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AUTOCALLABLE STRUCTURED PRODUCTS: EXPLORING THE EUROPEAN EQUITY MARKET

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A Project carried out as a Case Study for an Internship Report

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1. INTRODUCTION

Macroeconomic overview:

We started 2017 with a busy and uncertain political agenda and we are now heading into 2018 with the best economic conditions since the financial crisis, with muted focus on further geopolitical and political risks. In addition, there is no market crash or financial crisis expected next year so far, though financial market institutions are becoming more cautious, advising their clients to reduce risk exposure.

The last 50 years have been characterised by the secular downward trend in developed markets sovereign bond yields and intensified by the post-crisis waves of quantitative easing. The equity space has benefitted significantly from the low interest rate environment, which pushed index prices up, and from the add-on coming from the dividends in a recovering economy when investors were looking for yield. Hence, low bond yields pushed investors into riskier asset classes to enhance their expected returns.

The macro environment appears still supportive for risky assets as cyclical indicators are still not showing any weaknesses, corporate balance sheets are generally sound and central banks are still showing signs of easing. Nevertheless, stretched valuations, rising bond yields and possible complacency around what central banks will do in the future will limit the upside of global equities.

The US equity market is already pricing a rebound in growth and inflation. The rise in bond yields and Fed repricing should be a headwind against further US equity rerating. On the other hand, positive economic momentum should support the Eurostoxx 50 Index. However, the stronger EUR and higher bond yields will likely limit performance. Therefore, given the current macroeconomic conditions, we favour European Equities over US Equities.

The Product:

Nowadays, investors are looking for a combination between exposure to a risky asset and other additional features, such as capital protection, aiming to benefit from the positive performance of the Underlying, while still being protected in case of market downturns.

The best way to capture equity growth while having some sort of capital protection is through Structured Products, which are very popular among investors and have been capturing a large part of the market share in recent years. Product providers use them to offer significant high payoffs and lower risk, when compared to an investment on pure equities. As so, in a stable to slightly bullish environment, investors will benefit from exposure to the positive growth of the Underlying as well as a defensive capital protection on the downside.

Throughout this internship report, a general and flexible form of an Autocallable Structured Product on European Equities is analytically studied, a 5Y Double Phoenix Memory on the Euro iSTOXX EWC 50 Index. It's payoff and risk management properties are examined, taking into account its potential interest for an institutional investor that already has its own portfolio composed by European and US Equities. Accordingly, the product being analysed includes popular features (such as, Memory Coupons and an European Protection Barrier), which are included according to the client's requirements upon request.

The main goal of this report is to explore my daily tasks at work and simulate a product pitch to an institutional investor that requires a yield enhancement on his portfolio through the use of Structured Products. We will then propose an Underlying and explain the rational behind it, highlighting the higher coupon when compared to a similar product on the Eurostoxx 50 Index. Hence, we will analyse the product by presenting its mechanism, benefits and risks; and construct illustrative scenarios, in order to show how the product would have behaved in a bullish, neutral or bearish market. Consequently, we will examine the product past behaviour by computing a backtest with real historical data.

2. CURRENT MACROECONOMIC ENVIRONMENT

Political concerns may remove some upside; however, strong growth will help equities perform. This represents a supportive environment for risky assets, equity markets in particular. Studies demonstrate that equities tend to deliver outperformance in times of recovery and expansion, with the best potential reward coming in the early phases of recovery. In this context, equities should be preferred to fixed income, and the Eurozone should be preferred to the US.

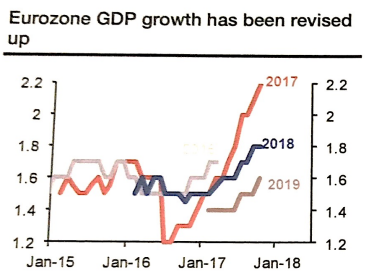
US Equities: already in expensive territory

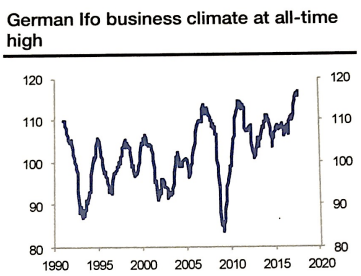
US Equities have not been in attractive territory valuation-wise for a while. Indeed, on all of the main valuation metrics, US Equities are trading above their long-term average and at a level only seen during the dotcom bubble. However, expected earnings growth for the next 12months is below the 20year annual earnings growth average.

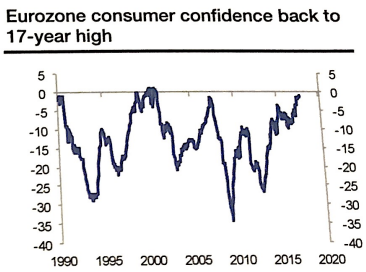
The prospect for higher bond yields should be a headwind for equity markets; meaning that, any increase in the bond yields should push US Equities into a more expensive territory relative to bonds. Therefore, US Equities are pricing in a good part of Trump's promises (tax cut, repatriation, deregulation, investment plan) and have benefitted from a Goldilock's scenario: fairly strong growth with lower bond yields and a weaker USD.

Eurozone Equities: the Eurozone recovery is now a well-known story

Gone are the days when markets doubted the Eurozone's economic situation. GDP growth expectations have been revised up, cyclical indicators like the German Ifo are at all time highs and consumer confidence is getting closer to a 17year high (see graphs below).







According to Bloomberg, the probability of a recession in the Eurozone over the next year is only 10%, even lower than the US (15%). While the link between Eurozone GDP growth and Eurozone earnings is not obvious, it is expected around 10% annual earnings growth for the next 3years. In addition, a better economy in the region would support the EUR and be a headwind for the region's profits.

3. INTRODUCTION TO STRUCTURED PRODUCTS

In this section, we will present the definition and components of Structured Products in a theoretical way, as this will allow us to explore and understand the large range of possible features in the construction of such products. Finally, we will randomly establish the parameters for an illustrative example, in order to better understand the composition of a Structured Product with a flexible payoff intended to meet client's needs.

Traditional products largely comply with the risk-return ratio, namely, the relationship between the expected return and the level of risk. The riskier the product, the more attractive it will be for an investor that is searching for yield enhancement. Therefore, Structured Products offer participation to the positive performance of a risky Underlying together with capital protection features, in order to provide investors with an attractive risk-return ratio.

How structured products can combine performance and capital protection?

In this first part, we will introduce option derivatives in order to interpret the intrinsic composition of a Structured Product, highlighting its two components: bonds and options.

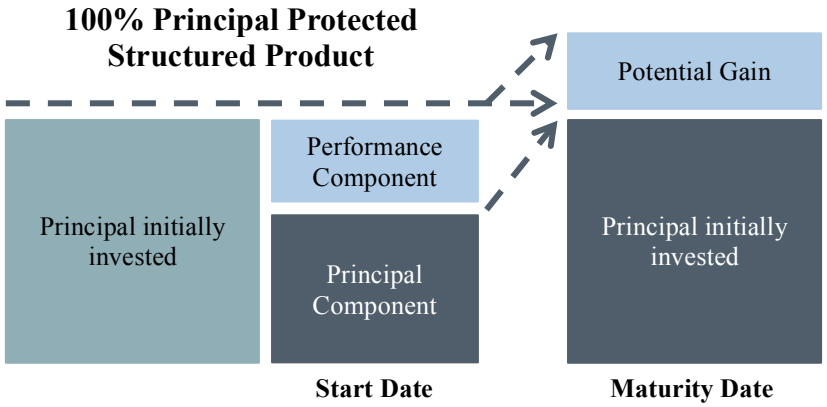
Then, we will display an illustrative example to simulate the creation of a Structured Product.

Construction of a Structured Product: A Structured Product is a combination of financial products that associate potential performance with risk management. We have two essential components, a bond component and a derivative component.

The bond component: The bond component has a capital protection feature, allowing the investor to secure a certain level of capital at maturity.

The derivative component: The derivative component will enable the client to achieve potential returns based on the performance of an Underlying.

We can see on this summary chart below, the evolution of the bond and option derivative components during the life of the product.



The bond component will have a central role in the creation of the product, providing partial or total capital protection at maturity. Indeed, the logic behind the use of this component is to enforce that, we want to receive 100% of our initial investment at maturity. Depending on the bonds we choose, the associated interest rate will enable us to determine the amount to be invested today, generating a discount factor.

The following reasoning is applied, what amount should be placed at an interest rate i in order for the investor to receive 100 € in 8years? This is expressed by the formula below.

$VA = \frac{VF}{(1+i)^n}$; with VA as the present value expressed in €, VF as the final value expressed in €, i as the interest rate of the bond expressed in % and n as the maturity.

Illustrative example: Let's assume that we want to invest in a Zero Coupon Bond with a 2% annual interest rate and a maturity of 8years. What is the present value of the bond? According to our formula: VA = 100 / (1 + 2%)^8 = 85.35€. Thus, the client must invest 85.35€ today at an annual rate of 2% in order to receive 100€ in 8years time. This is the first step in the construction of a Structured Product.

In this case, the bond component corresponds to 85.35% of the price of the Structured Product. As the product is sold to the client for 100%, we still have 14.65% (100% - 85.35%) remaining to invest in option derivatives linked to an Underlying, in order to benefit from attractive coupon payments.

We will invest 14.65% in option derivatives, which can be a simple call option to benefit from the positive performance of the Underlying, or a call spread to benefit from a fixed profit. This fixed profit can be both an advantage if the Underlying level at maturity is lower than the cap and a disadvantage if the Underlying level at maturity is higher than the cap.

Types of Option Derivatives: Call Option and Put Option

Options are transferable contracts that give the holder the right, not the obligation, to buy (Call Option) or sell (Put Option) a given quantity of a specific Underlying asset at a predetermined price (Strike); and at a specified maturity date (for European Barriers) or at any time up to the maturity date (for American Barriers).

In exchange for a premium paid by the buyer, the seller of the option agrees to sell or buy the Underlying asset in the event in which the option buyer freely decides to exercise his right.

Types of Option Derivatives: Barrier Options

Also called "dependent path" options (i.e. the value of the option depends on the price of the Underlying during the life of the option). We will highlight two of the Barrier Options that are important in the creation of our Structured Product.

- **A Down-And-In Put Option** has characteristics similar to those of a vanilla Put Option combined with a Knock-In trigger that activates the option in case of a decrease of the Spot below the Knock-In Barrier during the option's life (American Barrier) or at maturity (European Barrier). Additionally, the premium paid by the buyer of the option is significantly lower than that of the vanilla Put.
- **A Call Spread** is a combination of a Long Call and a Short Call; and it represents an alternative to a vanilla Call for investors having a moderately bullish view on the Underlying. Additionally, the premium paid by the buyer of the Call Spread is lower when compared to a vanilla Call.
- **A Digital Call** is a binary option with two possible outcomes: either a fixed gain or a loss of the premium. If the Spot is above the Strike, there will be a fixed gain; otherwise, there is no payout.

4. CASE STUDY ON AUTOCALLABLE PRODUCTS

In its standard form, an Autocallable Product is a Bond that is linked to a risky Underlying and has no fixed maturity. What is referred as the maturity of the autocall is the maximum duration of the product, in case of no Autocall Event.

In recent years, there has been a sharpe increase in the issuance of Autocallable Products. One of the reasons for this increase is the simplicity with which they can be indexed to the other products, acting as market-linked investments that benefit from an early redemption mechanism before the maturity date if certain pre-defined conditions are attained.

Most Autocallable Products display a protection feature (Protection Barrier) so that, if the Autocall Barrier has not been triggered before maturity, the capital is fully protected and the investor receives 100% of the invested capital at maturity, provided that the Underlying closes at or above the Protection Barrier. However, if the Underlying closes below the Protection Barrier, investors will be fully exposed to the downside risk and may suffer heavy losses. Additionally, they can offer a potential coupon linked to the performance of an Underlying, provided that the Underlying is at or above a pre-defined level (Coupon Barrier) on any observation date.

Thus, the best way to decompose an Autocallable Product is to split it into 3 components, two of which the investor is long and one of which the investor is short.

- **Capital Redemption Component:** Long Zero Coupon Bond, the duration of which is dependent on when or if the structure suffers an Autocall Event.

Like other Structured Products, Autocallable Products use a Zero Coupon Bond to provide capital redemption at maturity. However, they do not have a fixed investment term, as they may be redeemed early. Therefore, the value of the Zero Coupon Bond reflects the probability of the product being redeemed early on each observation date.

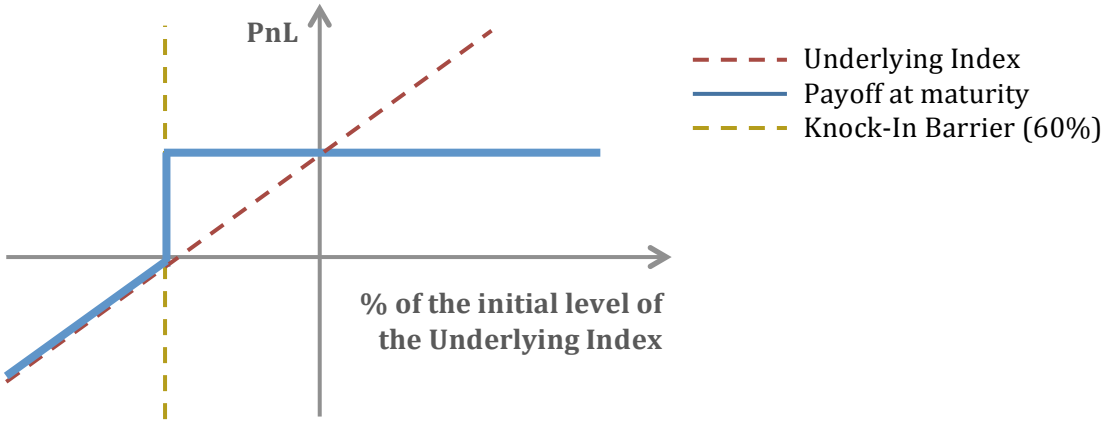
As an example, we will show that the value of a Zero Coupon Bond for a 5Y Autocall can be calculated as the following *(the values used in this example are given for illustrative purposes only, as this is no guarantee as to future returns and has no contractual value):*

Year	Probability of Autocall	Value of ZC Bond	Probability x Value of ZC Bond
1	50%	98.5%	50% x 98.5% = 49.25%
2	10%	97.2%	10% x 97.2% = 9.72%
3	5%	96.0%	5% x 96.0% = 4.80%
4	2%	95.0%	2% x 95.0% = 1.90%

5	33%	94.0%	33% x 94.0% = 31.02%
Total Value of ZC Bond = 49.25% + 9.72% + 4.80% + 1.90% + 31.02% = 96.69%			

- **Equity Risk Component:** Short Down-And-In Put (see graph below), which gives the investor, some downside risk. The downside risk disappears in the event of an autocall.

Selling a Down-And-In-Put



The premium received from the sale of the Down-And-In Put Option will be used to finance the purchase of Digital Options (Reward Component). Besides, the capital risk premium is received based on accepting some downside risk. If the Underlying is below the Protection Barrier at maturity, the investor will accept a 1:1 capital loss.

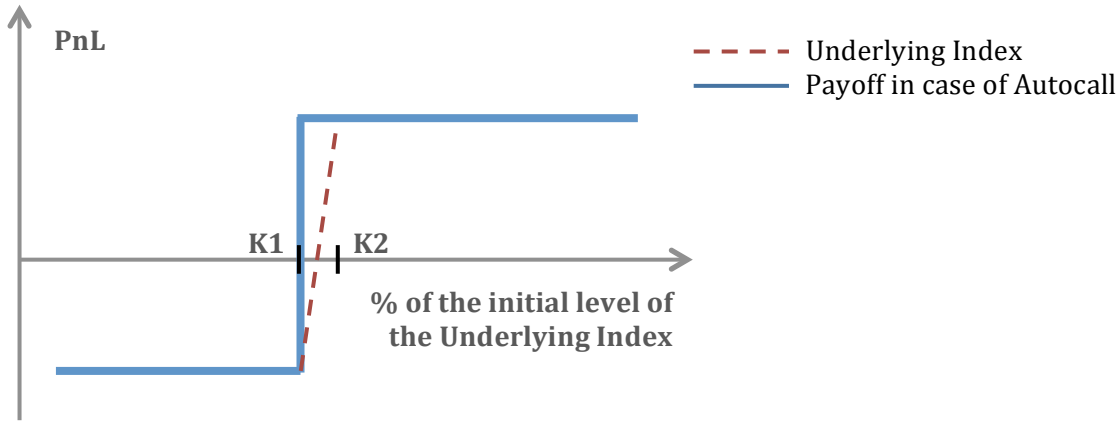
The premium received is combined with the Zero Coupon Bond discount in order to boost the potential reward. Therefore, a higher Protection Barrier provides a higher capital risk premium, which enables a greater potential reward.

Additionally, the short ATM Down-And-In Put will offer some capital protection when compared to a short ATM Put. Assuming a Strike of 100% and a Knock-In Barrier of 60%, if we sell a Vanilla Put, we will be exposed to a linear loss if the Underlying is below the Strike (100%) at maturity. On the other hand, if we sell a Down-And-In Put, we will only be exposed to a 1:1 loss if the Underlying is below the Knock-In Barrier (60%) at maturity; benefiting from 100% capital redemption if the Underlying is between the Knock-In Barrier

(60%) and the Strike (100%).

- **Reward Component:** Long Digital Call (see graph below), translated in a long position on a strip of escalating coupons, payment of which are contingent on the Underlying being at above the Autocall Barrier. We have seen in the introductory section to Structure Products that Digital Options are binary options that pay a pre-defined coupon if the condition is met; otherwise, the investor receives nothing.

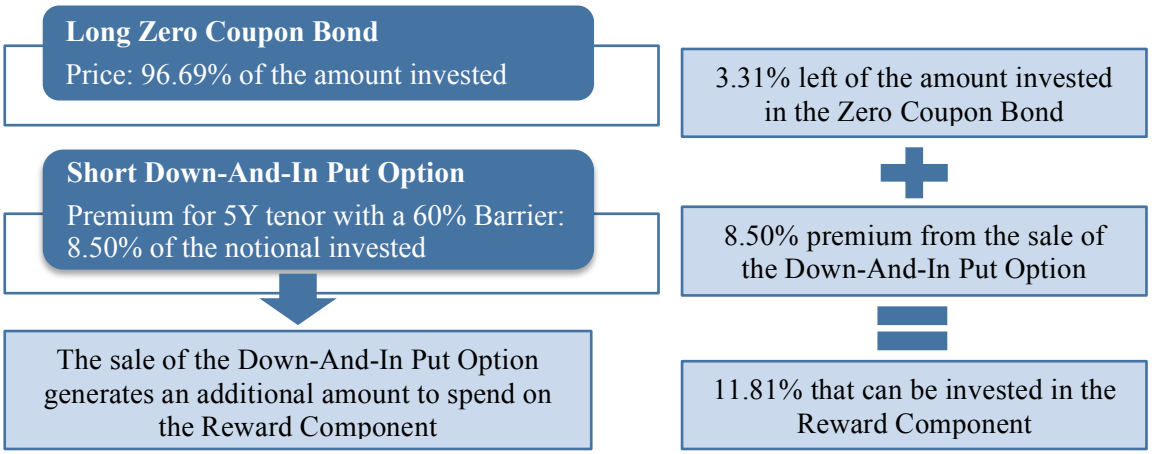
Buying a Digital Call



We will construct a proxy for a long Digital Call Option using a long Call Spread with Strikes close to each other, with the lower Strike (K1) equal to 100% and the higher Strike (K2) above 100%. As described in the introductory section to Structured Products, a Long position in a Call Spread is translated in the simultaneous purchase of a Call Option with the lower Strike (K1) and the sale of a Call Option with the highest Strike (K2).

Hence, the premium paid for the Long Call Spread will be lower than the premium needed to purchase a Long Call with the same parameters; and therefore, we can finance it through the sale of the Down-And-In Put mentioned above.

Accordingly, the difference between the Face Value of the Zero Coupon Bond and the discount price and the Put Option premium provide the amount available to invest in the Reward Component, as we can see from the illustrative example below:



The values of each of these components are dependent on the prevailing implied volatility, interest rates and dividend expectations.

Several observation dates within the product's life are pre-defined in the contract, typically on an annual or semi-annual basis. At each observation date, if the value of the Underlying is at or above the Autocall Barrier, the Note will redeem 100% of the capital at maturity, along with a coupon payment. The pre-defined Autocall Barrier is often defined as the initial level of the Underlying at inception.

If there is no early redemption, the Note continues until the next observation date, in which we have again, the possibility of an Autocall Event, and so on, until maturity.

Autocallable Structured Products provide a pickup in the Underlying in case of a stable to slightly bullish market, allowing the investor to receive potential annual coupons and benefit from an early redemption mechanism.

In this case study, we will place ourselves in the side of a financial institution and we will pitch an Autocallable Product with tailor-made features to an institutional investor, designed to meet its requirements in order to enhance his returns via Structured Products.

Therefore, we will have the following steps. First, we will analyse the client's prerequisites that must be taken into account in the creation of the product. For a simplification purpose, only the essential parameters will be presented, and the additional features will be for

illustrative purposes only. Successively, we will present the details and the mechanism of the product as well as the innovative features that we are proposing. Finally, we will create an illustrative scenario analysis in order to show the possible outcomes for a bullish, neutral and bearish market; and also, simulate historical data through backtesting to see how the product would have behaved if it was launched in the past.

The pre-defined details imposed by the client must be respected in the creation of the product; namely, maturity, capital protection, autocallability and minimum coupon.
Lets assume that the client has the following requirements:

Maturity	6 years max
Capital Protection	Up to a certain Protection Barrier
Autocallability	Yes
Maturity Scenario	100% indexed to the performance of the Underlying
Minimum coupon	2% per year elapsed
Performance Engine	European Equity Market

With the information provided by the client in this fictitious scenario, we will now construct a Structured Product that takes into account his needs.

Accordingly, we will present a 5Y Double Phoenix Memory on the Euro iSTOXX EWC 50 Index. An innovative product that provides investors with exposure to the Euro iSTOXX EWC 50 Index, an equally weighted index that consists of the same 50 stocks of the Eurostoxx 50 Index, the leading index in the Eurozone.

In the first part of the year, both Eurozone Equities and the EUR have been driven by improving cyclical momentum in the euro area. The correlation between the EUR and

Eurozone equities has reverted to normal, as Eurozone risk normalised: a stronger EUR has been a headwind for Eurozone Equities. Additionally, although the Fed is far ahead from the ECB, with few rate hikes on the pipe for next year, we are not expecting the ECB to start rising rates just yet, meaning that, yields will remain at low levels for the next 2 to 3years. Thus, we are expecting an additional downside on US Equities, and so, given the current macroeconomic environment, we prefer European Equities, benefiting from a slightly bullish view on the Underlying, with a limited upside.

First things said, Structured Product solutions offering high coupon payments still remain more attractive than investing directly in equities, due to its riskiness; and investing directly in bonds, due to the current low yield environment.

We will now compare the Underlying Index that was chosen for this specific request with the Eurostoxx 50 Index. Our client already has his own portfolio invested in European and US Equities, namely, Eurostoxx 50 Index, CAC 40 Index, FTSE 100 Index and S&P 500 Index. Moreover, in order to still benefit from Eurozone Equities while innovating in the weighting mechanism, we have decided to propose a product in which the Underlying Index is the Euro iSTOXX EWC 50 Index.

Comparison with the Eurostoxx 50 Index:

- **Similar investment universe:** The composition of the Euro iSTOXX EWC 50 Index is similar to that of the Eurostoxx 50 Index and uses the same rigorous selection criteria such as high liquidity and high market capitalisation.
- **A different component weighting strategy:** Unlike the Eurostoxx 50 Index where the components are weighted according to market capitalisation, the Euro iSTOXX EWC 50

Index applies the same weight to all of its components. Thus, each stock represents 2% of the total weight of the Index on each rebalancing date.

- **A fixed annual dividend removed each year:** Unlike the Eurostoxx 50 Index (Price Return Index), the Euro iSTOXX EWC 50 Index reinvests 100% of dividends paid by companies within the index and removes a fixed and steady annual dividend of 50 points.

Why the Euro iSTOXX EWC 50 Index instead of the Eurostoxx 50 Index?

The Euro iSTOXX EWC 50 Index applies an equally weighted mechanism and consists of the 50 stocks of the Eurostoxx 50 Index. The composition of the Index is reviewed on a quarterly basis, following the same rigorous selection criteria of the Eurostoxx 50 Index.

Consequently, our analysis will have 3 different focuses: limits of market capitalisation weighting, impact of removing a fixed dividend and similar performance when compared to the Eurostoxx 50 Index. We will explore each condition in more detail below.

Limits of market capitalisation weighting:

Why equally weighting instead of market capitalisation weighting? *" (...) There are a couple of reasons why an equal weight index outperforms market cap indices. For one thing, there is a higher weighting to small-cap and value stocks. These have historically outperformed growth and large-cap stocks over time. Another reason has to do with rebalancing. (...) When the portfolio is rebalanced back to an equal weighting, you will be selling one stock at a high price and buying more of the other at a low price. In other words, it forces you to buy low and sell high, the most basic rule of investing"* Pham, Peter. 29th March 2016. Forbes.

We will now focus on the 2 major limits of market capitalisation weighting when compared to equally weighting:

- **Risk of trend following:** With the market capitalisation weighting, the investment is skewed towards stocks with the largest market caps rather than to those with the smallest market caps. As a result, an index applying a market capitalisation weighting will be primarily made up of "expensive" stocks and underweight "value" stocks.
- **Risk of concentration on the largest market capitalisation stocks:** The profit or loss reported by the Eurostoxx 50 Index is concentrated in a small number of stocks. For example, the 10 companies with the largest market cap represent around 37% of the total weight of the index (source: Bloomberg, as of December 2017).

Impact of removing a fixed dividend:

Why don't we remove the dividends like in the Eurostoxx 50 Price Return Index?

Over the past few years, the issuance volume of Structured Products indexed to the Eurostoxx 50 Index has been high (82,784 in 2015 vs 31,526 in 2016). This structural flow has impacted the implied long-term dividends in the past, pushing them to lower levels. Therefore, this has led to an increase in hedging prices of Structured Products indexed to the Eurostoxx 50 Index. As it is expected a pick up in dividends for European companies in the next few years, we must see this as an opportunity to invest in the index.

In order to improve the price of the proposed payoffs, the Euro iSTOXX EWC 50 Index invents 100% of the dividends paid by companies within the Index and removes a fixed annual dividend of 50 points.

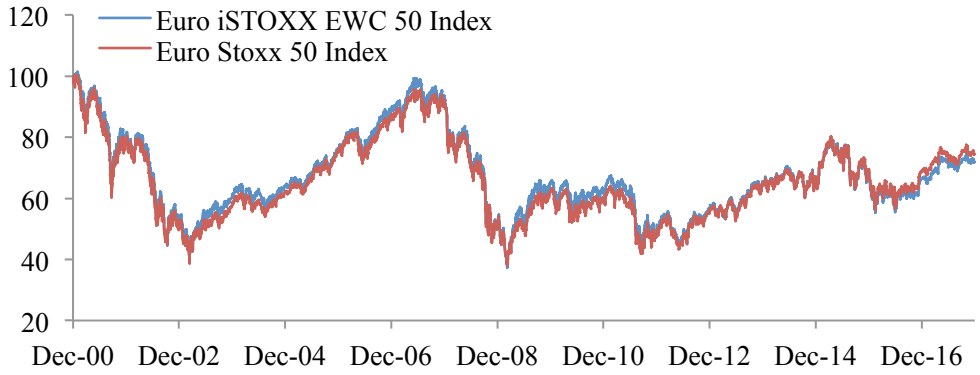
On one hand, if the gross dividends paid by companies within the Index are lower than the actually fixed dividend of 50 points, the performance of the Euro iSTOXX EWC 50 Index will be reduced by the difference between the level of the fixed dividend and the real gross dividends paid by companies. On the other hand, if the gross dividends paid by companies within the Index are higher than the annual fixed dividend of 50 points, the performance of

the Euro iSTOXX EWC 50 Index will be improved by the difference between the level of the fixed dividend and the real gross dividends paid by companies.

Similar performance when compared to the Eurostoxx 50 Index:

The Euro iSTOXX EWC 50 Index has been launched on the 19th November 2014 at an initial level of 1000 points. All data prior to this date were systematically simulated on historically market data to replicate the performance of the Index, as if it has been launched in the past. *The comparisons shown below are for illustrative purposes only, as they are not indicative for the future performances of the Index.*

We will now show the performances of the Index vs the Eurostoxx 50 Index during the last 17 years (see graph below – source: Bloomberg, as of 26th December 2017). As we can see, the indices display a high correlation with each other.



After years of downgrades, European companies are expected to benefit from a sharp rise in dividends in the coming years. Additionally, a similar product on the Eurostoxx 50 Index would display an Autocall Coupon of 5%, significantly lower than the Autocall Coupon of 7.80% presented in our product, with the Euro iSTOXX EWC 50 Index as Underlying. As so, we proposed innovative terms for the Underlying, considering several reasons that will be explained in the product mechanism below.

Product mechanism:

This product is designed for investors with a neutral to slightly bullish view on the Underlying, and therefore, they will benefit from the following characteristics:

- **Annual Autocall Feature:** If the Underlying Index closes at or above the Autocall Barrier, the product is redeemed early and the investor will receive 100% plus an annual coupon up to 7.80% per year elapsed.
- **Annual Memory Coupon:** At the end of each year, if the product is not autocalled, investors will receive an annual coupon of 3.55% if the Underlying Index closes at or above the Coupon Barrier. In addition, investors will recoup any coupons previously missed (i.e. Memory Coupon).
- **Defensive Protection Barrier:** At maturity, investors will redeem at least 100% of their initial investment if the Underlying Index closes at or above the Protection Barrier.

The product mechanism is defined by the following steps:

1) Coupon Payment:

- At the end of each year (including at maturity), if the Underlying Index closes at or above the Coupon Barrier but below the Autocall Barrier, the investor receives:

  Coupon = (3.55% x N) – Sum of coupons already paid

2) Autocall Feature (from year 1 to year 5):

- At the end of each year (including at maturity), if the Underlying Index closes at or above the Autocall Barrier, the product is redeemed early and the investor receives:

  100% of the Invested Capital + (7.80% x N) – Sum of coupons already paid, where N corresponds the number of elapsed years since inception
- Otherwise, the product continues.

3) Redemption at maturity (in case of no Autocall event):

- At maturity, if the Underlying Index closes at or above the Protection Barrier, the investor receives:

  100% of the Invested Capital + ((3.55% x N) – Sum of coupons already paid)

- Otherwise, the investor receives:

  Final Level of the Underlying Index / Initial Level of the Underlying Index

In order to summarise the product mechanism with a breakdown per component, the following table was constructed, displaying the potential gains or losses coming from each of the components:

- **At end of Y1 to Y4**

	Spot < 60%	**60% < Spot < 100%**	**Spot > 100%**
Zero Coupon Bond	-	3.55% p.a	3.55% p.a
Down-And-In Put	+8.50%	+8.50%	+8.50%
Digital Call	-8.50%	-8.50%	7.80% p.a – 3.55% p.a - 8.50%
Final Gain / Loss	No Coupon	3.55% p.a.	7.80% p.a.

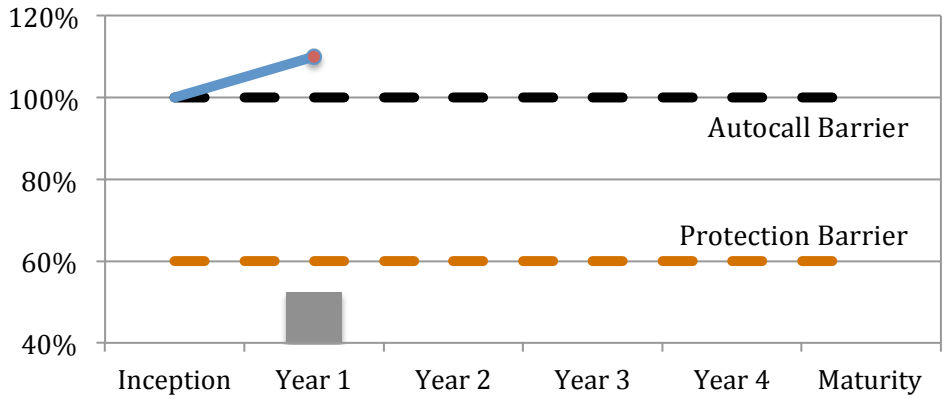
- **At end of Y5** (in a case where the Payoff < 60%, we will assume a Spot = 50%)

	Spot < 60%	**60% < Spot < 100%**	**Spot > 100%**
Zero Coupon Bond	100%	100% + 3.55 p.a	100% + 3.55 p.a
Down-And-In Put	-50% + 8.50%	+8.50%	+8.50%
Digital Call	-8.50%	-8.50%	7.80% p.a – 3.55% p.a - 8.50%
Final Gain / Loss	50% of Capital	100% of Capital + 3.55% p.a	100% of Capital + 7.80% p.a

After the creation of the Structured Product, backtesting simulations and scenario analysis are essential steps for the client. The product backtest includes historical simulations of the Underlying Index track to study the scenarios that could have occurred if the product had been launched daily since that day.

The scenario analysis corresponds to illustrative scenarios that could occur during the life of the product under a bullish, neutral or bearish macroeconomic environment. We will present illustrative examples for 3 different scenarios corresponding to a bearish, a neutral and a bullish market. *The figures used in these examples are given for purely indicative purposes, as the objective is to describe the mechanism of the product.* This will provide a better understanding on how the product would have behaved in different market stages over previous years, but it is no guarantee of future returns and has no contractual value.

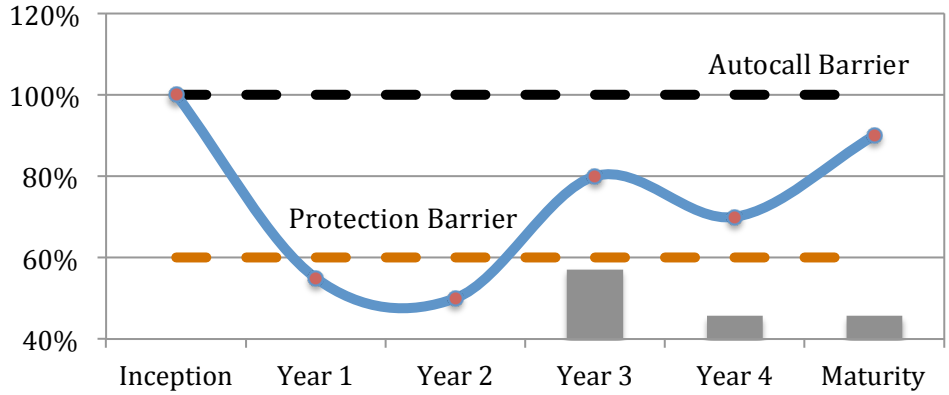
Scenario 1: Bullish Market



- Autocall occurs on Y1. At the end of Y1, the Underlying Index closed above the Autocall Barrier, 110% of its initial level, the product is redeemed early and the investor receives:

  100% + 7.80% = 107.80% (corresponding IRR of 7.80%)

Scenario 2: Neutral Market

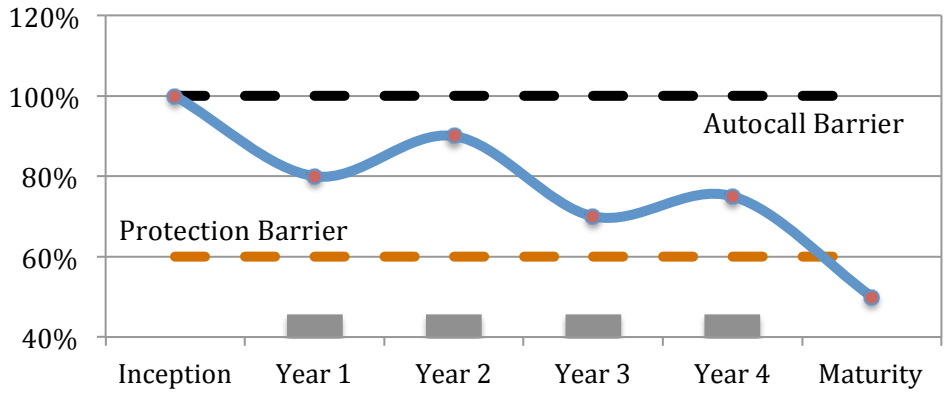


- No Autocall occurs until maturity. From Y1 to Y2, the Underlying Index close below the Coupon Barrier so no Autocall occurs and no coupon is paid.

- At the end of Y3, the Underlying Index closed above the Coupon Barrier, the investor receives: **Coupon = 3 x 3.55% = 10.65% p.a.**
- At the end of Y4, the Underlying Index closed above the Coupon Barrier, the investor receives: **Coupon = 3.55%**
- At maturity, the Underlying Index closed above the Coupon Barrier, 90% of its initial level, the investor receives:

  100% + 3.55% = 103.55% (corresponding IRR of 3.47%)

Scenario 3: Bearish Market



- No Autocall occurs until maturity. From Y1 to Y4, the Underlying Index closed above the Coupon Barrier, the investor receives: **Coupon = 3.55% p.a.**
- At maturity, the Underlying Index closed below the Protection Barrier, 50% of its initial level, the investor receives:

  50% of the Invested Capital (corresponding IRR of -9.35%)

Moreover, after analysing the product mechanism and the scenario analysis, we can conclude that the investor might benefit from the following features:

- A potential early redemption with an enhanced annual coupon of 7.80% if the Underlying Index closes at or above the Autocall Barrier on any annual observation date.
- A potential memory coupon of 3.55% p.a. if the Underlying Index closes below the Autocall Barrier but at or above the Coupon Barrier on any annual observation date.

- 100% capital redemption at maturity if the Underlying Index closes at or above the Protection Barrier.

Consequently, there are also risks associated to this product, namely:

- Risk of capital loss: This product includes a risk of capital loss. The redemption value may be less than the amount invested. In a worst case scenario, investors could sustain the loss of their entire investment.
- Due to the early redemption mechanism, investors do not know in advance the exact investment period.
- No participation on the upside of the Underlying Index: If the Underlying Index increases exponentially at maturity, the investor will not have exposure to the performance increase. In this case, investors will be capped on the amount of the Autocall Coupon (7.80%).
- Credit Risk: The investor will be exposed to the Credit Risk of the Bank, as the issuer of the product. Hence, the Bank's insolvency may result in the partial or total loss of the invested amount.
- Bond Risk: As we are using a Bond of the Bank to construct the product structure, the product is subject to a default risk that can be measured between the spread of a Bank Bond and a German Bond with the same features.

After the scenario analysis, it is therefore necessary to produce a numerical study on the potential gain, guarantee and early repayment of the product. In order to compute our backtesting, we have used the values of the Underlying Index since 29th December 2000, being able to simulate a product launch on that exact date.

In order to create a backtesting file, we have to include an amount of data that corresponds to the double of the maturity of the product; in this case, as it is a 5year maturity product, we will need to include at least 10 years of data for the Underlying Index. Then, as the

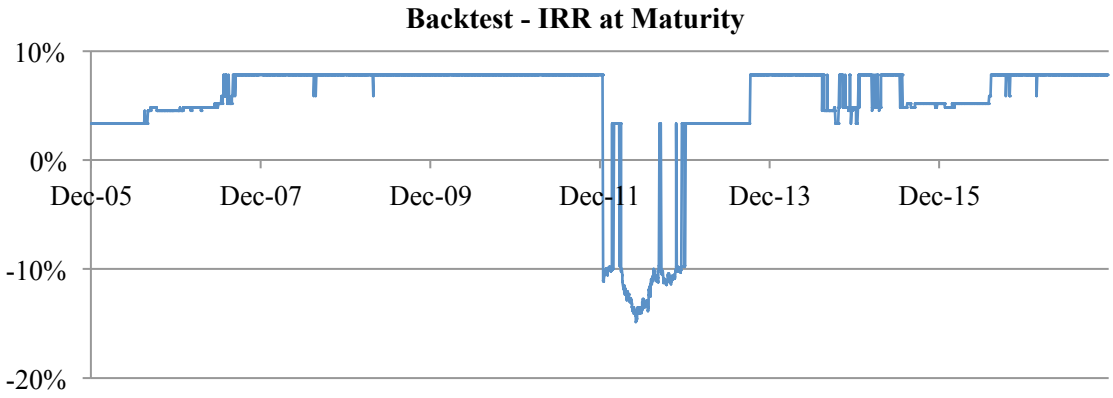
observation dates are annual, we need to go through each start date of a product and retrieve the payoff each year after launch, over the next 5 years. Then, we will set up tests on the payoff tracks in order to observe whether there would have been an early repayment; or, in case the product runs until maturity, if the client would have had a gain or a loss at maturity, as well as the value of the capital redemption.

To test how the product behaved on each annual observation date, we will just observe if the performance of the Underlying Index is at or above the Autocall Barrier. If the performance of the Underlying Index is greater than or equal to 100%, the product is redeemed early and the investor will have 100% capital redemption plus a gain of 7.80% per year. If the performance of the Underlying Index is below the Autocall Barrier but at or above the Coupon Barrier, the product will not be redeemed early but the investor will receive a coupon payment of 3.55% p.a. (the investor will recoup any previously missed coupons). Consequently, if the performance of the Underlying Index is below the Coupon Barrier no coupon is paid. At maturity, the test can be broken down into 3 stages:

- Check that the product has not already been subject to early redemption in any of the previous annual observation dates
- If the product has not been redeemed, calculate the performance of the Underlying Index between its final level and its initial level
    - If the performance of the Underlying Index is positive, the investor receives 100% of the invested capital as well as the Final Coupon
    - If the performance is negative, the investor still receives 100% of the invested capital if the performance of Underlying Index is at or above the Protection Barrier. Otherwise, the full capital invested is at risk
- If the product has been redeemed early, then there will be no refund at maturity.

Thus, for each scenario, we will calculate the payoff at maturity and the corresponding IRR (the annual average rate of the investment). As we can see from the graph below, the product behaves correctly during the period that was analysed, having significant drawdowns in the final payoff between the periods of March 2012 and December 2012. The average IRR is 5.25%, the high value is justified by the riskiness of the product.

Although investors benefit from a defensive Protection Barrier (60% of the initial level of the Underlying Index), if the Underlying Index is below the Protection Barrier at maturity, the full capital will be at risk. The highest IRR value is 7.80%, corresponding to an Autocall Event in year 1, in which the product will be redeemed early and automatically ends. Consequently, the lowest IRR value is -14.88%, achieved in June 2012, which reflected the worst period of the European Sovereign crisis.



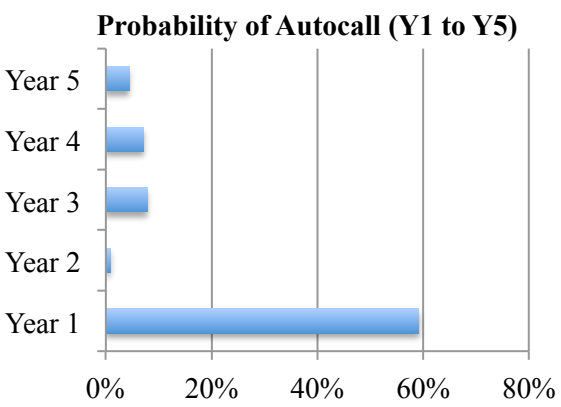
When computing a backtest, we are mainly interested in the probabilities of autocall per year, under the condition that the Underlying Index is at or above the Autocall Barrier (100% of its initial level).

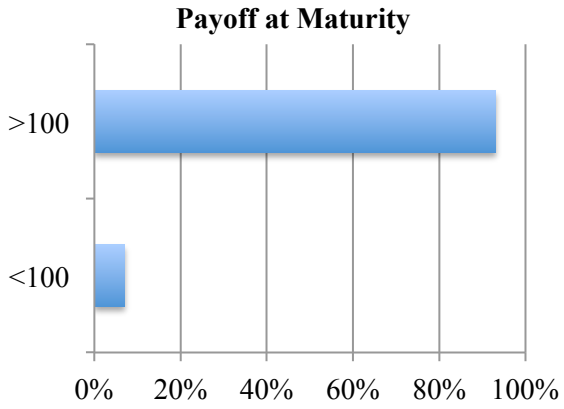
The IRR is a very important indicator that will help the client to compare rates of return with traditional products in order to check whether the Structured Product performed well or not.

As we can see from the graph below (left hand side), there is a 59.17% that the product benefits from an Autocall Event in year 1, with a corresponding maximum IRR of 7.80%.

Additionally, we can conclude that there is a 79.52% probability that the product is autocalled between year 1 and year 5, meaning that, the payoff at maturity will be equal or higher than 100%; and consequently, only 20.48% probability that the product is not autocalled.

From the graph below (right hand side), we can conclude that there is a 92.98% probability that the payoff at maturity is above 100%, including both the Autocall Events and the Underlying Index closing at or above the Protection Barrier, in which there will be a 100% capital redemption. On the other hand, there is a 7.02% probability that the payoff at maturity is lower than 100%, which includes the case when the Underlying Index closes below the Protection Barrier, and therefore, the full capital is at risk.





Through the computation of the backtest, we can highlight that this product is able to offer a very good performance, while guaranteeing 100% capital at maturity in 92.98% of the cases. In recent years, investors all over the world have been seeking new investment opportunities that offer attractive return; and therefore, differ from traditional investments, that are no longer profitable and offer a compensation of less than 1% per year. Thus, a complex and tailor-made structure that still gives exposure to traditional equities but at same time provides an interesting potential gain and some downside protection for investors, appears as a more attractive alternative. On the other hand, risk averse investors can benefit from 100% capital protected solutions that still offer interesting returns while reducing the risk of capital loss.

5. CONCLUSION

On this case study, we have highlighted that Structured Products could offer plenty of tailor-made solutions, due to the numerous features of the option derivatives component. As so, they appear as attractive financial solutions, with repayment payouts adapted to each risk profile.

On the other hand, the fact that interest rates are at historical lows is becoming a problem, as a substantially high percentage on the composition of Structured Products comes from the bond component. Thus, the lower the interest rate, the more expensive is the bond, and consequently, the less money we have to invest in option derivatives in order to boost returns. As a result, it is becoming increasingly difficult for financial institutions to present solutions as attractive as before.

Additionally, low volatility and liquidity withdrawal are key concerns. In a goldilocks scenario of low interest rates, abundant liquidity, stable growth and a focus on the "positive" Trump reforms, investors continue to push asset prices, volatility and leverage to historical extremes. Yet, a low volatility environment combined with an extreme short positioning in VIX is a dangerous combination.

Volatility remains low across asset classes, on the edge of further monetary policy normalisation; and it seems that markets for now are unwilling to recognise the gathering threats. Thus, this is not sustainable; and additional rate hikes from the Fed over the next two years should start putting pressure on the VIX, as it happened before, with damaging effects across asset classes. As a solution, there are many hedging solutions that can be explored, namely, a long position on VIX Futures in order to keep investors protected against a market collapse.

6. APPENDIX

Recommendation Letter from the Line Manager: Feedback from the internship

Bruna Palma Ribeiro - Employee Appraisal

Bruna has been working within the Engineering Team at Societe Generale as a Structured Product Marketer since the 5th June 2017. Her day to day role generally consists of creating product pitches designed to describe, inform and highlight the key elements for the various products we issue. A successful marketer must be able to combine the technical expertise and understanding of derivative products and finance with the commercial skills necessary to clearly explain and sell such products.

Bruna has delivered all of the above skills and more. Since joining, she has developed into an integral member of the team. She is well respected and trusted within the team as well as more broadly across the entire floor. Her willingness to learn, develop and get involved with new projects has allowed her to develop a core client base of sales and engineers with whom she is now one of the core marketing contacts.

Within our team we pride ourselves on being able to develop and nurture our interns to work autonomously and independently. We view them as full time employees and not interns. Bruna has thrived under this structure and the quality of her work allows us rely her for all of our day to day needs. She meets her deadlines, produces high quality work and has the hunger to learn.

In the past 6 months, Bruna has shown that she has the ability to convey technical messages and mechanisms in simple and understandable marketing documents. She seems to enjoy keeping up to date with the latest news and research which she is able to transfer and adapt in order to complement her marketing pitches.

Whilst Bruna has been hugely successful since starting here, her development is ongoing. As you might expect, different sales and clients require certain requirements which can only be learnt over time. This is one area that we expect to see her continue to improve as her internship continues. One additional area of improvement that has been highlighted in Bruna's recent review is her ability to organize and more importantly prioritise projects. Again, this comes with experience and time. If she can develop the confidence to question and push back on requests to i) fully understand what is needed and ii) formalize the deadline of such projects, I think this is something that can easily be learnt.

Since starting within the team, Bruna has been able to gain exposure to a wide number of products and has worked on a significant number of projects. To give some context, despite not being the most senior, Bruna has contributed to more presentations than any other intern since joining.

She has worked on a vast array of interest rate hedging strategies, targeting European institutional investors, as well as a number of business trip pitch books for use in Russia, Poland, Czech Republic, Ireland, Middle East and the U.K..

Given the core subject of Bruna's thesis, we have tried to involve her as much as possible with the extensive Autocall offer we provide. This has included the production of generic tutorials, full product pitch books, market research on product issuance as well as the creation of automated back testing files. Bruna has worked on our most basic Autocall products, as well as some of our newest and most innovative Autocall solutions (at least 15 variations).

Overall, we have been very pleased with Bruna since she started here and her greatest attribute is her dedication to work, which really is second to none. She is a pleasure to work with, both professionally and in terms of how she interacts with the rest of the team. We have seen her develop and grow since joining, particularly in terms of her product knowledge, and we look forward to seeing her continue to adapt to meet the requirements of different sales, clients and regions.

Daniel Needham
Societe Generale Engineering Department
Product Marketing