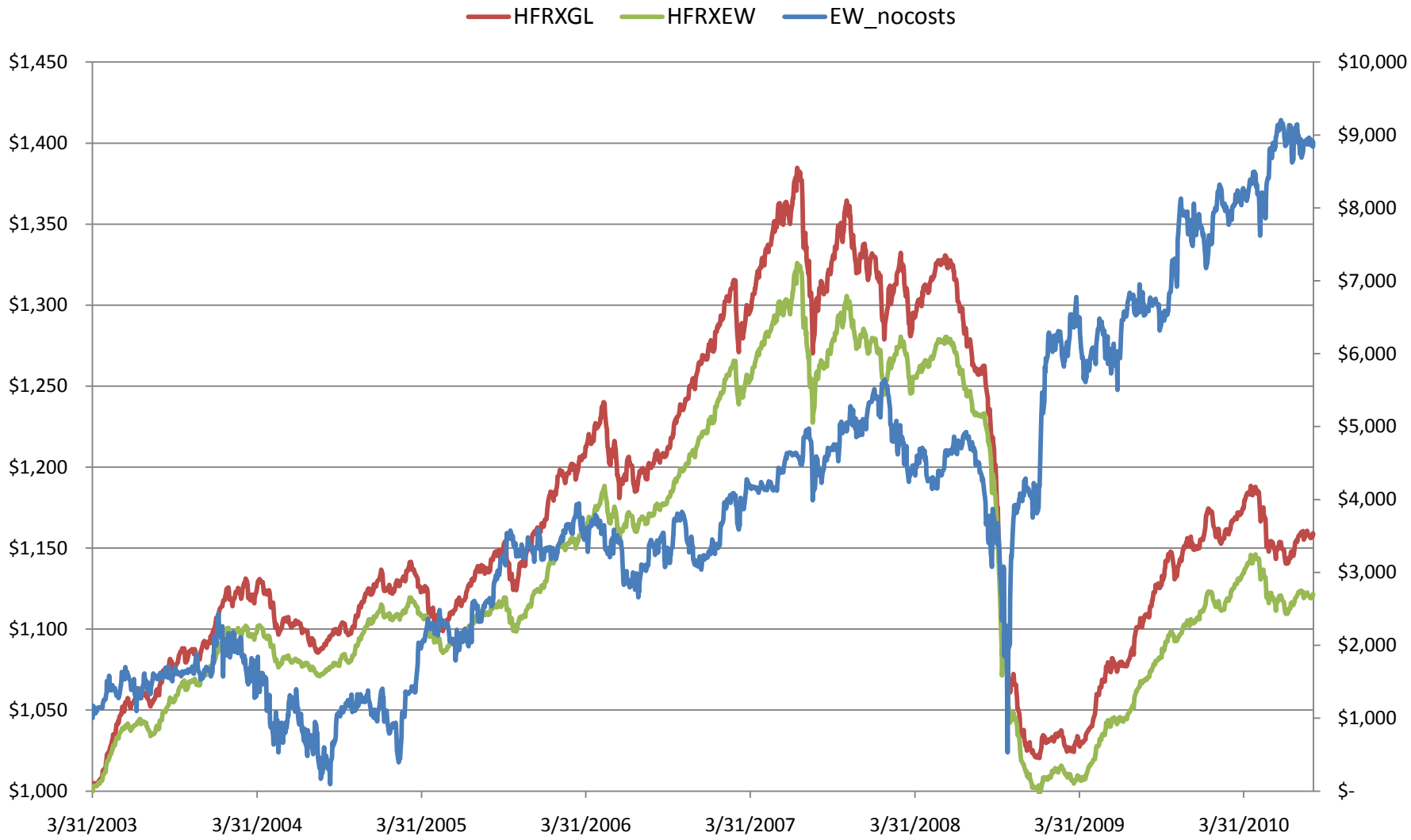
– Pairs are only traded when a new signal identifies the trade. This is to prevent openning position in the middle of a mean-reversion process. (NO MIDTERM OPENNINGS)

Results

EW no costs versus VIX



Are FX-Pairs returns linked to aggregate hedge fund risk premium?


HFRXGL
HFRXEW
EW_nocosts
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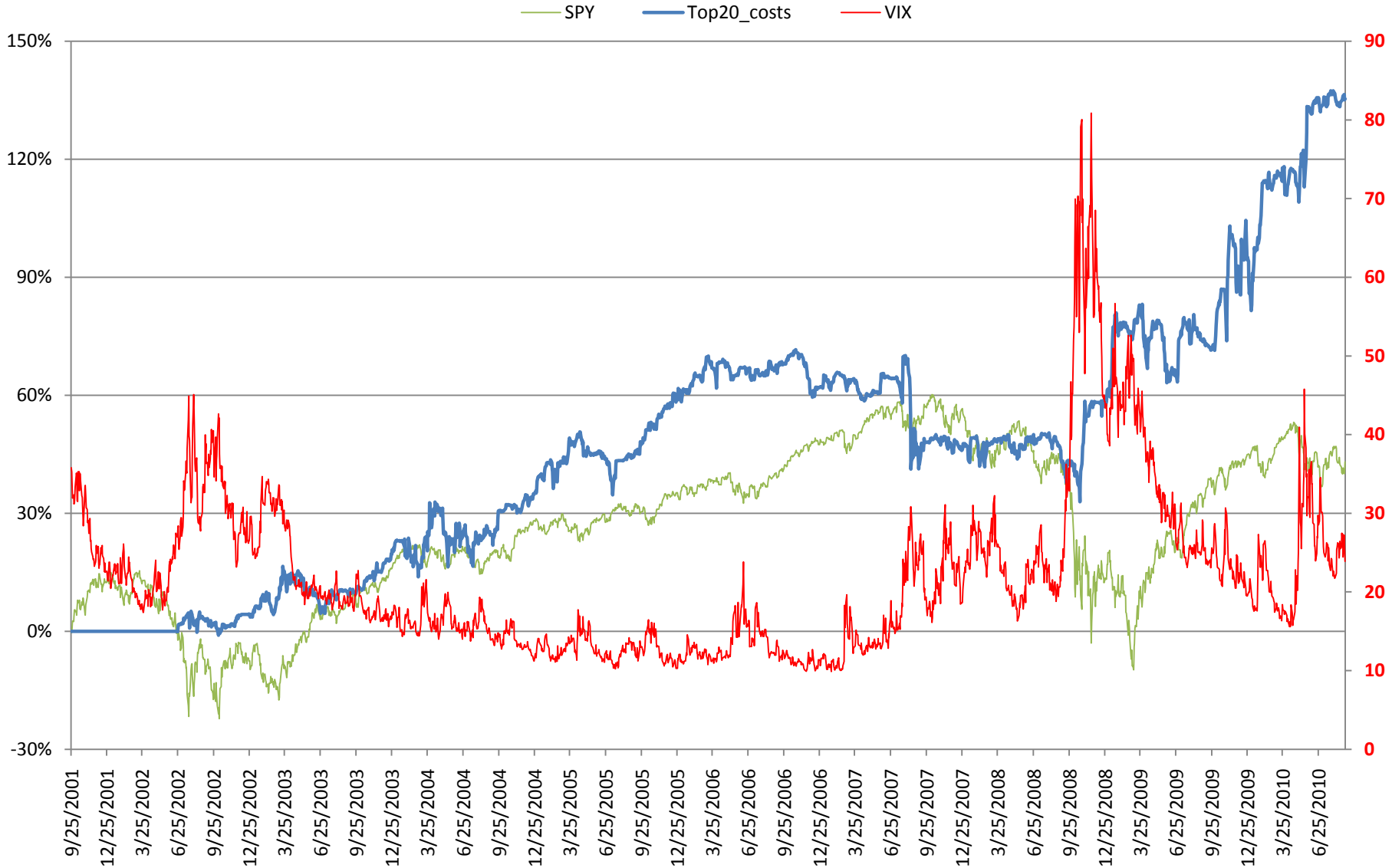
3/31/2010

Add t-costs assumptions

Assumed Transaction Costs

Currency	Last Price (9/2/2010)	T-cost
Australian Dollar	0.9110	0.0001
British Pound	1.5401	0.0001
Canadian Dollar	0.9498	0.0001
Danish Krone	0.1723	0.001
Euro	1.2825	0.0001
Japanese Yen	0.011864	0.000001
Mexican Peso	0.07673	0.00005
New Zealand Kiwi	0.7147	0.0001
Norwegian Krone	0.1628	0.0001
Singapore Dollar	0.7430	0.0005
South Africa Rand	0.138173	0.0002
South Korean Won	0.08488	0.0001
Swedish Krona	0.138073	0.0001
Swiss Franc	0.9874	0.0001

Top 20 with costs vs VIX



Conclusions/Enhancements

- FX markets behave favorably to mean-reversion extraction

- Applying “AL-technique” to FX markets uncovers some fascinating questions about linkages between fx pairs returns and aggregate hedge fund risk premium

- Possible extensions include incorporating ALBL (Black-Litterman) optimization techniques to fine-tune position sizing, applying s-score for confidence and conditional mean for views a la Liew and Roberts

- Alternative definitions of “middle”, such as PCs, EW, ERW, Min-Var, etc.

- Incorporate higher frequency data and possibly more realistic t-costs/impact models

- More research/work is needed… Anyone interested in collaborating? :)