Double Master's Degree in Economics and Finance

Internship Report

Equity Derivatives and Structured Products Sales

Barclays Investment Bank

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Table of Contents

Introduction

The report I developed is based on my work experience at Barclays Investment Bank in the Equity Derivatives and Structured Products Sales Team where I had the opportunity to do the Off-Cycle Internship starting from February to July 2022 in the Zurich Office, in Switzerland. My choice to apply for this position came up from my desire to amplify my knowledge about derivatives and exotic options which was less developed before this experience. In fact, during the first semester at University Paris Dauphine I choose to follow the course of Exotic Options and Structured Products as it was for my personal opinion the most challenging and interesting course, as well as an opportunity to learn a completely new financial topic. This turned to be one of the most important choice in my academic career as I developed an important passion and curiosity through the Equity Derivatives field up to get to the decision to apply for the position on "Equity Derivatives and Structured Solutions Sales" offered by Barclays. Besides having developed important knowledge in the area of structured products from the perspective of the "Sales" role, this position brought me into close contact with the Trading and Structuring desk, which triggered in me a passion and curiosity for the more analytical aspects of exotic options. In fact, my internship activities in the Sales team were very often intertwined with the Structuring desk activities, which led me to develop in the second chapter of this report a study on the logics behind the pricing of the most-selling structured product, the Autocall Reverse Convertible, from a trader's perspective, but also referring to the implications for the investor.

I would preface this Report by saying that it was not just my first work experience in the financial world, but rather a turning point in my career that I am enormously proud of. This experience helped me strengthen many aspects of my personality, starting with my self-confidence and determination to achieve my goals in a very highly competitive work-environment.

Chapter 1 The Off-Cycle Internship in EQD and Structured Products Sales

1.1 Barclays Investment Bank

Barclays is a British Multinational Universal Bank, founded on the 20th July 1896 in London, United Kingdom, and active in more than 40 countries, providing its products and services to millions of customers globally, with over 325 years of experience and more than 80 thousand employees. After UK leaving the European Union in March 2019, Barclays's operativity is split into two divisions: Barclays Bank PLC (BBPLC) and Barclays Bank Ireland (BBI). In particular, BBPLC is under the UK regulatory regime, and BBI is subject to the full prudential regime of the Central Bank of Ireland and as a significant institution falls under the remit of direct supervision by the European Central Bank (ECB). Depending on the nature of the counterparty, the client will face BBPLC or BBI, but services and products offered by Barclays remains the same.

The investment Banking division of Barclays offers strategic advisory, financing and risk management solutions to large corporate, governmental and institutional clients. Barclays is one of the main issuers of investment solutions at a European level, especially on Structured Products, with a strong presence as well as in America and Asia. Barclays is a solid bank from a rating standpoint, among the highest ratings at the moment on the market of issuers present worldwide, which is a key factor in investing in Structured Products as debt securities exposed to the Issuer's default risk.

1.2 The Sales Team

The Team I belong to is focused on the trading of structured products within two different asset classes: Equity and Interest Rates. The whole Team covers 4 regions: Switzerland, Germany, Italy and MENA (Middle East and North Africa), and is led by the Managing Director, followed by each Salespersons who are covering a role as Vice-President and Assistant Vice-President depending on the region covered and the number of years experienced in the Team. In the Zurich trading floor is based the Structured Solutions Sales Team, which covers the Swiss region.

The Team is composed by 8 Sales, 5 of them follows all clients for Switzerland, as it represents the most advanced business on Structured Products compared to the other regions, which are

covered by one single salesperson. Sales are in close communication and cooperation with different teams located around the world who are covering different functions for the Structured Products Business. Unlike the Swiss region, the business for Germany, MENA and Italy, have been starting later due to the different market opportunities of these regions. Starting with the Swiss region, the Structured Products Business has been increasingly taking hold as investment instruments in the Swiss derivative market since 2008, reaching a value of CHF 352 billion in 2019 and becoming the largest structured products market in Europe. Precisely for this reason, in order to better manage all opportunities that the Swiss market has to offer, my swiss sales team continues to set great growth goals and higher budgets every year. As for the Germany Region, the growth of this region is a bit more limited than in Switzerland. The business in Germany has been growing since 2018, the market in fact presents itself as one of the biggest in Europe for volumes sold. Regarding MENA, this region took the place of Russia in a certain way. In fact, from 2020 until February 2022, Russia was part of our business, until the decision to exclude every negotiation with the region following the Russian invasion of Ukraine on February 24th. This dramatic event led to unavoidable consequences also for the entire team, which has undergone changes at a structural level, which I will discuss later. As for the Italy region, the structured products industry has been growing and evolving rapidly during recent years. In particular, the Italian market is very different from the ones mentioned before, as the business derives mainly from the secondary market with listed products. The Italian business has been relaunched in October 2021 after 5 years of absence in the market, and as of today, we have already issued hundreds investment certificates in Italy with the ambition of expanding and developing the offer to retail investors and becoming one of the main players of Investment Certificates in Italy.

1.3 My role

My internship started in February 2022 until July 2022 on the Trading floor in the Zurich trading floor in Switzerland working from Monday to Friday. My role within this Team has not always been the same over the course of these 6 months. As well as some events that may seem distant to us, such as the war between Russia and Ukraine, they have an impact on everyone's life and work. Indeed, my internship began with the aim of supporting the Swiss region as for each region it was established to hire an intern with the aim of helping and supporting each specific business. For the

first two months of this internship, my activities were directed exclusively toward the Swiss region. The main activity was to price and execute trades through the Barclays' personal platform with Swiss clients and identify periodically (at least 1 time per week) some Trade Ideas that investors could benefit based on market conditions. Despite the initial difficulties in understanding the payoff and the impacts that single economics such as the currency or a single date can have on the entire price of the product, organization, speed of reasoning and execution were the key to being able to mature all the knowledge in such a short time.

However, the role of Sales cannot be substantiated only in pricing and provide new trade Ideas. Since we are the ones who agreed with the client on the executed product, is our responsibility drafting the trade documentation with the description of the economics and payoff of the product issued, as well as the life cycle management of all products and ensure that any inherent issue in the product is resolved as soon as possible. In particular, the drafting of the Term Sheet represents the trade's internal communication as all other documents are based on it, such as KIDs and Final Terms, but it will also be shared with the client immediately after executing the trade. For each specific payoff and depending on the legislation on which the product is issued, is required a specif wording for the payoff and for all inherent formulas, which must follow very strictly rules. At the first stage, as Barclays is one of the largest investment banks relying on thousands of employees around the world, it was very important to learn the process of the trade execution which requires the collaboration of different teams. The trade execution process begins with the client's price-request of one or more specific structures, very often requesting variants that can optimize the price. Once the trade is won, our primary task is to execute it in the platform paying attention to all agreed details. Sometimes is required an initial comparison with the Trading team before executing a trade, particularly if it is a large size to be threated or illiquid underlying(s). This discussion with Trading is critical as they will be the ones who have to hedge the position and, as I will explain in the last chapter of this report with the case of barrier options, structured equity derivatives products carry significant risk for the bank that Sales need to be aware of. Subsequently, it takes place a close communication between us and the Legal team regarding the documentation that needs to be drafted and disposed to the client, and the Market Exchange in case of listed products. There is also a close connection with different back-office and middle-office teams that deal with payments, trades amendments, publication of prices, calculation of coupons/trigger events, and so on. All this goes through Sales who are responsible for each trade

and have to give their approval or advise on what is asked. Therefore, it is not only about front office, it is very important to manage back and middle office relationships as well as know who internal references are by communicating every day with many different people.

Regarding the main activity, pricing, I was able to find that connection with my Swiss Sales Representative such that I could price and send the prices directly to the client without needing any more control on his side but helping each other in order to make the work more efficiently.

Just when I was able to find my role within the Team, on February 26 with the start of the Russian attack on Ukraine, the Moscow Exchange was closed as well as the Russian business of structured products. Precisely for this reason, the team has undergone changes within its internal structure, so that I was been able to continue following the Swiss Region but mostly focusing on the Italian one, as an Italian speaker. This was a radical change for me as the business in Italy was in its first steps and being a business that started a few months before my arrival, automation was still far behind Switzerland regarding pricing and documentation, which takes a lot of time if not automated, as per day there may come dozen trades to execute manually. Despite this, the opportunity to follow the growth of a business from the beginning, to participate in the initiation of relationships with new clients and to promote their development, was a unique opportunity for me. The lack of automation, the Term Sheets to be drafted manually and the manual interventions that must be done, have exposed me to a higher responsibility as the likelihood of making a mistake is definitely higher. The attention to details and the awareness of how much they could affect the bank in terms of loss are crucial in this role. Even what may seem insignificant can have a very negative consequence: for traders as they could have been hedging a position based on incorrect economics, for the legal team that has filled out and shared incorrect Final Terms, for the client who is expecting different levels, and for the confusion that could have been created internally among all different teams. Therefore, errors that may seem relatively small can have a very serious impact inside and outside the Bank, as well as on a reputational level. All this was clear to me right away, and despite it being my first work experience, the Head of Sales for Italy has entrusted me with his complete trust so much that I was at the center of many responsibilities. As already mentioned, there have been only few structured products issued since October 2021 to the end of February 2022, but in few months, we managed to issue hundreds of new structured products and built new partnerships with new clients, including banks and brokers based in Italy, Ticino and UK (specifically with clients covering the Italian market).

For this reason, although my activity was initially directed toward helping the Swiss Region for the first two months, in this report I will describe my day-to-day activity for the business in Italy, as the remaining months of teh internship were directed primarily towards helping and developing that business, although I still remained responsible for some activities and tasks for the Swiss region. Currently, only Sales that cover the Swiss region are located in Zurich, but in my case despite being covering Italy for most of my activities, I'm currently based in Zurich and I'll continue to work here and collaborate with Swiss sales covering both regions.

1.3.1 Day-to-day responsibilities

Initially, the transition from one business to the other was not immediate because the Retail market in Italy is substantially different from the Swiss market, so a lot of information gained in the first two months may not necessarily apply to the Italian market, and vice versa.

Me and the Head of Sales of Italy, are the only ones who manage and carry all the exotic products business for that market. The first part of my work definitely includes the pricing of the products that are proposed by our clients up to the manual drafting of the Term Sheet to all different trades related tasks. About 90% of the products that are most in demand in the Italian market are Equity linked products, such as Autocallable, Supertracker, Shark Fin, Digital etc. Therefore, in the description of the pricing activity in the following paragraphs, I will refer to the pricing of the Autocallable Reverse Convertible, as it represents the most traded product. Very often, the pricing activity is not only aimed at entering the data given by the client, but also requires optimization of the product. This consists of understanding how certain underlyings, the correlation between them, all market conditions on that moment, can lead to a better price level based on an optimization of certain parameters, such as the tenor, or autocall levels. In this phase, attention to details is definitely one of the skills I have most acquired during this work experience. In fact, a wrong strike level, a wrongly entered coupon date or a missing indication of any feature of the structure as taken for granted or due to errors of distraction, can cause a misprice of the product and an indication of a price that does not reflect the related risks/opportunities. Incorrect entry of any of these values, can result in incorrect calculation of the settlement at maturity as well as the incorrect valuation of any trigger event (reaching the principal barrier level, coupon barrier, worst performing underlying etc.), leading to losses for us and/or for the investor.

1.3.2 The listing activity and the Italian Market Exchange

Almost all italian products are listed on the Italian Exchange Market "Borsa Italiana". The Italian secondary market is one of the most active in the European landscape among the various marketplaces dedicated to securitized derivatives and it ensures a continuous trading phase from 9:00 a.m. to 5:30 p.m.. In order to ensure liquidity to the market, i.e., continuity of trading and the presence of certain price references for each financial instrument, Borsa Italiana requires a commitment by a specialist operator. Here our market maker acts in the secondary market through "buy" and "sell" operations of our certificates to facilitate liquidity and ensure the fluidity of the financial markets. On a daily basis, there is a close communication between me and the market maker about all the particularities of certificates. Thanks to this close communication, I was able to understand the order book mechanism of our listed products.

The Structured Product business in Italy is mostly represented by the secondary market of listed products addressed to retail customers who have the opportunity to buy and sell certificates at any time, increase their exposure, or simply monitor the value of their investment. Therefore, it is definitely not allowed make mistakes as once third-party investors have bought our certificates in the exchange, it is no longer possible to reject or modify the transaction. At this stage, it is my task to prepare the documentation required by Borsa for the listing application, as well as ensure that all communications on Corporate Actions and all trigger events occurred, such as Barriers triggers, Autocall events or periodic coupons that I personally calculate, have been sent to Borsa.

Whether is responsibility of our market maker to execute trades in the exchange market, I am responsible for executing all secondary trades in our internal platforms. This activity is not always so simple and straightforward, as there is a risk of mismatching between our internal booking and the trade executed on the exchange whether no attention is paid on the price, exact quantities, and any additional details to be entered. The time I have to book all trades is limited as I can no longer book these trades once trading hours have passed. In addition to this, very often there may be some issues which require to reach out to the IT Team and therefore the risk of not being able to book the trades on time increases. This implies that although the booking of secondary trades may appear to be a simple activity, many problems that can occur makes the activity difficult to manage if not communicated quickly and resolved in a timely manner.

1.4 Hands-on experience and Future Prospects

My work experience in Zurich led me to definitely improve some important technical skills but also those called "soft skills" within human relationships. Starting with the most important for me, especially during my Univeristy path: stress and anxiety. Seven months later, I want to express how much I feel I have improved this aspect of me. Working for a large investment bank in the Markets division was definitely the toughest test for dealing with stress and anxiety. Having been given so many responsibilities for an upcoming business like the Italian one, has matured in me the desire to continue to grow this Business, taking all the satisfaction as well as taking care of all its aspects. Starting with one of my trade idea on an Autocall Certificate which turned out to be the best-selling in Italy in the Cert-X Market in July 2022, according to Borsa Italiana's EuroTLX statistics; in the following links (Investing.com, freefinance.biz, investireoggi.it, teleborsa.it) can be found the web pages that have discussed about the Certificate.

Furthermore, this experience was certainly helpful in improving "problem-solving" skills, starting from analyzing the problem and describing it in detail to defining strategies and finding the way to solve it, in the shortest possible time and interpolate the smallest possible number of people working in different teams. In fact, although knowing how to work in a team has been fundamental in this field where inevitably the process of executing trades requires the participation of several people, it's very important for me to know which are my "weapons" and the possibilities I have to be able to solve it individually and be as efficient as possible. Another of the main skills in this job is "multi-tasking" and in particular the ability to manage multiple responsibilities at once by focusing on one task while keeping track of others. I could never focus on a single task for a period of time longer than 10 minutes. The amount of email (about 2 thousand emails per day) to be dealt requires a promptly answer in a concisely and clearly way, as well as the execution of what is requested by paying attention to details but also to incoming requests that may have a higher priority. This switching back and forth between tasks and effectively executing several tasks one after the other has definitely improved my multi-tasking skills, as well as knowing how to organize and keep well in mind all the tasks that need to be completed. Timeliness of execution is another skill that I have definitely improved as well as memorizing certain problems and in particular the solution identified, so that I can re-propose it if the same or similar problems come up again. In fact, is crucial to keep in mind the consequences that certain actions can entail since we are the ones who have to make decisions about our trades, and getting wrong decisions implies in 90% of

cases a loss for the bank (and for the investor, in the worst-case scenario). On the other hand, another no lesser quality is related to human relationships. In fact, the role of Sales also has some "advantages" including the fact of being able to meet our clients or simply interface with them by phone on a daily basis, leading me to work a lot on my self-confidence. In fact, in a context in which we are the "sell side" we cannot afford situations where we do not have the control, or we do not know what is being sold to the investor. It is not just a question of pricing in a platform, it is very important to be able to recognize what are the determinants that have led to that price and knowing how they can be optimized. This is the reason why in the next chapter I decided to deepen the concept of option pricing and in particular analyzing Greeks for an Autocallable product.

Halfway through my experience, I received an offer to remain at Barclays in order to continue to grow the Italian business. Being my first work experience, I received the offer to participate to the Graduate Program and subsequently be hired as Full Time. The Graduate Program will start in January 2023 for a period of 18 months, split in 1 year on the Zürich trading floor, and the following 6 months in London across a work rotation in the trading and structuring team. Therefore, I decided to continue working in Barclays by extending my internship immediately after the end of these 6 months until the beginning of that program, as during this period of time all my work was aimed to grow the business in Italy, not just taking on the role of the intern, but handling each situation and creating networks with our clients and potential ones as there would not have been an end. The internship did not start with this assumption and I was not convinced I could achieve that goal in such a competitive environment. I am enormously proud of how much I have learned in recent months despite many difficulties that arise from being in a new country and far from what was my comfort zone. The determination and my curiosity in learning something new was certainly the added value that most helped me in the pursuit of my goals.

As already mentioned, my role in the bank has largely been consolidated in the pricing of structured products. Therefore, in the next chapter I decided to deepen the concept of option pricing by briefly introducing Structured Products up to the calculation and analysis of the sensitivity of the Price of the most traded product, the Autocallable, through the calculation of the main Greeks: Delta, Gamma, Vega, Theta and Rho. The purpose is to be able to determine how the Price of the Autocall varies through the risk factors associated with options, introducing some Hedging concepts for a Knock-In Barrier.

Chapter 2 Option Pricing and Performance Study on the Autocallable Reverse Convertible

2.1 Motivations of investing in Structured Products

The great potential of structured products is attributable to its individual components, represented by both the more classic plain vanilla options and exotic options: their buy and sell composition allows protection against sideways or bearish market movements with a partial renunciation of yield in the event of stock's price rise. It is precisely in market phases such as the current one, characterized by high cyclical volatility, that structured products are an excellent alternative in terms of portfolio management, thus allowing various market agents to better manage their positions. In fact, they are efficient and innovative investment solutions that allow investors to take advantage of multiple opportunities offered by markets while optimally dosing their exposure to risk and effectively creating true tailor-made investment solutions. Structured products are also increasingly used in the insurance industry because they are easily adjusted to each investor's risk profile, such as capital-protected products which ensure repayment of the capital initially invested by following a buy-and-hold strategy. In general, the benefits of structured products are categorized as follows:

- Protection: some instruments allow the investor to bet on the rise (or fall) of the underlying asset while protecting his invested capital from any declines (or rises). In the event of a fall in the underlying asset, even below the protection threshold, the settlement amount at maturity will in any case never be less than the protection level itself;

- Periodic income: the investor receives an amount over the term of the product only if certain market conditions are met;

- Tax benefit: this is because their random and unsecured return belongs to the "different income of financial nature" field. In fact, all capital gains and income from, for example, the receipt of coupons of Certificates are considered "different income of a financial nature", and therefore can be used to recover previous capital losses[1];

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[1] Taking the taxation of Italy as an example, the taxation of income of a financial nature is set at 26%, Income of a financial nature is divided into two types: one is the "investment income", which is always positive and derived from the use of capital, includes: income from UCITS (e.g. dividends but especially income arising from the difference between the redemption value and subscription cost, of funds and ETFs, which fall under capital income); dividends

- Take advantage from the high volatility: most of the products are vega-negative: as volatility increases, the price of the Certificate decreases, all other conditions being equal. So, the strategy to ride volatility is simple: buy when the volatility is at its highs, sell when it has fallen from the highs. Most of the underlying in structured products are very liquid and capitalized, therefore the volatility of these shares is easier to study and predict than that of smaller and less capitalized shares;

- The presence of a strong "human" component linked to the preferences of investors and the innovation capabilities of issuers in modeling financial structures;

- The possibility of investing in multiple asset classes allows diversification and creation of a balanced portfolio through a wide range of instruments with different risk-return profiles;

- High flexibility being able to exploit different market scenarios and satisfy various portfolio needs.

2.2 Risks associated with the investment

Investing in structured products exposes the investor to various risks which can be mainly identified in:

- Issuer risk: structured products are issued by a bank or a financial intermediary. One possible risk is that the issuer may not be able to honor its obligations, i.e., settle the amounts due to the investor at maturity;

- Underlying risk: the value of these instruments is essentially linked to the performance of the underlying asset. The return cannot be predetermined, and in the event of a negative performance of the underlying asset, the value of the derivative may even go to zero;

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and other profits from holdings in companies or entities; interest from deposits and current accounts, from certificates of deposit and from public and private bonds, etc. On the other hand, we refer to "different income of financial nature", for those income which are uncertain in amount and existence, including capital gains (i.e., capital gains) and capital losses, i.e., both gains and losses from: the sale of qualified and unqualified corporate shareholdings; the sale and redemption of bonds and similar securities; the sale of financial instruments such as shares; the forward sale of foreign currencies; the sale of ETCs; and the exercise of derivative contracts. The problem lies in the fact that the two types of income "do not talk to each other," meaning that capital losses can only be offset against subsequent positive income of the same nature, i.e., falling under the category of different income of a financial nature.
In such a case, the income derived from Certificates, is considered "different income of financial nature", and therefore can be used to recover capital losses incurred in the past.

- Foreign exchange risk: If the underlying asset, share or security, is denominated in a currency other than the currency in which the certificate is denominated, the value of these instruments will also be affected by changes that occur in the exchange rate between the two currencies;

- Liquidity risk: the price of the certificates is also affected by the liquidity of the certificates in the trading market, presenting difficulties in liquidating them before maturity. In fact, taking the case of listed certificates, even though liquidity is ensured by the market maker, he may not be in the book when an investor want to buy or sell and therefore may have to suffer unexpected losses due to moves of the price of the certificate;

At the time of issuing the investment certificate, the issuer can decide whether to quote it directly on the secondary market or offer it to the distributor (a bank or a broker) who will push the product through a private placement or public offer (primary market).

2.3 The categorization of Structured Products: the SSPA Swiss Derivative Map

There are different optional structures offered on the market, and each of them represents a different investment objective and market expectation. An overview of the product types is defined by the Swiss Derivatives Map of SSPA (Swiss Structured Products Association)[2], successfully used for many years by investors and issuers with the aim to help reduce the existing information gap between different actors operating in the certificate sector, while also laying the basis for investors to make informed choices even within complex instruments.

The SSPA Swiss Derivative Map categorize structured products into homogeneous segments by type of product and investment purpose:

- Capital Protected Notes
- Yield Enhancement
- Participation
- Leveraged

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[2] The Swiss Structured Products Association (SSPA) was founded on 4 April 2006 and represents the shared interests of the most important market stakeholders within the structured products industry. It currently has 40 members. With an investment volume of around CHF 200 billion, Switzerland is the world's largest market for structured products. The SSPA aims to represent the entire value chain from issuers and buy-side issuers, trading platforms, buy-side to brokers and partners. Today the Association represents more than 95% of the market volume for structured products in Switzerland.

- Credit Linked Notes

As regards to Capital Protected Notes, i.e. products whose minimum repayment is equal to the nominal value, they are generally used by investors with bearish or moderately bearish market expectations, willing to give up to the yield potentially offered by market to guarantee themselves, in the event of purchase below par, a guaranteed minimum return or a total protection of the invested capital. According to the SSPA Swiss Derivative Map, the following products fall into the Capital Protected Notes category:

- Uncapped Capital Protection / Capped Capital Protection
- Shark Fin Capital Protection with Rebate
- Capital Protection with Coupon
- Double Twin Win / Butterfly

Subsequently, Yield Enhancement products are recognized by the fact that they provide a predefined return to offset the downside risk supported: they allow partial protection of the invested capital with limited participation in the upside of the underlying. Well-known products in this category are Autocall Reverse Convertible products, which contains the early redeem feature of the financial product upon the occurrence of certain price conditions of the underlying (we speak about Issuer Callable in case the callability is at the discretion of the issuer).

Yield Enhancement products can be generally identified as follows:

- Reverse Convertible
- Discount

Going forward, Participation certificates are products which allow investors to invest in a specific underlying (or a basket) by exposing themselves to the performance achieved, both downwards and upwards, in a linear manner (Benchmark Certificates) or with a leverage effect (Outperformance Certificate). The most common Participation products are Tracker certificates: they provide 1-to-1 participation to the performance of a basket of securities. The "raison d'être" of trackers is their ability to allow investments otherwise not possible or not economically feasible. For instance, to track an index, the investor may buy all its components individually, or buy a future on this index. The latter may not be possible because no future exists, and the former may not be possible because of minimum size requirements or too much expensive. The Map Derivatives distinguishes the following Participation products:

- Bonus / Bonus Outperformance

- Twin-win

- Tracker / Supertracker

- Outperformance Certificates

- Airbag Certificates

Leverage products are characterized by a mechanism whereby the investor through a certificate/note controls a certain underlying by investing only a fraction of the capital necessary to acquire possession. Since a leveraged certificate fully controls the underlying, when the price of the underlying changes, the value of the certificate changes to the same extent. However, since the purchase price of the certificate is only a fraction of the value of the underlying, the percentage variations of the certificate are greater than those of direct investment in the underlying.

In this way, the performance of the underlying is amplified upwards (allowing the investor to obtain even very high returns) in higher percentages than changes in the underlying, or downwards (exposing the investor also to the loss of the entire capital). Products falling into this category are the following:

- Mini Futures Certificates

- Turbo

- Warrants

- Spread Warrants

Last but not least, credit linked note products are bonds that pay interest rates higher than those of the market, in order to compensate the investor for the risk supported: the reimbursement of the principal and the interest is linked to the credit risk of the reference Entity. But that's not all: since there is also an issuer of the certificate, the credit risk for the investor is double because it is not limited to its reference entity, but also extends to the repayment capacity of the issuer. When a credit event occurs, there is an early repayment of the credit linked notes, in the form of periodic coupon flows.

2.4 The Valuation of Autocallable Reverse Convertible Products

The standard structured product is a combination of two products: the zero-coupon bond and a single option of a set of options of some underlying assets. Generally speaking, when we price a structured product, in most cases the issue price will be equal to 100%, excluding some products

such as Discounts or Recovery products which allow to set a lower issue price. The final price, let's say 100%, is the result of the sum of the Fair Value of the product and the fees applied by the issuer and the distributor as a gain from the emission and distribution of the product. The Fair Value, in turn, is the current value of the capital to be invested today to obtain 100% of the capital at maturity. Considering the Present Value of the bond as follows:

$$PV = \frac{NV}{(1 + r + f)^t}$$

With:

PV = Present Value

NV = Nominal Value

r = risk-free rate

f = funding rate

t = time to maturity

The optionality represents the return of the option included in the structured product and is calculated from the difference between PV (Present Value) of the bond price and the Fair Value of the structured product (i.e. the 100% issue price decreased by the commissions retained by the issuer and the distributor). Now, Funding is the interest rate that the issuer is willing to pay to the investor and varies by currency and by tenor. The more competitive the issuer's funding, the lower the Present Value (PV) is and the higher the margin that the issuer can pay to the investor in terms of "coupon", as in the simple case of Autocall Reverse Convertibles products. We mentioned that funding varies by tenor and by currency: as for the currency, USD interest rates, for instance, are higher compared with other funding currencies, and, consequently, financial assets in dollars yield more than those in EUR considering the same maturity; as for this maturity, the higher the tenor, the higher the funding. The intuitive justification comes from the "normal" Term Structure of interest rates which tends upwards from short to long-term maturities.

Very often, the client may ask us to optimize the structure of a certain product leaving us a leeway on some parameters, which can be optimized in regard to underlyings and market conditions.

One of the factors that particularly influences the price of structured products is the correlation of the underlyings in the case of a Basket of shares. In fact, considering the hypothesis of a Worst of basket of 2 underlyings, in which the performance of the structured product will depend solely on

the worst performance among these 2 underlyings, the higher the correlation between the underlyings, the greater the protection for the investor. This is because in the hypothesis of a positive scenario, it is more likely that both underlyings as correlated will be above the KI barrier, or even above the Autocall barrier. On the contrary, when the correlation is low, whether there is a positive scenario fo an underlying, this could imply a negative performance for the other underlying as it is decorrelated, leading to the risk of triggering below the barrier and lose the initial capital.

Since options are embedded in structured products, it is necessary to deal with the so-called "Greeks". These metrics are used to measure how different forces impacts the premium of an option, each of them referred by a greek letter:

1.   The sensitivity to the underlying price (*delta, Δ*)

2.   The sensitivity of delta to changes of the underlying price (*gamma, Γ*)

3.   The sensitivity to the time decay (*theta, Θ*)

4.   The sensitivity to interest rates (*rho, ρ*)

5.   The sensitivity to the implied volatility (*vega, V*)

In order to explain these concepts, in the following paragraphs will be discussed the payoff of a Single Asset Autocallable Reverse Convertible (ARC) with Memory. The product in question will pay a coupon if the underlying asset is above a certain coupon barrier level by the coupon observation date, and the security is automatically early redeemed if it exceeds an Autocall barrier level by a certain autocall valuation date. At maturity, if not early redeemed, depending on how the underlying asset performs, the investor will receive either his principal back in cash or a predetermined number of shares (calculated as the Calculation Amount divided by the Strike price) of the worst of performing stock, plus the difference between rounded shares and "arithmetical" shares in cash. The price of the Autocall is calculated as the present value of all expected future cash flows. To calculate the expected future cashflows, we start by computing the undiscounted conditional probabilities of receiving the coupons. Once these probabilities are computed, they should be multiplied by the coupons and then discounted. To give an example, I have set some parameters describing the Autocallable product in the table below.

Data	
Frequency	Annual
Risk-Free Interest rate	0.50%
Tenor	6 years
Strike Date	7-Jul-22
Issue Date	19-Jul-22
Final Valuation date	7-Jul-28
Payment Date	19-Jul-28
Strike	100%
Autocall Barrier	100%
Coupon Barrier	70%
Memory	Yes
Coupon p.a.	6%

In that case, the coupon barrier (70%) does not coincide with the autocall barrier (100%) but turns out to be lower, and therefore, if at the respective observation dates:

- The underlying exceeds the coupon barrier but not the autocall barrier, then the investor receives the coupon and the product continues to exist;

- The underlying exceeds the coupon and autocall barrier, then the investor receives the Principal plus the periodic coupon and any other coupon not previously paid (memory feature) and the product is early redeemed;

- The underlying does not exceed the coupon barrier, and therefore neither does the autocall barrier: the investor does not receive the coupon and the product continues to exist.

As anticipated, the product has the memory feature, whereby all coupons that are not paid on their respective observation dates will then subsequently be paid all at once on the next observation date when the Coupon barrier is triggered.

Observations Dates	Spot	Autocall	Already autocalled	Periodical Coupon	Coupon (with Memory)	Autocall (Principal + coupon)	Cash Flows (CF)	Discounted CF
7/7/23	62.1068	NO	NO	0.00%	0.00%	0.00%	0.00%	0.00%
7/7/24	69.2937	NO	NO	0.00%	0.00%	0.00%	0.00%	0.00%
7/7/25	75.2927	NO	NO	6.00%	18.00%	0.00%	18.00%	17.73%
7/7/26	89.2822	NO	NO	6.00%	6.00%	0.00%	6.00%	5.88%
7/7/27	104.2982	YES	NO	6.00%	6.00%	106.00%	106.00%	103.38%
7/7/28	146.5976	YES	YES	0.00%	0.00%	0.00%	0.00%	0.00%
								126.99%

In the table above, is shown the value of the product for which early redemption appears to have occurred at the fifth observation (7/7/27). The price of the product will then take into account the coupons that have been previously paid plus 100% redemption of the initial principal. Taking into account the effect of the discount, thus interest rate and time to maturity, the final payoff turns out to be 126.99%. This means that as of today, the investor would receive 100% of his initial principal plus 26.99% total coupons (6.00% x 5 times x Discount effect).

Discount Formula:

$$\sum_{i=1}^{n} A\, C i e^{-rt}$$

With:

C = Coupon (with Memory)

A = Autocall Redemption (100%)

r = Risk-Free Interest Rate

t = (T – t)/365

n = Number of observations up to the Autocall event (n=5)

As already mentioned, the Autocall Reverse Convertible involves for its investor selling a put option which leaves the bank in a long-put position. However, banks have more flexibility in their hedging position based on the afford outlook and tolerance for risk: they are no interested in taking any directional risk as their profit comes from selling the product while hedging their exposure and staying neutral on all their exposures. What happens in reality, is that the exact trade is not completely hedged, as its extremely expensive. The single position is added to the portfolio of hundreds of other structured products, and the risk from all amalgamated. As the market changes, the risk will change as well, therefore the role of the trader is to manage the risk by keeping it inside sensible limits and minimize it where its financially viable (it is possible to get it to zero, but very expensive). Regardless of where and how an investor buys a structured product, the price always includes what is known as the expected issuer margin. For the purpose of this study, going forward I'll analyze the exposure of the trader who sells an Autocall Reverse Convertible and therefore is in a long-put position, while the buyer is short the put, explaining what it means in terms of hedging, assuming a 100% hedge of the position for simplicity.

2.5 The Option Value

The value of an option depends on several factors, including the level of the strike, the underlying's spot price, its volatility and expected dividends, the risk-free interest rate, and the time to expiration. Based on these determinants, the higher the dividends, the strike price, the volatility, the longer time to expiration, and the lower the price of the underlying and the level of interest rates, the more expensive the premium of the put will be.

The option premium is composed of its intrinsic value and time value. Briefly, the intrinsic value is the value that would result from the immediate exercise of the option, i.e., for a Put option, the difference between the strike price and the spot value. When an option has positive intrinsic value, it is called "in the money", on the contrary, "at the money" and "out of the money" options have zero intrinsic value. As can be seen from the Figure 1 below, the value of a long at-the-money put option corresponds to the time value, its intrinsic value being zero. In fact, the payoff at the point where the price of the stock is equal to the strike (50 EUR), the value of the option is exactly the Time Value, i.e. the value of the option attributable to the time until expiration. The time value decreases as the option approaches its expiration because the probability that the option will end ITM is lower than an option with a longer time to expiration.
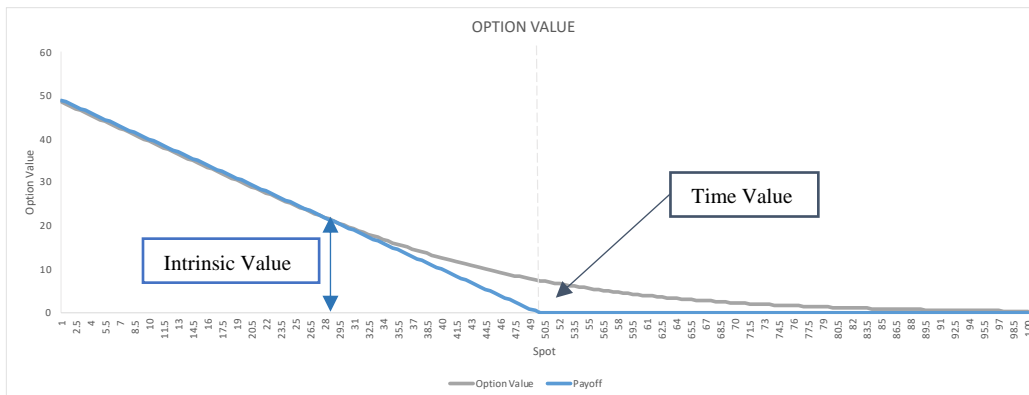

Figure 1: Long Put Option Value

2.5.1 Delta Δ

Referring to the Delta, $\Delta\Pi = \dfrac{\partial \Pi}{\partial S}$, which is the derivative of the option price with respect to the value of the underlying asset. In particular, the delta of a put option moves inversely with respect

to the price of the underlying, and therefore it assumes a negative value (-1 to 0) for the trader of an Autocallable, who is in the "sell side" and therefore in a long put position.

 To hedge the position as effectively as possible, the trader should strive to achieve a state of neutral delta, in which the price movements of the option are perfectly balanced against the movements of the underlying asset. To achieve the delta-neutral position, the trader must go long Delta (long forward) until the delta truly reflects the price movements of the underlying asset.

Delta is also sensitive to changes in volatility and time to expiration. As expiration approaches, delta approaches -1 for long ITM put options, while it takes on a value closer to 0 for OTM put options; for ATM put options it is generally constant and closer to -0.5. In the Figure 2 below it is represented the value of the Delta with respect to two different times to expiration (i.e. 5% Time to Expiration means that the option is much closer to maturity than the 95% Time to Expiration).
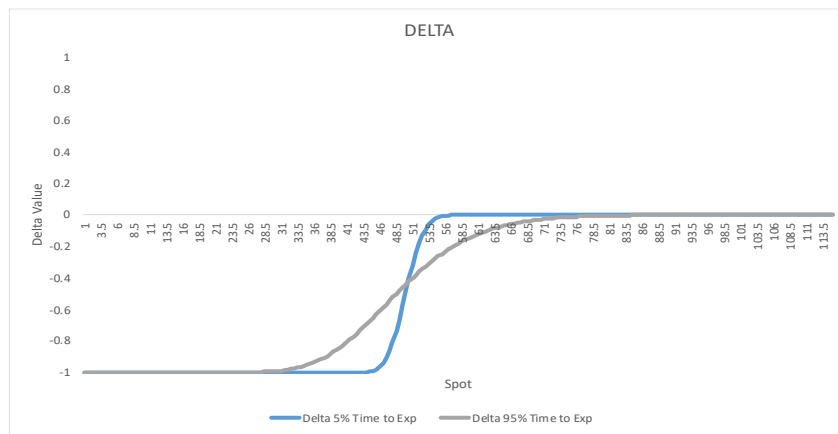

Figure 2: Delta with 95% and 5% Time to Expiration.

The Figure 3 below shows instead how volatility affects Delta. In fact, a low volatility of the Underlying Asset, assuming 20%, pushes the Delta closer to -1 for ITM options and closer to 0 for OTM options. Whereas, for ATM options, the Delta remains with a value of 0.5 both with high and lower volatility of the underlying. This happens because intuitively, with low volatility, the probability of the ITM put option suddenly becoming OTM is very low, and vice versa for the OTM option. Now, if we take the current "option premium" as one of the model inputs, we will be able to get an answer as to what the consensus view on volatility currently is: the "implied" volatility. Therefore, the volatility of the underlying asset expected by traders and embedded

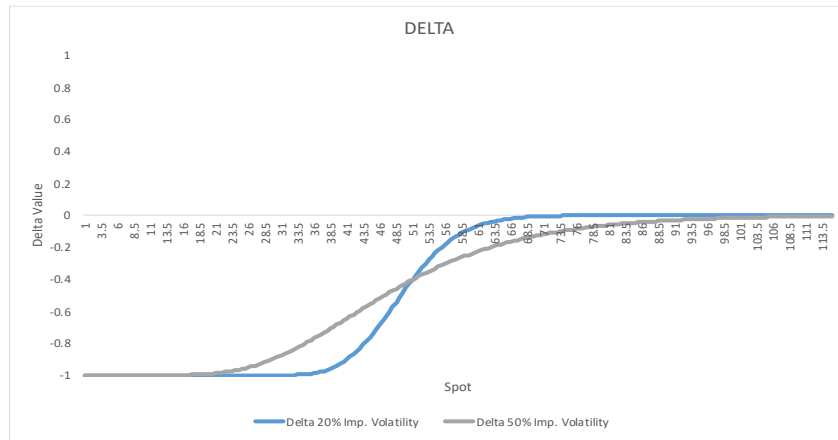("implied") in the option price. Thus, it is not directly available, but must be "extrapolated" from option market prices[3].

Figure 3: Delta with 20% and 50% of Underlying's Implied Volatility

2.5.2 Gamma Γ

Delta does not capture all the movement of the option price, as the option price is a non-linear function of the stock price, as we saw in the Figure 1. The delta-gamma approximation is used to estimate option price movements if the underlying stock price changes. To take into account the non-linear function of the option price, we can use gamma to make our option price estimate more precise. Gamma can be expressed as the second derivative of the premium of the option with respect to the price of the underlying asset, $\Gamma\Pi = \frac{\partial\Pi^2}{\partial S^2}$. In general, it is positive for long positions (both put and call), and negative for short positions (both put and call), and rapresents the rate of change between an option's Delta and the underlying asset's price. At this point it is important to note that Gamma is almost zero for Deep ITM and Deep OTM options since their Delta won't change as quickly with a movement in the Underlying's price, but instead it assumes the highest level for ATM options. In fact, deep-in-the-money put options already have a negative Delta. If the options become deeper in-the-money, the Delta will move toward -1.00 for puts and the

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[3] The VIX index, which is calculated by the Chicago Board Options Exchange (CBOE), is obtained as a weighted average of implied volatilities inferred from the price of options linked to stocks listed on the S&P 500. Because this index summarizes the implied volatility used to price options on stocks listed on the world's largest index, it expresses with good approximation the expectations that traders make about the future variability of the stock market.

Gamma will decrease because the Delta can't be lower than -1.00. And conversely if implied volatility decreases, delta will be lower and gamma will have "more to do", and it will increase. This occurs because, as is shown in the Figure 4 below, when volatility is low, deep ITM and OTM options are characterized by a relatively low time value, but this value increases significantly as the option price approaches the strike (ATM) because the Delta in this case is most sensitive to underlying price changes, as the Gamma is higher with ATM put options. In contrast, with high implied volatility, the possibility of more stock's movements is foreseen, then gamma has "less to do", so it decreases and tends to assume a more stable distribution over all Underlying's levels. If the investor of an Autocallable RC is short put (negative gamma), he is also short volatility. In fact, if implied volatility increases the option has a higher chance of becoming in the money (which is bad for the investor who is short put). In a higher implied volatility situation, the difference between the ATM and ITM (or OTM) gammas will be flatter, which is coherent with the Figure 4 below.
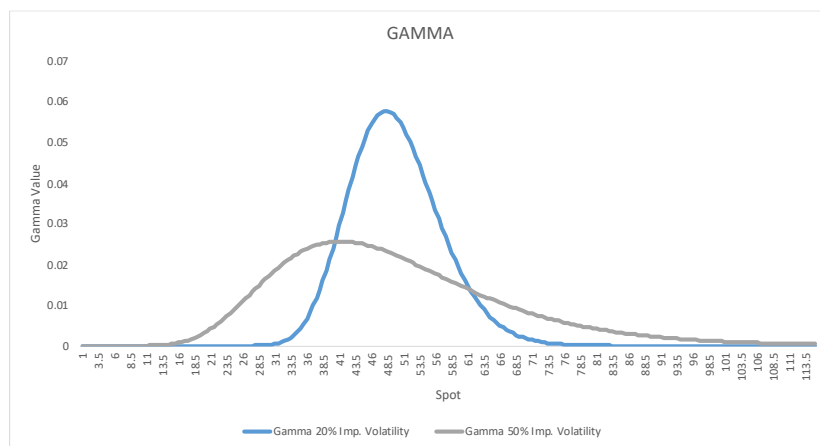

Figure 4: Gamma with 20% and 50% of Underlying's Implied Volatility

Gamma is also amplified by how long the time to expiration is: the shorter the time to expiration, the greater the impact of Gamma on the option premium, and thus the acceleration will be more relevant. Higher Gamma can increase the risk for option sellers (the investor of the autocall) as it accelerated Delta movements, but at the same time it also means much more difficulties for the trader to hedge the position. If gamma is high enough, a delta neutral portfolio may still be at risk from movements in the underlying price, since delta may change, and the portfolio may require rebalancing with respect to the new value of delta. Gamma is friendliest to long option holders: it accelerates profits for every $1.00 the underlying moves in his favor and decelerates losses for

every $1.00 the underlying moves against the Issuer. Considering the Issuer position, thus long put, knowing that the gamma for a long put is positive and equal to, for example, 0.05, the Delta is negative and equal to, for example, -0.8, his new position when the underlying's price moves up +$1.00 will be: -0.8 +0.05 = -0.75. Therefore Gamma "helps" the trader when the underlying is moving against him as it decelerates losses.

2.5.3 Theta Θ

The Theta of an option corresponds to the first derivative of the option value with respect to time decay, $\Theta\Pi = \frac{\partial\Pi}{\partial t}$. Theta is a representation of how much the price of an option will decrease as the option's expiration approaches. A long put option have negative theta, but it does not affect the value of an option uniformly. Theta has a greater impact on an option with fewer days to expiration than on an option with more time to maturity. In reference to an Autocallable approaching expiration, assuming all other variables are constant, it negatively affects the price of the product as the option price decreases as time passes. From the Figure 5 below, it is evident how for more time to expiration (90% Time to Exp.), the theta value assumes much more negative levels for a large range of Spot prices, unlike the theta with low time to expiration (10% Time to Exp.), in which theta assumes negative values for a narrower range of values around the Strike (where the option is ATM and the trader is long put). Depending on the level of the underlying, whether the option is ITM or OTM/ATM, is explained as follows:

-   For ITM options, whose value is composed of intrinsic value and time value, the time-passing erodes only the time value until expiration. At maturity, ITM options will only have intrinsic value and Theta will approach the value of $-rXe^{(-rt)}$;

-   In the case of ATM and OTM options, whose value is only given by the time value, the time-passing erodes all their premium: no longer time value, nor intrinsic value. At maturity, ATM and OTM options won't have any value and Theta will approach the value of 0.
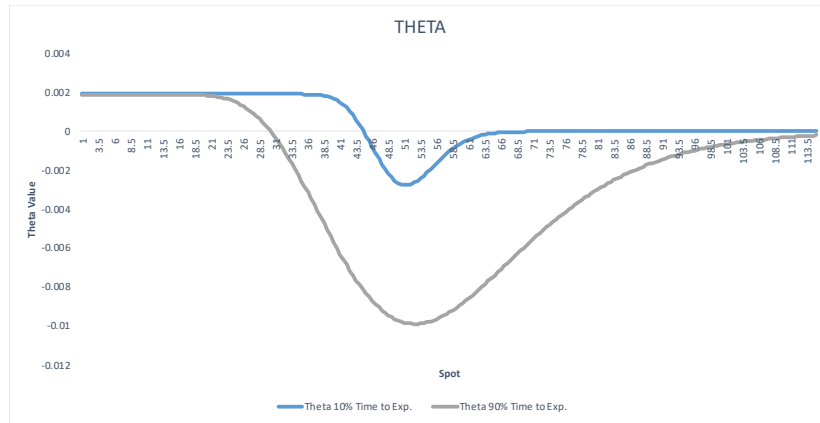
Figure 5: Theta with 10% and 90% Time to Expiration

2.5.4 Rho ρ

Rho measures an option's sensitivity to changes in the risk-free rate of interest and is expressed as the amount of money an option will lose or gain with a 1% change in interest rates, $\rho\Pi = \frac{\partial\Pi}{\partial r}$. Rho has a negative value for long put options, which means that the option value generally decreases as interest rates rise. In fact, for a vanilla put option, the holder acquires the right to sell at maturity the underlying asset, postponing the moment in which the resources could be invested with a higher interest rate. As can be shown in the Figure 6 below, although rho is a primary input into the Black-Scholes option pricing model, a change in interest rates generally has a smaller overall impact on the option value, further not being a frequent event.
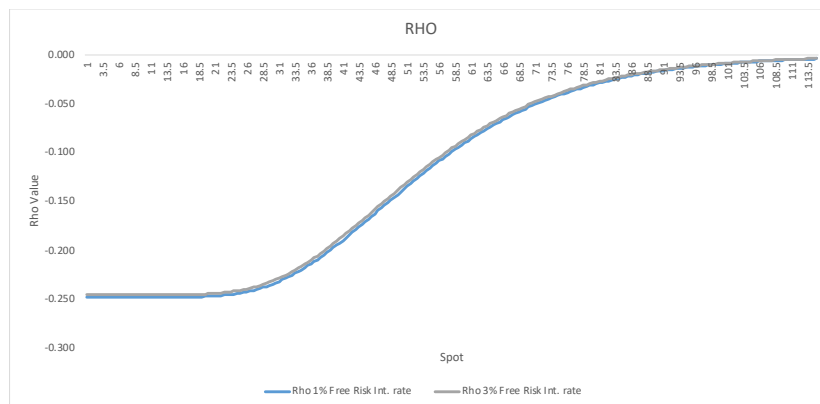

Figure 6: Rho with 1% and 3% Free-Risk Interest Rate

2.5.5 Vega V

Vega is the measurement of an option's price sensitivity to changes in the implied volatility of the underlying asset, $V\Pi = \frac{\partial \Pi}{\partial \sigma}$. Just like the other greeks, vega will be positive or negative depending on the strategy being implemented, long put options have positive vega, short put options have negative vega. For a long put, Vega is the highest when the option is at the money because a sharp spike or decline in volatility can be the difference between whether that option has value, or it expires worthless. Generally speaking, a higher volatility means a higher extrinsic value priced into the premium of an option. Higher implied volatility results therefore in higher option prices (higher coupons) because there is an expectation the price may move more than expected in the future. Investors that buy an Autocall RC can benefit when implied volatility decreases before the maturity, if not yet auto-called. The reason is that the time value is heavily influenced by the implied volatility: the longer time there is until the expiration, the higher the extrinsic value of the premium. In fact, a higher vega means a greater chance for the underlying asset to move in price and the option to increase in value before the expiration date. On the contrary, options which are close to expire are less sensitive to an increase of the implied volatility. As can be seen from the Figure 6 below, the value of the Vega is the higher the longer the remaining life of the option (90% Time to Exp.).
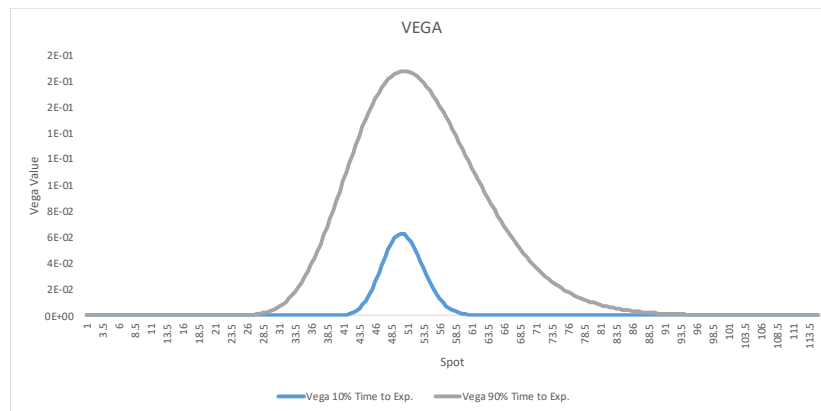

Figure 7: Vega with 10% and 90% of Time to Expiration

In our case, through buying a put option, the trader acquires a bullish ("long") position on volatility, with an additional gain when volatility rises. Conversely, by selling an option, the investor simultaneously acquires a bearish ("short") position on volatility. As already mentioned, the trader

will always hedge is position accordingly, therefore he will sell volatility on the trade date to hedge his vega. The position in volatility depends on the relative position of the forward price of the underlying with respect to the coupon barrier level. For instance, imagining an Autocall RC that pays a conditional coupon when the underlying level is above or equal the Coupon Barrier at the observation date, whether the Underlying price is above the barrier few days before the observation date, the issuer would prefer a high volatility which would results in a higher likelihood to won't hit that barrier rather than a low volatility which substantially would mean taking for grant that the coupon will be paid. The reason why I decided to study this Greek last is because I want to address in the last paragraph the concept of hedging a KI Barrier and understand how volatility can increase risks to the issuer for hedging purposes.

2.6 Hedging a Knock-In Barrier

Autocallable Reverse Convertibles are offered in the marketplace also in modified varieties that are more precisely tailored to investors' specific needs. The most widely used variation is the Barrier Autocall Reverse Convertible, which offers to the investor an additional protection against the downside risk to what is called the Knock-In barrier, for which the barrier event can be observed at any time during the option's life (American style) or at maturity only (European style). If the Barrier event is triggered, the investor receives an amount commensurate with the negative performance of the worst-performing underlying asset (or the Single Asset), resulting in a partial or total loss of the initial invested capital. If the barrier is not reached, the investor receives his initial capital, in addition to the coupons, if any. As already mentioned, the issuer will always hedge his position. Traders on the sell side are usually long the Knock-In Put and have to hedge the risks associated accordingly. To hedge a long KI Put, the issuer must need to buy delta shares of the underlying stock at the outset and dynamically adjust its delta hedge to remain delta neutral. Suppose that an investor buys an Autocall RC with an European Knock-In Barrier at 60% of the initial level, conditional coupons with memory with a coupon barrier at 80% and Autocall barrier at 100%, it is obviously worthless than the KI Put that can Knock-In any time before maturity (American style), as the risk for the investor to lose his initial capital would be lower. The payoff of Investor's position at maturity is represented in the Figure 8 in the next page.
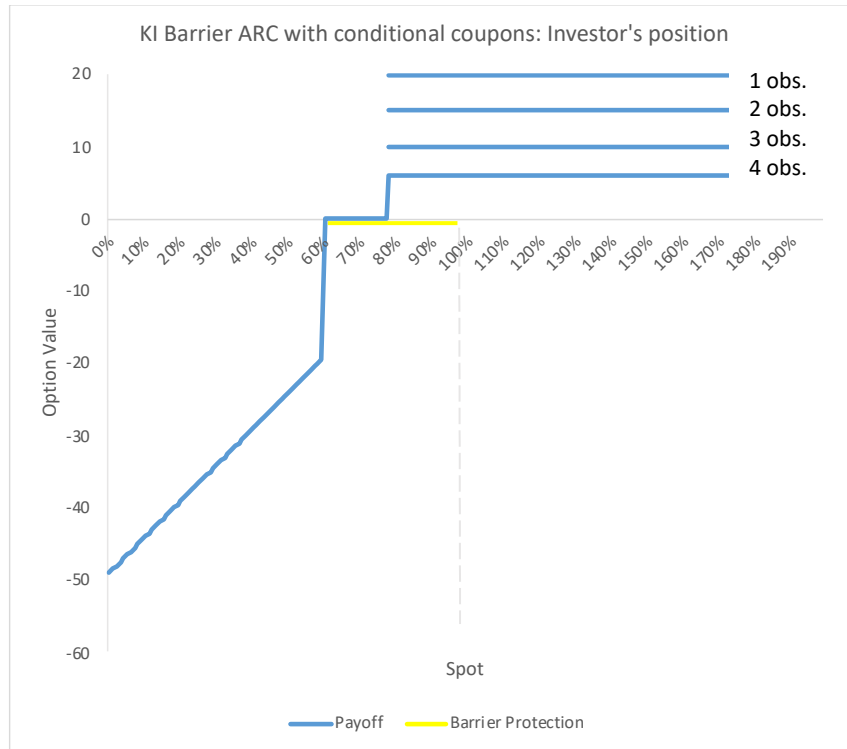
Figure 8: European Knock-In (60%) Autocall Reverse Convertible with conditional coupon with memory (Coupon barrier at 80% and Autocall barrier 100%) on a single Asset

Now, in order to discuss which are the risks for the trader who needs to hedge the KI Put, the Figure 9 below shows his position: the trader buys a 100% strike and 60% European KI Put (100/60%) on a Single Asset, let's suppose Netflix.
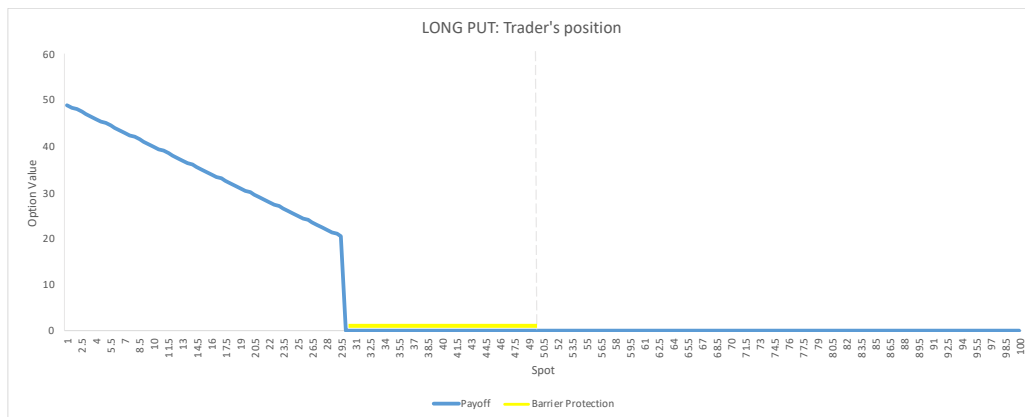

Figure 9: Long Knock-In Put option: Trader's position

The difficulty in hedging a KI Put comes primarily from the non-continuity of its payoff structure at expiration which creates unique challenges if the price of the underlying approaches the barrier. The fact is that with a KI barrier set low to protect the investor, it is equivalent to saying that the put gains value only after the price falls below the KI Barrier. In fact, when the price of Netflix crosses the 60% barrier level, the KI Put instantly goes from not being an option to being an ITM Put at 40%. As a result, the value of the KI Put increases significantly above the barrier, even though Netflix's stock price barely drops from 60.01% to 59.99% of its initial value. So, near the barrier, Gamma, the sensitivity of Delta to a movement in the underlying stock price, can be very large: this means that the absolute delta of the KI Put becomes extremely large when the price of the underlying asset approaches the barrier, often greater than 1. Since the Delta of an option can never be greater than 1, the trader will buy much more Netflix shares when its price approaches the barrier at Maturity. Then, when the KI Barrier is triggered, the trader will need to sell all his excess shares at exactly the level of the KI Barrier. Realistically speaking this won't be possible since having to sell a large amount of shares, the price will fall even more: resulting in a loss for the trader due to selling excess shares at a lower price. One way to manage this risk is to apply a barrier shift, which means hedging a 100/58% KI Put rather than a 100/60% KI Put. The 2% barrier shift (60% - 58%) implies that according to the trader he will be able to sell all the excess shares up to the minimum price of 58% without incurring a loss. This strategy is called bear leveraged spread put and, keeping our example of a trader long a 1Y 100/60% KI Put on Netflix where the option can only knock in at maturity, it can be replicated as follows:

- The issuer buys a 60% European KI put (by selling the Knock-In Autocall RC)
- The issuer buys 20 times a 60% European KI put
- The issuer sells 20 times a 58% European KI put

This can be explained as follows: traders on the sell side are long the "Down and In Put" and therefore, being short the forward, they will need to buy delta and adjust dynamically his delta hedge to remain delta neutral. Near payout discontinuities for an Autocall product with a KI Barrier, the trader reaches the point where he has accumulated excess shares and to avoid the liquidity risk of suddenly having to sell important quantities of shares, traders rely on overhedge techniques, which typically include replacing the KI barrier by a conservative put spread. Therefore, the fact that the trader buys a 20x 60/58% leveraged put spread is an overhedge and thus a conservative way to replicate the KI Put payoff at maturity. A wide put spread can be seen

as a more conservative barrier shift needed to protect the trader against a larger move of the underlying, which will result in a lower coupon for the investor. Conversely, the narrower the put spread, the more the replication converges to the effective price of the KI put. Usually, the higher KI Barrier the lower will be the barrier shift, which at the same will be reflected in a higher coupon for the investor (as he has less protection and more risk to lose his initial capital). The size of the barrier shift depends on several factors such as the stock liquidity, the size of the transaction and the volatility of the underlying, and the leverage of the put spread can be calculated by dividing the size of the discontinuity (the strike-barrier differential = 100% - 60%) by the width of the put spread (60% - 58%), equal to 40%/2% = 20x (leverage).

Moreover, when devising hedging strategies, banks have to face the limitations of real markets, like transaction costs, discrete trading, and lack of liquidity. One way of addressing these concerns is to limit the frequency of trading and to compensate the associated losses through hedging barrier options with regular options instead of buying/selling directly the underlying asset as regular options are more closely related to barrier options.

Appendix

Evaluation of the Head of EQD Structured Solution Sales of Italy

Klara joined the team and was pretty focused on the Italian indirect retail activity, that was re-launched in 2022 after years of absence from the market. Given the peculiarities of the market standards and the ongoing platform set-up, she faced very difficult tasks she completed coordinating different stakeholders, internally and externally. During the internship she was given more complex tasks she always completed with excellent results.

Klara has shown an outstanding spirit of initiative throughout her internship, taking care, even independently, of different aspects of the Italian activity and all the tasks given were completed in due manner. She has very strong commitment and excellent outcomes, she's very good in teamwork, building relationships with the different stakeholders whose help is key to make the activity smooth and successful.

My general comment is extremely positive. Her dedication to the business has been impressive as well as the results delivered.

12 August 2022

Francesco De Santis
Head of EQD Structured Solution Sales of Italy

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