



LISBON
SCHOOL OF
ECONOMICS &
MANAGEMENT
UNIVERSIDADE DE LISBOA

Case Studies in Financial Engineering

CASE 5

4 MONTHS REVERSE CONVERTIBLE NOTE ON SANTANDER

Sept. 2019

4 Months Reverse Convertible Note on Santander

Deutsche Bank AG, London has issued €5,823,000 of **Reverse Convertible Notes linked to Santander** share price and due **4 months after the issuing date**. The Notes were issued on April 23, 2010 and were contingent on the depreciation of the Santander Bank share prices.

The Reverse Convertible Notes on Santander is a short term investment that pays a guaranteed 4,5% coupon rate and has a redemption value that is dependent on the Santander prices at maturity.

According to the Indicative Terms and Conditions issued by Deutsche Bank on March, 4th 2010, although the coupon is guaranteed, the redemption of the Principal is conditional on the Santander share price observed at the maturity (settlement) date.

- If, on that date, Santander share price were greater than or equal to the 85% of its initial value observed on April 23rd 2010, then investors would be fully redeemed, that is, they would get the entire value of the Principal in cash (100% x Notional Amount).
- If, on that date, Santander share price were below 85% of its initial value observed on April 23rd 2010, then the physical settlement would apply. In this case, the number of shares to be paid had been determined on the initial moment as the quotient of (i) the Notional per Note (as numerator) and (ii) the Underlying Initial (as denominator). This ratio would then be rounded down to the nearest integer number. As the Notional per Note is €1,000, then:

$$\# \text{ Santander Shares} = INT\left(\frac{I_0}{S_0}\right)$$

Being:

$INT()$ = The rounded down nearest integer;

I_0 = Initial investment made by a Noteholder on April 23rd 2010, with a minimum of €1,000;

S_0 = Closing Santander share price on April 23rd 2010

In the case of a rounding down to an integer number in accordance with the previous explanations given above, an amount (the "Adjustment Amount") would be paid. This means that in financial terms the equation above can be rewritten as:

$$\# \text{ Santander Shares} = \frac{I_0}{S_0}$$

The Notes were issued in minimum denominations of €1,000.00 and integral multiples of €1,000.00.

The attached Indicative Terms and Conditions to announce the issue show the relevant details for the Case.

Questions:

- 1) Compute the historical volatility of the Santander Bank shares by using, at least, two different methodologies:
 - a. For the entire time period prior to the issue, that is, from 23/Apr/2005 to 23/Apr/2010 (the long run historical volatility)?
 - b. For the 4-months period prior to the issue (23/Dec/2009-23/Apr/2010)?
 - c. For the life of the note (23/Apr/2010 - 23/Aug/2010)?
- 2) What was the implied volatility of the Santander Bank shares for the life of the option, estimated on 23/Apr/2010?
- 3) What was the observed actual volatility of the Santander Bank shares. Comparing all figures estimated in 1a), 1b), 2) and 3) what do you conclude if the pricing of the product, at the issuing date, was based on the long run historical volatility?
- 4) How do you decompose the Note, contingent on Santander Bank shares in terms of simpler financial instruments (options and bonds)?
- 5) Assume that you are in the buy-side, pricing the Note on April 23, 2010, in order to release **a recommendation for an European investor that bases his wealth management in €EUR**, and asked your technical support.
 - a. What is the appropriated risk free rate to price the Reverse Convertible Notes on Santander? Explain.
 - b. What is the appropriated Deutsche Bank AG funding rate to price the Reverse Convertible Notes on Santander? Explain.
 - c. From the volatility that you estimated in questions 1 a), 1 b) and 2) what is your suggested volatility to price the Reverse Convertible Notes on Santander? Explain.
 - d. What would be your advice if the Deutsche Bank was bidding and offering at €1,017.20-€1,023.40 per €1,000 principal amount Note on May 23rd 2010? Do you think that it would be an interesting product to invest on May 23rd 2010, paying €1,023.40 per €1,000 principal amount Note?

In order to answer, please use all the following methods, assuming that the investment is denominated in Euros:

 - i. Monte Carlo simulation $\delta t=3$ months with historical distributions;
 - ii. Monte Carlo simulation $\delta t=3$ months with theoretical distributions;
 - iii. Binomial trees (assume $\delta t=1/2$ month = 1/24)
 - iv. Closed formula solutions - using Black-Scholes-Merton model
- 6) Assuming that Deutsche Bank was market-making (bid-offer) €1,017.20-€1,023.40 per €1,000 principal amount Note on May 23rd 2010, what is the implied volatility of the product that is being used by Deutsche Bank for both bid and the offer prices.
- 7) What is the maximum and the minimum value that an investor can obtain from €1,000.00 investment?

- 8) Why should an investor be interested in this Note? What should be the appropriated risk profile of the targeted investor and the rationale of the investment?
- 9) What were the major risks that investors faced when investing in these Notes? Why?
- 10) What was the probability of the notes to provide a positive rate of return, estimated on April 23, 2010? Assume that the investor underwrote the Notes on April 23rd 2010 and intended to hold them until maturity.
- 11) What was the probability of an investor to lose more than 20% of the investment, estimated on April 23rd 2010? Assume that the investor underwrote the Notes on April 23rd 2010 and intended to hold them until maturity.
- 12) What should be the issuer hedge position estimated on April 23rd 2010 in terms of number of Santander shares, in order to minimize its exposure to the product?



4 Months Reverse Convertible Note on Santander



EQUITY
DERIVATIVES
HOUSE
OF THE
YEAR


iFR
awards
2007

A Passion to Perform.

For internal use only

Deutsche Bank






4 Months Reverse Convertible Note on Santander

Indicative Terms and Conditions – 04/03/2010

Issuer	Deutsche Bank AG, London
Issuer Rating	AA- / Aa1 (S&P / Moody's)
Instrument	X-Markets Note
Issue Amount	5,823,000 EUR
Notional per Note	1,000 EUR
Issue Price	100% x Notional Amount
Reoffer Price	X% x Notional Amount
Underlying	Banco Santander SA (BBG Ticker: SAN SM <Equity>)
Payment Currency	EUR
Trade Date	04/03/2010
Issue Date	23/04/2010
Underlying Initial	Closing price of the Underlying on Initial Reference Date
Initial Reference Date	23/04/2010
Final Reference Date	23/08/2010 (Initial Reference Date + 4 Months)
Maturity Date	23/08/2010 (Issue Date + 4 Months)
Settlement Date	26/08/2010 (Maturity Date + 3 Business Days)
Coupon Amount	4.5% of Notional Amount
Coupon Payment Date	Settlement Date
Barrier	85% of Underlying Initial, observed on Final Reference Date
Redemption	On Settlement Date the Note holder will receive: <ul style="list-style-type: none">• If, on Final Reference Date, the Underlying is greater than or equal to the Barrier then: 100% x Notional Amount by cash settlement.• If on Final Reference Date, Underlying is below Barrier Level, physical settlement will apply, and each Noteholder will receive the Physical Settlement Amount in respect of each Note.
Secondary Market	Upon request Deutsche Bank will provide secondary market prices during the life of the Note. Under normal market conditions the Bid and Offer prices will not be distant by more than 1% of the Nominal Amount
Physical Settlement Amount	In respect of each Note, one unit of the Underlying (each a "Physical Settlement Unit"), multiplied by the quotient of (i) the Notional per Note (as numerator) and (ii)

For internal use only



Underlying Initial (as denominator), provided that such number will be rounded down to the nearest whole number and subject to adjustment in accordance with Product Condition 4. Notes belonging to the same Noteholder shall be aggregated for purposes of determining the aggregate Physical Settlement Amounts in respect of such Notes, provided that the aggregate Physical Settlement Amounts, in respect of the same Noteholder will be rounded down to the nearest whole Physical Settlement Unit. No fractions of a Physical Settlement Unit will be delivered. In case of a rounding down to a whole number in accordance with the provisions above, an amount (the "Adjustment Amount") will be paid.

Minimum Trading Size	50,000 EUR
Settlement	1) If the Underlying on the Final Reference Date is below Barrier Level, Physical Settlement; otherwise 2) Cash Settlement
Clearing Agent	Euroclear / Clearstream Bank
Business Days	Madrid, London
Business Day Convention	Following
Calculation and Paying Agent	Deutsche Bank AG, London
Governing Law	English Law
ISIN	TBD

For internal use only



TERMSHEET DISCLAIMER – IMPORTANT NOTICE

This term sheet has been prepared solely for discussion purposes and does not constitute an offer, an invitation or a recommendation to enter into any transaction. Terms and conditions herein are indicative and subject to change and/or negotiation between us. Full details of the final terms and conditions of these instruments will be contained in a prospectus or other offering document relating to this transaction, a copy of which will be available free of charge from Deutsche Bank. Although the information herein has been obtained from sources believed to be reliable, we do not warrant its accuracy, completeness or fairness. Opinions and estimates may be changed without notice and involve a number of assumptions which may not prove valid. Past performance is not indicative of future results. Losses to investments may occur due to a variety of factors. If capital protection is indicated, you should be aware this may only apply at the maturity of the product. If no capital protection is specified, you may lose the entire value of your investment.

In the event you decide to enter the proposed transaction, DB will be trading with you on a principal to principal basis and any resale or on-sale of this product by you to a third party will not be in the capacity of agent for DB. If you decide to market and/or on-sell the product to third party investors you will be solely responsible for the marketing and on-selling to such investors and for assessing the suitability and appropriateness of the product for such investors.

We are not acting as your financial adviser or in any other fiduciary capacity in respect of this proposed transaction or any other transaction with you unless otherwise agreed in writing. We or our affiliates or persons associated with us or such affiliates ("Associated Persons") may at any time maintain as part of our hedging or trading activities a long or short position in securities referred to herein or underlying constituents thereof, or in related futures or options, purchase or sell, make a market in, or engage in any other transaction involving such securities, as well as earn brokerage or other compensation. Whilst Deutsche Bank's trading or hedging activities are not intended to have any significant impact upon prices, our dealings could affect the price you pay or receive for transactions in these or related securities.

Calculations of returns on the securities referred to herein are linked to a particular market measure, reference entity, security or credit, the performance of which may affect the amount or timing of payments to be made or received in connection with this proposed transaction. As such, the securities may not be appropriate or suitable for persons unfamiliar with such basis of reference, or unwilling or unable to bear the risks associated with the securities. The securities referred to herein involve risk, which may include interest rate, index, currency, credit, political, liquidity, time value, share price volatility, commodity and market risk. In addition, products denominated in a currency other than the investor's home currency will be subject to changes in exchange rates, which may have an adverse effect on the value, price or income return of the products. These and other risks are interrelated in complex ways, and as a result, the effect of any one factor may be offset or magnified by the effect of another factor, and the term sheet does not identify all the risks (direct or indirect) or other considerations which might be material to you when entering into the transaction. Without limiting the above, investors may read more about pertinent risks of entering into a transaction of this nature at: www.globalmarkets.db.com/riskdisclosures.

There may be no secondary market for the instruments and the products may not be readily realizable investments. This document and the information contained herein may only be distributed and published in jurisdictions in which such distribution and publication is permitted. Any direct or indirect distribution of this document into the United States, the United Kingdom, Canada or Japan, or to US persons or US residents, is prohibited. You may not distribute this document, in whole or part, without our prior, express written permission.

BEFORE ENTERING INTO ANY TRANSACTION YOU SHOULD TAKE STEPS TO ENSURE THAT YOU UNDERSTAND AND HAVE MADE AN INDEPENDENT ASSESSMENT OF THE SUITABILITY AND APPROPRIATENESS OF THE TRANSACTION AND CONTRACTUAL RELATIONSHIP INTO WHICH YOU ARE ENTERING AND THE NATURE AND EXTENT OF YOUR EXPOSURE TO RISK OF LOSS IN LIGHT OF YOUR OWN OBJECTIVES, FINANCIAL AND OPERATIONAL RESOURCES AND OTHER RELEVANT CIRCUMSTANCES. YOU SHOULD TAKE SUCH INDEPENDENT INVESTIGATIONS AND SUCH PROFESSIONAL ADVICE AS YOU CONSIDER NECESSARY OR APPROPRIATE FOR SUCH PURPOSE.

For internal use only



For internal use only

NEITHER THIS DOCUMENT NOR ANY COPY HEREOF MAY BE TAKEN INTO, TRANSMITTED OR DISTRIBUTED DIRECTLY OR INDIRECTLY INTO OR WITHIN THE UNITED STATES, CANADA, JAPAN OR TO ANY US PERSON. PLEASE SEE THE IMPORTANT NOTICE AT THE END OF THIS TERM SHEET FOR THE FULL DISCLAIMER.