

Online Appendix for Chen and Gwati, “FX Options and Excess Returns”

Table AT1: Quoting Conventions in OVER-THE-COUNTER FX Options Market

Symbol	Definition	Base currency	Domestic currency	Positive Skewness means
AUDUSD	USD per AUD	AUD	USD	USD depreciation
EURUSD	USD per EUR	EUR	USD	USD depreciation
GBPUSD	USD per GBP	GBP	USD	USD depreciation
USDCAD	CAD per USD	USD	CAD	CAD depreciation
USDJPY	JPY per USD	USD	JPY	JPY depreciation

Table AT2 : SUMMARY STATISTICS OF UNFILTERED IMPLIEDMOMENTS**AT2A) AUSUSD**

Tenor:	1 Week	1 Month	2 Month	3 Month	6 Month	9 Month	12 Month
St Dev							
Mean	0.0223	0.0440	0.0441	0.0742	0.0991	0.1124	0.1401
Median	0.0201	0.0409	0.0416	0.0720	0.0983	0.1121	0.1400
Max	0.0802	0.1141	0.0988	0.1437	0.1698	0.2110	0.2349
Min	0.0103	0.0190	0.0193	0.0305	0.0393	0.0250	0.0489
Std. Dev.	0.0104	0.0175	0.0159	0.0249	0.0340	0.0442	0.0544
AR(1)	0.9700	0.9870	0.9900	0.9900	0.9930	0.9880	0.9950
Skew							
Mean	-0.3709	-0.6359	-0.7035	-0.9789	-1.3939	-1.8803	-2.8638
Median	-0.3515	-0.6314	-0.6931	-0.9358	-1.1964	-1.5125	-2.4541
Max	0.5759	0.0426	-0.0869	-0.1592	-0.5396	6.3861	-1.2250
Min	-1.4614	-2.7105	-2.7768	-2.5680	-3.3599	-5.3707	-11.2889
Std. Dev.	0.2135	0.2681	0.2594	0.3670	0.6096	1.1442	1.4008
AR(1)	0.8180	0.9310	0.9270	0.9630	0.9820	0.9390	0.9710
Kurt							
Mean	-0.3709	-0.6359	-0.7035	-0.9789	-1.3939	-1.8803	-2.8638
Median	-0.3515	-0.6314	-0.6931	-0.9358	-1.1964	-1.5125	-2.4541
Max	0.5759	0.0426	-0.0869	-0.1592	-0.5396	6.3861	-1.2250
Min	-1.4614	-2.7105	-2.7768	-2.5680	-3.3599	-5.3707	-11.2889
Std. Dev.	0.2135	0.2681	0.2594	0.3670	0.6096	1.1442	1.4008
AR(1)	0.6280	0.7880	0.7810	0.9120	0.9580	0.4190	0.9160
# Obs.	1104	1098	1080	1058	992	924	861
Start Date							
End Date							

Note: “St Dev”, “Skew”, and “Kurt” are the implied standard deviation, skewness, and kurtosis of the risk-neutral FX distribution.

AT2B) EURUSD

Tenor:	1 Week	1 Month	2 Month	3 Month	6 Month	9 Month	12 Month
St Dev							
Mean	0.0169	0.0340	0.0344	0.0576	0.0769	0.0891	0.0999
Median	0.0153	0.0323	0.0342	0.0594	0.0823	0.0951	0.1000
Max	0.0453	0.0800	0.0759	0.1199	0.1472	0.1615	0.1685
Min	0.0075	0.0143	0.0150	0.0254	0.0333	0.0411	0.0469
Std. Dev.	0.0067	0.0129	0.0125	0.0201	0.0261	0.0312	0.0316
AR(1)	0.9700	0.9880	0.9910	0.9920	0.9930	0.9950	0.9870
Skew							
Mean	-0.1988	-0.4435	-0.4634	-0.7682	-1.1958	-1.6412	-2.8128
Median	-0.2035	-0.4706	-0.4947	-0.6892	-1.0576	-1.4161	-2.4503
Max	0.3289	0.3020	0.2620	0.1607	-0.1340	-0.3712	-1.1891
Min	-2.0134	-3.1767	-3.4239	-4.0626	-4.3822	-4.1621	-6.3494
Std. Dev.	0.2171	0.3216	0.3293	0.5077	0.7006	0.9376	1.1598
AR(1)	0.8720	0.9520	0.9610	0.9760	0.9860	0.9920	0.9850
Kurt							
Mean	4.0105	4.7704	4.9550	6.5168	9.0338	11.8916	25.7120
Median	3.8455	4.3357	4.5254	5.7231	8.2222	10.8935	24.1740
Max	18.7486	26.7492	28.7477	32.7929	32.2953	43.0947	57.1391
Min	2.6307	3.5263	3.7334	4.2912	5.1553	5.8064	13.4277
Std. Dev.	0.9713	1.6693	1.7016	2.6616	3.5715	5.2229	9.7778
AR(1)	0.7080	0.8720	0.8670	0.9250	0.9430	0.9530	0.9730
# Obs.	1096	1084	1075	1053	988	924	858
Start Date							
End Date							

Note: “St Dev”, “Skew”, and “Kurt” are the implied standard deviation, skewness, and kurtosis of the risk-neutral FX distribution.

AT2C) GBPUSD

Tenor:	1 Week	1 Month	2 Month	3 Month	6 Month	9 Month	12 Month
St Dev							
Mean	0.0167	0.0338	0.0346	0.0583	0.0771	0.0881	0.1064
Median	0.0154	0.0321	0.0346	0.0635	0.0865	0.1023	0.1103
Max	0.0429	0.0863	0.0718	0.1064	0.1422	0.1623	0.1880
Min	0.0069	0.0132	0.0146	0.0234	0.0219	0.0068	0.0037
Std. Dev.	0.0066	0.0132	0.0123	0.0200	0.0299	0.0395	0.0489
AR(1)	0.9910	0.9920	0.9940	0.9950	0.9950	0.9850	0.9870
Skew							
Mean	-0.4147	-0.5884	-0.6455	-1.0067	-1.5539	-3.1671	-16.60
Median	-0.4135	-0.5645	-0.6297	-0.9327	-1.2546	-1.5752	-2.2119
Max	0.0746	0.0387	-0.0238	-0.1962	-0.3217	-0.5112	-0.9410
Min	-1.6774	-1.9809	-2.0258	-2.5969	-4.6617	-169	-4256
Std. Dev.	0.1694	0.2594	0.2341	0.4184	0.9220	7.5363	172
AR(1)	0.9170	0.9560	0.9540	0.9640	0.9790	0.2340	0.3110
Kurt							
Mean	4.2205	4.9203	5.1886	7.0634	11.7242	436	74252
Median	4.0806	4.4382	4.6369	6.1275	8.5456	11.5178	18.410
Max	23.54	25.58	27.32	36.84	99.41	281543	61617815
Min	3.5418	3.6963	3.9191	4.4163	4.7321	5.2810	10.040
Std. Dev.	1.1058	1.6985	1.8085	3.0707	9.7115	9388	2100288
AR(1)	0.7520	0.8820	0.8830	0.9360	0.9510	0.0980	-0.0010
# Obs.	1117	1100	1079	1058	992	920	852
Start Date							
End Date							

Note: “St Dev”, “Skew”, and “Kurt” are the implied standard deviation, skewness, and kurtosis of the risk-neutral FX distribution.

AT2D) USDCAD

Tenor:	1 Week	1 Month	2 Month	3 Month	6 Month	9 Month	12 Month
St Dev							
Mean	0.0179	0.0361	0.0363	0.0613	0.0836	0.0976	0.1156
Median	0.0166	0.0346	0.0354	0.0607	0.0847	0.0970	0.1141
Max	0.0497	0.0792	0.0744	0.1159	0.1494	0.1710	0.2007
Min	0.0088	0.0175	0.0175	0.0282	0.0355	0.0282	0.0434
Std. Dev.	0.0067	0.0123	0.0115	0.0186	0.0262	0.0334	0.0412
AR(1)	0.9770	0.9860	0.9770	0.9840	0.9860	0.9830	0.9970
Skew							
Mean	0.0125	-0.0805	-0.0912	-0.3332	-0.7241	-1.2178	-2.1438
Median	0.0108	-0.0876	-0.0902	-0.2684	-0.6846	-1.0401	-1.8377
Max	0.8151	1.0039	0.9693	0.7633	0.6807	0.6103	-0.3307
Min	-0.6352	-0.8012	-0.8215	-1.5271	-2.5209	-3.8885	-5.2412
Std. Dev.	0.2565	0.3580	0.3626	0.5241	0.7559	1.0832	1.2069
AR(1)	0.9270	0.9850	0.9760	0.9890	0.9930	0.9860	0.9890
Kurt							
Mean	3.7347	4.3401	4.4631	5.3523	7.0511	9.7699	18.4042
Median	3.5126	4.0217	4.1687	4.9215	5.9945	7.2565	13.4801
Max	15.5448	16.7358	18.0890	22.2253	32.9993	47.0678	76.9181
Min	2.5425	3.4347	3.1098	3.8555	4.3717	4.6060	9.4879
Std. Dev.	0.9266	1.1468	1.1752	1.4376	2.5305	5.7552	10.5205
AR(1)	0.6310	0.7900	0.7570	0.8850	0.9400	0.9690	0.9820
# Obs.	1105	1086	1074	1052	982	915	861
Start Date							
End Date							

Note: “St Dev”, “Skew”, and “Kurt” are the implied standard deviation, skewness, and kurtosis of the risk-neutral FX distribution.

AT2E) USDJPY

Tenor:	1 Week	1 Month	2 Month	3 Month	6 Month	9 Month	12 Month
St Dev							
Mean		0.0380	0.0372	0.0632	0.0859	0.0930	0.1142
Median		0.0355	0.0356	0.0614	0.0865	0.0985	0.1225
Max		0.1188	0.0925	0.1492	0.1781	0.1501	0.1713
Min		0.0119	0.0125	0.0165	0.0087	0.0091	0.0162
Std. Dev.		0.0130	0.0115	0.0201	0.0270	0.0260	0.0297
AR(1)		0.9740	0.9800	0.9820	0.9860	0.9690	0.9910
Skew							
Mean		-0.6330	-0.7242	-0.8334	-0.8473	-1.0701	-2.8045
Median		-0.6941	-0.7789	-0.8855	-1.0668	-1.3964	-2.4632
Max					101.209	196.372	
Min		-0.0404	0.8577	0.8677	8	2	28.9330
Std. Dev.		-2.0588	-1.9129	-2.3189	-3.1653	-3.6191	-8.9543
AR(1)		0.2587	0.2582	0.2983	3.6277	6.9245	1.9669
		0.9420	0.8990	0.8820	0.5150	0.0250	0.8510
Kurt							
Mean		4.4195	4.6722	5.6832	12.2751	1306	32.01
Median		4.0921	4.1575	4.4797	5.2154	7.5190	15.13
Max		28.34	26.06	72.08	3111	1161172	4294
Min		3.5486	3.5853	3.7662	4.2488	4.7272	6.2411
Std. Dev.		1.5032	1.9842	4.3158	105.60	38162	172
AR(1)		0.8220	0.8850	0.9040	0.4240	0.0060	0.6240
# Obs.		1098	1079	1057	992	920	861
Start Date							
End Date							

Note: "St Dev", "Skew", and "Kurt" are the implied standard deviation, skewness, and kurtosis of the risk-neutral FX distribution.

Table AT3: SMILE ANALYSIS: FULL SAMPLE, FILTERED MOMENTS

$$f_t^{t+\tau} - s_{t+\tau} = \gamma_0 + \gamma_1 * STDEV_{t,\tau} + \gamma_2 * SKEW_{t,\tau} + \gamma_3 * KURT_{t,\tau} + \delta_0 * D1 + \delta_1 * D1 * STDEV_{t,\tau} + \delta_2 * D1 * SKEW_{t,\tau} + \delta_3 * D1 * KURT_{t,\tau} + \varepsilon_{t+\tau}$$

AT3A) AUDUSD

	1W	1M	2M	3M	6M	9 M	12M
St Dev	0.33	1.63	1.59	-0.17	-4.39	0.81	6.26
	[0.27]	[0.37]	[0.51]	[0.28]	[1.73]	[1.05]	[0.4]
P value	0.23	0	0	0.55	0.01	0.44	0
Skew	0.01	0	0.09	0.2	0.35	0.24	0.07
	[0.01]	[0.04]	[0.07]	[0.05]	[0.03]	[0.02]	[0.01]
P value	0.34	0.92	0.22	0	0	0	0
Kurt	-0.04	-0.08	-0.05	0.04	0.03	0.02	0.01
	[0.02]	[0.02]	[0.03]	[0.01]	[0.01]	[0]	[0]
P value	0.02	0	0.08	0.01	0	0	0
D1* St Dev	-0.67	-3.52	-5.08	-2.05	0.35	-5.34	-8.8
	[0.46]	[0.54]	[0.84]	[0.51]	[1.82]	[1.12]	[0.69]
P value	0.15	0	0	0	0.85	0	0
D1*Skew	-0.02	0	-0.06	-0.16	-0.5	-0.19	-0.13
	[0.02]	[0.04]	[0.08]	[0.06]	[0.05]	[0.03]	[0.03]
P value	0.13	0.98	0.4	0.01	0	0	0
D1*Kurt	0.03	0.06	0.05	-0.04	-0.06	-0.02	-0.04
	[0.02]	[0.02]	[0.03]	[0.02]	[0.01]	[0]	[0.01]
P value	0.04	0	0.15	0.01	0	0	0
Adj. R²	0.08	0.34	0.31	0.35	0.69	0.82	0.88
F- stat	13.68	76.55	51.81	57.3	303.36	621.37	591.49

Note: Newey-West (NW) HAC Standard Errors and Covariance (lag truncation=5). D1 = break dates selected in Table 4. Filtering means replacing each value of each of the series for explanatory variables with the fitted value obtained from using Least Median Regression with a window of 30. We use the R function `robreg.filter()` found in the package **robfilter** written by Fried, Schettlinger and Borrowski(2012) . F-stats report Wald test of the null $\gamma_1 = \gamma_2 = \gamma_3 = \delta_1 = \delta_2 = \delta_3 = 0$.

AT3B) EURUSD

	1W	1M	2M	3M	6M	9 M	12M
St Dev	1	-0.23	-0.96	-1.15	-3.98	3.15	8.1
[SE]	[0.44]	[0.4]	[0.37]	[0.26]	[0.74]	[0.79]	[0.62]
P value	0.02	0.56	0	0	0	0	0
Skew	0.01	0.1	0.21	0.14	0.19	0.12	-0.06
[SE]	[0.01]	[0.02]	[0.03]	[0.02]	[0.02]	[0.01]	[0.03]
P value	0.44	0	0.57	0	0	0	
Kurt	0	-0.01	-0.01	0.01	0.02	0.01	-0.01
[SE]	0	[0.01]	[0.01]	[0]	[0]	[0]	[0]
P value	0.2	0.21	0.01	0.06	0	0	
D1* St Dev	-0.76	0.72	-0.53	-1.46	2.54	-6.24	-8.94
[SE]	[0.54]	[0.73]	[0.81]	[0.77]	[0.91]	[0.93]	[0.84]
P value	0.16	0.32	0	0.06	0.01	0	
D1*Skew	-0.02	-0.15	-0.26	-0.18	-0.24	-0.07	0.1
[SE]	[0.01]	[0.03]	[0.04]	[0.03]	[0.04]	[0.07]	[0.03]
P value	0	0	0.37	0	0		
D1*Kurt	0	-0.01	-0.02	-0.03	-0.04	-0.03	-0.01
[SE]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0]
P value	0.72	0.08	0.51	0	0	0	
Adj. R²	0.07	0.19	0.29	0.43	0.58	0.78	0.81
F- stat	15.03	42.38	73.25	129.14	229.56	553.09	616.29
Prob(F-stat)	0	0	0	0	0	0	0

Note: Newey-West (NW) HAC Standard Errors and Covariance (lag truncation=5). D1 = break dates selected in Table 4, Filtering means replacing each value o of each of the series for explanatory variables with the fitted value obtained from using Least Median Regression with a window of 30. We use the R function robreg.filter() found in the package **robfilter** written by Fried, Schettlinger and Borrowski(2012) . F-stats report Wald test of the null $\gamma_1 = \gamma_2 = \gamma_3 = \delta_1 = \delta_2 = \delta_3 = 0$.

AT3C) GBPUSD

	1W	1M	2M	3M	6M
St Dev	1.26	3.31	1.82	6.32	1.48
[SE]	[0.43]	[0.35]	[0.3]	[1.09]	[0.7]
P value	0	0	0	0	0.03
Skew	0	0.08	0	0.07	0.21
[SE]	[0.02]	[0.02]	[0.03]	[0.08]	[0.03]
P value	0.95	0	0.99	0.39	0
Kurt	-0.01	0.02	-0.03	0.01	0.02
[SE]	[0.01]	[0.01]	[0]	[0.01]	[0]
P value	0.69	0	0	0.35	0
D1* St Dev	-1.41	-2.33	-1.1	-0.1	-0.24
[SE]	[0.61]	[0.45]	[0.99]	[1.21]	[0.83]
P value	0.02	0	0.26	0.94	0.77
D1*Skew	-0.02	-0.11	0	-0.2	-0.2
[SE]	[0.02]	[0.03]	[0.04]	[0.08]	[0.04]
P value	0.32	0	0.91	0.01	0
D1*Kurt	0.01	-0.03	-0.02	-0.06	-0.04
[SE]	[0.02]	[0.01]	[0.02]	[0.01]	[0]
P value	0.66	0	0.14	0	0
Adj. R²	0.09	0.31	0.4	0.53	0.68
F- stat	18.36	75.55	101.54	169.17	257.96
Prob(F-stat)	0	0.01	0	0	0

Note: Newey-West (NW) HAC Standard Errors and Covariance (lag truncation=5). D1 = break dates selected in Table 4, Filtering means replacing each value of each of the series for explanatory variables with the fitted value obtained from using Least Median Regression with a window of 30. We use the R function `robreg.filter()` found in the package **robfilter** written by Fried, Schettlinger and Borrowski(2012) . F-stats report Wald test of the null $\gamma_1 = \gamma_2 = \gamma_3 = \delta_1 = \delta_2 = \delta_3 = 0$.

AT3D) USDCAD

	1W	1M	2M	3M	6M	9 M	12M
St Dev	-2.14	7.69	0.07	1.58	-5	-7.12	-8.8
[SE]	[0.95]	[0.7]	[1.89]	[0.72]	[0.57]	[1.05]	[0.57]
P value	0.02	0	0.97	0.03	0	0	0
Skew	0	0.23	-0.14	-0.18	0.07	0.05	0.04
[SE]	[0.02]	[0.03]	[0.08]	[0.05]	[0.03]	[0.03]	[0.01]
P value	0.94	0	0.07	0	0.01	0.13	0
Kurt	0.01	0.23	0.05	0.01	0	0	-0.01
[SE]	[0.01]	[0.02]	[0.03]	[0.01]	[0.01]	[0]	[0]
P value	0.08	0	0.14	0.33	0.57	0.44	0
D1* St Dev	2.46	-7.92	-1.58	-0.9	8.3	8.89	10.34
[SE]	[1.07]	[0.76]	[1.94]	[0.78]	[0.65]	[1.09]	[0.65]
P value	0.02	0	0.41	0.25	0	0	0
D1*Skew	-0.01	-0.2	0.1	0.16	0.09	0	-0.06
[SE]	[0.02]	[0.03]	[0.08]	[0.05]	[0.03]	[0.04]	[0.02]
P value	0.49	0	0.23	0	0	0.93	0
D1*Kurt	-0.02	-0.22	-0.04	0.01	0.04	0.04	0.03
[SE]	[0.01]	[0.02]	[0.04]	[0.01]	[0.01]	[0.01]	[0.01]
P value	0.01	0	0.25	0.5	0	0	0
F- stat	22.38	19.59	94.35	184.93	478.33	483.94	587.41
Prob (F-stat)	0	0	0	0	0	0	0

Note: Newey-West (NW) HAC Standard Errors and Covariance (lag truncation=5). D1 = break dates selected in Table 4, Filtering means replacing each value o of each of the series for explanatory variables with the fitted value obtained from using Least Median Regression with a window of 30. We use the R function `robreg.filter()` found in the package **robfilter** written by Fried, Schettlinger and Borrowski(2012) . F-stats report Wald test of the null $\gamma_1 = \gamma_2 = \gamma_3 = \delta_1 = \delta_2 = \delta_3 = 0$.

AT3E) USDJPY

	1M	2M	3M	6M	12M
St Dev	0.78	1.73	0.74	-1.46	0.99
[SE]	[0.21]	[0.32]	[0.3]	[0.32]	[0.37]
P value	0	0	0.01	0	0.01
Skew	0	0	-0.08	-0.14	0.02
[SE]	[0.02]	[0.02]	[0.02]	[0.02]	[0.01]
P value	0.95	0.99	0	0	0.03
Kurt	0.01	0.02	0	0	0
[SE]	[0]	[0]	[0]	[0]	[0]
P value	0.02	0	0.03	0.1	0
D1* St Dev	-3.65	-6.79	-3.79	-0.84	-1.3
[SE]	[0.52]	[0.76]	[0.47]	[0.39]	[0.46]
P value	0	0	0	0.03	0.01
D1*Skew	-0.04	-0.1	0	0.09	-0.01
[SE]	[0.03]	[0.03]	[0.03]	[0.03]	[0.01]
P value	0.14	0	0.99	0	0.53
D1*Kurt	-0.03	-0.04	-0.02	-0.02	0
[SE]	[0.01]	[0.03]	[0]	[0]	[0]
P value	0	0	0	0	0.13
Adj. R²	0.17	0.3	0.24	0.54	0.33
F- stat	37.39	72.84	51.43	188.31	60.98
Prob(F-stat)	0	0	0	0	0

Note: Newey-West (NW) HAC Standard Errors and Covariance (lag truncation=5). D1 = break dates selected in Table 4, Filtering means replacing each value of each of the series for explanatory variables with the fitted value obtained from using Least Median Regression with a window of 30. We use the R function `robreg.filter()` found in the package **robfilter** written by Fried, Schettlinger and Borrowski(2012) . F-stats report Wald test of the null $\gamma_1 = \gamma_2 = \gamma_3 = \delta_1 = \delta_2 = \delta_3 = 0$.

Table AT4 :**SMILE ANALYSIS: SUBSAMPLE ANALYSIS, FILTERED MOMENTS**

$$f_t^{t+\tau} - s_{t+\tau} = \gamma_0 + \gamma_1 * STDEV_{t,\tau} + \gamma_2 * SKEW_{t,\tau} + \gamma_3 * KURT_{t,\tau} + \varepsilon_{t+\tau}$$

A4A) AUDUSD

	1W		1M		2M		3M		6M	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
St	0.33	-0.34	-1.56	-1.89	1.59	-3.49	-0.29	-4.22	-4.39	-4.04
Dev										
[SE]	[0.27]	[0.37]	[0.45]	[0.4]	[0.51]	[0.66]	[0.33]	[0.46]	[1.73]	[0.6]
P	0.24	0.35	0	0	0	0	0.39	0	0.01	0
value										
Skew	0.01	-0.01	-0.01	0	0.09	0.02	0.25	0.09	0.35	-0.15
[SE]	[0.01]	[0.01]	[0.02]	[0.02]	[0.07]	[0.03]	[0.08]	[0.03]	[0.03]	[0.04]
P	0.34		0.68	0.88	0.22	0.37	0	0	0	0
value										
Kurt	-0.04	0	-0.01	-0.01	-0.05	-0.01	0.04	-0.01	0.03	-0.03
[SE]	[0.02]	[0]	[0.01]	[0.01]	[0.03]	[0.01]	[0.02]	[0]	[0.01]	[0.01]
P	0.02		0.12	0.03	0.08	0.32	0.11	0.24	0	0
value										
Adj.	0.08	0.02	0.15	0.19	0.18	0.33	0.17	0.56	0.83	0.42
R²										
F-	17.95	5.46	33.85	43.07	39.78	88.99	38.08	216.9	656.8	138.13
stat										
P	0	0	0	0	0	0	0	0	0	0
value										

Note: Pre and Post indicate sub-samples before and after the break dates in Table 4. Newey-West (NW) HAC Standard Errors and Covariance (lag truncation=5). Filtering

means replacing each value o of each of the series for explanatory variables with the fitted value obtained from using Least Median Regression with a window of 30. We use the R function `robreg.filter()` found in the package **robfilter** written by Fried, Schettlinger and Borrowski(2012) . F-stats report Wald test of the null that $\gamma_1 = \gamma_2 = \gamma_3 = 0$.

AT4B) EURUSD

	1W		1M		2M		3M		6M	
	PRE	POS	PRE	POS	PRE	POS	PRE	POS	PRE	POST
St	1	0.25	-0.23	0.49	-0.9	-3.53	-1.15	-2.61	-3.98	-1.44
Dev		T		T		T		T		
[SE]	[0.44	[0.3]	[0.4]	[0.6]	[0.37]	[1.09	[0.26]	[0.72	[0.74	[0.55]
P	0.02	0.4	0.56	0.42	0.02	0	0	0	0	0.01
valu										
e										
Ske	0.01	-0.02	0.1	-0.06	0.21	-0.04	0.14	-0.04	0.19	-0.06
w										
[SE]	[0.01	[0]	[0.02	[0.01	[0.03]	[0.02	[0.02]	[0.02	[0.0]	[0.03]
P	0.44	0	0	0	0	0.01	0	0.05	0	0.07
valu										
e										
Kurt	0	0	-0.01	-0.02	-0.01	-0.02	0.01	-0.02	0.02	-0.03
[SE]	[0]	[0.01	[0.01	[0]	[0.01]	[0.01	[0]	[0]	[0]	[0.01]
P	0.2	0.93	0.21	0	0.34	0	0.06	0	0	0
valu										
e										
Adj.	0	0.04	0.19	0.18	0.36	0.24	0.48	0.36	0.83	0.35
R²										
F-	24.61	9.88	44.17	0.18	100.6	54.02	166.5	97.24	684.5	105.0
stat					8		2			7
P	0	0	0	0	0	0	0	0	0	0
valu										
e										

Note: Pre and Post indicate sub-samples before and after the break dates in Table 4. Newey-West (NW) HAC Standard Errors and Covariance (lag truncation=5). Filtering means replacing each value o of each of the series for explanatory variables with the fitted value obtained from using Least Median Regression with a window of 30. We use the R function robreg.filter() found in the package **robfilter** written by Fried,

Schettlinger and Borrowski(2012) . F-stats report Wald test of the null that $\gamma_1 = \gamma_2 = \gamma_3 = 0$.

AT4C) GBPUSD

	1 WEEK		1 M		2 M		3M		6 M	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
St Dev	1.26	-0.16	3.31	0.97	1.82	0.72	3.93	3.98	1.48	1.24
[SE]	[0.43]	[0.44]	[0.35]	[0.29]	[0.3]	[0.94]	[0.46]	[0.34]	[0.7]	[0.4]
P value	0	0.72	0	0	0	0.44	0	0	0.03	0
Skew	0	-0.02	0.08	-0.03	0	0	0.09	-0.06	0.21	0.01
[SE]	[0.02]	[0.01]	[0.02]	[0.02]	[0.03]	[0.02]	[0.04]	[0.02]	[0.03]	[0.02]
P value	0.95	0.03	0	0.15	0.99	0.83	0.04	0	0	0.7
Kurt	-0.01	0	0.02	-0.01	-0.03	-0.05	0.01	-0.03	0.02	-0.02
[SE]	[0.01]	[0.01]	[0.01]	[0]	[0]	[0.01]	[0.01]	[0]	[0]	[0]
P value	0.69	0.83	0	0	0	0	0.01	0	0	0
Adj. R²	0.2	0.02	0.51	0.1	0.35	0.38	0.46	0.64	0.59	0.66
F- stat	40.94	4.22	166.77	23.11	103.2	103.12	134.9	350.9	222.5	332.7
P value	0	0.01	0	0	0	0	0	0	0	0

Note: Pre and Post indicate sub-samples before and after the break dates in Table 4. Newey-West (NW) HAC Standard Errors and Covariance (lag truncation=5). Filtering means replacing each value α of each of the series for explanatory variables with the fitted value obtained from using Least Median Regression with a window of 30. We use the R function `robreg.filter()` found in the package **robfilter** written by Fried, Schettlinger and Borrowski(2012) . F-stats report Wald test of the null that $\gamma_1 = \gamma_2 = \gamma_3 = 0$.

AT4D) USDCAD

	1W		1M		2M		3M		6M	
	PRE	POS	PRE	POS	PRE	POS	PRE	POST	PRE	POST
St Dev	-2.14	0.32	7.69	-0.24	0.07	-1.52	1.58	0.68	-5	3.3
[SE]	[0.95	[0.45]	[0.7]	[0.3]	[1.89]	[0.41]	[0.72]	[0.31]	[0.57]	[0.31]
]									
P value	0.02	0.48	0	0.44	0.97	0	0.03	0.03	0	0
Skew	0	-0.01	0.23	0.03	-0.14	-0.05	-0.18	-0.02	0.07	0.16
[SE]	[0.02	[0.01]	[0.03]	[0.01]	[0.08]	[0.01]	[0.05]	[0.01]	[0.03]	[0.01]
]									
P value	0.94	0.08	0	0	0.07	0	0	0.02	0.01	0
Kurt	0.01	-0.01	0.23	0.01	0.05	0.01	0.01	0.02	0	0.05
[SE]	[0.01	[0]	[0.02]	[0]	[0.03]	[0]	[0.01]	[0]	[0.01]	[0.01]
]									
P value	0.08	0.06	0	0.15	0.14	0.01	0.33	0	0.57	0
Adj. R2	0.22	0.02	0.67	0.04	0.42	0.14	0.52	0.49	0.71	0.75
F- stat	45.94	6.07	136.9	14.6	115.6	34.9	195.6	164.7	270.0	662.9
			5		7		9	9	9	1
P value	0	0	0		0	0	0	0	0	0

Note: Pre and Post indicate sub-samples before and after the break dates in Table 4. Newey-West (NW) HAC Standard Errors and Covariance (lag truncation=5). Filtering means replacing each value o of each of the series for explanatory variables with the fitted value obtained from using Least Median Regression with a window of 30. We use the R function `robreg.filter()` found in the package **robfilter** written by Fried,

Schettlinger and Borrowski(2012) . F-stats report Wald test of the null that $\gamma_1 = \gamma_2 = \gamma_3 = 0$.

AT4E) USDJPY

	1M		2M		3M		6M	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST
St Dev	0.78	-2.87	1.73	-5.06	0.74	-3.04	-1.46	-2.3
[SE]	[0.21]	[0.48]	[0.32]	[0.68]	[0.3]	[0.36]	[0.32]	[0.23]
P-value	0	0	0	0	0.01	0	0	0
Skew	0	-0.04	0	-0.1	-0.08	-0.08	-0.14	-0.05
[SE]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]
P value	0.95	0.01	0.99	0	0	0	0	0.02
Kurt	0.01	-0.03	0.02	-0.02	0	-0.02	0	-0.02
[SE]	[0]	[0]	[0]	[0]	[0]	[0]	[0]	[0]
P value	0.02	0	0	0	0.03	0	0.1	0
Adj. R²	0.09	0.26	0.17	0.42	0.09	0.41	0.55	0.52
F- stat	17.38	69.04	36.98	140.41	17.52	129.95	142.15	238.44
P value	0	0	0	0	0	0	0	0

Note: Pre and Post indicate sub-samples before and after the break dates in Table 4. Newey-West (NW) HAC Standard Errors and Covariance (lag truncation=5). Filtering means replacing each value o of each of the series for explanatory variables with the fitted value obtained from using Least Median Regression with a window of 30. We use the R function robreg.filter() found in the package **robfilter** written by Fried, Schettlinger and Borrowski(2012) . F-stats report Wald test of the null that $\gamma_1 = \gamma_2 = \gamma_3 = 0$.

Table AT5: SMILE REGRESSION RESULTS USING 10Δ OPTION-IMPLIED MOMENTS

Table AT6: Principal Component Analysis
Cumulative Proportion of First Three Principal Components
A) Base Series: 7 Tenors by FX, by Risk-Neutral Moments

	AUSUSD	EURUSD	GBPUSD	USDCAD	USDJPY
St. Dev					
PC1	91.4%	93.6%	57.1%	94.1%	93.4%
PC2	99.3%	99.4%	73.9%	99.5%	99.3%
PC3	99.8%	99.8%	88.1%	99.8%	99.9%
Skew					
PC1	73.7%	78.7%	65.1%	92.7%	55.9%
PC2	89.4%	96.0%	85.5%	97.9%	83.3%
PC3	94.5%	98.9%	96.2%	99.3%	96.0%
Kurt					
PC1	73.7%	81.1%	57.1%	63.8%	76.8%
PC2	89.4%	95.2%	73.9%	97.4%	93.3%
PC3	94.5%	98.3%	88.1%	99.2%	99.7%

Note: We report the cumulative proportion of the top three principal components extracted from the term structure of each risk-neutral moments for every currencies.

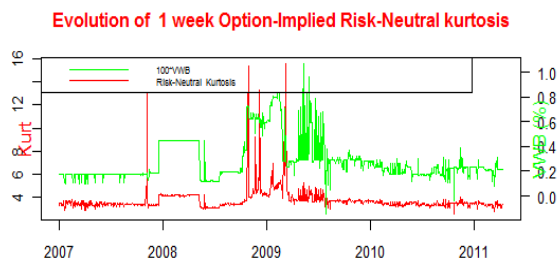
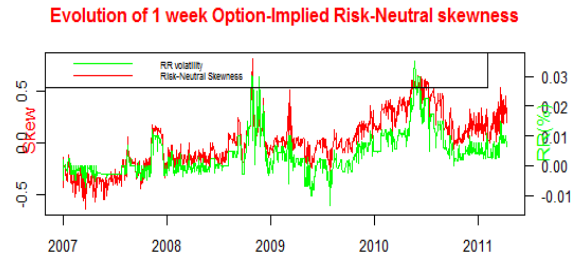
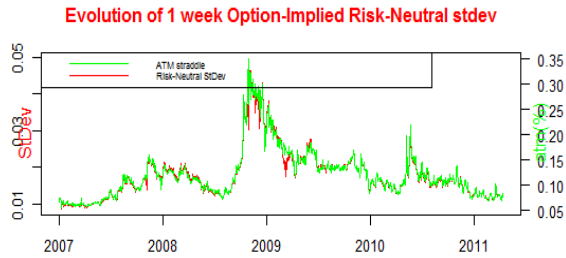
B) Global Principal Components

	Base Series: 3-Month Moments over all FX (5)	Moments over all FX, all Tenors (34)
St. Dev		
PC1	90.7%	87.7%
PC2	95.9%	93.1%
PC3	97.9%	95.9%
Skew		
PC1	55.8%	51.1%
PC2	75.8%	65.2%
PC3	87.7%	75.9%
Kurt		
PC1	43.7%	29.2%
PC2	65.8%	46.9%
PC3	84.1%	62.4%

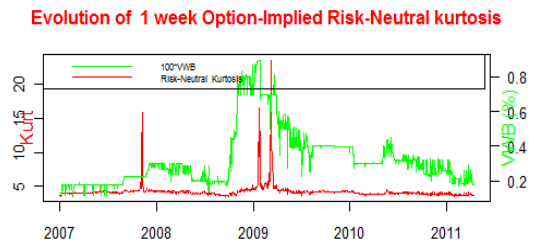
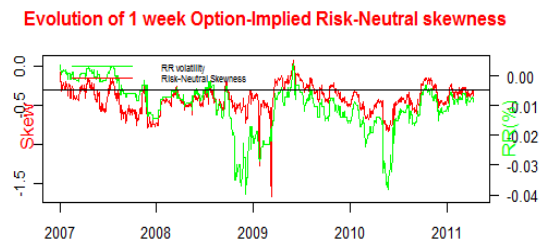
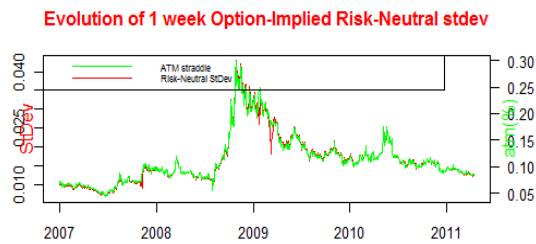
Note: the 1st column reports the cumulative proportions of the top 3 principal components extracted from the 3-month risk-neutral moments across the 5 currencies, capturing 3 month common factors across currencies. The 2nd column reports the same numbers extracted from risk-neutral moments from all currencies and all tenors (34 series total for each moments.)

TIME SERIES EVOLUTIONS OF EXTRACTED RISK-NEUTRAL MOMENTS

USDCAD 1WK

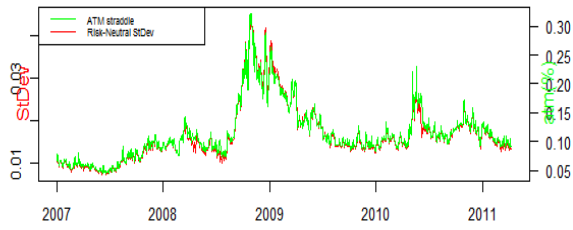


GBPUSD 1WK

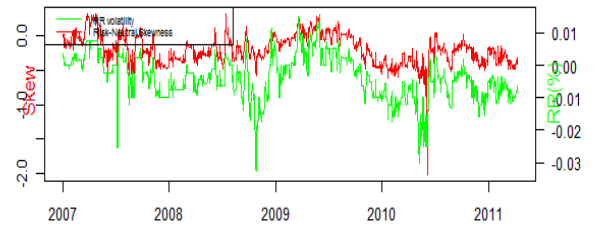


EURUSD 1WK

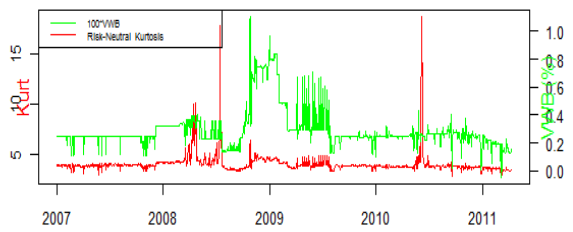
Evolution of 1 week Option-Implied Risk-Neutral stdev



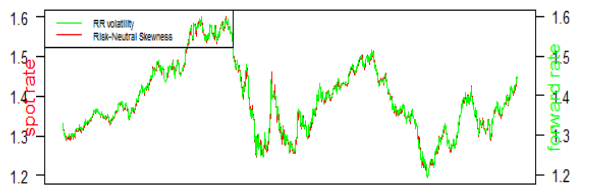
Evolution of 1 week Option-Implied Risk-Neutral skewness



Evolution of 1 week Option-Implied Risk-Neutral kurtosis

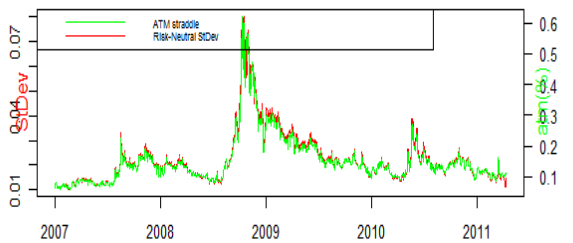


Evolution of spot rate

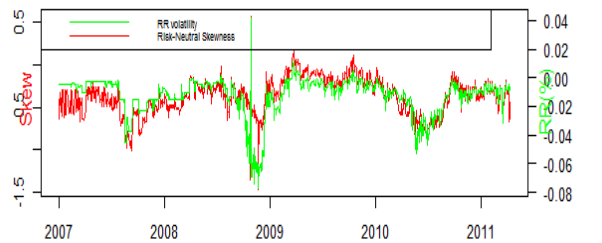


AUDUSD 1WK

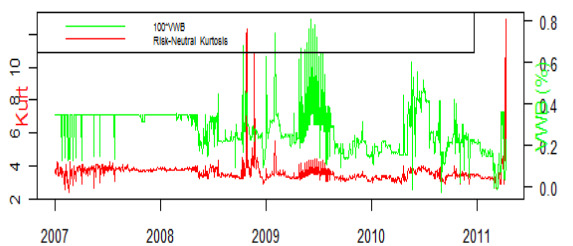
Evolution of 1 week Option-Implied Risk-Neutral stdev



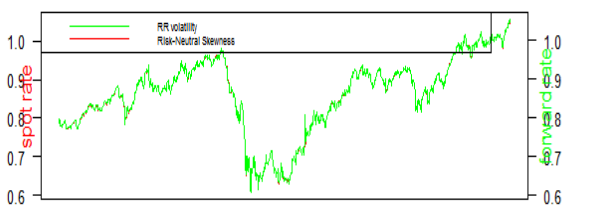
Evolution of 1 week Option-Implied Risk-Neutral skewness



Evolution of 1 week Option-Implied Risk-Neutral kurtosis



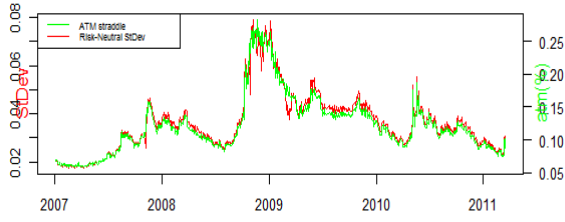
Evolution of spot rate



Figures A2-11–A2-15: Time series plots of option-implied moments: 1WK tenor

USDCAD 1M

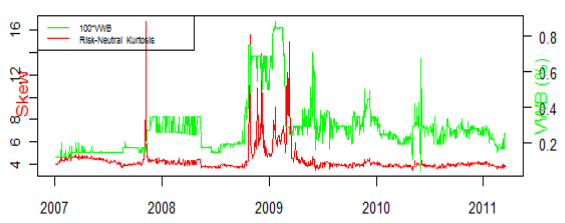
Evolution of 1m Option-Implied Risk-Neutral stdev



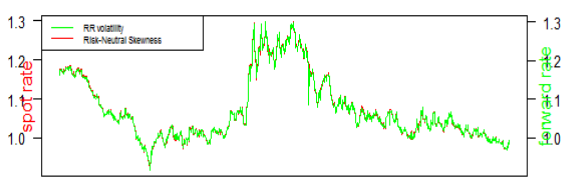
Evolution of 1m Option-Implied Risk-Neutral skewness



Evolution of 1m Option-Implied Risk-Neutral kurtosis

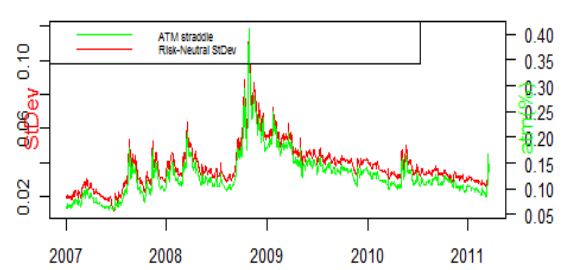


Evolution of spot rate

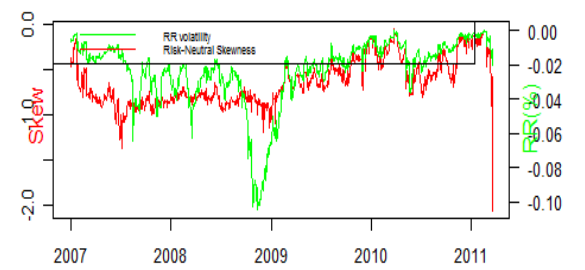


USDJPY 1M

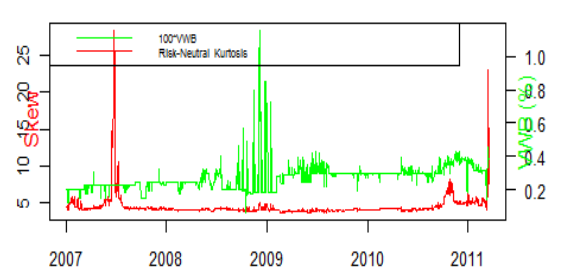
Evolution of 1m Option-Implied Risk-Neutral stdev



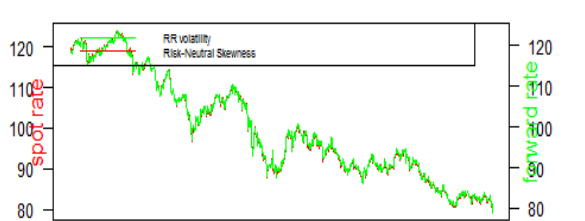
Evolution of 1m Option-Implied Risk-Neutral skewness



Evolution of 1m Option-Implied Risk-Neutral kurtosis

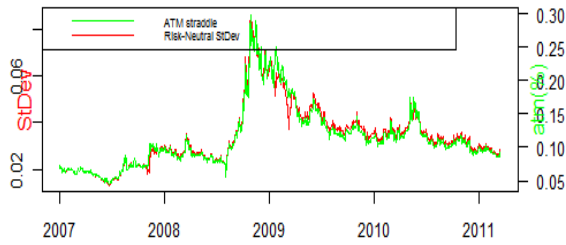


Evolution of spot rate

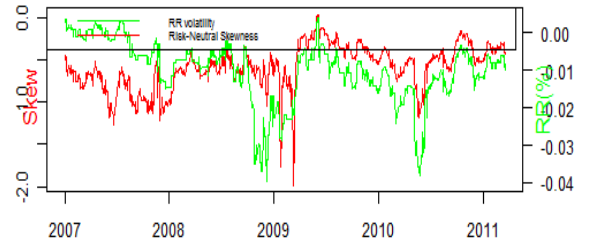


GBPUSD 1M

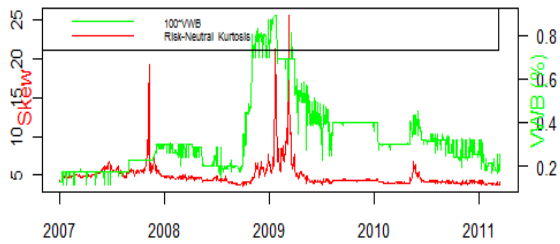
Evolution of 1m Option-Implied Risk-Neutral stdev



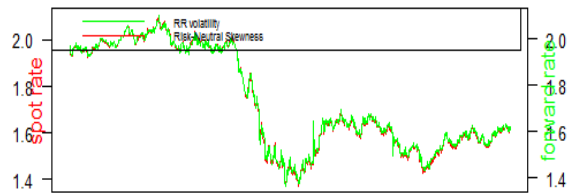
Evolution of 1m Option-Implied Risk-Neutral skewness



Evolution of 1m Option-Implied Risk-Neutral kurtosis

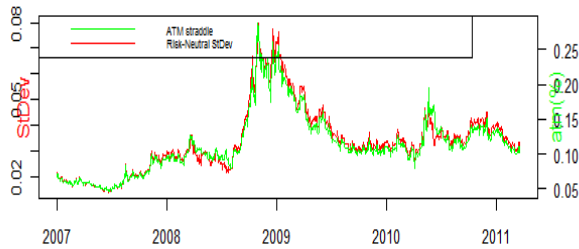


Evolution of spot rate

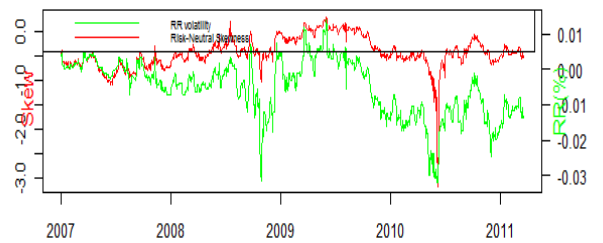


EURUSD 1M

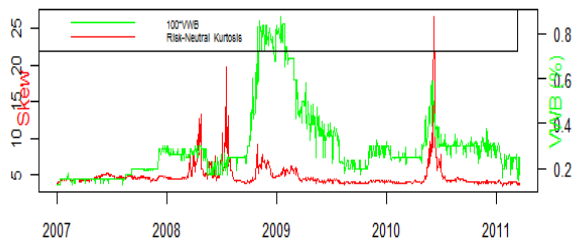
Evolution of 1m Option-Implied Risk-Neutral stdev



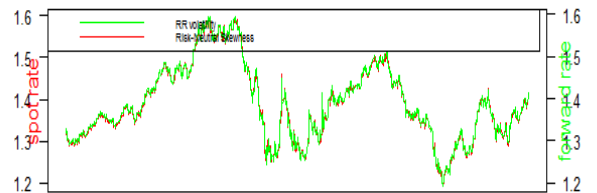
Evolution of 1m Option-Implied Risk-Neutral skewness



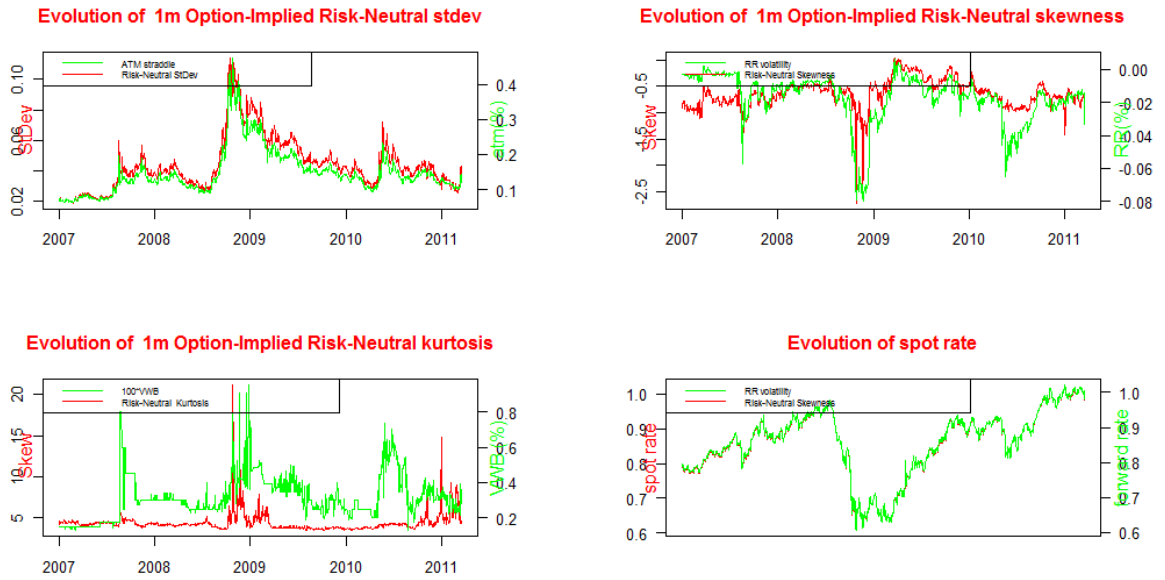
Evolution of 1m Option-Implied Risk-Neutral kurtosis



Evolution of spot rate



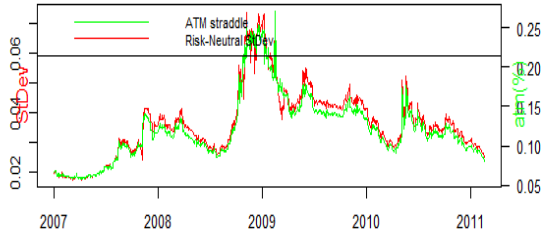
AUDUSD 1M



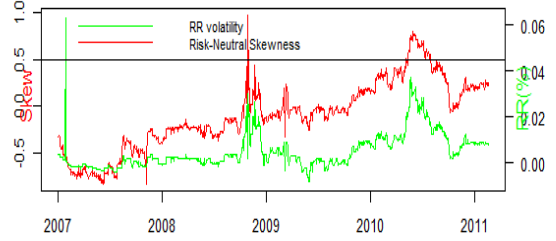
Figures A2-21- A2-25: Time series plots of option-implied moments: 1M tenor

USDCAD 2M

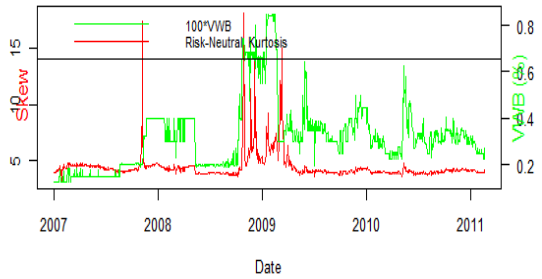
Evolution of 2m Option-Implied Risk-Neutral stdev



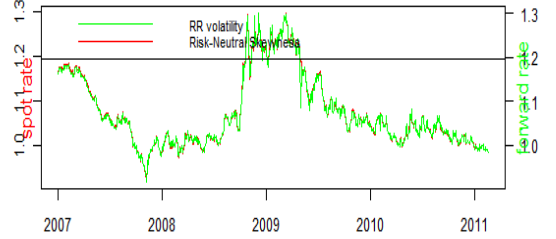
Evolution of 2m Option-Implied Risk-Neutral skewness



Evolution of 2m Option-Implied Risk-Neutral kurtosis

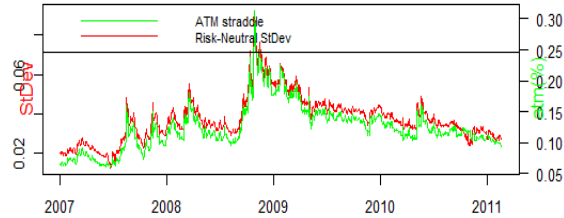


Evolution of spot rate

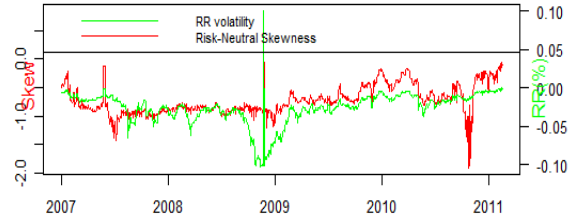


USDJPY 2M

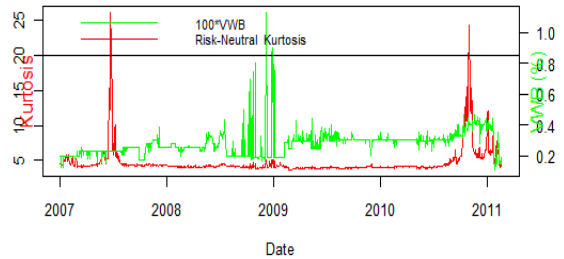
Evolution of 2m Option-Implied Risk-Neutral stdev



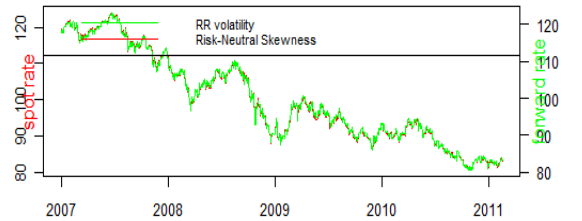
Evolution of 2m Option-Implied Risk-Neutral skewness



Evolution of 2m Option-Implied Risk-Neutral kurtosis

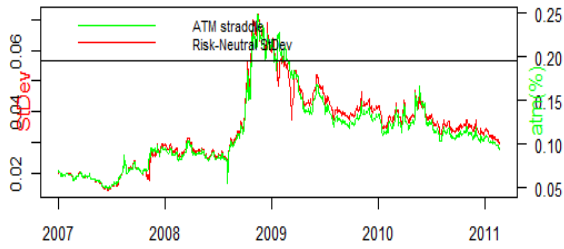


Evolution of spot rate

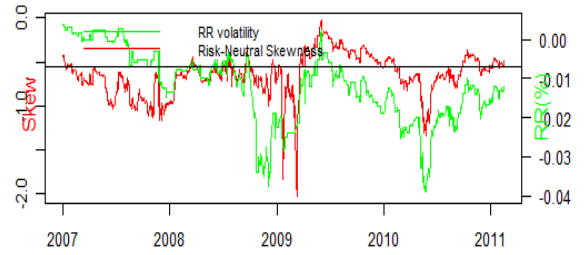


GBPUSD 2M

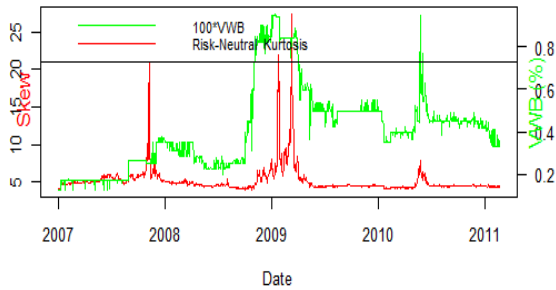
Evolution of 2m Option-Implied Risk-Neutral stdev



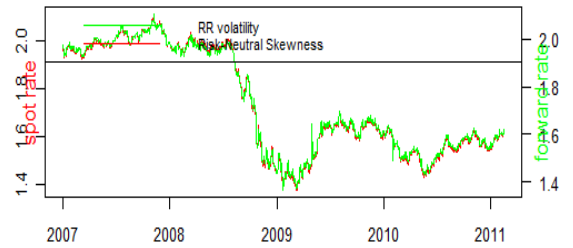
Evolution of 2m Option-Implied Risk-Neutral skewness



Evolution of 2m Option-Implied Risk-Neutral kurtosis

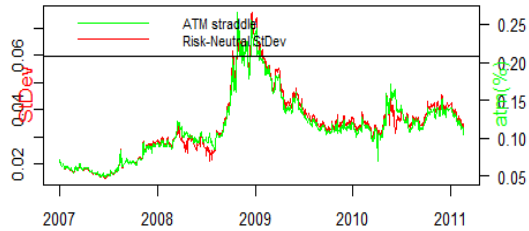


Evolution of spot rate

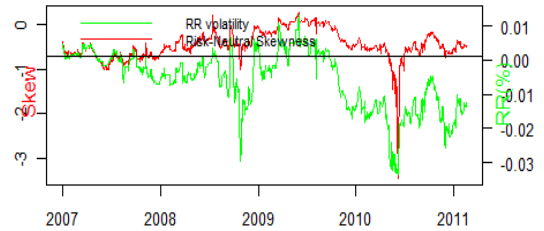


EURUSD 2M

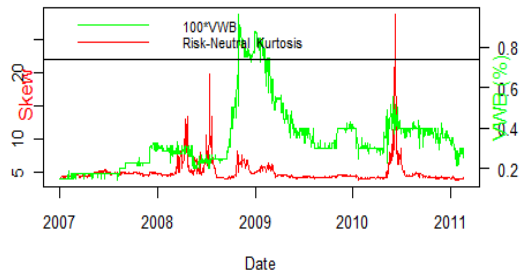
Evolution of 2m Option-Implied Risk-Neutral stdev



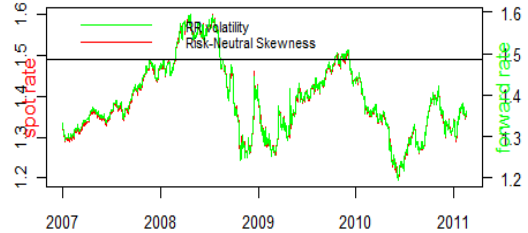
Evolution of 2m Option-Implied Risk-Neutral skewness



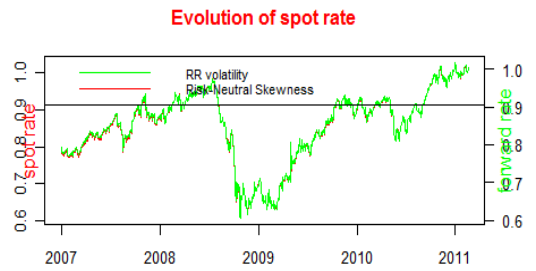
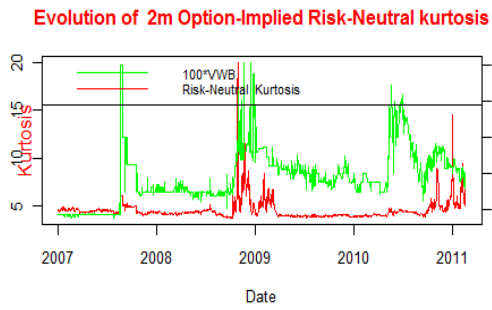
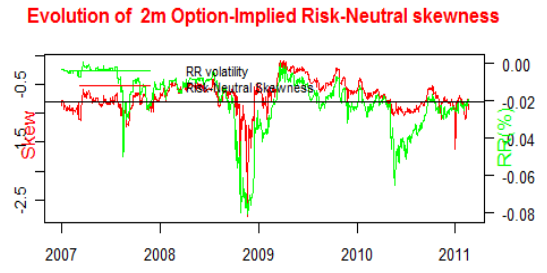
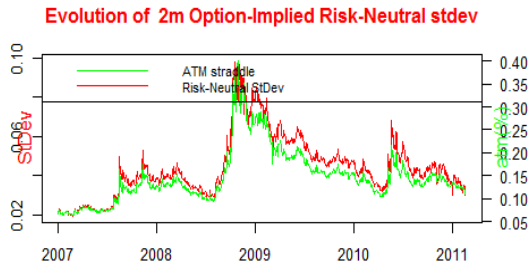
Evolution of 2m Option-Implied Risk-Neutral kurtosis



Evolution of spot rate



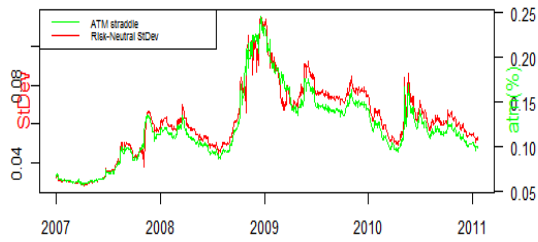
AUDUSD



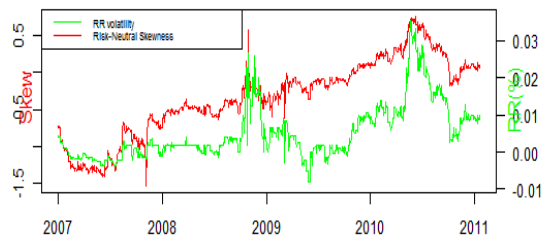
Figures A2-31- A2-35: Time series plots of option-implied moments: 2M tenor

USDCAD 3M

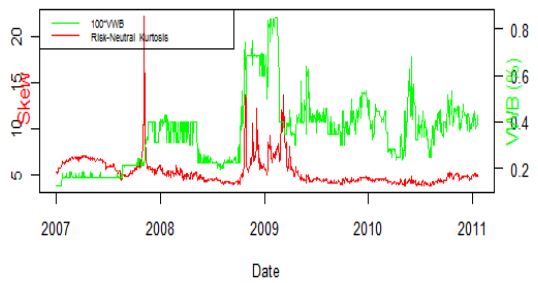
Evolution of 3m Option-Implied Risk-Neutral stdev



Evolution of 3m Option-Implied Risk-Neutral skewness



Evolution of 3m Option-Implied Risk-Neutral kurtosis

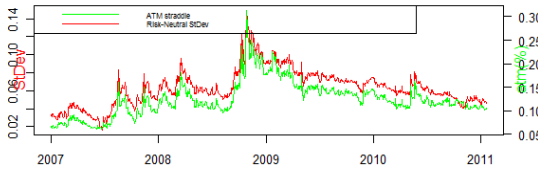


Evolution of spot rate

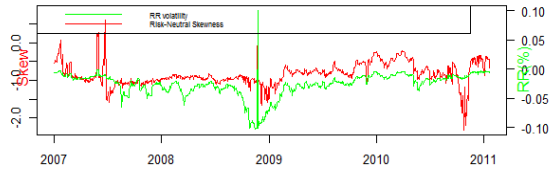


JPYUSD 3M

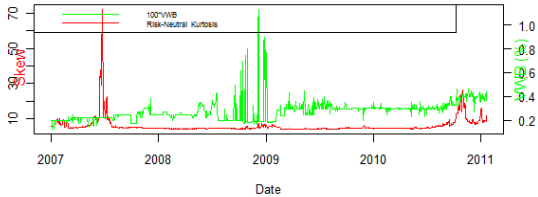
Evolution of 3m Option-Implied Risk-Neutral stdev



Evolution of 3m Option-Implied Risk-Neutral skewness



Evolution of 3m Option-Implied Risk-Neutral kurtosis

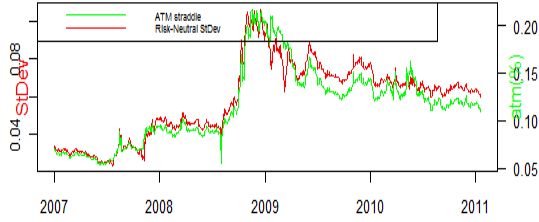


Evolution of spot rate

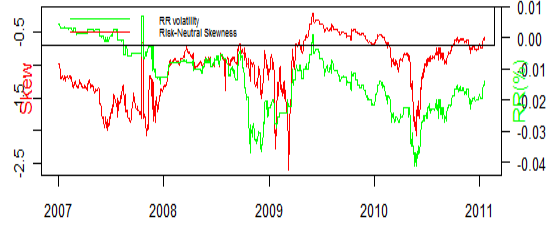


GBPUSD 3M

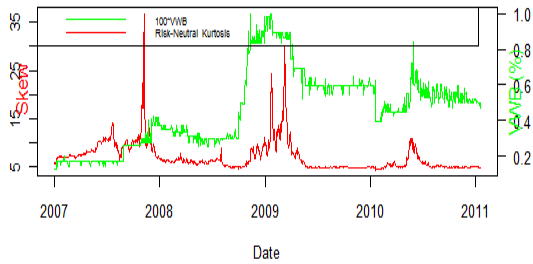
Evolution of 3m Option-Implied Risk-Neutral stdev



Evolution of 3m Option-Implied Risk-Neutral skewness



Evolution of 3m Option-Implied Risk-Neutral kurtosis



Evolution of spot rate

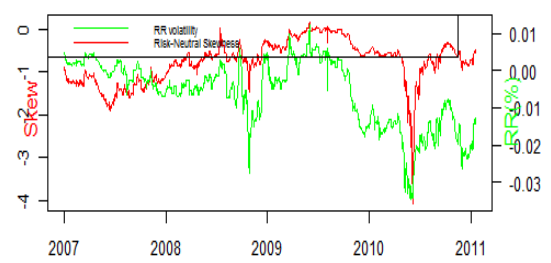


EURUSD 3M

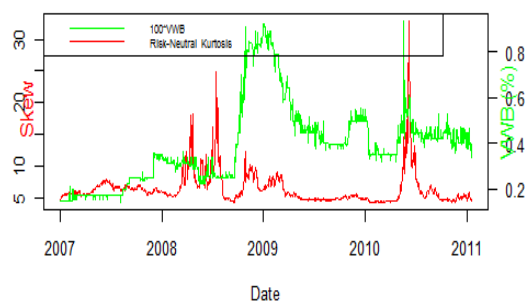
Evolution of 3m Option-Implied Risk-Neutral stdev



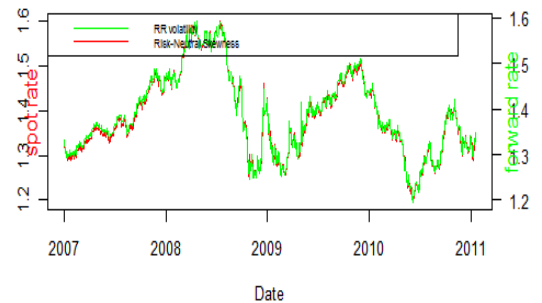
Evolution of 3m Option-Implied Risk-Neutral skewness



Evolution of 3m Option-Implied Risk-Neutral kurtosis

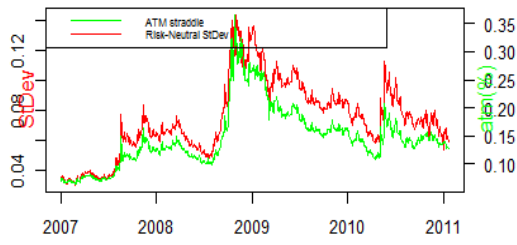


Evolution of spot rate

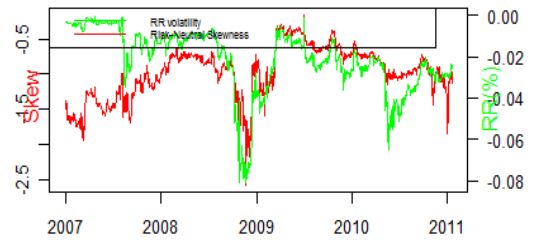


AUDUSD 3M

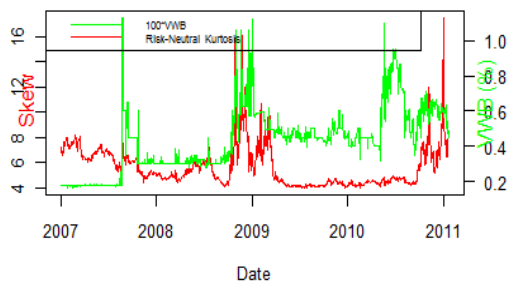
Evolution of 3m Option-Implied Risk-Neutral stdev



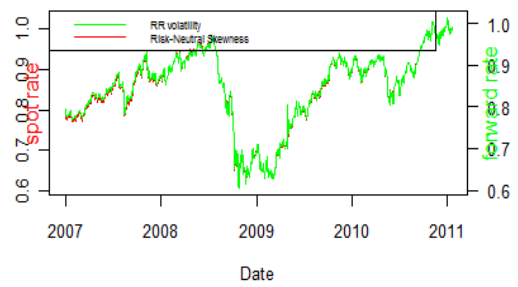
Evolution of 3m Option-Implied Risk-Neutral skewness



Evolution of 3m Option-Implied Risk-Neutral kurtosis



Evolution of spot rate



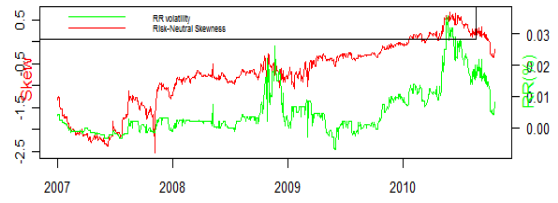
Figures A2-41 - A2-45: Time series plots of option-implied moments: 3M tenor

USDCAD 6M

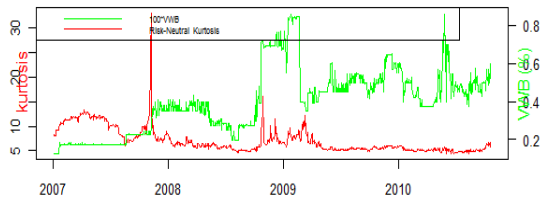
Evolution of 6m Option-Implied Risk-Neutral stdev



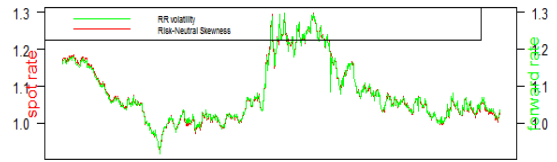
Evolution of 6m Option-Implied Risk-Neutral skewness



Evolution of 6m Option-Implied Risk-Neutral kurtosis

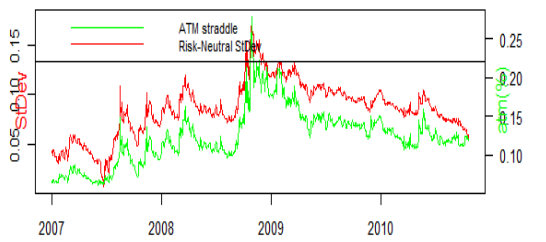


Evolution of spot rate

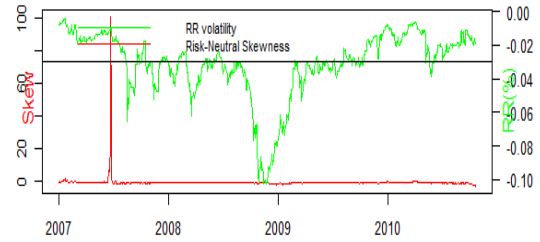


USDJPY 6M

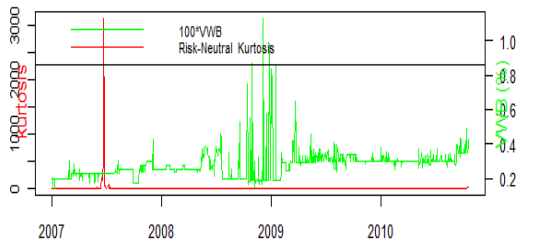
Evolution of 6m Option-Implied Risk-Neutral stdev



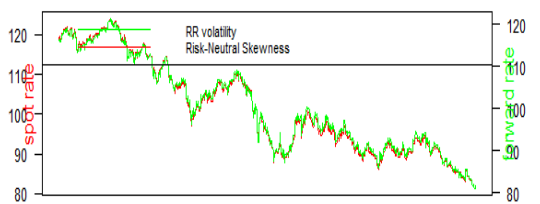
Evolution of 6m Option-Implied Risk-Neutral skewness



Evolution of 6m Option-Implied Risk-Neutral kurtosis

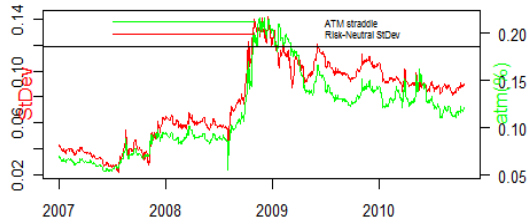


Evolution of spot rate

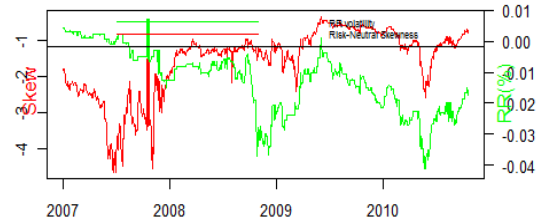


GBPUSD 6M

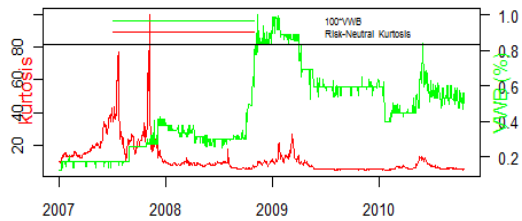
Evolution of 6m Option-Implied Risk-Neutral stdev



Evolution of 6m Option-Implied Risk-Neutral skewness



Evolution of 6m Option-Implied Risk-Neutral kurtosis



Evolution of spot rate

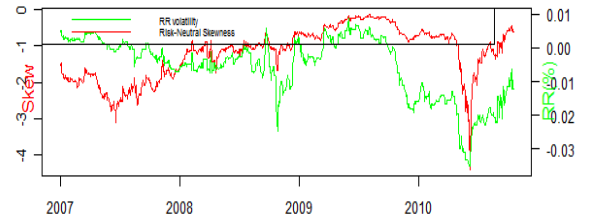


EURUSD 6M

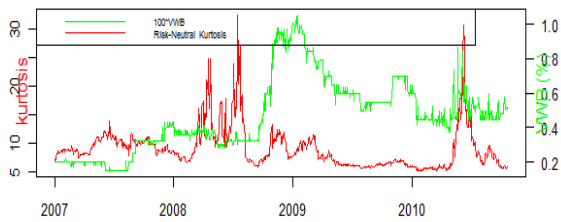
Evolution of 6m Option-Implied Risk-Neutral stdev



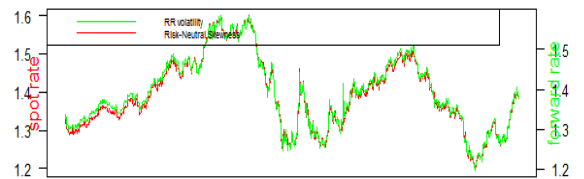
Evolution of 6m Option-Implied Risk-Neutral skewness



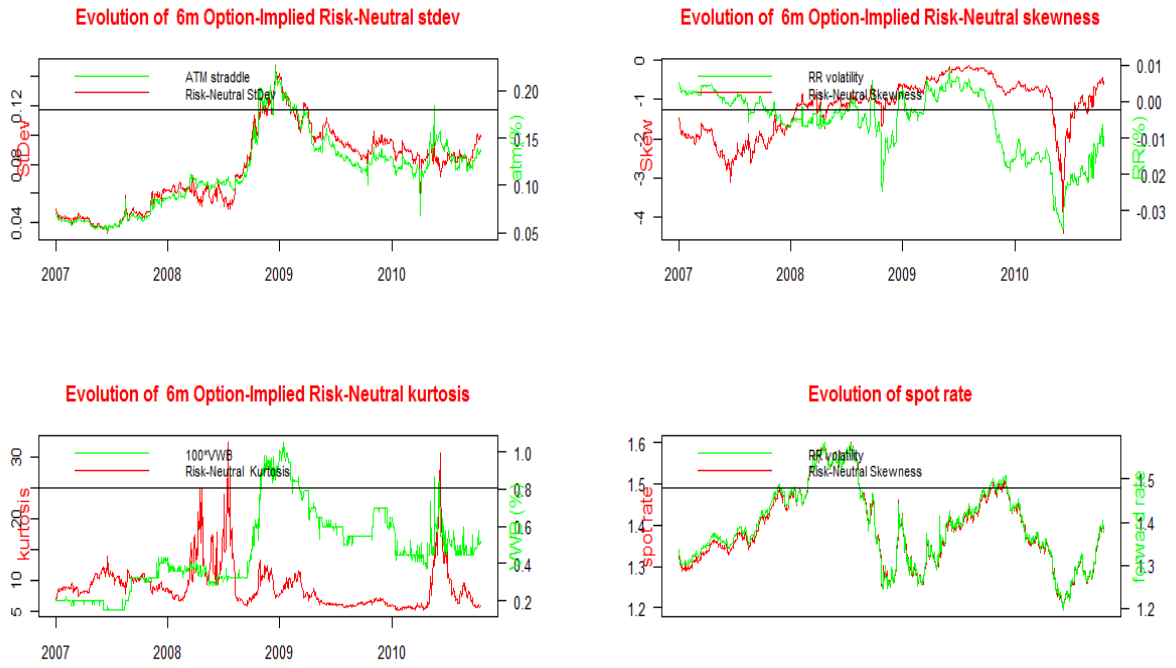
Evolution of 6m Option-Implied Risk-Neutral kurtosis



Evolution of spot rate



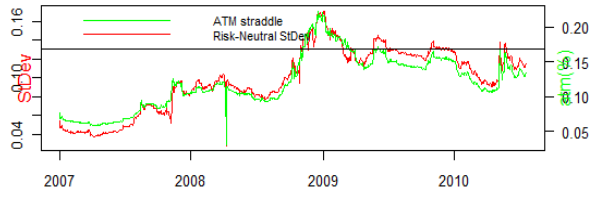
AUDUSD



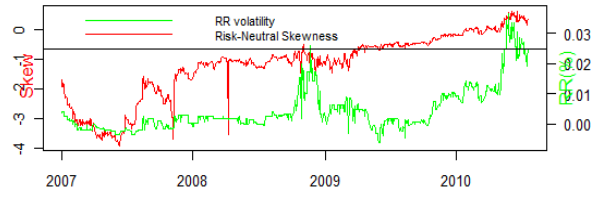
Figures A2-51- A2-56: Time series plots of option-implied moments: 6M tenor

USDCAD 12M

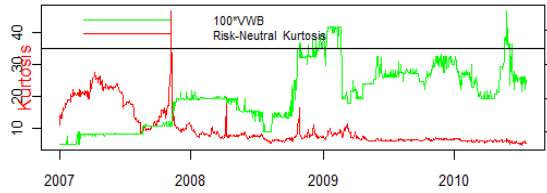
Evolution of 9m Option-Implied Risk-Neutral stdev



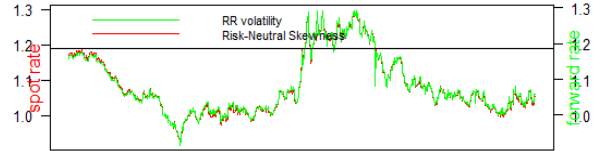
Evolution of 9m Option-Implied Risk-Neutral skewness



Evolution of 9m Option-Implied Risk-Neutral kurtosis

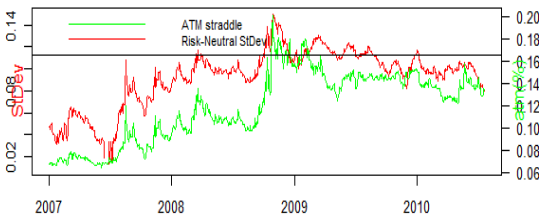


Evolution of spot rate

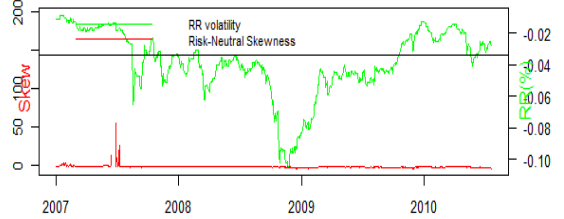


USDJPY 12M

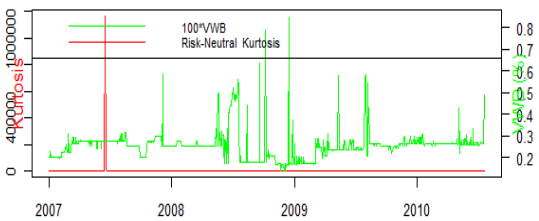
Evolution of 9m Option-Implied Risk-Neutral stdev



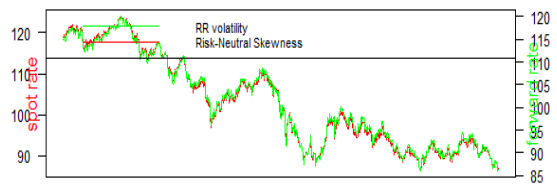
Evolution of 9m Option-Implied Risk-Neutral skewness



Evolution of 9m Option-Implied Risk-Neutral kurtosis

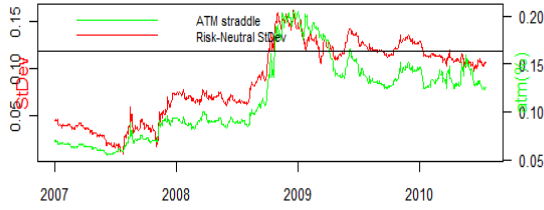


Evolution of spot rate

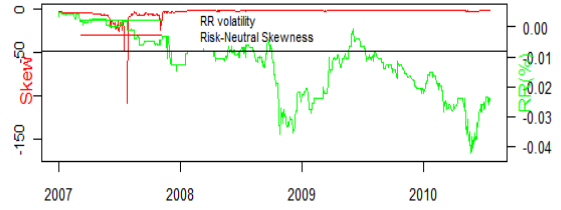


GBPUSD 12M

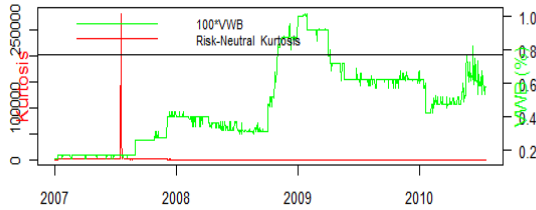
Evolution of 9m Option-Implied Risk-Neutral stdev



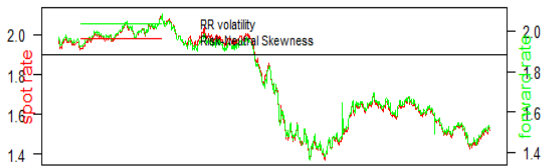
Evolution of 9m Option-Implied Risk-Neutral skewness



Evolution of 9m Option-Implied Risk-Neutral kurtosis

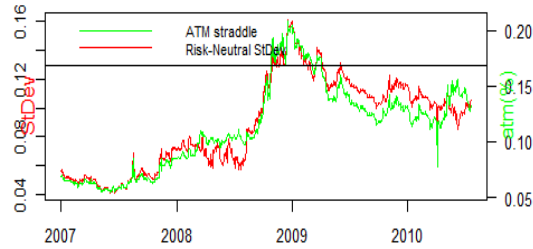


Evolution of spot rate

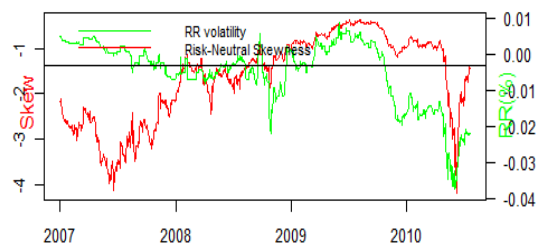


EURUSD

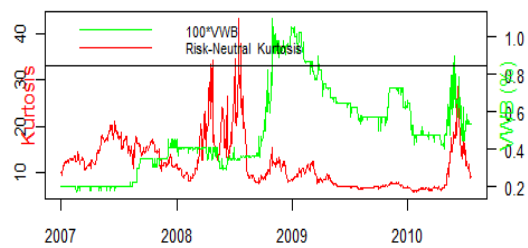
Evolution of 9m Option-Implied Risk-Neutral stdev



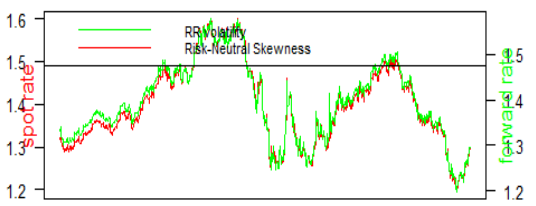
Evolution of 9m Option-Implied Risk-Neutral skewness



Evolution of 9m Option-Implied Risk-Neutral kurtosis



Evolution of spot rate



AUDUSD

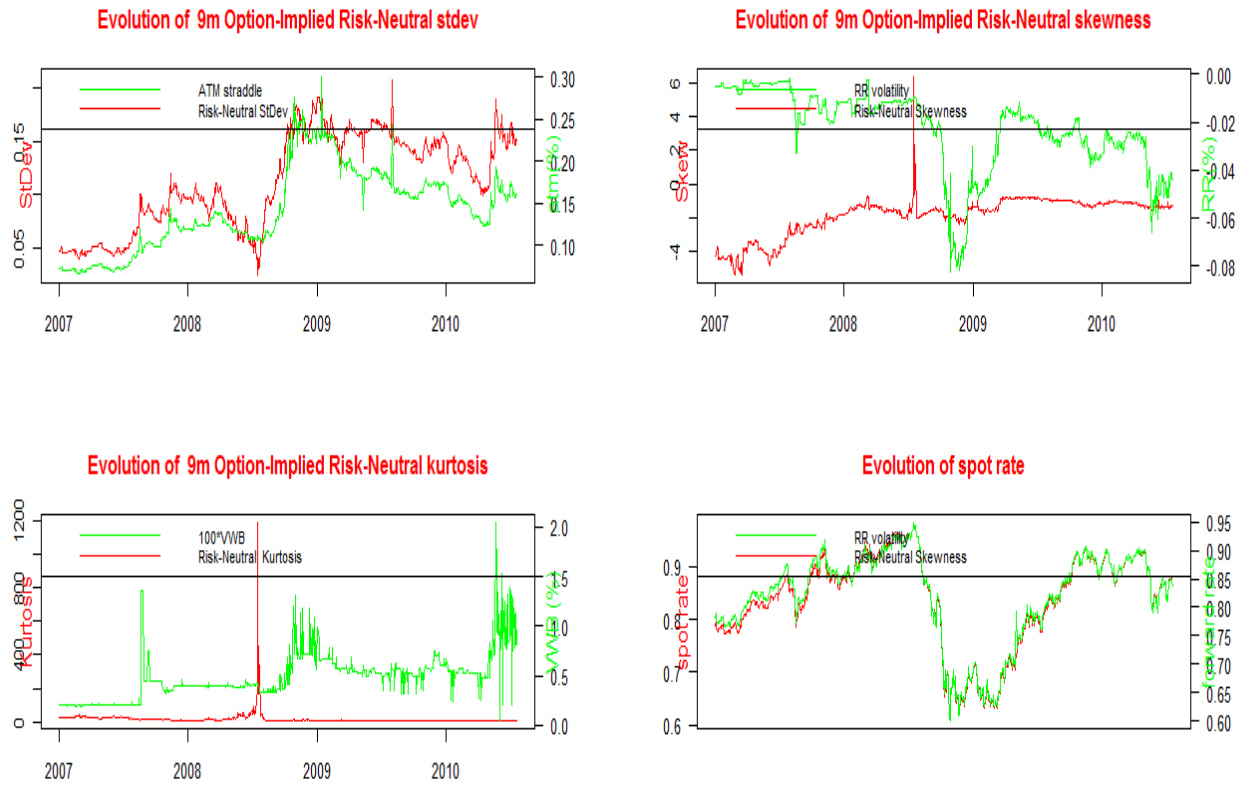
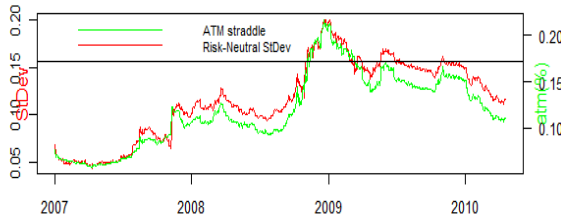


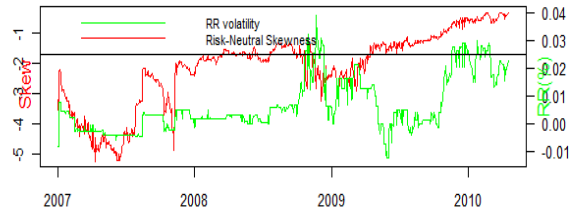
Figure A2-61-2-65: Time series plots of option-implied moments: 9 M tenor

USDCAD

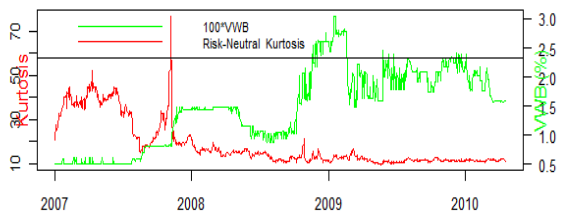
Evolution of 12m Option-Implied Risk-Neutral stdev



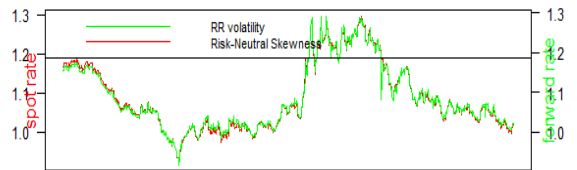
Evolution of 12m Option-Implied Risk-Neutral skewness



Evolution of 12m Option-Implied Risk-Neutral kurtosis

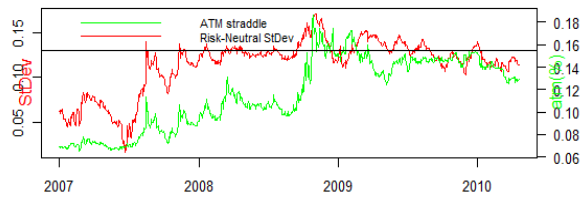


Evolution of spot rate

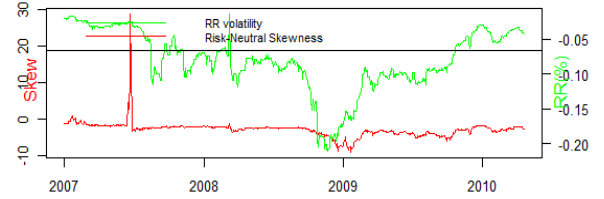


USDJPY

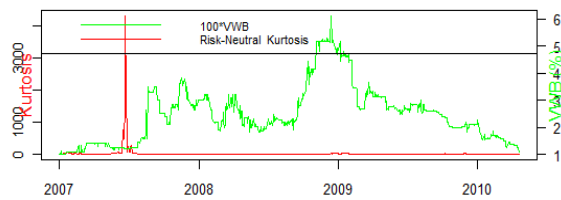
Evolution of 12m Option-Implied Risk-Neutral stdev



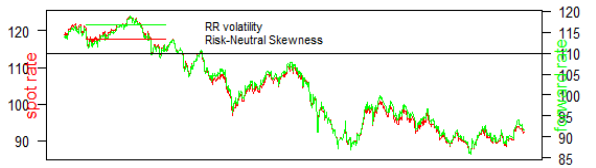
Evolution of 12m Option-Implied Risk-Neutral skewness



Evolution of 12m Option-Implied Risk-Neutral kurtosis

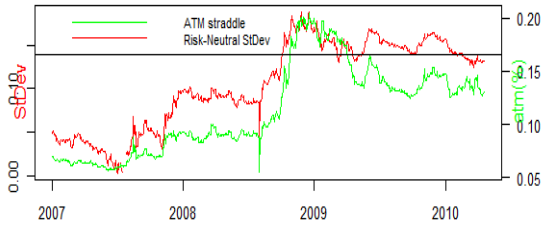


Evolution of spot rate

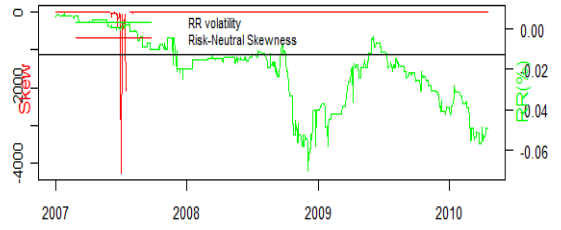


GBPUSD

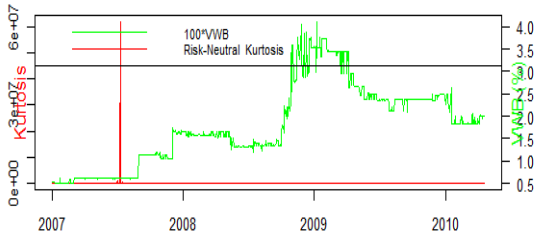
Evolution of 12m Option-Implied Risk-Neutral stdev



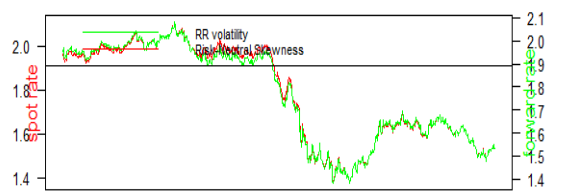
Evolution of 12m Option-Implied Risk-Neutral skewness



Evolution of 12m Option-Implied Risk-Neutral kurtosis

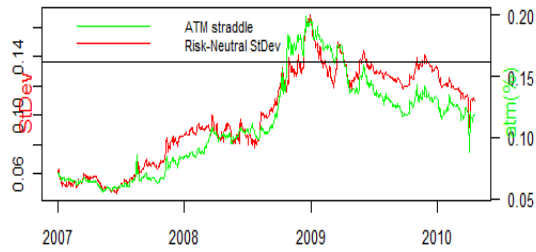


Evolution of spot rate

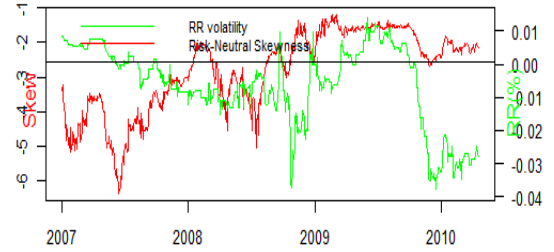


EURUSD

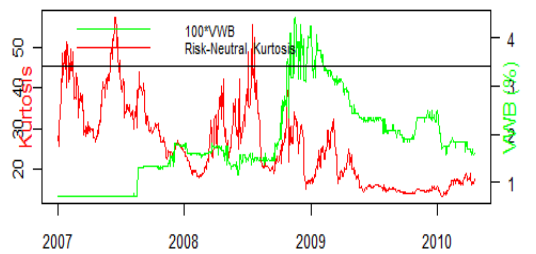
Evolution of 12m Option-Implied Risk-Neutral stdev



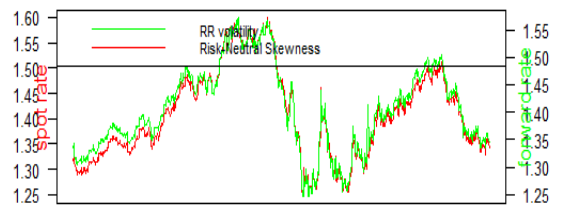
Evolution of 12m Option-Implied Risk-Neutral skewness



Evolution of 12m Option-Implied Risk-Neutral kurtosis



Evolution of spot rate



AUDUSD

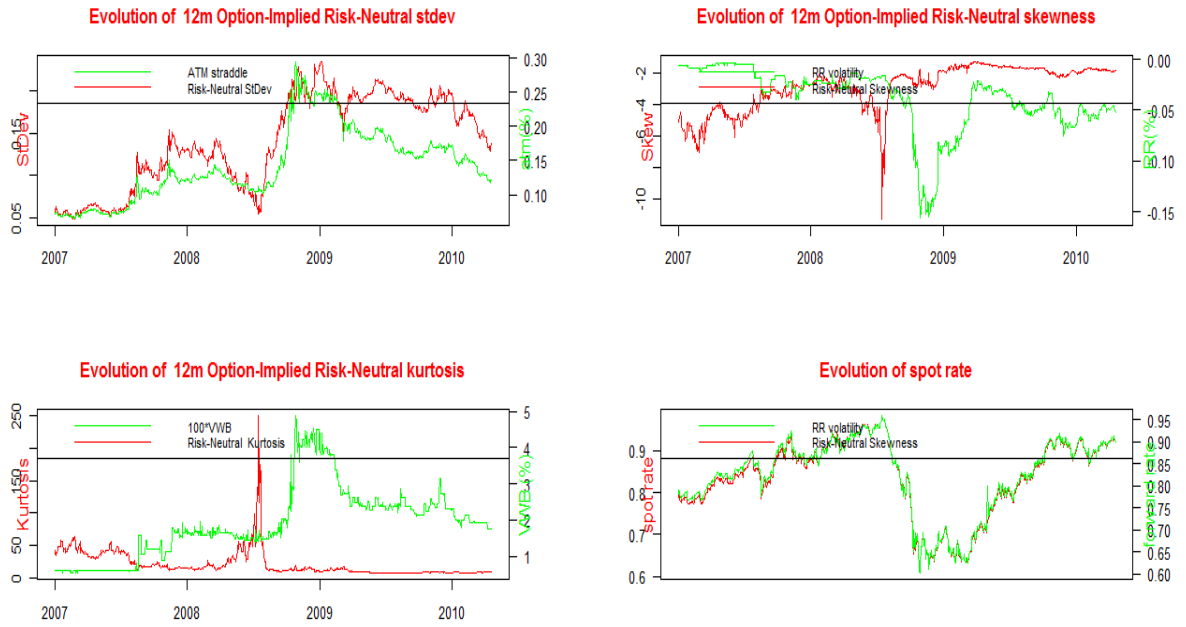
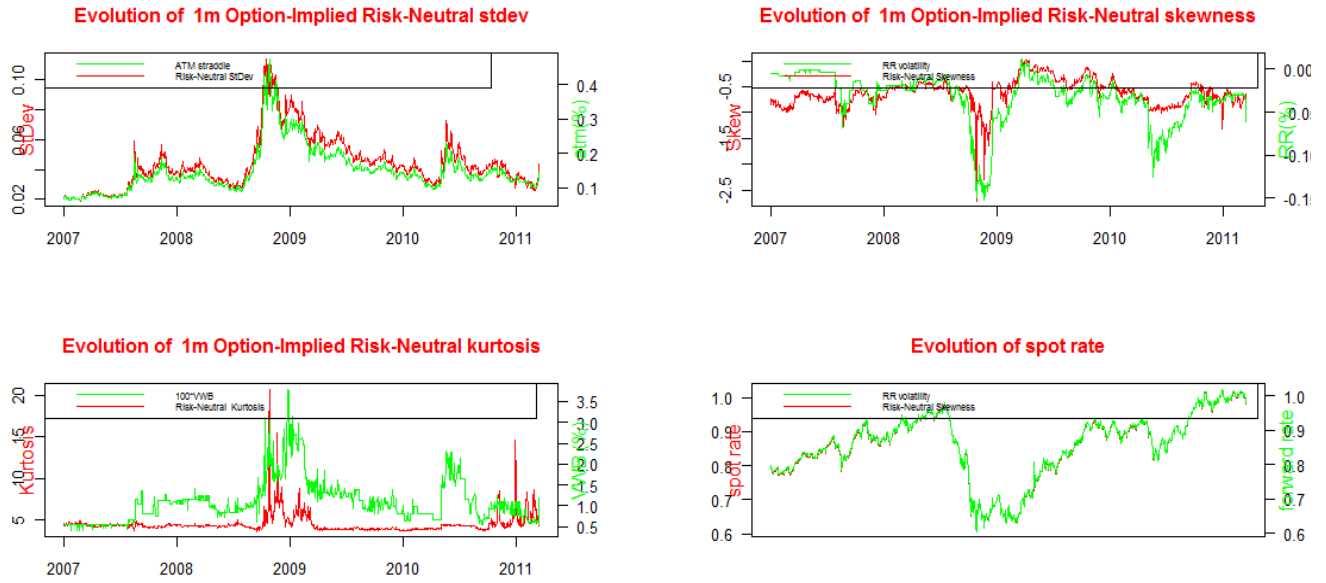


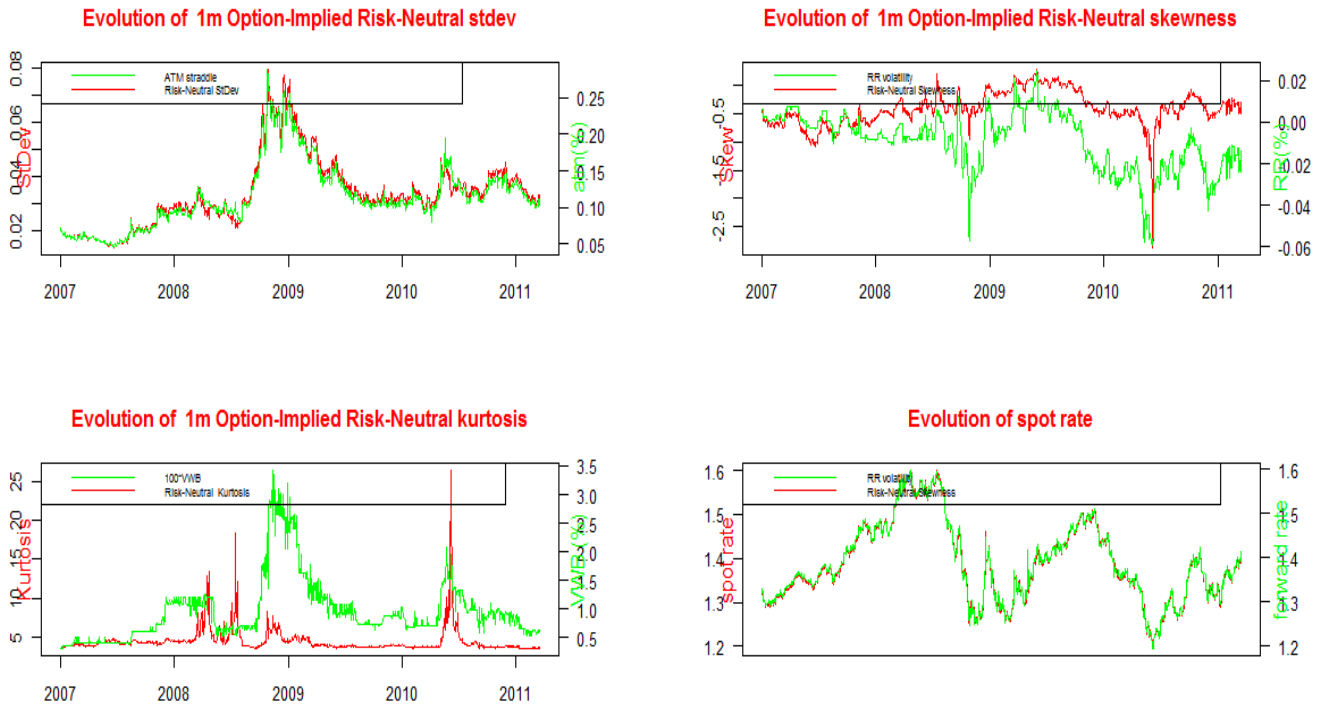
Figure A2-71- 2-75: Time series plots of option-implied moments: 12M tenor

Figure 2: Time Series Plots Options-Implied Moments Using 10Δ Options

AUDUSD 1M

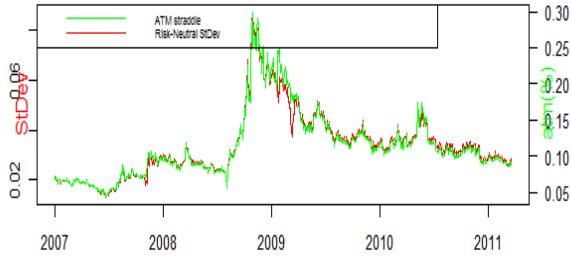


EURUSD 1M

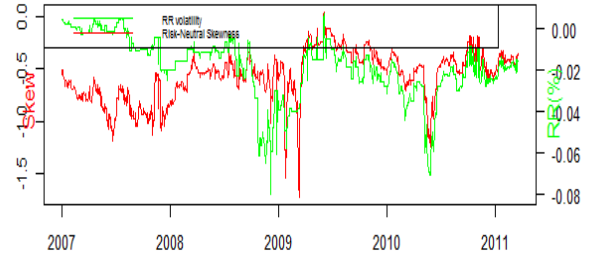


GBPUSD 1M

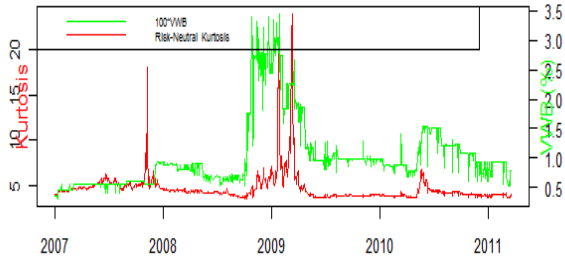
Evolution of 1m Option-Implied Risk-Neutral stdev



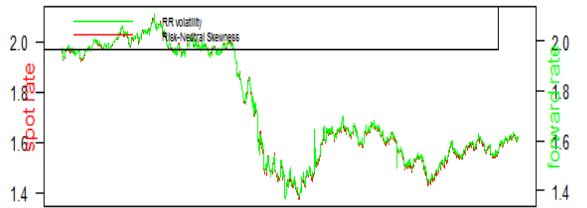
Evolution of 1m Option-Implied Risk-Neutral skewness



Evolution of 1m Option-Implied Risk-Neutral kurtosis

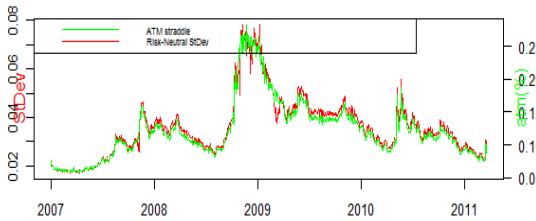


Evolution of spot rate

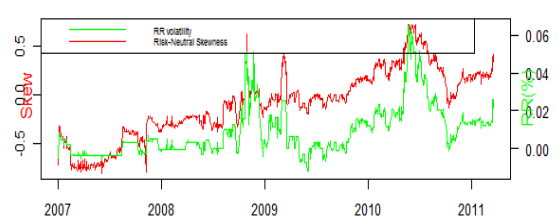


USDCAD 1M

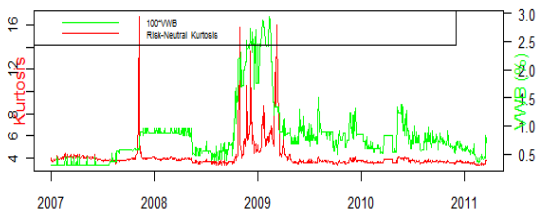
Evolution of 1m Option-Implied Risk-Neutral stdev



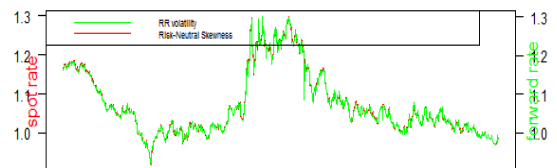
Evolution of 1m Option-Implied Risk-Neutral skewness



Evolution of 1m Option-Implied Risk-Neutral kurtosis

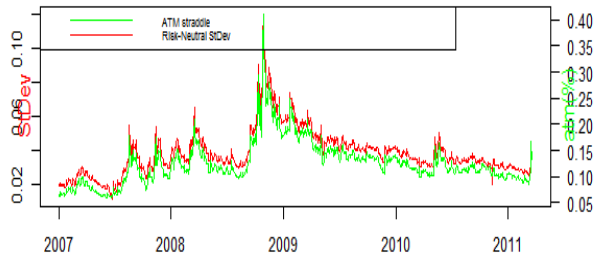


Evolution of spot rate

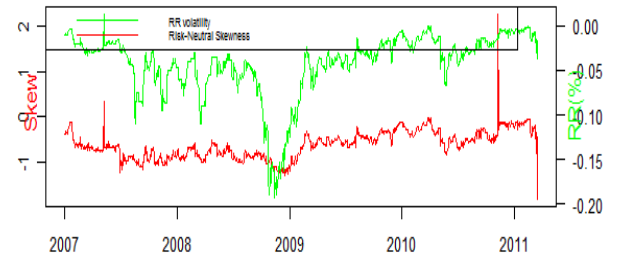


USDJPY 1M

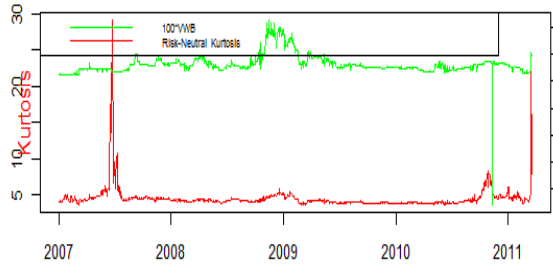
Evolution of 1m Option-Implied Risk-Neutral stdev



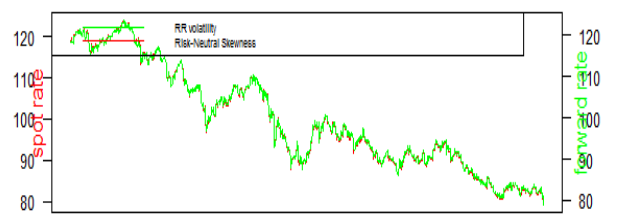
Evolution of 1m Option-Implied Risk-Neutral skewness



Evolution of 1m Option-Implied Risk-Neutral kurtosis

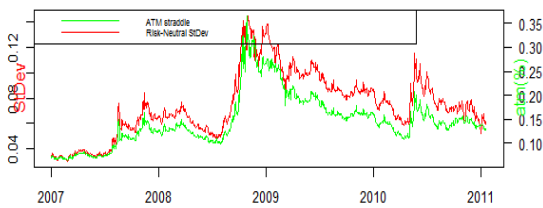


Evolution of spot rate

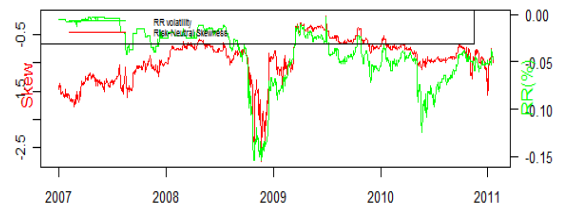


AUDUSD 3M

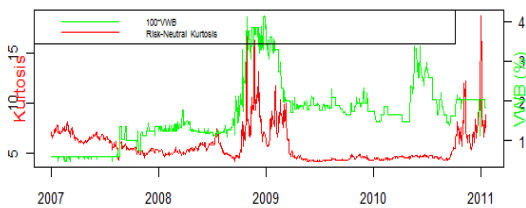
Evolution of 1m Option-Implied Risk-Neutral stdev



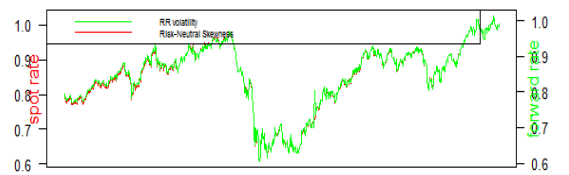
Evolution of 1m Option-Implied Risk-Neutral skewness



Evolution of 1m Option-Implied Risk-Neutral kurtosis



Evolution of spot rate

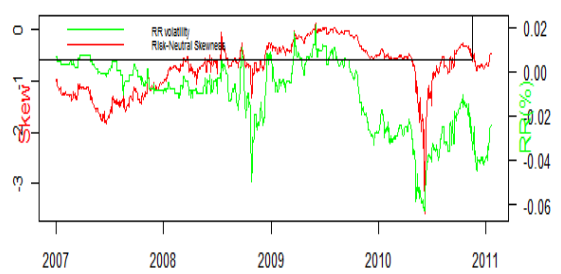


EURUSD 3M

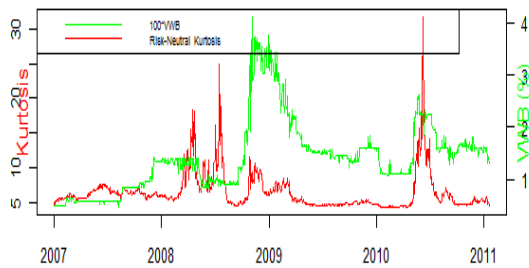
Evolution of 1m Option-Implied Risk-Neutral stdev



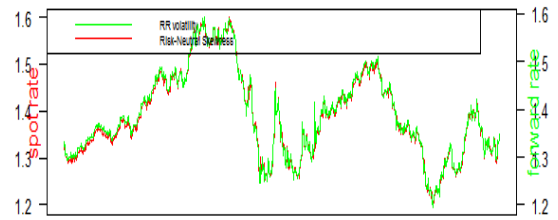
Evolution of 1m Option-Implied Risk-Neutral skewness



Evolution of 1m Option-Implied Risk-Neutral kurtosis



Evolution of spot rate

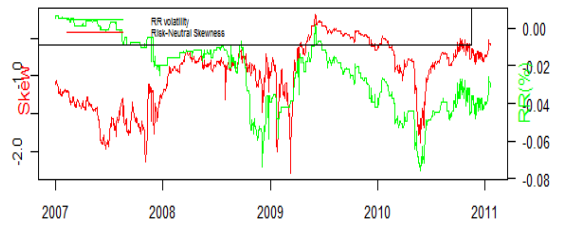


GBPUSD 3M

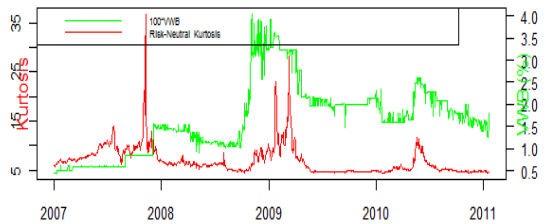
Evolution of 1m Option-Implied Risk-Neutral stdev



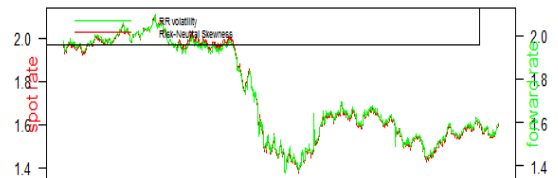
Evolution of 1m Option-Implied Risk-Neutral skewness



Evolution of 1m Option-Implied Risk-Neutral kurtosis

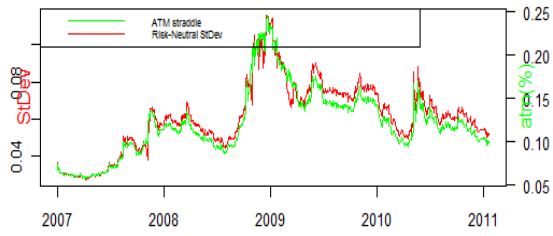


Evolution of spot rate

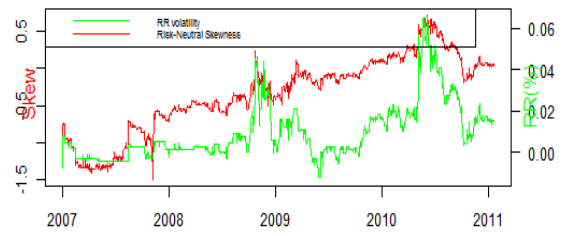


USDCAD 3M

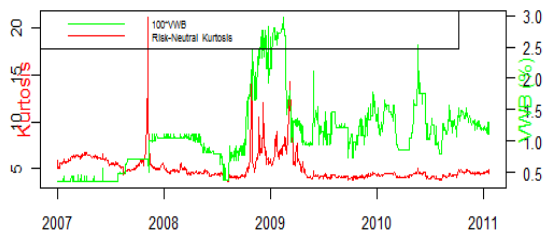
Evolution of 1m Option-Implied Risk-Neutral stdev



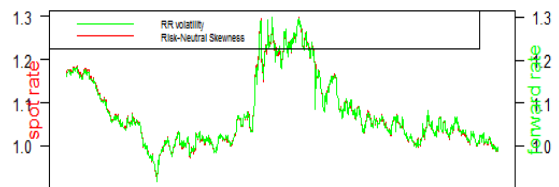
Evolution of 1m Option-Implied Risk-Neutral skewness



Evolution of 1m Option-Implied Risk-Neutral kurtosis

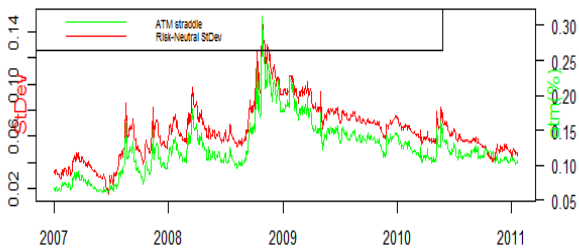


Evolution of spot rate

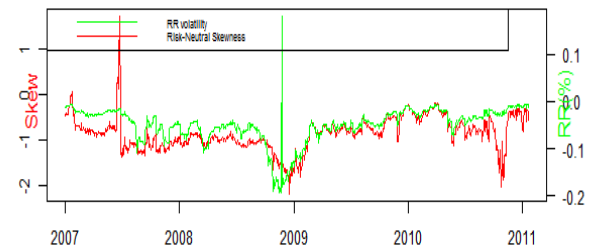


USDJPY 3M

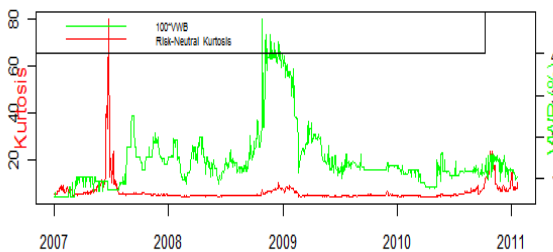
Evolution of 1m Option-Implied Risk-Neutral stdev



Evolution of 1m Option-Implied Risk-Neutral skewness



Evolution of 1m Option-Implied Risk-Neutral kurtosis



Evolution of spot rate

