Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

iTraxx 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
0	35	2	-2	22	-2	-4	1.60	0.2	0.2
0	33	2	-1	22	-4	-1	1.54	0.3	0.0
0	41	3	-5	26	-2	-13	1.54	0.2	0.4

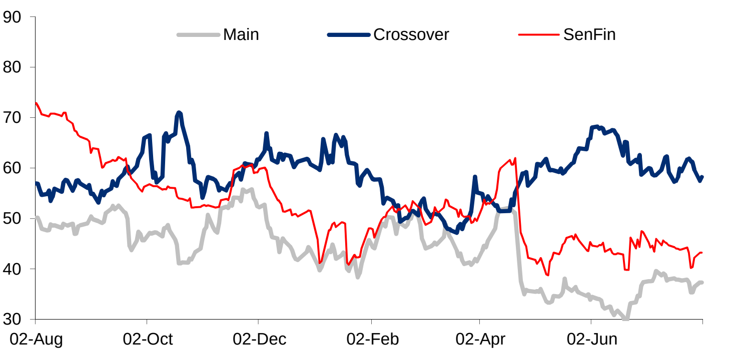
	1m Implied vol (bp/day)	Real. vol (bp/day)
0	1.2	#N/A
0	5.2	#N/A
0	1.3	#N/A

	3m Implied vol (%)	1w chg	1m chg	3m Real. vol (%)	1w chg	1m chg	3m Imp / real vol ratio	1w chg	1m chg
0	37	0	-0	22	1	-5	1.68	-0.0	0.3
0	35	0	1	21	-0	-3	1.68	0.0	0.2
0	43	-0	-2	33	-1	-10	1.31	0.0	0.3

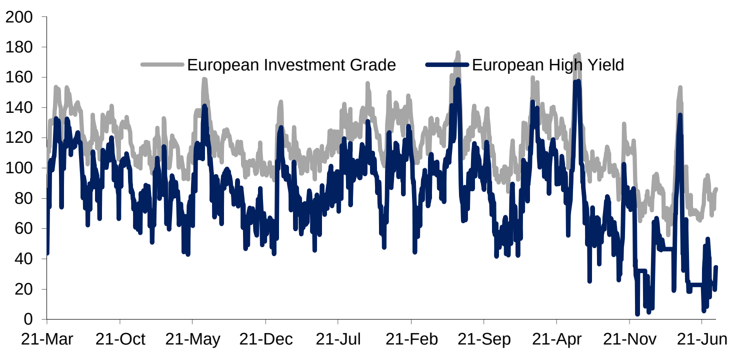
	3m Implied vol (bp/day)	Real. vol (bp/day)
0	1.3	#N/A
0	5.6	#N/A
0	1.5	#N/A

3m ATM implied volatility

In %.

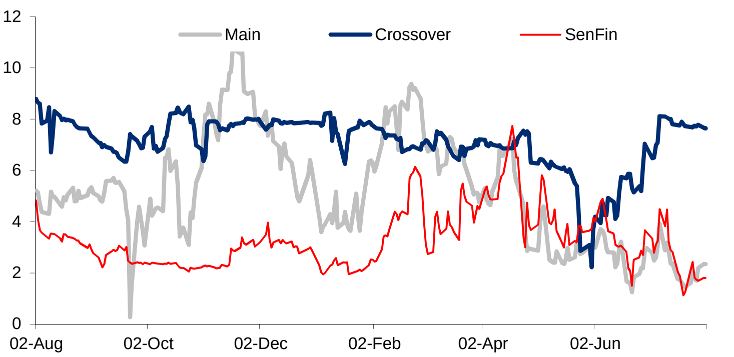


European Credit VIX Indices



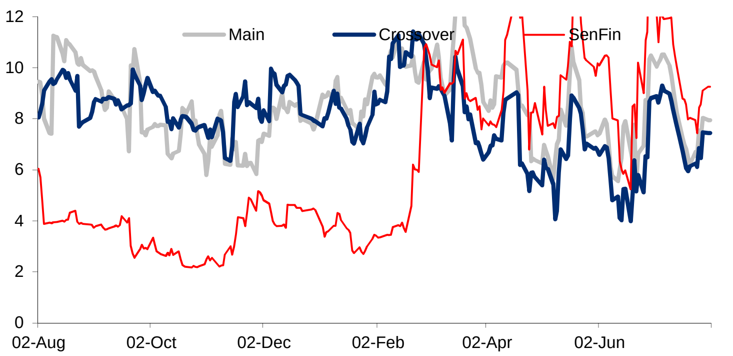
3m Receiver SKEW, in %.

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



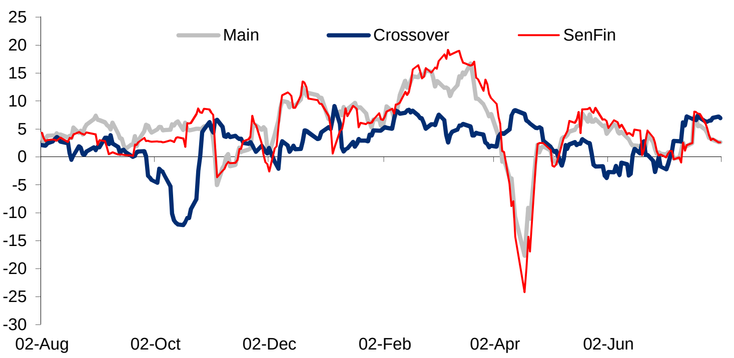
3m Payer SKEW, in %.

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



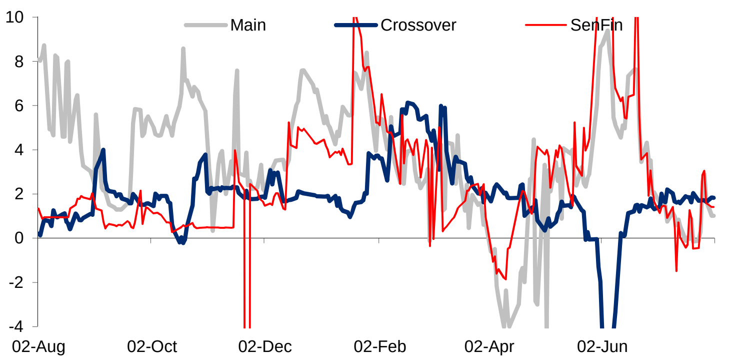
TERM STRUCTURE of ATM implied volatility, in % - 3-1m

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.

Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

Data as of COB: 01 Aug 17

iTraxx Main

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	35	2	-2	22	-2	-4
3m	37	0	-0	22	1	-5
6m	38	1	-1	26	-0	-0

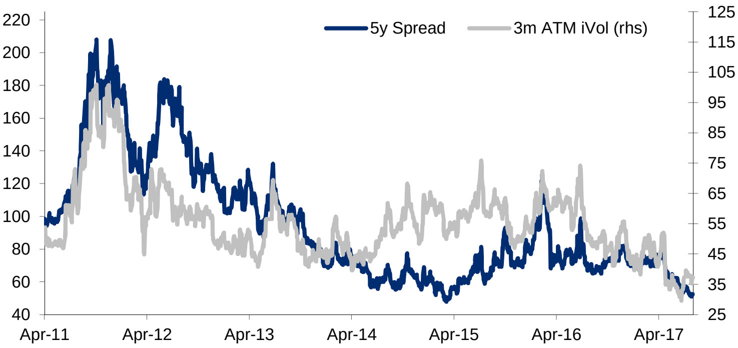
Implied to realised ratios and current volatilities expressed in daily bp movements

Expiry	Imp / real vol ratio	1w chg	1m chg
1m	1.6	0.2	0.2
3m	1.7	-0.0	0.3
6m	1.5	0.0	-0.0

Expiry	Implied vol (bp/day)	Real. vol (bp/day)	Forward spread
1m	1.2	#N/A	54
3m	1.3	#N/A	56
6m	1.4	#N/A	59

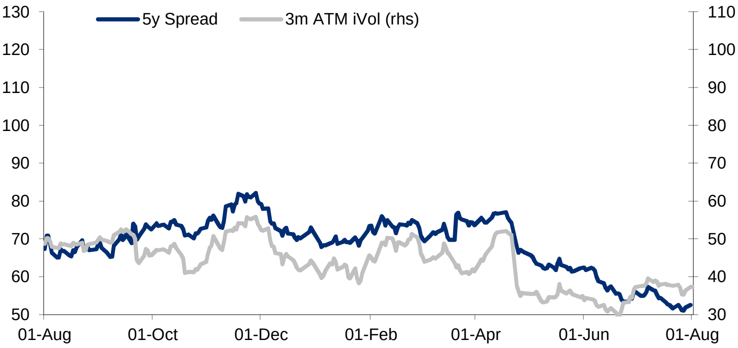
Index spread & 3m ATM implied volatility
Data since: 01-Apr-11

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



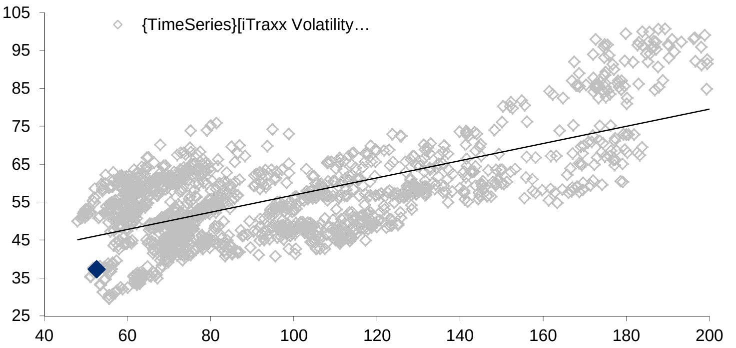
European Credit VIX Indices
Data since: 01-Aug-16

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



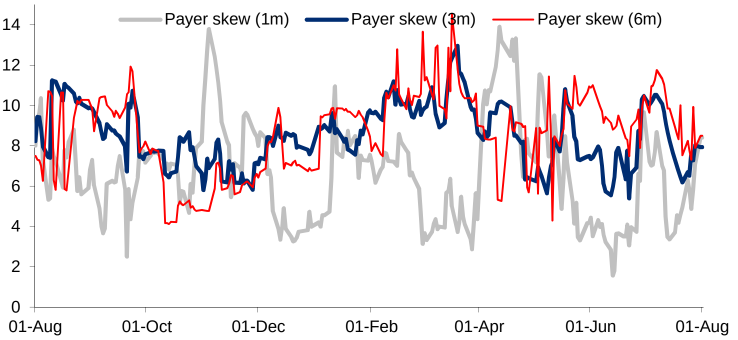
3m ATM implied volatility vs. index spread
Data since: 01-Apr-11

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



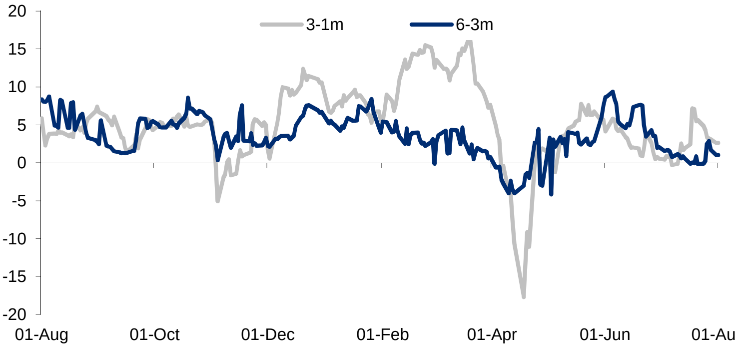
Main Payer SKEW, in %.

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



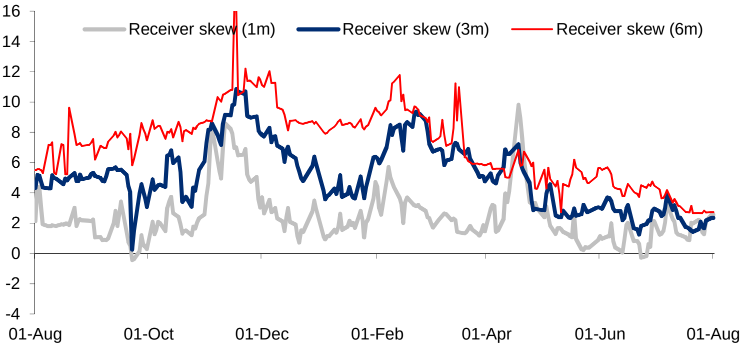
TERM STRUCTURE of ATM implied volatility, in %.

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.



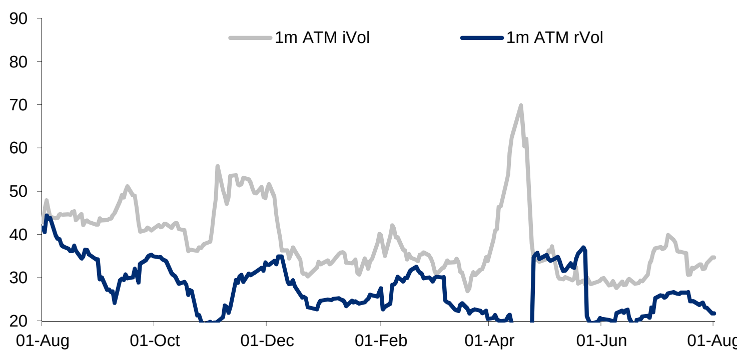
Source of all charts and tables: Citi Research and Markit.

Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

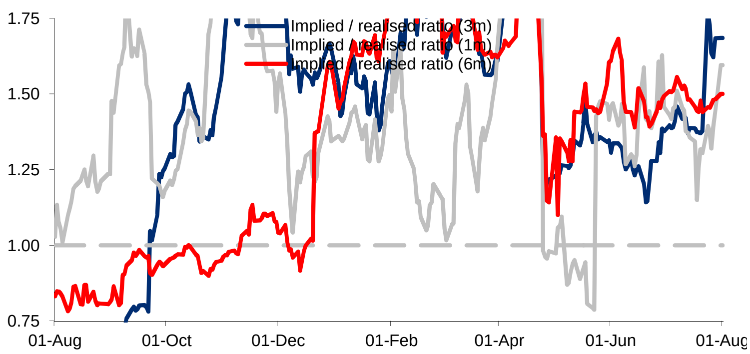
Data as of COB: 01 Aug 17

iTraxx Main - Implied/realised vol ratios

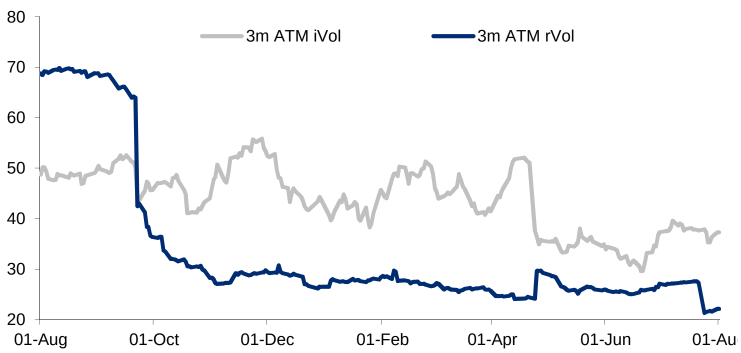
1 month implied (ATM) & realised volatility
In %



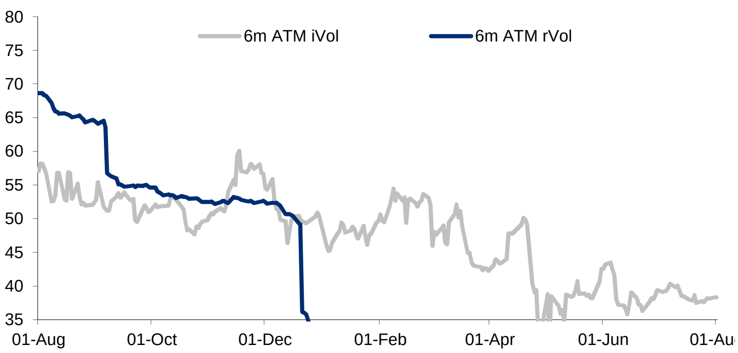
Ratio of implied to realised volatility



3 month implied (ATM) & realised volatility
In %

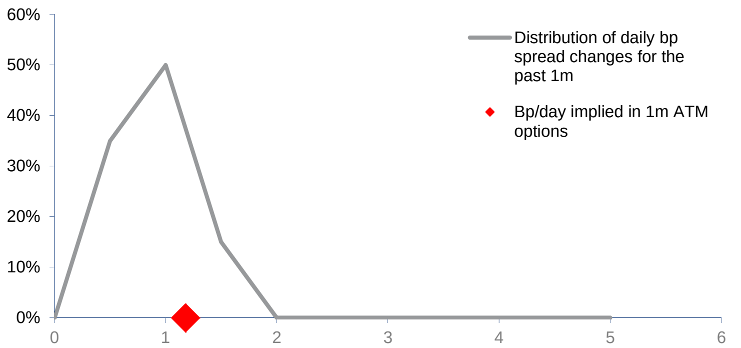


6 month implied (ATM) & realised volatility

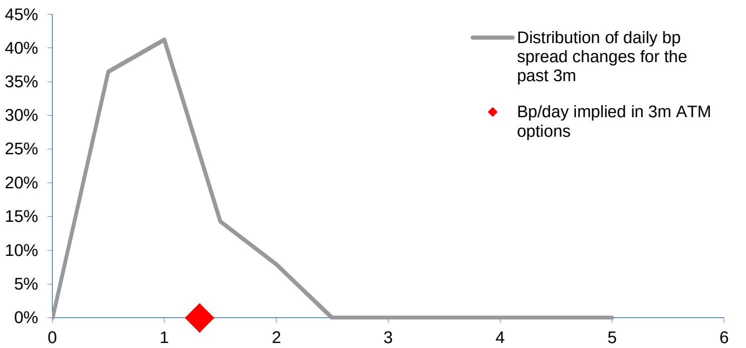


iTraxx Main - Distribution of realised bp daily changes vs. implied

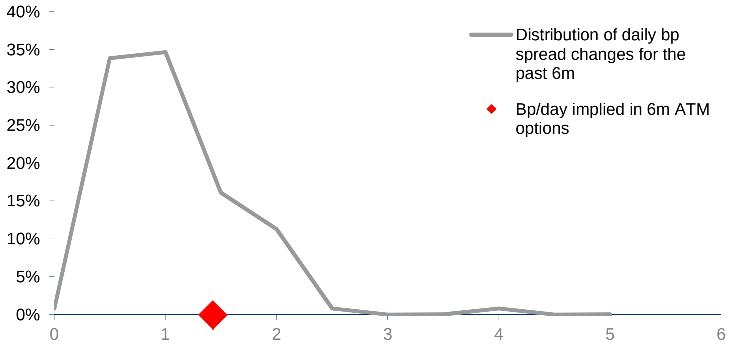
Distribution of daily bp changes vs. implied daily bp volatility - 1m data
X-axis: Daily bp changes.



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.



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

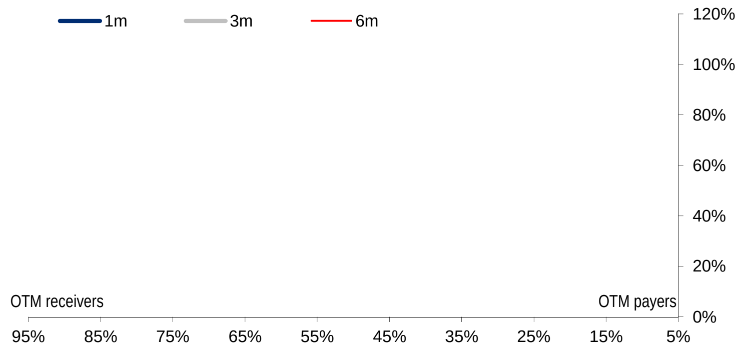
Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

Data as of COB: 01 Aug 17

iTraxx Main - Skew and Term Structure

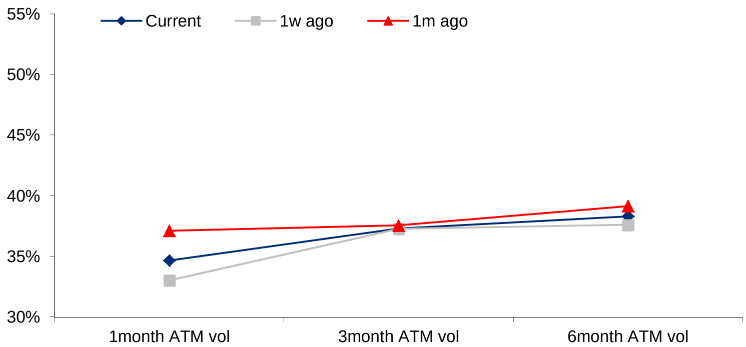
Current volatility SKEW for different option expiries

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



Main ATM volatility TERM STRUCTURE

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



Implied volatility across deltas/strikes and expiries

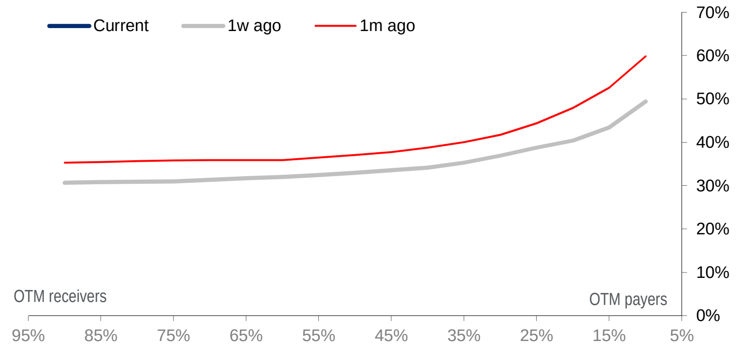
Y-axis: Implied volatility; X-axis: Payer delta (%).

	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	35%	33%	37%
3month ATM vol	37%	37%	38%
6month ATM vol	38%	38%	39%
Index spread (bp)	#N/A	#N/A	#N/A

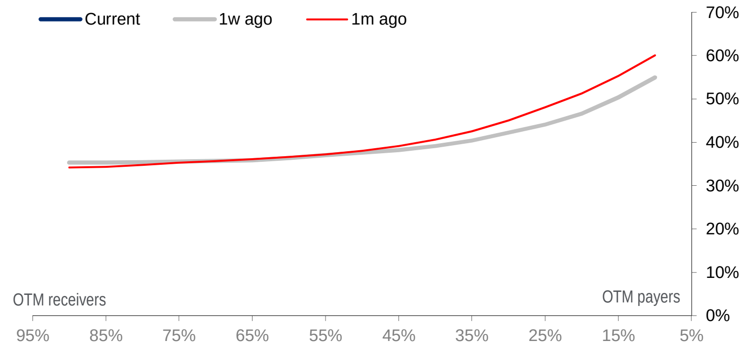
Changes in volatility SKEW for 1m options

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



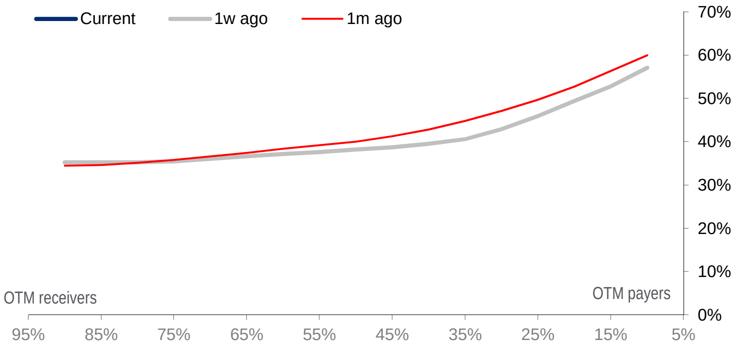
Changes in volatility SKEW for 3m options

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



Changes in volatility SKEW for 6m options

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



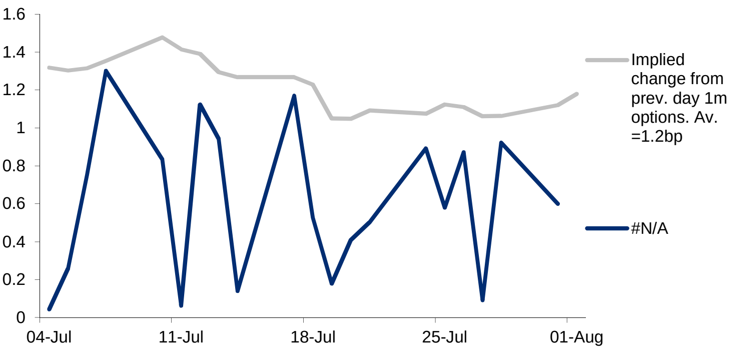
Source of all charts and tables: Citi Research and Markit.

Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

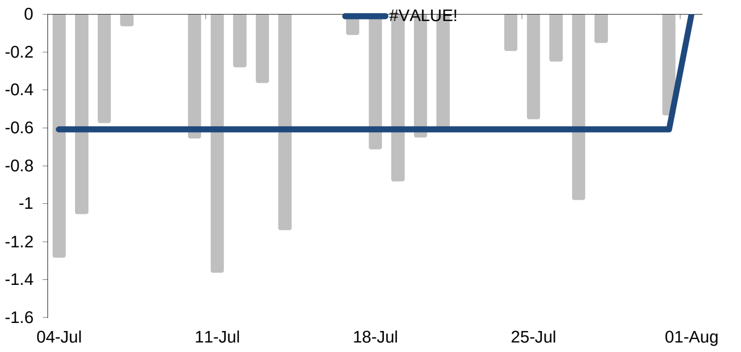
Data as of COB: 01 Aug 17

iTraxx Main - Realised vs. Implied Daily Spread Changes

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

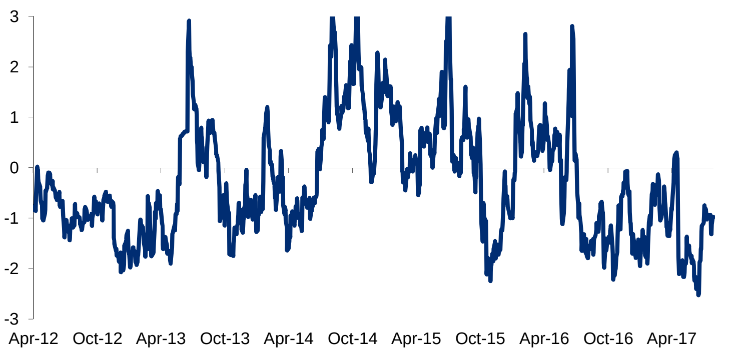


Realised close-to-close change minus implied change from prev. day 1m options
In bp. Data for the past 1m.

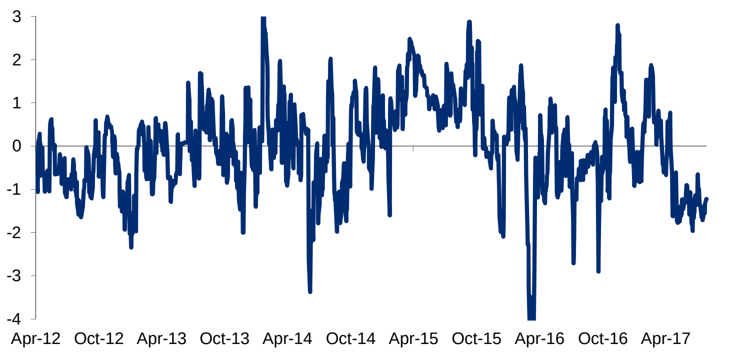


iTraxx Main - Vol Z-Scores

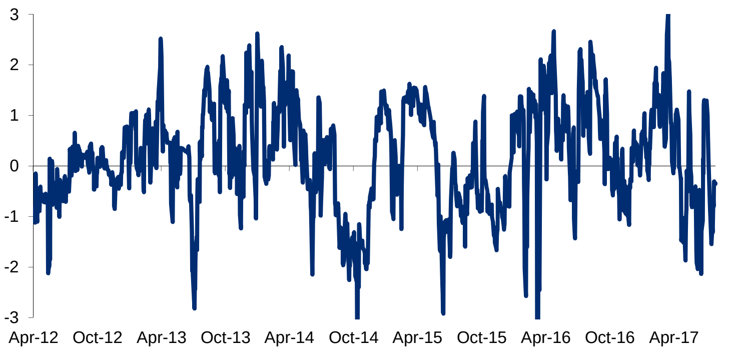
3m ATM Implied Vol - Z-score
Z-score (Current - average / st.dev) using the average and st.dev for the previous 12m; rolling.



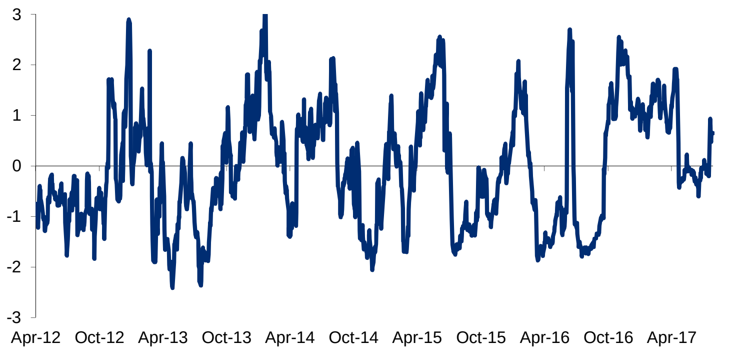
3m Receiver Skew (25% - 50% delta) - Z-score
Z-score (Current - average / st.dev) using the average and st.dev for the previous 12m; rolling.



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.



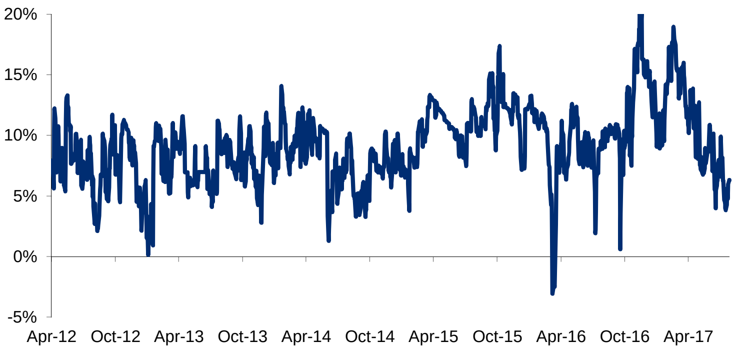
Source of all charts and tables: Citi Research and Markit.

Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

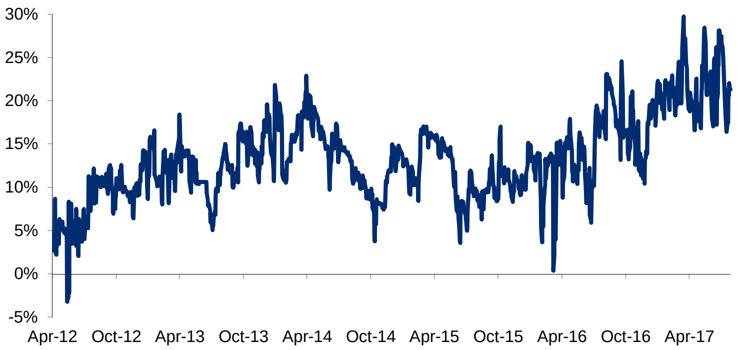
Data as of COB: 01 Aug 17

iTraxx Main - Skew vs. ATM Vol

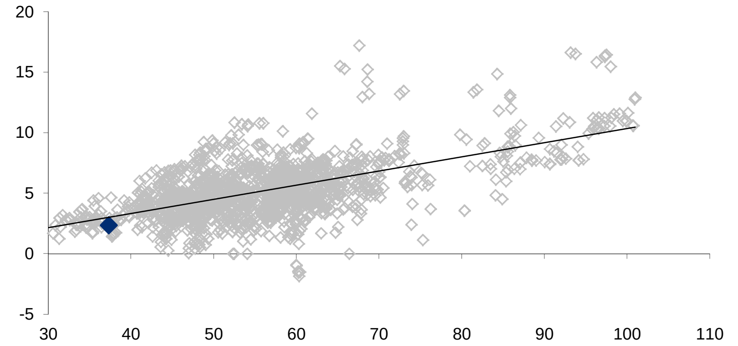
Receiver Skew / ATM iVol Ratio - 3m options
Skew defined as: 25% - 50% delta implied vol



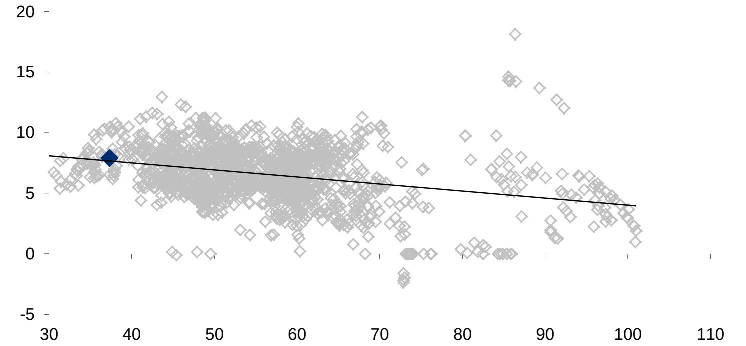
Payer Skew / ATM iVol Ratio - 3m options
Skew defined as: 25% - 50% delta implied vol



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

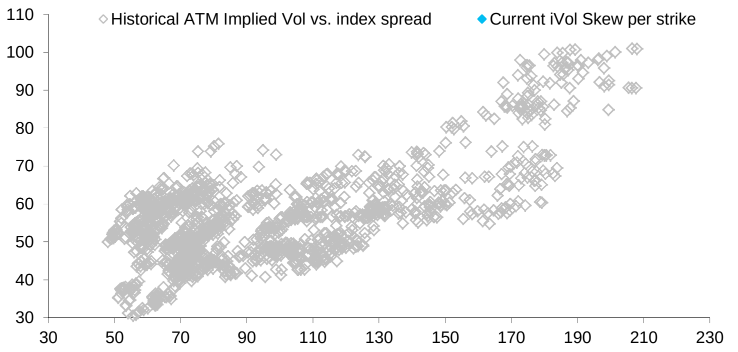


3m Payer Skew vs. ATM implied vol
X-axis: ATM implied vol. Y-axis: Skew defined as: 25% - 50% delta implied vol

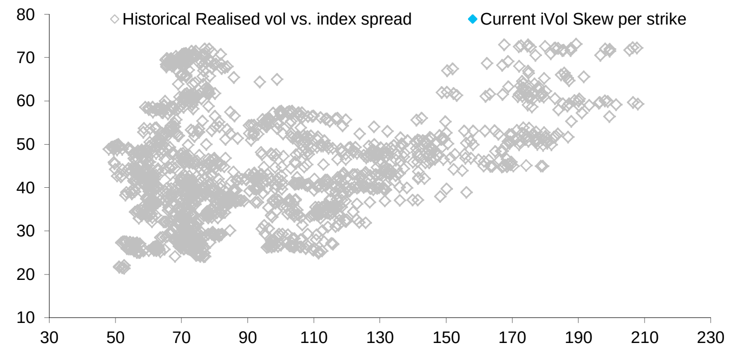


iTraxx Main - Current vol skew vs. historical vol per index spread

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)



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

Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

Data as of COB: 01 Aug 17

iTraxx Crossover

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	33	2	-1	22	-4	-1
3m	35	0	1	21	-0	-3
6m	36	-0	0	23	-0	0

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

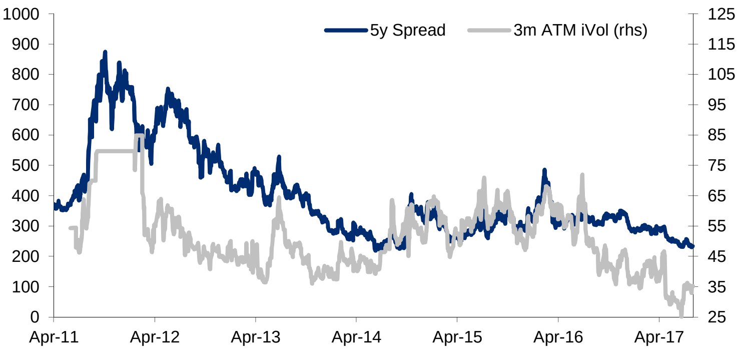
Expiry	Imp / real vol ratio	1w chg	1m chg
1m	1.5	0.3	0.0
3m	1.7	0.0	0.2
6m	1.6	0.0	0.0

Expiry	Implied vol (bp/day)	Real. vol (bp/day)	Forward spread
1m	5.2	#N/A	245
3m	5.6	#N/A	253
6m	6.1	#N/A	267

Index spread & 3m ATM implied volatility

Data since: 01-Apr-11

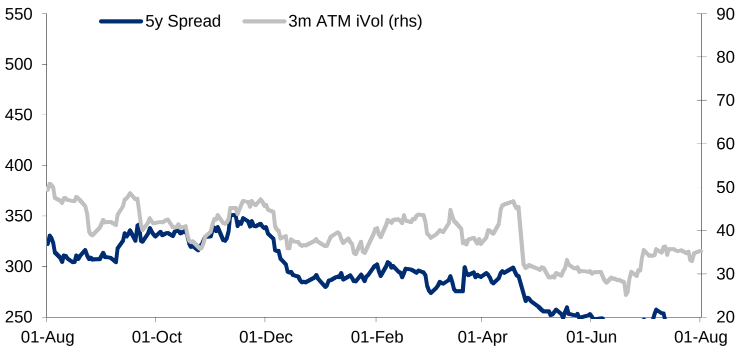
LHS: 5y on-the-run spread (bp); RHS: ATM implied volatility (%).



European Credit VIX Indices

Data since: 01-Aug-16

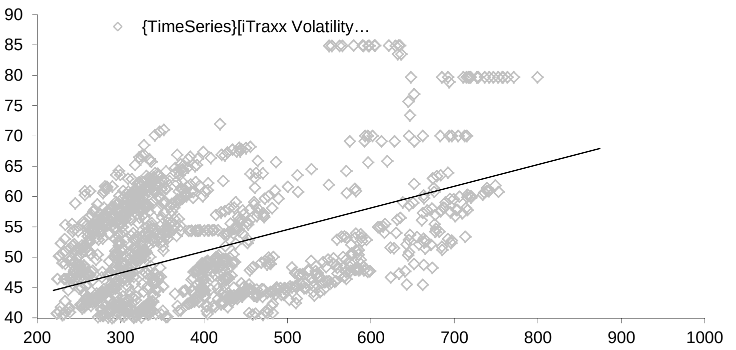
LHS: 5y on-the-run spread (bp); RHS: ATM implied volatility (%).



3m ATM implied volatility vs. index spread

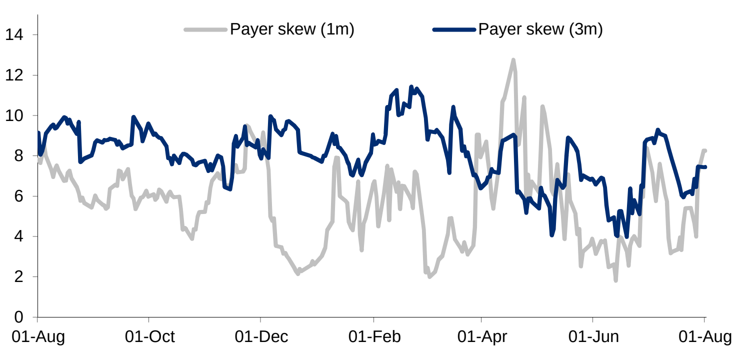
Data since: 01-Apr-11

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



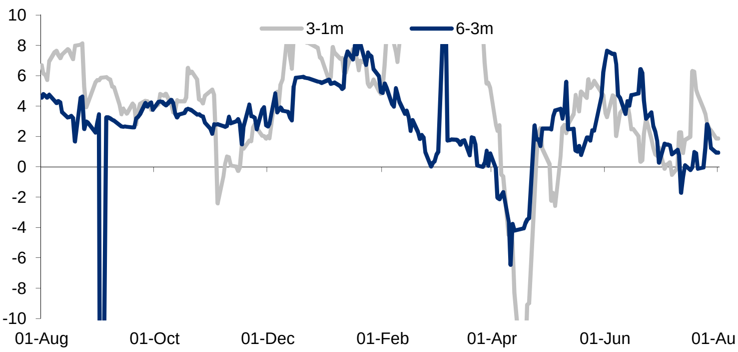
Payer SKEW, in %.

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



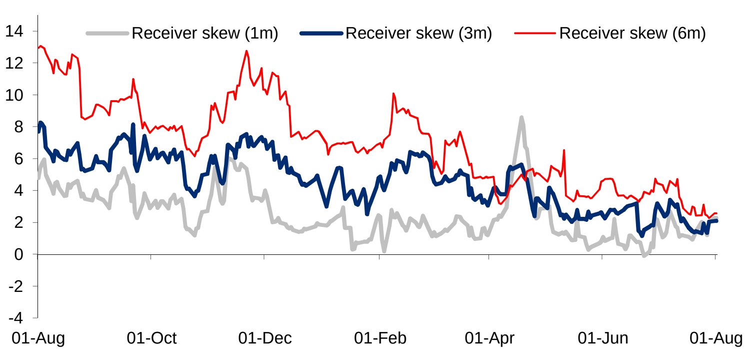
TERM STRUCTURE of ATM implied volatility, in %.

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.



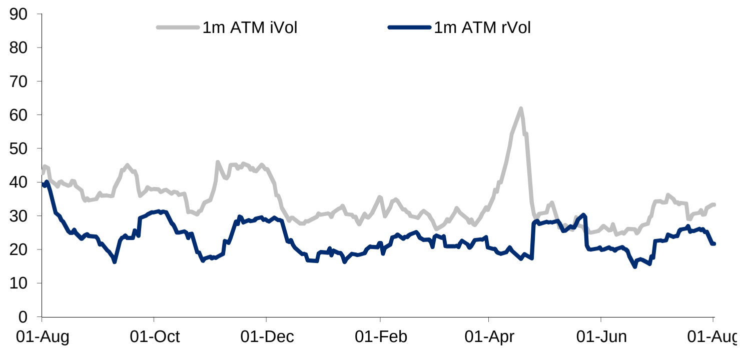
Source of all charts and tables: Citi Research and Markit.

Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

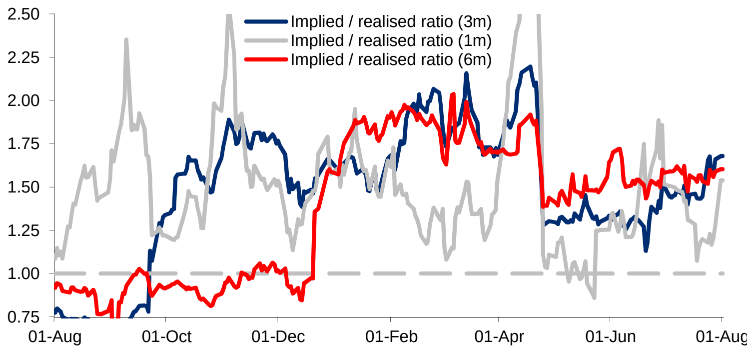
Data as of COB: 01 Aug 17

iTraxx Crossover- Implied/realised vol ratios

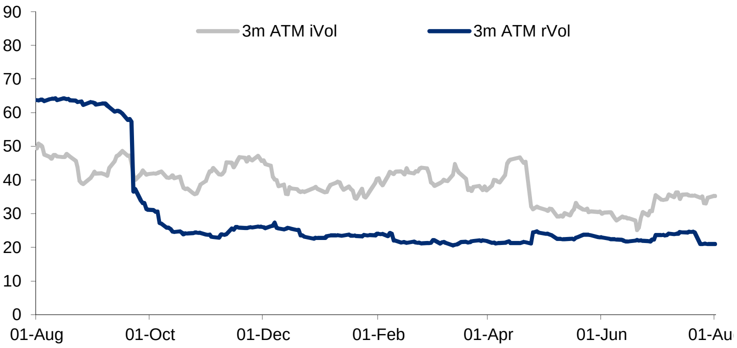
1 month implied (ATM) & realised volatility
In %



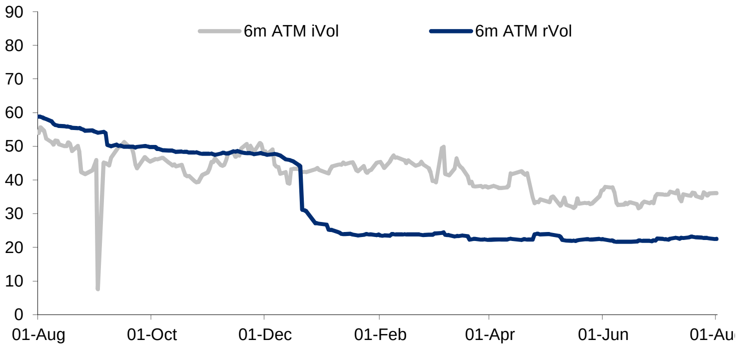
Ratio of implied to realised volatility



3 month implied (ATM) & realised volatility
In %

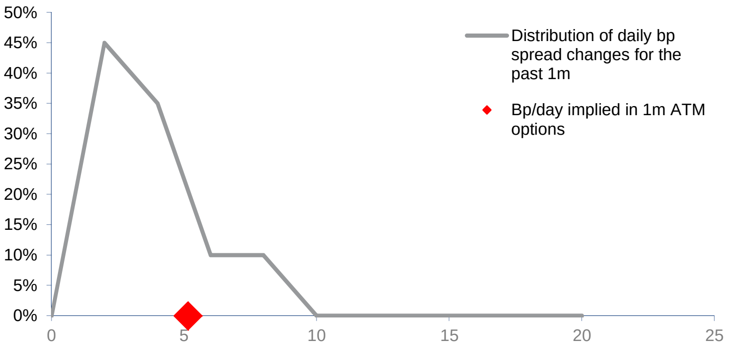


6 month implied (ATM) & realised volatility

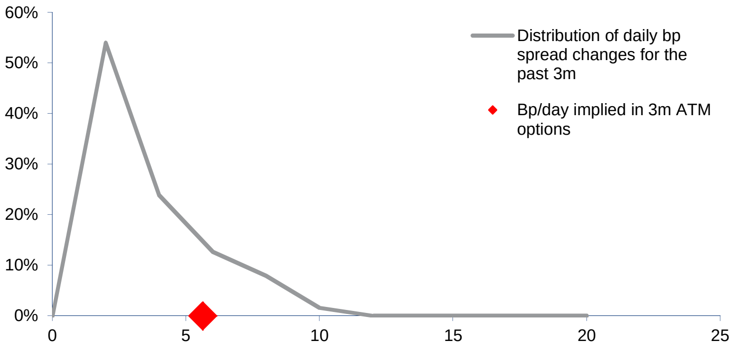


iTraxx CrossoverDistribution of realised bp daily changes vs. implied

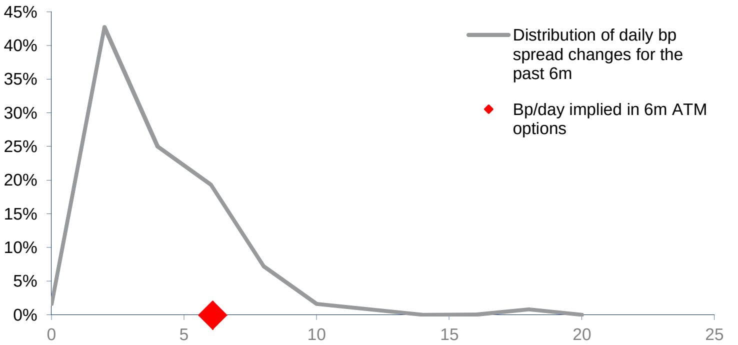
Distribution of daily bp changes vs. implied daily bp volatility - 1m data
X-axis: Daily bp changes.



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.



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

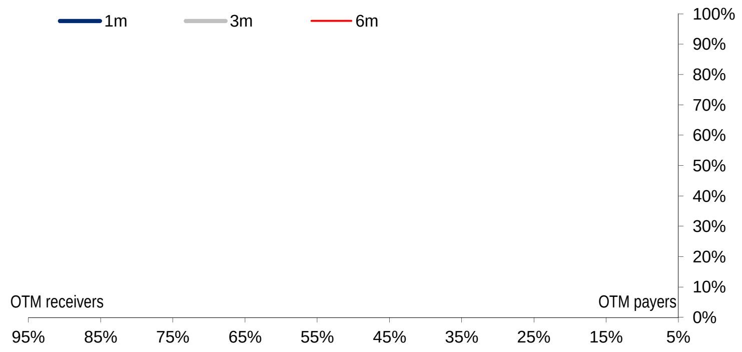
Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

Data as of COB: 01 Aug 17

iTraxx Crossover- Skew and Term Structure

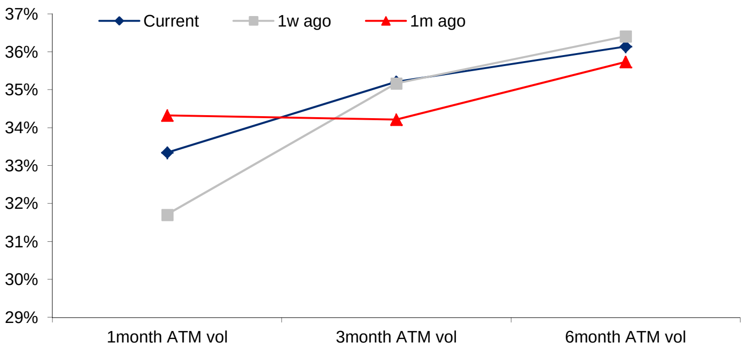
Current volatility SKEW for different option expiries

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

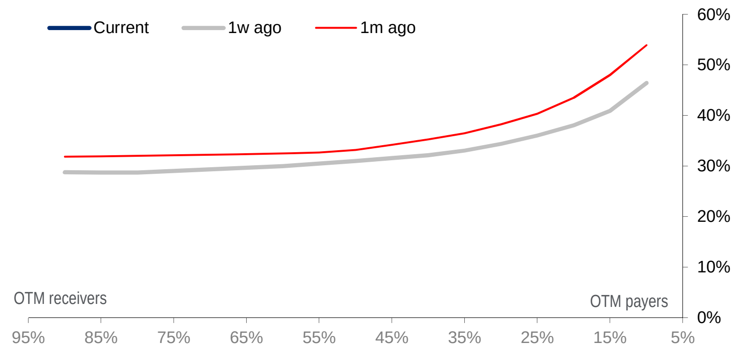
Y-axis: Implied volatility; X-axis: Payer delta (%).

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

	Current	**1w ago**	**1m ago**
1month ATM vol	33%	32%	34%
3month ATM vol	35%	35%	34%
6month ATM vol	36%	36%	36%
Index spread (bp)	#N/A	#N/A	#N/A

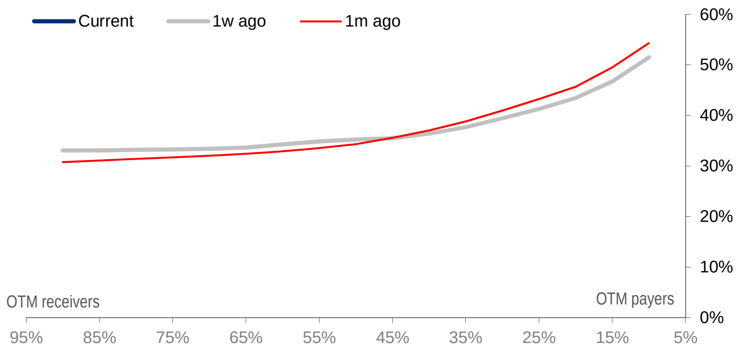
Changes in volatility SKEW for 1m options

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



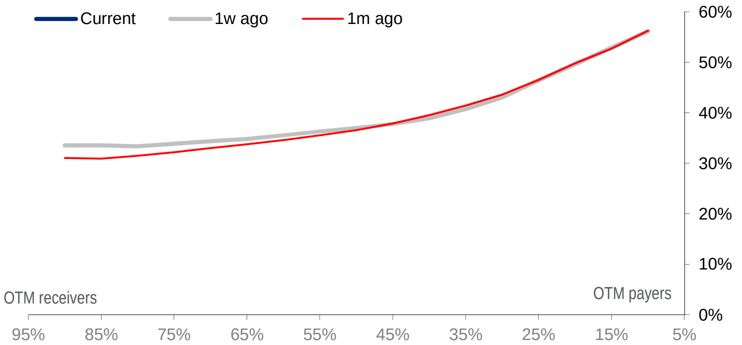
Changes in volatility SKEW for 3m options

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



Changes in volatility SKEW for 6m options

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



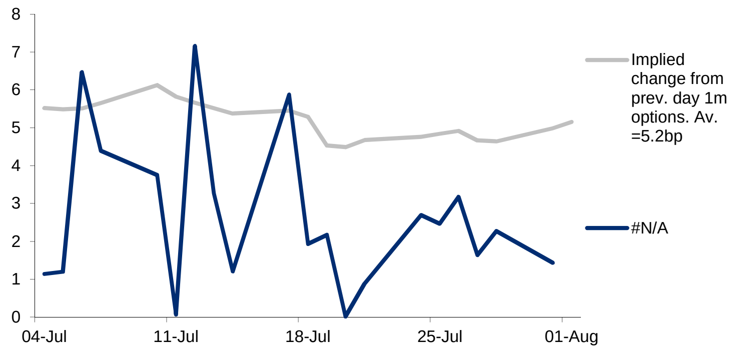
Source of all charts and tables: Citi Research and Markit.

Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

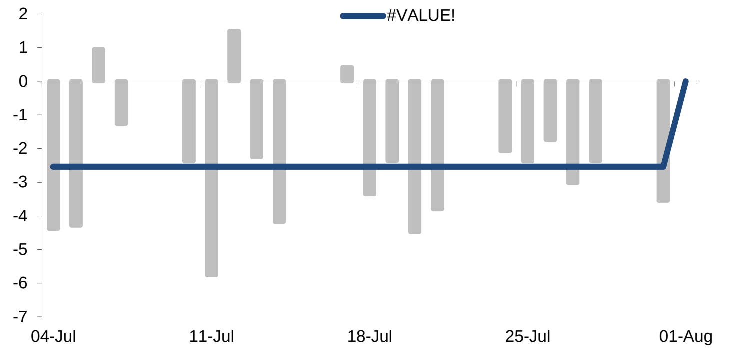
Data as of COB: 01 Aug 17

iTraxx Crossover- Realised vs. Implied Daily Spread Changes

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

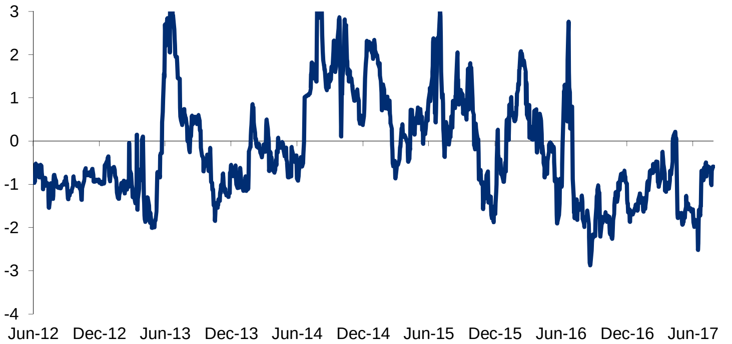


Realised close-to-close change minus implied change from prev. day 1m options
In bp. Data for the past 1m.

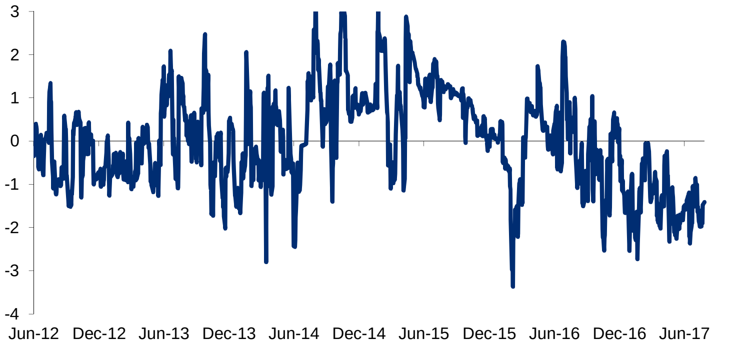


iTraxx Crossover- Vol Z-Scores

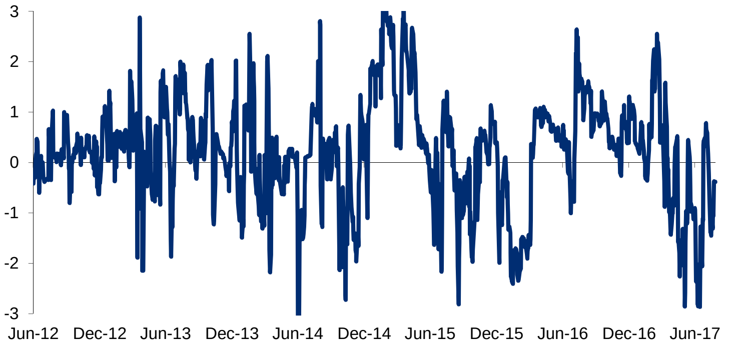
3m ATM Implied Vol - Z-score
Z-score (Current - average / st.dev) using the average and st.dev for the previous 12m; rolling.



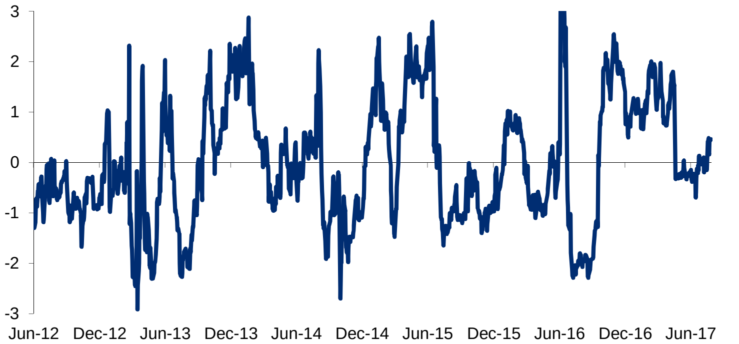
3m Receiver Skew (25% - 50% delta) - Z-score
Z-score (Current - average / st.dev) using the average and st.dev for the previous 12m; rolling.



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.



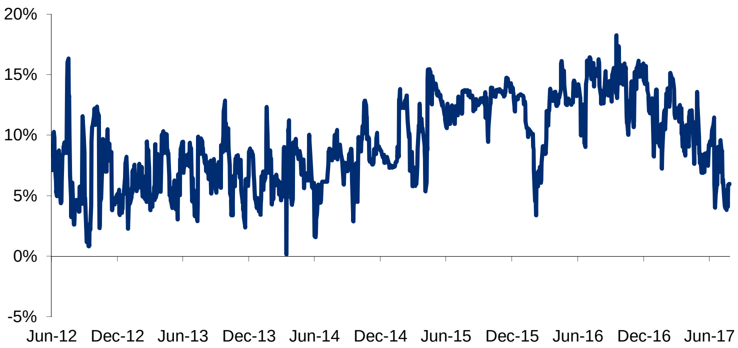
Source of all charts and tables: Citi Research and Markit.

Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

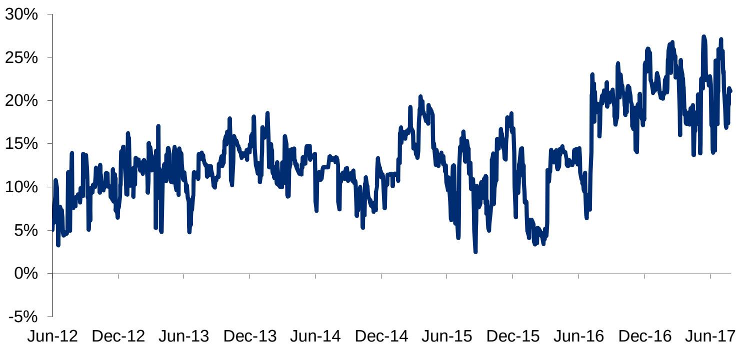
Data as of COB: 01 Aug 17

iTraxx Crossover- Skew vs. ATM Vol

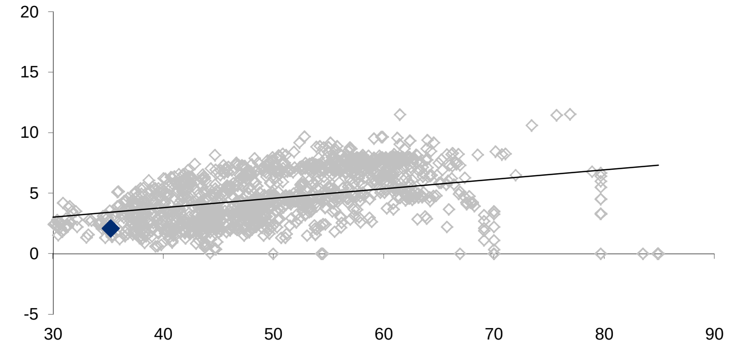
Receiver Skew / ATM iVol Ratio - 3m options
Skew defined as: 25% - 50% delta implied vol



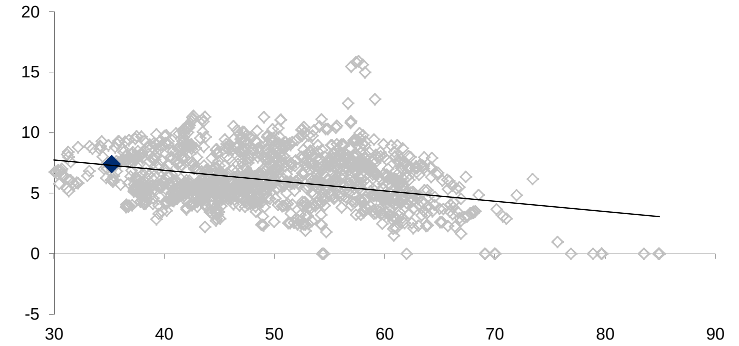
Payer Skew / ATM iVol Ratio - 3m options
Skew defined as: 25% - 50% delta implied vol



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

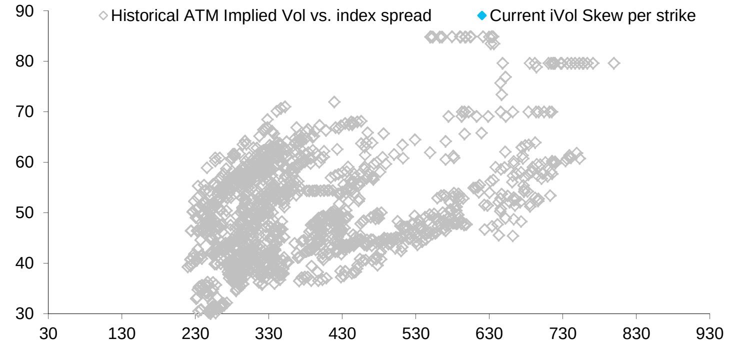


3m Payer Skew vs. ATM implied vol
X-axis: ATM implied vol. Y-axis: Skew defined as: 25% - 50% delta implied vol

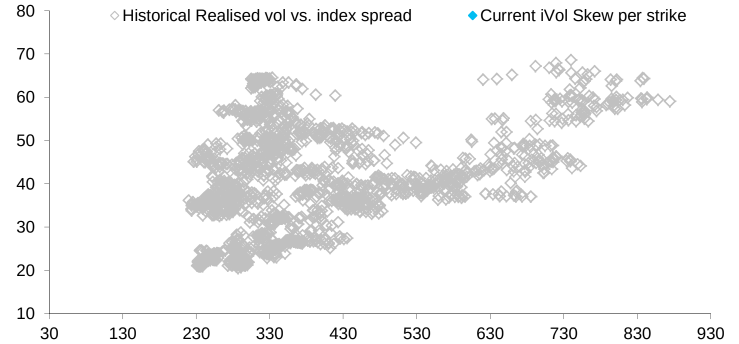


iTraxx Crossover- Current vol skew vs. historical vol per index spread

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)



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

Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

Data as of COB: 01 Aug 17

iTraxx Senior Financials

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	41	3	-5	26	-2	-13
3m	43	-0	-2	33	-1	-10
6m	45	1	-2	37	-0	-0

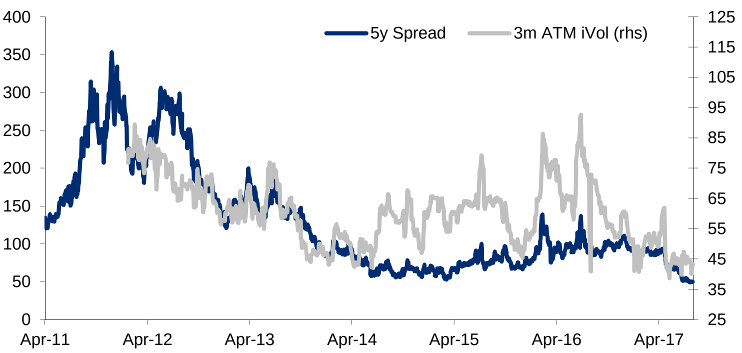
Implied to realised ratios and current volatilities expressed in daily bp movements

Expiry	Imp / real vol ratio	1w chg	1m chg
1m	1.5	0.2	0.4
3m	1.3	0.0	0.3
6m	1.2	0.0	-0.0

Expiry	Implied vol (bp/day)	Real. vol (bp/day)	Forward spread
1m	1.3	#N/A	52
3m	1.5	#N/A	54
6m	1.6	#N/A	57

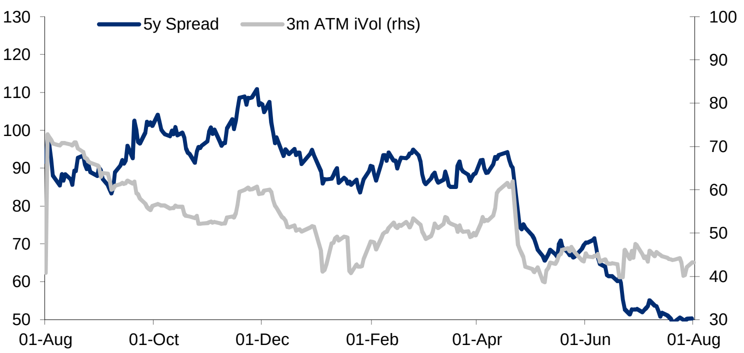
Index spread & 3m ATM implied volatility — Data since: 01-Apr-11

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



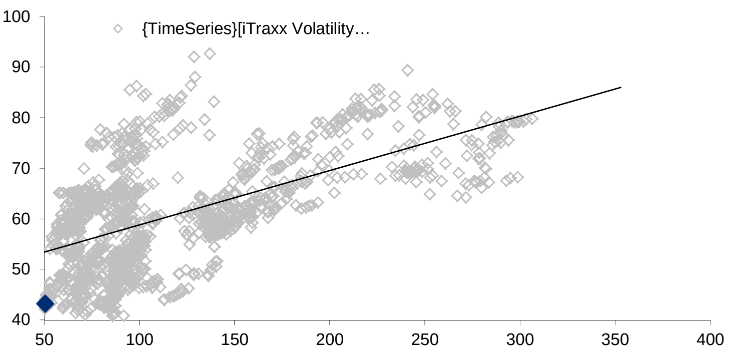
European Credit VIX Indices — Data since: 01-Aug-16

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



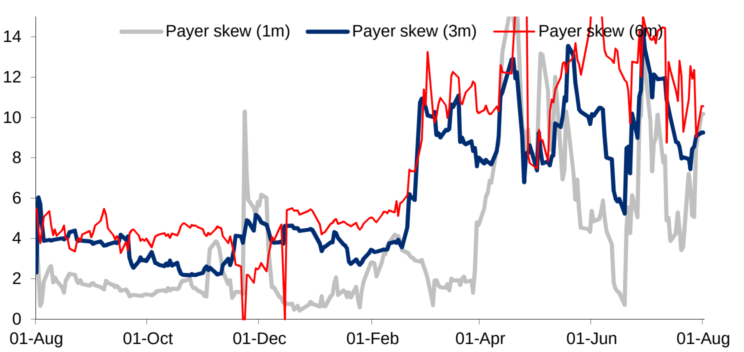
3m ATM implied volatility vs. index spread — Data since: 01-Apr-11

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



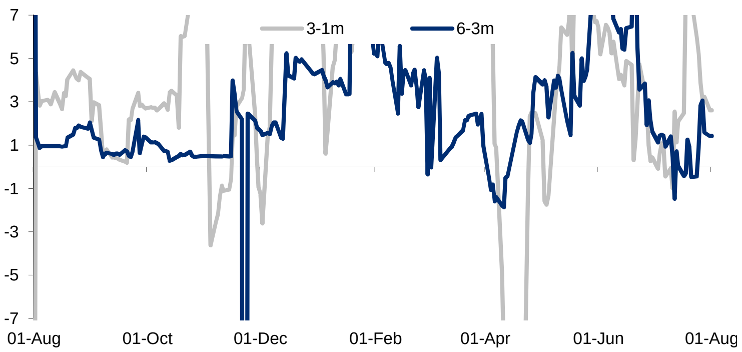
Sen Fins Payer SKEW, in %.

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



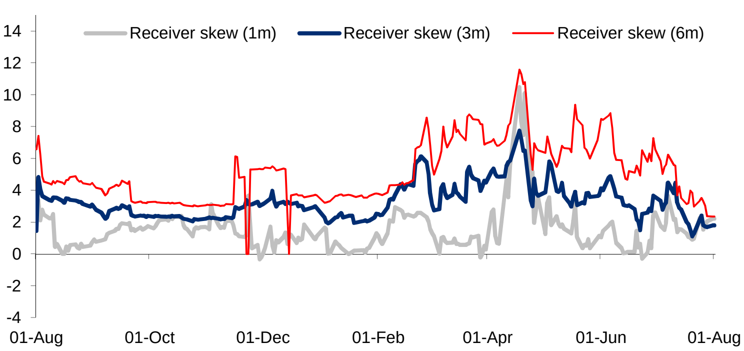
TERM STRUCTURE of ATM implied volatility, in %.

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.



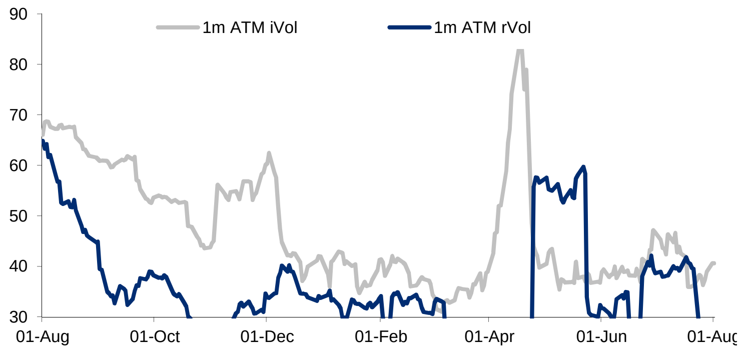
Source of all charts and charts and tables: Citi Research and Markit.

Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

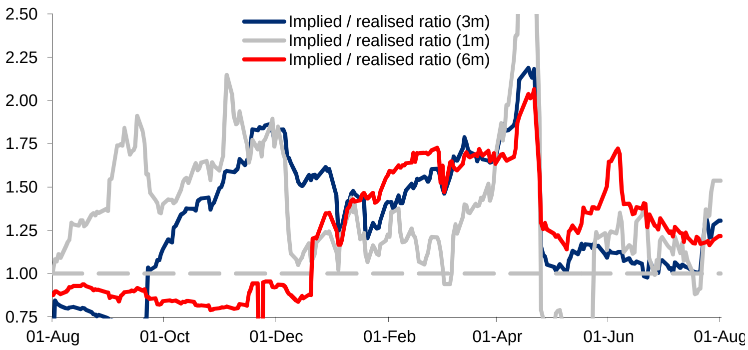
Data as of COB: 01 Aug 17

iTraxx Senior Financials- Implied/realised vol ratios

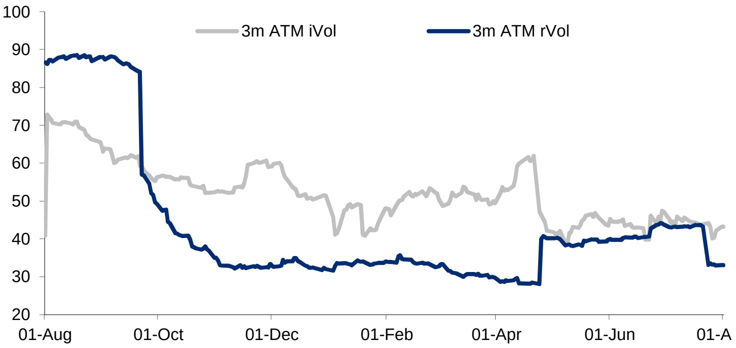
1 month implied (ATM) & realised volatility
In %



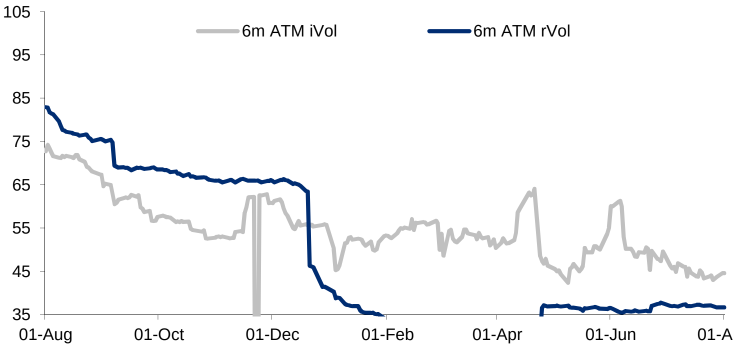
Ratio of implied to realised volatility



3 month implied (ATM) & realised volatility
In %

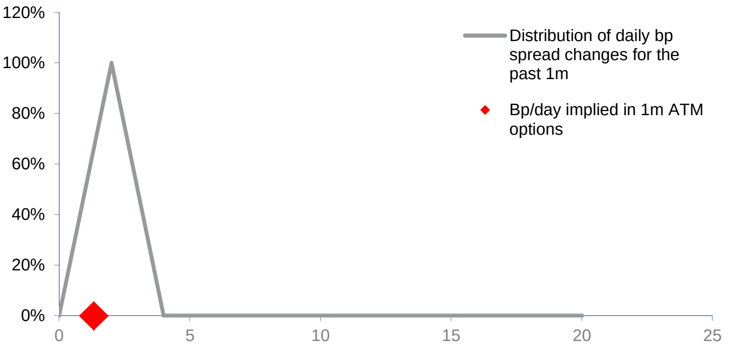


6 month implied (ATM) & realised volatility

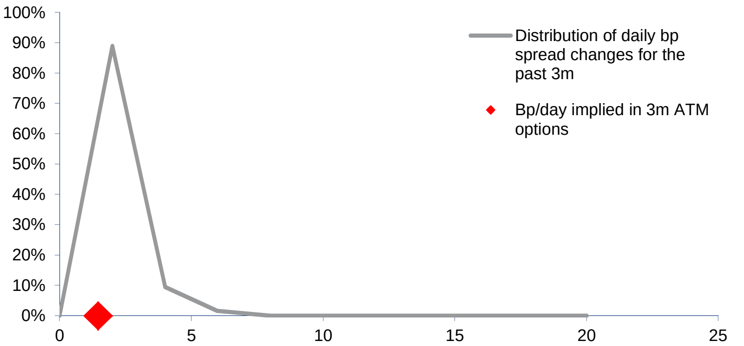


iTraxx Senior Financials- Distribution of realised bp daily changes vs. implied

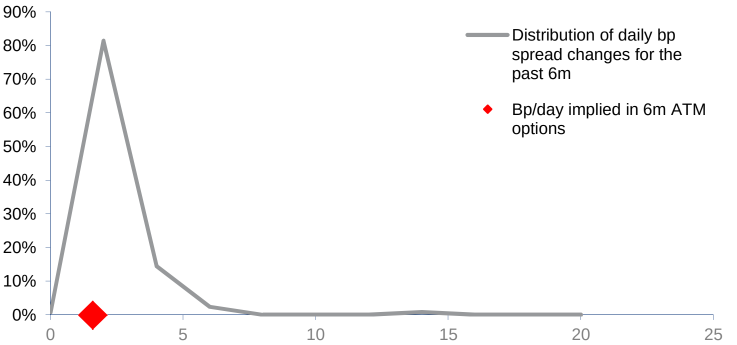
Distribution of daily bp changes vs. implied daily bp volatility - 1m data
X-axis: Daily bp changes.



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.



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

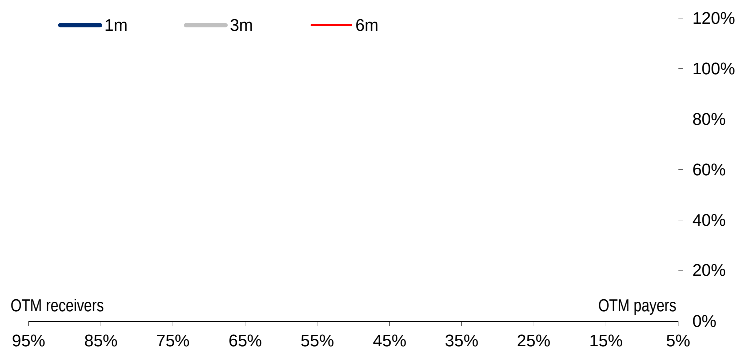
Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

Data as of COB: 01 Aug 17

iTraxx Senior Financials- Skew and Term Structure

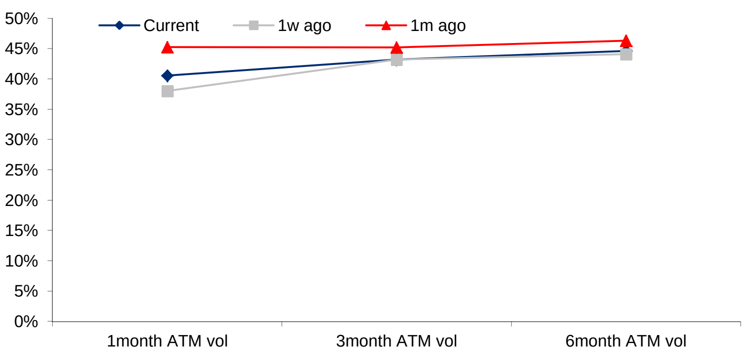
Current volatility SKEW for different option expiries

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

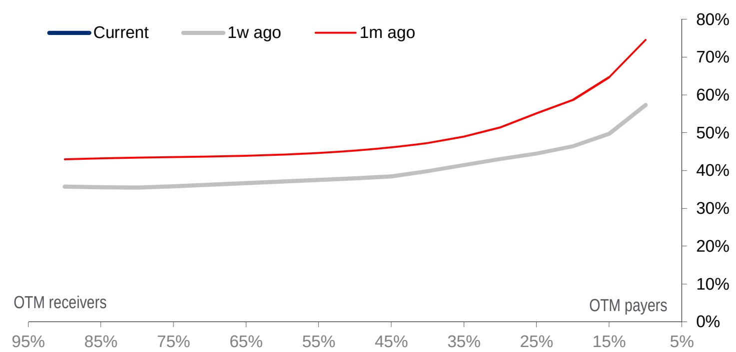
Y-axis: Implied volatility; X-axis: Payer delta (%).

	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	41%	38%	45%
3month ATM vol	43%	43%	45%
6month ATM vol	45%	44%	46%
Index spread (bp)	#N/A	#N/A	#N/A

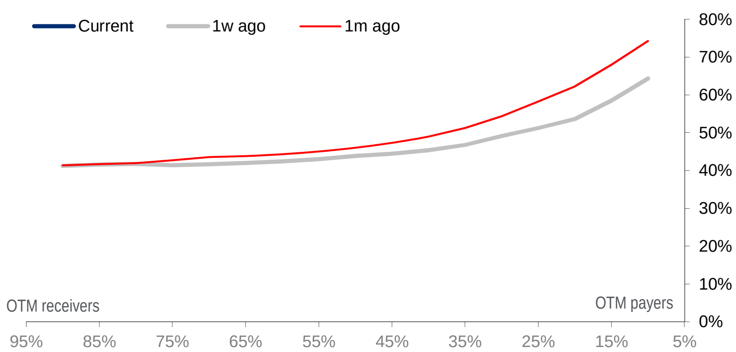
Changes in volatility SKEW for 1m options

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



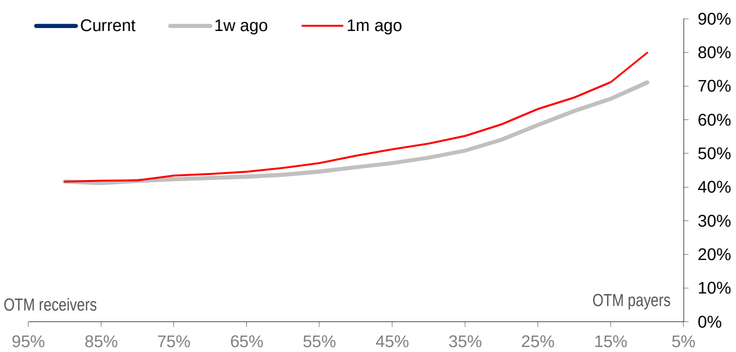
Changes in volatility SKEW for 3m options

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



Changes in volatility SKEW for 6m options

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



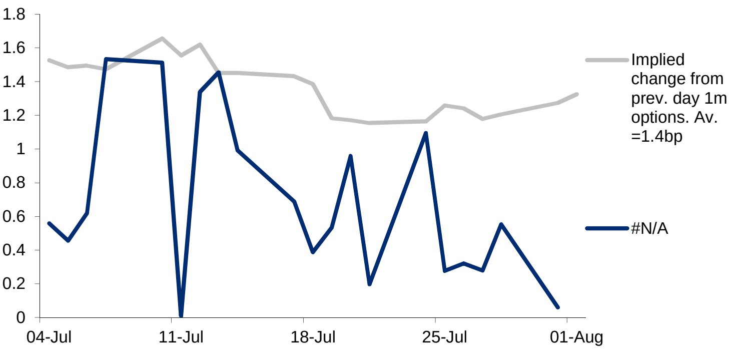
Source of all charts and tables: Citi Research and Markit.

Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

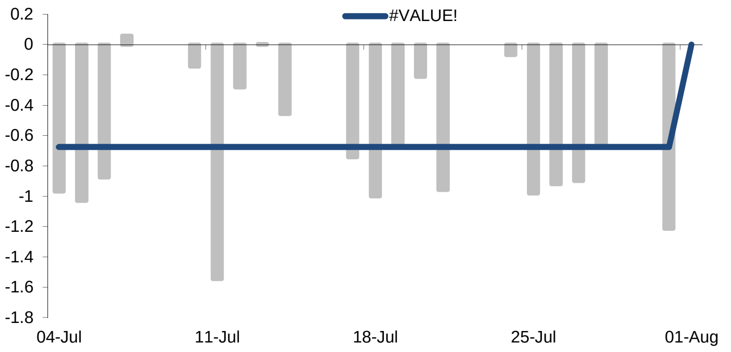
Data as of COB: 01 Aug 17

iTraxx Senior Financials- Realised vs. Implied Daily Spread Changes

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

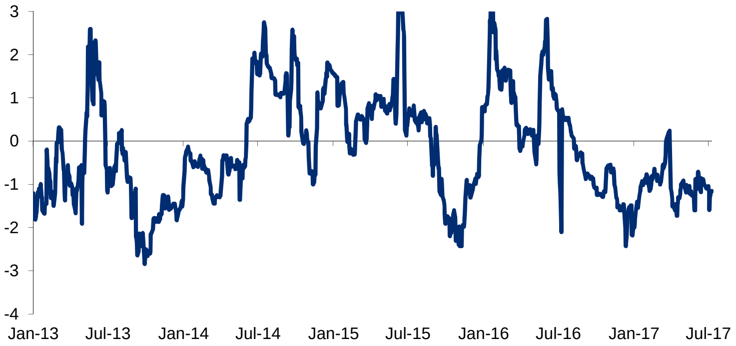


Realised close-to-close change minus implied change from prev. day 1m options
In bp. Data for the past 1m.

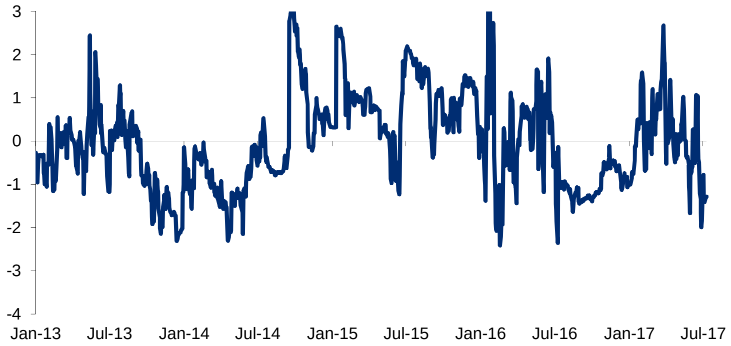


iTraxx Senior Financials- Vol Z-Scores

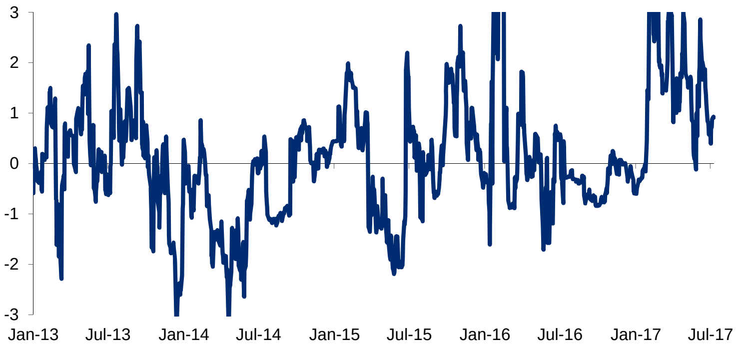
3m ATM Implied Vol - Z-score
Z-score (Current - average / st.dev) using the average and st.dev for the previous 12m; rolling.



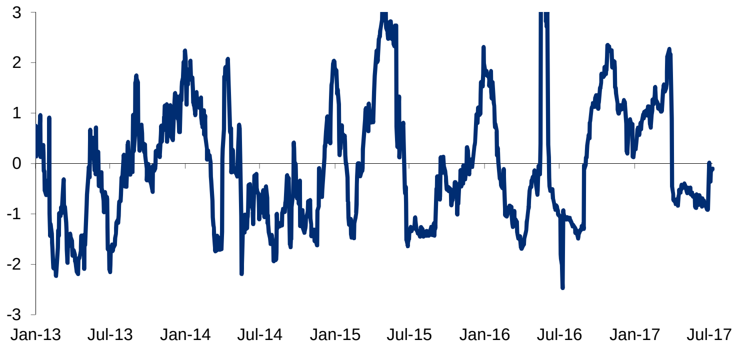
3m Receiver Skew (25% - 50% delta) - Z-score
Z-score (Current - average / st.dev) using the average and st.dev for the previous 12m; rolling.



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.



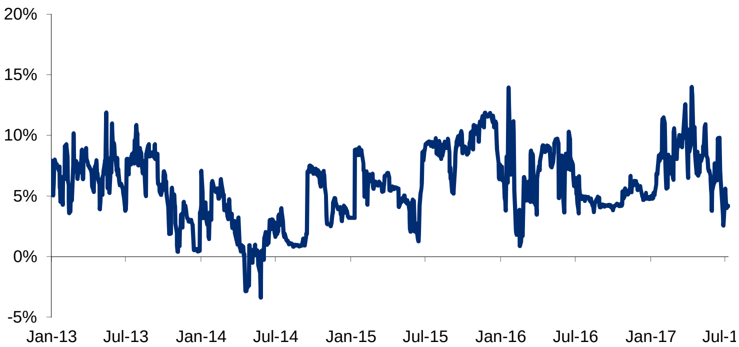
Source of all charts and tables: Citi Research and Markit.

Aritra Banerjee
+44-20-3569-4544
aritra2.banerjee@citi.com
Citigroup Global Markets Ltd.
Credit Products Strategy

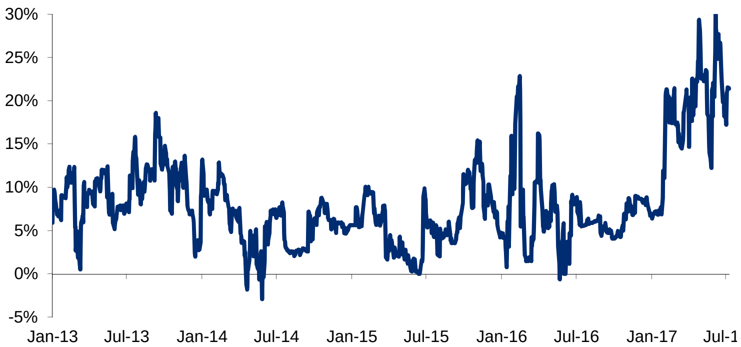
Data as of COB: 01 Aug 17

iTraxx Senior Financials- Skew vs. ATM Vol

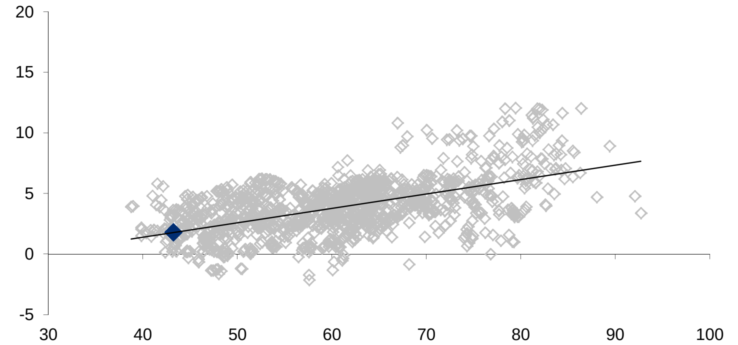
Receiver Skew / ATM iVol Ratio - 3m options
Skew defined as: 25% - 50% delta implied vol



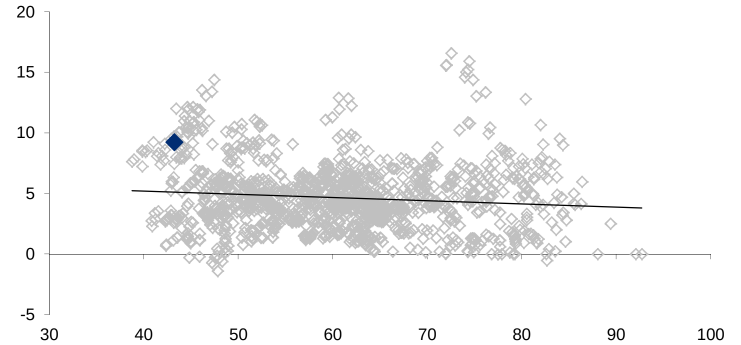
Payer Skew / ATM iVol Ratio - 3m options
Skew defined as: 25% - 50% delta implied vol



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

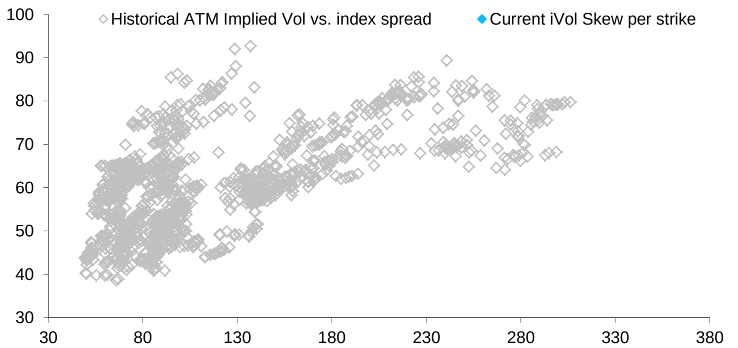


3m Payer Skew vs. ATM implied vol
X-axis: ATM implied vol. Y-axis: Skew defined as: 25% - 50% delta implied vol

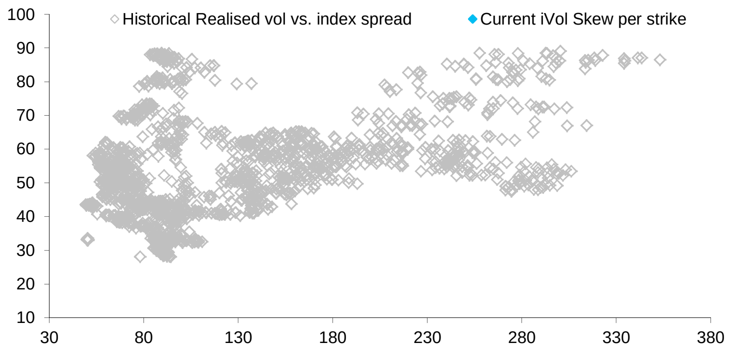


iTraxx Senior Financials- Current vol skew vs. historical vol per index

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)



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

Appendix A-1

Analyst Certification

The research analyst(s) primarily responsible for the preparation and content of this research report are named in bold text in the author block at the front of the product except for those sections where an analyst's name appears in bold alongside content which is attributable to that analyst. Each of these analyst(s) certify, with respect to the section(s) of the report for which they are responsible, that the views expressed therein accurately reflect their personal views about each issuer and security referenced and were prepared in an independent manner, including with respect to Citigroup Global Markets Inc and its affiliates. No part of the research analyst's compensation was, is, or will be, directly or indirectly, related to the specific recommendation(s) or view(s) expressed by that research analyst in this report.

IMPORTANT DISCLOSURES

Analysts' compensation is determined based upon activities and services intended to benefit the investor clients of Citigroup Global Markets Inc. and its affiliates ("the Firm"). Like all Firm employees, analysts receive compensation that is impacted by overall firm profitability which includes investment banking revenues.

For important disclosures (including copies of historical disclosures) regarding the companies that are the subject of this Citi Research product ("the Product"), please contact Citi Research, 388 Greenwich Street, 28th Floor, New York, NY, 10013, Attention: Legal/Compliance [E6WYB6412478]. In addition, the same important disclosures, with the exception of the Valuation and Risk assessments and historical disclosures, are contained on the Firm's disclosure website at https://www.citivelocity.com/cvr/eppublic/citi_research_disclosures. Valuation and Risk assessments can be found in the text of the most recent research note/report regarding the subject company. Historical disclosures (for up to the past three years) will be provided upon request.

NON-US RESEARCH ANALYST DISCLOSURES

Non-US research analysts who have prepared this report (i.e., all research analysts listed below other than those identified as employed by Citigroup Global Markets Inc.) are not registered/qualified as research analysts with FINRA. Such research analysts may not be associated persons of the member organization and therefore may not be subject to the NYSE Rule 472 and NASD Rule 2711 restrictions on communications with a subject company, public appearances and trading securities held by a research analyst account. The legal entities employing the authors of this report are listed below:

Citigroup Global Markets Ltd	Aritra Banerjee

OTHER DISCLOSURES

For securities recommended in the Product in which the Firm is not a market maker, the Firm is a liquidity provider in the issuers' financial instruments and may act as principal in connection with such transactions. The Firm is a regular issuer of traded financial instruments linked to securities that may have been recommended in the Product. The Firm regularly trades in the securities of the issuer(s) discussed in the Product. The Firm may engage in securities transactions in a manner inconsistent with the Product and, with respect to securities covered by the Product, will buy or sell from customers on a principal basis.

Securities recommended, offered, or sold by the Firm: (i) are not insured by the Federal Deposit Insurance Corporation; (ii) are not deposits or other obligations of any insured depository institution (including Citibank); and (iii) are subject to investment risks, including the possible loss of the principal amount invested. Although information has been obtained from and is based upon sources that the Firm believes to be reliable, we do not guarantee its accuracy and it may be incomplete and condensed. Note, however, that the Firm has taken all reasonable steps to determine the accuracy and completeness of the disclosures made in the Important Disclosures section of the Product. The Firm's research department has received assistance from the subject company(ies) referred to in this Product including, but not limited to, discussions with management of the subject company(ies). Firm policy prohibits research analysts from sending draft research to subject companies. However, it should be presumed that the author of the Product has had discussions with the subject company to ensure factual accuracy prior to publication. All opinions, projections and estimates constitute the judgment of the author as of the date of the Product and these, plus any other information contained in the Product, are subject to change without notice. Prices and availability of financial instruments also are subject to change without notice. Notwithstanding other departments within the Firm advising the companies discussed in this Product, information obtained in such role is not used in the preparation of the Product. Although Citi Research does not set a predetermined frequency for publication, if the Product is a fundamental research report, it is the intention of Citi Research to provide research coverage of the/those issuer(s) mentioned therein, including in response to news affecting this issuer, subject to applicable quiet periods and capacity constraints. The Product is for informational purposes only and is not intended as an offer or solicitation for the purchase or sale of a security. Any decision to purchase securities mentioned in the Product must take into account existing public information on such security or any registered prospectus.

Investing in non-U.S. securities, including ADRs, may entail certain risks. The securities of non-U.S. issuers may not be registered with, nor be subject to the reporting requirements of the U.S. Securities and Exchange Commission. There may be limited information available on foreign securities. Foreign companies are generally not subject to uniform audit and reporting standards, practices and requirements comparable to those in the U.S. Securities of some foreign companies may be less liquid and their prices more volatile than securities of comparable U.S. companies. In addition, exchange rate movements may have an adverse effect on the value of an investment in a foreign stock and its corresponding dividend payment for U.S. investors. Net dividends to ADR investors are estimated, using withholding tax rates conventions, deemed accurate, but investors are urged to consult their tax advisor for exact dividend computations. Investors who have received the Product from the Firm may be prohibited in certain states or other jurisdictions from purchasing securities mentioned in the Product from the Firm. Please ask your Financial Consultant for additional details. Citigroup Global Markets Inc. takes responsibility for the Product in the United States. Any orders by US investors resulting from the information contained in the Product may be placed only through Citigroup Global Markets Inc.

Important Disclosures for Bell Potter Customers: Bell Potter is making this Product available to its clients pursuant to an agreement with Citigroup Global Markets Australia Pty Limited. Neither Citigroup Global Markets Australia Pty Limited nor any of its affiliates has made any determination as to the suitability of the information provided herein and clients should consult with their Bell Potter financial advisor before making any investment decision.

The Citigroup legal entity that takes responsibility for the production of the Product is the legal entity which the first named author is employed by. The Product is made available in **Australia** through Citigroup Global Markets Australia Pty Limited. (ABN 64 003 114 832 and AFSL No. 240992), participant of the ASX Group and regulated by the Australian Securities & Investments Commission. Citigroup Centre, 2 Park Street, Sydney, NSW 2000. The Product is made available in Australia to Private Banking wholesale clients through Citigroup Pty Limited (ABN 88 004 325 080 and AFSL 238098). Citigroup Pty Limited provides all financial product advice to Australian Private Banking wholesale clients through bankers and relationship managers. If there is any doubt about the suitability of investments held in Citigroup Private Bank accounts, investors should contact the Citigroup Private Bank in Australia. Citigroup companies may compensate affiliates and their representatives for providing products and services to clients. The Product is made available in **Brazil** by Citigroup Global Markets Brasil - CCTVM SA, which is regulated by CVM - Comissão de Valores Mobiliários, BACEN - Brazilian Central Bank, APIMEC - Associação dos Analistas e Profissionais de Investimento do Mercado de Capitais and ANBID - Associação Nacional dos Bancos de Investimento. Av. Paulista, 1111 - 11º andar - CEP. 01311920 - São Paulo - SP. If the Product is being made available in certain provinces of **Canada** by Citigroup Global Markets (Canada) Inc. ("CGM Canada"), CGM Canada has approved the Product. Citigroup Place, 123 Front Street West, Suite 1100, Toronto, Ontario M5J 2M3. This product is available in **Chile** through Banchile Corredores de Bolsa S.A., an indirect subsidiary of Citigroup Inc., which is regulated by the Superintendencia de Valores y Seguros. Agustinas 975, piso 2, Santiago, Chile. The Product is distributed in **Germany** by Citigroup Global Markets Deutschland AG ("CGMD"), which is regulated by Bundesanstalt fuer Finanzdienstleistungsaufsicht (BaFin). CGMD, Reuterweg 16, 60323 Frankfurt am Main. Research which relates to "securities" (as defined in the Securities and Futures Ordinance (Cap. 571 of the Laws of Hong Kong)) is issued in **Hong Kong** by, or on behalf of, Citigroup Global Markets Asia Limited which takes full responsibility for its content. Citigroup Global Markets Asia Ltd. is regulated by Hong Kong Securities and Futures Commission. If the Research is made available through Citibank, N.A., Hong Kong Branch, for its clients in Citi Private Bank, it is made available by Citibank N.A., Citibank Tower, Citibank Plaza, 3 Garden Road, Hong Kong. Citibank N.A. is regulated by the Hong Kong Monetary Authority. Please contact your Private Banker in Citibank N.A., Hong Kong, Branch if you have any queries on or any matters arising from or in connection with this document. The Product is made available in **India** by Citigroup Global Markets India Private Limited, which is regulated by Securities and Exchange Board of India. 1202, 12th Floor, FIFC, G Block, Bandra Kurla Complex, Bandra East, Mumbai - 400051 Corporate Identity Number: U99999MH2000PTC126657 Tel: +9102261759999 Fax: +9102261759961. The Product is made available in **Indonesia** through PT Citigroup Securities Indonesia. 5/F, Citibank Tower, Bapindo Plaza, Jl. Jend. Sudirman Kav. 54-55, Jakarta 12190. Neither this Product nor any copy hereof may be distributed in Indonesia or to any Indonesian citizens wherever they are domiciled or to Indonesian residents except in compliance with applicable capital market laws and regulations. This Product is not an offer of securities in Indonesia. The securities referred to in this Product have not been registered with the Capital Market and Financial Institutions Supervisory Agency (BAPEPAM-LK) pursuant to relevant capital market laws and regulations, and may not be offered or sold within the territory of the Republic of Indonesia or to Indonesian citizens through a public offering or in circumstances which constitute an offer within the meaning of the Indonesian capital market laws and regulations. The Product is made available in **Israel** through Citibank NA, regulated by the Bank of Israel and the Israeli Securities Authority. Citibank, N.A, Platinum Building, 21 Ha'arba'ah St, Tel Aviv, Israel. The Product is made available in **Italy** by Citigroup Global Markets Limited, which is authorised by the PRA and regulated by the FCA and the PRA. Via dei Mercanti, 12, Milan, 20121, Italy. The Product is made available in **Japan** by Citigroup Global Markets Japan Inc. ("CGMJ"), which is regulated by Financial Services Agency, Securities and Exchange Surveillance Commission, Japan Securities Dealers Association, Tokyo Stock Exchange and Osaka Securities Exchange. Shin-Marunouchi Building, 1-5-1 Marunouchi, Chiyoda-ku, Tokyo 100-6520 Japan. If the Product was distributed by SMBC Nikko Securities Inc. it is being so distributed under license. In the event that an error is found in an CGMJ research report, a revised version will be posted on the Firm's Citi Velocity

website. If you have questions regarding Citi Velocity, please call (81 3) 6270-3019 for help. The Product is made available in **Korea** by Citigroup Global Markets Korea Securities Ltd., which is regulated by the Financial Services Commission, the Financial Supervisory Service and the Korea Financial Investment Association (KOFIA). Citibank Building, 39 Da-dong, Jung-gu, Seoul 100-180, Korea. KOFIA makes available registration information of research analysts on its website. Please visit the following website if you wish to find KOFIA registration information on research analysts of Citigroup Global Markets Korea Securities Ltd. http://dis.kofia.or.kr/websquare/index.jsp?w2xPath=/wq/fundMgr/DISFundMgrAnalystList.xml&divisionId=MDIS03002002000000&serviceId=SDIS03002002000. The Product is made available in Korea by Citibank Korea Inc., which is regulated by the Financial Services Commission and the Financial Supervisory Service. Address is Citibank Building, 39 Da-dong, Jung-gu, Seoul 100-180, Korea. The Product is made available in **Malaysia** by Citigroup Global Markets Malaysia Sdn Bhd (Company No. 460819-D) ("CGMM") to its clients and CGMM takes responsibility for its contents. CGMM is regulated by the Securities Commission of Malaysia. Please contact CGMM at Level 43 Menara Citibank, 165 Jalan Ampang, 50450 Kuala Lumpur, Malaysia in respect of any matters arising from, or in connection with, the Product. The Product is made available in **Mexico** by Acciones y Valores Banamex, S.A. De C. V., Casa de Bolsa, Integrante del Grupo Financiero Banamex ("Accival") which is a wholly owned subsidiary of Citigroup Inc. and is regulated by Comision Nacional Bancaria y de Valores. Reforma 398, Col. Juarez, 06600 Mexico, D.F. In **New Zealand** the Product is made available to 'wholesale clients' only as defined by s5C(1) of the Financial Advisers Act 2008 ('FAA') through Citigroup Global Markets Australia Pty Ltd (ABN 64 003 114 832 and AFSL No. 240992), an overseas financial adviser as defined by the FAA, participant of the ASX Group and regulated by the Australian Securities & Investments Commission. Citigroup Centre, 2 Park Street, Sydney, NSW 2000. The Product is made available in **Pakistan** by Citibank N.A. Pakistan branch, which is regulated by the State Bank of Pakistan and Securities Exchange Commission, Pakistan. AWT Plaza, 1.1. Chundrigar Road, P.O. Box 4889, Karachi-74200. The Product is made available in the **Philippines** through Citicorp Financial Services and Insurance Brokerage Philippines, Inc., which is regulated by the Philippines Securities and Exchange Commission. 20th Floor Citibank Square Bldg. The Product is made available in the Philippines through Citibank NA Philippines branch, Citibank Tower, 8741 Paseo De Roxas, Makati City, Manila. Citibank NA Philippines NA is regulated by The Bangko Sentral ng Pilipinas. The Product is made available in **Poland** by Dom Maklerski Banku Handlowego SA an indirect subsidiary of Citigroup Inc., which is regulated by Komisja Nadzoru Finansowego. Dom Maklerski Banku Handlowego S.A. ul.Senatorska 16, 00-923 Warszawa. The Product is made available in the **Russian Federation** through ZAO Citibank, which is licensed to carry out banking activities in the Russian Federation in accordance with the general banking license issued by the Central Bank of the Russian Federation and brokerage activities in accordance with the license issued by the Federal Service for Financial Markets. Neither the Product nor any information contained in the Product shall be considered as advertising the securities mentioned in this report within the territory of the Russian Federation or outside the Russian Federation. The Product does not constitute an appraisal within the meaning of the Federal Law of the Russian Federation of 29 July 1998 No. 135-FZ (as amended) On Appraisal Activities in the Russian Federation. 8-10 Gasheka Street, 125047 Moscow. The Product is made available in **Singapore** through Citigroup Global Markets Singapore Pte. Ltd. ("CGMSPL"), a capital markets services license holder, and regulated by Monetary Authority of Singapore. Please contact CGMSPL at 8 Marina View, 21st Floor Asia Square Tower 1, Singapore 018960, in respect of any matters arising from, or in connection with, the analysis of this document. This report is intended for recipients who are accredited, expert and institutional investors as defined under the Securities and Futures Act (Cap. 289). The Product is made available by The Citigroup Private Bank in Singapore through Citibank, N.A., Singapore Branch, a licensed bank in Singapore that is regulated by Monetary Authority of Singapore. Please contact your Private Banker in Citibank N.A., Singapore Branch if you have any queries on or any matters arising from or in connection with this document. This report is intended for recipients who are accredited, expert and institutional investors as defined under the Securities and Futures Act (Cap. 289). This report is distributed in Singapore by Citibank Singapore Ltd ("CSL") to selected Citigold/Citigold Private Clients. CSL provides no independent research or analysis of the substance or in preparation of this report. Please contact your Citigold//Citigold Private Client Relationship Manager in CSL if you have any queries on or any matters arising from or in connection with this report. This report is intended for recipients who are accredited investors as defined under the Securities and Futures Act (Cap. 289). Citigroup Global Markets (Pty) Ltd. is incorporated in the **Republic of South Africa** (company registration number 2000/025866/07) and its registered office is at 145 West Street, Sandton, 2196, Saxonwold. Citigroup Global Markets (Pty) Ltd. is regulated by JSE Securities Exchange South Africa, South African Reserve Bank and the Financial Services Board. The investments and services contained herein are not available to private customers in South Africa. The Product is made available in the **Republic of China** through Citigroup Global Markets Taiwan Securities Company Ltd. ("CGMTS"), 14 and 15F, No. 1, Songzhi Road, Taipei 110, Taiwan and/or through Citibank Securities (Taiwan) Company Limited ("CSTL"), 14 and 15F, No. 1, Songzhi Road, Taipei 110, Taiwan, subject to the respective license scope of each entity and the applicable laws and regulations in the Republic of China. CGMTS and CSTL are both regulated by the Securities and Futures Bureau of the Financial Supervisory Commission of Taiwan, the Republic of China. No portion of the Product may be reproduced or quoted in the Republic of China by the press or any third parties [without the written authorization of CGMTS and CSTL]. If the Product covers securities which are not allowed to be offered or traded in the Republic of China, neither the Product nor any information contained in the Product shall be considered as advertising the securities or making recommendation of the securities in the Republic of China. The Product is for informational purposes only and is not intended as an offer or solicitation for the purchase or sale of a security or financial products. Any decision to purchase securities or financial products mentioned in the Product must take into account existing public information on such security or the financial products or any registered prospectus. The Product is made available in **Thailand** through Citicorp Securities (Thailand) Ltd., which is regulated by the Securities and Exchange Commission of Thailand. 399 Interchange 21 Building, 18th Floor, Sukhumvit Road, Klongtoey Nua, Wattana, Bangkok 10110, Thailand. The Product is made available in **Turkey** through Citibank AS which is regulated by Capital Markets Board. Tekfen Tower, Eski Buyukdere Caddesi # 209 Kat 2B, 23294 Levent, Istanbul, Turkey. In the **U.A.E**, these materials (the "Materials") are communicated by Citigroup Global Markets Limited, DIFC branch ("CGML"), an entity registered in the Dubai International Financial Center ("DIFC") and licensed and regulated by the Dubai Financial Services Authority ("DFSA") to Professional Clients and Market Counterparties only and should not be relied upon or distributed to Retail Clients. A distribution of the different Citi Research ratings distribution, in percentage terms for Investments in each sector covered is made available on request. Financial products and/or services to which the Materials relate will only be made available to Professional Clients and Market Counterparties. The Product is made available in **United Kingdom** by Citigroup Global Markets Limited, which is authorised by the Prudential Regulation Authority ("PRA") and regulated by the Financial Conduct Authority ("FCA") and the PRA. This material may relate to investments or services of a person outside of the UK or to other matters which are not authorised by the PRA nor regulated by the FCA and the PRA and further details as to where this may be the case are available upon request in respect of this material. Citigroup Centre, Canada Square, Canary Wharf, London, E14 5LB. The Product is made available in **United States** by Citigroup Global Markets Inc, which is a member of FINRA and registered with the US Securities and Exchange Commission. 388 Greenwich Street, New York, NY 10013. Unless specified to the contrary, within EU Member States, the Product is made available by Citigroup Global Markets Limited, which is authorised by the PRA and regulated by the FCA and the PRA.

Pursuant to Comissão de Valores Mobiliários Rule 483, Citi is required to disclose whether a Citi related company or business has a commercial relationship with the subject company. Considering that Citi operates multiple businesses in more than 100 countries around the world, it is likely that Citi has a commercial relationship with the subject company.

Many European regulators require that a firm must establish, implement and make available a policy for managing conflicts of interest arising as a result of publication or distribution of investment research. The policy applicable to Citi Research's Products can be found at https://www.citivelocity.com/cvr/eppublic/citi_research_disclosures.

Compensation of equity research analysts is determined by equity research management and Citigroup's senior management and is not linked to specific transactions or recommendations.

The Product is not to be construed as providing investment services in any jurisdiction where the provision of such services would not be permitted.

Subject to the nature and contents of the Product, the investments described therein are subject to fluctuations in price and/or value and investors may get back less than originally invested. Certain high-volatility investments can be subject to sudden and large falls in value that could equal or exceed the amount invested. Certain investments contained in the Product may have tax implications for private customers whereby levels and basis of taxation may be subject to change. If in doubt, investors should seek advice from a tax adviser. The Product does not purport to identify the nature of the specific market or other risks associated with a particular transaction. Advice in the Product is general and should not be construed as personal advice given it has been prepared without taking account of the objectives, financial situation or needs of any particular investor. Accordingly, investors should, before acting on the advice, consider the appropriateness of the advice, having regard to their objectives, financial situation and needs. Prior to acquiring any financial product, it is the client's responsibility to obtain the relevant offer document for the product and consider it before making a decision as to whether to purchase the product.

Citi Research generally disseminates its research to the Firm's global institutional and retail clients via both proprietary (e.g., Citi Velocity and Citi Personal Wealth Management) and non-proprietary electronic distribution platforms. Certain research may be disseminated only via Citi's proprietary distribution platforms; however such research will not contain changes to earnings forecasts, target price, investment or risk rating or investment thesis or be otherwise inconsistent with the author's previously published research. Certain research is made available only to institutional investors to satisfy regulatory requirements. Individual Citi Research analysts may also opt to circulate published research to one or more clients by email; such email distribution is discretionary and is done only after the research has been disseminated.

The level and types of services provided by Citi Research analysts to clients may vary depending on various factors such as the client's individual preferences as to the frequency and manner of receiving communications from analysts, the client's risk profile and investment focus and perspective (e.g. market-wide, sector specific, long term, short-term etc.), the size and scope of the overall client relationship with Citi and legal and regulatory constraints.

Citi Research product may source data from dataCentral. dataCentral is a Citi Research proprietary database, which includes Citi estimates, data from company reports and feeds from Thomson Reuters. The printed and printable version of the research report may not include all the information (e.g., certain financial summary information and comparable company data) that is linked to the online version available on Citi's proprietary electronic distribution platforms.

ADDITIONAL INFORMATION IS AVAILABLE UPON REQUEST