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Credit Products Strategy

Citi Research

CDX Volatility Report

See Appendix A-1 for Analyst Certification, Important Disclosures and non-US research analyst disclosures

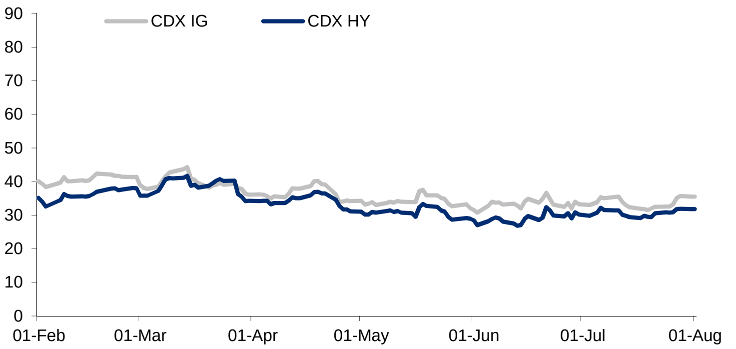
Data as of COB: 01 Aug 17

	1m Implied vol (%)	1w chg	1m chg	1m Real. vol (%)	1w chg	1m chg	1m Imp / real vol ratio	1w chg	1m chg		1m Implied vol (bp/day)	Real. vol (bp/day)
0	32	3	4	19	-6	-11	1.72	0.6	0.8	0	1.2	#N/A
0	26	2	1	16	-6	-10	1.56	0.5	0.6	0	5.3	#N/A

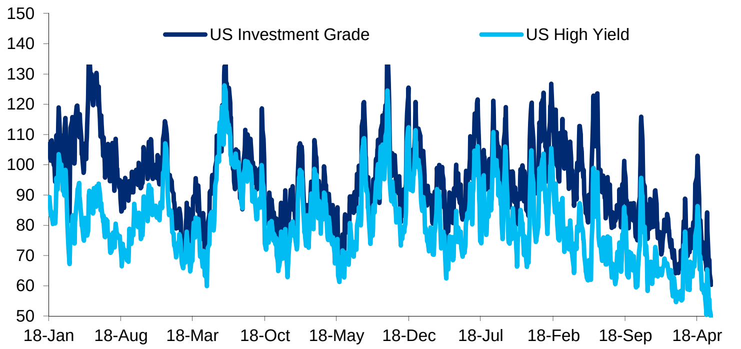
	3m Implied vol (%)	1w chg	1m chg	3m Real. vol (%)	1w chg	1m chg	3m Imp / real vol ratio	1w chg	1m chg		3m Implied vol (bp/day)	Real. vol (bp/day)
0	36	3	3	26	0	-1	1.39	0.1	0.1	0	1.4	#N/A
0	32	1	2	21	0	-0	1.50	0.0	0.1	0	6.8	#N/A

3m ATM implied volatility

In %.

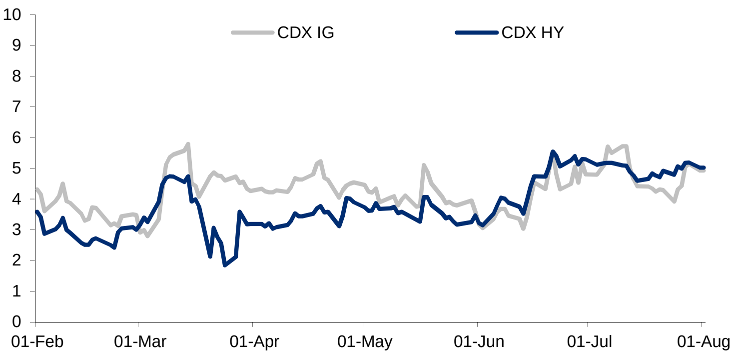


US Credit VIX Indices



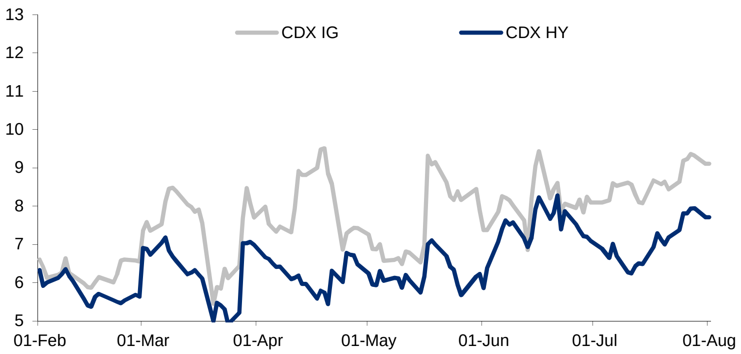
3m Receiver SKEW, in %.

Implied volatility difference between payer options with 50% delta and with 75% delta.



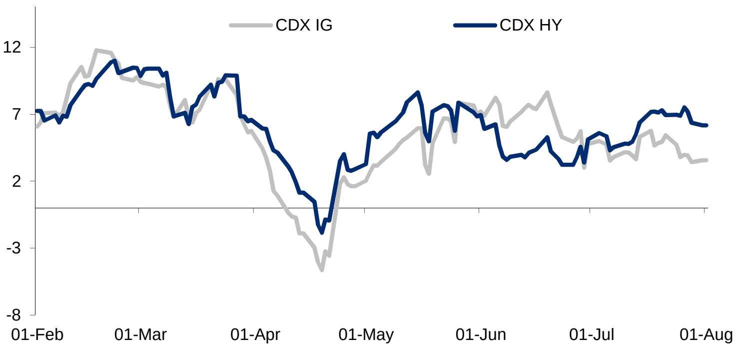
3m Payer SKEW, in %.

Implied volatility difference between payer options with 25% delta and with 50% delta.



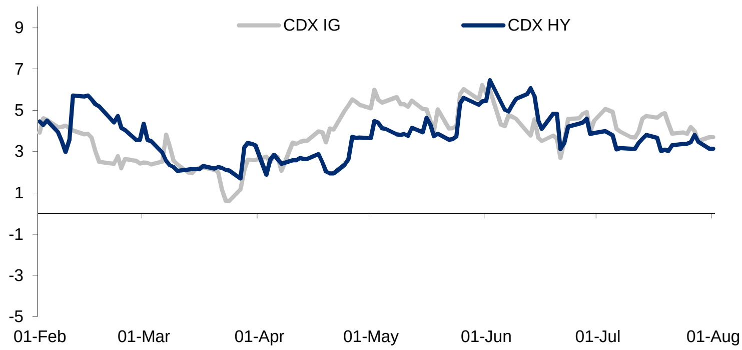
TERM STRUCTURE of ATM implied volatility, in % - 3-1m

Implied volatility difference between ATM options with different expiries (longer dated minus shorter dated).



TERM STRUCTURE of ATM implied volatility, in % - 6-3m

Implied volatility difference between ATM options with different expiries (longer dated minus shorter dated).



Source of all charts and tables: Citi Research and Markit.

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Data as of COB: 01 Aug 17

CDX IG

Summary: index spread, implied and realised volatilities

	Spot	1w chg	1m chg
Index spread (bp)	#N/A	#N/A	#N/A

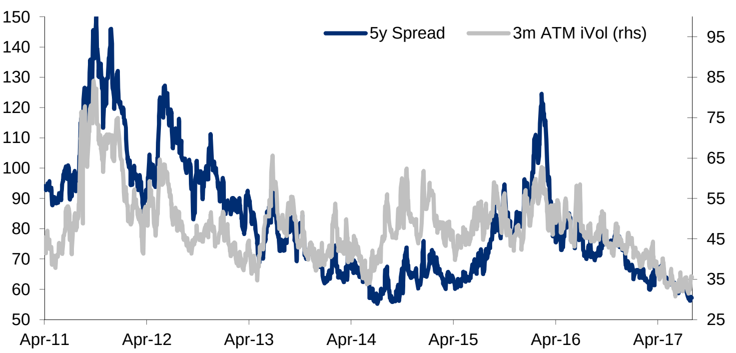
	Implied vol			Real. vol		
Expiry	(%)	1w chg	1m chg	(%)	1w chg	1m chg
1m	32	3	4	19	-6	-11
3m	36	3	3	26	0	-1
6m	39	3	1	24	-0	0

Implied to realised ratios and current volatilities expressed in daily bp movements

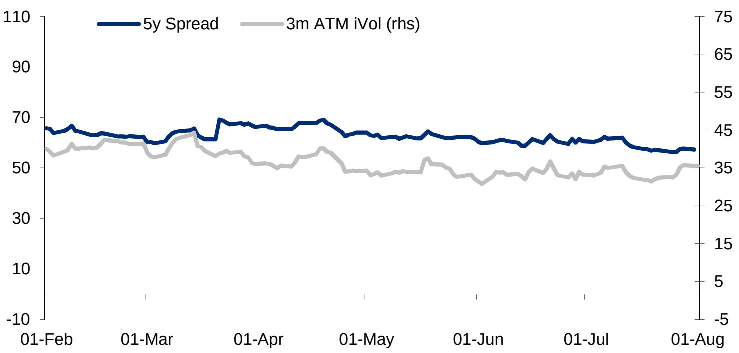
Expiry	Imp / real vol ratio	1w chg	1m chg
1m	1.7	0.6	0.8
3m	1.4	0.1	0.1
6m	1.6	0.1	0.0

Expiry	Implied vol (bp/day)	Real. vol (bp/day)	Forward spread
1m	1.2	#N/A	59
3m	1.4	#N/A	61
6m	1.6	#N/A	64

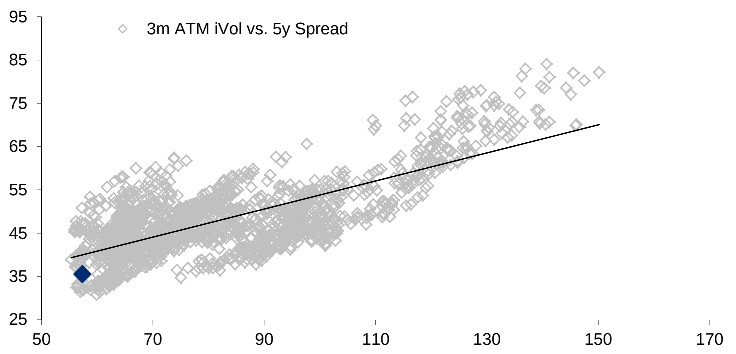
Index spread & 3m ATM implied volatility — Data since: 01-Apr-11
LHS: 5y on-the-run spread (bp); RHS: ATM implied volatility (%).



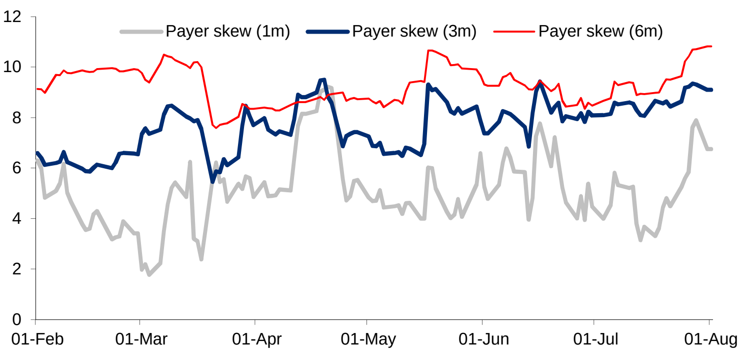
Index spread & 3m ATM implied volatility — Data since: 01-Feb-17
LHS: 5y on-the-run spread (bp); RHS: ATM implied volatility (%).



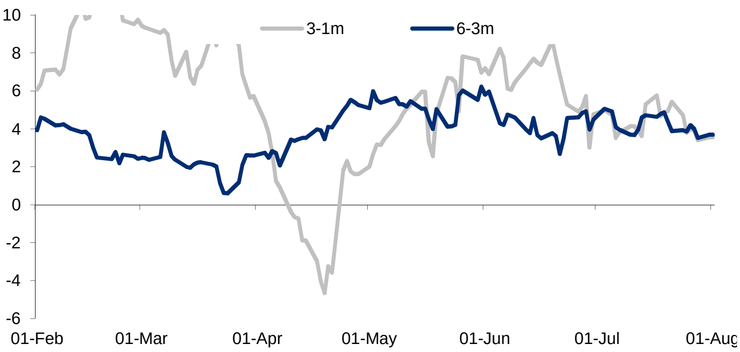
3m ATM implied volatility vs. index spread — Data since: 01-Apr-11
Y-axis: ATM implied volatility (%); X-axis: 5y on-the-run spread (bp).



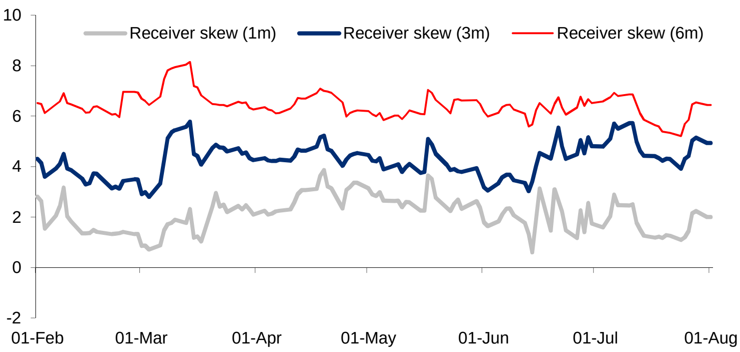
Payer SKEW, in %.
Implied volatility difference between payer options with 25% delta and with 50% delta.



TERM STRUCTURE of ATM implied volatility, in %.
Implied volatility difference between ATM options with different expiries (longer dated minus shorter dated).



Receiver SKEW, in %.
Implied volatility difference between payer options with 50% delta and with 75% delta.



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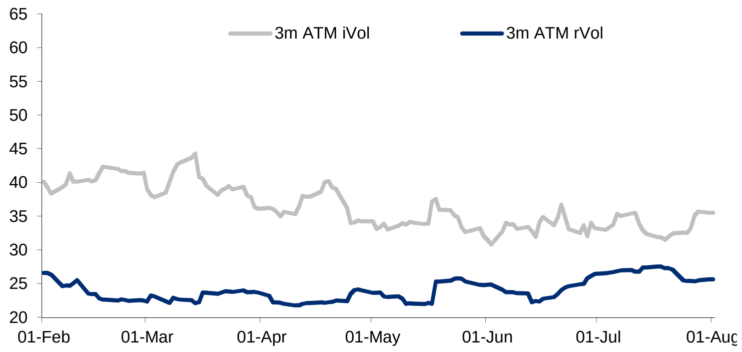
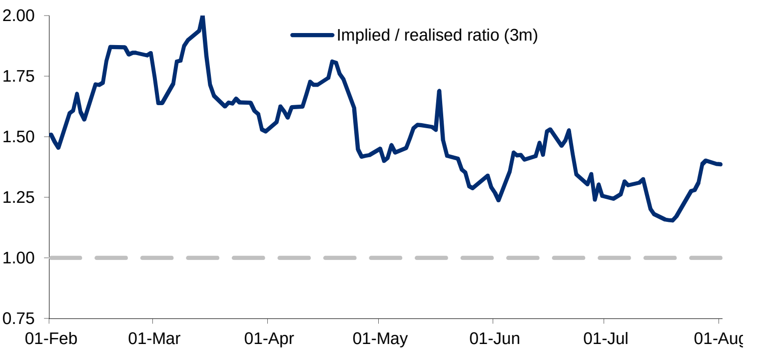
CDX IG - Implied/realised vol ratios

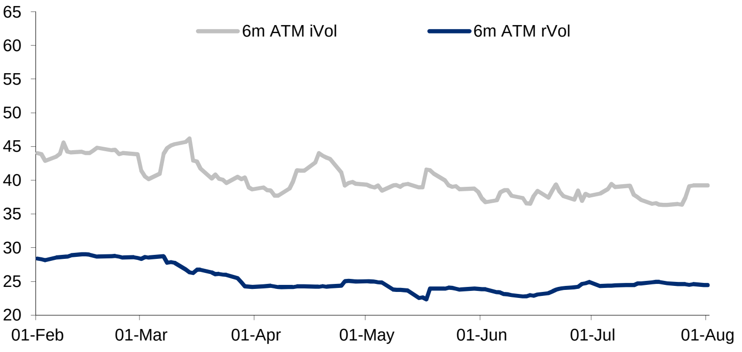
3 month implied (ATM) & realised volatility
In %



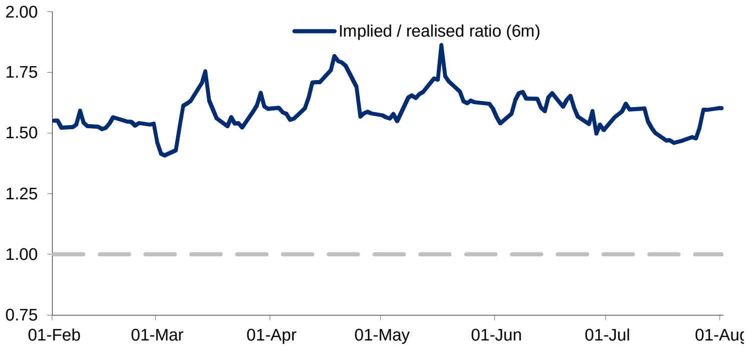
Ratio of 3 month implied to realised volatility



6 month implied (ATM) & realised volatility
In %

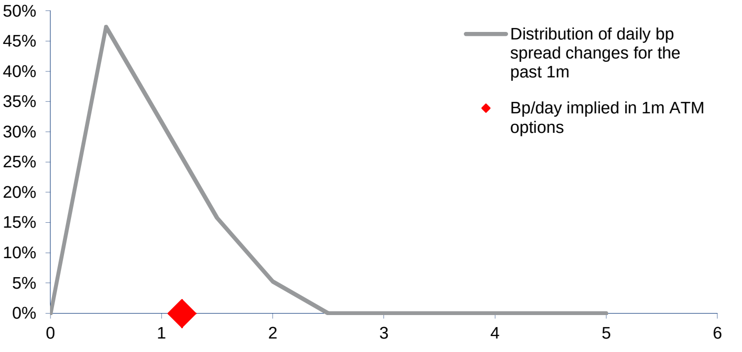


Ratio of 6 month implied to realised volatility

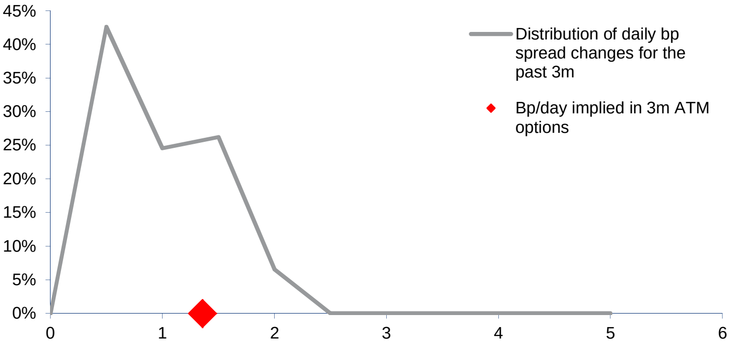


CDX IG - Distribution of realised bp daily changes vs. implied

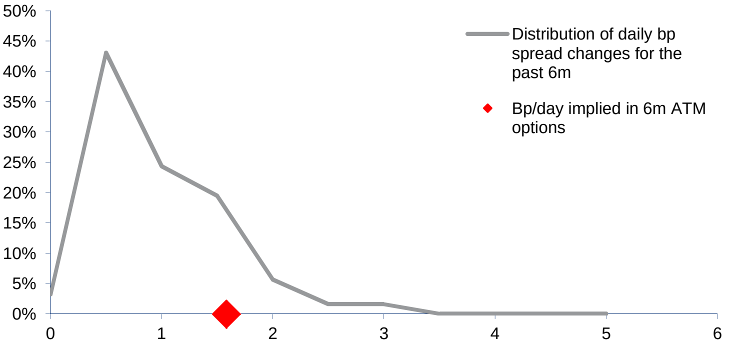
Distribution of daily bp changes vs. implied daily bp volatility - 1m data
X-axis: Daily bp changes.



Distribution of daily bp changes vs. implied daily bp volatility - 3m data
X-axis: Daily bp changes.



Distribution of daily bp changes vs. implied daily bp volatility - 6m data
X-axis: Daily bp changes.



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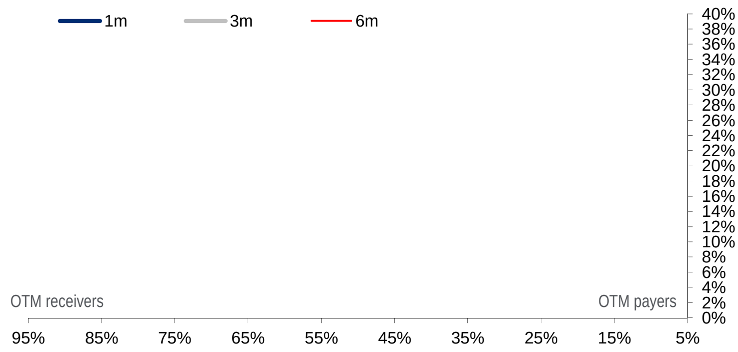
CDX IG - Skew and Term Structure

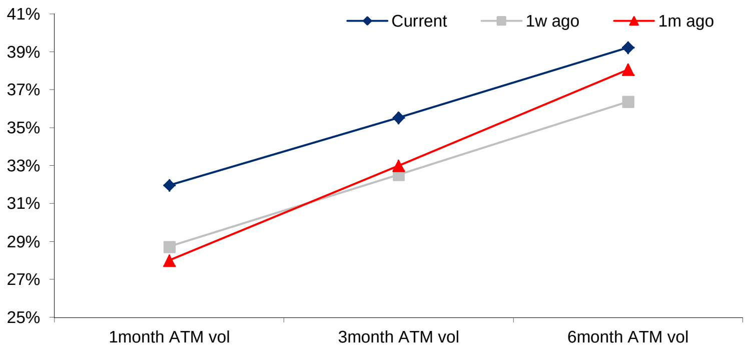
Current volatility SKEW for different option expiries

Y-axis: Implied volatility; X-axis: Payer delta (%).



ATM volatility TERM STRUCTURE

Y-axis: ATM implied volatility; X-axis: option expiry (months).



Implied volatility across deltas/strikes and expiries

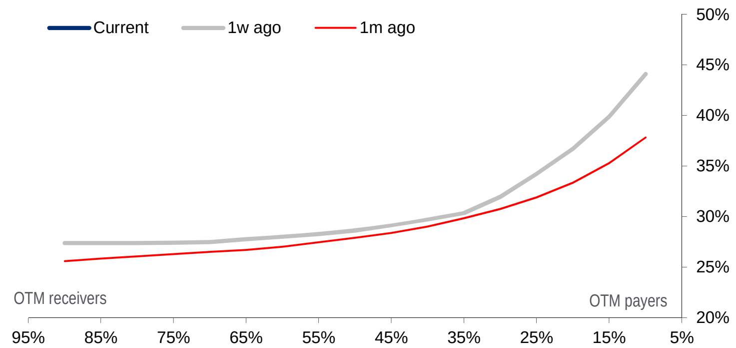
Y-axis: Implied volatility; X-axis: Payer delta (%).

	1 month		3 month		6 month	
Payer delta	Strike	iVol	Strike	iVol	Strike	iVol
90%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
85%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
80%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
75%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
70%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
65%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
60%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
55%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
50%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
45%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
40%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
35%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
25%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
20%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
15%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
10%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

	Current	**1w ago**	**1m ago**
1month ATM vol	32%	29%	28%
3month ATM vol	36%	33%	33%
6month ATM vol	39%	36%	38%
Index spread (bp)	#N/A	#N/A	#N/A

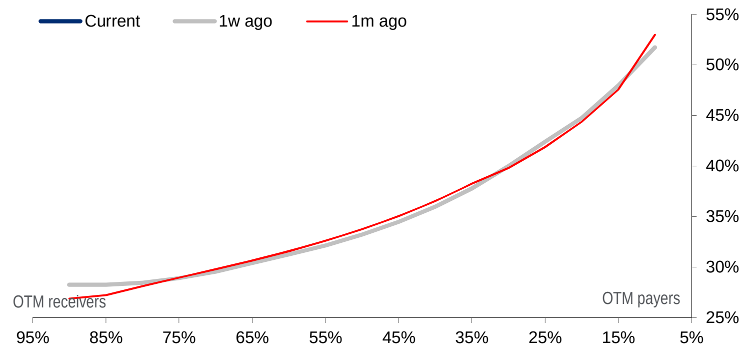
Changes in volatility SKEW for 1m options

Y-axis: Implied volatility; X-axis: Payer delta (%).



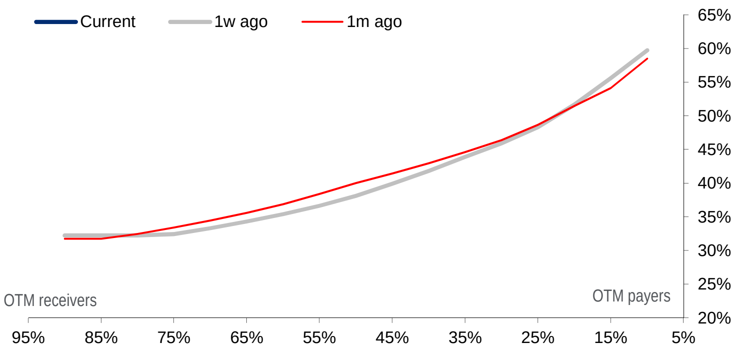
Changes in volatility SKEW for 3m options

Y-axis: Implied volatility; X-axis: Payer delta (%).



Changes in volatility SKEW for 6m options

Y-axis: Implied volatility; X-axis: Payer delta (%).



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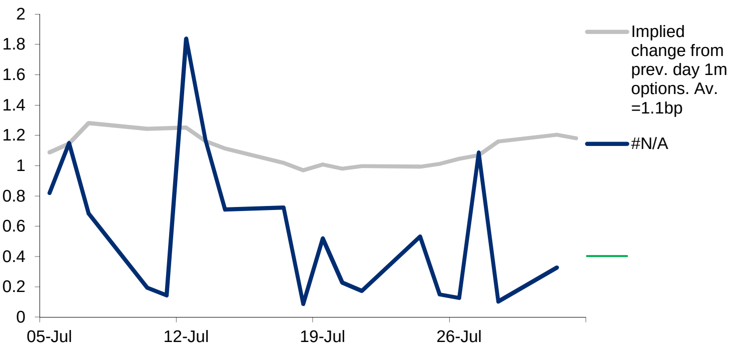
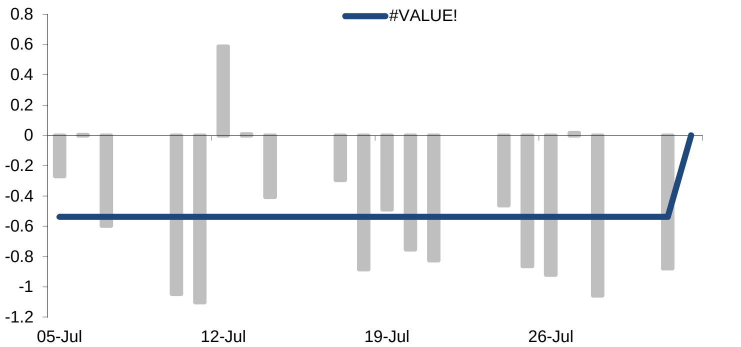
Data as of COB: 01 Aug 17

CDX IG - Realised vs. Implied Daily Spread Changes

Daily spread changes: implied, close-to-close and intra-day range
In bp. Data for the past 1m.

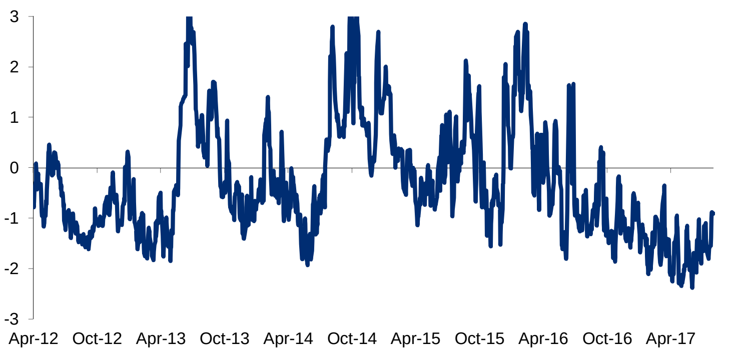


Realised close-to-close change minus implied change from prev. day 1m options
In bp. Data for the past 1m.

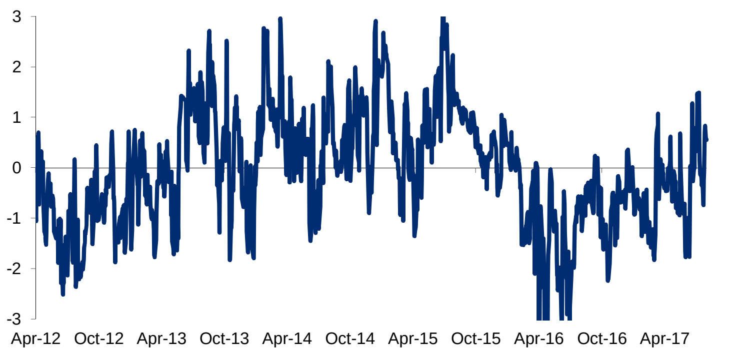


CDX IG - Vol Z-Scores

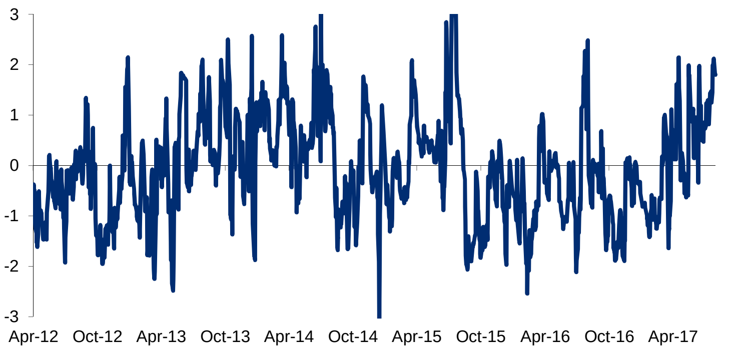
3m ATM Implied Vol - Z-score
Z-score (Current - average / st.dev) using the average and st.dev for the previous 12m; rolling.



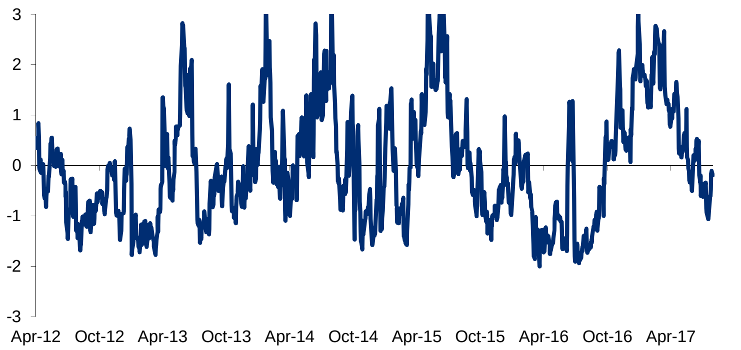
3m Receiver Skew (25% - 50% delta) - Z-score
Z-score (Current - average / st.dev) using the average and st.dev for the previous 12m; rolling.



3m Payer Skew (25% - 50% delta) - Z-score
Z-score (Current - average / st.dev) using the average and st.dev for the previous 12m; rolling.



3m Implied Vol/ Realised Vol Ratio - Z-score
Z-score (Current - average / st.dev) using the average and st.dev for the previous 12m; rolling.



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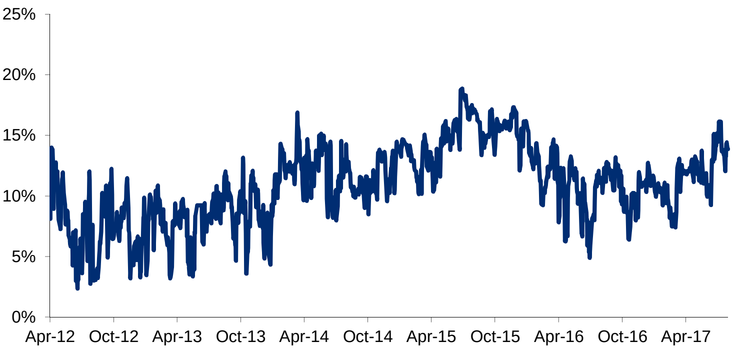
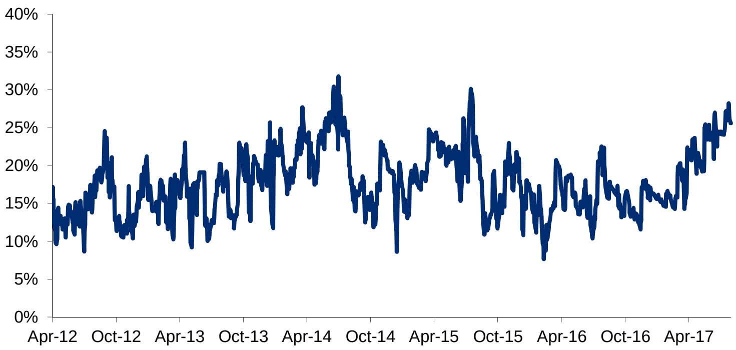
CDX IG - Skew vs. ATM Vol

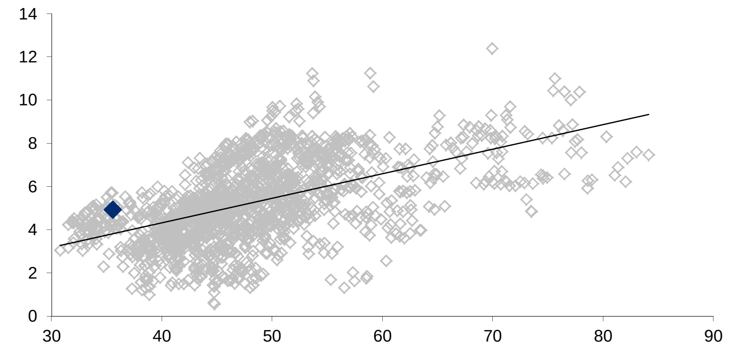
Receiver Skew / ATM iVol Ratio - 3m options
Skew defined as: 25% - 50% delta implied vol



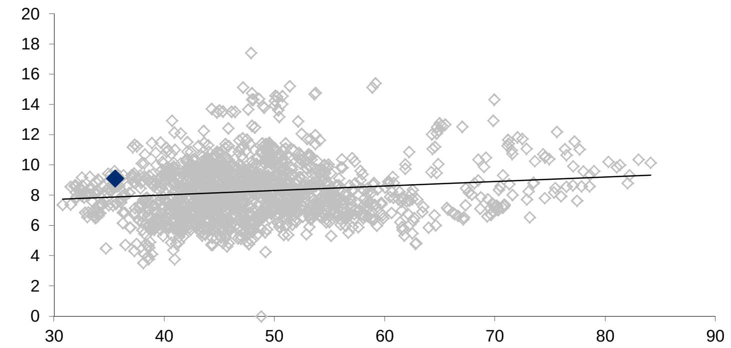
Payer Skew / ATM iVol Ratio - 3m options
Skew defined as: 25% - 50% delta implied vol



3m Receiver Skew vs. ATM implied vol
X-axis: ATM implied vol. Y-axis: Skew defined as: 25% - 50% delta implied vol

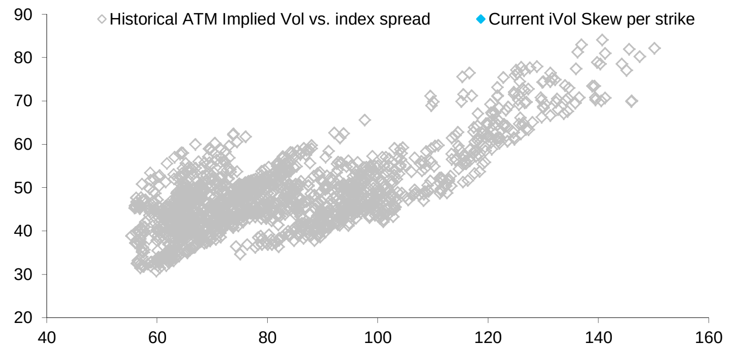


3m Payer Skew vs. ATM implied vol
X-axis: ATM implied vol. Y-axis: Skew defined as: 25% - 50% delta implied vol

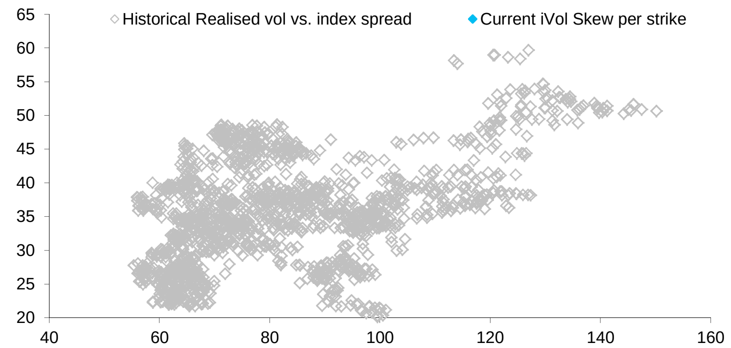


CDX IG - Current vol skew vs. historical vol per index spread

3m implied vol skew vs. historical ATM implied vol
Y-axis: Volatility (%); X-axis: Index spread (bp)



3m implied vol skew vs. historical realised vol
Y-axis: Volatility (%); X-axis: Index spread (bp)



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CDX HY

Summary: index spread, implied and realised volatilities

	Spot	1w chg	1m chg
Index spread (bp)	#N/A	#N/A	#N/A

Expiry	Implied vol (%)	1w chg	1m chg	Real. vol (%)	1w chg	1m chg
1m	26	2	1	16	-6	-10
3m	32	1	2	21	0	-0
6m	35	1	1	24	-0	0

Implied to realised ratios and current volatilities expressed in daily bp movements

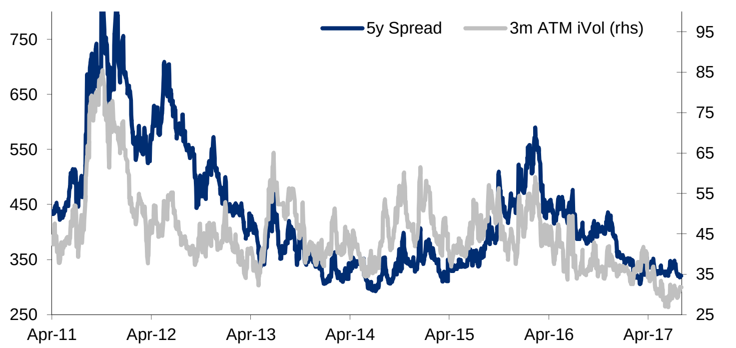
Expiry	Imp / real vol ratio	1w chg	1m chg
1m	1.6	0.5	0.6
3m	1.5	0.0	0.1
6m	1.5	0.0	0.0

Expiry	Implied vol (bp/day)	Real. vol (bp/day)	Forward spread
1m	5.3	#N/A	330
3m	6.8	#N/A	341
6m	7.9	#N/A	358

Index spread & 3m ATM implied volatility

Data since: 01-Apr-11

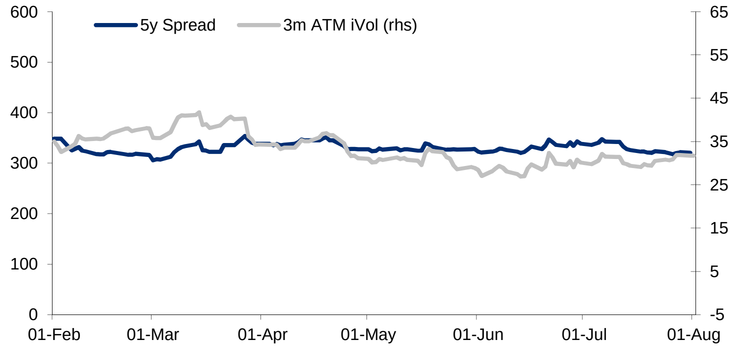
LHS: 5y on-the-run spread (bp); RHS: ATM implied volatility (%).



Index spread & 3m ATM implied volatility

Data since: 01-Feb-17

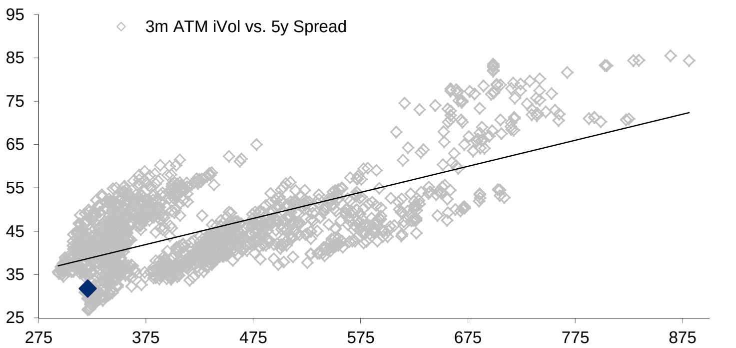
LHS: 5y on-the-run spread (bp); RHS: ATM implied volatility (%).



3m ATM implied volatility vs. index spread

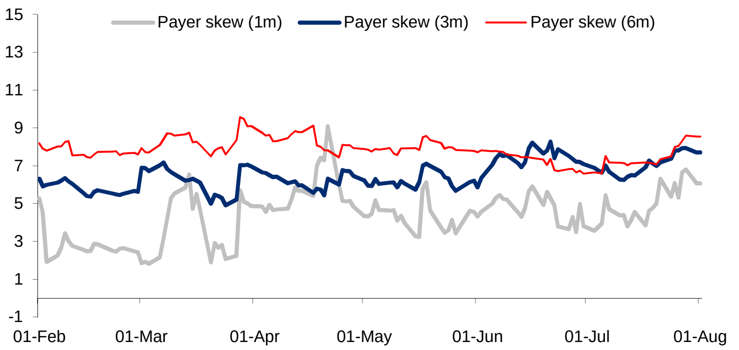
Data since: 01-Apr-11

Y-axis: ATM implied volatility (%); X-axis: 5y on-the-run spread (bp).



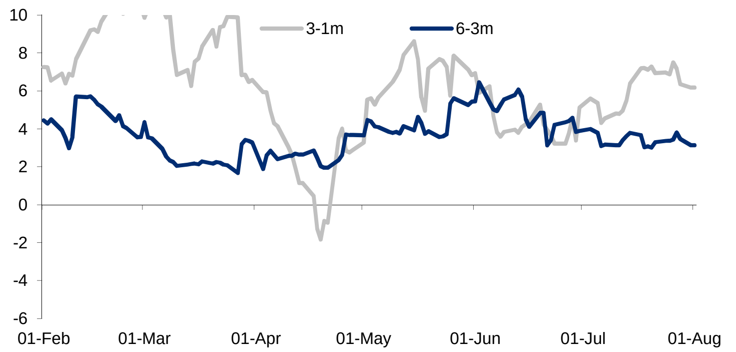
Payer SKEW, in %.

Implied volatility difference between payer options with 25% delta and with 50% delta.



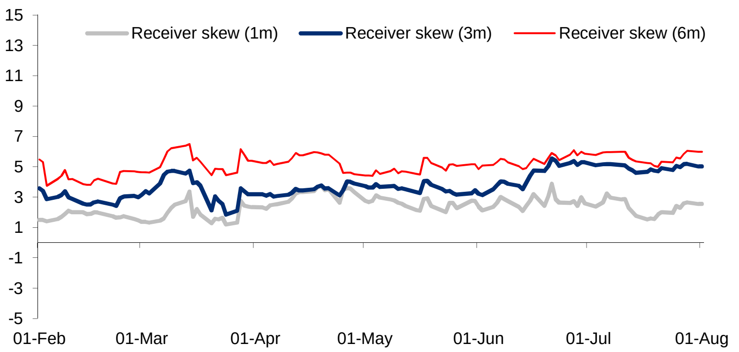
TERM STRUCTURE of ATM implied volatility, in %.

Implied volatility difference between ATM options with different expiries (longer dated minus shorter dated).



Receiver SKEW, in %.

Implied volatility difference between payer options with 50% delta and with 75% delta.



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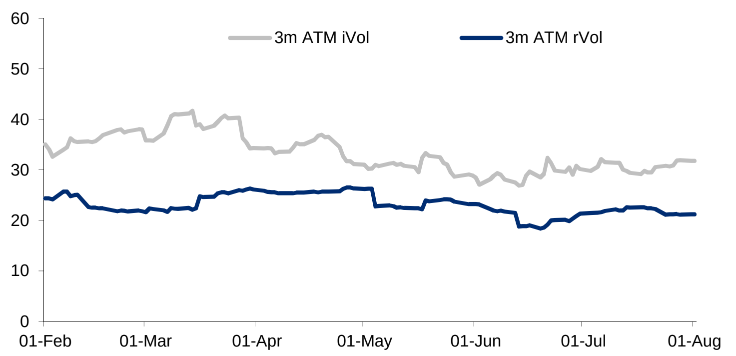
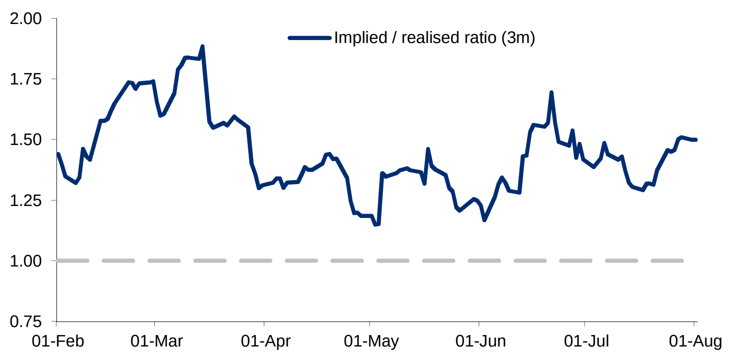
CDX HY - Implied/realised vol ratios

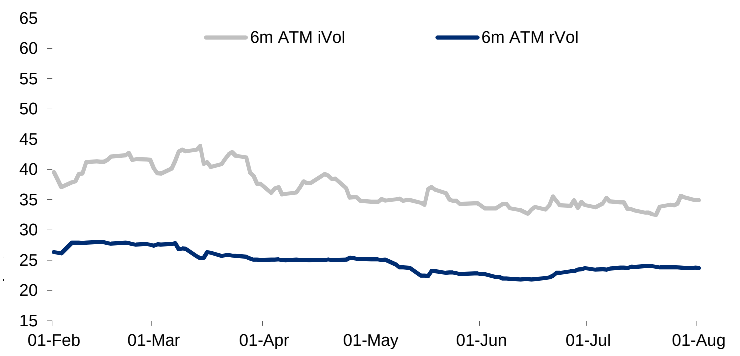
3 month implied (ATM) & realised volatility
In %



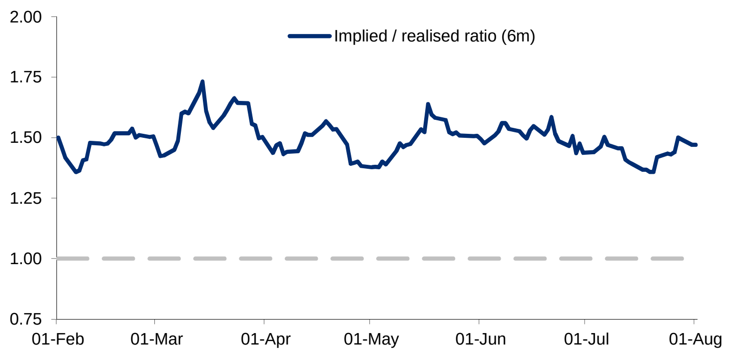
Ratio of 3 month implied to realised volatility



6 month implied (ATM) & realised volatility
In %

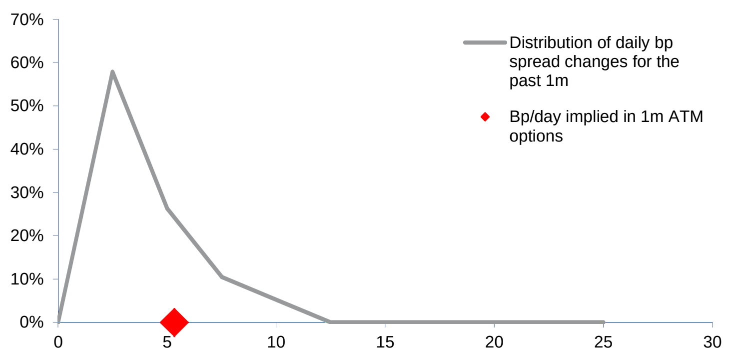


Ratio of 6 month implied to realised volatility

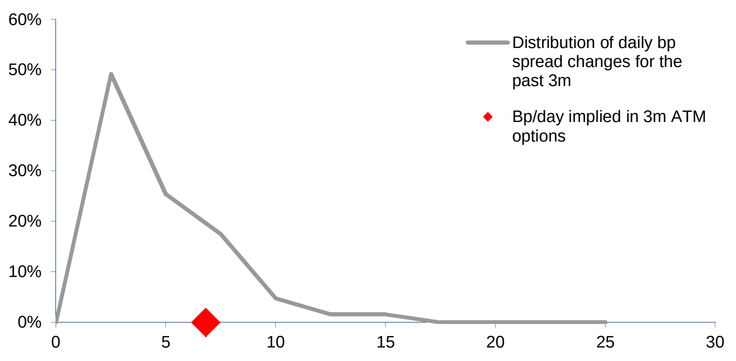


CDX HY - Distribution of realised bp daily changes vs. implied

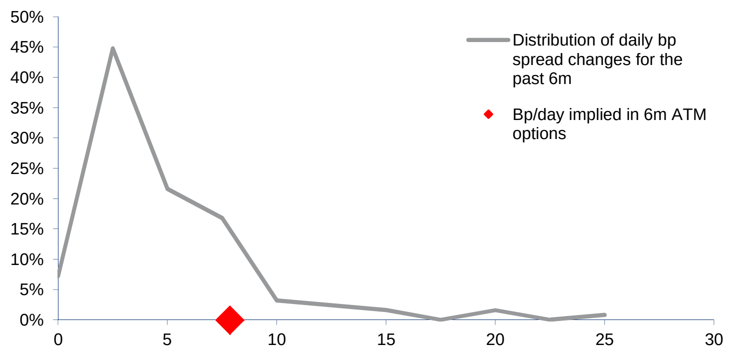
Distribution of daily bp changes vs. implied daily bp volatility - 1m data
X-axis: Daily bp changes.



Distribution of daily bp changes vs. implied daily bp volatility - 3m data
X-axis: Daily bp changes.



Distribution of daily bp changes vs. implied daily bp volatility - 6m data
X-axis: Daily bp changes.



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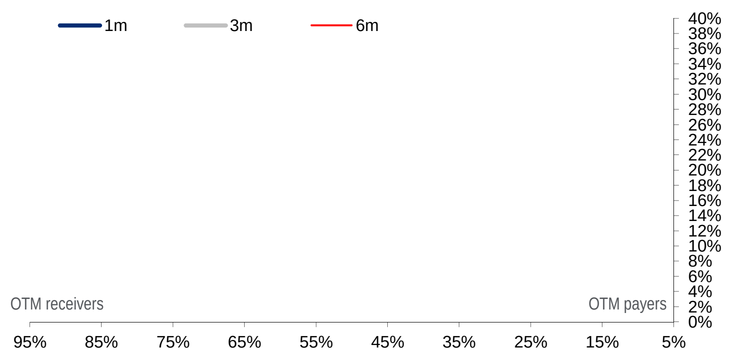
CDX HY - Skew and Term Structure

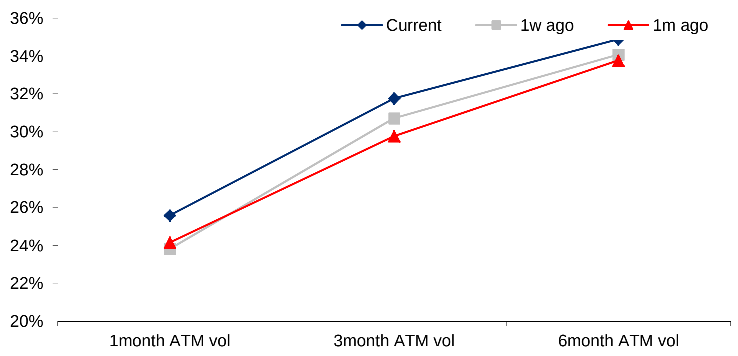
Current volatility SKEW for different option expiries

Y-axis: Implied volatility; X-axis: Payer delta (%).



ATM volatility TERM STRUCTURE

Y-axis: ATM implied volatility; X-axis: option expiry (months).



	Current	1w ago	1m ago
1month ATM vol	26%	24%	24%
3month ATM vol	32%	31%	30%
6month ATM vol	35%	34%	34%
Index spread (bp)	#N/A	#N/A	#N/A

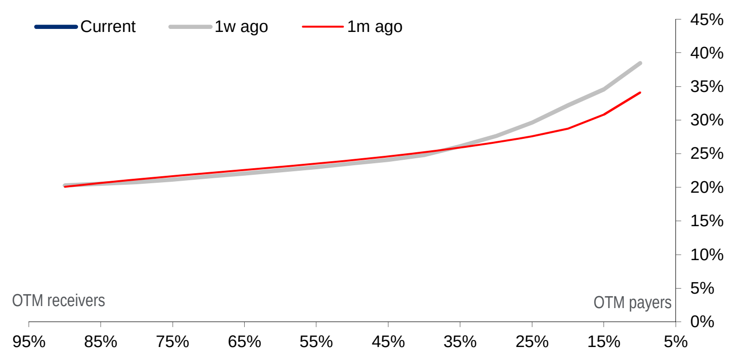
Implied volatility across deltas/strikes and expiries

Y-axis: Implied volatility; X-axis: Payer delta (%).

Payer delta	1 month Strike	iVol	3 month Strike	iVol	6 month Strike	iVol
90%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
85%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
80%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
75%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
70%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
65%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
60%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
55%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
50%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
45%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
40%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
35%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
30%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
25%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
20%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
15%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
10%	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

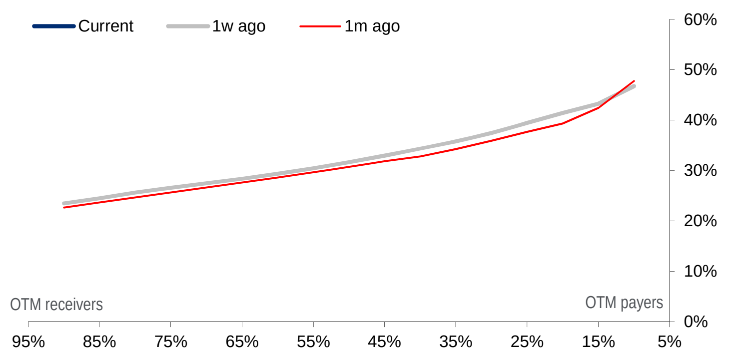
Changes in volatility SKEW for 1m options

Y-axis: Implied volatility; X-axis: Payer delta (%).



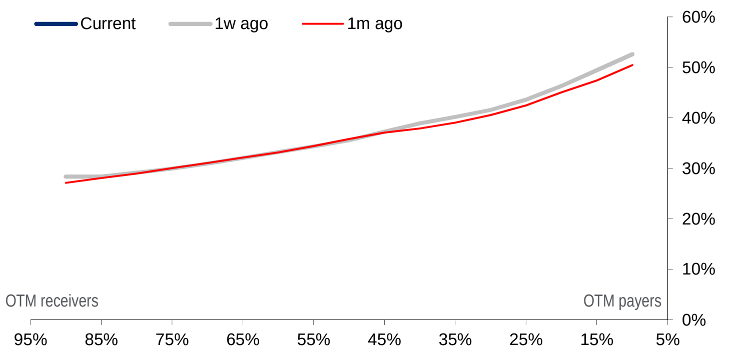
Changes in volatility SKEW for 3m options

Y-axis: Implied volatility; X-axis: Payer delta (%).



Changes in volatility SKEW for 6m options

Y-axis: Implied volatility; X-axis: Payer delta (%).



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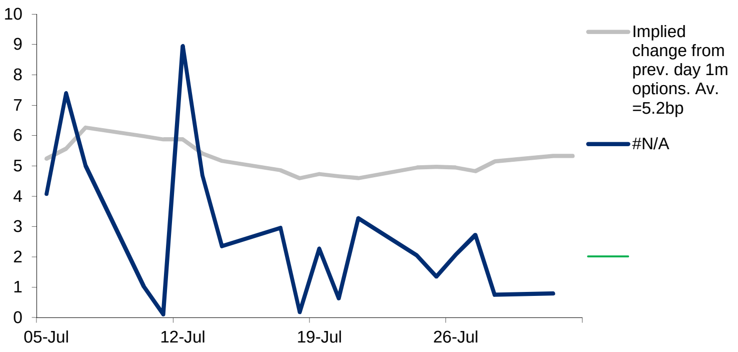
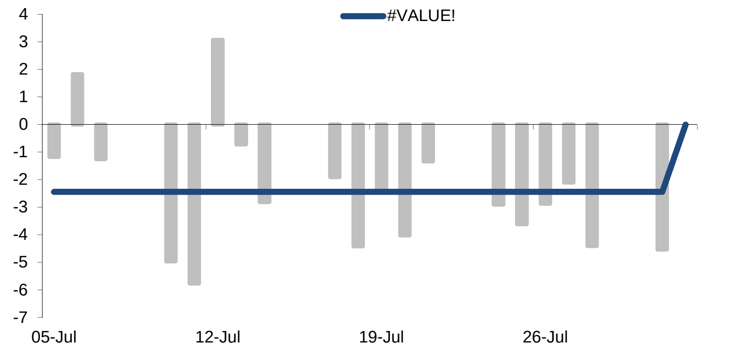
CDX HY - Realised vs. Implied Daily Spread Changes

Daily spread changes: implied, close-to-close and intra-day range
In bp. Data for the past 1m.

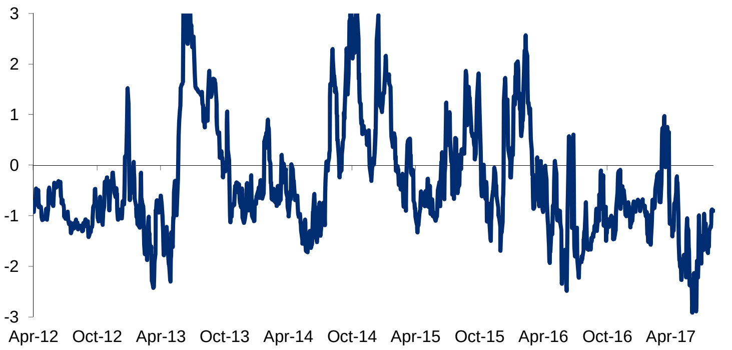


Realised close-to-close change minus implied change from prev. day 1m options
In bp. Data for the past 1m.

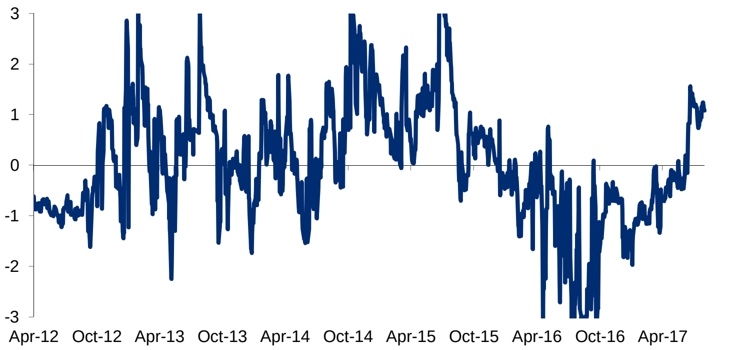


CDX HY - Vol Z-Scores

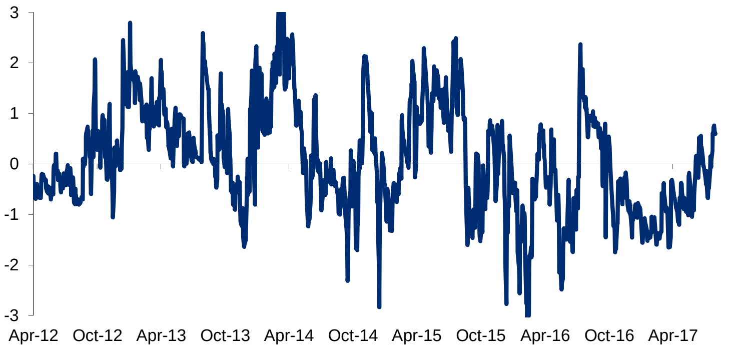
3m ATM Implied Vol - Z-score
Z-score (Current - average / st.dev) using the average and st.dev for the previous 12m; rolling.



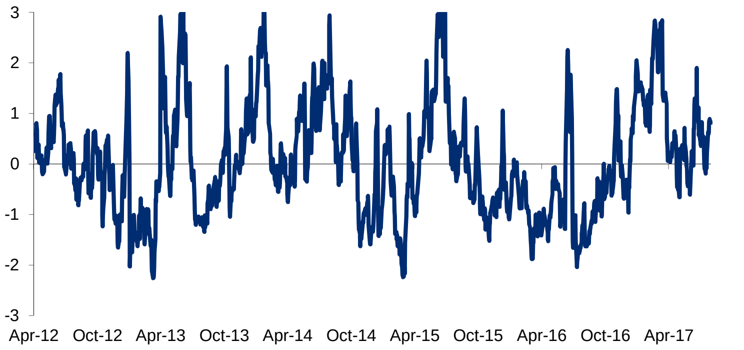
3m Receiver Skew (25% - 50% delta) - Z-score
Z-score (Current - average / st.dev) using the average and st.dev for the previous 12m; rolling.



3m Payer Skew (25% - 50% delta) - Z-score
Z-score (Current - average / st.dev) using the average and st.dev for the previous 12m; rolling.



3m Implied Vol/ Realised Vol Ratio - Z-score
Z-score (Current - average / st.dev) using the average and st.dev for the previous 12m; rolling.



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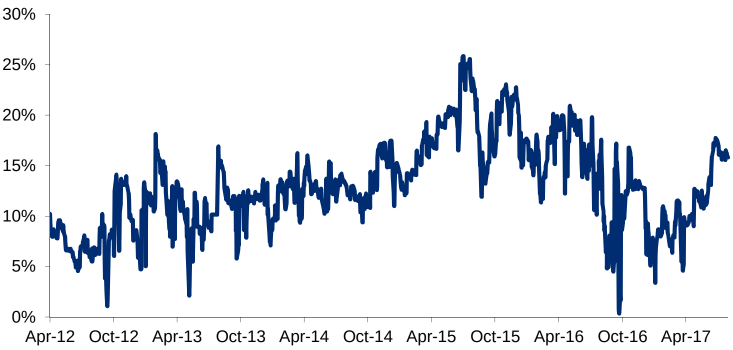
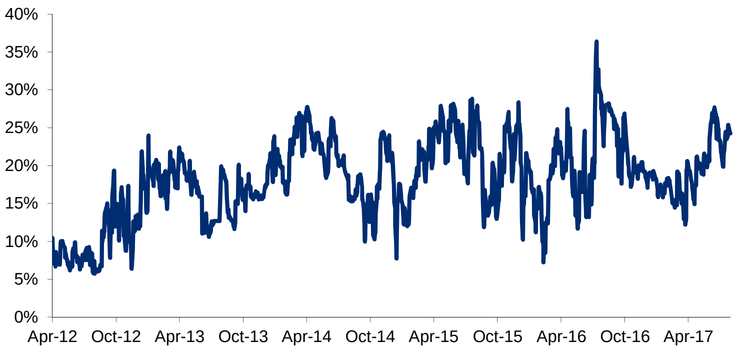
CDX HY - Skew vs. ATM Vol

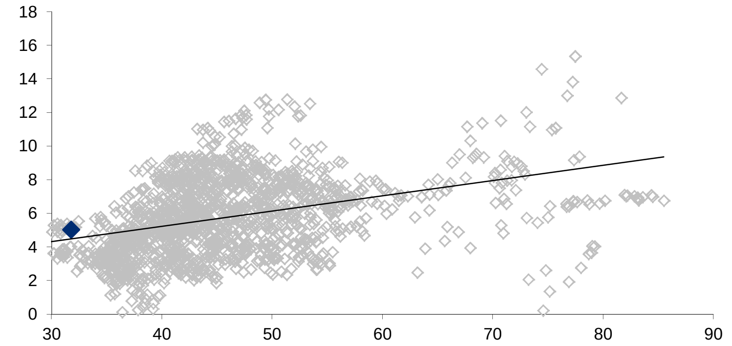
Receiver Skew / ATM iVol Ratio - 3m options
Skew defined as: 25% - 50% delta implied vol



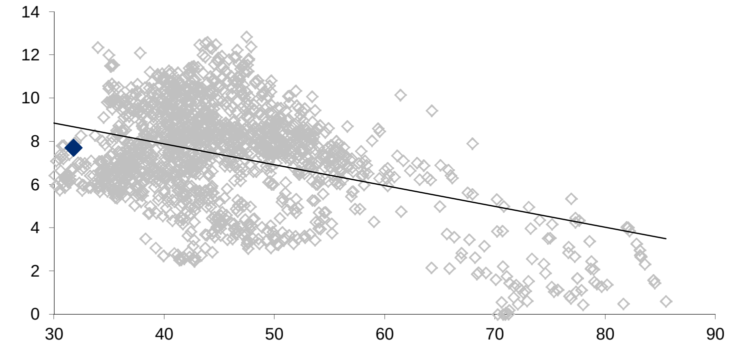
Payer Skew / ATM iVol Ratio - 3m options
Skew defined as: 25% - 50% delta implied vol



3m Receiver Skew vs. ATM implied vol
X-axis: ATM implied vol. Y-axis: Skew defined as: 25% - 50% delta implied vol

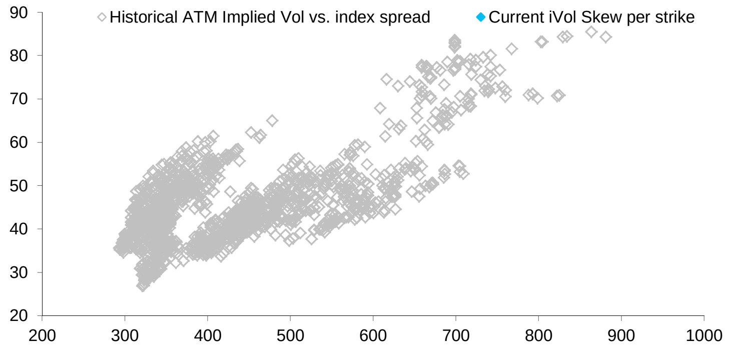


3m Payer Skew vs. ATM implied vol
X-axis: ATM implied vol. Y-axis: Skew defined as: 25% - 50% delta implied vol

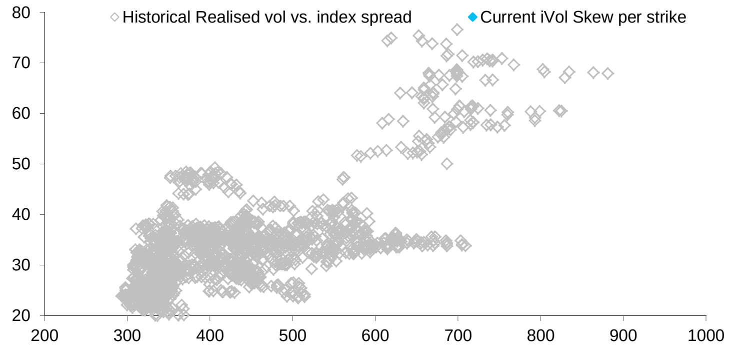


CDX HY - Current vol skew vs. historical vol per index spread

3m implied vol skew vs. historical ATM implied vol
Y-axis: Volatility (%); X-axis: Index spread (bp)



3m implied vol skew vs. historical realised vol
Y-axis: Volatility (%); X-axis: Index spread (bp)



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Appendix A-1

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