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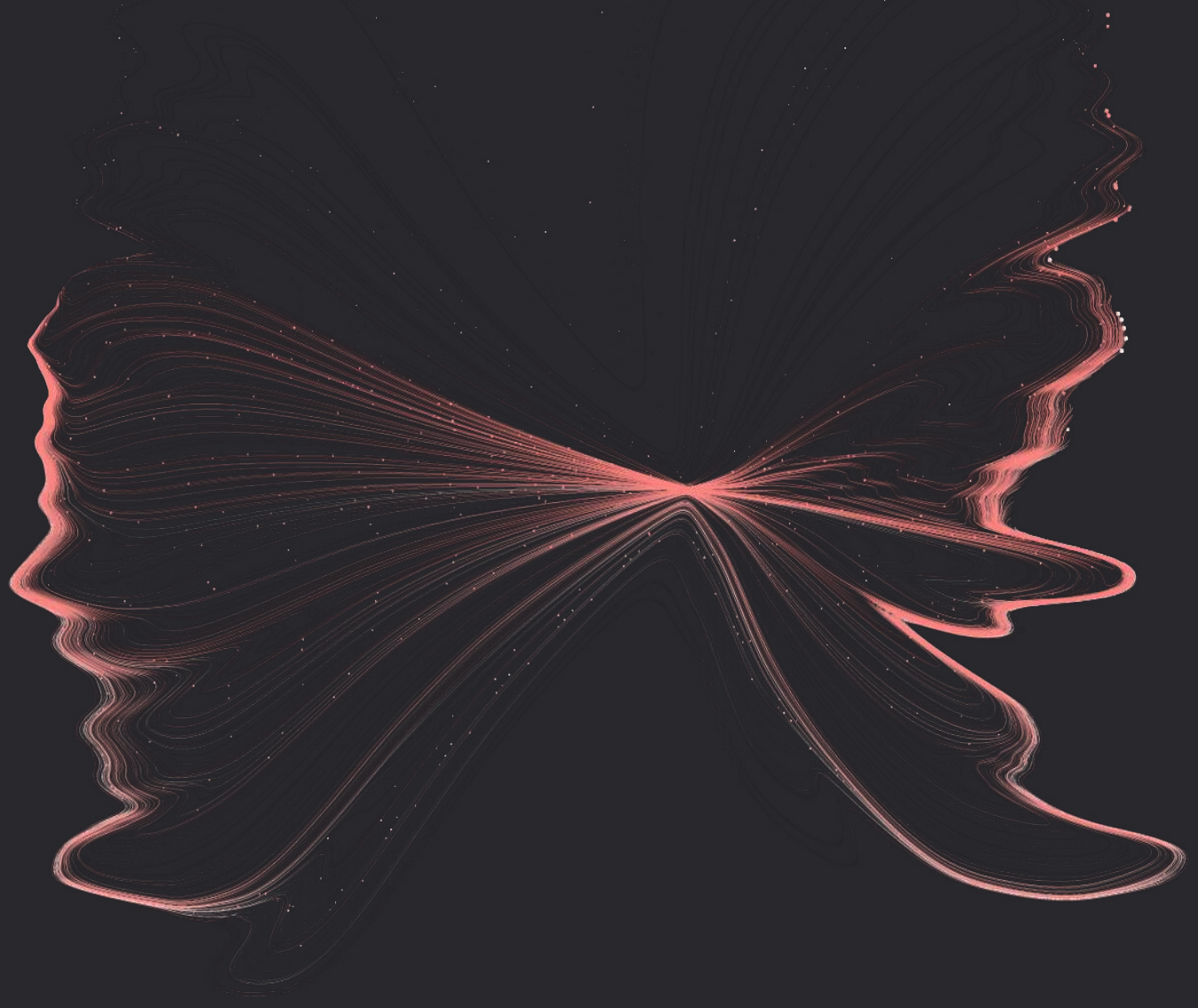
Capital Markets Digitization

Barrier-Hit-Risk Report 2020

DAX Bonus Certificates



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Key Facts

Subject of the investigation

104,993 DAX Bonus Certificates listed at Börse Stuttgart

Investigation period

1 January 2020 to 31 December 2020

3.7% was the annual performance of the DAX® in 2020

38.78% was the crash in the DAX® in mid-March, that was the deepest plunge in all its history, during which the highest number of barrier hit events were observed in 2020

37.17% of 104,993 DAX Bonus Certificates suffered from a Barrier Hit in between 01/JAN/2020 and 31/DEC/2020

38.55% of DAX long products (ie. DAX Bonus Classic Certificates and DAX Bonus Capped Certificates) encountered a barrier hit event in 2020

33.95% of DAX short products (ie. DAX Bonus Reverse Certificates and DAX Bonus Reverse Capped Certificates) encountered a barrier hit event in 2020

8.13% of 55,431 DAX Bonus Certificates experienced barrier breaches in Q4-2020

83.24% of all barrier breaches for DAX long products was observed during the last week of October 2020, due to the sharpest dip in the DAX® in Q4-2020

1. Highlights

Bonus Certificates are mostly used as an alternative investment to a direct investment in the underlying stock or index. Investors who choose Bonus Classic Certificates as an alternative investment gain partial protection and usually benefit from markets that are moving sideways. As long as the price of the underlying asset never breaches the barrier, the owners of Bonus Certificates are entitled to a bonus payment. Once the barrier is touched (barrier hit event), the investors lose their entitlement to the bonus payment.

The performance of the Bonus Classic Certificates after the barrier hit event is equal to the performance of the underlying asset. In order to aid investors in better quantifying the probability of a future barrier breach, TTMzero computes the Barrier-Hit-Risk (BHR) for more than 104,000 Bonus Certificates. The Barrier-Hit-Risk is one of the most important risk management key figures. The computation of the BHR of a single Bonus Certificate requires Monte-Carlo-Simulation of 50,000 paths taking into account implied volatility, time to maturity and distance to the barrier (buffer).

For this research study, TTMzero – now part of United Fintech – analyzed 104,993 DAX Bonus Certificates listed at Börse Stuttgart in the whole year of 2020. Bonus Classic, Bonus Capped, Bonus Reverse and Bonus Reverse Capped Certificates are likewise included in this study.

- 37.17% of the DAX Bonus Certificates suffered from a Barrier Hit in between 01/JAN/2020 and 31/DEC/2020. The 3 days with the highest number of barrier hit events in 2020 are largely observed in mid-March, when the DAX® witnessed a bloody freefall of 38.78%.
- Zooming into Q4-2020 between 01/OCT/2020 and 30/DEC/2020, only 8.13% of 55,431 DAX Bonus Certificates during this period experienced barrier breaches. This ratio is significantly less than the same ratio of the whole year.
- In Q4-2020, DAX® was moving mainly sideways generally. There was a sharp dip during late October, which significantly affected DAX long products. During this time, 83.24% of all barrier breaches for DAX long categories in Q4-2020 were observed. However, the rebound right afterwards pulled the DAX® back on its track.
- Despite a very unusually turbulent year, the DAX® ended up with a positive annual yield for 2020 at 3.7%.
- The Barrier Hit Risk and about 100 other important Key Figures are made available by TTMzero in cooperation with Börse Stuttgart.
- Investors can obtain TTMzero's Barrier-Hit-Risk as well as other important Key Figures for Structured Products and their underlying spot price on https://ttmzero.com/ and on the website of the largest issuers and independent web portals. TTMzero's data is always updated in Real Time. Investors that have access to TTMzero's data benefit from making well-informed trading decisions.

2. Subject of examination

- TTMzero analyzed 104,993 DAX Bonus Certificates for the whole year of 2020, among which only those Bonus Certificates which had at least one day of intact barrier during the respective quarter were taken into account.
- The considered DAX Bonus Certificates are all listed at Börse Stuttgart.

3. Analysis period and Methodology

For each bonus certificate, the performance of the certificate was compared with the performance of the DAX® index in the respective time period. The individual observation period for a certificate starts with the first trading day of the certificate in the respective quarter and ends with the last trading day of the certificate in the same quarter. The following assumptions apply:

Assumptions calculating the performance of the certificates

- The entry price is defined as the first ask price on the first trading day of the certificate in the respective quarter. For certificates issued after 1 January 2020 when analyzing all 4 Quarters, or after 1 October 2020 when analyzing only Q4, the first price on the first trading day is defined as the entry price.
- The last bid price on the last trading day in the respective quarter is defined as the exit price. If the certificate matures during this period, the exit price is the redemption amount.
- In the case a Bonus Certificate encounters a barrier hit during the analyzed period, its performance continues to be calculated in line with the movement of the DAX® respectively.

Assumptions for calculating the performance of the DAX® in the observation period

- The performance of the DAX® is calculated from the respective opening price of the index on the first observation day of the corresponding certificate and the closing price of the index on the last observation day of the corresponding certificate in the respective time period (year or quarter).

Calculation of the Barrier-Hit-Risk (BHR)

- The BHR is being calculated continuously by TTMzero from the first trading day of the certificate until the day it encounters a barrier hit or matures.
- The computation of the BHR of a single Bonus Certificate requires a Monte-Carlo-Simulation of 50,000 paths, taking into account implied volatility, time to maturity and distance to the barrier (buffer).

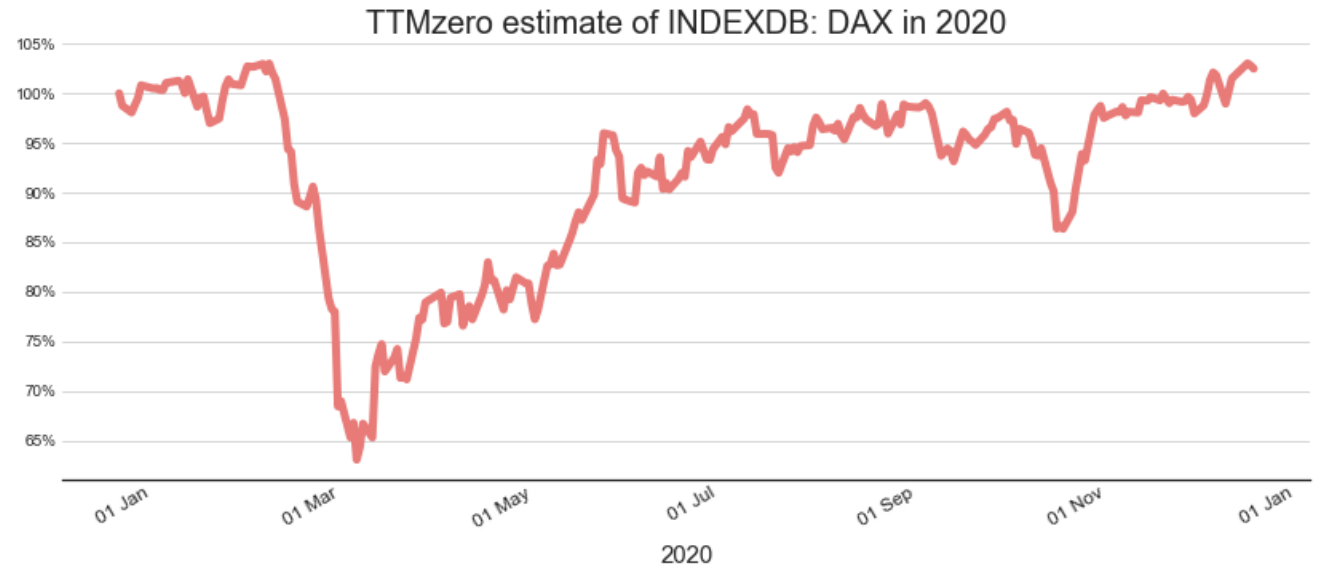
4. Full year 2020 in figures

- Average ratio for observed barrier breaches across all product categories of DAX Bonus Certificates for the whole year of 2020 is 37.17%. The observed barrier breaches of DAX long products in 2020 at 38.55% is just slightly higher than DAX short products (33.95%). This fact can be explained by analyzing the DAX® performance in 2020.

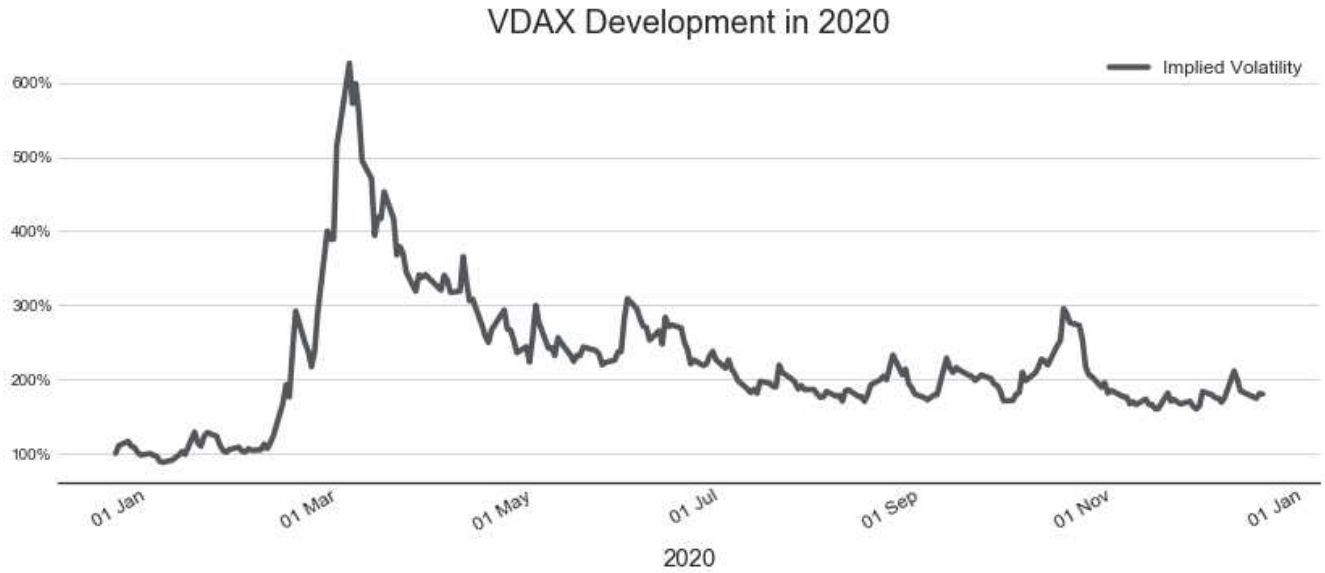
	Barrier hit events	Issued products in 2020	Products matured in 2020*	Number of products in the beginning of 2020*	Number of products by the end of 2020*	Number of products with at least 1 day of intact barrier in 2020*	Percentage of products with barrier hits in 2020
Bonus Certificates	**39,031**	**78,442**	**25,413**	**27,987**	**40,450**	**104,993**	**37.17**
Bonus Classic	6,024	11,010	2,071	3,917	6,586	14,681	41.03
Bonus Capped	22,338	44,364	15,080	15,129	21,374	58,891	37.93
Bonus Reverse	2,309	3,266	804	1,439	1,536	4,649	49.67
Bonus Reverse Capped	8,360	19,802	7,458	7,502	10,954	26,772	31.23

Without barrier hit

- There is quite a balance between bullish and bearish DAX® movements throughout 2020. After the steepest crash in its own history down to the lowest on 18/Mar (8,441 points), it has made an impressive rebound and finally surpassed the DAX® high earlier in the year on 19/Feb (13,789 points) reaching a new high at the close on 28/Dec (13,790.29 points).
- Despite many critics fearing that the recovery road might take much longer, the DAX was at 13,718.78 points by the end of 2020, a level that is 3.7% higher than its starting point at the beginning of the year.



***Indexed to 100% on 1/Jan/2020**



Indexed to 100% on 1/Jan/2020

Interestingly, when looking at VDAX® which measure the implied volatility level on DAX options, it could be easily spotted in the above chart that:

- In Q1: Prices of options on DAX® were quite stable from January to mid-February. The respective volatility index was moving during the pre-Covid period within a range of 20%. However, the implied volatility levels climbed dramatically for the DAX options (an increase of over 5 times) when comparing the level at the beginning of the year to the highest point in 18/Mar.
- In Q2 & Q3: DAX® was generally bullish during Q2 and Q3. The absolute levels of implied volatilities have stabilized at levels higher than during the pre-Covid regime, yet much lower than the peak observed during March.

- In Q4: The implied volatility of DAX options shot up swiftly during the last two weeks of October as the DAX® slumped suddenly. It later bounced back quickly and moved up at a rather stable pace. Hence, DAX options' implied volatility level stayed rather calm during the last 2 months of 2020.

• knock_out_date	• No. of products with barrier breaches	• % of Bonus Classic / Bonus Capped
• **12-Mar-2020**	• 7,775	• 100
• **9-Mar-2020**	• 5,358	• 100
• **16-Mar-2020**	• 3,518	• 100

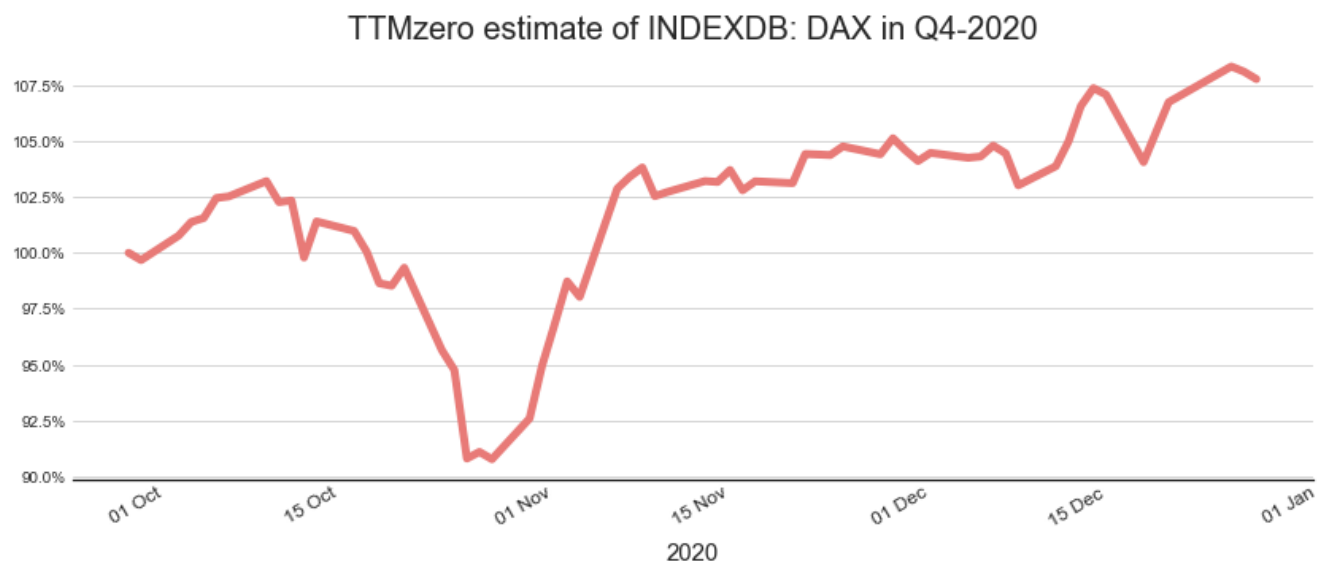
- Throughout the whole year of 2020, the 3 days that DAX Bonus Certificates encountered the most barrier breaches were all in March, when the market witnessed the most dramatic crash. Additionally, 100% of products that suffered a barrier hit were long products (ie. Bonus Classic and Bonus Capped). This is due to the fact that DAX® movements during March were the most dramatic along the whole year, and caused a great number of products to suffer.

5. Q4-2020 in figures

- The ratio of certificates with observed barrier breaches (across all DAX Bonus Certificate categories) for Q4 was low at 8.13%.
- In particular, 6.96% of DAX long products and 10.72% of DAX short products breached the barrier in Q4.

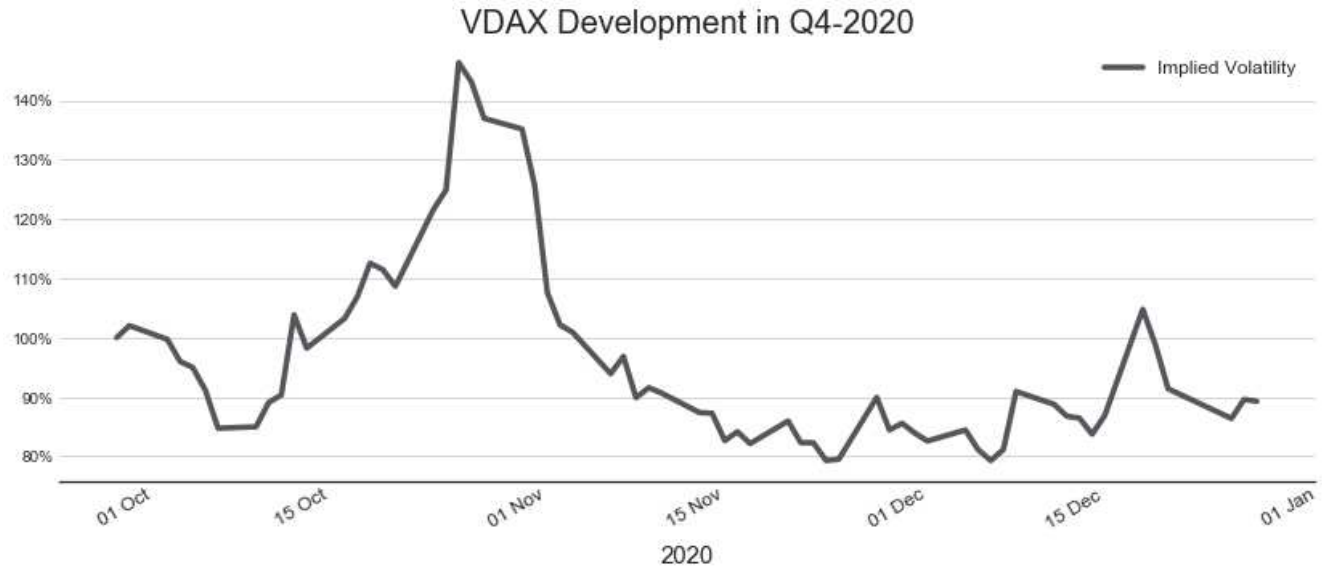
	Barrier hit events	Issued products in Q4-2020	Products matured in Q4-2020*	Number of products in the beginning of Q4-2020*	Number of products by the end of Q4-2020*	Number of products with at least 1 day of intact barrier in Q4-2020*	Percentage of products with barrier hits in Q4-2020
Bonus Certificates	**4,507**	**12,329**	**10,375**	**43,276**	**40,702**	**55,431**	**8.13**
Bonus Classic	817	2,318	1,127	6,234	6,605	8,530	9.58
Bonus Capped	1,851	5,462	6,431	24,373	21,491	29,755	6.22
Bonus Reverse	436	788	283	1,471	1,569	2,255	19.33
Bonus Reverse Capped	1,403	3,761	2,534	11,198	11,037	14,891	9.42

Without barrier hit



Indexed to 100% on 1/Oct/2020

- Although the overall performance of Q4 ends up at only 7.76%, the chart above displays a much wider range of the DAX® movement during Q4 – 17.55% in relative scale.
- Moving inversely proportional to the DAX®, a crisp jump in implied volatility of 46.37% in a matter of days compared to its starting level at the beginning of Q4 mirrored the sharp dip in DAX® during late October.
- However, being hand in hand with the DAX bull-run during November, its implied volatility level has gone downward significantly. Despite a 3% crash of the DAX® during mid-December, implied volatility on DAX options closed on 30/Dec/2020 at a level 10.72% lower than its starting point.



Indexed to 100% on 1/Oct/2020

- Out of the 3 days with the highest number of barrier hit events in Q4, two of them were during the bear market in the last week of October: 28/Oct (1,826 barrier breaches), and 26/Oct (365 barrier breaches). 100% of DAX Bonus Certificates that encountered a barrier hit event on these 2 days are indeed DAX long products.

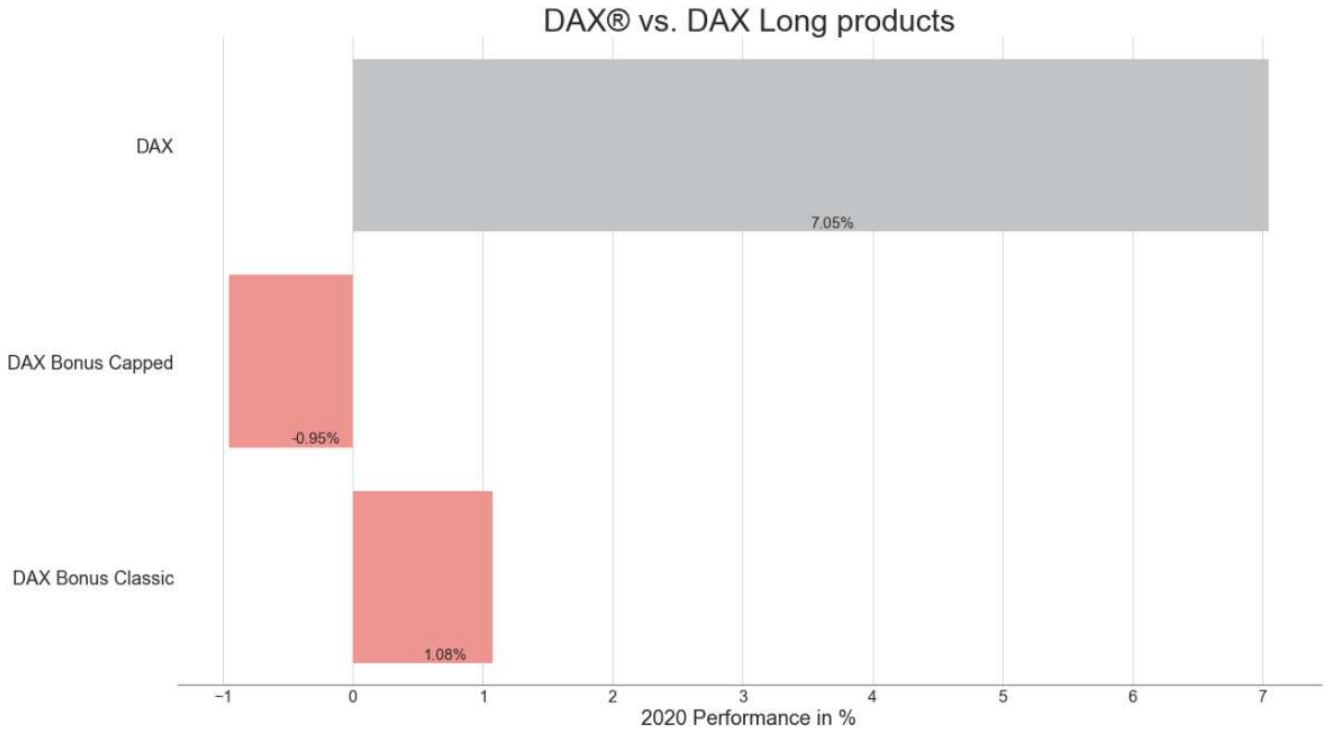
knock_out_date	No. of products with barrier breaches	% of Bonus Classic / Bonus Capped	% of Bonus Reverse / Bonus Reverse Capped
28-Oct-20	1,826	100	0
17-Dec-20	583	0	100
26-Oct-20	395	100	0

KEY TAKEAWAYS

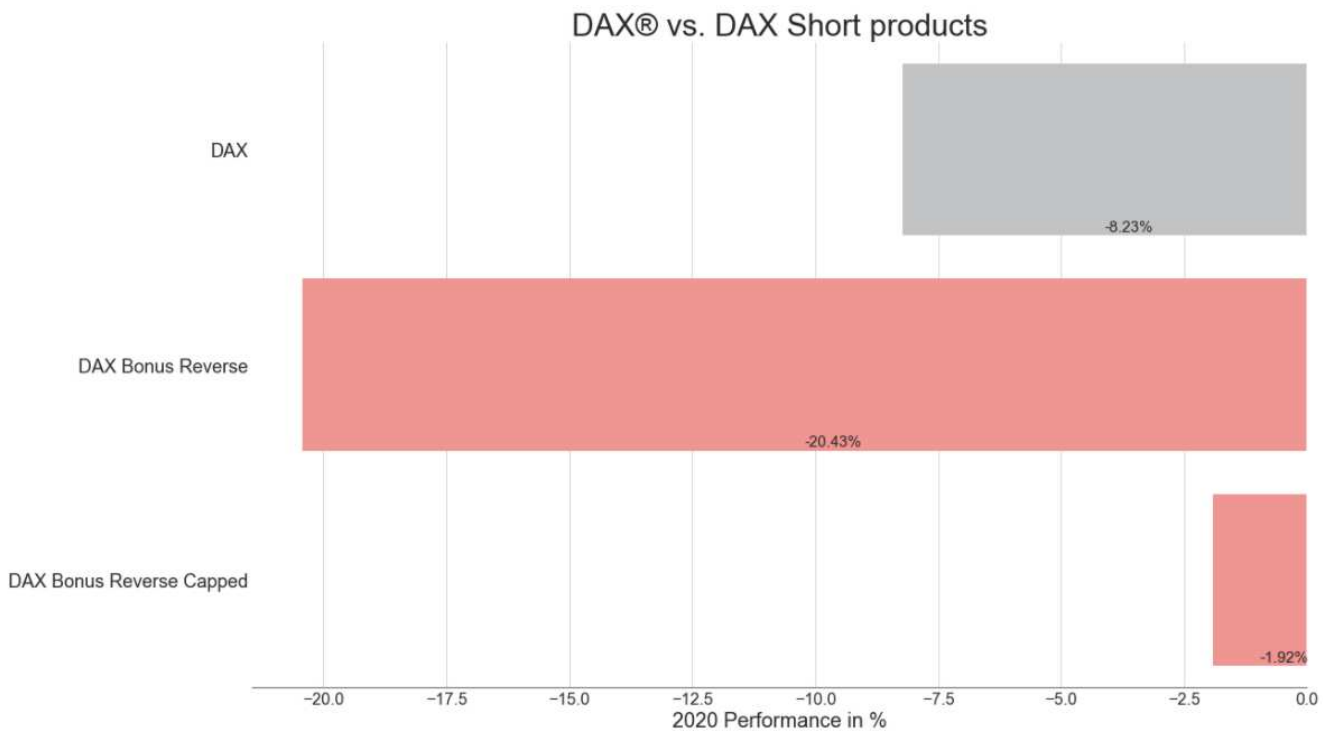
- In general, there was quite a balance between bullish and bearish movements in DAX® throughout the whole year of 2020. This resulted in a roughly similar ratio of products with barrier hit events among each category of DAX Bonus Certificates (41.03% for Bonus Classic, 37.93% for Bonus Capped, 49.67% for Bonus Reverse and 31.23% for Bonus Reverse Capped).
- In Q4, DAX® witnessed a significantly lower ratio of products with barrier hit events (8.13%) due to the largely sideways trend during the last Quarter of 2020.

6. Full year 2020: Performance of DAX vs. DAX Bonus Certificates

- *Background:*
  The "average" performance of the DAX® in the comparison with long or short categories may differ from the actual overall DAX® performance due to:
  - DAX® "average" performance used for comparison here is calculated in accordance with the holding time of respective DAX Bonus Certificates.
  - DAX® "average" performance is analyzed in direct comparison with either long or short category. With regards to Long products, the performance of the certificate is positive when the actual performance of the DAX® is positive. For the Short products, the performance of the certificate is positive when the actual performance of the DAX® is negative. And vice versa.
  - When the actual performance of the DAX® is positive, in comparison to the Short products, it is considered a negative performance as the underlying and Short positions are inversely proportional. And vice versa.

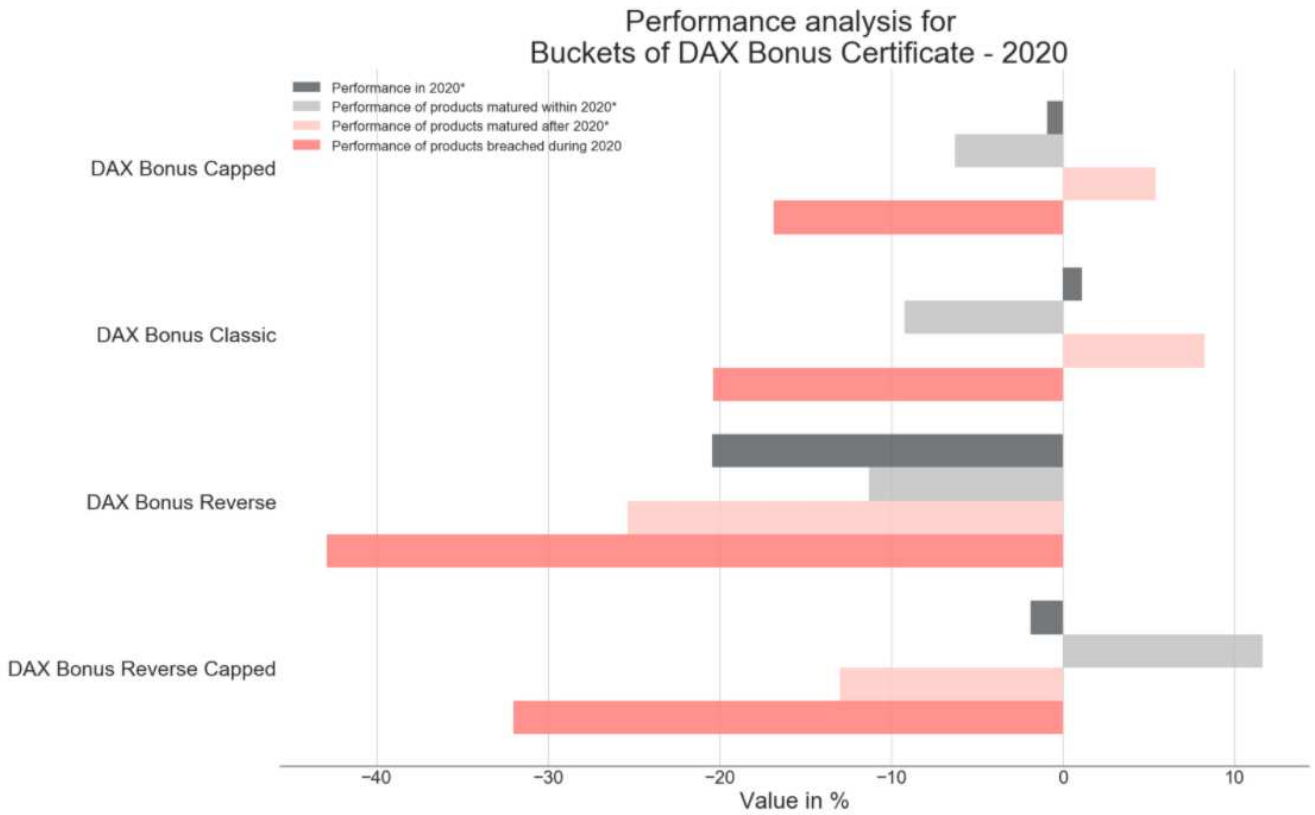


- The "average" performance of DAX® at 7.04% is higher than the performance of DAX long categories (ie. Bonus Classic Certificates and Bonus Capped Certificates).



- DAX Bonus Reverse Certificates performed worse than the short DAX®. However, DAX Bonus Reverse Capped Certificates outperformed the short DAX®.
- 43.8% of DAX Bonus Classic Certificates were able to outperform the DAX®.

	Number of Bonus Certificates that outperformed the DAX in 2020	in %
DAX Bonus Capped	19,234	32.64
DAX Bonus Classic	6,445	43.8
DAX Bonus Reverse	465	10.43
DAX Bonus Reverse Capped	5,656	21.7

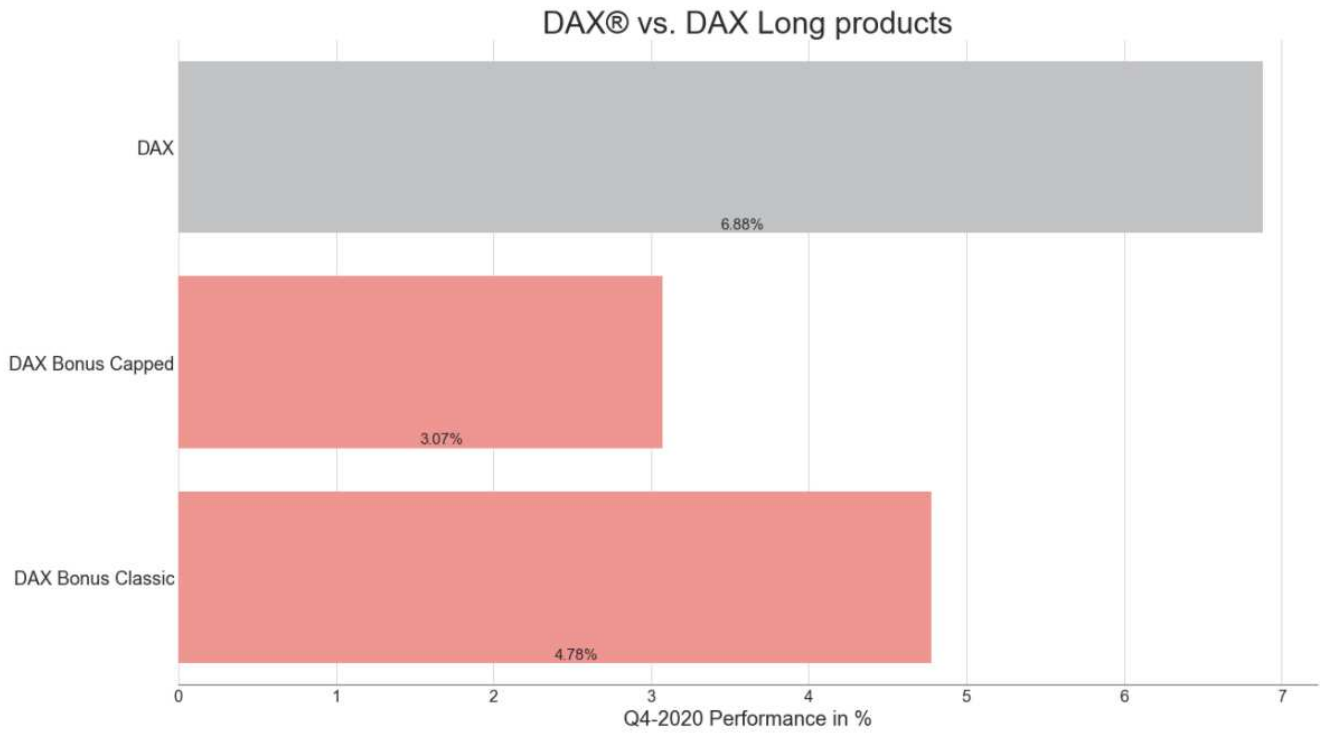


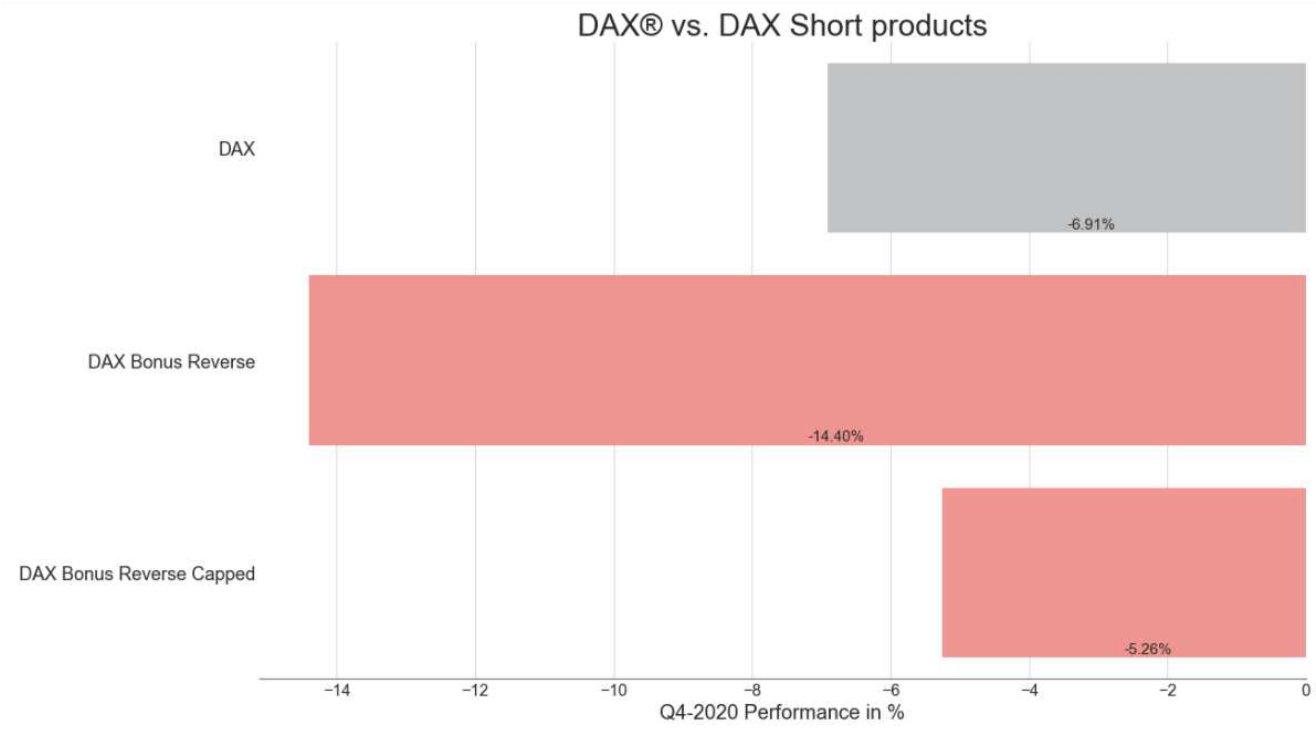
	Annualized return in 2020* (%)	Annualized return of products with maturity before 31/DEC/2020* (%)	Annualized return of products with maturity after 31/DEC/2020* (%)	Annualized return of breached during 2020 (%)
DAX Bonus Capped	-0.95	-6.3	**5.37**	-16.87
DAX Bonus Classic	1.08	-9.26	**8.23**	-20.4
DAX Bonus Reverse	-20.43	**-11.32**	-25.39	-42.89
DAX Bonus Reverse Capped	-1.92	**11.6**	-13.01	-32.02

Without barrier hit

- For the whole 2020, the annualized return of DAX short products with maturity before 31/Dec/2020 have achieved a much better result when compared with the annualized return of all DAX short products. Moreover, DAX Bonus Reverse Capped Certificates significantly outperformed the short DAX® (11.6% vs. -8.23%).
- DAX long products that mature after 2020 have achieved a higher performance than the average performance of the DAX long categories. In particular, the average return of DAX Bonus Classic Certificates that mature after 2020 (8.23%) is also slightly better than the DAX® (7.05%).

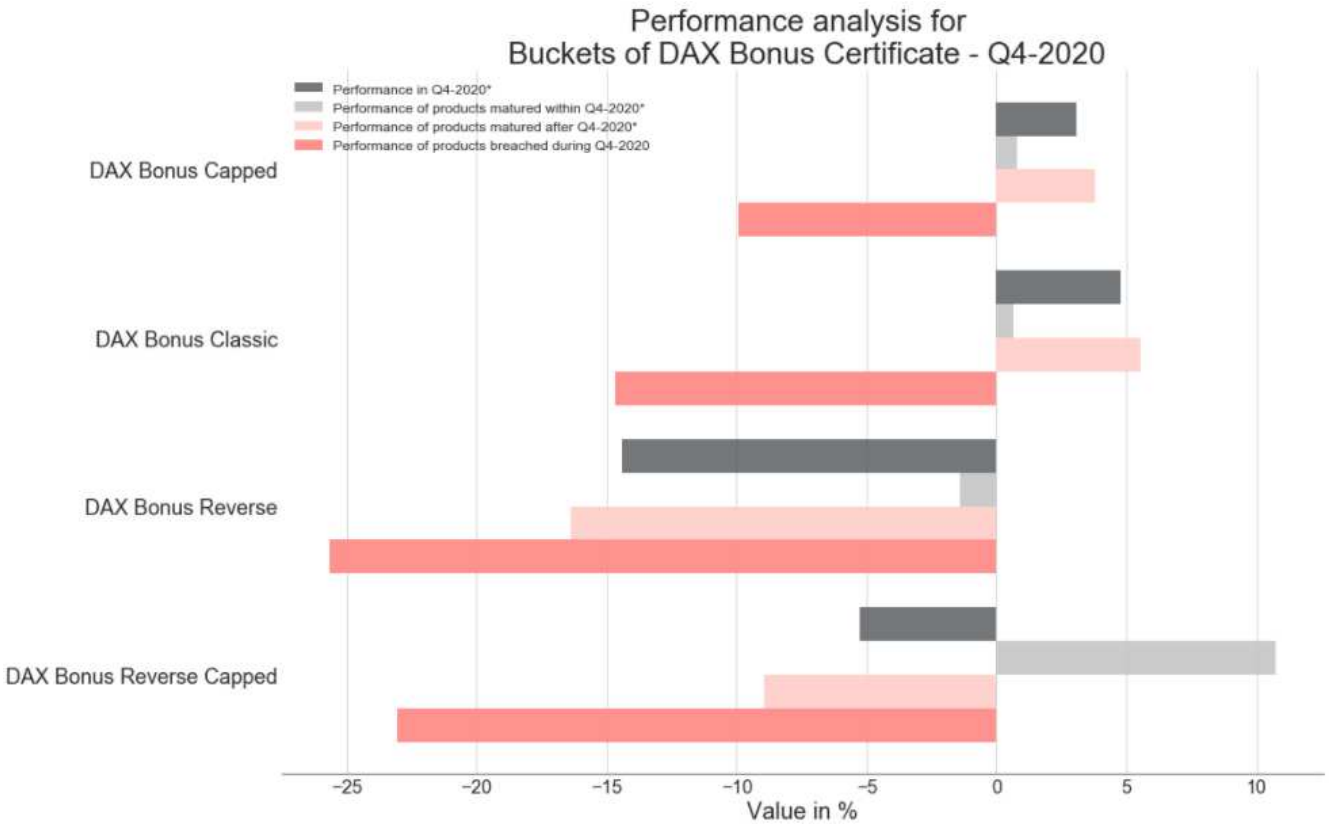
7. Q4-2020: Performance of DAX vs. DAX Bonus Certificates





	Number of Bonus Certificates that outperformed the DAX in Q4-2020	in %
DAX Bonus Capped	4,015	13.49
DAX Bonus Classic	2,969	34.87
DAX Bonus Reverse	83	3.71
DAX Bonus Reverse Capped	1,136	7.93

- In Q4-2020, the "average" performance of DAX® at 6.88% for long position is higher than the performance of DAX long categories (ie. Bonus Classic Certificates and Bonus Capped Certificates)
- On the other hand, the "average" performance of DAX® for short position is -6.91%. In the short categories, the average yield of DAX Bonus Reverse Capped Certificates at -5.26% slightly outperformed the DAX®.
- 34.87% of DAX Bonus Classic Certificates were able to outperform the DAX®.



	Annualized return in Q4-2020* (%)	Annualized return of products matured within Q4-2020* (%)	Annualized return of products maturing after Q4-2020* (%)	Annualized return of products breached during Q4-2020(%)
DAX Bonus Capped	**3.07**	0.79	**3.78**	-9.92
DAX Bonus Classic	**4.78**	0.65	**5.55**	-14.68
DAX Bonus Reverse	-14.4	**-1.42**	-16.37	-25.67
DAX Bonus Reverse Capped	-5.26	**10.73**	-8.92	-23.03

Without barrier hit

- DAX long products that are maturing after Q4-2020 have a slightly higher yield than the average performance of the long categories in Q4-2020.
- In contrast, DAX short products that matured within Q4-2020 perform much better than the average performance of the short categories in Q4-2020.
- Especially, a return of 10.73% for DAX Bonus Reverse Capped Certificates that matured within Q4-2020 remarkably outperformed the DAX® performance in Short positions (-6.91% in Q4-2020).

8. Barrier-Hit-Risk as an early indicator

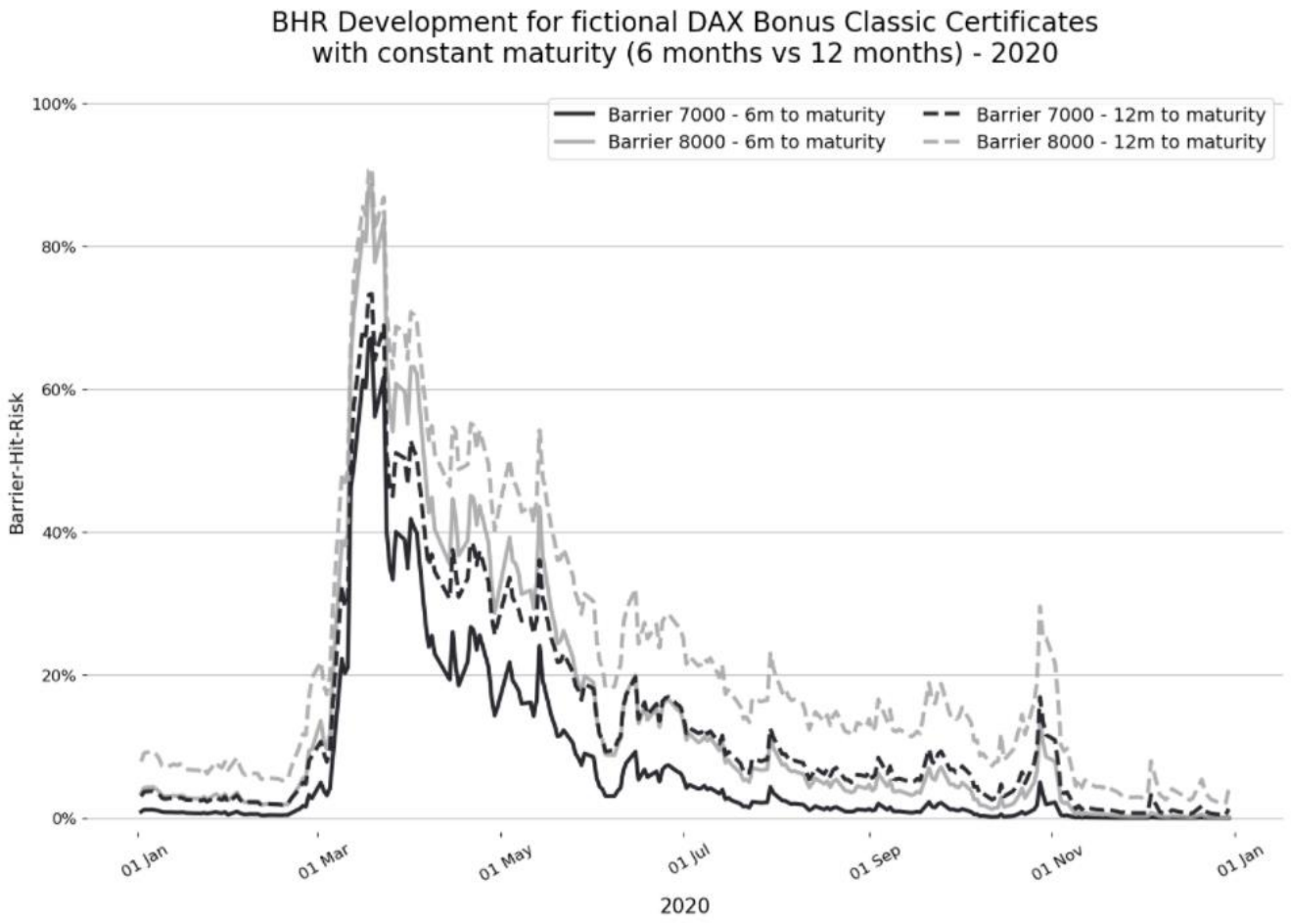
- The Barrier-Hit-Risk (BHR) is a key figure that continuously quantifies the probability of a barrier breach that a certain Bonus Certificate encounters. It is not static, but a dynamic parameter that is constantly changing.

- The BHR is being calculated continuously in real-time by TTMzero from the first trading day of the certificate until the day it encounters a barrier hit or matures.

- The computation of the BHR of a single Bonus Certificates requires a Monte-Carlo-Simulation of 50,000 paths taking into account implied volatility, time to maturity and distance to the barrier (buffer).

9. BHR and Time to Maturity – DAX Bonus Classic Certificates

- *Background:*
  The following chart shows the BHR development during 2020 for four fictional DAX Bonus Classic Certificates. Time to Maturity is fixed to either 6 months or 12 months starting from the end of 2020.
- For DAX Bonus Classic Certificates, the absolute barrier levels are 7,000 (in black) and 8,000 (in grey) respectively on every observation date during the year 2020. Note that products with barriers of 8,500 were breached during the plunge in March.



KEY TAKEAWAYS

- The higher the Time To Maturity, the higher the BHR.
- The smaller the difference between Spot Price and Barrier, the higher the BHR.
- The smaller the difference between Spot Price and Barrier, the heavier the reaction of the BHR to changing market conditions.

10. BHR and Distance to Barrier

- This table demonstrates the translation of Barrier-Hit-Risk into the buffer in DAX® points for DAX Bonus Classic Certificates with **1-year** remaining maturity.
- The Spot prices on 18/MAR when the DAX® was at YTD lowest (below 8,500), at the end of Q2 (DAX® at 12,310), at the end of Q3 (DAX® at over 12,700), and at the end of Q4 (DAX® at 13,718) were taken for calculation.

BHR in %	Buffer in DAX® points as spotted on 18/MAR	Relative distance in %	Buffer in DAX® points at the end of Q2-2020	Relative distance in %	Buffer in DAX® points at the end of Q3-2020	Relative distance in %	Buffer in DAX® points at the end of 2020	Relative distance in %
10	3,358	39.65	3,399	27.73	3,236	25.19	3,018	21.96
20	2,756	32.54	2,711	22.12	2,569	20	2,361	17.18
30	2,291	27.06	2,208	18.01	2,087	16.24	1,897	13.81
40	1,903	22.47	1,805	14.73	1,701	13.24	1,533	11.16
50	1,541	18.2	1,439	11.74	1,352	10.52	1,209	8.79
60	1,204	14.21	1,108	9.04	1,038	8.08	921	6.7
70	868	10.25	785	6.4	733	5.71	645	4.69
80	524	6.18	462	3.77	431	3.35	375	2.73
90	157	1.85	125	1.02	114	0.89	95	0.69

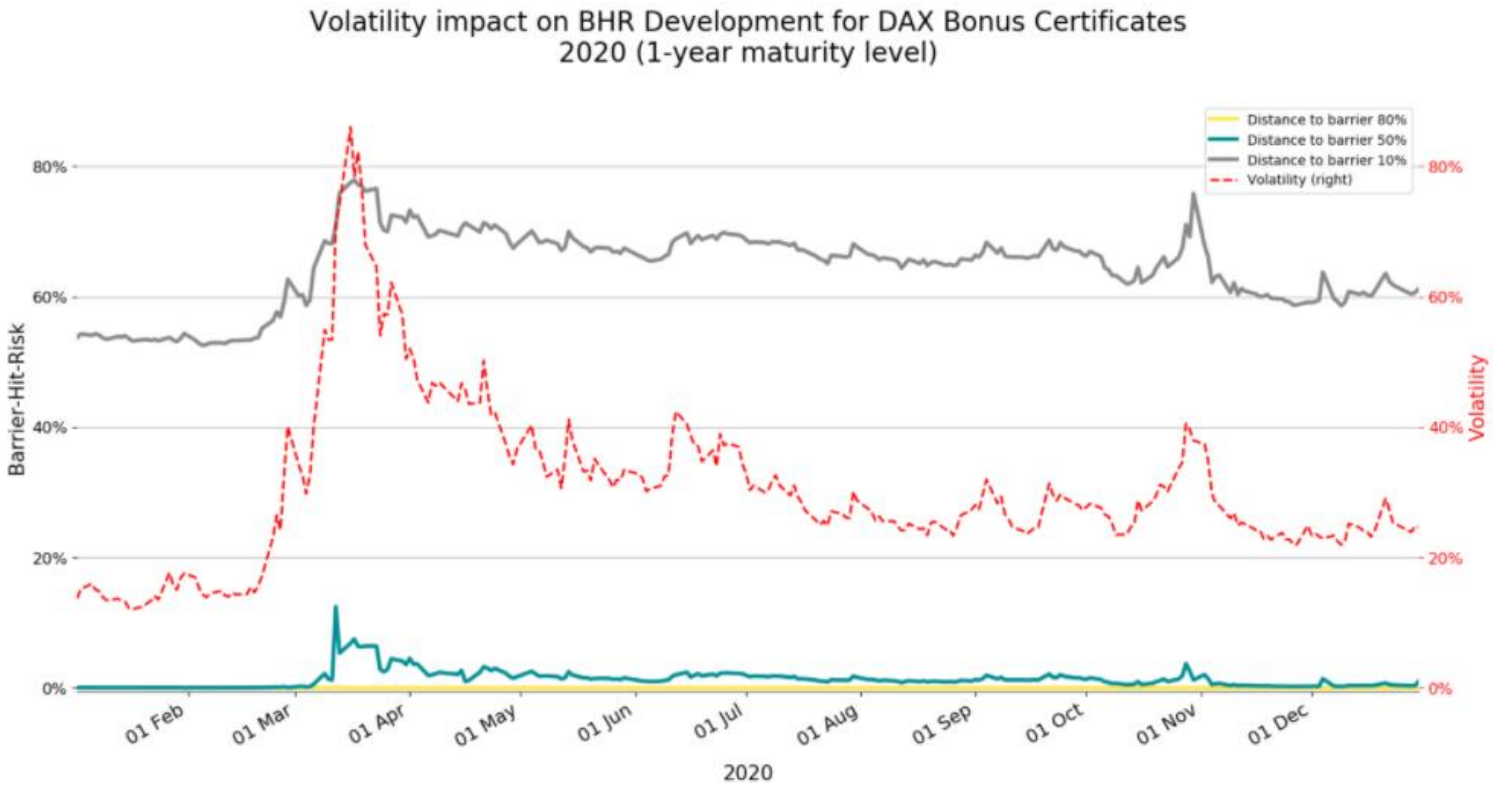
- During Q1, investors needed to select DAX products with a relative distance of 32.54% between spot and barrier to maintain a Barrier Hit Risk of 20%. A relative distance of 22.12% at the end of Q2, 20% at the end of Q3, or 17.18% at the end of 2020 were sufficient to maintain the same level of BHR.

KEY TAKEAWAYS

- ➢ The changes in the volatility regime have dramatic effects on the relative distance between Spot and Barrier that investors would have to choose to maintain a stable BHR.
- ➢ Relative distance between Spot and Barrier of a product is positively correlated with the volatility level of the index.

11. BHR and Implied Volatility

- All products considered for the demonstrated distance to barrier levels during the observed time between Jan2020-Dec2020 have a fixed maturity of 1 year, which correspond to Jan2021-Dec2021.
- The chart below describes the impact of DAX options' implied volatility on DAX Bonus Classic Certificates for different levels of distance to barrier (as a percentage of spot levels: 10%, 50%, 80%).



KEY TAKEAWAYS

- For products with relative distances of 80% or more between spot and barrier, the BHR remained below 5% during the whole 4 Quarters of 2020 despite the high range of volatilities that were observed.
- The smaller the differences between spot and barrier, the heavier the reactions of the BHR with respect to the changes in volatility.